14th Biennial

State of the San Francisco Estuary Conference

October 21-22,

Poster Abstracts 2019

Abstracts for posters presented at the 2019 State of the San Francisco Estuary Conference are compiled in this document. Abstracts are ordered by Poster Topic. In the abstracts, names of presenting authors are underlined.

Table of Contents

Note: Click on the poster theme below to jump to that theme's abstracts. You will be taken to the bottom of the first abstract's page.

Poster Clusters

General Sessions

Enhancing Marsh Resilience, Blue Carbon Function and Sea Otter Habitat Through Sediment Addition

Monique Fountain[1], Rikke Jeppesen[1], Kerstin Wasson[1], Andrea Woolfolk[1], Ivano Aiello[2], Beth Watson[3]

[1]Elkhorn Slough National Estuarine Research Reserve, Watsonville, CA
[2]Moss Landing Marine Laboratories, Moss Landing, CA
[3]Department of Biodiversity, Earth & Environmental Sciences, Drexel University, Philadelphia, PA

monique@elkhornslough.org, rikke@elkhornslough.org, kerstin.wasson@gmail.com, amwoolfolk@gmail.com, iaiello@mlml.calstate.edu, elizabeth.b.watson@gmail.com

Over the past 150 years, human actions have altered the tidal, freshwater, and sediment processes that are essential to support and sustain Elkhorn Slough (Monterey County). Large areas of tidal marshes were diked and drained in the 20th century. This caused subsidence and when dikes failed, the areas were too low to support healthy marsh. In these previously diked areas the salt marsh habitat is almost entirely gone with just sparse fringing marsh in narrow bands along the shoreline and on dikes still high enough to have infrequent tidal inundation. In addition to this habitat degradation, modeling suggests most of Elkhorn Slough's remaining marshes will be lost within 50 years due to sea-level rise. The 66-acre Hester marsh restoration project is the first large scale restoration, of its type, in this estuary. Over 200,000 cubic yards of soil were needed to bring the marsh up to a sustainable elevation, high in the tidal frame. We project that the newly restored salt marsh, the highest in Elkhorn Slough, will provide a significant "blue carbon" benefit, support recovering sea otter populations, and be the most resilient to sea-level rise in the estuary. Restoring this degraded habitat took many hands from planning to planting and highlights the importance of a collaborative, interdisciplinary approach to restoring sustainable habitat for the future. Cluster title: Elkhorn Slough Restoration Science

Keywords: Habitat Restoration, Climate Change, Special Status Species, Blue Carbon

Poster Cluster Title: Elkhorn Slough Restoration Science

UAV as a Tool for Elevation Monitoring at Restoration Site

Alexandra Lapides[1], Charlie Endris[1], John Haskins[1]

[1]Elkhorn Slough National Estuarine Research Reserve

alapides17@gmail.com, charlie@elkhornslough.org, recyclerjh@gmail.com

Salt marshes provide several critical ecosystem functions, but only thrive in a narrow elevation range. As part of an effort to raise 61 acres of flooded salt marsh habitat, we used an Unmanned Aerial Vehicle (UAV) to monitor the restoration. In early stages, UAV imagery allowed us to track construction and weekly environmental changes. Now we continue to collect imagery as part of long-term monitoring for the area. UAV flights allow us to track vegetation colonization, sediment movement, and marsh elevation. These data allow us to understand and quantify ecosystem variations as part of a massive, multi-year restoration effort and gives us valuable insight into the salt marsh ecosystem.

Keywords: UAV, UAS, drone, restoration, estuary, GIS

Poster Cluster Title: Elkhorn Slough Restoration Science

Examining Drivers of Marsh Colonization at a Sediment Addition Restoration Site

Alexandra Thomsen[1], Karen Tanner[2], Kerstin Wasson[3], Charlie Endris[3], Alex Lapides[3], John Haskins[3], Andrea Woolfolk[3], Monique Fountain[3]

[1]CSU Monterey Bay
[2]UC Santa Cruz
[3]Elkhorn Slough National Estuarine Research Reserve

athomsen@csumb.edu, karen.e.tanner@gmail.com, kerstin.wasson@gmail.com, charlie@elkhornslough.org, alapides@ucsc.edu, john@elkhornslough.org, amwoolfolk@gmail.com, monique@elkhornslough.org

