Invertebrate Responses to Eelgrass and Oyster Restoration in a San Francisco Estuary Living Shorelines Project

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This research was conducted to monitor the response of aquatic macroinvertebrate populations to the restoration of intertidal habitat, including eelgrass (*Zostera marina*) and native oyster reefs (*Ostrea lurida*) in the San Francisco Estuary. Plots of each habitat-forming species, alone and interspersed, were established in 2012 and 2013 by the State Coastal Conservancy's Living Shorelines: Nearshore Linkages project (LSP). Living shorelines have been used throughout the world to reduce physical impacts on shorelines (e.g., increased wave action from storm surges and sea level rise), while simultaneously providing habitat to intertidal invertebrate and fish species. The LSP was the first project in the Estuary to implement restoration of eelgrass and oyster reef at a scale large enough (30m x 10m plots) to quantify both biological and physical results. Quarterly invertebrate and fish monitoring was conducted in the restoration plots for one year prior to restoration (2011-12), and for two years post restoration (2012-15), using a series of traps, shoot collection, and vacuum sampling. The results from the trapping and suction sampling were intended to inform the degree to which restored eelgrass and oyster reef habitat, alone and together, promote colonization and use by invertebrates. The results from the shoot sampling were intended to determine if epiphytic invertebrate assemblages vary significantly between natural and restored eelgrass beds in the Estuary. Within two years, correspondence analysis revealed that eelgrass and oyster reef supported a unique invertebrate assemblage composition as compared to baseline and control plots, and that the composition was intermediate in combined eelgrass/oyster plots. Restored eelgrass has not established an assemblage equivalent to natural beds; several invertebrates beneficial to eelgrass growth are absent. We conclude that habitat structure provided through restoration will quickly support many invertebrate species, but some may require manual addition to provide the full range of natural functions.

Keywords: living shorelines, eelgrass, oyster, intertidal, restoration, invertebrates, *Zostera marina*

Poster Topic: Living Shorelines Project

Avian Predator and Invertebrate Prey Response to Subtidal Restoration Efforts: Living Shorelines Near-shore Linkages Project 2011-2015

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The San Francisco Bay Living Shorelines Near-shore Linkages Project is a multi-objective habitat restoration pilot project with the overarching goal to create biologically rich and diverse subtidal and low intertidal habitats, including eelgrass and oyster reefs, as part of a self-sustaining estuary system that restores ecological function and is resilient to changing environmental conditions. Using an experimental approach we established native oyster, eelgrass, eelgrass and oyster, and control treatments at a site in San Rafael. The USGS Western Ecological Research Center, San Francisco Bay Estuary Field Station conducted one year of avian and benthic invertebrate pre-installation (Nov 2011 – April 2012) and three years of post-installation (September – April 2012 – 2015) monitoring. Our primary objective was to determine species and guild specific responses to restored habitat relative to control areas and pre-installation conditions using a Before-After Control-Impact (BACI) design. Oyster reefs appeared to influence avian diversity and species richness, as densities of some avian species increased at treatment plots in comparison to pre-installation and control densities. Black Oystercatchers, Forster's Terns, dabbling ducks and wading birds used oyster reefs at low tide; some species, including oystercatchers, used them primarily for foraging. Preliminary analyses suggest that Living Shoreline treatments have influenced density, richness and biomass of benthic invertebrates. The oyster treatments appeared to have a positive effect on amphipod density, while eelgrass treatments benefited polychaete density. Our results suggest that some avian and invertebrate species are responding positively to established oyster and eelgrass habitat restoration. Repeating this experiment at additional sites and continued long-term monitoring of these habitats will be important for understanding species responses to living shoreline restoration methodologies.

Keywords: Living Shoreline, oystercatcher, invertebrates, shorebirds, restoration, waterfowl, wading birds

Poster Topic: Living Shorelines Project

Invertebrates Isotopic Niche Widths and Trophic Relationships in a San Francisco Bay Living Shorelines Project

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Disentangling trophic interactions can provide an understanding of restored ecosystems beyond structural monitoring, contributing critical information for assessing functionality of restoration projects. The San Francisco Bay Living Shorelines Project is a pilot ecological restoration study aimed at answering key questions about the individual and interactive effects of eelgrass plantings (*Zostera marina*) and native Olympia oyster beds (*Ostrea lurida*), and their potential to act as an adaptation method to climate change. We used natural abundance stable isotopes (SI), including ^{13}C, ^{15}N and ^{34}S, as a way to 1) identify the main organic matter sources fueling food webs in different restoration treatments (either eelgrass, oyster reefs or together), 2) characterize the diet of consumers for which they provide habitat, and 3) compare the isotopic niche widths of those recently established invertebrate communities. Roughly 1.5 years after project construction, the potential autochthonous and allochthonous sources of organic matter were collected in May, June and July 2014 to account for any short-term variability in their signatures and for potentially different tissue turnover rates in the consumers, which were collected in July. Primary food sources supporting invertebrates in the eelgrass habitat included eelgrass tissue itself and epiphytes (*Ampithoe valida*), particulate matter (Bryozoa) and macroalgae (*Corophiidae*). Community-wide isotopic niche metrics suggested a greater degree of trophic diversity, more trophic levels and increased trophic redundancy in the oyster and combination plots. At this stage of the restoration process, while little or no differences were observed in individual species SI composition between the eelgrass or oysters only and "combination" treatments, the oyster reefs appear to add some variety and complexity in trophic linkages, associated with higher species richness. With this baseline study for comparison, future "isotopic" monitoring events should allow us to capture potential changes in trophic structure as the restored habitats mature and new species eventually establish.

Keywords: food web, stable isotopes, eelgrass, oyster, restoration

Poster Topic: Living Shorelines Project

Effects of Living Shorelines on Substrate, Sedimentation, and Waves: the San Francisco Bay Living Shorelines Near-shore Linkages Project

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The San Francisco Bay Living Shorelines: Near-shore Linkages Project is a multi-objective habitat restoration pilot project managed by the State Coastal Conservancy, in collaboration with scientists with San Francisco State University, University of California, Davis, USGS Western Ecological Research Center, and consultants at ESA. The goal of the project is to create biologically rich and diverse subtidal and low intertidal habitats, including eelgrass and oyster reefs, as part of a self-sustaining estuary system that restores ecological function and is resilient to changing environmental conditions. While not a new concept, Living Shorelines projects are new to San Francisco Bay. The San Francisco Bay Living Shorelines project was constructed in July-August 2012. This poster presents three years of physical processes monitoring data for the project, as part of a five-year monitoring program.

Waves, currents, sedimentation/erosion, and substrate composition are monitored at four experimental 32 m x 10 m plots in San Rafael Bay. Turbidity of the water column is also measured. The plots consist of an oyster reef, an eelgrass planting, a combination of oyster-eelgrass elements, and a control plot of native mudflat. Wave and current monitoring instruments were deployed to provide data for a wave model that examines wave attenuation by the reef structures. Sedimentation rates and substrate stability were calculated from high-resolution topographic surveys of the bed. The wave model and sedimentation rates provide guidance for future designs of reefs on how they attenuate waves and impact sediment trapping.

Keywords: Living Shorelines, Oyster, Wave Attenuation, Mudflat, San Francisco Bay, Sedimentation

Poster Topic: Living Shorelines Project

Community Creek Cleanups

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Over the past year, Keep Coyote Creek Beautiful has hosted a dozen cleanups with an average of 100 volunteers each to remove over 40 tons of trash from Coyote Creek. Participants range from 8-year-old Girl Scouts to seniors from the Vietnamese-American neighborhood group. Students from K-12 and colleges have all pitched in to "make new friends and getting the satisfaction of cleaning the creek". Volunteers come out repeatedly because the "most rewarding part is knowing that I made the creek slightly cleaner". We've hauled out legacy trash that has been in the creek for 30 years or more and trash from homeless people who cannot afford to live in Silicon Valley. This poster will highlight the successes from the cleanups and the myriad of partners who make these events happen to cleanup Coyote Creek.

Keywords: creek cleanups, volunteers, trash

Poster Topic: Partnerships for a Healthy Coyote Creek

Ebb and Flow: Connecting Creek and Curriculum at SJSU

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Over the past academic year, faculty and students at San Jose State University (SJSU) put energy into Coyote Creek as a focal point for academic endeavors. Students from advertising and journalism created articles, videos, and social media tools to help people learn more about and to participate in improving Coyote Creek. A climate action project focused taught students how to communicate the message of volunteering to heal the creek through incentives in partnership with local sports teams. SJSU hosted the Coyote Creek Howl conference in April, and faculty and students created the public relations for the conference, and developed and moderated sessions. A public, interactive ensemble performance capped off the academic efforts by students pairing homelessness and the creek. Also, students came out in force to the creek cleanups, including volunteering as photographers. This collaboration between the university and community groups continues to expand into the next academic year.

Keywords: university, curriculum, education, students

Poster Topic: Partnerships for a Healthy Coyote Creek

Coyote Creek Mural Project

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In April 2015, children and adults from Olinder Elementary School in San Jose and neighbors came out to unveil the Coyote Creek Mural. Olinder School is adjacent to Coyote Creek, so the creek was the inspiration for the mural. Through a collaboration between the City of San Jose's Clean Creeks, Healthy Communities project, CommUniverCity San Jose, the school and the surrounding communities not only determined the content of the mural, but also painted it back in December. One boy at the unveiling commented that he "painted the beaver and it looks so good". By participating in the process from design to implementation, the community takes pride and ownership over the mural and will continue to value this beautiful art as a reflection of their neighborhood. The mural also impacts the residents and visitors to the park who may have been unaware of the creek and the importance of the watershed.

Keywords: mural, school, neighborhood, creek community

Poster Topic: Partnerships for a Healthy Coyote Creek

Beautifying Neighborhoods with Creek-themed Public Art

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Over the course of the past four years, the Clean Creeks, Healthy Communities project in San Jose, CA, has engaged the neighborhoods and schools to take pride in their community. One of the most colorful ways to do so is by painting creek-themed art throughout the various neighborhoods that Coyote Creek winds through. These boxes are inspired by scenes in and around the creek, from water scenes, animals and birds, and people interacting with the creek. These beautiful works of art, designed and painted by professional artists, are available for viewing through a self-guided art walk. This collaboration between the City of San Jose, the neighborhoods, and professional artists reflect the pride of partnerships to beautify communities.

Keywords: art, creek, neighborhood, art walk, San Jose

Poster Topic: Partnerships for a Healthy Coyote Creek

Project Study on Clean Creeks, Healthy Communities

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The Clean Creeks, Healthy Communities (CCHC) project was created to improve water quality in Coyote Creek by preventing and removing trash resulting from littering, illegal dumping, and homeless encampments along the creek. The project area was a three-mile segment of Coyote Creek between Tully Road and Williams Street. This effort, led by the City of San José Environmental Services Department (ESD), partnered with the U.S. Environmental Protection Agency, Santa Clara Valley Water District, Downtown Streets Team, Destination Home, the eBay Foundation, and San José State University's Urban and Regional Planning Department. The project successfully met all of its targets, including removing tons of trash from Coyote Creek and surrounding neighborhoods at numerous cleanups. Also, since the program's inception, staff has participated in or organized 109 outreach events to engage the community with activities such as litter collection, community outreach and public art and reached an estimated 13,417 residents and students with watershed protection and anti-litter messages. A mural and six utility boxes in the project area have been painted with watershed themed images. Structural barriers were erected in five locations within the project area to limit access.

The success of the project will be ultimately measured by its ability to create a tipping point whereby the community is able to maintain the creek with volunteer efforts and deter trash-generating behaviors through passive and active monitoring. By working together, SJSU Urban Planning students and faculty and the City of San José staff learned a lot about the neighborhoods and residents living along the project area of Coyote Creek, such as the language diversity of the neighborhood, and the relative awareness and perceptions of Coyote Creek.

Keywords: creek study, urban planning, university students, neighborhood, trash

Poster Topic: Partnerships for a Healthy Coyote Creek

The Coyote Creek Howl - A Community Conference

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In April 2015, San Jose State University hosted the Coyote Creek Howl, a one-day community conference focused on the ecology and human issues related to the Coyote Creek Watershed, the largest watershed in Santa Clara County. The conference culminated in actions that participants can take to help restore the creek. Attendees joined panelists in discussions about the creek's pollution problems, wildlife struggles and neighborhood concerns. Speakers inspired and motivated the community to work with representative groups to heal the creek. Success stories by agency and community groups identified potential collaboration opportunities. The publicity and published materials for the conference were the result of a SJSU public relations class project. Coyote Creek-inspired student projects were showcased, including art, journalism, advertising, and communication. Many of the 130 attendees, including 50 college students, are now collaborating and learning more about creating healthier South Bay creeks. New connections were forged, and collaborations are gaining momentum.

Keywords: university, conference, students, posters

Poster Topic: Partnerships for a Healthy Coyote Creek

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

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The California Coastal Conservancy and U.S. Fish and Wildlife Service's San Francisco Estuary Invasive *Spartina* Project (ISP) has implemented four years of a five year program to rapidly enhance habitat for California Ridgway's rail (*Rallus o. obsoletus*) in areas affected by the invasion and subsequent removal of non-native *Spartina*. After successful removal of non-native *Spartina,* natural recruitment of some native species has been very successful (e.g., perennial pickleweed, *Salicornia pacifica*). Our program has focused on planting two key components of rail habitat still missing at some sites, marsh gumplant (*Grindelia stricta)* and the native Pacific cordgrass (*Spartina foliosa*). ISP and partners designed and installed plantings that aim to rapidly establish dense, strategically-located patches of vegetation that will benefit nesting, foraging and roosting rails as well as provide high tide refuge.

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

Keywords: Active revegetation, tidal marsh, marsh gumplant, Pacific cordgrass, Ridgway's Rail

Poster Topic: Restoration Enhancement work by the Invasive Spartina Project

Creating 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 in part by a lack of high-tide refuge habitat in San Francisco Estuary marshes. To decrease predation on Ridgway's rail, the California Coastal Conservancy has constructed 43 "high-tide refuge islands" in 11 tidal marshes in the San Francisco Estuary. These islands were designed to mimic natural slough channel levees dominated by gumplant (*Grindelia stricta*). Island locations expected to have the greatest positive effect on Ridgway's rail survival were selected. Islands were constructed during the winters of 2012 (6 islands), 2013 (16 islands), and 2014 (21 islands). They were built primarily using pickleweed sod (*Salicornia pacifica*) harvested from a nearby slough channel edge and excavated sediment. In one marsh, imported clean terrestrial soil was used. Island tops were constructed to elevations of 1.0 foot above mean higher high water (MHHW) in 2012, 1.3 feet above MHHW in 2013, and 1.8 feet above MHHW in 2014. All islands were then covered with the pickleweed sod and planted with gumplant and saltgrass (*Distichlis spicata*). Topography and vegetation were monitored in May 2013 and September/October 2014. Gumplant survival in both monitoring years was positively correlated with the elevation of island tops above MHHW ($R^2 = 0.78$, $R^2 = 0.68$, respectively). Gumplant was most robust on the islands constructed using terrestrial soil; therefore, in 2014, terrestrial soil was added into gumplant planting wells on 13 of the 21 islands constructed. Pickleweed currently provides 70–100% cover on all the islands, and gumplant cover continues to develop. Additional monitoring is scheduled for September 2015. Information obtained from the monitoring results will be incorporated into the design of 19 additional islands that will be constructed in winter 2015.

Keywords: California Ridgway's rail, refuge, island, gumplant, elevation

Poster Topic: Restoration Enhancement work by the Invasive Spartina Project

San Jose-Santa Clara Regional Wastewater Facility: Treating Wastewater & Enhancing the Bay

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San Jose-Santa Clara Regional Wastewater Facility is working with regional agencies to monitor biological health of downstream marshes. The results are also being used to inform citizens about the value of both the wastewater treatment facility and restored salt marshes.

Problem: How can we evaluate the impact of treated wastewater on marsh habitat?

Approach: Over the past two to five years, we collected water quality data and collaborated with regional researchers who study Bay fish, benthic invertebrates, migratory birds, and other indicators of water quality beneficial use attainment. The goal was to document quality of wildlife habitat watered by facility effluent.

Results: Facility effluent provides high quality fresh water to local marshes, albeit it is still a significant source of nitrogen and phosphorus nutrients. Those nutrients attenuate very rapidly as they mix with tides and flow downstream. Meanwhile, abundance and species diversity in benthic, fish, and bird communities appear to be as good, or better, than seen in comparable nearby areas.

Conclusions: San Jose-Santa Clara Regional Wastewater Facility found it very productive to use biological abundance as indicators of beneficial use attainment. The results also provide a narrative that is now being shared with USFWS and the adjacent wildlife refuge.

Keywords: Wastewater, Nutrients, Fish, Ducks, Benthos, Tides, Nitrogen, Ammonia

Poster Topic: San Jose-Santa Clara Regional Wastewater Facility: Treating Wastewater and Enhancing the Bay

Nutrient Removal at the San Jose-Santa Clara Regional Wastewater Facility

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The San Jose-Santa Clara Regional Wastewater Facility (RWF) is the largest Biological Nutrient Removal (BNR) treatment plant discharging to San Francisco Bay. BNR incorporates full nitrification and achieves partial denitrification. The RWF's BNR process occurs in two locations, historically referred to "Secondary" and "Nitrification" areas. Each area is further divided in to "A-side" and "B-side" batteries, resulting in four separate BNR treatment trains.

Despite progress made by the RWF in reducing nutrient loads to Bay, there is a growing concern of nutrient enrichment in San Francisco Bay.

The RWF measures ammonia in influent and total nitrogen in effluent twice monthly. Staff calculated nutrient loads using concentration data and corresponding flow data for influent and effluent. Seasonal variations of concentrations and loads were evaluated for both influent and effluent. Changes in effluent nutrient concentrations were also compared to concentrations in each of the four BNR batteries to determine how performance of individual batteries ultimately affects effluent concentrations.

The majority of total nitrogen in the RWF influent was in the form of ammonia (NH3), whereas most of the total nitrogen discharged is in the form of nitrate, which is consistent with full nitrification. Influent flow volume has steadily declined, resulting in increased concentrations of influent ammonia and effluent total nitrogen. There was no significant difference in influent total nitrogen load by season. However, there was significant seasonal variability of effluent total nitrogen load, likely due to lower temperatures in the wet season, which affects BNR efficiency. Decreased effluent flows in the dry season due to recycled water demand also contributed to lower dry season total nitrogen effluent loads.

Conclusions: Even in an advanced BNR facility, managing nutrients is challenging due uncontrollable factors such as influent flow, influent ammonia concentration and seasonal effects.

Keywords: Wastewater, treatment, nutrient, nitrogen, ammonia, secondary, nitrification

Poster Topic: San Jose-Santa Clara Regional Wastewater Facility: Treating Wastewater and Enhancing the Bay

Nutrients Variation with Tides in Artesian Slough

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Elevated nutrient levels in San Francisco Bay have raised concerns over the potential for eutrophication. Wastewater treatment plants are an identified source of nutrients to the Bay and the San Jose-Santa Clara Regional Wastewater Facility (RWF) is the largest wastewater treatment plant discharging to the Bay. The RWF provides wastewater treatment for 1.4 million Silicon Valley residents and discharges tertiary treated wastewater to Artesian Slough, a tributary to Lower South Bay. Although the RWF achieved dramatic reductions in nutrient loads to the Bay through upgrades in 1998, RWF effluent still supplies consistent nitrogen loads to the Lower South Bay. Understanding the fate of these nutrients through unbiased monitoring is a necessary step towards understanding eutrophication potential. This analysis examines how tidal stage affects nutrient concentrations in Artesian Slough during consistent nutrient inputs from wastewater discharge.

RWF scientists have monitored nutrients monthly at six locations in Artesian Slough and lower Coyote Creek since 2012. Monitoring events target an equal mix of ebb and flood tides to avoid tidally biased concentration data. A statistical comparison of the ebb and flood tide concentrations of ammonia, total kjeldahl nitrogen, and nitrate indicates that tidal stage significantly affects nitrogen concentrations at stations proximate to the RWF. Nitrate concentrations are significantly higher during ebb tides when the influence of RWF discharge is greatest. In contrast, ammonia concentrations are significantly higher during flood tide, indicating that the ammonia in Artesian Slough comes mostly from the Bay rather than the RWF.

The RWF achieves complete nitrification and discharges very little ammonia, so these results are not surprising. Many factors can affect ambient nutrient concentrations including external loads, in Bay transformations, uptake, flushing, and mixing. This study demonstrates the importance of considering tidal variability to avoid biased results when designing monitoring, assessment, and modeling studies for nutrients.

Keywords: Nutrients, Wastewater, Tidal influence, Lower South Bay, Artesian Slough

Poster Topic: San Jose-Santa Clara Regional Wastewater Facility: Treating Wastewater and Enhancing the Bay

Tracking Benthic Communities in Artesian Slough

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The San Jose-Santa Clara Regional Wastewater Facility (RWF) discharges 80 to 100 million gallons per day of tertiary treated effluent into Artesian Slough, a tributary to Coyote Creek and Lower South San Francisco Bay. In 2005, the RWF connected Pond A18, an 856 acre former salt pond, to Artesian Slough. Between 2005 and 2006, an additional 5 ponds (Ponds A16, 17, 19, 20, 21) located within the immediate vicinity of Artesian Slough and Coyote Creek were also connected to the Bay. Benthic community data was collected just prior to and three times during the six months following the opening of these ponds. Additional events were conducted in 2014 by USGS under contract with City of San Jose. This study examines how the changes in the hydrology in Artesian Slough due to the opening of Pond A18 and surrounding ponds affected the benthic community.

Species richness data at four stations from the RWF into Coyote Creek was compared across sampling events as a measure of benthic community health. Data collected prior to and three times within six months following the opening of Pond A18 was collected by S.R. Hansen & Associates with a Van Veen sampler. Comparable benthic data was also collected in 2014 by USGS.

Species richness data indicate a diverse and stable benthic community composition across all stations, with disturbances only occurring immediately following initial release of salt ponds. Species richness was consistent among events conducted prior to pond opening, at 6 months after and 9 years after pond opening.

Benthic community species composition in Artesian Slough, characterized in the context of species richness, is diverse and stable despite considerable changes and disturbances in the hydraulic regime of Artesian Slough over the course of the past nine years.

Keywords: Benthos, pond restoration, wastewater effluent

Poster Topic: San Jose-Santa Clara Regional Wastewater Facility: Treating Wastewater and Enhancing the Bay

Tracking Fish Communities in Artesian Slough

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General description: The San Jose-Santa Clara Regional Wastewater Facility (RWF) discharges 80 to 100 million gallons per day of treated effluent. The effluent flows via Artesian Slough, a productive fishery, into shallow marshes in Lower Coyote Creek and the Lower South San Francisco Bay. The effluent channel runs along the western boundary of former salt pond A18 which was purchased by the City of San Jose in 2004/2005 and has been circulating ever since. Pond A18 encompasses 856 acres. Circulation flow is one-direction: Bay water enters the pond at a point furthest from RWF discharge then leaves the pond close to the RWF outfall. Flow volume from Pond A18 averages about 15 million gallons per day; a little more than a quarter of total hydraulic flow through Artesian Slough. The hydraulic structures that control pond flow allow reversing the flow, but this has never been attempted until now.

Problem: Due to equipment failure, Pond A18 flow had to be reversed from February through May 2015. What was the impact on the Artesian Slough fish community during the period that A18 was drawing away fresh RWF discharge water at the base of the slough and discharging it at the mouth?

Approach: Fish community data was collected at three stations in Artesian Slough over a four year period that includes the three months in 2015 when Pond A18 flow was reversed. This fish data was collected by monthly otter trawls by UC Davis principal investigator, Dr. Jim Hobbs.

Results: Trawl catch data for a dozen species shows strong temporal trends over recent years. However, fish population changes appear to be driven by larger factors such as drought, local habitat restoration, and decadal climate cycles.

Conclusions: Reversing Pond A18 flow had no discernible impact on fish populations in Artesian Slough.

Keywords: Fish, fishery, habitat, wastewater, treatment, pond, restoration,

Poster Topic: San Jose-Santa Clara Regional Wastewater Facility: Treating Wastewater and Enhancing the Bay

Ducks at the Regional Wastewater Facility

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Populations of ducks have been increasing on San Jose-Santa Clara Regional Wastewater Facility property. Facility personnel have been noting a large increase in ducks roosting and feeding in Biosolids processing areas in recent years.

Problem Statement: What has caused this explosive increase in duck populations?

Approach: Facility staff compiled 40 years of Audubon Society Christmas Bird Count data from the "Alviso Complex" in Lower South San Francisco Bay that provide an annual historic census. Staff also conducted a number of photo surveys to establish current population density and species diversity on RWF property. Fifteen species of ducks were identified on RWF by discrete photography during the 2014/15 winter season.

Results: Audubon Christmas Bird Counts document dramatic increases in winter time duck populations following restoration or circulation of several nearby salt ponds. The population increase is most dramatic in Pond A18 where water is maintained at one to two foot depth. Duck populations fluctuate in tidal or muted tidal ponds, but nonetheless, have increased in those ponds as well. Roughly 1,000 ducks regularly roosted on RWF property through 2011. This number steadily increased to over 4,000 by 2014 after the last large block of former salt ponds were opened to circulation with Bay water. The same data show that local gull populations appear to be declining as ponds were restored.

Conclusions: The increase in duck populations on facility property is real, not a figment of imagination. The increase clearly correlates with restoration or circulation of former salt ponds in the vicinity.

Keywords: Ducks, restoration, wildlife, habitat, wastewater, treatment, pacific, flyway

Poster Topic: San Jose-Santa Clara Regional Wastewater Facility: Treating Wastewater and Enhancing the Bay

Outreach Collaboration: Wastewater Facility and the Wildlife Education Center

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Effluent from the San Jose-Santa Clara Regional Wastewater Facility (Facility) is discharged into the South Bay waters of the Don Edwards SF Bay National Wildlife Refuge (Refuge). Visitors to the Refuge's Environmental Education Center in San Jose learn about the wastewater facility, and the need for water quality, habitat restoration and pollution prevention. This partnership meets the regulatory requirements for public outreach of the NPDES permit.

Problem Statement: How can the Regional Wastewater Facility educate the public about its function, and its impact on the South Bay environment?

Approach: San Jose has partnered with the neighboring federal environmental educators, and other agencies, to develop messages for the general population about the Facility. Refuge staff provide programs for children and young adults on the ecosystem of the South Bay and the importance of salt marshes, the impact of the facility on clean water, and how to prevent pollution. Through additional partnerships and funding, the City and Refuge provide education on water conservation and recycled water, riparian restoration, and how to prevent litter and trash impacts in local creeks.

Results: Visitors to the wildlife refuge have grown from almost 13,000 in 1997 to 25,000 in 2014. For the 2013/2014 school year, between the various programs for kids, 5,000 children learned about what the wastewater facility does to provide clean water to the South Bay.

Conclusions: The refuge is uniquely located and staffed for providing the valuable in situ public education about this important environmental topic: the role and impact of human activity on the watershed. The City's funding of these educational programs meets the regulatory requirements for public education in an effective way.

Keywords: wastewater, permit requirement, public education, South Bay

Poster Topic: San Jose-Santa Clara Regional Wastewater Facility: Treating Wastewater and Enhancing the Bay

Trends in Harbor Seal Numbers Illuminate Changing Conditions within SF Bay Estuary: Comparing 2015 Harbor Seal Counts to the 2000-2010 Benchmark

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Harbor seals are the only year round resident marine mammal in SF Bay. Researchers have been concerned about human impacts on the health of these seals dating back to the 1970s when premature births and elevated toxins were documented. Because seals forage, rest and breed in the bay, changes in population numbers can indicate perturbations to their prey or their habitats that are likely of concern to other species residing in the bay. We used a long term dataset of seal counts (1998 to present) at two representative haulout locations (Yerba Buena Island and the Richmond-San Rafael Bridge) to design a benchmark for evaluating and interpreting seal counts. We defined a benchmark as the average maximum number counted between May and July from 2000 to 2010. We defined 1 standard deviation (SD) or more above the benchmark as "good" and 1 SD or more below the benchmark as "poor". The benchmark is calculated as 328 seals; the range for "fair" is between 273 and 382 (i.e., 328 ± 54 [SD]) seals. Results of 2015 seal counts, which continue through July, will be evaluated against the benchmark and the results interpreted and compared with central California coastal counts for a regional perspective. We expect the occasional poor year due to environmental conditions like El Niño that may alter harbor seal prey assemblages; however, three sequential poor years likely are cause for concern and would precipitate actions such as monitoring and/or management actions (for example, seal protection zones around haulout locations to reduce effects of disturbance). We will evaluate the 2015 seal counts against the benchmark and interpret the results in context with the long term dataset, oceanic conditions, and disturbances observed in the 2015 season. We also will compare SFB counts with central California coastal counts for a regional perspective.

Keywords: Harbor seals, benchmark, changing conditions

Poster Topic: State of the Estuary Report 2015

Feast or Famine: Fish Food in the Upper San Francisco Estuary

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Zooplankton is an important component of the pelagic food web, providing a key trophic link between fish and phytoplankton. Most larval and juvenile fish in the upper San Francisco Estuary (SFE) feed on zooplankton, and some smaller fish like Delta Smelt and Longfin Smelt feed on zooplankton throughout their lives. Monitoring of zooplankton in the upper SFE is conducted by the California Department of Fish and Wildlife's Zooplankton Study as part of the Interagency Ecological Program. To assess trends in fish food resources, the Zooplankton Study has provided zooplankton abundance estimates since 1972. Since the late 1980s, zooplankton has decreased in most areas of the upper SFE, particularly in the low salinity zone. This decrease has been attributed in large part to *Potamocorbula amurensis*, an invasive clam found in the low salinity zone that was introduced in 1986. Competition with *P. amurensis* for phytoplankton, a shared food resource, as well as predation on copepod nauplii by *P. amurensis* has reduced zooplankton abundance. The decline is particularly evident in Suisun Bay, a region heavily impacted by *P. amurensis.* Calanoid copepods and mysids are crustaceans that were chosen for the zooplankton indicator for the State of the Estuary Report because they are important food items for Delta Smelt and Longfin Smelt, two listed fish species in the upper estuary. Mysid biomass has declined in both the Suisun and Delta regions of the upper San Francisco Estuary since monitoring began. Calanoid copepod biomass has declined in the Suisun region, but increased in the Delta region of the upper San Francisco Estuary since monitoring began. The resultant zooplankton decline in the low salinity zone has been implicated as one of the many causes of the pelagic organism decline (POD) which described the dramatic decline of several pelagic fish species beginning in the early 2000s.