Sediment addition has gained popularity in recent decades as a strategy to restore degraded salt marshes. This strategy has been implemented at Hester Marsh, a 61-acre marsh restoration site in Central California's Elkhorn Slough. In the period immediately following sediment addition, much of the future marsh landscape was initially bare, with few surviving plants. Active planting was limited to portions of the ecotone transition zone between the marsh plain and adjacent grassland. This project provides a unique opportunity to examine drivers of marsh plant colonization, as large-scale projects using substantial amounts of sediment addition require further study in order to understand expectations and best practices. We are using a combination of traditional field survey and unmanned aerial vehicle (UAV) methods to examine these drivers, including distance to existing vegetation and tidal creeks; soil type or texture; and elevation. This research will inform the design of future tidal marsh restoration projects by improving expectations for establishment of vegetative cover, identifying differences in colonization ability between species, and identifying factors that promote or inhibit colonization.

Keywords: salt marsh restoration, sediment addition, plant colonization

Poster Cluster Title: Elkhorn Slough Restoration Science

Testing Clustered Plantings to Improve Salt Marsh Restoration Success

Karen Tanner[1], Kerstin Wasson[1], Ingrid Parker[1], Alexandra Thomsen[2]

[1]UCSC
[2]CSUMB

ketanner@ucsc.edu, kerstin.wasson@gmail.com, imparker@ucsc.edu, alexandra_thomsen@alumni.brown.edu

At coastal restoration sites, grading is often needed to create an incline with appropriate elevation to support salt marsh, and moisture evaporates quickly from exposed soil. Rapid evaporation also concentrates salts, and both processes contribute to plant stress. Research in other systems has shown that clustering plants together can reduce this stress. However, the benefits of clustering might come at a cost, especially as plants grow - and these effects may differ across species. At Elkhorn Slough, we are testing whether clustering can improve transplant performance in the high marsh, where the relative influence of positive and negative plant interactions is likely to vary with tidal inundation as well as rainfall. We are comparing performance of five native species in Uniform and Clustered plantings at a large-scale restoration site to learn whether clustering can improve outcomes.

Keywords: salt marsh, habitat restoration

Poster Cluster Title: Elkhorn Slough Restoration Science

Small-Scale Experimental Seagrass Restoration Success with Large-Scale Consequences

Kathryn Beheshti[1], Brent Hughes[2], Kathy Boyer[3], Kerstin Wasson[4], Kerstin Wasson[1]

[1]UC Santa Cruz
[2]Sonoma State University
[3]San Francisco University
[4]Elkhorn Slough National Estuarine Research Reserve

kbehesht@ucsc.edu, hughes@sonoma.edu, katboyer@sfsu.edu, kerstin.wasson@gmail.com, kerstin.wasson@gmail.com

Seagrasses are in global decline despite restoration efforts. The majority of restorations to date have been deemed unsuccessful. While many cite the scale of the restoration as cause of failure others call for a need to ameliorate the local environmental or biological stressors prohibiting the successful establishment of targeted transplants or seeding. Elkhorn Slough, a highly eutrophic system suffered massive seagrass (*Zostera marina*) loss in the mid 1900s. Beginning in 1980 Elkhorn Slough seagrass beds have been naturally recovering to what is today a 10-hectare deficit of its historical extent. Unfortunately, the rate of recovery has plateaued in recent years. To promote local seagrass recovery and look at the role of ephemeral macroalgae we conducted three small-scale experimental restorations in 2015, '16 and '18 that explored the effect of time of year, initial plot size and initial shoot length on restoration success. In total we have restored over a quarter hectare of seagrass habitat; a noteworthy accomplishment considering initial plot size was 0.5m2(n=100), 0.25m2(n=4) and 1m2(n=4). Our results have also demonstrated that restoration can a) significantly enhance local biodiversity relative to adjacent mudflat, b) improve local water clarity and quality and c) quickly mirror the community composition of critical mesograzers to that of existing natural beds. Despite eutrophication and other anthropogenic stressors, restoration in Elkhorn Slough was possible, making it a model system for future restorations along the West Coast where restoring conditions conducive to natural seagrass recovery are unlikely.

Keywords: Elkhorn Slough, seagrass restoration, water quality, biodiversity, restoration success, eutrophication

Poster Cluster Title: Elkhorn Slough Restoration Science

Olympia Oyster Restoration Aquaculture in a Recruitment-Limited Estuary

Kerstin Wasson[1], Dan Gossard[2], Luke Gardner[2], Susanne Fork[1], Chela Zabin[3], April Ridlon[1], Brent Hughes[4]

[1]Elkhorn Slough National Estuarine Research Reserve
[2]Moss Landing Marine Laboratories
[3]Smithsonian Environmental Research Center
[4]Sonoma State University

kerstin.wasson@gmail.com, dgossard@mlml.calstate.edu, lgardner@ucsd.edu, skfork@gmail.com, zabinc@si.edu, ctenophores@gmail.com, hughes@sonoma.edu

Olympia oyster populations in Elkhorn Slough are at risk of local extinction. No successful reproduction has occurred in the estuary since 2012, leaving an aging population of about 1000 remaining oysters. In May 2018, 85 oysters were collected and brought temporarily to Moss Landing Marine Laboratory. With sufficient food and elevated temperatures, they were induced to spawn and release larvae. Spat were settled on native gaper clam shells and outplanted back into Elkhorn Slough in October 2018, in naturalistic clusters mimicking historic oyster habitat. Survival and growth of these oysters has been excellent over the past year: they are now adult-sized. These hatchery-raised oysters have tripled the population size in the estuary and provided the first new cohort since 2012. Restoration aquaculture is a powerful tool that could more broadly be applied to coastal foundation species limited by reproduction.

Keywords: oyster, restoration, aquaculture

Poster Cluster Title: Elkhorn Slough Restoration Science

Elkhorn Slough Restoration Science

Kerstin Wasson[1],

[1]Elkhorn Slough National Estuarine Research Reserve

kerstin.wasson@gmail.com

Elkhorn Slough estuary faces many of the same threats as San Francisco Bay, which lies only about 70 km to the north. Extensive loss of foundation species has occurred in both estuaries, and efforts are underway separately in each to restore some of the lost habitat. This cluster shares information on current science-based restoration of salt marsh, eelgrass and oysters in Elkhorn Slough, with lessons learned applicable to other California estuaries.

Keywords: Elkhorn Slough, marsh, habitat, estuary, eelgrass, oyster

Poster Cluster Title: Elkhorn Slough Restoration Science

Revealing San Francisco Bay's Natural and Constructed Rocky Shores: Ecological Insights to Inform Nature-Based Adaptation and Restoration

Karina Nielsen[1], Chela Zabin[1,2]

[1]San Francisco State University, Estuary & Ocean Science Center
[2]Smithsonian Environmental Research Center

knielsen@sfsu.edu, zabinc@si.edu, zabinc@si.edu

Rocky shores and cobble beaches of San Francisco Bay (SFB) support a diverse group of marine and estuarine species including seaweeds, invertebrates, fishes and birds. These habitats contribute to SFB biodiversity, ecological functioning and ecosystem services, especially in central SFB where they are most common. Coastal armoring, including riprap and seawalls, creates additional hard-bottom habitat throughout the San Francisco Estuary. However, armoring replaces natural habitats, has different physical characteristics, disrupts natural ecosystem processes and is not resilient to sea level rise. Studies from other regions have shown that the structure of communities on armored shores is different from those on naturally rocky shores. We conducted rapid biological and physical surveys of 20 sites around central SFB including intertidal rocky shores, cobble beaches, riprap and seawalls to increase our understanding of these habitats to inform conservation and restoration as well as advance nature-based adaptation approaches for the estuary. We estimated cover and diversity and mapped shore profiles on five shore-normal transects per site extending from mean lower low water to the upper extent of intertidal biota. We complemented these with more detailed quadrat surveys of the low and mid intertidal zone. Rockweed beds (*Fucus distichus*) formed biogenic habitat on all four types of hard-bottom benthos, but were less prevalent on smooth vertical surfaces on seawalls. Green ulvoid seaweeds and the red seaweed *Mastocarpus papillatus* were also common. Under the rockweed canopy, limpets, mussels, chitons, small crustaceans, a variety of red seaweeds were observed. Native oysters (*Ostrea lurida*), a species of conservation concern, were also present becoming more abundant lower on the shore. The small crustaceans living in and on these intertidal seaweed beds are nutritious prey for fishes and birds. Additional studies are needed to understand the roles these habits play in the ecology of SFB.