Keywords: Zooplankton, Food web, State of the Estuary Report, fish food

Poster Topic: State of the Estuary Report 2015

Increasing Dominance of Floating Aquatic Vegetation in the Sacramento – San Joaquin Delta over the Past Decade

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Invasive aquatic plants have far-reaching impacts on the Delta ecosystem. Aquatic plants change shoreline habitat by slowing water flow and increasing water clarity, which have reverberating effects across the entire food chain. Invasive aquatic plants also impede boat travel and are difficult and expensive to control. We measured the distribution and acreage of invasive and native aquatic plant species using remote sensing imagery from 2004 to 2008, and again in 2014. Results show that submerged aquatic vegetation (SAV) cover, dominated by Brazilian waterweed, decreased from almost 8000 acres in 2004 to 4300 acres in 2008 before increasing to 6070 acres in 2014. From 2004 to 2008, floating aquatic vegetation (FAV) cover varied between 800 to 1700 acres. During this time period, the two most dominant FAV species, native pennywort and invasive water hyacinth, had comparable cover followed by invasive water primrose. However, in 2014, FAV species cover increased three-fold covering 6500 acres over the entire Delta compared to its previous maximum measured in 2006 (1700 acres). Moreover, the FAV species cover is now comprised mainly of just the two invasive species, water hyacinth (69%) and water primrose (31%). The total invaded area in the Delta (SAV + FAV) has increased from the previous recorded maximum of 9000 acres in 2004 to almost 12500 acres in 2014. Both SAV and FAV have especially flourished in flooded islands in the Delta, colonizing new areas. The prolonged drought has likely reduced water levels and increased shallow habitat with slow moving water ideal for the establishment of SAV and FAV. Coincidently, mild winters and lack of large storms and floods have also favored the establishment and spread of these species.

Keywords: water hyacinth, submerged aquatic vegetation, invasive species, remote sensing, AVIRIS

Poster Topic: State of the Estuary Report 2015

Updating the State of Bay-Delta Science to Reflect New Findings Learned about the System Since 2008

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The State of Bay-Delta Science, 2008 (SBDS, 2008), a synthesis of the scientific knowledge of the Bay-Delta system, is currently being updated by the Delta Science Program (DSP). The update to *SBDS, 2008* will be written for a broad audience with different sections of the report addressing diverse needs. The executive summary will target high-level decision-makers, including the Governor, agency secretaries, the legislature, and Congress, while the main document will target decision-makers and agency managers who are familiar with the system, as well as technical specialists and scientists. The key questions to be addressed revolve around the state of scientific knowledge, including changes throughout the system, insights from an integrated synthesis of data and analyses, and prevailing certainties and uncertainties. This living document, which will be revised by scientific experts every four years, will include future web-based updates as new information arises.

Topics may include: a brief summary of *SBDS, 2008*; defining a new baseline for the big issues of water quality, aquatic ecosystems, levee system fragility, water supply and climate change; a systems-scale view; alternative futures; the role of science and other social science perspectives; and the way forward.

Future updates to the document will complement the DSP Science Action Agenda by identifying actions necessary to fill knowledge gaps and address uncertainties of the system. In turn, this document will be shaped by information gleaned from actions performed under the Science Action Agenda. The next update to *SBDS* is scheduled for completion in 2015.

Keywords: State of scientific knowledge, water quality, aquatic ecosystems

Poster Topic: The Key to Effective Decision-making through Science and Communication: A Preview of the State of Bay-Delta Science, 2015

Recent Advances in Understanding Flow Dynamics and Transport of Water-quality Constituents in the Sacramento – San Joaquin River Delta

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This abstract summarizes a draft chapter of the State of Bay-Delta Science report that describes advances during the past decade in understanding flow dynamics and how water-quality constituents move within California's Sacramento-San Joaquin River Delta (Delta). Water-quality constituents include salinity, heat, oxygen, nutrients, contaminants, organic particles, and inorganic particles. These constituents greatly affect the quantity and quality of benthic, pelagic, and intertidal habitat in the Delta and how water diversions and other human manipulations of flow alter habitat. The Pacific Ocean, the Central Valley watershed, human intervention, the atmosphere, and internal biogeochemical processes are all drivers of flow and transport in the Delta.

Improved understanding of flow and transport has led to identification of significant new policy-relevant issues such as transport pathways created by the Delta Cross Channel, residence time, and the continued clearing of Delta waters. When the Delta Cross Channel is open, flow of water and transport of water-quality constituents from the Sacramento River into the central Delta is enhanced. Residence time is a key ecological variable that varies tremendously within the Delta. Some channels efficiently transport water and its constituents to the Bay or pumps and some dead-end sloughs have much smaller tidal excursions and longer residence times. Submerged aquatic vegetation (SAV) has increased dramatically in the Delta, particularly in the south Delta, and appears to trap sediment and increase water clarity. SAV and decreased sediment supply from the watershed may explain observed decreases in turbidity. To address these issues and to manage the ongoing drought, continuous monitoring of flow and constituent fluxes and research on residence time, effects of SAV, effects of placement and removal of salinity barriers, and deposition and erosion of particulates are needed.

Keywords: flow, water quality, transport, Delta, State of Bay-Delta Science report

Poster Topic: The Key to Effective Decision-making through Science and Communication: A Preview of the State of Bay-Delta Science, 2015

Water Quality, Contaminants, and Their Effects on Delta Species, Ecosystem Services, and Drinking Water Supply

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Contaminants in the Delta affect water quality, impact associated species, and potentially impact drinking water supply. They originate from agricultural and urban runoff, wastewater treatment effluent discharge, industrial waste, and atmospheric deposition, as well as being applied directly to surface waters. There is also a legacy of contaminants such as persistent organic compounds, mercury, and selenium, which can accumulate through the food chain leading to health risks for humans and wildlife.

Although the Bay-Delta is one of the most studied surface water systems in the world, the ecological impacts of contaminants remain unquantified, and their effects poorly understood. Fish kills that were a common occurrence in past decades are now confined to spills or first flush events, however, sublethal effects of significant concern have been reported. In fish, for example, contaminants can negatively affect the immune system, impact growth and development, directly alter behavior, and have detrimental impacts on sensory systems that affect the ability to avoid predators, recognize kin, find spawning grounds, and reproduce successfully. These sublethal impairments are often difficult to measure and to attribute to specific contaminant classes, because contaminants co-occur in space and time and can interact additively, synergistically, and antagonistically.

Standard bioassay methods that are based on acute toxicity of select species are not sufficient to adequately address the impact of contaminants on aquatic life. Bioassay endpoints that are currently used to evaluate contaminant impacts for regulatory purposes thus need to be enhanced.

Contaminants are also a concern in regard to the Delta as a source for drinking water. Drinking water agencies that rely on the Delta have invested in upgrades to water treatment processes over the last decade, and have also implemented an integrated system of monitoring and forecasting tools to inform water treatment operations.

Keywords: Contaminants, Fish Health, Population Effects, Toxicity, Bioassays, Bioaccumulation, Sublethal Effects,

Poster Topic: The Key to Effective Decision-making through Science and Communication: A Preview of the State of Bay-Delta Science, 2015

Delta Smelt: Biology of a Once Abundant Species in the San Francisco Estuary

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The delta smelt (*Hypomesus transpacificus*) is a small, semi-transparent pelagic fish, endemic to the upper San Francisco Estuary (SFE). Although once very abundant, it may soon be extinct in the wild. They are now mainly found in the lower Sacramento River, north Delta, and associated areas. Delta smelt use tides and river flows to maintain themselves in cool (<24°C), low salinity (<7 ssu), turbid (>12 ntu) water. Most adults move up to spawn in fresh water and juveniles move down to rear in brackish water, where they feed on zooplankton. Some smelt have also been found year-around in fresh water. Delta smelt have well-developed predator avoidance mechanisms except as eggs and larvae. Their populations fluctuate widely from year to year but the trend since the 1980s has been downward, most conspicuously since 2002, with record low numbers in 2014-15. The ultimate cause of decline is growth of water demand by a rising human population and the growing California economy. Proximate causes are multiple and interactive, but reduced food supply, predation on larvae, and changes in water quality seem to be especially important. In general, the SFE has become an increasingly unfavorable environment for smelt, especially during the current drought. The Delta smelt is facing new insults to its survival, including effects of physical changes, climate change, and new alien invaders. The captive population can only be used for recovery if suitable conditions exist for smelt in the wild for its entire life cycle. The decline of smelt and other species suggests a general failure to manage the SFE for the "co-equal" goals of biotic sustainability and water supply reliability. The delta smelt is a conservation reliant species; recovery to self-sustaining populations would take massive changes to the SFE.

Keywords: native fishes, reconciliation, POD

Poster Topic: The Key to Effective Decision-making through Science and Communication: A Preview of 5he State of Bay-Delta Science, 2015

Anadromous Salmonids in the Delta: New Science 2006-2016

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The functional role of the Sacramento-San Joaquin River Delta in the salmon's life cycle depends on the extent to which each life stage uses the Delta. However, the Delta's complex channel network poses significant challenges for quantifying the role of the Delta and the effect of water management actions on population dynamics of anadromous salmonids. As part of the upcoming report on the State of Bay-Delta Delta Science, we review recent and emerging science over the past decade that is shedding new light on anadromous salmonids in the Delta. Over the past decade we have observed the wide-spread adoption of biotelemetry techniques, which provides detailed spatiotemporal information on tagged individuals as they migrate unimpeded through a network of stationary telemetry stations situated throughout the Delta. These studies have provided new insights about the residence time, behavior, movements, migration routing, and survival of juvenile salmon in the Delta. For example, new statistical methodologies now allow researchers to estimate 1) the proportion of fish using key migration routes, 2) survival within each migration, and 3) the contribution of each migration route to overall survival of juvenile salmon migrating through the Delta. However, telemetry studies have been restricted to large, taggable-sized fish (> 90 mm), primarily of hatchery origin. Consequently, there remains a significant knowledge gap about wild juveniles and fry- and parr-sized fish — life-stages that are expected to rear for considerable time in the Delta. To address the diversity of life stages and life-history strategies of salmon that rely on the Delta, life-cycle models and individual-based models are currently being developed to evaluate the effect of proposed water management actions in the Delta. This new research is shaping water and fisheries management in the Delta, helping managers to understand how specific management actions will affect particular life stages at specific locations.

Keywords: salmon, Delta, water management, telemetry, life cycle models, survival

Poster Topic: The Key to Effective Decision-making through Science and Communication: A Preview of the State of Bay-Delta Science, 2015

Predation on Fishes in the Sacramento – San Joaquin Delta: Current Knowledge and Future Directions

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The Delta is a heterogeneous, highly modified aquatic system and it is a challenge to quantify the precise impact of predation on fish populations because of the plethora of covarying factors capable of negatively affecting fish populations (e.g., habitat loss, water export and altered flows, invasive species, contaminants, and disease). In addition, because of anthropogenic alterations in physical habitat, predation intensity varies spatially and includes localized high predation "hotspots". I reviewed the general background of predator-prey theory, and then described predator-prey relationships of Delta fishes. I first evaluated the quality of the data on predator-fish prey interactions in the Delta and then, based on frequency of occurrence data, I ranked predator consumption rates of prey as occasional, moderate, and common. I recorded 32 different predator categories, although some categories contained multiple species (e.g. gulls). I recorded 36 different prey species and five multi-species categories (e.g. unidentified fishes). The data indicated that most predators were occasional consumers of individual prey species. Most predators consumed a variety of both native and invasive fishes, indicating a lack of specialization. Both striped and largemouth bass exhibited wide dietary breath preying upon 32 and 28 categories of piscine prey respectively. Sacramento pikeminnow, also displayed wide dietary breadth of piscine prey with 14 different prey categories eaten. Data for reptilian, avian and mammalian predators were sparse, however these predators may have significant effects in altered habitats or when salmonids are stocked. In conclusion, extant data suggest that invasive and native fish piscivores, are generalists that likely consume whatever is locally available (i.e., mainly invasive prey species). However, the data base of predators and their fish prey is not strong and I would urge future efforts to undertake long-term dietary studies with attempts to establish predator preferences, rather than just consumption.

Keywords: Predation, Predators, Invasives, Interior Delta, Population Regulation

Poster Topic: The Key to Effective Decision-making through Science and Communication: A Preview of the State of Bay-Delta Science, 2015

The Impact of the 2014 Severe Drought on Microcystis Blooms in the San Francisco Estuary

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Microcystis blooms have occurred in the San Francisco Estuary since 2000 and are important to estuarine production, because they adversely affect the health and survival of phytoplankton, zooplankton and fish. *Microcystis* blooms are expected to increase over time in association with the increased frequency and intensity of drought with climate change. To gain more knowledge on how drought can impact these blooms, an intensive *Microcystis* field sampling program was conducted during the 2014 severe drought. The 2014 drought was characterized by a 66% to 85% reduction in streamflow during the summer and significantly increased the amplitude and duration of the *Microcystis* bloom and its ecological impact. *Microcystis* biomass increased by two orders of magnitude over previous dry years and was accompanied by elevated levels of the toxin microcystin-LR. The persistence of warm water temperature extended the *Microcystis* bloom into December, two months longer than previous blooms. The bloom was associated with extreme water quality conditions, including a 20 year high in soluble phosphorus and low in ammonium concentration. Correlations suggest the bloom varied with both inorganic and organic nutrient sources as well as environmental conditions. Biological impacts included a shift in the *Microcystis* species, increased abundance of other toxic cyanobacteria and adverse impacts to fish survival.

Keywords: Microcystis, drought, toxins, cyanobacteria bloom

Poster Topic: The Microcystis Bloom during the 2014 Drought

Drought Enhances Abundance and Biodiversity of Cyanobacteria in the Sacramento-San Joaquin Delta

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Severe cyanobacterial blooms are one of many environmental risk factors associated with drought impacts in the Sacramento-San Joaquin Delta. This study focused on molecular analyses of ambient water collected from the Delta during August to December of 2014, a record drought year. The samples were analyzed by quantitative PCR (qPCR) to quantify recurring key cyanobacteria and by Next Generation Sequencing technology to identify emerging cyanobacterial species in the environment (i.e. eDNA). The qPCR results showed prolonged blooms of *Microcystis aeruginosa* up to September; the magnitude was approximately 7.7 times higher compared to 2013, a moderately dry year. In addition, blooms of *Aphanizomenon flos-aquae* were prominent in 2014: the abundance of *A. flos-aquae* was over 30,000 cells per ml in August 2014 while in 2013, this species was barely observed. Interestingly, the presence of DNA sequence encoding the toxin-synthetase gene of *Anabaena* sp. was identified by eDNA analysis. To the best of our knowledge, this is the first report on the occurrence of potentially toxin producing *Anabaena* sp. in the Sacramento-San Joaquin Delta. We are currently developing specific qPCR assay for the toxin-synthetase gene of *Anabaena* sp. to investigate their temporal and spatial distribution. These results indicate that severe drought conditions provide favorable environment for *Microcystis aeruginosa*, *Aphanizomenon flos-aquae*, and other emerging cyanobacterial species that potentially impact aquatic organisms and ecosystems in the Delta.

Keywords: Drought, Cyanobacteria, qPCR, NGS

Poster Topic: The Microcystis Bloom during the 2014 Drought

Water Quality Issue during Drought Year in the Sacramento-San Joaquin Delta

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Drought is impacting the aquatic environment. To evaluate the impacts on aquatic organisms, we performed fish embryo toxicity testing using medaka (*Oryzias latipes*) with the surface water collected from the Sacramento-San Joaquin River Delta during August and September of 2014, a record drought year. High mortality rate was observed in the surface water collected at San Joaquin River, Franks Tract, Mildred Island, Jersey Point, and Liberty Island (>70%) while mortality was barely recorded at Antioch and Collinsville (<10%). Embryos incubated in the surface water exhibited characteristic features: embryos became yellowish in color and egg shells became thinner and softer. Some embryos exhibited exclusion of a portion of egg yolk or whole body from the shells before completion of embryonic development (<5%). In addition, growth of microscopic organisms (bacteria or protozoa) was occasionally observed. The water physical parameters such as pH, nitrate, and ammonia concentrations were within normal ranges, therefore we speculate that the mortality was likely because of contaminants. The exact cause of mortality is still unknown. Another drought is forecasted in 2015, suggesting we will likely experience similar water quality issues in the Sacramento-San Joaquin River Delta. To understand the impacts of drought on aquatic environment and protect aquatic organisms, we propose to formulate plans for testing and measurement of water quality using various endpoints.

Keywords: Drought, Fish Embryo, Toxicity, Water Quality

Poster Topic: The Microcystis Bloom during the 2014 Drought

Changes in Zooplankton Composition and Abundance during the 2014 Microcystis Bloom

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2014 was one of the driest years on record in California, resulting in increased residence times and water temperatures in the San Francisco Estuary. Such conditions are favorable for cyanobacterial harmful algal blooms (CHAB), including *Microcystis aeruginosa,* a known toxic cyanobacteria. A drought response study investigated the distribution, abundance, genetic composition, toxin production and food web impact of *Microcystis spp.* in the San Francisco Estuary. The goal of this study was to determine the abundance and distribution of key zooplankton taxa as it relates to *Microcystis spp.* blooms during the critical drought year 2014. *Microcystis spp.*, zooplankton, water quality, and ambient water samples were collected biweekly from ten stations in the San Francisco Estuary from July to December 2014. Zooplankton samples were preserved in 70% ethanol and were identified by taxa and enumerated for biomass using a FlowCAM digital imaging flow cytometer. Results showed that copepod and cladoceran species were the most abundant zooplankton present during the CHAB. Data suggests that sites along the inner delta yielded the highest biomass and diversity. These findings are significant as *Microcystis spp.* may have adverse impacts on the Sacramento-San Joaquin aquatic food web.

Keywords: Zooplankton, Drought, Microcystis, Harmful Algal Bloom

Poster Topic: The Microcystis Bloom during the 2014 Drought

Napa River Restoration Projects

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The Napa River flows though one of the most scenic landscapes in the Bay Area, and supports one of the largest remaining salmon runs, but it faces many challenges. In the mid-20th century the river corridor was squeezed from a broad ribbon to a narrow thread, as land managers cut off secondary channels and confined the river behind levees. At the same time urbanization and land drainage funneled more water into a narrower floodway. The result was channel incision with bank collapse, erosion of channel bedforms (riffles, bars, pools) important to salmonids, and a reduced riparian corridor due to the lack of a functional floodplain. A broad coalition of organizations has been collaborating on 14 miles of river restoration within the Rutherford Reach and Oakville to Oak Knoll (OVOK) Reach. Restoration elements aim to restore physical and biological processes and include floodplain benches, large woody debris structures, biotechnical stabilization, non-native invasive management, native revegetation and buried boulder grade control designed to enhance existing hydraulic, geomorphic and depositional processes associated with riffle/pool maintenance and development, refugia and establishment of native riparian vegetation. Enhancement of the physical processes throughout these reaches will help sustain riffles over time and potentially improve spawning substrate and habitat conditions for multiple life-stages of salmonids. Construction in the Rutherford Reach was completed in 2015 and construction in the OVOK Reach will begin in July of 2015 and is anticipated to continue until 2019. A long term channel monitoring and maintenance program has been established by the Napa County Flood Control and Water Conservation District financed with dedicated funding from river front landowners. Costs and benefits of the project are being borne equally by landowners, the local Napa community, and state and federal grant programs.

Keywords: River Restoration, Habitat Enhancement, Bioengineering, TMDL, Riparian Ecology

Poster Topic: The Napa River: Working Together to Build a Resilient Watershed and a Living River

Fish Barrier Removal Projects in the Napa River Watershed

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Building on the success of the Zinfandel Lane Bridge Fish Habitat Improvement Project, a project that removed a historic fish barrier that impeded access to over 50% of the available spawning and rearing habitat for fall run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*Oncorhynchus mykiss*) in the Napa River watershed, the County of Napa is again embarking on several additional fish barrier remediation projects in 2015 and 2016 that will both restore access to upstream salmonid habitat and also repair failing infrastructure.

Two road crossings on the mainstem of the Napa River, the Oakville Cross Road Bridge and Greenwood Avenue culvert, are considered partial or full barriers to upstream and downstream fish migration during low flow scenarios and both structures were compromised as a result of the August 24, 2014 South Napa Earthquake. Both crossings will be replaced in 2015 and design includes suitable hydraulic conditions for passage of adult and juvenile salmonids, maintaining channel stability and creating onsite habitat structures for endangered California freshwater shrimp (CFS) (*Syncaris pacifica*). Additionally, Napa County will be removing another fish migration barrier on Milliken Creek, a significant tributary on the Napa River. The Milliken Creek project will include both the removal of a dam and restoration of the adjacent riparian habitat in addition to construction of a flood bypass/weir to ensure a flood detention area does not overflow into neighboring homes.

All projects include pre- and post-construction channel geometry surveys and fisheries monitoring in the areas upstream and downstream of the construction areas in order to document hydraulic conditions in the channel and salmonid use. These projects are funded by grants from the California State Coastal Conservancy, the U.S. Environmental Protection Agency, Napa County Public Works and the citizens of Napa County through Measure A Watershed Improvement Funds.

Keywords: Fish Passage Barrier, River Restoration, Watershed Management

Poster Topic: The Napa River: Working Together to Build a Resilient Watershed and a Living River

Beavers: Nature's Engineers at Work in the Napa River Watershed

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A series of major land use changes beginning with Euro-American settlement has had significant influence on the Napa River ecosystem that is present today. Increased inputs of water relative to the inputs of course sediment has contributed to incision of the mainstem and its tributaries and has resulted in abandoned floodplains, a simplified river morphology, and a decline in complex habitat and water quality. It has long been recognized that opportunities exist in the watershed to improve the overall ecological health of the river system, and in 2012, the San Francisco Estuary Institute recommended that beaver populations be restored to build low dams that trap fine sediment, restore riparian communities, reverse incision, and increase overall river ecosystem complexity. Beavers were known to exist in the Napa River in 2012, but in recent years there has been a noticeable increase in beaver activity along the Napa River and within tributaries throughout Napa County. The Napa County Flood Control District has been mapping and monitoring beaver activity in several tributaries and along the Napa River. In the City of Napa there are about 14-20 dams, 3-5 lodges or bank dens, and at least 15-20 beavers that have been identified. Throughout the County the number of dams, lodges or bank dens, and individuals is likely much larger but seems to fluctuate from year to year. Beaver dams and lodges in the tributaries seem to persist from year to year, and during large rain events most of the dams within these tributaries break up and are quickly re-built once stream flow recedes. Current observations indicate that beaver dams are promoting complex habitat for small mammals and contributing to the establishment of new vegetation. Long-term monitoring will help identify how large the beaver population is and how they are influencing watershed processes and functions.

Keywords: Beaver, Napa River, Wildlife Habitat, Wildlife,

Poster Topic: The Napa River: Working Together to Build a Resilient Watershed and a Living River

Youth at Work in the Watershed: LandSmart Youth Stewards and Youth Ecology Crops

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Watershed conservation is a community activity; there's a role to play for people of every age group. Two recently established programs, LandSmart Youth Stewards and the Napa County Youth Ecology Corps, are striving to include Napa County's youth in the community of watershed stewards.

Youth Stewards is a project-based, service learning program that connects 5^{th} -12^{th} graders to environmental processes of their home watershed. Concepts such as human impacts on watershed function, climate change, and engineering come alive when students are given Napa-centric examples.

Class visits introduce students to watershed topics, then students apply the lessons during up to five field days at local open spaces, farms, or school campuses. Students conduct restoration work and environmental investigation during field trips. Planting native vegetation, building erosion control structures, and surveying creeks are just some of the ways students engage with their site. Students explore careers in conservation; professionals work alongside students during field days, discussing academic choices and career pathways. In the 2014-15 school year, classes from seven schools planted over 400 native riparian plants. An American Canyon student summed up the experience: "I love the hands-on real-world work, we are doing and learning."

Youth Ecology Corps is a natural resource workforce that provides training and environmental education to at-risk young adults (18-24). A broad coalition supports the Corps by providing restoration projects at which the Corps work, as well as exposing Corps members to a breadth of careers that interface with conservation. Corps crews work on invasive plant management and litter abatement on the Napa River Flood Protection Project, St. Helena Flood Protection Project, Napa River Restoration Projects and on the County's Stream Maintenance Program. Crew members gain valuable training in natural resource management, plant identification, trail maintenance, invasive management. Graduates may enroll in one year of continued employment and training in the CCC.

Keywords: environmental education, youth at-risk, stewardship, workforce training, restoration, students service

Poster Topic: The Napa River: Working Together to Build a Resilient Watershed and a Living River

Napa River Sediment TMDL Monitoring Program: Pilot Implementation

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The 2009 Napa River Sediment TMDL and Habitat Enhancement Plan outlines an approach for addressing the primary factors determined to be affecting steelhead and salmon populations and establishes a plan to improve overall stream habitat conditions throughout the watershed. It establishes numeric targets for inter-gravel streambed permeability and channel bed-scour values associated with successful salmonid spawning and survival-to-emergence, to be measured throughout the Napa River watershed during a long-term monitoring effort. The monitoring approach and methods are described in a Monitoring Plan, approved by the Water Board in 2012. Here we describe the methods and results of an initial pilot monitoring effort, which was implemented during the 2012–2013 winter high flow season to: (1) test the sampling design outlined in the Monitoring Plan, (2) ascertain whether numeric targets are being met with a high level of statistical confidence, and (3) provide information and recommendations to adjust the design if necessary using an adaptive management approach. Analysis of the pilot gravel permeability data indicated that the sample size of 18 samples per reach was sufficient to statistically distinguish the reach-aggregated values from the TMDL target, particularly when assessing non-compliance. Permeability was unaffected by discharge or sample timing. The ability to assess statistical significance of inter-reach bed scour and bed texture was limited due to poor recovery of scour chains and the low number of pebble-count sites, respectively. A modified field method and increased sample size were recommended to improve scour-chain recovery. Power analysis indicated that 21 pebble-count sample sites per reach would be necessary to confirm a relative difference of 10% in the geometric means with 95% confidence and 80% power. Overall, the TMDL-recommended monitoring frequency of 2–5 years for approximately 10–20 years was supported by the outcomes of the pilot study.

Keywords: TMDL, fine sediment, monitoring, permeability, spawning gravel

Poster Topic: The Napa River: Working Together to Build a Resilient Watershed and a Living River

Napa County Dry-Weather Storm Drain Outfall Assessment

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Municipal storm drain outfalls are identified as non-point discharge sources that may contribute to declines in water quality throughout the State. As such, municipalities across the State are required to monitor and control illicit discharges from storm drains. In 2014, the Napa County Resource Conservation District conducted a county-wide dry-weather assessment of municipal storm drain outfalls on behalf of the Napa Countywide Stormwater Pollution Prevention Program (NCSPPP). The purpose of the assessment was to identify and curtail illicit discharges in each Napa County jurisdiction by assessing every outfall, sampling and analyzing dry-season flow when encountered, and investigating the source of the flow if action level concentrations were exceeded. In total, 304 outfalls were assessed. 87% of outfalls were in normal structural condition, 8% showed signs of structural damage, and 5% could not be assessed for maintenance condition due to heavy overgrowth of vegetation. Related to discharges, approximately 11% (34) of the outfalls were found to be discharging water and only 0.6% (2) of those were found to represent potential pollution concerns. Corrective action was taken at one site and the source of discharge at the other site was determined to be shallow riverside groundwater including brackish tidal water of the adjacent river. The results of the assessment will be used by NCSPPP to identify priority outfalls and establish a dry-weather flow monitoring program.

Keywords: water quality, outfall, stormwater

Poster Topic: The Napa River: Working Together to Build a Resilient Watershed and a Living River

Leaching Fractions Achieved in South Delta Soils under Alfalfa Culture

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The Sacramento – San Joaquin River Delta region is a unique agricultural region of California, with approximately 500,000 cultivated acres. Delta farming, however, is challenged by salinity, which can stress crops and reduce yields. Alfalfa is a widely grown Delta crop and is moderately sensitive to salinity. To prevent hay yield reductions, Delta soils should be leached of salts by applying water in excess of crop evapotranspiration. The leaching fraction (LF) is defined as the minimum fraction of the total applied water that must pass through the root zone to prevent a reduction in crop yield from excess salts. Two factors establish the LF: the salt concentration of the applied water and the salt sensitivity of the crop. Alfalfa is irrigated with surface water in the Delta; thus, the quality of surface water affects growers' ability to leach salts. The California State Water Resources Control Board adopts water quality objectives for the protection of various beneficial uses in the Bay-Delta, including agricultural uses. Current objectives for the south Delta – approximately 100,000 cultivated acres southwest of Stockton, CA – were set in the 2006 Water Quality Control Plan. The objectives are 0.7dS/m (April-August) and 1.0dS/m (September-March). Seven south Delta alfalfa fields were selected for this study based on soil type and irrigation source water. Over the course of the study period (2013-2015), spring average root zone salinity (ECe) from the 150-cm soil profile ranged from 0.67-10.36dS/m across the seven sites, and the fall average ranged from 0.81-10.66dS/m. Average irrigation water salinity (ECw) ranged from 0.36-1.96dS/m. The LF at the base of the root zone ranged from 3-25%. These data show that salts are building in the soil during the irrigation season, irrigation water salinity can exceed the objective, and the LF is often inadequate to leach salts in the south Delta.

Keywords: salinity, alfalfa, leaching fraction, irrigation, water quality, south Delta

Poster Topic: Agriculture and Water Quality

The AFRI Rice Project: Benefits of Nitrogen Fertilizer Treatment in Rice Planting on the Sacramento–San Joaquin Delta to Encourage Subsidence Prevention, Sustainability of Soil Conditions and Water Management Affects on GHG Emissions

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About two thirds of the Sacramento-San Joaquin Delta (Delta) islands are agriculture lands. The drained peat soils of the Delta have provided fertile soils for agriculture since the late 1800s. Unfortunately during that time, the environment in the Delta island region has dramatically deteriorated as evidenced by subsidence. On many of the Delta islands peat soil has oxidized causing subsidence of up to 20 feet, or more, below sea level. Subsidence is responsible for severe consequences including extensive greenhouse gas emissions, construction of a 110-mile levee network, risks to California's water supply and the degradation of water quality. If current agricultural practices remain unchanged, things will only get worse. As a partner in a UC Davis and UC Berkeley study, East Contra Costa County high school students are participating in the AFRI Rice Culture Mitigation Study to determine if growing rice, as opposed to other Delta crops, would help in mitigating subsidence and concurrently mitigating GHG emissions and soil loss; reducing risks to California water supply, including the agricultural users throughout the San Joaquin Valley downstream of the Delta; and protecting water quality. In this study, conducted in a Learning Lab rice field on Jersey Island, the main focus is the effect of fertilizers on rice as related to yield and environmental effects. A number of hypotheses will be tested: nitrogen is a limiting nutrient in the Delta for rice; soil under treatments with nitrogen fertilizer additions will contain higher concentrations of extractable NO_3 during the growing season compared to treatments lacking nitrogen; GHG emissions are affected by water management and rice developmental stages; rice fields are sources of NO_3 and PO_4 in water. Through soil, water and air quality samplings students hope to use examples of soil nitrogen levels, N_2O and CH_4 emissions and chloride changes to prove hypotheses.

Keywords: Island Subsidence, Levee, GHG, Greenhouse Gas, Carbon Emissions, Rice, Peat

Poster Topic: Agriculture and Water Quality

The AFRI Rice Project: Benefits of Nitrogen Fertilizer Treatment in Rice Planting on the Sacramento-San Joaquin Delta to Encourage Subsidence Prevention, Sustainability of Soil Conditions and Water Management Affects on GHG Emissions Public Education Project

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Local high school students are getting the opportunity to work on a hands-on, real-time research project on the Sacramento–San Joaquin Delta along the San Joaquin River. The project is being run as an outreach educational program through the Delta Science Center. Students are working on taking air, soil and water samples, as well as building a rice field to run the experiments on.

Project description: About two thirds of the Sacramento-San Joaquin Delta (Delta) islands are agriculture lands. The drained peat soils of the Delta have provided fertile soils for agriculture since the late 1800s. Unfortunately during that time, the environment in the Delta island region has dramatically deteriorated as evidenced by subsidence. On many of the Delta islands peat soil has oxidized causing subsidence of up to 20 feet, or more, below sea level. Subsidence is responsible for severe consequences including extensive greenhouse gas emissions, construction of a 110-mile levee network, risks to California's water supply and the degradation of water quality. If current agricultural practices remain unchanged, things will only get worse.

As a partner in a UC Davis and UC Berkeley study, East Contra Costa County high school students are participating in the AFRI Rice Culture Mitigation Study to determine if growing rice, as opposed to other Delta crops, would help in mitigating subsidence and concurrently mitigating GHG emissions and soil loss; reducing risks to California water supply, including the agricultural users throughout the San Joaquin Valley downstream of the Delta; and protecting water quality.

In this study, conducted in a Learning Lab rice field on Jersey Island, the main focus is the effect of during the study the students will also be creating a series of videos about the project, share data through posters with their peers and others and producing a winter science fair.

Keywords: Island Subsidence, Levee, Greenhouse Gas, Carbon Emissions, Public Education, Outreach

Poster Topic: Agriculture and Water Quality

Thermal Metabolic Performance of Wild Juvenile *Oncorhynchus mykiss* in the Lower Tuolumne River: A Case for Local Adjustment to High River Temperature

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Oncorhynchus mykiss and other species adjust to local thermal conditions. We tested the hypothesis that the Tuolumne River *O. mykiss* population below La Grange Diversion Dam is locally adjusted to the relatively warm summer thermal conditions of the Tuolumne River. Locally-caught wild juvenile *O. mykiss* (100-200 mm fork length) were tested, and then safely returned to the river within ~one day. Measurements of each fish's basic oxygen requirements for living (routine metabolic rate; RMR) and how quickly oxygen can be extracted from the water to support tissues of maximally swimming fish (maximum metabolic rate; MMR) were performed in swim tunnel respirometers. Paired measurements of RMR and MMR were obtained for 37 of 44 individual fish tested at 13°C to 25°C. Subtracting RMR from MMR estimates absolute aerobic scope (AAS), the capacity of each fish to supply oxygen to tissues above and beyond the basic routine need. These estimates and factorial aerobic scope (FAS = MMR/RMR) were used to define the optimum temperature range for tested fish.

Over the test temperature range of 13°C to 25°C, RMR increased exponentially with temperature and MMR increased linearly to a lesser degree. As a result, estimated peak AAS was at 21.2°C and the thermal range over which the fish maintained 95% of peak aerobic capacity was 17.8°C to 24.6°C. Between 13 and 23°C, all individual fish maintained FAS >2.0, suggesting fish possess sufficient capacity to perform necessary functions, such as swim, catch prey, digest a meal, avoid predators, etc. The upper thermal tolerance limit (the temperature where AAS is zero) was not determined due to study permit conditions, but must lie above 25°C. This study supports the hypothesis that juvenile *O. mykiss* captured in the lower Tuolumne River are locally adjusted to the relatively warm thermal conditions that typify the summer months in this location.

Keywords: *Oncorhynchus mykiss*; steelhead; temperature; Tuolumne;

Poster Topic: At Risk Species: Fish

Evaluation of the Condition of Wild Delta Smelt (*Hypomesus transpacificus*) Supplemented to the Refuge Population at the Fish Conservation & Culture Laboratory (FCCL)

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The Delta Smelt (DS) refuge population is serving as a genetic bank in case of species extinction in the wild. Each year, the refuge population at the UC Davis Fish Conservation and Culture Laboratory (FCCL) is supplemented with few wild DS (<100) to maintain the genetic integrity and replace lost refuge DS families. Fish were collected from Lower Sacramento River near Sherman Island and Deep Water ship channel in December and early January and cultured till spawning. The aim of this study is to investigate the changes in body weight (BW), fork length (FL) and Fulton's condition index (K) in captive wild DS collected for the 2012-2015 spawning season. The fish were fed with *Artemia* for one week and then weaned to dry feed. FL (g) and BW (mm) were measured two times (March and May) per year. A total of 211 individuals (76 females, 74 male and 62 not-sexed) were analyzed. Mean BW of the fish ranged from 1.98± 0.44 to 2.40±0.60 g, and FL ranged from 63.29 ± 3.75 to 69.83 ±4.52 mm. No significant difference of K values was found during the time that fish were held in captivity (from March to May), which may indicate the condition of fish didn't change during the time being held at the FCCL. For all years studied (except for 2012), the BW-FL relationship showed that captive wild male DS had a negative allometric growth ($b<3.0$) while females had a positive one ($b>3.0$), which indicates females gained weight faster than grew length. Wild DS captured in 2012 had a significantly ($p<0.001$) higher K value (0.85±0.14), indicating fish were healthier than the other years.

Keywords: Delta Smelt, refuge population, weight, length, condition factor

Poster Topic: At Risk Species: Fish

When Salmon go Salty...

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Recent research has improved our understanding of the distribution of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) around the California Central Valley system during rearing and outmigration to the ocean, however, it is notoriously difficult to link these data with adult survivors in order to identify the most successful strategy(s). By analyzing strontium isotopes in the otoliths (earstones) of adults after they have returned to spawn (i.e., focusing on the subset of "successful" individuals) we can retrospectively identify the size and age of individuals at the point at which they entered the estuary as juveniles. We have carried out size analyses using otolith isotope data from fall, spring and winter run adults, incorporating more than a decade of returns and spanning a large variety of hydrologic conditions. We have cohort-matched these isotopic analyses with size and distribution data from the Juvenile Fish Monitoring Program to attempt to identify broad patterns in juvenile phenotype expression and survival. Preliminary analyses have implied greater size variation at freshwater exit in wetter outmigration years, which may increase resilience to environmental perturbations via a portfolio effect. The ecological and management implications of these findings will be discussed, particularly in terms of hatchery release practices.

Keywords: Chinook salmon, otolith, strontium isotopes, outmigration, life history diversity, portfolio

Poster Topic: At Risk Species: Fish

An Investigation into Differences in Early Growth and Life History Strategies of Delta Smelt, *Hypomesus transpacificus*

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Previous studies conducted under the Fall Low Salinity Habitat (FLaSH) study have shown three different life history strategies among delta smelt. Using the data collected from the Interagency Ecological Program (IEP) long-term fish monitoring surveys the Fall Midwater Trawl and the Spring Kodiak Trawl, we further investigate the different life history strategies of delta smelt. Very little is known about any potential growth, morphological and/or behavioral difference in individuals with varying life history strategies. Here we investigate whether there is any connection between early growth rates, encompassing the first 90 days, and resident versus migrating life histories and look at inter-annual variability in this pattern.

Relevance: Understanding how delta smelt growth may influence movement pattern and life history strategies can assist in making informed decisions about habitat use and water management.

Keywords: Delta Smelt, Fall Low Salinity Habitat

Poster Topic: At Risk Species: Fish

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

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The Longfin Smelt Project Work Team has identified a suite of studies that would expand our current understanding of Longfin Smelt distribution, abundance, abundance trends, spawning location(s), and the relationship between Delta outflow and Longfin Smelt abundance (e.g. Kimmerer 2002). The UCD Davis Fisheries Research Team launched a field survey in 2015 to document the geographic extent of Longfin Smelt adult distribution and larval rearing in San Francisco Bay tributaries. In four tributaries, (Napa River, Sonoma Creek, Petaluma River & Coyote Creek) Longfin Smelt adults are sampled using an otter trawl while larvae are sampled using DFW's Smelt Larval Survey sled bi-weekly from January-April. In January and February of 2015, adult Longfin Smelt were found at the upstream extent of each bay tributary, with Coyote Creek having the highest catch. Larval Longfin Smelt were found in Napa Slough, Steamboat Slough and Mud Slough in the Napa River Marsh, and at several locations in the Petaluma River. No larval Longfin Smelt were found in Coyote Creek. Although the catch of Longfin Smelt in SF Bay tributaries during the spawning season was low in 2015, spawning and successful rearing of young in the Napa and Petaluma marshes of San Pablo Bay may be associated with the strong fall abundance to X2 relationship. Future studies will include developing otolith chemical fingerprints of SF Bay tributaries to determine proportions of the adult population originating from different natal areas of the estuary.

Keywords: Longfin Smelt, POD, X2, Restoration, Napa River, Petaluma River

Poster Topic: At Risk Species: Fish

Using Next-generation Sequencing to Identify Copepod Diets in Delta Smelt Habitat

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Food web interactions are fundamental characteristics of ecosystems. In California's Sacramento-San Joaquin Delta, endangered delta smelt, *Hypomesus transpacificus*, eat planktonic copepods. Copepods eat microplankton, but the food web interaction between copepods and microplankton is poorly understood; traditional prey sampling methods provide too little taxonomic resolution. Moreover, copepod species can have different feeding patterns, which can change in time and space. We use next-generation sequencing (NGS) to describe the microplankton community and copepod diets in a key delta smelt habitat, the Cache Slough Complex (CSC). Our results provide new insights into the food web that supports delta smelt and other fish species in the Delta. This project is part of a larger study of zooplankton abundance and species composition in the CSC.

Keywords: plankton, foodweb, genetics, copepod, predation

Poster Topic: At Risk Species: Fish

Quantifying Factors that Influence Salmon Smolt Predation in the San Joaquin River

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Telemetry studies that track downstream migration and mortality of salmonids in the Central Valley have demonstrated high mortality rates (80-99%) during emigration through the freshwater and estuarine portions of the watershed. In recent years, estimated survival rates for juvenile Chinook salmon in the lower San Joaquin River declined to approximately 5%, despite increased river flows and reduced spring water exports. The hypothesized cause of these low survival rates is a combination of factors that includes predation by non-native fishes. Although predation has been suggested as a major cause of salmon smolt mortality, there is insufficient research in the San Joaquin Delta to rigorously evaluate this hypothesis. Before any potential management actions might be considered, more studies are needed to quantify predator density, movement, and predation rates, as well as examine how environmental and anthropogenic factors influence predation of salmon smolts. To address this research need, a predation study took place over two years (2014-2015) in the San Joaquin River in collaboration with the DWR, DFW, USFWS, USGS and USBR. This study revolved around a predator density manipulation in nine 1-km river reaches (3 control; 3 predator removal; 3 predator addition). Effects were assessed before/after manipulations with 1) release of >3000 acoustically tagged Chinook salmon and steelhead smolts, 2) capture/release of acoustically tagged predators (striped bass, largemouth bass, channel catfish, and white catfish), 3) quantification of relative salmon smolt predation using drifting Predation Event Recorders (PERs) in each of the study reaches, 4) quantification of predator density and fish habitat using hydroacoustic imaging, 5) determination of prey items using genetic analysis of predator stomach contents, and 6) species diversity and abundance surveys. A total of 2,846 predators were captured and removed/relocated from 70 hr of electrofishing over two years. Preliminary results indicated spatiotemporal hotspots of predation within the San Joaquin River.

Keywords: salmon, predators, striped bass, largemouth bass, channel catfish, white catfish

Poster Topic: At Risk Species: Fish

Gonadal Fatty Acid Indices of Enzymatic Activity and Ratios in Wild Delta Smelt *Hypomesus transpacificus*

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Reproductive biology studies on gonadal fatty acid enzymatic activity are useful to determine essential or conditionally essential fatty acid deficiencies. Indices of enzymatic activity may be obtained from product-to-precursor ratios of fatty acids. Ovaries of 97 delta smelt at stage 4 Late were selected from the Spring Kodiak Trawl Survey (SKT) years 2012, 2013 and 2014 and were analyzed for their fatty acid profiles using a Gas Chromatography with Flame Ionization Detector system. Stations of the SKT covered the Deep Water Ship Chanel and Cache Slough (DWSC & CS), Confluence and Suisun Marsh. Indices of Enzymatic Activity of Delta 6 and 5 desaturase (D6D and D5D) and Elongase-5 from n-6 and n-3 fatty acids, and docosahexaenoic acid/arachidonic acid (DHA/ARA), DHA/eicosapentaenoic acid (EPA) and alpha linolenic acid/linoleic acid (ALA/LA) ratios were calculated.

Results show higher enzymatic activity of D6D, D5D and elongase-5 (C22:5n-3/C20:5n-3) for the n-3 products than for the n-6 products. By contrast, Elongase 5 for C20:4n-3/C18:4n-3 was lower than for C20:3n-6/C18:3n-6. Considering fish distribution, gonads from the DWSC & CL show relatively low DHA/ARA, DHA/EPA and ALA/LA ratios, and enzyme activity of D6D of the n-6 fatty acids, and Elongase-5 and D5D of the n-6 and n-3 fatty acids show an increase. Increase in D6D, D5D and elongase-5 activities have been related to diets deficient in DHA and ALA in rats. By contrast, D5D in Suisun marsh is relatively low, which suggests DHA and ARA formation is met. DHA and ARA are important in neuronal development and fish reproduction.

Our results suggest that indices of enzymatic activity may identify essential fatty acids requirements in delta smelt gonad such as docosahexaenoic acid and alpha linolenic acid in the Deep Water Ship Chanel and Cache Slough regions, and that food in Suisun marsh may be of better fatty acid quality.

Keywords: D6D, D5D, Elongase5, Reproduction, DHA, Enzyme Activity Indices

Poster Topic: At Risk Species: Fish

Historical Bioaccumulation of Methyl Mercury in Tidal Wetlands of San Francisco Bay, California

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San Francisco Bay, California is today considered a mercury-impaired watershed. Elevated concentrations of mercury are found in water and sediment as well as fish and estuarine birds. Sources of mercury to the watershed since 1845 include sediment-associated mercury from mercury mining, mercury losses from gold amalgamation activities in mines of the Sierra Nevada, aerial deposition of mercury from global and regional emissions to air, and the direct discharge of mercury to Bay waters associated with the urbanization and industrialization of the estuary. We assessed historical trends in mercury bioaccumulation by measuring mercury concentrations in feathers of the endangered California Ridgway's rail (formerly California Clapper Rail) using museum specimens. San Francisco Bay differed from findings in other ecosystem studies by showing extreme historic contamination with significant declines in mercury from the 19th to 21st century. Despite the decline, rails in San Francisco Bay continue to have six times higher mercury concentrations than congeneric counterparts in southern California estuaries. We developed a structural equation model to attribute variation in historical bioaccumulation to sources of mercury. Our final model indicated that mining in New Almaden Mining District explained 69% of the historical variance in mercury concentration in rail feathers in the South Bay and 53% of the variance in the Central Bay. We did not find a statistically significant connection between urban development or aerial deposition patterns and rail mercury concentrations, but urbanization and California-wide mercury mining explained 93% of the variation of mercury flux into Lake Tahoe. We estimated the toxicological consequences of extreme mercury exposure to rails from known correlations between feather and blood mercury concentrations, and concluded that mercury poisoning was likely a contributor to the population decline of the California Ridgway's rail, especially in the southernmost reaches of the Bay.

Keywords: Methyl Mercury, Feathers, Sediment, Structural Equation Model, Clapper Rail, wetland

Poster Topic: At Risk Tidal Marsh Species

Characterizing Functional Genetic Variation in the Salt Marsh Harvest Mouse, *Reithrodontomys raviventris*

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The salt marsh harvest mouse (*Reithrodontomys raviventris*) is endemic to diked and tidal marshes of the San Francisco Bay Estuary and is endangered due to habitat limitation and disruption. Conservation planning for *R. raviventris* is challenging because there are few data pertaining to current population sizes, gene flow, or selective pressures for this species. In addition, morphological species identification is problematic between the endangered species and another native and common *Reithrodontomys* species. This study addresses these challenges by genetically identifying sampled mice to species and characterizing functional genetic variation in populations across the range of *R. raviventris*. Using the mitochondrial cytochrome b locus, we have identified 124 *R. raviventris* individuals out of 167 samples collected from a total of 12 sites in Suisun, San Pablo, and South San Francisco Bays. Assessing genetic variation at functional loci contributes to our understanding of how endangered organisms adapt to a rapidly changing environment. In particular, adaptive immune system variation is frequently characterized in endangered species to assess the potential of limited populations to respond to disease. We have isolated the first adaptive immune system locus from *R. raviventris* in the major histocompatibility complex (MHC, Class II DRB). Preliminary findings indicate low genetic variation at this locus. This may indicate limited adaptive potential of populations, raising concern for the future of this species. Population studies using these loci will be used to estimate effective population size, population connectivity, and selection, enabling effective management of *R. raviventris* genetic diversity as mandated by state and federal regulations.

Keywords: endangered species, conservation genetics, immunogenetics, habitat fragmentation

Poster Topic: At Risk Tidal Marsh Species

Alameda and Contra Costa County Wildlife-Friendly Livestock Pond Initiative

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The survival and recovery of two California amphibians is dependent on the land stewardship of land-managers and cattle ranchers in the east San Francisco Bay Area. The California red-legged frog and California tiger salamander occur primarily on rangelands, where the dominant management activity is cattle grazing. Livestock ponds provide alternative, high-quality aquatic habitat for these species and have become vital features on the landscape as the amphibians' natural habitat is lost due to land development and conversion to cropland. Many of the stockponds in Alameda and Contra Costa counties were built 30-60 years ago and have met the end of their lifespan. They are now failing due to erosion and siltation. The Wildlife-Friendly Livestock Pond Initiative provides funds through the Natural Resources Conservation Service, with matching funds from California Rangeland Conservation Coalition signatories and other partners, to rehabilitate ponds specially for habitat and to provide a reliable source of drinking water for livestock. It is expected that this Initiative will not only directly improve breeding habitat for these amphibians and other native animal species, but will assist our local livestock operators with implementing a healthy land management strategy.

Keywords: rangeland, amphibians, grazing, habitat, restoration, partnerships, conservation, voluntary, livestock, ponds

Poster Topic: Biological Species

Evaluating Tidal Restoration: A Comparison of Restored and Managed Wetlands in the Suisun Marsh

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Suisun Marsh is the largest contiguous brackish water marsh in the western United States. Located in the center of the San Francisco Estuary, the marsh serves as important habitat for a number of fish and wildlife species including native fishes like delta smelt and Sacramento splittail. Much of the marsh consists of diked wetlands that are managed to support waterfowl; however, the Suisun Marsh Plan proposes to restore 5,000-7,000 acres in the marsh to full tidal action over the next 30 years. While there is a major push for tidal restoration in this area, little is known about the effectiveness of restoration actions for the benefit of native fishes or how current wetland management practices influence fish populations. To explore these issues, California Department of Fish and Wildlife scientists teamed up with researchers from UC Davis in order to evaluate the effectiveness of a restoration site at Blacklock (a property in the northeastern region of the marsh) that was restored in 2006. Adjacent habitats were also sampled, including a diked wetland that is managed as waterfowl habitat. A variety of methods were used to evaluate the effectiveness of the restoration and explore the benefits of current management practices. Monthly sampling included trawling for fish and zooplankton, as well as water quality monitoring. Results have found that while fish are using the restored site, fish abundance and diversity is lower than in adjacent slough channels. In addition, it was shown that diked wetlands can be beneficial by supporting productivity as well as abundant and diverse fish populations. The results from this project will have important implications for future restoration and wetland management actions in the Suisun Marsh and can serve as a model for evaluating other tidal restoration efforts in the future.

Keywords: Tidal Restoration, Managed Wetlands, Native Fish, Suisun Marsh

Poster Topic: Biological Species

The "Blob" Brings Subtropical Visitors to San Francisco Estuary

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A "blob" of warm ocean water was first noticed off of Alaska in late 2013. Now extending from Alaska to Baja California and about 5 degrees Fahrenheit warmer than normal, this is reportedly the most extensive and longest-lasting temperature anomaly in the eastern Pacific Ocean in the modern record. Many northern shifts of ocean species, from zooplankton to sea turtles, have been reported. Less well publicized are changes in the San Francisco Estuary's fish and invertebrate communities.

CDFW's San Francisco Bay Study first noticed increased catches of species associated with warmer ocean water in 2013. The number and abundance of these warm-water species increased in 2014 and 2015 and by summer 2015, we collected several subtropical species normally found off of Southern and Baja California.

The appearance of these warm-water species varied based on several life history traits, including the planktonic larval duration, spawning temperature cues, and their normal northern distribution. Larvae of species with long planktonic phases typically ride the south to north current that drives many warm water events. One such species, the California Tonguefish, first increased in abundance in 2013, and was the dominant flatfish in the estuary in 2014 and 2015. Other species require a minimum temperature for spawning that is not typical of the coastal ocean here, resulting in local recruitment only during extended warm-water events. The California Halibut is a good example of a species that spawns locally with warmer ocean water. Beginning in 2014, we started to record the largest year classes of juvenile halibut since the 1997-98 El Niño event.

Other subtropical species not typically found in the estuary, but collected in 2014 and 2015, included the California Grunion, Pacific Sardine, Queenfish, Shovelnose Guitarfish, Striped Mullet, Thornback, yellow rock crab, and brown shrimp.

Concurrent with this increase in subtropical species, many of the cold-water species that dominated our catches since the early 2000s declined. This includes English Sole and Dungeness crab.

Keywords: Warm water, fish, invertebrates, community

Poster Topic: Biological Species

Community Patterns and Environmental Associations for Fish Dominated Assemblages in the Upper San Francisco Estuary

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Understanding how species are interrelated and respond to environmental and spatio-temporal variation are central ecological and management questions. Long-term declines of pelagic organisms in the Upper San Francisco Estuary (USFE), including native species like the listed Delta Smelt, and introduced species, justify the need for analyses that target adult Delta Smelt. The Spring Kodiak Trawl (SKT) is an annual survey conducted by the Interagency Ecological Program that samples the USFE monthly from January to May. Data were analyzed over the years 2002-2014 to evaluate: 1) species relative abundance, 2) species association patterns, and 3) community structure in relation to temporal-spatial covariates. Species associations were analyzed using cluster analysis and community-environmental relations were inferred through Canonical Correspondence Analysis (CCA). Two alternative sampling units were used to evaluate community patterns: SKT stations (n= 39), and areas (groups of geographically close SKT stations, n= 10). Collected taxa included fishes (19 native and 16 introduced species); decapods (2 introduced species and 1 genus); and 1 introduced jellyfish. The introduced Threadfin Shad comprised most (33.6%) of the total abundance, while Pacific Herring, Chinook Salmon, Delta Smelt and Mississippi Silverside, each comprised at least 8 % of the total relative abundance across all samples and years. Among the 35 species considered in cluster analysis, several species associations derived from stations and areas were consistent, suggesting similar spatial-temporal distributions. Community structure for species occurring in at least 5% of the sample units was significantly related to abiotic factors (salinity, water temperature, turbidity) and spatio-temporal scales (latitude, longitude, month) in CCA and accounted for 31% (areas, 15 species) and 35.8% (stations, 9 species) of the community variation. These preliminary findings highlight the presence of heterogeneous, non-coevolved, species assemblages and their overall response to abiotic and spatio-temporal variability in the USFE.

Keywords: fishes, survey, community, species, abundance, distribution, environmental factors, introduced species

Poster Topic: Biological Species

Fish Rescue, Deterrence, and Lessons Learned at a Former Naval Dry Dock

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In 2011, a private company reopened a former naval dry dock located in northern San Francisco Bay. The Mare Island dry docks facility operates two dry docks, each capable of servicing vessels up to 700 feet in length and holding over 13 million gallons of water. Due to the facilities location within San Francisco Bay, several protected fish species including longfin smelt, Delta smelt, green sturgeon and three species of salmonid have the potential to occur in the area. Because of this, state and federal regulators required a first of its kind fish rescue and relocation to identify, quantify, and relocated fish that enter the dry dock during the movement of vessels into and out of the facility. Working with the operating company, state, and federal resource agency regulators, fish deterrence measures were designed and incorporated into the dry docks operations. By using an adaptive management approach, the number of native and protected fish encountered within the dry docks was significantly reduced. This poster will present a summary of the unique fish sampling location, species encountered, deterrence measures used, and lessons learned with balancing fisheries management, regulation, and private industry in a dynamic environmental setting.

Keywords: fish salvage, management, monitoring, fish deterrence, protected species

Poster Topic: Biological Species

Double-crested Cormorant Declines on San Francisco Bay Bridges

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The double-crested cormorant (*Phalacrocorax auritus*) is a seabird known to occupy urban structures as nesting habitat. The old east span of the San Francisco-Oakland Bay Bridge (SFOBB) and the Richmond-San Rafael Bridge (RSRB) have hosted the two largest colonies of this species in the region. However, boat counts of these colonies in 2015 showed precipitous declines on both bridges; less than half of each colony remained from 2014. The old east span of the SFOBB is currently being dismantled, and despite social attraction techniques employed to attract cormorants to nesting platforms on the new SFOBB east span, the cormorants have not used these structures yet. The RSRB has maintenance projects that have blocked off where the cormorants have nested in the past. So it begs the question: where will the double-crested cormorants nest in the future? We are undergoing a region-wide study of double-crested cormorant colonies by censusing aerial photographs (2004-2014). These results will provide a regional status assessment for this species, as well as inform us on how this species moves and uses different areas in the Bay. Double-crested cormorants are known to move to other colonies within their west coast range, as evidenced by a banded double-crested cormorant on the SFOBB; this bird was hatched at East Sand Island in Oregon, a large double-crested cormorant colony which is soon to be reduced by the U.S. Army Corps of Engineers in an attempt to protect endangered salmonids in the Columbia River Estuary.

Keywords: double-crested cormorant, regional population, decline, bridges

Poster Topic: Biological Species: Birds

Avian Predator Community and Foraging Behavior during Winter Tides in San Francisco Bay Saltmarshes

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Inundation from seasonal and diurnal tides can present predictable periods of increased risk for tidal marsh wildlife to avian predator species which are commonly found in and around San Francisco Bay saltmarshes. While tidal inundation is a normal phenomenon and part of the predator-prey interaction found in this habitat type, higher winter tides and storm surges present an event driven increase in predation risk which is difficult to assess through typical survival study methodologies. We attempted to expand on Evens and Page's (1986) observations which suggested increased predation on saltmarsh-dependent vertebrates occurred during high winter tides. Direct measures of mortality for marsh vertebrates is complicated by low recapture and detection probabilities and a general lack of knowledge on fine-scale movement between and connectivity of adjacent habitat parcels, especially for species of concern. Alternatively, in 2010 and 2011 we conducted paired low and high tide surveys between September and February to assess the number and activity of avian predator species in relationship to site, season, time of day and tide height at four tidal marshes in San Francisco Bay estuary. Commonly observed avian predator species observed included; White-tailed Kite, Great Egret, Northern Harrier, Great-Blue Heron and Red-tailed Hawk. We found that species diversity varied across sites, and that prominent species seemed to be influenced by adjacent land type bordering saltmarsh. During a January 2010 El Nino storm surge event, where the marshes were inundated above predicted tides, certain marshes recorded 50% capture efficiency by avian predators during marsh plain flooding. Our results suggest that while predation events were opportunist, the particular avian predator species and marsh site also influence predation risk during marsh flooding events, especially during storm surges.

Keywords: avian, predation, saltmarshes, storm surges, tides,

Poster Topic: Biological Species: Birds

Controlling Physical and Chemical Characteristics of Habitat Islands in the San Francisco Bay Estuary

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Islands in San Francisco Bay provide important nesting, resting, roosting, and foraging habitat for a myriad of waterbirds. However, creating islands that can provide persistent high quality habitat without continuous maintenance is challenging. Test islands utilizing 5 different surface treatments were constructed in 2013 at Eden Landing and the results were analyzed. Based on these results, 4 nesting islands were surfaced with a combination of (a) lime treatment (b) oyster shells and (c) pea gravel. Bird usage, vegetation establishment, cracking, and erosion are being observed. Preliminary results indicate that surfacing new and existing islands utilizing this surface treatment method provides benefit for nesting waterbirds at a reasonable cost.