Keywords: Rocky intertidal, cobble beach, coastal armoring, estuarine, restoration, nature-based, adaptation

Poster Cluster Title: Revealing San Francisco Bay's Natural and Constructed Rocky Shores: Ecological Insights to Inform Nature-Based Adaptation and Restoration

The Rockweed Beds of San Francisco Bay are Habitat for Abundant Invertebrate Prey for Fishes and Birds

Byron Riggins[1], Chelsey Wegener[1], Daniela Barceló Rosario[1], Chela Zabin[1,2], Karina Nielsen[1]

[1]San Francisco State University's Estuary and Ocean Science Center
[2]Smithsonian Environmental Research Center

briggins@mail.sfsu.edu, cwegener@mail.sfsu.edu, daniela.barcelo@upr.edu, zabinc@si.edu, zabinc@si.edu, knielsen@sfsu.edu

The ecological structure and function of rockweed (*Fucus distichus*) habitats in estuaries of the Northeastern Pacific have not been a focus of intense scientific study. However, there has been increasing recognition of the importance of marine riparian habitats to estuarine wildlife emerging from ecosystem studies in the Salish Sea (Pacific Northwest). Urban estuaries like San Francisco Bay (SFB) have been highly modified by coastal development and water diversions, and are vulnerable to climate change and associated sea level rise (SLR). Coastal armoring and development results in the loss of intertidal habitats and reduce connectivity through "coastal squeeze" which is accelerated by SLR. Marine riparian habitats including rocky shores, cobble beaches, rip-rap and seawalls support abundant rockweed beds in SFB. Conservation and restoration planning for SFB acknowledge information gaps for the ecological structure and function of these habitats. Each month, we surveyed rockweed populations and sampled epiphytic invertebrates at four sites in Central SFB for over a year. We strategically sampled for epiphytic invertebrates over a tidal gradient at one site. We conducted community surveys of 20 sites in Central SFB, including natural and armored sites. We also initiated a rockweed removal experiment. Amphipods and isopods were observed at all four sites and were present for most of the year, except during February and March 2019 when their abundances plummeted during an extended period of low salinity. Amphipod abundances were also low in July and August 2018. Isopod abundances were less consistent over time and among sites, but rarely exceeded one individual per thallus. No amphipods or isopods were present in the upper intertidal edge of the rockweed bed and were more abundant in the lower edge than the middle of the rockweed zone. Additional context will be presented from our community surveys and rockweed removal experiment.

Keywords: Rockweeds, *Fucus distichus*, rocky intertidal, invertebrates, coastal armoring, estuarine

Poster Cluster Title: Revealing San Francisco Bay's Natural and Constructed Rocky Shores: Ecological Insights to Inform Nature-Based Adaptation and Restoration

Distributional Limits of San Francisco Bay Rockweed Populations are Influenced by Substratum Slope and Tidal Height

Daniela Barceló Rosario[1 2], Elizabeth Max[1], Chela Zabin[1 3], Karina Nielsen[1]

[1]San Francisco State University - Estuary & Ocean Science Center
[2]University of Puerto Rico at Rio Piedras
[3]Smithsonian Environmental Research Center

daniela.barcelo@upr.edu, daniela.barcelo@upr.edu, zabinc@si.edu, zabinc@si.edu, knielsen@sfsu.edu

Rockweed (*Fucus distichus*) is a bed-forming macroalgae and habitat for marine life in San Francisco Bay (SFB), used for spawning by Pacific herring, food and shelter by small crustaceans, bivalves and other mollusks, and foraging for birds and fishes. Fucoid algae are important habitat-forming species worldwide, however their ecology in Northeastern Pacific estuaries is understudied. We surveyed *F. distichus* at 20 sites of natural and armored rocky shores around Central SFB measuring their intertidal distribution and the slope of their physical habitat. At one armored site the arrangement of large concrete blocks (1.25 x 1.25 x 0.7 m) used as rip-rap formed an excellent study system. We measured the abundance of rockweed on the five surfaces of two shore-parallel rows of blocks within the rockweed zone, and their surface slopes, orientations and tidal heights. Temperature and light levels of each surface were also measured during morning low tides in the summer. The density of *F. distichus* varied with slope and block orientation. It was almost completely absent from downward sloping surfaces (18 of 22 had densities < 3 thalli 0.25 m-2); The highest densities (> 53 thalli 0.25 m-2) were only found on upward facing surfaces. They were most dense on the top, north and west (shoreward) facing surfaces. Incident light was lowest on the north and east (bayward) facing surfaces, and highest on the top and south facing sides. The west facing sides varied most. The south and top facing sides generally had the highest temperatures, while the north and east facing sides had lower temperatures, but these varied with tidal height and time since sunrise. These data will be compared to field data from the 20 sites surveyed. These results provide useful information for optimizing rockweed habitat restoration and developing climate adaptation strategies to support estuarine wildlife.