Keywords: Islands, nesting, waterbirds, desiccation cracking, bay mud, saltponds

Poster Topic: Biological Species: Birds

Assessment of Habitat Displacement of Waterbirds in Central San Francisco Bay: Lessons from the 34th America's Cup Races

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In 2012 and 2013, San Francisco Bay (SFB) hosted the 34th America's Cup sailing races, an event which drew >1,000 spectator boats on the busiest race days. Many of the races coincided temporally and spatially with nesting and fall arrival of migratory waterbirds. Thus, the races provided a unique opportunity to quantify effects of high-density water traffic on waterbirds and identify best management practices to minimize future impacts. Our objective was to examine guild and species-specific responses to watercraft density. We divided the event area into 1-km^2 grids and conducted bird and boat counts from five fixed survey locations. We used generalized linear mixed models and model selection to assess the influence of habitat characteristics, boat abundance, event status, and weekday/weekend on the abundance of bird guilds (cormorants, grebes, gulls, seabirds). We conducted 177 ground surveys over 26 days, spanning event/non-event weekdays/weekends covering an average of 24.19±2.33 km^2 per survey. Mean waterbird density was 2.72±3.27 birds/km^2, and was higher on event (2.46±2.86 birds/km^2) compared to non-event (3.23±3.72 birds/km^2) weekends, with gulls displaying the greatest densities (4.84±3.04 birds/km^2). Mean boat density was 5.59±8.30 boats/km^2 (event weekends = 10.92±11.39 boats/km^2; non-event weekends = 3.69±1.61 boats/km^2). Motorboats (581%) and sailboats (256%) were more dense on event weekends than non-event weekends. Model results suggested that for every 100 additional boats, abundance decreased by 61% for cormorants, and 81% for grebes, while gull abundance increased by 195%. Boats were not a factor for other seabirds. Habitat characteristics affecting abundance included Beaufort sea state, distance to Alcatraz Island, and depth. Our results suggest some migratory bird species are displaced from Central SFB habitat by increased abundances of watercraft associated with large-scale events, such as America's Cup. Managers can use these results to consider impacts to waterbirds when planning for future events and water transit changes

Keywords: Disturbance, habitat displacement, vessel traffic, cormorants, gulls, grebes, seabirds

Poster Topic: Biological Species: Birds

Shorebird Response to Varying Salinity and Water Depth in an Experimental Design in Salt Pond Management

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San Francisco Bay Estuary supports thousands of shorebirds during fall and spring migration and over winter. These shorebirds rely on foraging opportunities in the bay mud flats and former salt production ponds. The South Bay Salt Pond Restoration Project plans to restore 50-90% of salt ponds to tidal marsh and the resulting sediment demand for restoration may reduce the extent of remaining mud flat. Ponds E12 and E13 in the Eden Landing Ecological Reserve were enhanced to provide varying levels of salinity and water depth for increased shorebird foraging and roosting opportunities. Each pond was divided into three cells and foraging mounds were constructed to provide variation in topography. Our objectives were to understand shorebird use and invertebrate colonization immediately post-construction. We surveyed shorebirds across the cells and within survey plots on foraging mounds during the first winter (Jan-April) post-construction. We measured water quality and collected benthic macro-invertebrate cores and sweep samples on the mounds. Small shorebirds, predominantly Western Sandpiper and Dunlin, were the most abundant shorebirds, with over 5,000 observed across all cells each month. Small shorebird abundance on foraging mounds ranged from zero to several hundred; however only 10% were observed foraging. We found aquatic invertebrates in our sweep samples and primarily ostracods in our sediment cores; however, we expect additional colonization to occur over time. Our research highlights immediate shorebird use of managed ponds manipulated to provide suitable water depths for roosting and foraging opportunities. Our on-going studies at these experimental ponds will increase our understanding of shorebird spatial distribution in relation to water salinity, depth, and invertebrate composition, and will provide managers with key information to optimize ponds for wintering and migrating shorebirds.

Keywords: waterbirds, salt ponds, habitat, invertebrates

Poster Topic: Biological Species: Birds

Surprising Invertebrates Common on the Bottom of Ship Channels of Our California Delta

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Wetlands, mainly marshes and flooded farms, have dominated this largest set of shorelines within California, the California Delta. But truly deep, ~13-meter (40-feet) -deep areas also are extensive there, a deep habitat reportedly used by white sturgeon, green sturgeon, salmon species, and other fishes. Diverse, novel, benthic sampling methods are being applied to these difficult-to-sample bottoms of ~13-m-deep dredged ship channels, and nearby, naturally deep areas, NW of Stockton, CA. Initial sampling during fall through spring, 2014-15, already has yielded surprising, previously unreported diversities and population densities of live sponge colonies, hydroids, and several taxa of live freshwater mollusks, among of other epibenthic and infaunal macro invertebrates there. Epifauna were common on these firm, muddy bottoms, swept by quite swift, murky freshwater. With secchi depths measuring 50 ~ 120 cm, no detectable light reaches these 13-meter-deep habitats, yet drift plants often are common there. Many epifauna there are suspension feeders, analogous to several organisms observed previously in Delta boat houses, in deep shade. Yet naturally, equally deep (and deeper) regions of the historical San Joaquin River are not far from ship channels. Centers of those river channel sites reportedly were never dredged, but apparently maintained deep naturally, through periodic scour such as during floods. With fishes associated with these deep bottoms, these deep channels may turn out to be a surprisingly naturally occurring, and sometimes man-made, significant habitat in our otherwise shallow Delta. Gratitude is extended to San Francisco Bay Wildlife Society and MWH Global, with encouragement of other agencies, for making this ongoing, expanding work possible on these otherwise rarely studied Delta resources.

Keywords: San Joaquin River, Delta, Dredged Ship Channel, Benthic Invertebrate Ecology

Poster Topic: Biological Species: Invertebrates

Benthic Response to Water Quality and Biotic Pressures in Lower South Bay-Alviso-Coyote Creek

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Benthic communities are monitored because they reflect the water quality over their lifetime, in some cases these communities may control available carbon resources, and are common prey for birds, larger invertebrates and fish. Benthic communities monitor stressful environments because they are stationary, accumulate contaminants, and respond, sometimes dramatically, to low and high phytoplankton biomass as well as low oxygen conditions.

Benthic communities can also affect water quality by grazing pelagic food resources and increasing the rate of nutrient regeneration through feeding and bioturbating the sediment. South Bay is a system dependent on phytoplankton as the base to the food web. Despite abundant nutrients, South Bay has limited phytoplankton production in the last several decades due to poor light conditions and high grazing losses.

Our primary objective is to characterize the South Bay's benthic community to determine if the observed changes can be attributed to water quality or biological pressures.

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

While amphipods and bivalves were both present year round in Guadeloupe and Alviso sloughs, amphipods were numerically dominant in the early months of 2014 and bivalves were the numerical dominant during the summer of 2014.

Changes to the numerically dominant species in the lower South Bay and the associated Sloughs represent changes in prey species and hence food quality to predators.

We acknowledge support from San Jose-Santa Clara Regional Wastewater Facility for funding this project.

Keywords: Benthic Community, Invasive Species, South SF Bay

Poster Topic: Biological Species: Invertebrates

Ramshorn Snails: Temperature, Density and Ammonia Effects on Growth and Fecundity

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Ramshorn snail (*Helisoma Anceps*) is an aquatic freshwater snail native to the California Delta. They are essential for the Delta Smelt larvae culture at the UC Davis Fish Conservation and Culture Laboratory (FCCL). Several experiments were conducted in this study investigating the effects of feed, stocking density, temperature, and ammonia on their growth, fecundity, incubation period, and hatching rate. Results show there was no significant difference on the growth, sexual maturation, and fecundity among the four food sources (algae pellets, algae pellets with oyster shell, fish feed, and fish feed with oyster shell) tested except for the egg amounts produced by the fish feed group, which was significantly lower. A significant increase of growth and fecundity was observed in the lowest stocking density (6 snails/125 mL) versus the higher densities (20 and 40 snails/125 mL). In addition, snails stocked in the lowest density started producing eggs around 30-40 days post hatch (dph), while snails in the two higher densities did not spawn until 70-80 dph. Temperature had significant effects on the growth and fecundity of the snails as well. Within the three temperatures (12, 16, and 20°C) tested, the growth and fecundity increased with the increasing of temperature. The incubation period of egg clutches increased in relation to temperature, and a significantly lower hatching rate was found at 12°C. Another factor affecting the hatching rate dramatically was the ammonia level eggs were exposed to. Four ammonia levels (0, 5, 10, and 20 mg/L) were tested, and results show a negative effect on the hatching rate when the ammonia concentration was increased. An ammonia concentration of 20 mg/L proved to be out of the survivable range, resulting in a hatching rate of 0%. No effect was observed on the incubation time with a fixed temperature at 20°C during the ammonia trials.

Keywords: Delta, aquatic freshwater snail, temperature, density, ammonia

Poster Topic: Biological Species: Invertebrates

Copepods, Fish and Clams Need Omega-3 Fatty Acids Too: Application of a Phytoplankton Food Quality Index

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Phytoplankton are the largest living component of biomass in San Francisco Bay and the primary food source upon which the Bay's consumers, such as copepods, crabs, flatfish and shrimp, ultimately depend. The patterns and processes of phytoplankton biomass variability in this estuary are well-studied, but what about the quality of this food resource for consumers? Food quality varies with phytoplankton attributes such as cell size, palatability, and biochemical composition. We address one biochemical component, the phytoplankton derived long-chain fatty acids (LCEFA). LCEFA cannot be synthesized by animals, yet are essential dietary components and serve as indicators of food quality for consumers. We used results of a new meta-analysis that indexes phytoplankton food quality based on differences in LCEFA content and essential fatty acid ratios among algal groups. This index reflects the greater nutritional value of diatoms, dinoflagellates, and cryptophytes, due to their higher LCEFA content and larger fatty acid ratios, as compared to that of chlorophytes and cyanobacteria. We applied the index to our USGS multi-decadal time series of phytoplankton community composition to explore seasonal, spatial, and long-term patterns of phytoplankton food quality in the different sub-embayments of San Francisco Bay.

Keywords: phytoplankton, nutritional value, food quality, diatom, essential fatty acids

Poster Topic: Biological Species: Invertebrates

Clean Vessel Act Program - SFEP's Comprehensive Approach to Curb Sewage Discharge

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Sewage discharge from boats in the San Francisco Bay is a well-known issue; however, we are lacking quantitative data to ascertain the extent or frequency of discharges. Due to limited knowledge, resources, or respect for the aquatic environment, some boaters do discharge their sewage into the San Francisco Bay and Sacramento Delta.

To address this issue, the San Francisco Estuary Partnership Clean Vessel Act Program is working with the Division of Boating and Waterways, the boating community, marina operators, and stakeholders to provide information and resources, as well as sewage infrastructure monitoring. This comprehensive program plans to address the largest barriers to proper sewage disposal as reported in the 2010 California Boater Survey Report, written by the Division of Boating and Waterways. It will also streamline the adoption of best management practices within boating facilities to proactively prevent sewage discharge.

This poster will highlight the different components of the San Francisco Estuary Partnership Clean Vessel Act Program, how it addresses the pollutant of concern, and what our expected outcomes are.

Keywords: Sewage, Water Quality, Outreach, Education, Boating

Poster Topic: Clean Vessel Act

San Francisco Bay Advanced Quantitative Precipitation Information (AQPI) System

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The Bay Area Advanced Quantitative Precipitation Information (AQPI) System employees a moderate-range C-band radar unit and four advanced short-range radar units strategically located in the Bay Area to augment existing C-band (NEXRAD) radar units, rain gauges, moisture probes and other technology to deliver to flood protection managers, reservoir operators, wastewater treatment plant operators, emergency responders, transportation officials and others very precise information on where, when and with what intensity precipitation will fall. Lead time will be between 2 and 12 hours.

NOAA, SFPUC and Sonoma CWA will contribute millions of dollars as matching funds for the $19 million expected to be funded by DWR with a 2015 Round Prop 84 grant.

In particular the AQPI system will give precipitation information about atmospheric rivers, the source of 50% of the Bay Area's precipitation. This is increasingly important as climate change is causing atmospheric rivers to be more intense and unpredictable.

Keywords: Atmospheric rivers, radar, flood protection, reservoir operations, emergency response, wastewater

Poster Topic: Climate Change

Hot off the Press! San Francisco Bay Responds to Record High Temperatures

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Headline from 2014: “U.S. scientists have announced that the year so far has been the warmest on record, setting expectations for a long, hot, dry year ahead” (ClimateCentral.org). News reports across California called 2014 the hottest year on record for the State as record high air temperatures were set across southern California while warmer winters made headlines in Northern California. Thus far, 2015 has shown no sign of cooling. Statewide air temperatures for January through March 2015 topped the 2014 record by 1.8°F, and air temperature at San Francisco International Airport recorded extreme values for winter months in both 2014 and 2015. We analyzed water temperature measurements made by USGS from 1968-2015 to determine how the estuary has responded to these record-high winter air temperatures. We compared seasonal trends in the six major sub-embayments of the Bay-Delta system: Lower South Bay, South Bay, Central Bay, San Pablo Bay, Suisun Bay, and the lower Sacramento River. Initial results of monthly average water temperature from 1968-2015 show periods of record high temperatures estuarywide in 2014 and 2015, correlating with record high air temperatures. Warming of the Bay has important ecological implications, water temperature is an important habitat attribute, and is a strong regulator of metabolism and life cycles of biota from bacteria to fish. We will extend our analyses to determine how much of the water temperature variability is explained by air temperature, and to measure seasonal and spatial patterns of estuarine response to the recent high-temperature anomalies.

Keywords: climate change, water temperature, record high temperatures, Bay-Delta

Poster Topic: Climate Change

Integrating Fluvial and Oceanic Drivers in Operational Flooding Forecasts for San Francisco Bay

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The U.S. Geological Survey (USGS) and National Weather Service (NWS) are developing a state-of-the-art flooding forecast model for the San Francisco Bay area that will predict watershed and ocean-based flooding up to 72 hours in advance of an approaching storm. The model framework for flood forecasts is based on the USGS-developed Coastal Storm Modeling System (CoSMoS) that was applied to San Francisco Bay under the Our Coast Our Future project. For this application, we utilize Delft3D-FM, a hydrodynamic model based on a flexible mesh grid, to calculate water levels that account for tidal forcing, seasonal water level anomalies, surge and in-Bay generated wind waves from the wind and pressure fields of a NWS forecast model, and tributary discharges from the Research Distributed Hydrologic Model (RDHM), developed by the NWS Office of Hydrologic Development. The flooding extent is determined by overlaying the resulting water levels onto a recently completed 2-m digital elevation model of the study area which best resolves the extensive levee and tidal marsh systems in the region. Here we present initial pilot results of a hindcast for a winter storm in January 2010, with a focus on the Coyote Creek and Guadalupe River watersheds. We also demonstrate the feasibility of predicting flooding on an operational time scale that incorporates both atmospheric and hydrologic forcings.

Keywords: Flood Forecasting; Sea Level Rise; Coastal Storm Modeling

Poster Topic: Climate Change

Resilient Design for New Coastal Shoreline Park

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Breuner Marsh is an innovative coastal shoreline park on San Francisco Bay. It is one of the first restoration projects in the San Francisco Bay Area that anticipates and accommodates rising sea levels due to climate change. Simultaneously, it creates habitat for endangered and threatened tidal marsh species endemic to the region, including the salt marsh harvest mouse, Ridgway's rail, and California black rail. Restoration, already underway, will benefit endangered species and provide public access to the Bay now and into the future. Following a century of coastal marsh loss from human development, the park restores and enhances 40 acres of tidal and seasonal wetlands. Using rigorous data and spatial modeling, the project plans habitat for endangered and threatened species and access to parkland for adjacent underserved communities.

Anticipating three feet of sea level rise, the team planned site grading to allow the tidal marsh to migrate incrementally to higher elevations over the next 50 to 100 years. The analysis also helped to identify the location of the trail to avoid disruptions to public access in the future. Surface models and vibrant three-dimensional graphics, were created for the community meetings. These provided the stakeholders with a clear idea of the design and played a significant role in consensus-building.

Preservation of Breuner Marsh is the culmination of planning by the East Bay Regional Park District following decades of community-led activism. Situated on a 150-acre shoreline site in the City of Richmond, the project fills a 1.5-mile gap in the San Francisco Bay Trail, a regionally significant trail system. A raised boardwalk integrates public access with protection of sensitive wetland habitat. These enhancements benefit the local community, including the adjacent neighborhood, with access to expanded open space.

Keywords: resilient design, habitat restoration, endangered species, shoreline, wetlands, public access

Poster Topic: Climate Change: Habitat Restoration

Movin' On Up: How Uplands Can Save Wetlands and Restore San Francisco Bay Tidal Marshes

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Over a billion dollars have been spent in San Francisco Bay restoring lands to tidal action, with millions more needed in order to reach the 60,000 additional acres recommended in the Baylands Ecosystem Habitat Goals Report. However, with limited dollars, decision-makers need to be strategic in selecting where, within the Estuary, those marsh acres should be restored. Upland areas that provide space for tidal marshes to move to as sea levels rise are not often considered in marsh conservation efforts. These areas will be essential in sustaining tidal marshes, especially under higher rates of sea-level rise. Acquiring these lands now will increase the diversity of marsh habitats along the elevational gradient, and provide a buffer to storm surge and flooding in the future. However, natural topography, development, and levees can block wetland migration. The Future San Francisco Bay Tidal Marshes Climate-Smart Planning Tool provides spatially explicit projections of marsh and marsh bird response to sea-level rise at multiple scales bay-wide. We demonstrate how Point Blue's Future Marshes Tool can be used to map upland areas around the Bay that can accommodate marsh migration and reveal areas that may require action such as removing barriers to current or future tidal flows. We will demonstrate areas where marshes are projected to exist through 2110, under a range of sea-level rise (0.5 m and 1.65 m) and accretion assumption scenarios. Including marsh migration space in permitting, acquisition, and restoration decisions can lead to a more resilient tidal marsh ecosystem. The goal is to guide decision-making in order to create a thriving Bay that provides habitat for diverse avian species and benefits Bay communities, both now and in the future.

Keywords: restoration, tidal marsh, upland transition zone, sea-level rise, planning tool

Poster Topic: Climate Change: Habitat Restoration

Bringing Climate-Smart Conservation to the San Francisco Bay Estuary: California Landscape Conservation Cooperative

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The California Landscape Conservation Cooperative (CA LCC) is a science-management partnership designed to promote understanding of and integrate climate science into natural resource management. Through the process of Climate-Smart Conservation, the CA LCC informs the implementation of conservation actions that increase the adaptive capacity of species and ecosystems in the face of climate change.

In the San Francisco Bay Estuary, the CA LCC has supported projects that develop management-relevant science on the topics of Pacific coastal fog and sea-level rise modeling. Collaborating with San Francisco Bay scientists and managers, the CA LCC is supporting the development of adaptation strategies in the Gulf of the Farallones National Marine Sanctuary that will be piloted in Green Resilient Shoreline projects. The CA LCC is also building collaborative partnerships through structured decision making to conserve tidal marsh ecosystems and scenario planning in support of the South Bay Salt Pond Restoration Project.

The CA LCC will continue to support Climate-Smart Conservation through collaborative partnerships and projects. Complete information about CA LCC efforts can be found on the CA LCC's website at californialcc.org and all data and products are made available on the Climate Commons (www.climate.calcommons.org). The Climate Commons also offers a starting point for discovery of climate change data and related resources, information about the science that produced it, and guidance for applying climate change science to conservation in California.

Keywords: Climate-Smart Conservation, Collaborative, Adaptation Strategies, Landscape-scale

Poster Topic: Climate Change: Habitat Restoration

Toward an Integrated Vision for a Resilient Urban Estuary: SFEI's Shore Resilience Initiative

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Climate change and associated stressors – sea level rise, water availability, temperatures, and extreme floods - as well as reduced sediment supply, add complexity and new challenges to managing the San Francisco Bay ecosystem. With an uncertain future, it is imperative that we promote landscapes that support Bay ecosystems which benefit both people and wildlife, that are likely to adapt, thrive, and be self-sustaining over time – that is, landscapes that are ecologically resilient. We need to integrate ecological, social and economic dimensions to create a holistic vision for an urbanized estuary.

SFEI (Resilient Landscapes Program) has undertaken interdisciplinary projects to begin informing and visioning this future landscape. Numerous historical ecology studies provide an understanding of San Francisco Bay's unique ecological and geophysical context. Comprehensive mapping of present day flood infrastructure and the adjacent Bay shore; the mapping of marsh edge change in San Pablo Bay; the tracking of the 'head of the tide' and quantifying sediment budgets in creeks around the Bay are providing much-needed information on the 'present condition' along with opportunities and constraints. Looking ahead, we are developing some of the first integrated resilient landscape visions for the Bay at Walnut Creek and Novato Creek with a focus on flood risk management and along the East Bay shore with the focus on wastewater. Tying these elements together, SFEI has been instrumental at the regional level for defining landscape resiliency, recognizing natural landscape units and promoting collaborative science.

Our poster demonstrates how these studies contribute to the development of broader visions for the Bay; it also shows where other initiatives undertaken by state and regional partners dovetail into the complex puzzle. Above all, it illustrates the need for further collaboration and integration in the Bay community if we are to develop and realize the vision.

Keywords: sea level rise, resiliency, ecology, flood, wastewater, Baylands, landscape planning

Poster Topic: Climate Change: Habitat Restoration

Tidal Marsh Vulnerability to Climate Change in the San Francisco Bay Estuary

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Multiple climate change drivers, including sea-level rise (SLR), extreme weather events and changes to atmospheric and oceanic conditions are expected to impact the structure and functioning of wetlands in the San Francisco Bay estuary and Delta. To assess tidal marsh vulnerability to climate change in the region, our team integrates observational, experimental and modeling approaches. Since 2008 at sites throughout San Francisco Bay, we have collected baseline data on marsh topography and vegetation composition, tidal datums, salinity, and historic accretion rates and integrated these data into a mechanistic model of SLR to project potential future habitat composition. Starting in 2015, we will expand our research program into Suisun Bay and the Delta. To better understand SLR impacts to marsh function and refine model accuracy, we are also conducting experiments to assess how plant productivity and decomposition vary along inundation gradients. In a "marsh organ" experiment at Petaluma marsh during summer 2014, we found differences in inundation-productivity relationships among three common species: *Spartina foliosa*, *Sarcocornia pacifica* and *Bolboschoenus maritimus*. *S. pacifica*, a dominant species in many of California's tidal wetlands, was least tolerant of greater inundation. Our initial results also suggest that organic matter decomposition rates varied by species, but were not highly affected by changes in inundation. On-going and future experiments will assess how productivity changes along the region's salinity gradient and how productivity varies in the presence of other species. Our data indicate that vegetation composition may be an important factor affecting how individual wetlands in the San Francisco Bay-Delta region respond to future climate change.

Keywords: primary production; salt marsh; sea-level rise

Poster Topic: Climate Change: Habitat Restoration

Greenhouse Gas Emissions and Carbon Sequestration Potential in Restored Wetlands in the Sacramento – San-Joaquin Delta, California

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Wetlands have the ability to accumulate large amounts of carbon (C), and therefore wetland restoration has been proposed as a means of sequestering atmospheric C to help mitigate climate change. However, wetlands are also the largest natural source of methane (CH_4), a potent greenhouse gas (GHG) that can offset wetland C sequestration. Few studies have quantified the balance between C uptake by wetland vegetation and ecosystem CH_4 dynamics during wetland development. In this study, we examined to what degree CH_4 emissions offset C sequestration during wetland restoration, and how this varies during ecosystem development. To address these objectives, fluxes of CO_2 and CH_4 were measured for multiple years using the eddy covariance method at two restored freshwater marshes of differing ages in the Sacramento – San-Joaquin Delta.

Both restored wetlands were net sinks of atmospheric CO_2, with the younger wetland sequestering between 141 and 1409 g CO_2 m^{-2} yr^{-1} and the older restored wetland sequestering between 2394 and 1466 g CO_2 m^{-2} yr^{-1}. However, both wetlands were large sources of CH_4, with higher CH_4 emissions from the younger wetland (up to 68 g CH_4 m^{-2} yr^{-1}) than the older wetland (up to 51 g CH_4 m^{-2} yr^{-1}). Both the wetlands were always C sinks with the younger wetland sequestering less C than the older wetland (up to 334 and 622 g C m^{-2} yr^{-1}, respectively). In terms of the GHG budgets, the younger wetland was a net GHG source, emitting on average 954 g CO_2 eq m^{-2} yr^{-1}, while the older wetland was consistently a GHG sink, sequestering on average 755 g CO_2 eq m^{-2} yr^{-1}. This study suggests that restored wetlands have the potential to act as net C and GHG sinks but this may depend on the time since restoration.

Keywords: Wetlands, restoration, greenhouse gases, methane, carbon dioxide, eddy covariance

Poster Topic: Climate Change: Habitat Restoration

Grindelia stricta Seed Germination Responses to Salinity

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Understanding seed dynamics in relation to the salinity regime that tidal marsh species experience is crucial for understanding the development of tidal marsh plant communities. Projected sea-level rise rates associated with climate change are expected to exceed tidal marsh accretion rates, leading these ecosystems to experience more saline conditions which may inhibit seed germination and growth by complicating physiological mechanisms.

Our research looks at regional variation in germination response to salinity of a widely distributed tidal marsh sub-dominant found throughout the west coast of North America*, Grindelia stricta.* We measured germination success, weekly, across eight populations of *G. stricta*, ranging from the San Francisco Bay to Oregon under varying salinity treatments (0-25ppt) in the lab. We modeled germination response to increasing salinity levels, running generalized linear models to then create logistic models for both the Northern region (Humboldt-Oregon) and Southern region (SF Bay) populations to better understand the establishment behavior of this species. We found support for our first hypothesis, which predicted that Northern region populations have an increased ability to allocate resource energy into individual seeds because of the increased freshwater input and overall lower salinity regimes they experience. We did not find support for our second hypothesis that predicted increased germination success in the Northern region sites under freshwater treatment. Finally, we did not find support for our third hypothesis, which predicted a steeper decline in germination success in higher salinity treatments between the two regions.

Our analysis shows that *G. stricta* germination declines with increasing salinity. Sea-level rise, inter-annual variation in precipitation, reduced freshwater inputs, and increases in temperature associated with climate change can cause increased salinity conditions affecting germination of *G. stricta* seeds. The application of germination success models in the context of increasing salinity may help to inform future tidal marsh restoration establishment efforts.

Keywords: *Grindelia stricta*, salinity, germination, sea-level rise, climate change, restoration

Poster Topic: Climate Change: Habitat Restoration

A Tale of Two Marshes: 15 Years of Vegetation Change at China Camp and Muzzi Marsh

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Understanding temporal trends in plant community composition is an important aspect of interpreting restoration outcomes. Here, we explore plant community trends from 1990 to 2005 along transects at a restoration site (Muzzi Marsh) and a reference site (China Camp) in Marin County, CA. Emerging from the drought of the late 1980's and early 1990's, average diversity per plot at China Camp was low and began to increase following above average rainfall during the 1994-1995 rain year. These trends were largely driven by the increase in sub-dominant, high marsh species. Diversity at China Camp peaked in 1998, following extreme rainfall during the major 1997-1998 El Niño event. Diversity slightly decreased between 1998 and 2005, but by 2005 was still about 3 times greater than during the drought period. Conversely, average diversity at Muzzi Marsh began to decline following above average rainfall during the 1994-1995 rain year, largely driven by the replacement of *Salicornia virginica* by *Salicornia pacifica* and *Spartina foliosa*. Diversity at Muzzi Marsh reached its lowest point following the 1997-1998 El Niño event due to increased dominance per plot, but rebounded by 2005. Percent bare ground decreased over time, declining to nearly zero by 2005. The development of sub-dominant species diversity at Muzzi Marsh lags far behind that of China Camp, even 30 years after initial restoration actions. However, total average diversity per plot is higher at Muzzi Marsh due to the intermixing of *Salicornia pacifica* and *Spartina foliosa.* These results highlight the need to consider the temporal trends at both reference and restoration sites to understand the dynamic nature of vegetation development.

Keywords: Restoration, Plant Community, Long-term data, El Nino, Drought

Poster Topic: Climate Change: Habitat Restoration

Environmental Education for Public Outreach

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The Sacramento-San Joaquin Delta and Suisun Marsh (Delta) is a vital natural resource as the largest estuary on the Pacific Coast, and an important supply of water for California. Given the local and statewide significant of the Delta, it is important that members of the public are aware of issues such as climate change which are impacting this natural resource. Over the last three years, the Sacramento-San Joaquin Delta Conservancy, in coordination with the Water Education Foundation, have coordinated multiple environmental education events for public outreach in the Delta. These events have covered a wide range of topics, from a symposium on the science behind climate change impacts to the Delta, to an event where agencies and the public came together in a forum on flow. Complex Delta issues, such as water conservation, take place at the individual as well as at the policy level. Therefore providing information and engagement on an individual level to the public is key for addressing the critical natural resource management issues of our time.

Keywords: environmental education, outreach

Poster Topic: Community Outreach

Living Arroyos Program: Forging New Community Partnerships

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Living Arroyos was initiated in July 2013 as a partnership of the City of Livermore, Urban Creeks Council, and Zone 7 Water Agency. The "Living Arroyos Program" increases opportunities for local residents to engage in hands-on stewardship and establish relationships to the streams in their community as 'apprentices' or volunteers. Local college students are engaged as 'apprentices' who learn real-world stream management techniques that complement their in-class learning. Apprentices are given real time, hands-on responsibility for implementing environmental improvement projects for agency partners.

In the first two years of the program, apprentices and volunteers contributed 3,338 hours planting acorns (6,894 acorns in 2,298 planting sites), installing riparian trees (3,389 native trees), seeding native grassed (150 lbs), and removing invasive weeds (470 cubic feet), and other trash and debris (25 cubic feet). The number of unique volunteers increased from 388 in the first year to 533 in year 2 and the response to the program has been phenomenal. A survey of Living Arroyos volunteers revealed that 88% of volunteers felt more knowledgeable about streams and streamside habitats, and 91% expressed interest in preserving urban streams. 98% of survey respondents said they would volunteer with Living Arroyos again.

In the first two years, this program has demonstrated that communities and local agencies can collaborate on stream projects that meet maintenance and permitting objectives. Further, the overwhelming community response implies that there is a thirst for opportunities to connect with nature, and a dedication to being part of and bringing about positive change in their environment. In this way, Living Arroyos has made significant strides toward achieving its goal of enhancing urban streams in the Livermore Valley and educating the public by re-establishing the connection between people and the arroyos in their own backyards.

Keywords: volunteer, partnership, community, habitat enhancement, stream maintenance

Poster Topic: Community Outreach

Citizen Science at the Don Edwards San Francisco Bay National Wildlife Refuge

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The Don Edwards San Francisco Bay National Wildlife Refuge, the SF Bay Wildlife Society, and the SF Bay Bird Observatory were interested in engaging the public through volunteer monitoring of plant and bird species. To do this the Refuge joined the national phenology network and Cornell's eBird database. The eBird.org and Natures Notebook websites offer a place for citizen scientists to catalogue their data which can then be used by scientists worldwide.

The DESFBNWR is a hotspot for spotting shorebirds, including many seasonal migrants. In order to encourage visitors to contribute to eBird, interpretive signs about the eBird project were installed at several entrances to popular birding trails. The sign points were stocked with flyers for birders to record their bird sightings and provided instructions on how to create an account. Five sighting points were established along a pathway for birders to compare which species they observed at different locations. This will give the Refuge a better idea if the plant restoration efforts are creating the appropriate habitat for native bird species.

This sparked an interest in monitoring several plant species in the same restoration area as the eBird trail. Since two individuals of each species were chosen to monitor staff has learned that many of the plants seemed to be having a tough time with the drought. One of the live oaks had a moderate show of acorns, but another, located slightly uphill from the first, did not show any fruit at all this year. Likewise, the California wildrose had trouble getting fruits reach full ripeness. The project has proven to be a fun way for volunteers to engage with the refuge's ecosystem and the staff look forward to learning more about the natural ebb and flow of the plants as they continue to monitor through the seasons.

Keywords: Citizen Science, Phenology, eBird, Monitoring, Volunteers,

Poster Topic: Community Outreach

Learning by Doing Science: Oakland High School Students Help in Salt Marsh Restoration Research at Lake Merritt

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Over 95% of tidal wetlands in San Francisco, including salt marsh, have been lost since the Gold Rush. A tidal lagoon extending from the Bay, Lake Merritt has suffered from heavy urbanization of its watershed causing pollution, sedimentation and poor water quality. Flood control measures replaced natural shorelines with concrete seawalls and landscaped banks. Measure DD, passed in 2002, aimed to return Lake Merritt to a more natural condition to improve water quality, and create a more natural habitat for wildlife and people to enjoy.

A demonstration salt marsh was constructed on the Lake Merritt Channel downstream from Lake Merritt Boulevard and upstream from 10th Street. Retired Measure DD Project Manager Joel Peter and Kristin Hopper of the Oaktown Native Plant Nursery invited Oakland High's Environmental Science Academy students to learn by doing real restoration work and citizen science at the site. Besides planting and weeding, students collected monitoring data from project experiments investigating the important question: What factors determine the survival of species added to the restoration site?

Pickleweed (*Salicornia pacifica,*), marsh *jaumea* (*Jaumea carnosa*) and marsh rosemary (*Limonium calfornicum*) were planted at three different elevations (tidal zones) on the shore protected in wire exclosures from geese and other herbivores. Some pickleweeds had rocks at the base, while others did not. The survival of the plants was monitored by the students from December 2014 (planting) to April 26, 2015. Their observations suggest that 1) protection from herbivores is essential, 2) pickleweed survives best in the low intertidal zone and near rocks 3) jaumea survives slightly better in the upland than in midzone, and 4) marsh rosemary survives better in the upland, although other factors of location may be important. The results are preliminary, but they suggest that an experimental approach to plant survival may be useful in the future.

Keywords: environmental education, citizen science, habitat, community, exclosures, elevation, biotic, abiotic,

Poster Topic: Community Outreach

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

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Seventeen City of Oakland staff are responsible for maintaining the City's storm drain system and its more than 10,000 storm drains, 370 miles of drain pipe, seven pump stations and 40 miles of creeks.

To supplement staff servicing the storm drain system, Oakland has enlisted volunteers to "adopt" storm drains and provide basic maintenance on their inlets.

A small amount of volunteer help goes a long way. Keeping inlets clear helps keep water flowing and ensure "only rain down the drain." This is especially helpful during storm events when blocked storm drains can back up and cause flooding. Year round storm drain maintenance helps intercept trash before it enters the storm drains and connecting creeks and water bodies. Removing litter before it enters the storm drains keeps our waterways cleaner and is required by the San Francisco Bay Regional Water Quality Control Board, which has imposed limits on the amount of trash entering our waterways. Cities are required to prevent all trash from entering their storm drain system by 2022. *Adopt a Drain* volunteers are critical for helping Oakland meet this requirement and reduce flooding and improve water quality.

Over 550 Oakland *Adopt a Drain* volunteers participate in the program. Program growth has been spurred by an easy to use online interface (www.AdoptaDrainOakland.com), social media and word of mouth, and timely news coverage during storm events. The City provides volunteers instruction, tools and supplies, assistance with debris pickups, and notification of impending storm events.

The www.AdoptaDrainOakland.com interface 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 software is open source and can and is being adapted freely by other municipalities.

For more information visit www.oaklandadoptaspot.org and www.AdoptaDrainOakland.com.

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

Poster Topic: Community Outreach

Creek and Watershed Interactive Map of Western Alameda County

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The Alameda County Flood Control and Water Conservation District (ACFC&WCD) sought to increase access and use of watershed information. Maps and information had only been available on paper or in for certain watersheds, some digital resources were online, but difficult to find and use.

To increase access, the ACFC&WCD took advantage of Google Earth technology to create a dynamic map of watersheds in Western Alameda County, featuring details on creeks, culverts, channels, storm drains, geographical features, roads and points of interest.

Approach:
To create the map, we engaged map professionals to design a layered file, giving users the ability to turn features on and off. Each mapped watershed is accompanied by information on the area; including lists of waterbodies, flora, fauna, restoration projects, recreation opportunities, and ways that volunteers can get involved. To support access, the map and the watershed information is hosted on the ACFC&WCD website, http://acfloodcontrol.org/resources/explore-watersheds. The content for each watershed is hosted on its own page, which increases search optimization.

Results:
Presentations of the Map have resulted in interest from environmental professionals, naturalists and educators. It will be used as part of an ACFC&WCD/Sulphur Creek Nature Center partnership Watershed Education Program. A Google Earth Station in the program allows students and visitors to use the map. Teachers can use it to perform simple lessons, such as locating their school on a map and finding the nearest creek and then its watershed.

Conclusions:
The map provides access and improved learning about watersheds while exposing the public and students to current technology. The regional map has the ability to demonstrate the larger watershed picture. Students can easily make connections between their surroundings and the system of watersheds in which they live.

Keywords: Education Map Google Earth, website, interactive, learning, teaching tools

Poster Topic: Data/Tools: Mapping

Mapping Dynamic Estuarine Intertidal Features using WorldView-3 and Unmanned Aerial Surveillance

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One key uncertainty identified within the South Bay Salt Pond Restoration Project (SBSPRP) Adaptive Management Plan is whether the use of mudflats as a sediment source for restoration will come at the expense of critical mudflat habitat. If so, erosion of existing mudflats may result in changes in foraging area and food resources, thus reducing the ecosystem benefits of this habitat to waterbirds and other species As a result, the SBSPRP requires methods for tracking changes to the distributions, extent and quality of mudflats. One impediment to tracking mudflats using imagery is that they must be mapped while they are exposed at the lowest tides (mean lower low water, MLLW), due to restricted wavelength penetration in water for most sensors. An interdisciplinary team of scientists is developing a three step approach for mapping mudflats that is both cost-effective and modular. As a first step, the USGS obtained a World View-3 satellite image close to MLLW in Spring 2015 through the Commercial Imagery Derived Requirements Program. In addition to the demonstrated potential of standard multispectral imagery to map exposed mudflats, the team will utilize the Coastal Blue Bird (CBB) to map shallow water mudflats. Mudflat boundaries derived from this image will be compared to existing high resolution LIDAR to delineate a baseline for tracking changes into the future. Second, we will explore the use of integrating Unmanned Aerial Surveillance (UAS) with commercial cameras outfitted with CBB filters for tracking mudflat extent and quality. Mudflat ”quality” here refers to the presence (and density) of biofilm along the mudflat. Third, we will compare and asses the ability of both the satellite and UAS based CBB imagery to delineate mudflat distribution, extent and quality.

Keywords: mudflats, remote sensing, biofilm, UAS, restoration, salt pond, LIDAR

Poster Topic: Data/Tools: Mapping

Use of GIS and GPS Technology in the Invasive *Spartina* Project's Revegetation Program

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Since 2011, the State Coastal Conservancy's Invasive *Spartina* Project (ISP) has undertaken a program of active revegetation in San Francisco Bay salt marshes with the goal of enhancing habitat for the endangered California Ridgway's Rail (*Rallus obsoletus obsoletus*). Most of the ISP's revegetation plantings involve two plant species, Pacific cordgrass (*Spartina foliosa)* and marsh gumplant (*Grindelia stricta*), which are important components of rail habitat. Throughout all stages of the implementation of the ISP's revegetation program, GIS and GPS technology is used to plan, install, and monitor plantings. During the planning and ground-truthing stage, the ISP uses remote sensing data including aerial imagery and LiDAR to target plantings to particular areas within each revegetation site. After the general planting area has been selected, biologists go into the field to select and flag locations for individual patch locations based on both planting suitability and likely value as rail habitat. At each patch location, biologists use a professional-grade GPS unit to map the plot and collect data concerning biotic and abiotic characteristics of the patch location. During installation, GPS units loaded with this data are used to plan efficient movement of materials and personnel through the site and to record progress of installation. Every year, the ISP monitors revegetation plantings, using GPS units to collect data on survivorship and expansion. The ability to easily couple the data collected during ground-truthing, the data collected during installation, and the data collected in each year's monitoring allows us to easily compare the success of sites and of installation techniques. These comparisons allow us to make informed adaptive management decisions concerning the selection of future revegetation sites and planting methods.

Keywords: GIS, revegetation, *Spartina*, *Grindelia*, restoration, Ridgway's Rail

Poster Topic: Data/Tools: Mapping

Mapping Occurrences of California Ridgway's Rails

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Annual monitoring for the endangered California Ridgway's rail (*Rallus obsoletus obsoletus*; hereafter, rail) is an essential component of the State Coastal Conservancy's Invasive *Spartina* Project (ISP). Rails are year-round residents of the tidal wetlands of the Estuary and co-occur with native and non-native *Spartina.* The ISP requires information on the number and distribution of rails at each site for the planning and permitting of *Spartina* treatment. Every year since 2005, the ISP conducts breeding-season surveys for the rail. Biologists navigate to pre-selected survey stations using GPS and record the estimated distance and direction to each rail detected during the survey period. Then, using GIS in the office, they are able to plot the location of every rail detected on a map. This mapping method helps the ISP to more accurately estimate the number of rails at each marsh, as well as to visualize the distribution of rails throughout the marsh. Rail location data not only guide the ISP in planning and permitting, but also in site access during on-the-ground *Spartina* treatment and monitoring. Rail locations are included on ISP biologists' GPS units when mapping and treating non-native *Spartina*, helping to avoid rails and minimize the impacts of ISP activities in the marsh.

Keywords: California Ridgway's rail, GIS, GPS, mapping

Poster Topic: Data/Tools: Mapping

Enhancing Regional Capacity for Habitat Project Tracking, Assessment and Reporting

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This project significantly expanded EcoAtlas, the State's repository for wetland project data, to include hundreds of habitat protection, enhancement, and restoration projects throughout the Central Valley and San Francisco Bay-Delta regions. Detailed project data critical for natural resource managers, such as acres of distinct habitat types, species benefitted by project, project progress and status, and funding information, were added to the project tracking database. Additional functionality was added to EcoAtlas to allow for the visual display, querying and extraction of this tabular and spatial project data. As new projects are developed and existing projects enter new phases, information can be expanded and updated through the new data portal that allows project proponents to enter and update information displayed in EcoAtlas. Additional data layers such as modern Delta habitats were added to EcoAtlas to allow users to evaluate projects within the context of existing ecological resources and other landscape characteristics and uses.

Additional data, querying and mapping functionality will allow for improved analyses of changes in habitat extent and condition; landscape-scale conservation planning; prioritization of restoration areas; evaluation of progress toward meeting conservation objectives; partnership establishment; and leveraging of 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 conserve important habitats strategically in the future.

Keywords: Database, Habitat Restoration, Project Tracking, Data

Poster Topic: Data/Tools: Mapping

Invasive *Spartina* Mapping and Monitoring Methods

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The State Coastal Conservancy's San Francisco Estuary Invasive *Spartina* Project (ISP) has used GIS and GPS data collection software since 2000 to map and monitor invasive *Spartina* in the San Francisco Bay. Mapping efforts have documented the reduction of the infestation from a peak of 319 hectares to less than 12 hectares as a result of regionally coordinated treatment efforts since 2005.

The project's mapping methods have become increasingly sophisticated over time in order to address the complexity of locating, identifying and ensuring the treatment of small remaining patches of invasive *Spartina*. The project integrates current-year genetic testing results into GPS data layers to inform differentiation between the invasive *S. alterniflora x foliosa* and the native *S. foliosa* in the field, and tracks the location and extent of patches of invasive *Spartina* and their treatment on an annual basis. Technical advances include use of tablet PCs running customized ArcPad data collection software to inform mapping efforts, speed data collection and validate data entry at time of collection; use of ArcGIS data reviewer software to automate data quality control tasks; and use of ArcGIS Server to allow real-time data synchronization between surveyors in the field to ensure thorough mapping and treatment efforts.

This poster addresses the complexity of mapping a hybridizing population of invasive plants to inform eradication efforts over time. The associated interactive GIS and GPS mapping displays demonstrate the patch-level data collection and visualization methods currently used by the ISP to map and track treatment of invasive *Spartina*.

Keywords: *Spartina*, Conservancy, Invasive, GPS, GIS

Poster Topic: Data/Tools: Mapping

The NOAA Sentinel Site Cooperative: Partnering to Meet the Challenges of Sea Level Rise in the Bay Area

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Planning for and adapting to changing coastal flood conditions requires regional collaboration to translate and focus available science, identify vulnerabilities, and consider feasible adaptation options. The San Francisco Bay and Outer Coast Sentinel Site Cooperative is one of five cooperatives in the nation participating in a NOAA program focused on fostering regional resilience to sea level rise. The Cooperative Management Team is made up of representatives from the San Francisco Bay Conservation and Development Commission, NOAA's Office for Coastal Management, NOAA's Greater Farallones National Marine Sanctuary, the San Francisco Bay National Estuarine Research Reserve, and California Sea Grant. The Cooperative aims to (1) improve the capacity of coastal decision-makers to use sea level rise and coastal flooding models and tools, (2) support on-the-ground efforts of partners engaged in adaptation planning in the region and facilitate sharing of lessons-learned, (3) bridge adaptation work focused on natural resources and built communities, (4) foster a regional coastal intelligence network to allow for early detection and forecasting of changes to critical marsh ecosystems, and (5) facilitate integration of science and management at the ocean-bay interface. The Cooperative is currently working to improve collaboration and build new partnerships that connect local- and regional-scale NOAA programs and partners to national NOAA resources. Toward this end, we showcase several Management Team efforts in the San Francisco Bay Region, including Adapting to Rising Tides, the Climate-Smart Adaptation Project for the North-Central Coast and Ocean, and the collaborative "Lifting the Fog" workshop series focused on sea level rise models and tools. We highlight the freely available information and decision-support tools that underlie these projects, as well as project-specific products that can be used to initiate or strengthen adaptation planning efforts throughout the region.

Keywords: sea level rise, resilience, vulnerability, adaptation, climate change, decision-support tools

Poster Topic: Data/Tools: Monitoring the Bay

Watershed Based Ecosystem Condition Profiles in Santa Clara County

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The Santa Clara Valley Water District's (District) Safe, Clean Water and Natural Flood Protection Program is a voter approved program with five, broad-sweeping priorities. Priority D – Restore Wildlife Habitat and Provide Open Space is a countywide effort to restore and protect wildlife habitat, and provide opportunities for increased access to open space. The Ecological Data Collection and Analysis project (Priority D5) focuses on establishing a comprehensive, watershed approach to monitoring and assessment, improving the District's and other organizations' capabilities to make informed watershed and asset management decisions.

SFEI's Wetlands Science team is working with District staff to implement their Ecological Monitoring and Assessment Framework (Framework) in five watersheds within Santa Clara County. The District's Framework employs the science tools developed to support California's Wetland and Riparian Protection Policy, and Wetland and Riparian Area Monitoring Plan (WRAMP). WRAMP recommends the USEPA's three-level approach to wetlands assessment: (1) Mapping – to characterize the distribution and abundance of aquatic resources; (2) Rapid Condition Assessment – to conduct probability-based rapid field surveys assessing the overall ecological condition of target resources; and (3) Intensive Assessment – to conduct focused monitoring techniques to better understand potential causes of poor ecological condition. The watershed approach with quantitative measures is consistent with the USACE and USEPA compensatory mitigation for losses of aquatic resources final rule, and regulatory guidance.

SFEI has been working with the District to characterize and track the distribution and abundance of the aquatic resources based on the Bay Area Aquatic Resources Inventory (BAARI) and District's ArcGIS inventory, and assess the overall ecological condition of streams based on the California Rapid Assessment Method (CRAM). SFEI developed probability based sampling designs and is supporting the District in assessing and reporting on stream and watershed conditions using CRAM in five watersheds within Santa Clara County.

Keywords: Ecological Monitoring and Assessment Framework, CRAM, watershed approach

Poster Topic: Data/Tools: Monitoring the Bay

Innovative Visualization Tool for Water Quality Data

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The Contaminant Data Display and Download Tool or CD3 (cd3.sfei.org) is an innovative visualization tool for accessing water quality data for the San Francisco Bay-Delta and northern montane regions. It is the primary tool for accessing and downloading the San Francisco Bay Regional Monitoring Program's (RMP) long-term dataset and other project data stored in the San Francisco Estuary Institute's (SFEI) Regional Data Center (RDC). Data stored in SFEI's RDC are comparable with the state's data management business rules and are regularly exchanged with the California Environmental Data Exchange Network (CEDEN).

CD3 was recently redesigned to leverage SFEI's other interactive mapping efforts. It debuts impressive new functionality, including enhanced spatial querying and dynamic statistical summaries. Other key benefits of the redesigned tool include aggregating data from different projects and sampling events for an analyte; accessing all data collected across multiple years for a project; spatial querying by county, Water Board, hydrologic region, or user-defined area of interest; generating surface model maps for RMP data; selecting among several chart types for data analysis (e.g., mean and error; box and whiskers, histogram); downloading data as a tabular or spatially displayed dataset; and customizing and downloading charts for use in reports and presentations. The tool is updated regularly with new datasets and has the flexibility to display all public data stored in SFEI's Regional Data Center database.

The data stored in CD3 comprise the informational base of the RMP. By providing dynamic and transparent access to one of the most rigorously vetted and significant data collections in California, CD3 inspires confidence in the RMP's scientific analyses, findings, and recommendations.

Keywords: data visualization, water quality

Poster Topic: Data/Tools: Monitoring the Bay

Remote and In Situ Observing -- San Francisco Bay Ecosystem (RIO-SFE) 2: Model Validation with In Situ and Satellite Data

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One challenge facing Earth system science is to understand and quantify the impacts and feedbacks of human influences on rivers, estuaries, and coastal zone ecology especially in regions of high population density like the San Francisco Bay and Delta Ecosystem (SFE). The goal of our NASA Interdisciplinary science project is to put in place a modeling framework to inform stewardship of freshwater and marine resources within the SFE and adjacent ocean ecosystems. Our SFE project combines four components: (1) satellite observations, (MERIS, HICO, Landsat-8, and in the future Sentinel-3); (2) field observations (nutrients, phytoplankton, suspended sediments, CDOM, and optical properties); (3) the CoSiNE ecological model integrated with (4) a SCHISM hydrological model of the SFE.

The unstructured grid model known as SCHISM (Semi-implicit Crossscale Hydroscience Integrated System Model) is used to model the San Francisco Bay/Estuary with a variable spatial resolution from 1 km at the ocean boundary to 10 meters inside the estuary. The lateral boundary conditions outside the Golden Gate are provided by the Regional Ocean Modeling System (ROMS) model covering the entire California coast. Both SCHISM and ROMS are coupled with the CoSiNE biogeochemical model with 13 components. Here we present initial results of coupled SCHISM and CoSiNE model validation results with *in situ* and remote sensing. Results from a 10-year model hindcast/reanalysis will be validated against in situ and remote sensing data to compare drought and non-drought years.

Keywords: San Francisco Bay, modeling, in situ, remote sensing data

Poster Topic: Data/Tools: Monitoring the Bay

Remote and In Situ Observing -- San Francisco Bay Ecosystem (RIO-SFE) 1: Remote Sensing and In Situ Data

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One challenge facing Earth system science is to understand and quantify the impacts and feedbacks of human influences on rivers, estuaries, and coastal zone ecology especially in regions of high population density like the San Francisco Bay and Delta Ecosystem (SFE). The goal of our NASA Interdisciplinary science project is to put in place a modeling framework to inform stewardship of freshwater and marine resources within the SFE and adjacent ocean ecosystems. Our SFE project combines four components: (1) satellite observations, (MERIS, HICO, Landsat-8, and in the future Sentinel-3); (2) field observations (nutrients, phytoplankton, suspended sediments, CDOM, and optical properties); (3) the CoSiNE ecological model integrated with (4) a SCHISM hydrological model of the SFE. Here we compare *in situ* biological and optical data with remote sensing from two instruments; the Hyperspectral Imager for the Coastal Ocean (HICO, 100 m GSD, hyperspectral imager, 2009-2014) and Landsat-8 (30 m GSD with a limited land-oriented band set, ongoing). The ship data provides a detailed understanding of conditions in the estuary and the satellite data is used to put that data in the context of the entire system.

Keywords: remote sensing, water quality measurements, ecosystem modeling

Poster Topic: Data/Tools: Monitoring the Bay

Automated Tool for Generating Recurrent Storm Events of Different Durations from Raw Precipitation Data

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PRECIP is an automated tool for developing recurrent storm event hydrographs from raw precipitation data. The model can read in raw precipitation data at any time step, in incremental or cumulative format from a text or spreadsheet file. The data is evaluated and the peak annual precipitation for each year is computed for any duration from 5 minutes through 96 hours. From this annual data, the return frequency for each duration is computed using a Log Pearson Type III analysis. These return frequencies are then used to develop balanced storm hydrographs with a specified return frequency of 1-year through 500-year event. The duration of each event hydrograph can be set by the user from a 1-hour to a 96-duration. The hydrographs can be saved to a text file for pasting input into any hydrologic model.

The full time series of the precipitation data can be used in the analysis, or specific time periods from the data can be used to evaluate changes in precipitation patterns over the time period of the data collected by the gage. The data is displayed graphically and can be exported into a report. All the computed data results, frequency summary, and outlier analysis is summarized in an output file for each gage.

Keywords: Precipitation, Hydrograph, Stormwater, Frequency Analysis, Rainfall, Log Pearson

Poster Topic: Data/Tools: Monitoring the Bay

The Climate Commons: Making Climate Science Accessible for Conservation Planning

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The Climate Commons is a comprehensive online library of climate change science relevant to conservation planning in California. Land managers can rely on the Commons as a starting point for discovery of climate change data and related resources, information about the science that produced it, and guidance for applying climate change science to conservation.

Climate data and information are organized in searchable catalogs that are continuously updated. The Commons also contains helpful materials explaining key concepts for applying climate change science in the conservation planning process, and for getting started with processes such as vulnerability assessment and scenario planning. Data hosted by the Commons includes the California Basin Characterization Model, a collection of downscaled climate and hydrologic projections used to evaluate the impacts of future climates on biodiversity, natural resources, and human systems. Tools developed for understanding and projecting changes due to sea-level rise and other impacts to the San Francisco Bay Estuary are compared side-by-side, and the spatial datasets behind them are made available for download.

The Commons, developed in partnership with Point Blue Conservation Science and UC Davis Information Center for the Environment, is the repository for all products of the applied research projects funded by the California Landscape Conservation Cooperative. Project leads work with the Commons team to provide their results and data along with documentation to support ongoing use, promoting the delivery of science to managers in a timely and relevant manner to inform the stewardship of a resilient San Francisco Bay Estuary ecosystem.

Keywords: Climate change data, online resources

Poster Topic: Data/Tools: Network

Delta Watershed Initiative Network

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The Sacramento-San Joaquin Delta and Suisun Marsh (Delta) waterways are identified as threatened and are listed on the Clean Water Act Section 303(d) list as impaired by multiple pollutants. The current drought and projected impacts of climate change are expected to exacerbate existing water quality problems. Many water quality and ecosystem problems have multiple causes and are therefore best addressed using an integrated and coordinated approach, at the watershed level. A comprehensive approach supports sound science, informs adaptive management, uses innovative thinking, and implements best management practices. The Sacramento San Joaquin Delta Conservancy (Conservancy) is moving forward with this approach through the Delta Watershed Initiative Network (Delta WIN). Delta WIN is an initiative that integrates multiple efforts to improve water quality and ecosystem health while providing regional and state-wide benefits. One main focus of Delta WIN is coordinated water quality monitoring. A framework and toolset for coordinated monitoring exists under the auspices of the California Water Quality Monitoring Council and its workgroups. This framework is to guide evaluation and reporting on the public's investment in ecosystem health across its various public policies and programs throughout the Bay-Delta ecosystem. Delta WIN is piloting this framework through coordinated water quality monitoring using standardized methods. Achieving a vision for coordinated regional efforts includes applying standard methods through existing state infrastructure rather than developing new stand-alone programs.

Keywords: water quality, pollutants, watershed, standardized methods

Poster Topic: Data/Tools: Network

Estuary-wide Data Repository

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The Sacramento-San Joaquin Delta (Delta) is the backdrop for some of the most pressing water supply and ecological 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 mandates for water resources and ecological management. In 2014, a Data Summit was held to discuss the vision for an open community of science with interoperability standards, state-of-the-art data exchange and access tools, and the documentation to correctly interpret the data. To support this goal, the Sacramento-San Joaquin Delta Conservancy is collaborating with the Aquatic Science Center and Delta Science Program to integrate disparate data from multiple sources and legacy data that are currently not currently in any of the State's data sharing systems. This project is expanding the existing infrastructure to house water quality data from the Delta to address management questions. Ultimately, this makes it possible for data to be uploaded, aggregated and displayed in tools such as those created under the auspices of the California Water Quality Monitoring Council, like EcoAtlas and the My Water Quality Portals. The project presents an opportunity to provide accurate, accessible, and synthesized data for scientists and decision-makers as a foundation to inform management actions with the best available science.

Keywords: data exchange, tools, integration, synthesized, best available science

Poster Topic: Data/Tools: Network

WARMF-Online: Data and Model-based Forecast Visualization for Real-time Management of Salinity in the San Joaquin Basin

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Collaborative, real time water quality management is best facilitated when all stakeholders have a forum and toolset for aggregating and accessing the data and information used to inform management decisions and operations. These data include reports, GIS data, DEMs, telemetered data (real time, discrete and historic), model inputs and results, graphs, visualizations and much more. The SJR real time management program has developed a comprehensive online resource to support collaborative efforts to provide a salt assimilative capacity forecasting model and supplemental decision support tools to improve salinity management in the lower San Joaquin River. The online decision support platform combines WARMF model output visualizations alongside customizable data dashboards with the supplemental data visualizations for understanding the bigger picture. The tools provide collaborators with timely information and a transparent process for estimating their salt load contributions to the River in relation to other dischargers in the Basin. The collaborative forum creates opportunity to coordinate west-side Basin salt loading schedules with reservoir releases of high quality flows from the East-side of the Basin. The talk will provide information on the long-term goals of the project, demonstrate accomplishments to date and details of the various GIS-based visualization techniques being deployed on a publicly accessible web server to support real-time salinity management.

Keywords: salinity, real-time, visualization, San Joaquin River, TMDL

Poster Topic: Data/Tools: Network

California Estuary Monitoring Workgroup – Using Web Portals to Improve Scientific Understanding

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The California Water Quality Monitoring Council was mandated to improve the efficiency of California's water quality and associated ecosystem monitoring, assessment, and reporting through increasing collaboration between the numerous governmental agencies and non-governmental organizations that monitor California's waters. Under the guidance of the Monitoring Council, the Estuary Monitoring Workgroup is answering stakeholder questions with a collaborative toolset that brings together peer-reviewed datasets with tools to help practitioners tell their stories. One of the tools is the California Estuaries Portal, an interactive website under development that will present information for decision makers and the public on the health of California estuaries. The portal includes information about water quality and quantity, living resources, habitat, ecosystem processes, and stewardship for California's estuaries. While currently the focus is on the San Francisco Bay-Delta Estuary, content relating to other California estuaries will be added in future updates. The Estuary Monitoring Workgroup continues to develop the public portal, which will include improved web-based tools for enhanced access to environmental monitoring data. Currently the workgroup is developing additional data query and visualization functions for the Department of Water Resources' online interactive Delta Water Quality Conditions Report, as well as the U.S. Fish and Wildlife Service's Delta Juvenile Fish Monitoring Program. Additional portal content is also being developed for several ecosystem health indicators detailed in the State of the Estuary Report 2015. To learn more about the Estuary Portal and how you can participate in this collaborative effort, visit: www.mywaterquality.ca.gov/eco_health/estuaries/.

Keywords: Water quality, species, data, habitat, monitoring, Delta, Estuary, Bay, public

Poster Topic: Data/Tools: Network

Decision Support Tools for Understanding Juvenile Salmon Entrainment and Survival in the South Sacramento/San Joaquin Delta through the Use of Acoustic Telemetry and Hydrodynamic Measurements

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The intent of the web application is to support National Marine Fisheries Services, U.S. Fish and Wildlife, U.S. Bureau of Reclamation, California Department of Water Resources, and U.S. Geological Survey and participating agencies with key ***RPA analysis and decisions*** as well as fundamental management and support of the acoustic telemetry receiver network operations. This Data Dashboard will offer visualizations of raw and processed data from the receivers as well as aggregate time series data from the real time data network via web services.

34 North presents this data through its OPENNRM data dashboard technology on www.BAYDELTALIVE.com.

Collaborators include: USFWS, USGS, DWR, USBR, MWD.

Keywords: decision support tools, fisheries management, data dashboards, real time management

Poster Topic: Data/Tools: Network

Potential Place of Refuge (PPOR) Sites in the San Francisco Bay Area

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Decision-makers must address both operational and environmental issues when determining where to direct a stricken vessel. The U.S. Coast Guard Captain of the Port (COTP) has jurisdiction to approve a PPOR site for a vessel in distress. The COTP will confer with other federal, state, and local officials while deciding where and when to move a stricken vessel. Selection of a PPOR site by the COTP, in consultation with other agencies and stakeholders, will always be made on a case-by-case basis. However, prior identification of PPOR sites significantly enhances the decision-making process, facilitates the overall response operation, and helps prevent or minimize potential adverse effects to the vessel, the public, the environment, and resource users.

Workgroups were established for the San Francisco Bay and Delta (SFBD) Area of Responsibility (AOR) to develop a PPOR decision-making process and a framework for establishing pre-incident information on PPOR sites for inclusion in Area Contingency Plans (ACPs). Participants developed an approach to pre-survey PPOR sites, not pre-determine them. Data gathered was streamlined and incorporated into a California Statewide PPOR Database including: pre-incident summaries containing PPOR site-specific data; NOAA Trajectory Analysis Planner (TAP II) modeling results for shoreline impacts; and PPOR area maps.

A number of PPOR sites were identified within SFBD and included in the California Statewide PPOR Database. A subcommittee consisting of representatives from various SFBD Area Committee organizations including vessel pilots, natural resource agencies, and port authorities chose the 94 sites. These participants were later involved with providing physical, navigational, human health and safety, and economic information for 22 designated deep draft PPOR sites for the SFBD AOR. Additionally, a natural resource workgroup branched off from this PPOR subcommittee to address natural resource concerns for these 22 sites, ensuring validation of information with natural resource trustees within the SFBD AOR.