Keywords: Rockweed, *Fucus distichus*, intertidal, rocky shore, distribution, restoration, coastal armoring

Poster Cluster Title: Revealing San Francisco Bay's Natural and Constructed Rocky Shores: Ecological Insights to Inform Nature-Based Adaptation and Restoration

Reproductive Phenology of the Rockweed, *Fucus distichus*, in San Francisco Bay

Chelsey Wegener[1], Byron Riggins[1], Karina Nielsen[1]

[1]SFSU

chelseywegener@gmail.com, briggins@mail.sfsu.edu, knielsen@sfsu.edu

The rockweed, *Fucus distichus*, provides food and habitat for marine invertebrates including oysters, mussels, juvenile crabs, snails, amphipods and isopods, as well as fishes and birds in San Francisco Bay (SFB). Rockweed beds are actively cleaned and monitored after oil spills to assess ecological damage because of the well-documented ecological function of fucoid algae as biogenic habitat in temperate marine ecosystems. Effective restoration of rockweed beds is of interest to natural resource managers and a focus of research by marine restoration ecologists. Methodological approaches might include "out-planting" of rockweed germlings cultured on ceramic tiles, temporarily securing fertile thalli to rocks to release gametes, or transplanting mature thalli growing on cobbles from nearby sites. Successful efforts depend on establishing successfully reproducing populations. Knowledge of the reproductive ecology to *F. distichus* in SFB can help optimize the timing of restoration efforts. While extensive research on *F. distichus* and related fucoid taxa has been done in the Baltic Sea and Atlantic Ocean, relatively little research has been done on Pacific populations and none to our knowledge focus on reproductive phenology. We studied the reproductive phenology of *F. distichus* at four field sites in central SFB starting in May 2018. We quantified density of thalli, cover, and reproductive status in the field, and reproductive tissue allocation and reproductive potential (enumerating conceptacles and oogonia) in the laboratory from collected samples. We observed two reproductive peaks in SFB *F. distichus* populations in spring and fall, even though oogonia were present year-round. This contrasts with the winter and early spring timing of reproductive peaks observed in Western Atlantic populations. Our results suggest the most effective timing for restoration efforts in SFB might be during spring or fall when the higher reproductive potential of *F. distichus* may promote successful establishment of zygotes and recruitment of juveniles.

Keywords: Rockweeds, *Fucus distichus*, reproductive ecology, restoration, phenology, San Francisco Bay

Poster Cluster Title: Revealing San Francisco Bay's Natural and Constructed Rocky Shores: Ecological Insights to Inform Nature-Based Adaptation and Restoration

Saving Salty: How Emerging Research on Salt Marsh Harvest Mouse Ecology - Beyond Habitat Preferences - Can Influence Recovery

Katie Smith[1,2]

[1]UC Davis
[2]WRA, Inc.

ratsmith@ucdavis.edu, ratsmith@ucdavis.edu

Recent advancements in the understanding of the habitat requirements of the salt marsh harvest mouse (SMHM; *Reithrodontomys raviventris*) reveal that the ecology of the species is not as closely linked to rigid habitat requirements as once believed. This has opened the door to a plethora of new research questions, chiefly among them, if SMHM are capable of using habitats other than tidal marshes dominated by pickleweed, then why are they still largely restricted to marsh habitats? Any number of potential ecological stressors could be influencing the ecology and realized distribution of the species, and researchers have recently began digging deeper. Could it be community dynamics, such as competition with conspecifics, or stress from parasites? Could it be dietary requirements? How much of an influence do regional genetic relationships have? And how do extreme, stochastic climate events come into play? In reality, the ecology of the SMHM is influenced by all of these factors, and they will all have increasingly important implications as we move toward a future where we may struggle to conserve this endangered species in an increasingly unstable ecosystem.