Keywords: Natural resource protection, navigation, emergency

Poster Topic: Environmental Cleanup

A Novel and Cost-Effective Method to Document Trash Reduction in Stormwater

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Numerous urban creeks and shorelines in California are listed as impaired by trash on the Clean Water Act's 303(d) list. As a result, over the course of the last decade, NPDES stormwater permits have included stringent requirements that mandate extensive trash reductions designed to improve local waterways. As such, municipalities have developed new and enhanced control measures to reduce the generation or transport of trash through storm drain systems. Cities and counties in the Los Angeles and San Francisco Bay regions have installed tens-of-thousands of "full-capture" systems to intercept trash, which are certified by the State Board and coined “Track One” controls in the recently adopted amendments to the statewide Ocean and Inland Surface Waters Plans by the State Board. Other municipalities are enhancing institutional controls such as street sweeping and storm drain cleaning, improving franchise waste hauler agreements to improve garbage containment and transport, implementing extensive on-land cleanup programs utilizing business improvement districts and volunteers, and adopting ordinances that reduce the generation of litter-prone items that end up in stormwater. These types of actions are coined “Track Two” controls by the State Board. Unlike certified full capture systems, track two controls require monitoring to verify their effectiveness and determine that they have an equivalent level of performance to full capture systems. Identifying the need for a cost-effective method to establish full capture equivalency, Bay Area communities developed an On-Land Trash Assessment Protocol and have conducted over 1,000 assessments to-date. Visual on-land assessments are rapid and low-cost. With a bit of training this method can be used by municipal staff and volunteers to assess improvements in trash conditions in local watersheds. The poster will provide an overview of this visual assessment protocol and results to date.

Keywords: trash, stormwater, assessment, litter, monitoring, control, assess, storm drain

Poster Topic: Environmental Cleanup

Delta Mercury Exposure Reduction Program (Delta MERP)

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Elevated levels of mercury in fish are present in parts of the Sacramento-San Joaquin River Delta (Delta). Those who eat Delta fish may be exposed to harmful mercury levels. Mercury is a toxic metal that is most harmful to infants, children, and the developing fetus. As it will take many years to reduce the levels of mercury in fish, the Central Valley Regional Water Quality Control Board, California Department of Public Health, Office of Environmental Health Hazard Assessment, and Sacramento-San Joaquin Delta Conservancy are taking action now to protect public health by implementing the Delta Mercury Exposure Reduction Program (Delta MERP). This program aims to reduce human exposure to mercury through collaborative work with community-based organizations, community members, local agencies, and other entities. Delta MERP activities educate at-risk populations about mercury exposure from eating contaminated fish caught in the Delta and elsewhere. Following interviews with local social service, Tribal, and community-based organizations, the project team developed a multi-pronged approach for education and outreach based on the needs and interests of the organizations. The Delta MERP approach to reduce risk includes developing and distributing multilingual educational materials based on existing fish consumption advisories, building capacity of community-based organizations through small grants to promote culturally relevant outreach in their respective communities, developing and posting signs at fishing locations, sharing information through community stakeholder meetings, providing trainings, and supporting programs already operating in the Delta to educate about fish contamination.

Keywords: outreach, education, mercury, fish advisory, public health, fish contamination

Poster Topic: Fish Contamination

Impact of Hypersalinity on Embryonic Development of the Japanese Medaka (*Oryzias latipes*)

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Increasing salinity of freshwater is one understudied component of climate change. Rising sea levels, decreased precipitation, decreased snow melt input and drought have led to an increase in salinity of certain water restrained estuaries, such as the San Francisco Bay Delta. Furthermore, two desalination plants have been proposed to combat water shortages in the area. These plants will dispose of concentrated brine back into the estuary, which could further increase salinity. The SF Bay Delta is a unique habitat and several key species of fish spawn in these waters, including salmonids and Delta smelt. Saltwater of differing ionic contents may have varying impacts on fish development and chronic effects of hypersalinity coupled with other stressors on fish development remain unknown. The goal of this research was to determine toxicity thresholds for fish embryos exposed to different types of saltwater. Embryos of the euryhaline model fish, Japanese medaka (*Oryzias latipes*), were treated with different dilutions of artificial seawater (35, 42, 49, 56 and 70 parts per thousand), saline San Joaquin River water (13, 19, 24 and 30ppth) and desalination brine from Monterey Bay Aquarium (37, 43, 51, and 67ppth) beginning at fertilization. Embryos were monitored for survival, hatch, deformities and survival for 3 days post hatch. Thresholds for each type of saltwater were calculated. Seawater and desalination brine caused significant mortality beginning at 56ppth and greater numbers of deformities were observed in San Joaquin River Valley saltwater. These results will aid regulators investigating the effects of hypersalinity on fish population decline.

Keywords: climate change, salinity, desalination, fish development

Poster Topic: Fish Contamination

Immunogenetic Variation in X-cell Tumor Diseased Fish across an Estuarine Gradient of Contaminants

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Juvenile English sole (*Parophrys vetulus*) use the San Francisco Bay Estuary (SFBE) as a nursery but are subject to environments with different sediment contaminant loads. Juveniles are susceptible to parasitic protozoans that cause skin tumors. We used molecular methods to confirm the presence of the causative pathogen, known in fish pathology literature as X-cell disease. In other regions higher incidences of skin tumors have been seen in urbanized estuaries. Contaminants in urbanized estuaries can alter adaptive immune response in flatfish. Habitat in San Pablo Bay (SPB) is less impacted by contaminants than regions in the South Bay (SB). We examine variation in Major Histocompatibility Complex (MHC) genes, which recognize parasites and diseases. We isolated the exon 2 region of the MHC class IIB genes from infected and uninfected English sole caught in the two differentially impacted regions. In other studies, contaminants and disease have been shown to be important influences on variation in the MHC. By examining fish from these two contrasting environments in SFBE, we assess how contaminants may be influencing relationships between population genetics and disease. We compare differences in the antigen binding region of the MHC protein from infected and uninfected fish in contaminated and less contaminated areas. Preliminary data from 50 individuals (27 from SPB and 23 from SB) shows high levels of allelic diversity and substitutions concentrated on inferred antigen binding sites of the protein. Selection tests using confirmed alleles show a signal of positive selection in samples from both regions of the bay combined ($dN/dS = 2.35$ $p = 0.010$, n= 14 confirmed alleles) and each separately (SPB: $dN/dS = 2.28$ $p = 0.012$, n=13, SB: $dN/dS = 2.32$ $p = 0.011$, n=10). This study will provide information on immunogenetic diversity in juvenile fish in SFBE in relation to contaminant distribution patterns.

Keywords: Immunogenetics, juvenile fish, flatfish, *Parophrys vetulus*, MHC, selection

Poster Topic: Fish Contamination

San Francisco Bay Creosote Piling Removal and Pacific Herring Restoration Project: Pilot Site Selection Using Spatial Models and Regional Datasets for Screening Prior to Completion of Site Specific Investigations

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In support of the San Francisco Bay Subtidal Habitat Goals (Goals) and enhancement of Pacific herring habitat, the California State Coastal Conservancy (Conservancy) has initiated a pilot project to remove creosote pilings and restore herring spawning habitat under a grant from the National Fish and Wildlife Foundation (NFWF). Creosote contains a mixture of chemicals, many of which are toxic to marine organisms, and has proven detrimental to herring eggs that are adhered to treated piles and timbers. To complete this work, the Conservancy has retained the assistance of AECOM and Merkel & Associates to assist in bringing the project to fruition.

The Goals report includes an appendix document, Removal of Creosote Treated Pilings and Structures from San Francisco Bay (SFEI 2010) identifying over 30,000 creosote pilings (an underestimate as subtidal pilings could not be located and mapped) clustered in 630 “hotspots” throughout the bay. The large number of piles spread through the Bay posed a significant challenge to development of a cost effective means of selecting sites within which to undertake a pilot project that meets multiple goals of a large quantity of piles being removed, providing high benefit to herring, and providing opportunities to replace lost pile habitat with more desirable spawning habitat. To address this challenge a multi-tier screening process was developed that included a desktop GIS analysis and modeling (Tier I), a subsequent site specific remote data evaluation (Tier II), and field data collection (Tier III). At each tier, the number of sites moving forward in the analysis was filtered down. The Tier I modeling intersected existing and new data layers with habitat restoration opportunities predicted through habitat suitability modeling. Tier I reduced potential sites from 630 to 11, Tier II dropped the number to six, and Tier III resulted in the final selection of two sites.

Keywords: herring, creosote piles, eelgrass, oysters, San Francisco Bay, subtidal restoration

Poster Topic: Habitat Restoration: Fish

Preliminary Two-Year Comparison of Effectiveness Monitoring for the Bobcat Flat Rehabilitation Project, Tuolumne River, CA

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The downward trend in anadromous salmonid populations in California has been attributed to the loss and degradation of existing spawning and rearing habitat. In-channel habitat rehabilitation (gravel augmentation) targeting fall-run Chinook salmon spawning and rearing habitat enhancement was carried out in two phases (2005 and 2011) at river mile 43 ("Bobcat Flat") within the lower Tuolumne River below La Grange Dam. The primary goal of the Bobcat Flat Rehabilitation Project is to enhance spawning and rearing habitat for Chinook salmon. Two years (2013 and 2014) of a 3-5 year monitoring plan to evaluate post-rehabilitation effectiveness has been completed. Preliminary results from year 1 young-of-the-year (YOY) rearing surveys revealed that the restored reach supported higher numbers of rearing YOY fall-run Chinook salmon than unrestored reaches (restored = 58.9 fish/50 ft; unrestored = 51.0 and 34.3 fish/50 ft). However, variation in fish density increased when viewed at successively smaller scales (i.e. site, mesohabitat, and microhabitat). Mean combined habitat suitability index (HSI) scores (0-1.0) developed from observed depth, velocity, and cover data at 170 cfs, ranked the restored reach (0.17 median HSI; n=92) just below the upstream reference reach (0.20 median HSI; n=71) and higher than the downstream reach (0.13 median HSI; n=64). Overall, Year 1 HSI analysis revealed that fish utilized expected velocity ranges, though preferred a wide range of depths and demonstrated very high preference for instream woody cover. Interim interpretation of Year 1 monitoring results suggest that: (1) rearing YOY fall-run Chinook salmon may be over-crowded within the selected study reaches; and (2) gravel augmentation projects should target sites having intact, quality riparian woody vegetation, as this can provide more suitable rearing habitat than sites lacking such conditions. Analysis of Year 2 monitoring results is underway, which includes an evaluation of relative benthic macroinvertebrate production between restoration and reference sites.

Keywords: river rehabilitation, effectiveness monitoring, Chinook salmon, rearing habitat, benthic macroinvertebrates

Poster Topic: Habitat Restoration: Fish

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

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Greater than 90% of tidal wetlands in the San Francisco Bay Estuary were reclaimed for urban and agricultural uses including industrial salt production ponds in the early 1900's. Currently we are restoring 15,100 acres of salt ponds in South San Francisco Bay to fully tidal, muted tidal and managed wetlands to benefit the estuaries biota, and buffer coastal communities against sea level rise from climate change. In 2010, we began an effort to monitor and document the benefits of salt pond restoration for fish and macro-invertebrates. We conducted monthly surveys of restored salt ponds using a variety of sampling techniques in the Alviso Marsh, Eden Landing and Bair Island. We have documented over 90 species from 40 identifiable taxa of fish invertebrates using newly restored salt ponds. We discovered communities using restoration sites were similar to adjacent extent slough and marsh habitat and at times, abundance was greater in restoration sites. The restoration sites provided nursery habitat for many important fish species including, Pacific herring, Northern anchovy, the state threatened longfin smelt, and supported high primary and secondary production. It was clear that salt pond restoration provided benefits to fish and macro-invertebrates however; not all restorations were created equal. Muted tidal and managed salt ponds supported fewer species, had more invasive species and poor water quality in summer. Tidally muted and managed ponds also resulted in significant environmental regulation and costs to the restoration project. We discuss the benefits of tidal marsh restoration in the San Francisco Estuary for our ailing native biota in the light of environmental regulation, future restoration activities and climate change.

Keywords: Salt pond restoration, Alviso Marsh, Eden Landing, Bair Island

Poster Topic: Habitat Restoration: Salt Ponds

No Rain Much Pain: Challenges and Lessons Learned in Transition Zone Restoration during a Drought

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

Unpredicted drought conditions lead to a failed hydroseed attempt, an increased need for supplemental watering for newly installed plants, and an increase in staff resources to help support the supplemental watering effort. Hypersaline soil conditions required extra watering to improve soil conditions for plant growth and recruitment. Reduced rainfall slowed this process, leaving a harsher medium for plants to establish and requiring more staff time to water plants. Site visits by restoration staff were also limited by proximity to nesting Snowy Plovers. This subsequently reduced access to the plants between November and March over a two-year period and limited the amount of watering and maintenance that could be done during the Spring and Summer seasons.

These challenges provide insight into preforming restoration work under restricted conditions and provide the opportunity to experiment and adjust our restoration strategy including adding soil amendments and modifying the plant palette. These lessons learned can be applied to existing and future transition zone restoration designs.

Keywords: Transition Zones, Drought, Habitat Restoration, Eden Landing, Salt Ponds

Poster Topic: Habitat Restoration: Salt Ponds

Morphological Plasticity of a Native SAV Species in the San Francisco Estuary

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Submerged aquatic vegetation (SAV) is an important habitat-builder in estuary ecosystems. In San Francisco Estuary (SFE), the native pondweeds *Stuckenia* spp*.,* are widespread in the ecologically important low-salinity zone, but were unstudied in the region prior to 2011. We now know there are over 500 hectares of *Stuckenia* spp*.* in the SFE, spanning more than 25 kilometers from east to west, and that they appear to be expanding. We have been conducting a series of studies on these pondweeds since 2011, but some basic questions such as species identity remain unanswered. Individuals are morphologically ambiguous, and have been identified as either *S. pectinata* or *S. filiformis*. In the field, we observe patches with distinctly different plant architecture and morphological complexity, which may be due to phenotypic plasticity, or genetic differences. We hypothesized that both species and/or hybrid individuals may be present, and have investigated that question with a combination of common garden experiments and genotyping. Preliminary results show that these plants are morphologically plastic in response to flow conditions. When genetically identical plant shoots from the same rhizome were separated and grown in mesocosms with high water flow or no water flow, sister plants in the two treatments became significantly distinct in multiple morphological traits. In the field, these morphological differences may affect the food web, since different levels of habitat complexity can influence abundance and composition of epifaunal communities. The results from this experiment and from our genetic work will allow us to predict how these plants may respond to changing conditions in the SFE, including changes in flow dynamics that could result from different management scenarios. Further, conservation and restoration actions may be informed by an understanding how species identity and plasticity relate to habitat values.

Keywords: Submerged Aquatic Vegetation, Suisun Bay, Pondweeds, Low Salinity Zone, plasticity

Poster Topic: Habitat Restoration: Seagrass

San Francisco Bay Living Shorelines Project: Progress in restoring *Zostera marina* in San Rafael Bay

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Seagrasses provide valuable habitat for fish and invertebrates and ecosystem services such as sediment stabilization and carbon sequestration. These marine plants are declining worldwide, thus restoration is planned or underway in many regions, including San Francisco Bay. The San Francisco Bay Living Shorelines: Nearshore Linkages Project is working to advance understanding of how to successfully restore native eelgrass (*Zostera marina*) as well as native Olympia oysters (*Ostrea lurida*) while evaluating shoreline stabilization functions. At our project site in San Rafael, we transplanted eelgrass from two sources (Point Molate and Point San Pablo) to assess the importance of donor choice, and conducted these plantings either in an eelgrass only plot, or interspersed with reef mounds of Pacific oyster shell (to serve as a substrate for Olympia oyster settlement) to evaluate whether oyster reefs could be beneficial to eelgrass and vice versa. Project delays led to a late summer (2012) planting of eelgrass, which did not survive; however, following a replanting effort the next spring both plots are now well established, with 132% of the original planted number of shoots overall. There are fewer shoots in the plot where oyster shell bags are present, possibly due to leaf abrasion and space limitation. For the first year we were able to track success of the two donors, before the plants spread outside of the original planting configuration; the majority of the plants originated from Point Molate, perhaps due to more similar soils at this donor site and the restoration site. We conclude that donor choice may be an important consideration and that we should plant in spring to maximize success. Further, this restoration has successfully provided new habitat to many fish and invertebrate species, which is maximized by the presence of both habitat-forming species.

Keywords: Seagrass, restoration, *Zostera*, habitat, sediment,

Poster Topic: Habitat Restoration: Seagrass

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

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North Bay wetlands were diked and drained for a century to make land for development, including industries that left remnant pollutants in soils and water. Drained, subsided marshland and contaminated soils were two of the restoration challenges in the Peyton Slough Remediation and Restoration Project in Martinez, California. Eco Services Operations LLC., who currently owns the project site, launched a project in 2004 to remediate remnant contaminants and restore tidal wetlands. Construction was completed in 2006, and eight years of annual monitoring have been conducted. Monitoring has shown considerable use of the restored wetlands and slough across the food web including by benthic invertebrates, fish, river otter, waterfowl and shorebirds.

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

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

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

Poster Topic: Habitat Restoration: Tidal Marsh

Experimental Propagation Methods for the Oro Loma Horizontal Levee Demonstration Project

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

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

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

Keywords: Habitat Restoration, Native Plant Propagation, Horizontal Levee

Poster Topic: Habitat Restoration: Tidal Marsh

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

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

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

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

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

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

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

Poster Topic: Habitat Restoration: Tidal Marsh

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

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

Summary of findings:

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

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

Poster Topic: Habitat Restoration: Tidal Marsh

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

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

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

Poster Topic: Habitat Restoration: Tidal Marsh

Remote Sensing of Canopy Leaf Area Index and Decadal Changes in Wetland Greenness in the Delta and Suisun Marsh

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Canopy leaf area index (LAI; one-sided leaf area per unit ground area) is a key instrumental variable used in models of plant-atmosphere carbon, water and energy exchange, greenhouse gas budgets and canopy-based wildlife habitats. Though extensively studied in upland terrestrial landscapes, this parameter remains largely uncertain in wetland ecosystems globally, which limits the capacity to up-scale functional properties of wetland vegetation to regional landscapes. This study assessed LAI in several natural and restored wetlands of the Sacramento-San Joaquin Delta, California, USA (the Delta) in growing seasons of 2013-2014 and tested the possibility to model LAI spatially using indicators of vegetation greenness (such as normalized difference vegetation index (NDVI)) from Landsat satellite images at 30m spatial resolution. Results indicate that field-measured LAI significantly correlated with a number of Landsat-based greenness metrics and that the goodness-of-fit in these relationships was improved by >50% by corrections to account for the fraction of non-vegetated surface cover at the pixel level. The analysis of temporal trajectories in the satellite-derived greenness metrics over 2000-present further revealed that a number of areas experienced declines in the peak-summer greenness, some of which could be explained by accumulation of dead biomass in some of wetland canopies, establishment of non-native species with different phenology and other factors that need further investigation. Overall, results indicate that despite relatively coarse resolution, Landsat satellite imagery is promising for monitoring of wetland dynamics and modeling of key canopy properties such as LAI in the Delta due to spectral sensitivity to wetland surface properties, instantaneous coverage of the study landscape and high quality of image time series in this region. Exploring this capacity further could greatly facilitate future efforts on monitoring and modeling wetland ecosystem services and restoration site trajectories and provide complementary capacity to circumvent the constraints on extensive field sampling.

Keywords: monitoring, "leaf area index", "remote sensing", canopy, vegetation, habitat, greenness

Poster Topic: Habitat Restoration: Tools to Restore

Direct Seeding for Habitat Restoration Projects

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The San Francisco Public Utilities Commission (SFPUC) is undertaking several habitat mitigation projects as a result of infrastructure repair and replacement activities in San Mateo, Alameda and Santa Clara Counties. A goal of the mitigation projects under the Bioregional Habitat Restoration (BHR) program is to restore upland, wetland, and riparian habitats within the greater San Francisco Estuary Watershed. Historically, the SFPUC sourced propagules (seeds or cuttings) from within local watersheds, grew these plants in a nursery, and then planted container plants within their restoration sites. In 2014, the discovery of *phytophthora,* a soil born pathogen, in restoration plantings caused the SFPUC to evaluate routes of introduction and decide to propagate onsite from direct seeding for the remaining plant installations. Challenges of direct seeding have included 1.) Responsibly collecting propagules from a drought stressed watershed. 2.) Determining an appropriate number of seeds to install in each planting basin. 3.) Providing shelter and irrigation for delicate seedlings.

To keep track of the collection efforts across multiple sites, years, and contractors, a database was developed to track propagule collection and avoid over-collection of any given target plant population. This GIS database allows for a collector to view location, number and phenology of plants observed or collected, last year a collection took place, collection quantities, and how many propagules may be available to collect from the site. The database format is a useful tool for managers to track propagule collection efforts.

Seeds per planting basin were determined based on nursery germination rates and protocols, and personal experience. Seeds were planted in the winter of 2014/15 and monitored in spring/summer 2015 for germination success and seedling survival. Results differentiate species with high and low direct seeding success rates. These results will help managers make decisions about future reseeding efforts across multiple mitigation sites.

Keywords: Propagule collection, direct seeding, habitat restoration, SFPUC BHR sites, *Phytophthora*

Poster Topic: Habitat Restoration: Tools to Restore

Back to the Future: Tule Marsh Restoration at Shin Kee for the Giant Garter Snake (*Thamnophis gigis*)

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The Shin Kee restoration project was created from 144 acres of farmland to provide habitat for wetlands and listed species, primarily the state- and federally-listed Giant Garter Snake (GGS). The project was initially designed to host more than 30 acres of tule marsh and with other elements known to benefit GGS such as wide, shallow ecotones and upland refugia. The initial hydrologic calculations did not take into account Delta-specific issues, however, and implementation of the original plan resulted in the creation of what was essentially a large unvegetated pond with little suitable habitat for GGS. Zentner and Zentner was asked to address the site issues and, with assistance from US Fish and Wildlife Service staff, completed a series of hydrologic and vegetation analyses to determine the ideal water elevations for tule growth and tule marsh establishment. We modified the tidal regime, lowered the tidal elevations and planted several thousand tule "super-plugs", an experimental container stock developed with a local grower. Four years later, Shin Kee now hosts more than 33 acres of thriving tule marsh and provides important lessons for future Delta restoration projects.

Keywords: Delta wetland restoration, Giant Garter Snake, tule marsh, endangered species

Poster Topic: Habitat Restoration: Wetland and Riparian

Riparian Understory Restoration of White Root (*Carex barbarae*) and Creeping Wild Rye (*Elymus triticoides*) in Post-Burn Areas at Bushy Lake, Sacramento, CA USA

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CSU Sacramento and Sacramento County Department of Regional Parks are collaborating on the Bushy Lake Restoration Project as part of an Earth Stewardship Initiative. Riparian habitats along the American River remain essential for regional flora and fauna; however, the areas are fire prone due to homeless populations, drought, and invasive species with biomass production stimulated by prolonged spring rains. The primary goal of this experiment is to test cost-effective, resilient restoration and adaptive management strategies for depressional wetland restoration by creating habitat islands of native species to recruit and expand spatially and temporally in the area. Two dominant riparian understory species in the Sacramento-San Joaquin Delta with drought tolerant and fire resilient characteristics are tested to restore riparian understory in post-burn areas on the American River Parkway, Sacramento, CA. Under experimental field conditions, we compared the survival, biomass, productivity, and relative cover between white root (*Carex barbarae*) and creeping wild rye (*Elymus triticoides*) treatments, using two different planting densities and three different species compositions to find the most efficient treatment for restoration. The interaction between plant and plant densities was also observed, although preliminary findings show no significant difference, meaning that the species and densities treatments do not affect one another in the short term. The pilot study shows that monotypic *Elymus triticoides* has the highest cover, followed by mixed Elymus-Carex, with *Carex barbarae* monotypic stands having significantly less cover. Long-term monitoring of the experiment needs to be employed to obtain conclusive results about which treatment would be most suitable for an effective restoration. Encroachment of weeds in the study area restricts the recruitment of native species, and experimental plots will also need to be hand watered during dry, warm months. Adaptive management will allow for the control of weeds and water to sustain the experimental native plants.

Keywords: riparian understory, depressional wetland, CRAM, restoration, fire resiliency

Poster Topic: Habitat Restoration: Wetland and Riparian

Monitoring Post-fire Resiliency in a Depressional Wetland using California Rapid Assessment Methodology (CRAM), Intensive Vegetation, and Avian Species Richness to Establish Long-term Monitoring using Citizen Science

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This project entails monitoring of depressional wetlands at Bushy Lake after a fire on the American River Parkway, a joint project between CSU Sacramento and Sacramento County Parks Department. The primary goal of this study is to collect baseline data for the Bushy Lake Restoration Project, which will be used to establish long-term monitoring using citizen science. We used the California Rapid Assessment Method (CRAM) to assess the quality of the ecosystem and validated our data by collecting intensive L3 vegetation data and conducting bird counts. CRAM data was compared to avian species richness to illustrate the significance that this project will have for birds native to the Sacramento region as well as species who utilize the American River Parkway during migrations. Intensive vegetation data was used to verify that the CRAM scores were representative of dominant vegetation and invasive species at Bushy Lake. CRAM data was found to be representative of on-site vegetation, and was found to be more efficient and less time consuming to collect monitoring data. This is an important finding for long term monitoring projects, where funding is limited and data collection efforts are often sporadic or non-existent. We hypothesize that Bushy Lake restoration and post-fire resiliency will increase the number of plant layers and plant biodiversity, which will increase overall potential avian habitat. Validating the CRAM with intensive vegetation and bird count data provides further insight into monitoring habitat conditions, effective adaptive management practices, and the overall health of the ecosystem. Birds are often used as ecological indicators and are relatively easy to observe in comparison to other wildlife, making it possible to use citizen science as a cost effective tool in monitoring the success of this restoration project.

Keywords: CRAM, depressional wetland, intensive vegetation, avian species richness, citizen science

Poster Topic: Habitat Restoration: Wetland and Riparian

Species Composition and Contribution of Marine Invasive Species to Fouling Communities of San Francisco Bay

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The overall objective of this project is to determine the extent, patterns and effects of marine species invasions on the California Coast. Estimating the relative contribution of non-indigenous species (NIS) to site- and bay-level diversity will help us to understand NIS effects on communities. To assess diversity in fouling communities, we conducted standardized field surveys to measure patterns of invasion across sites and bays. After ~15 years of repeated surveys of sites throughout San Francisco Bay, we have compiled a comprehensive list of fouling species in the bay and their distribution in relation to environmental parameters. Here, we present a subset of data from 2012 showing the diversity patterns of mobile organisms associated with the sessile community. The species composition of the sites varies based on distance from the mouth of the bay, with less diversity and richness at lower salinities far from the Golden Gate. The importance of NIS to overall diversity levels is clearly demonstrated by the mobile organisms associated with the sessile species.

Keywords: Invasive species, *Peracarida*, fouling communities, NIS, San Francisco Bay

Poster Topic: Invasive Species

Predation of Juvenile Salmon in the Tuolumne River

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The presence of several non-native species in the Tuolumne River known to prey on juvenile salmonids has long been of concern. Repeated, intentional introductions of striped bass, smallmouth bass, and largemouth bass to the Sacramento-San Joaquin drainage occurred during the past century. Despite mounting evidence that predation by non-native species appears to be a significant source of mortality of juvenile Chinook salmon in the San Joaquin Basin and Delta, and that reduced juvenile survival due to predation is a key factor restricting the success of efforts to increase salmon survival, few studies have been conducted to directly quantify predation risk.

During 2012, a drier water year, a study was conducted on the Tuolumne River to estimate predator abundance and predation rates. In a 25-mile reach between two rotary screw trap monitoring locations where juvenile salmon abundance was estimated, the lower 95 percent confidence bounds for species abundance determined by depletion electrofishing expanded for shoreline length were 2,406 largemouth bass, 2,476 smallmouth bass, 99 striped bass, and 50 Sacramento pikeminnow during summer. Species-specific predation rates averaged for all run-pools and special run pools sampled during March and May were 0.07 juvenile salmon per predator per day for largemouth bass, 0.09 for smallmouth bass, 0.68 for striped bass, and 0.0 for Sacramento pikeminnow.

Total potential consumption of juvenile salmon was estimated to be about 42,000 individuals during March 1-May 31, 2012, with about 15% of potential consumption attributed to striped bass, 49% to smallmouth bass, and 37% to largemouth bass. This study provides the first direct assessment of potential predation impacts to juvenile salmon in the Tuolumne River and findings indicate that predation by introduced predators appears to be a significant source of mortality in at least some years.

Keywords: Predation, Chinook salmon, Tuolumne River

Poster Topic: Invasive Species

Mapping the Marsh with Unmanned Aerial Systems

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Change detection in estuarine systems is notoriously difficult to assess. Complex vegetation assemblages, unique geomorphic features, and hydrologic processes confound monitoring activities. Further difficulties arise in sites with sensitive biological resources and where regulatory constraints and narrow monitoring windows create additional challenges for land managers, researchers, and others who rely on timely and accurate data. Recent innovations in remote sensing, UAV, and GIS, technologies provide tremendous opportunities to overcome the limitations of traditional monitoring approaches, and more importantly opportunities to maximize the efficiency and effectiveness of monitoring at the landscape scale.

The Solano Land Trust in partnership with the SF Bay National Estuarine Research Reserve (SF NERR) has recently began work on a remote sensing methodology intended to support the long term vegetation monitoring requirements on more than 12,000 acres including one of the largest intact tidal brackish marsh systems in the U.S., Rush Ranch. This program seeks to develop a standardized, repeatable methodology for annual and long term vegetation monitoring that is broadly applicable across ecological gradients, including the estuarine component of the lands managed by each respective organization. The methodology adapts current GIS and remote sensing methodologies and integrates innovative research and technologies developed within the past decade.

We are reporting on our first experiences using an unmanned aerial system (aka “drone”) equipped with near-infrared and color imagery sensors to map invasive weed species and impacts of feral swine in a remnant tidal marsh and adjacent uplands at Rush Ranch in Suisun Bay. We evaluated the system’s ability to detect and map various weed species and swine rootings using high resolution imagery (2-3 cm); we also report on our successes in developing an image classification for several common invasive species. We discuss the use of low-cost unmanned aerial systems for landscape-scale mapping and monitoring.

Keywords: invasive species, aerial imagery, unmanned aerial systems

Poster Topic: Invasive Species

Identifying Emerging Invasive Plants for Early Eradication on the San Mateo County Coast

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Identifying and removing new invasive plants before they become widespread is a cost-effective strategy that prevents ecological impacts. As in most areas, invasive plant management on the San Mateo County coast has mostly focused on high-profile species, including Cape-ivy, European beach grass, pampasgrass, Hardinggrass, and Canary Island St. Johnswort. Working on less well-established invasive plants, for which eradication remains feasible, has been promoted by Cal-IPC and the Bay Area Early Detection Network (BAEDN). In previous years BAEDN had identified several isolated populations of known weeds in the region as strategic targets. As a next step, Cal-IPC and the region's land managers wanted to better understand the potential future threat from emerging weeds. With support from the US Fish & Wildlife Service's Coastal Program, Cal-IPC analyzed non-native plant species already naturalized in the region to determine which presented the highest risk of causing environmental harm in the future. The project used three complementary tools: the Calflora database to determine non-native plants that were not widespread in the region; expert interviews to check on distribution and perceived risk; and the Plant Risk Evaluation (PRE) criteria system from UC Davis to predict risk based on life history factors. Using these tools, we identified 9 species as potential early-eradication targets and 11 species as surveillance targets. Local partners, including the San Mateo County Resource Conservation District (RCD), will collect additional information on distribution of each species, and public landowners will undertake control efforts to learn about the efficacy of different approaches. This process could be adapted to other counties around the San Francisco Bay and Estuary to prioritize future efforts on invasive plants.

Keywords: invasive species, restoration, early detection, land management

Poster Topic: Invasive Species

Mapping and Prioritizing the Invasive Plant *Arundo donax* for Eradication in the Legal Delta

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The invasive plant *Arundo donax* has become widespread in California. In Southern California some riparian habitat has been reduced to monotypic stands, devastating native species locally. Eradication has been extensive and costly. In Northern California, *Arundo* infestations are less widespread. However eradication efforts began later and primarily have been occurring piecemeal as individual organizations fight local infestations.

The Sacramento-San Joaquin Delta Conservancy and the California Department of Water Resources have begun an initiative to eradicate *Arundo* within the Legal Delta. For Phase 1 of this project, the Sonoma Ecology Center has been contracted to complete the mapping of *Arundo*, and prioritizing it for eradication. Additionally, within the Cache Slough Complex, Sonoma Ecology Center will eradicate *Arundo* and perform native plant restoration as a pilot project. A series of eradication and restoration projects will follow in coming years.

High quality mapping was achieved through the following methods: imagery analysis by trained technicians was followed by a series of ground and boat truthing sweeps throughout the Legal Delta. Innovative technology was deployed enabling restoration teams to complete validation of 52% of mapped infestations in minimal field time.

Prioritization was achieved through utilization of the Indexed Multispecies Conservation Value (IMCV) metric and other ground condition factors. A multi-organizational group of biologists contributed expertize to the selection of key species on which to base prioritization and the development of habitat suitability rankings for these species. VegCamp map of the Legal Delta was source map. The habitat suitability rankings, weighted by endangered/threatened status form the core of the IMCV metric. Numerous other ground condition factors can be combined with the IMCV to develop ranked prioritization of all *Arundo*.

Eradication and restoration will begin in the Cache Slough Complex in the summer of 2015.

Keywords: Legal Delta, Invasive *Arundo*, Mapping, Prioritization, Threatened Species

Poster Topic: Invasive Species

The USDA-ARS Areawide Pest Management Project for Integrated Management of Water Hyacinth, Brazilian Waterweed, *Arundo* and Associated Pests in the Sacramento-San Joaquin Delta

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Water resources flowing into the 28,000 ha- Sacramento-San Joaquin Delta support $25 billion in irrigated agriculture and drinking water for 25 million people statewide, and also support ecosystem health throughout the San Francisco Estuary. Floating water hyacinth (*Eichhornia crassipes*), submersed Brazilian waterweed (*Egeria densa*), and giant reed or *Arundo* (*Arundo donax*), an emergent riparian grass, each occupy several thousand ha in the Delta, wasting water and hindering its use, obstructing recreational and commercial navigation, and reducing environmental quality by displacing native plant species, harboring disease-vectoring mosquitos, and (in the case of *Arundo*) spreading fires and increasing erosion. A USDA-ARS-funded Areawide Pest Management Program has been initiated to develop and implement integrated assessment and decision-support tools to improve Delta-wide management of aquatic invasive plants using chemical, mechanical, physical, cultural, and biological methods. Satellite- and aerial-based remote sensing tools and analyses of water quality and flow data are being used to prioritize water hyacinth infestations, leading to improved early-season control. Information on aquatic plant growth and responses to existing and new herbicides is being used to optimize the timing of chemical and mechanical control. Three new insect agents are being released for biocontrol of water hyacinth and *Arundo*. Coordinated aquatic plant-mosquito control operations are being implemented to reduce the ability of live and decaying weeds to support mosquito outbreaks in areas where human health is most at risk. Cascading effects of the control programs on aquatic food webs are being monitored. Site selection for restoration of native aquatic plants is being initiated. The economic impacts of aquatic weeds in the Delta, and the benefits of the Areawide aquatic plant control approach, are being modeled to predict and document project impact. By integrating research with aquatic plant management operations, this project is expected to help protect scarce water resources in the Delta.

Keywords: Invasive aquatic vegetation, Herbicide, Navigation, Biological control

Poster Topic: Invasive Species

Invasion Trends in San Francisco Estuary Sessile Invertebrate Communities over Fifteen Years (2000 to 2014)

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Invasions by non-native species are well-known drivers of significant ecological change worldwide. Despite considerable available information on marine invasions in California, and particularly 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. We addressed this issue for hard substrate-dwelling sessile invertebrate communities, which make up a significant portion of invasions worldwide, by conducting repeated, standardized surveys of fouling communities throughout the San Francisco Estuary over a fifteen-year period spanning a wide range of environmental conditions.

We characterized communities using settlement panel surveys at sites throughout the estuary, from Antioch to the Golden Gate to the Dumbarton railroad bridge in the South Bay, from 2000 to 2014. These years spanned recent dry and wet extremes, including two major droughts and several wetter winters.

Non-native species were prevalent throughout the estuary, but achieved greater dominance following dry winters. Community composition at any given site during the summer period (May to October) was predicted by environmental conditions, especially the previous winter's precipitation, which is linked to salinity levels. 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. 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, non-native species, sessile invertebrates, fouling, salinity

Poster Topic: Invasive Species

Treatment Plant Nutrient Removal Utilizing a Freshwater Marsh

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This study examines the effectiveness and regulatory constraints of utilizing a freshwater marsh as a treatment process for removal of nutrients from effluent of an advanced secondary wastewater treatment plant. San Francisco Bay Area wastewater treatment plants are facing potentially more restrictive NPDES permit limits for nutrients. This requires the treatment plants to seek cost effective techniques to optimize nutrient removal in the near term. Renzel Marsh is located adjacent to the City of Palo Alto Regional Water Quality Control Plant. The plant discharges treated wastewater to the freshwater marsh as well as directly to the San Francisco Bay. Typically, Renzel Marsh receives about 5 percent (1 MGD) of the total effluent flow from the plant. Data from phase I of this study has shown that the anaerobic bacteria residing on the root systems of the plants in the marsh has been effective at removing nitrate from the water via a process called denitrification. Statistics show that the marsh was able to significantly reduce total nitrogen mass load discharged by the plant by 2 percent at current flow levels. Phase II of the study evaluated the effectiveness of nutrient removal within the marsh with respect to an increase to 2 MGD. After the system reached steady state, water quality sampling occurred at the marsh inlet and outlet in summer 2015. Water quality data was used to determine the applicability of the marsh as a treatment process for enhanced nutrient removal at this larger scale. Data was also used to determine any potential compliance issues with existing NPDES permit limits.

Keywords: Nutrients, Nitrogen, Phosphorus, Wetland, Wastewater, NPDES, Treatment, Denitrification, Marsh, Watershed

Poster Topic: Nutrient Removal

Opportunities to Increase Bayshore Resiliency and Reduce Infrastructure Vulnerability by Re-plumbing the East Bay

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The East Bay Dischargers Authority (EBDA) currently discharges treated wastewater effluent into SF Bay through a deep water outfall; however, this infrastructure is aging and vulnerable to rising sea level. This project assessed the opportunities and constraints of decentralizing EBDA's discharge and re-introducing freshwater inputs to the San Leandro to Fremont shoreline. Historically, freshwater interfaced with the baylands through creek connections and more diffusely via groundwater and surface runoff. These freshwater inputs were an important component of the baylands ecosystem, creating salinity gradients that added physical and ecological diversity to the baylands landscape as well as facilitating rapid vertical marsh growth. Today, the extent, magnitude, and seasonality of freshwater to the baylands has been greatly altered. Technical studies and stakeholder workshops were held to consider: 1) opportunities for re-using treated wastewater for improved ecosystem functions, 2) opportunities most appropriate given historical and present landscape features, and 3) regulatory and governance needs for successful implementation of these types of innovative projects. Workshop participants identified concept alternatives for the present discharge including: 1) routing freshwater to creek systems, 2) routing freshwater through a seepage slope as part of a horizontal levee, 3) contained wetland treatment systems, and 4) re-use of water. We assessed the seasonality, volume, and nutrient concentrations of EBDA's effluent and reviewed the area needed to treat EBDA's discharge through open water or vegetated wetlands. Conceptual models were also completed to illustrate how varies strategies could create a coherent landscape given physical and ecological considerations. While further research and planning is certainly needed to assess feasibility, this project was successful in informing EBDA of opportunities other than maintaining its existing outfall. Importantly it bought together diverse stakeholders to further the conversation on using treated wastewater as a resource for a resilient future East Bay shoreline.

Keywords: Wastewater, Freshwater, Baylands, Horizontal Levee, Water Re-use, Sea Level Rise

Poster Topic: Nutrient Removal

The Horizontal Levee: Combining Nutrient Removal from Wastewater With Flood Control and Habitat Restoration

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In response to increased concerns about the effects of nutrient discharges on the San Francisco Bay, wastewater utilities have begun to look for innovative nutrient management schemes. Subsurface-flow treatment wetlands provide a means of removing nutrients that also provides habitat restoration and flood control. To study these systems, a set of demonstration-scale wetlands is being constructed adjacent to the Oro Loma Sanitary District's wastewater treatment plant. The system capitalizes on heterogeneous conditions to remove trace contaminants from wastewater by combining subsurface wetlands with surface-flow wetlands. The surface-flow wetlands also provide additional water storage for flood control during heavy precipitation events while the subsurface wetlands can protect against sea level rise and can provide important habitats for migratory birds, and other vulnerable terrestrial species. The subsurface wetlands are divided into twelve cells to allow for experiments on the optimal conditions for removal of nutrients. As the system equilibrates over the next two years, we will monitor improvements in water quality that can be achieved in the horizontal wetlands. Microcosm experiments will be used to study nitrogen dynamics, as well as the potential for these systems to remove trace organic contaminants (e.g., pharmaceuticals and personal care products). Initial results from the microcosms suggest that organic amendments, such as woodchips, can enhance nitrogen removal by providing a carbon source for denitrification. They also indicate that dissolved organic nitrogen (DON) may be released from the subsurface wetlands. Although subsurface wetlands are a viable nitrogen management strategy, further research is required to optimize the systems and assess their long-term performance.

Keywords: nitrate, denitrification, subsurface wetlands, organic contaminants

Poster Topic: Nutrient Removal

Monitoring Water Quality in the San Francisco Bay-Delta Using High-resolution Remote Sensing

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The San Francisco Bay Delta is a major source of freshwater for California and a profoundly human-impacted environment. The water quality monitoring that is critical to management of this important water resource and ecosystem relies primarily on a system of fixed water-quality monitoring stations, but the limited spatial coverage often hinders understanding. Here, we demonstrate how the spatial variability of important water quality indicators can be derived using the latest remote-sensing technology. Hyperspectral radiometry from the airborne Portable Remote Imaging SpectroMeter (PRISM) was used to derive high-resolution (~2-m scale) spatial distributions of turbidity, dissolved organic carbon (DOC) concentration, and chlorophyll-a concentration in a region influenced by wetlands. Furthermore, filter-passing methylmercury (MeHg) vs. DOC relationships were developed for co-collected *in-situ* samples, which allowed for the development of high-resolution maps of MeHg concentration in surface waters of the study area. Our results demonstrate how high-resolution remote sensing can be used to inform management and policy development by facilitating the detection of point- and non-point-source pollution and providing data to help assess the complex, diffuse impacts of wetland restoration, and climate change on water quality and ecosystem productivity in highly dynamic and heterogeneous systems such as estuaries.

Keywords: Water quality, imaging spectroscopy, remote sensing, turbidity, DOC, chlorophyll-a, methylmercury

Poster Topic: Nutrients

Nutrients Affecting the Water Quality in State Water Project Supplies

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Nutrients Affecting the Water Quality in State Water Project Supplies, Marcia Scavone-Tansey, Environmental Scientist, CDWR, DES, MWQI

A certain level of nutrients is necessary for biological production and, therefore, vital for healthy ecosystem function. Excessive nutrients, however, can cause too much production and lead to adverse effects. The presence of nutrients in aquatic systems promotes primary productivity, which can clog filters at the water treatment plant and waterways, block sunlight to the below-surface layers of the water column, and absorb dissolved oxygen in the water that could be available for aquatic life. In addition, some algae species are associated with undesirable compounds, such as geosmin and 2-methylisoborneol (MIB), which produce objectionable odors and tastes. Species of cyanobacteria, such as Microcystis, produce toxins that may be harmful to humans.

The objective of this initial study is to understand the sources of nutrients to the State Water Project, and the nutrient transformations and changes in conveyance structures. This work could lead to better control of algal and macrophyte growth, and could potentially lead to development of a nutrient component of the aqueduct extension model.

Our approach is to obtain data available from the Water Data Library (WDL), DWR O&M Division, and other sources, and develop a database and graphs for locations along the aqueduct including the North and South Bay Aqueducts, Delta inflows, Aqueduct Inflows, and the branches of the SWP. The following water quality constituents were included in the analysis: Nitrate + Nitrite, Nitrate, Ammonia, Total Kjeldahl Nitrogen, Total Nitrogen (TKN + Nitrate + Nitrite), Total Phosphorus, and Dissolved Orthophosphate. The partial results are analyzed in this poster.

Keywords: Nutrient, Nitrate, Nitrate+Nitrite, Ammonia, TKN, Nitrogen, Phosphorus, Orthophosphate

Poster Topic: Nutrients

Characterization of and Potential Mechanisms for Low Dissolved Oxygen in the Sloughs of San Francisco Bay

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The southern part of San Francisco Bay (SFB), Lower South Bay (LSB), is a collection of deep and shallow sub-tidal habitats, intertidal mudflats, and a large area of wetlands undergoing restoration which exchange with open SFB via many shallow sloughs. Dissolved oxygen (DO) has historically been monitored 1-2x monthly in the deep channel of LSB and is typically 6-8 mg/L despite high nutrient loading. However, recent high-frequency data demonstrate that DO in the deep channel can dip below 5 mg/L. We hypothesize this is caused by exchange with low DO water in sloughs and wetlands along the periphery. These regions have not been systematically monitored to date, but initial observations at one moored slough station show DO frequently drops below 5 mg/L and reaches concentrations as low as 1-3 mg/L; the severity and duration of these low-DO events is in part influenced by spring/neap tidal cycles. At this same station, elevated chlorophyll-a (chl-a) concentrations on ebb tides, 5-10x higher than observed in open SFB, suggest that there is an external source of organic matter. In this project, we established a series of continuous sensors at slough and deep channel sites and also collected high-spatial resolution data and vertical profiles to answer the following questions: (1) How do DO and chl-a concentrations in slough habitats vary in space (along channel and vertical) and in time (tidal to seasonal time scales)?; (2) What is the severity, extent and duration of low-DO events, and what are controlling mechanisms (i.e., organic matter exported from wetlands vs. in situ respiration)?; and (3) How does connectivity with sloughs and wetlands affect open Bay conditions? We present our findings from the first year of observations, evaluate the relative importance of different organic matter sources, and explore implications for DO, carbon and nitrogen budgets in LSB.

Keywords: Nutrients, dissolved oxygen, high-frequency monitoring, South Bay

Poster Topic: Nutrients

Fixed-Station Measurements and Synoptic Spatial Characterization Provide Insights into Organic-Matter, Nutrient, and Algal-Pigment Dynamics in the San Francisco Bay-Delta

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Continuous water-quality measurements (nutrients, organic matter, turbidity, algal pigments, dissolved oxygen, pH, temperature, conductivity) on autonomous and Lagrangian measurement platforms in the San Francisco Bay Delta (Delta), have improved our knowledge of important biogeochemical and eco-hydrological processes. The Delta is naturally, hydrodynamically complex and affected by human (wastewater and agricultural discharge, water withdrawals, land-surface alterations) and natural perturbations (floodplain and riparian interactions, wind, precipitation, snowmelt), which add complexity across eco-hydrological and water-management domains. Biogeochemical change can occur in the Delta in a matter of minutes to hours, with attendant longer term changes in the ecology of aquatic habitats and human use of the resource. Autonomous water-quality measurements collected over fine temporal and spatial scales help to effectively identify important drivers of biogeochemical processes in the Delta. An established network of autonomous, continuous water-quality monitoring stations in the Delta operated by the USGS, Sacramento, CA, currently provides temporally rich data at fixed locations. The fixed-station measurements reveal complex, hydrodynamically driven changes in water quality, useful to describe habitat conditions for pelagic organisms and to guide future tidal marsh restoration efforts in the delta.

To complement the fixed-station measurements, spatially dense data monitoring using a boat equipped with a GPS time-stamped high-frequency flow-through monitoring system, allow for real-time spatial mapping. Here, we present examples from the fixed-station monitoring network, combined with boat based Lagrangian measurements. We find that real-time mapping in concert with fixed-station monitoring is useful for identifying sources and sinks of nutrients and organic material, and to identify important biogeochemical drivers relating to pelagic habitat quality, algal productivity, and foodweb dynamics.

Keywords: Water quality, Nitrate, Mapping, Organic Matter, Algal Pigments

Poster Topic: Nutrients

Do Drought Conditions Increase Nutrients and Productivity in the Northern San Francisco Estuary?

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The extreme drought conditions experienced by California will impact estuarine water quality and productivity by increasing most nutrient concentrations due to decreased dilution from freshwater flow. However anthropogenic nutrient inputs from wastewater treatment will likely stay similar to non-drought conditions as a result of permitting and management practices. A publication in 2014 observed increased chlorophyll in the Bay/Delta related to the drought. To further investigate the consequences of extreme climate conditions on the different forms of nutrients and lower trophic levels of the pelagic food web of the northern San Francisco Estuary to establish if this was a repeatable response, we carried out temporally and spatially intensive cruises from 2012 to 2015 for comparison with data collected in earlier, normal or wet years. We hypothesized that during drought conditions phytoplankton biomass and production would increase in response to elevated nitrate and longer residence time. To provide a mechanistic interpretation of any observed changes in biomass, phytoplankton nutrient and carbon uptake rates were measured in addition to monitoring of nutrients and chlorophyll. Cruises were made across 13 stations that spanned salinities of 0 to 25, between Isleton in the Sacramento River and Central San Francisco Bay. In 2014, nutrients were elevated to levels not seen in recent history and four phytoplankton blooms, rare in this system, were observed. These blooms were evaluated for community composition and were dominated by diatoms, although one bloom in the shoals also had abundant chlorophytes. Higher productivity was measured during these blooms than in prior years. Blooms near the confluence of the Sacramento and San Joaquin Rivers primarily took up ammonium while blooms downstream in Suisun Bay took up both ammonium and nitrate. The interaction of anthropogenically derived nutrients with changes in climate (e.g. droughts) needs to be considered in decision making and resource management practices.

Keywords: drought, nitrate, phytoplankton,

Poster Topic: Primary Productivity

The Influence of Irradiance and Nutrients on the Growth of Two Diatoms Isolated from Northern San Francisco Bay

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Irradiance has long been hypothesized to exert a negative control on phytoplankton productivity and biomass accumulation in San Francisco Estuary. More recently, it has also been suggested that nitrogen type and concentration can exert a negative control on phytoplankton by selectively promoting certain taxa over others. Because investigations typically examine the impact of irradiance or nitrogen source separately, it's not clear which parameter exerts the greatest influence, or how the two parameters interact to impact phytoplankton. We isolated the diatoms *Thalassiosira weissflogii* and *Entomoneis paludosa* from Suisun Bay into pure monocultures in order to examine the interactive influences of varying irradiance simultaneously with varying the nitrogen type and concentration on phytoplankton productivity and growth. These freshly isolated strains were maintained at concentrations of nitrogen similar to concentrations at the time of isolation until the growth experiments were performed. Here we present the results of a nutrient-irradiance matrix with ammonium and nitrate additions varying from 20-1000 µmoles N L^{-1} and irradiance levels varying from 25 to 600 µmol photons m^{-2} s^{-1}. Effects on phytoplankton physiology were determined from measurements of photosystem II yield (F_v/F_m), ^{14}C primary productivity, cell abundance, and growth rates. The specific questions addressed with these experiments were: 1) Does changing the irradiance have a similar effect on phytoplankton growth as changing the nitrogen source or concentration? 2) Does changing the irradiance effect growth of phytoplankton using nitrate versus those using ammonium differently? And finally, 3) is the ammonium toxicity threshold of diatoms affected by irradiance?

Keywords: Diatoms, Growth Rate, Primary Productivity, Irradiance, Ammonium, Nitrate

Poster Topic: Primary Productivity

Temporal Trends of Benthic and Pelagic Primary Production in Historical Marshes

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Pelagic primary production has been well studied in the San Francisco Estuary (SFE), however there is much to learn about benthic photoautotrophs (i.e. the microphytobenthos), and their role as contributors to overall ecosystem function. Studies from other temperate estuaries suggest that the microphytobenthos has considerable impact on carbon cycles. This study aims to quantify primary production by both pelagic and benthic photoautotrophs at two historical SFE marshes, China Camp State Park (San Rafael, CA) and Rush Ranch (Suisun Marsh). These two sites differ in many environmental parameters including salinity, turbidity and hydrology. However both are reserved for recreational use only and are thus exposed to similar impacts. Primary production rates were assessed monthly (Mar-Sept 2015) using ^{13}C tracer incubations. Pelagic and benthic primary production rates were compared taking into account the differences in habitat afforded each group (i.e. the pelagic zone has more volume while mudflats support higher concentrations of algae). The results from this study will lead to increased understanding of how SFE wetland carbon cycling is impacted by both pelagic and benthic primary producers and how the food web quality of these areas might be affected by this cycling.

Keywords: Primary Production, Phytoplankton, Microphytobenthos, Food Web, Carbon Cycling, Wetlands, Marshes

Poster Topic: Primary Productivity

The Response of Bay Delta Phytoplankton Communities to Wastewater Ammonium Inputs and Changes in Irradiance

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The Bay Delta ecosystem exhibits unusually low levels of productivity, given the high levels of inorganic nutrient loading to the system. It has been suggested that anthropogenic ammonium (NH_4^+) loading inhibits nitrate (NO_3^-) uptake and growth of diatoms, thereby preventing blooms. From May 5-May 9, 2015, we conducted experimental manipulations and water column profiling research in the Bay Delta to assess the ecological effects of anthropogenic nutrient loading in the lower Sacramento River on phytoplankton growth, community structure, and dissolved inorganic nitrogen (N) uptake rates. We collected surface water at three locations, two located above and one below the Sacramento Regional wastewater treatment plant's diffuser pipe and incubated water for 48 hours. Experimental treatments included control, $+NH_4^+$ to 60 µM, $+NO_3^-$ to 7.5 µM, and added whole wastewater effluent containing 60 µM NH_4^+. The water was incubated at ambient water temperature in 10-L cubitainers at two light levels: 50% and 5% of surface irradiance. Over two days, chlorophyll *a* (Chl *a*) concentrations increased seven-fold in response to both the $+NH_4^+$ and effluent additions at the upstream stations in the 50% light treatment, suggesting strong phytoplankton growth in response to added NH_4^+. At all stations, Chl *a* accumulation was strongly affected by light limitation in the 5% light treatment. We also report changes in phytoplankton community structure, based on microscopy enumeration, HPLC pigment analysis, and analysis on a FlowCam, among treatments over the 48 hours. Additionally, we assessed variations in NO_3^- and NH_4^+ uptake and CO_2 fixation across treatments over the course of the incubation. Taken as a whole, our results suggest that NH_4^+ from wastewater effluent does not inhibit phytoplankton growth in the Bay Delta, contrary to what has been previously suggested, and that light limitation plays a major role in controlling the productivity of the lower Sacramento River.

Keywords: ammonium, phytoplankton, nutrients, nitrogen, nitrate, wastewater, light uptake

Poster Topic: Primary Productivity

Emulating Volcanism to Create a New Class of Recycled Water

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Volcanoes release significant amounts of sulfur dioxide into the atmosphere and oceans. This phenomenon appears to provide the quintessential chemical reaction that drives all of our planet's ecosystems and all of the life forms that inhabit them. Volcanism is integral to how our planet continuously resets and keeps the elements *hydrogen* (H^+), *oxygen* (*O*), *sulfur* (*S*), and *carbon* (*C*) in a constant state of flux. This chemistry is shown below:

$$S + O_2 \rightarrow SO_2 + H_2O \rightarrow H_2SO_3 + HCO_3^- \rightarrow H_2CO_3 + HSO_3^- \rightarrow H_2O + CO_2\uparrow + HSO_3^- + .5O_2 \rightarrow H^+ + SO_4^=$$

This chemistry illustrates how nature provides the: *acidity* needed to control *pH*; deconstructs chemical compounds; transforms *alkalinity* (*bicarbonates/carbonates*) into *water* (which provides dilution to prevent our planet's oceans from supersaturating and precipitating out of solution); *carbon dioxide* to maintain the atmosphere; *bisulfite*, an inorganic compound and energy source that feeds bacteria (*chemolithotrophs)*; and *sulfate*, the nutrient that aids in the formation of amino acids Cysteine and Methionine.

Unlike nature, current wastewater treatment methods use artificial chemicals such as sodium hypochlorite, sodium bisulfite, polymers, ferric chloride, etc., which increase salts, incapable deconstructing chemical compounds, and stresses ecosystems. Nature always has the final say and the near collapse of important aquatic ecosystems such as the San Francisco Bay Delta Estuary, rapid accumulation of salts on our precious farm ground, indicate that our current wastewater processing methods and use of these materials are unsustainable. To become sustainable, we must recognize the integral role volcanism has to our planet. Doing so will help us to better understand how our planet actually works and how to emulate the same chemistry nature uses to process and create a new class of recycled water.

Keywords: Wastewater

Poster Topic: Recycled Water

Effects of California's Drought on San Francisco Bay Specific Conductance and Temperature

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The current drought in California is poised to be the most significant in recent history. As the drought persists, reduced freshwater flows and increased demand on surface- and ground water reservoirs will allow coastal ocean waters to intrude further inland in the San Francisco Bay-Delta Estuary. For this study we analyzed up to 24 years of continuous records of specific conductance and temperature collected in San Francisco Bay (Bay). Salinity can be calculated from specific conductance and they covary. Instruments equipped with specific conductance and temperature sensors recording every 15 minutes were deployed at seven fixed locations throughout the Bay—Benicia Bridge, Carquinez Bridge, Richmond-San Rafael Bridge, Alcatraz Island, San Mateo Bridge, Dumbarton Bridge, and Alviso Slough (listed geographically from north to south). Five of the locations were deep enough to deploy instruments at two depths in the water column to assess vertical variations, for a total of 12 instruments and 145 sensor-years of data. During water year (WY) 2014 (1 Oct 2013 through 30 Sep 2014), record-high values were observed for nine specific conductance and seven temperature sensors. For specific conductance, the maximum values were lowest in the northeastern region (nearest the major source of freshwater inflow) and highest in the southern extent of the Bay (far from ocean boundary). For temperature, the maximum values generally increased moving landward from the ocean boundary in both north and south directions. The quantity of record high values we observed during WY2014 is unprecedented and demonstrates both the effect of the drought on the Bay and the value of long-term monitoring. Better understanding of the effects of reduced flows from the Delta and their impact on the natural and human environment in the Bay will provide insight on potential effects from future droughts or other reductions in Delta flow.

Keywords: water quality, monitoring, drought

Poster Topic: Regional Monitoring Program for Water Quality in San Francisco Bay

Evaluation of Mercury and PCB Trends in San Francisco Bay Region Stormwater

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San Francisco Bay is listed as a water body impaired due to chemical pollution, including mercury and polychlorinated biphenyls (PCBs) bioaccumulating in fish consumed by wildlife and humans. This has led to development of Total Maximum Daily Load (TMDL) control plans for these legacy contaminants, which call for significant reductions in stormwater loads. Some challenges of evaluating the efficacy of these plans include: (1) the heterogeneous distribution of these contaminants in urban areas (particularly PCBs), (2) the difficulty of representatively sampling episodic and individually unique storm events, (3) the mixing of loads from managed and unmanaged areas, and (4) climatic variation leading to highly variable interannual loads. All these factors confound the differentiation of impacts of management action from those arising from other drivers of environmental spatial and temporal variability. Work is ongoing to develop a set of trends indicators to allow local stakeholders to measure the benefits of implemented and planned management actions. We examined data for samples from various watersheds collected since 2010. Parameters such as contaminant concentrations directly measured on solids collected from stormwater, or surrogate measures such as whole water contaminant concentrations normalized to suspended sediment concentration (SSC), show promise for reducing the uncertainty from climatic variation in characterizing loads from some watersheds. However, there remain unknown or poorly characterized factors affecting contaminant delivery for other watersheds. Power analyses using currently available data suggest that for the least variable watersheds, modest changes arising from management action may be detectable within a decadal time frame. However, for the most variable watersheds, much larger reductions over a longer multi-decadal scale may be needed to distinguish benefits of management action with any reasonable or usable degree of certainty.