Keywords: salt marsh harvest mouse, genetics, diet, parasites, competition, environmental stochasticity

Poster Cluster Title: Saving Salty: How Emerging Research on Salt Marsh Harvest Mouse Ecology - Beyond Habitat Preferences - Can Influence Recovery

Ecological Interactions Among the Salt Marsh Harvest Mouse and Co-Occurring Species

Lydia Stroupe[1]

[1]Department of Biological Sciences - California State University San Marcos

strou010@cougars.csusm.edu

The salt marsh harvest mouse is an endangered species that is endemic to the marshes of the San Francisco Bay area, and is currently threatened by natural and anthropogenic habitat loss. Other stressors, such as competition with other wetland rodents, may further impact its survival. Previous research addressing habitat use of the salt marsh harvest mouse and other wetland rodents has revealed considerable overlap among species, which may be indicative of competitive interactions among rodents in the San Francisco Bay area. Here we investigate interspecific interactions among the salt marsh harvest mouse and other species, specifically the house mouse, the western harvest mouse, and the California vole, to determine how these interactions affect salt marsh harvest mouse populations in the Suisun Marsh. We describe spatial (based on GIS) and stable isotope approaches to quantify fine-scale patterns of habitat use in these species, to help shed light on if and how they partition resources. The results of this study will not only provide ecological data on species where it is sorely lacking, but will also inform salt marsh harvest mouse conservation and management efforts.

Keywords: salt marsh harvest mouse, *Reithrodontomys raviventris*, GIS, stable isotope analysis

Poster Cluster Title: Saving Salty: How Emerging Research on Salt Marsh Harvest Mouse Ecology - Beyond Habitat Preferences - Can Influence Recovery

The Salt Marsh Harvest Mouse (SMHM; *Reithrodontomys raviventris*) Workgroup 2019 update: Identifying Recovery Needs and Filling Data Gaps

Isa Woo[1], Laureen Barthman-Thompson[2], Rachel Tertes[3], Meg Marriott[3], Katherine Smith[4], Sarah Estrella[2], Susan De La Cruz[1]

[1]USGS Western Ecological Research Center
[2]California Department of Fish and Wildlife
[3]US Fish and Wildlife Service
[4]UC Davis, Dept Wildlife, Fish, and Conservation Biology

iwoo@usgs.gov, Laureen.Thompson@wildlife.ca.gov, Rachel_Tertes@fws.gov, meg_marriott@fws.gov, ratsmith@ucdavis.edu, Sarah.Estrella@wildlife.ca.gov, sdelacruz@usgs.gov

The Salt Marsh Harvest Mouse (SMHM; *Reithrodontomys raviventris*) is a federally and state endangered species that is endemic to a variety of marsh habitats in San Francisco Bay. Several pivotal studies conducted in the 1960-1980's established an ecological foundation from which recent studies on identification, genetics, and habitat use continue to build upon our knowledge base. Yet, many questions regarding their ecology and interactions with the habitat and other species, genetics, and species long-term trends remain unresolved. A SMHM workgroup was initiated to facilitate interagency coordination, standardize measurement protocols, standardize identification techniques, and to summarize recent research and observations. This group also serves to inform the Tidal Marsh Recovery Implementation Team, and is comprised of State, Federal, University, and NGO partners/collaborators. Here we summarize one of our key outputs: SMHM recovery needs at a variety of scales including, Bay-wide, Regional (Suisun, San Pablo, and South Bay regions) and localized projects. Integrating SMHM needs across spatial and temporal scales can provide a framework from which to fill data gaps in support of SMHM recovery.

Keywords: Endangered Species, Recovery, Regional scales

Poster Cluster Title: Saving Salty: How Emerging Research on Salt Marsh Harvest Mouse Ecology - Beyond Habitat Preferences - Can Influence Recovery

The Ins and Outs of Parasitology in the Salt Marsh Harvest Mouse and Sympatric Rodents

Sadie Trombley[1], Douglas Kelt[1], Janet Foley[1], Patrick Foley[2]

[1]University of California, Davis
[2]California State University, Sacramento

sntrombley@ucdavis.edu, dakelt@ucdavis.edu, jefoley@ucdavis.edu, patfoley@csus.edu