Keywords: stormwater, trends, PCB, mercury

Poster Topic: Regional Monitoring Program for Water Quality in San Francisco Bay

Fipronil Water Pollution and Its Sources

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Both professional and non-professional urban pesticide users are shifting to new pest control chemicals, partly in response to California state regulatory actions addressing widespread aquatic toxicity from pyrethroid insecticides. The first alternative to pyrethroids to gain significant urban market share in California is fipronil. Fipronil is a phenylpyrazole insecticide with multiple stable degradates, some of which are more toxic to aquatic organisms than the parent chemical. California fipronil sales nearly tripled from 2003 to 2011. In California, fipronil is used for structural pest control and pet treatments; it is not approved for agricultural use. Except in the Coachella Valley (Palm Springs region), fipronil may not be used on landscaping in California. Recent monitoring has revealed the presence of fipronil and its degradates in urban runoff, municipal wastewater treatment plant effluent, and in both water and sediment in rivers, streams, and estuaries. Measured fipronil and degradate concentrations are reaching—and in some cases exceeding—concentrations known to cause toxicity to sensitive aquatic organisms. Based on fipronil use patterns, urban drainage designs, monitoring data, and environmental fate data, the most likely source (outdoor structural pest control) and pathways for fipronil to move into urban runoff are relatively clear. Further exploration is needed to determine the major source for fipronil flowing into municipal wastewater treatment plants, which may relate to pet treatments and/or structural pest control applications, uses not typically considered likely to entail discharges to the sewer system. Additional urban monitoring data, particularly data characterizing the presence of fipronil and its degradates in wastewater influent, effluent, biosolids, estuaries and sediments, would strengthen understanding of the types of urban areas with fipronil water pollution. Toxicity testing (particularly with *Chironomus dilutes* and *Americamysis bahia*) paired with chemical analysis of environmental samples is recommended. Degradates warrant further characterization (toxicity, chemical properties, environmental fate).

Keywords: Pesticides, Fipronil, Surface water, Wastewater, Stormwater, Sources

Poster Topic: Regional Monitoring Program for Water Quality in San Francisco Bay

Microplastic Contamination in San Francisco Bay

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Microplastic is a term used to describe fragments of plastic 5 mm or smaller. Sources of aquatic microplastic pollution include microbeads used in personal care products such as facial scrubs and toothpastes, pellets used as precursors for industrial products, plastic fibers derived from washing clothes made with synthetic materials, and fragments of larger plastic items. Motivated by recent state and federal efforts to ban microbeads in personal care products, the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) characterized Bay surface waters and wastewater treatment plant (WWTP) effluents for microplastic contaminants. Nine Central and South Bay surface water samples were collected using a manta trawl. Two-hour sieved samples of effluent were collected from eight WWTPs discharging to the Bay. Microplastics in samples were characterized by size, type, and abundance. Preliminary results from this survey for plastic pollution in the San Francisco Bay are presented.

Keywords: Microplastic, microbeads, RMP, wastewater, effluents, San Francisco Bay

Poster Topic: Regional Monitoring Program for Water Quality in San Francisco Bay

Poly- and Perfluoroalkyl Substances in Wastewater Effluent Discharged to SF Bay

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Perfluorooctane sulfonate (PFOS) has been measured at persistently high concentrations in San Francisco Bay wildlife. To assess potential sources of PFOS and other poly- and perfluoroalkyl substances (PFASs) to the region, wastewater effluent samples from eight local treatment plants were collected for PFAS analysis. Wastewater samples were analyzed directly for a suite of PFASs and were also subjected to an oxidation assay to indirectly estimate the total concentration of polyfluorinated compounds.

Effluent collected from the San Francisco Airport industrial treatment plant and Fairfield Suisun contained the highest total concentrations of individually measured PFASs, 2900 ng/L and 450 ng/L, respectively. Both these treatment plants receive runoff from areas that are likely impacted by aqueous film forming foam, a major source of PFASs. In the other six effluent samples, between 75 and 150 ng/L of individual PFASs were measured. Short chain perfluorinated acids (i.e., C6 and shorter perfluorinated carboxylates) predominated in most samples, followed by the C8 forms, PFOS and PFOA. Polyfluorinated species that were indirectly measured accounted for 30% to 60% of total molar PFASs, and also indicated a predominance of short chain species in all the effluent samples. These results overall indicate that C8 PFASs are waning relative to their shorter chain counterparts in SF Bay effluent.

The views expressed herein are those of the authors and do not necessarily reflect those of the California Department of Toxic Substances Control.

Keywords: perfluorinated, PFC, PFAS, PFOS, wastewater effluent, AFFF

Poster Topic: Regional Monitoring Program for Water Quality in San Francisco Bay

Biogeochemical Effects of Shifts in Ammonia-Oxidizing Microbial Community Structure and Gene Expression in the Waters of Suisun Bay and the Sacramento River

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Ammonia oxidation is the link between reduced and oxidized forms of inorganic nitrogen, and is therefore a crucial step in the aquatic nitrogen cycle. Yet, the microbial ecology and biogeochemistry of this process is largely unknown in estuary and river waters. Few studies have measured nitrification rates in tandem with functional gene (*amoA*) expression, abundance, and diversity, yet these organisms and this process are a critical link in the nitrogen cycle of nutrient-rich estuaries. We sampled diverse regions throughout northern San Francisco Bay and the lower Sacramento River to determine the community structure and biogeochemical impact of ammonia-oxidizing microbes, using functional gene-based PCR assays and stable isotope tracer experiments to quantify the microbial ecology and biogeochemistry of nitrification, respectively. Ammonia-oxidizing archaea (AOA) generally outnumbered ammonia-oxidizing bacteria (AOB) throughout the sampled gradient, though the relative abundance of AOB increased in brackish regions. AOA were always numerically dominant in the Sacramento River. Based on gene diversity, distinct AOA communities were present in fresh, brackish, and marine waters, whereas AOB were split into freshwater and non-freshwater communities. mRNA expression of *amoA* appeared to largely track DNA abundance, but suggested only a fraction of the ammonia-oxidizing community was typically active. While the pulse of ammonium delivered via wastewater discharge had little effect on microbial abundance, nitrification rates and gene expression increased downstream of the discharge site. Profiles of nitrification rates also suggested high biogeochemical activity near the sediment-water interface. This work increases our knowledge of the ecology and dynamics of ammonia oxidizers in the San Francisco Bay-Delta, and provides an initial attempt to link nitrification rates to microbial gene expression in this river and estuary.

Keywords: nitrogen, biogeochemistry, ammonium, microbiology, salinity, ecology, archaea, bacteria, isotopes

Poster Topic: Regional Monitoring Program for Water Quality in San Francisco Bay

Impact of Small Urban Reservoirs on Water Quality in East Bay Watersheds

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The urban San Francisco Bay area is home to more than 200 reservoirs. These reservoirs are maintained for a variety of uses including recreation and irrigation water storage. The influence of major freeways, historic mines, and continued development alters contaminant loads. Understanding biogeochemical cycles in urban watershed/reservoirs systems provides new insight into anthropogenic influences on the function of these systems. Differing management strategies in these systems may mitigate or exacerbate contaminant discharge to the urban-influenced coastal ocean. Understanding these impacts is critical to future best management of these systems for improved water quality and beneficial use.

Our study investigates three East Bay region watershed/reservoir systems to better understand contaminant cycling and mobility in urban environments. Study sites include Lion Creek/Lake Aliso, influenced by acid mine drainage, and San Lorenzo Creek/Don Castro Reservoir, impacted by freeways and residential land uses. Wildcat Creek/Lake Anza, which lies primarily in parkland, serves as a background comparison. Water quality data (including standard geochemistry, as well as nutrient and trace element concentrations) from reservoir inlets and outlets at each of these systems is collected bimonthly. Depth profiles of pH, conductivity, temperature, and dissolved oxygen within each lake are also collected biweekly. In addition, sediment cores from multiple locations in each lake were collected and analyzed for nutrient and trace element concentration (see poster by K. Faul).

Results suggest urban reservoirs are important controls on biogeochemical cycling in urban watersheds and downstream water quality. Reservoir mixing varies over the course of a year and leads to reducing conditions prevailing during warm summer months and oxidizing conditions dominating during more winter months. The redox state of these reservoirs determines whether metals and nutrients are mobilized or retained by the lakes. Therefore, these lakes provide great insight into how best to manage water levels to reduce contaminant outfluxes.

Keywords: Reservoirs, Metals, Nutrients, Urban, Watershed, Water Quality, Dam, Lake

Poster Topic: Reservoir Monitoring

Sediment Core Derived History of Metal Cycling through Small Urban Reservoirs in the San Francisco East Bay Area

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Urbanization and a long local mining legacy have left many San Francisco Bay region watershed/reservoir systems contaminated with pollutants. Small reservoirs may serve as previously unquantified sinks for metals, organic carbon, and nutrients from urban streams that might otherwise discharge into the San Francisco Bay.

To reconstruct the history of deposition of these contaminants over the life of the reservoirs, we collected sediment records from three urban stream/reservoir pairs in the East Bay region: Leona Creek/Lake Aliso, impacted by urbanization and acid mine drainage, San Lorenzo Creek/Don Castro Reservoir, impacted by urbanization, and Wildcat Creek/Lake Anza in Tilden Park, which is relatively unimpacted. Sediment cores were collected using a vibracoring system and were analyzed for color, grain size, bulk density, metals, organic carbon, nutrients, stable isotopes of carbon and nitrogen, and Pb-210. In addition, bimonthly water quality data from reservoir inlets and outlets at each of these systems as well as depth profiles of pH, conductivity, temperature, and dissolved oxygen within each lake are collected (see poster by L. Rademacher).

Preliminary isotopic data suggests variations in source for organic matter to the lakes. Scanning x-ray fluorescence measurements indicate that metal concentrations varied through depth in the core in individual lakes and in space at different lakes. Analysis of discrete samples for metals in the sediment cores by inductively coupled plasma optical emission spectrometry will be combined with Pb-210 analysis to produce a detailed time constrained history of metals cycling in the reservoirs.

These analyses will provide insight into whether small reservoirs act as sinks for pollutants or allow pollutants to pass through the system and ultimately discharge in the Bay. Results from this research will be useful in developing reservoir management strategies in the San Francisco Bay area.

Keywords: San Francisco East Bay, metals, reservoir, sediment records, nutrients

Poster Topic: Reservoir Monitoring

Watershed Planning for Green Infrastructure Implementation through the GreenPlan-IT Toolkit

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The benefits for greening the urban landscape through Green Infrastructure (GI) are numerous, including water-quality improvements derived from filtering runoff pollution, reduction of urban flooding risks, and increased groundwater recharge. Other benefits include traffic calming effects, improvement of the bike/pedestrian environment, improved connectivity of green spaces (and habitats for birds and wildlife), as well as beautification of neighborhoods and increased property values. But how do we ensure that GI placement is optimized to yield the water-quality and flow reduction outcomes called for within the NPDES permits?

GreenPlan-IT is a planning level tool that is designed to support the cost-effective selection and placement of GI in urban watersheds. The GreenPlan-IT toolkit is comprised of three tools: (a) a GIS-based Site Locator Tool to map and rank potential GI sites; (b) a Modeling Tool to determine baseline conditions and project runoff and pollutant load reduction from GI scenarios; and (c) an Optimization Tool that uses cost-benefit analysis to identify the best GI installation scenario within a watershed for achieving flow/load reduction goals. Tool outputs are used by municipalities to develop watershed master plans to guide future GI implementation toward addressing water quality and quantity targets.

GreenPlan-IT is a product of the Green Plan Bay Area project, a collaborative effort between San Francisco Estuary Partnership (SFEP), San Francisco Estuary Institute (SFEI) and Bay Area municipalities. New enhancements for the GreenPlan-IT toolkit will be developed through new US EPA Water Quality Improvement funding that will facilitate broader implementation among Bay Area municipalities.

Keywords: stormwater, low-impact development, green infrastructure, load reduction, GIS, municipal planning

Poster Topic: Runoff Infrastructure

Rain Gardens in Richmond: A Low-cost, Community Driven Solution for Stormwater Filtration

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In Richmond, a grassroots approach is creating a system of rain gardens along the Richmond Greenway providing solutions to non-point pollution and stormwater drainage issues while positively engaging community members.

Railroad development in Richmond began in 1895, and industrialization expanded from there, bringing pavement and pollution to the city. As a result, this area contributes some of the highest levels of non-point pollution flowing into the Bay. The Richmond Greenway is a walking and biking path, built several years ago as part of the Rails to Trails Initiative. However, the Greenway faces drainage issues leading to polluted stormwater accumulating where city streets intersect with the path. Richmond's financial limitations have previously been seen as inhibiting solutions to these environmental problems as there is a perception that expensive and sophisticated engineering solutions are required to solve these challenges.

This poster shows how The Watershed Project, a small non-profit, found a low-cost, grassroots solution to this large-scale drainage problem, using a network of rain gardens along the Richmond Greenway. Through collaborations with partnering organizations, hiring and mentoring local youth known as the Green Collar Corps, and the help of many volunteers, we have built a system of five rain gardens and bioswales along the Greenway, with several more planned. This project is a model for communities facing similar problems around the Bay Area.

The rain gardens and bioswales alleviate flooding and eliminate post-storm ponding through "slow, it spread it, sink in" designs: slowing down the water, spreading it, and allowing it to infiltrate into the soils where it is filtered by microbes. Other benefits include improved water quality in the Bay, adding much needed green spaces around the mostly paved City of Richmond, and an engaged local community dedicated to beautifying the city and protecting green spaces.

Keywords: Richmond, stormwater, rain garden, bioswale, community partnership, low cost solution

Poster Topic: Runoff Infrastructure

Performance of a Bioswale on Urban Runoff Management

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Bioswales have proved to be an effective best management practice (BMP) to control runoff. Most bioswale evaluation studies have been conducted a few years following construction, perhaps underestimating the pollutant control value of mature trees because their crowns and root systems were not fully developed. This study evaluates the effectiveness of a bioswale eight years after construction in Davis, California. The bioswale was installed in 2007 and measured 9 m x 1 m x 1 m (LxWxD). Engineered soil (80% native lava rock and 20% loam soil by volume) replaced the native Yolo loam soil. Four Red Tip Photinia (*Photinia ×fraseri Dress*) trees and two Blueberry Muffin Hawthorn (*Rhaphiolepis umbellata (Thunb.) Makino*) shrubs were planted in the bioswale. Runoff flowed into the bioswale from an adjacent 171 m^2 panel of turf grass. An identically sized control plot consisting of non-disturbed native soil was located immediately adjacent to the treatment plot. The same plants were planted in the control site. Surface runoff, pollutant loading, and woody plant growth were measured. Compared to the control, the treatment reduced N, P, and TOC loading by 99.4%, 99.7%, and 99.6%, respectively. These reductions were primarily due to a reduction of surface runoff by 99.4%. After eight years, plant growth was not significantly different, perhaps because the native Yolo loam is a very productive agricultural soil. The superior performance of the bioswale for reducing pollutants demonstrates the importance of additional long-term monitoring and the potential for large-scale application as an effective urban runoff control measure.

Keywords: bioswale, engineered soil, urban runoff, water quality

Poster Topic: Runoff Infrastructure

Sediment: Checks and Balances

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Sediment in the San Francisco Estuary is ever changing. Consisting of a range of coarse- and fine-grained particles that create predominantly muddy or sandy subtidal substrate, the San Francisco Bay floor is habitat to numerous subtidal flora and fauna. Human activities in and around the Bay have direct and indirect impacts on both the biological components of the estuarine system, but also the physical components of the system such as the tidal prism, sediment transport and dynamics, erosion, accretion, tidal fluctuations, among others. Several human activities influencing sediment dynamics include maintenance dredging, aggregate mining, sediment placement at beneficial reuse sites, and sediment disposal in or out of the Bay. Climate change and sea level rise add complexity to our understanding of sediment dynamics. Management of sediment in a way that balances the concerns of both resource agencies as well as those concerned with sediment availability and the ability of marshes to keep pace with rising sea levels requires a comprehensive understanding of sediment sources, sinks, and influencing factors.

Here, we present a visual summary of some of the major players in the sediment story. From maintenance dredging and sand mining, to multi-benefit flood control and restoration projects, large volumes of fine and coarse-grained sediment are naturally or manually being transported throughout the Bay. Dredged material may be used for restoration, returned to the Bay, or dumped in the ocean depending on its quality, and managers around the Bay are striving to work together to meet each others' sediment needs in the face of rising seas.

Keywords: Sediment, dredging, beneficial reuse, accretion, management, sea level rise, restoration

Poster Topic: Sediment Transport

Observations and Modeling of Dumbarton Mudflat Evolution at Decadal Time Scales

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Estuarine tidal flats are rich habitats that evolve morphologically in response to changes in climate and sea level. Their shape and width is determined by a number of factors including the interplay of wind waves, tides, and sediment availability. To explore the processes governing tidal flat evolution, we use a combination of observations and 1D process-based modeling (Delft3D) of the tidal flat-channel system at Dumbarton Bridge in South San Francisco Bay, CA. At the decadal time scale, bathymetric surveys collected approximately every 30 years from 1858 to 2005 document that tidal flat width varied from 550 to 900 m. Width is correlated with net deposition/erosion of lower South Bay, defined as south of Dumbarton Bridge. Tidal flats, which are concave up near the shore and convex up at their bayward edge, widened during periods of net sediment import and narrowed during net sediment export. Experimental model runs with constant sediment supply, waves, and tide forcing show bayward widening of tidal flats and slow development from a flat bed towards a concave-up equilibrium within 5 years. Equilibrium consists of similar erosion and deposition rates, maintaining locally high sediment concentrations above the tidal flat. Sensitivity analysis is carried out with respect to forcing conditions and sediment characteristics. Important research questions are to what extent rare, extreme wave events determine the profile compared to typical conditions and whether forcing and sediment availability change too rapidly for the system to reach equilibrium. This study will also improve our ability to assess possible impacts of ongoing restoration projects and sea level rise on tidal flat morphology.

Keywords: mudflats, modeling, sea level rise, sediment supply, intertidal equilibrium

Poster Topic: Sediment Transport

Sediment Source Analysis to Inform Sediment Management Actions for Wildcat Creek, California

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High rates of erosion in the Wildcat Creek Watershed have led to instability in Wildcat Creek and tributary channels, sediment accumulation in Jewel Lake and Lake Anza reservoirs managed by the East Bay Regional Park District (EBRPD), and sediment deposition in the downstream and urbanized reach that has reduced flood conveyance. Management concerns related to increased sediment supply and transport include impacts to resident fish (including native rainbow trout, three-spine stickleback, and Sacramento perch), degradation of infrastructure and recreational facilities in the upper watershed managed by EBRPD, and reduced flood conveyance in the lower watershed.

EBRPD conducted a sediment and erosion control analysis to locate, prioritize, and develop multi-objective solutions to reduce erosion in the Upper Wildcat Creek Watershed. EBRPD facilitated local stakeholder involvement to guide development of sustainable and multi-objective sediment management solutions that also support desired habitats and land uses. EBRPD located and mapped significant sources of sediment in the Upper Wildcat Creek Watershed, created a sediment source Geographic Information System (GIS) database, developed multi-objective conceptual design solutions, and identified methodologies for erosion control. Next, EBRPD assessed each conceptual design solution for feasibility, cost, sediment reduction, habitat benefit, and long term sustainability. Lastly, EBRPD developed recommendations for implementation of the highest ranked sediment control conceptual design for the long term, programmatic maintenance of the Upper Wildcat Creek Watershed. The highest ranked conceptual sediment designs include bypassing Jewel Lake with a restored channel that provides passage for native rainbow trout and repairing storm water outfalls that have developed into large gullies along Wildcat Canyon Road. EBRPD conducted this study to maintain healthy, sustainable ecosystems throughout the upper watershed and to improve sediment management both in the upper watershed and downstream.

Keywords: Wildcat Creek, sediment, conceptual design, channel restoration, watershed management

Poster Topic: Sediment Transport

High-resolution Field Measurements of Cohesive Sediment Characteristics and Dynamics in Northern San Francisco Bay

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Cohesive sediments play an essential role in estuaries like San Francisco Bay by affecting primary productivity through turbidity effects on in-water light levels. However, current management decisions are based on imperfect knowledge of the relationship between flow, suspended sediment, and light. Because we lack understanding of fundamental physical processes, there is a need for high-resolution data that can only be collected using fieldwork. Our work addresses this gap through advanced field measurements of currents and turbulence (Teledyne RDI ADCP, Rockland Scientific VMP-200), primary particle and floc size distributions (Beckman Coulter LS 13 320, Sequoia Scientific LISST-100X), and background water quality and light conditions (Seabird Electronic 19+ CTD-PAR). We quantify the relationship between tidally-driven flow and suspended cohesive sediment properties such as floc sizes, density, and settling velocity. Results from stationary and transect measurements collected in northern San Francisco Bay show flocculation (floc aggregation and break-up) to be important in determining sediment settling velocity. Ultimately, a careful understanding of the physics controlling flocculation will help improve sediment transport predictions and facilitate accurate development of sediment models.

Keywords: Cohesive sediment, flocculation, sediment transport, turbulence, light availability

Poster Topic: Sediment Transport

Implementing Fine Sediment TMDLs on Private Lands with the Voluntary, Incentive-based Fish Friendly Farming Environmental Certification Program

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The Fish Friendly Farming (FFF) Environmental Certification Program was designed to implement source control of fine sediment on private agricultural lands. It is the most rigorous certification program in California. In the Napa River and Sonoma Creek watersheds over 78,000 acres have enrolled. The fine sediment TMDLs for these two watersheds recognize the FFF program as a compliance measure. The Ca Land Stewardship Institute (CLSI) runs the FFF program and completes detailed farm conservation plans for the entire parcel including the agricultural lands. All potential sources of fine sediment are assessed including farmed areas, roads, all concentrated flow outlets, all creeks and other sites. The FFF program also called Napa Green, is very popular with growers demonstrating that farmers will voluntarily improve the environment. Each farm plan lays out the management measures needed to: reduce fine sediment generation and delivery to streams; reduce use of chemicals with high toxicity to fish and wildlife; reduce water use and assure water sources do not negatively affect endangered fish species; remove invasive non-native plant species along creeks and uplands and restore riparian corridors; evaluate geomorphic features of creeks and change management practices and restore natural form to creeks. Certification is done by agencies - National Marine Fisheries Service and the County Agricultural Commissioner. Each site is re-certified every 5 years and CLSI completes numerous restoration projects with growers. The restoration of the Napa River between the Oakville Crossroad and Oak Knoll Ave currently managed by Napa County began with growers certified in the FFF program and a detailed concept plan completed by CLSI. The FFF program also called Napa Green, is very popular with growers demonstrating that farmers will voluntarily improve the environment. Currently the FFF program operates in 9 counties and there is interest in setting up the program in the Delta.

Keywords: Agriculture, TMDL, fine sediment, pollution, salmon restoration, Napa River restoration

Poster Topic: Sediment Transport

Water Supply and Instream Habitat Improvements in Suisun Creek

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The California Land Stewardship Institute (CLSI) has been involved in watershed restoration in Suisun Creek watershed since 2001. In 2004 a watershed plan, funded by the Coastal Conservancy, was completed and included extensive monitoring of water temperatures in Suisun Creek and its tributaries Wooden Valley and White Creeks. The plan recommended evaluation of Lake Curry releases to enhance cold water habitat in Suisun Creek for steelhead trout as well as a number of other actions. CalFed provided funding for implementation of the Suisun Creek Watershed Plan. Several studies were completed for Lake Curry. An engineering evaluation included a bathymetric survey and monitoring of stream flow in Suisun Creek below the dam. A computer model was set up to look at the temperatures of water in Lake Curry under various rainfall conditions (normal, dry and very dry) and the length of time that water releases to Suisun Creek would last under various release rates. In addition water temperatures were monitored using dataloggers at 15 stations on Suisun Creek while release rates from Lake Curry were varied from 2 cfs, 4 cfs, and 6 cfs. The study of Lake Curry concluded that during a normal or wet year, the reservoir is full on April 1 and can release 5.5 cfs from April 1 to November 1 of 68^{o} F water. The experiment found that a maximum release of 6 cfs of cold water creates cold water conditions at Stations SC 10 to SC 8 in the first 3 miles of Suisun Creek below the reservoir. The analysis of the 2006 experiment found that the stream temperatures warmed downstream of SC 8 largely due to the large volume of water in the creek channel heated by solar inputs and the lack of riparian canopy. Next steps will be illustrated.

Keywords: water supply, steelhead trout, Suisun Creek, reservoir reoperation

Poster Topic: Watershed Management

Upper Napa River Water Quality Improvement and Habitat Enhancement Program

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The Upper Napa River Restoration Project stretches 5.3 miles from Calistoga to Big Tree Lane. The project started with the Fish Friendly Farming Program and landowners along the river wanting to reduce bank erosion and improve the river environment. The California Land Stewardship Institute (CLSI) led an interdisciplinary team evaluating the physical and ecological features of the river. Ground-based LIDAR was coupled with aerial LIDAR and surveyed cross sections of the channel to create detailed topographic maps of the channel. Geomorphic features were delineated, riparian condition and regeneration potential was assessed as were instream salmonid habitats. The plan documented widespread channel incision. Incision is believed to occur during very wet years when banks slump into the channel creating new floodplains and damming long glides in the channel. This pattern of change differs significantly from reaches downstream where eroded banks are largely swept out of the river channel during floods. This drop in base level from incision migrates up every tributary and drainage ditch until hard rock or another type of grade control is reached. This process is increasing fine sediment pollution and damage to properties and habitat. This project focuses on widening the main river channel to reduce water velocities and thus stop any further drop in the river's base level and the subsequent long-term sediment generation it causes. The physical form of the channel translates to healthy aquatic and riparian habitats. The riparian ecosystem needs complex channel habitats to regenerate new trees to replace older trees that erode into the water, to provide for a diversity of tree species and to produce the physical heterogeneity of plant growth forms (trees, shrubs, vines, and herbs) needed to support fish and wildlife. This project addresses the cause of poor habitat: a narrow and deep channel with high velocity flood flows

Keywords: channel, incision, riparian regeneration, LIDAR, Napa River, agriculture, restoration

Poster Topic: Watershed Management

Central Valley Flood System Conservation Strategy - Planning Tools, Key Datasets, and Measurable Objectives

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The Central Valley Flood System Conservation Strategy is an integral component of the 2017 Central Valley Flood Protection Plan (CVFPP). It provides a framework for achieving ecological improvements within flood risk reduction projects through the development of restoration targets, planning tools and key datasets, and geographically specific measurable objectives. These efforts are focused on the Sacramento and San Joaquin Rivers within the Systemwide Planning Area of the CVFPP. Restoration targets include fundamental riverine processes and habitats, focused species conservation, and proposed reductions in stressors such as fish passage barriers. Planning tools and key datasets describe the existing conditions and potential for ecosystem uplift. Measurable objectives have been developed through analyses of the conservation and recovery needs of sensitive terrestrial and aquatic wildlife and plant species which depend upon riparian systems within the Central Valley. The CDWR is working closely with federal, state, and regional flood management and resource agencies, local stakeholders, and non-governmental organizations to develop multi-benefit flood risk reduction projects which address both flood risk management and ecosystem goals and objectives. There are ongoing and future opportunities for collaboration with large-scale restoration programs such as the San Joaquin River Restoration Program to achieve ecological uplift by meeting conservation strategy objectives. Through these efforts, the flood management community and others will contribute to the resilience and sustainability of riparian systems within the Central Valley.

Keywords: Flood Management, Multi-benefit Projects, Endangered Species Recovery, Watershed Management

Poster Topic: Watershed Management

RipZET: A GIS-Based Decision Support Tool for Estimating Riparian Zones at the Watershed and/or Project Scale

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The loss of riparian areas throughout the Bay-Delta region has affected water quality and habitat conditions and presented a number of challenges for resource managers related to water management and land use planning. Current approaches for restoring and protecting riparian areas are starting to focus on appropriate riparian functions or ecological services, including stream shading, bank stabilization, organic and inorganic material input, runoff filtration, floodwater storage, and groundwater recharge. Land-use planners therefore need tools to help delineate and map the extent of "functional riparian width" as a means of ensuring appropriate riparian width in developed stream reaches targeted for restoration and relatively undisturbed stream reaches targeted for development.

The Riparian Zone Estimation Tool (RipZET) is a recently released GIS-based decision support tool that estimates functional riparian width based on channel type and associated riparian functions. The tool provides reach-scale functional riparian width estimates based on average height of mature riparian vegetation, the steepness of hillslopes adjacent to the channel, and the floodplain inundation extent for large storm events. The appropriate width estimate for a reach is then determined based on the riparian functions associated with different channel types, which range from steep headwater channels to low-gradient, meandering channels with broad floodplains.

RipZET has been tested to date in the San Francisco Bay Area, as well as in the Tahoe Basin and Central Coast, and has been reviewed by regional science and management experts. This presentation will provide an example of applying the tool in the Bay Area to estimate functional riparian widths using readily available topographic, vegetation, and hydraulic data. The tool is now ready for use by the watershed management community and can be downloaded at http://www.sfei.org/projects/ripzet.

Keywords: Riparian Restoration Watershed Habitat Management Tools Ecological services Water quality

Poster Topic: Watershed Management

Using Multiple Indicators and Assessment Methods to Develop an Ecological Baseline

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The Zone 7 Ecological Baseline Conditions Report (Baseline) describes the condition of ecological resources within the delineated Study Area in eastern Alameda County. A suite of seven assessment methods including calculation of five multi-metric indices were selected to characterize different watershed attributes as well as address the U.S. EPA's Level 1-2-3 assessment framework. Selected methods included standardized protocols such as the Surface Water Ambient Monitoring Program (SWAMP) Bioassessment Methodology, and California Rapid Assessment Method (CRAM), as well as field and desktop methods to assess conditions for riparian forests, fish, birds, reptiles and amphibians. Of the seven assessment methods selected, four assessment methods in this Baseline followed the probability-based survey design—CRAM, SWAMP, RiVR, and fish.

In general, the overall condition of streams and riparian resources within the Study Area can be described as "Fair" condition overall. The landscape and its resources have been affected by urbanization and its associated anthropogenic effects—landcover is largely dominated by non-native vegetation types and historical channelization has simplified the arroyos and riparian vegetation in many places. However, fish communities as well as a number of other watershed attributes appear to be in good condition suggesting that there are areas where management actions could maintain or improve existing conditions.

Most importantly, this extensive baseline data collection effort has established an ecological benchmark of great value to understanding the current conditions in the Study Area. This Baseline was critical to Zone 7's ability to properly manage watershed resources and mark progress toward established goals. The data and analyses developed through this Baseline will guide specific recommendations for the management of resources in the Study Area. Three complementary courses of action —conservation, restoration, and management— will be explored and their probable costs and outcomes estimated.

This work was completed with financial assistance from the Coastal Conservancy.

Keywords: bioassessment, baseline monitoring, CRAM, SWAMP, watershed assessment

Poster Topic: Watershed Management