The salt marsh harvest mouse (*Reithrodontomys raviventris*, SMHM) is a federally endangered wetland specialist, endemic to the salt and brackish marshes of the San Francisco Bay Estuary. SMHM recovery is often solely focused on habitat restoration, but cryptic threats, e.g. disease, have been ignored. Habitat modifications associated with urbanization, including the diking of tidal wetlands into seasonal ponds, likely influence interspecific dynamics between SMHM and both native and non-native rodents. These changes could in turn lead to increased competition for resources and parasite mediated competition via spillover. Mild climate, diverse rodent communities, aquatic habitat, feral cats, and nearby cattle can facilitate pathogen transmission at our study site in the Suisun Marsh. We sought to determine if the parasite load in SMHM is affected by these factors and others including duration of standing water, proximity to urban areas, seasonality, and rodent diversity. We collected ectoparasites, blood, and feces from 650 rodents trapped year-round at eight sites in Suisun Marsh, from April 2018 to April 2019. We identified fleas and ticks to explore relationships among ectoparasites (species and loads), rodent species (diversity and density), and seasonality to investigate the potential for vector-borne pathogen exposure. We found that SMHM share flea species typically associated with non-native rodents, indicating that parasite transmission occurs. We will also conduct assays on feces and blood to detect endoparasites—which negatively affect rodent fitness and are of concern due to nearby cattle and the aquatic habitat. This project is the first effort to comprehensively investigate pathogen dynamics in the rodent community of Suisun Marsh. Preliminary data indicate that there are complex interactions between pathogens, SMHM, and other rodents. Results of this study will ultimately allow managers to finally incorporate this threat in recovery planning.

Keywords:

Poster Cluster Title: Saving Salty: How Emerging Research on Salt Marsh Harvest Mouse Ecology - Beyond Habitat Preferences - Can Influence Recovery

Spatial and Seasonal Dietary Analysis of Salt Marsh Harvest Mouse using DNA Metabarcoding

Cody Aylward[1], Mark Statham[1], Benjamin Sacks[1], Douglas Kelt[1]

[1]University of California, Davis

cmaylward@ucdavis.edu, statham@ucdavis.edu, bnsacks@ucdavis.edu, dakelt@ucdavis.edu

Salt marsh harvest mouse (SMHM; *Reithrodontomys raviventris*) is a federally endangered species endemic to the San Francisco Estuary wetlands. Historically, SMHM were presumed to specialize on pickleweed (*Salicornia sp*.) for habitat and diet. However, recent data from cafeteria trials suggest a wider breadth of dietary resource use and potential preference for non-native plants commonly used in waterfowl management. Understanding the dietary resources utilized by SMHM and potential competitors is important for guiding conservation and restoration efforts in their historic range. We used high-throughput sequencing to identify plant DNA sequences in scats of SMHM, western harvest mouse (WHM; *R. megalotis*) and house mouse (*Mus musculus*). We collected 312 scat samples from Summer 2018 through Spring 2019 in sites distributed throughout Suisun Bay and from Spring 2019 in Eden Landing Ecological Reserve in the South Bay. We amplified the ITS2 locus, a commonly used plant genetic marker, using degenerate primers designed to amplify a broad taxonomic range of plants. Preliminary data from a limited sample size (n = 20) collected in Summer 2018 at Goodyear Slough in Suisun Bay suggest interspecific overlap of the primary dietary items (*Salicornia, Atriplex*). In addition, grasses (*Bromus, Festuca, Hordeum, Sonchus*) were detected in WHM scats but not SMHM scats, suggesting potential dietary partitioning by native harvest mice. Data analysis is underway for the remaining samples, which will reveal seasonal and spatial characteristics of SMHM diet and resource competition dynamics of small mammals in the San Francisco Estuary wetlands.

Keywords: *Reithrodontomys*, endangered species, diet, metabarcoding, next generation sequencing, community ecology

Poster Cluster Title: Saving Salty: How Emerging Research on Salt Marsh Harvest Mouse Ecology - Beyond Habitat Preferences - Can Influence Recovery

It's Getting Hot in Here: Salt Marsh Harvest Mouse Survival and Recovery after a Wildfire

Melissa Riley[1,2], Katherine Smith[2,3], Candice Rose[1], Sadie Trombley[1,2], Laureen Barthman-Thompson[1], Sarah Estrella[1]

[1]California Department of Fish and Wildlife
[2]University of California, Davis
[3]WRA, Inc.

melissa.riley@wildlife.ca.gov, melissa.riley@wildlife.ca.gov, ratsmith@ucdavis.edu, ratsmith@ucdavis.edu, candice.rose@wildlife.ca.gov, sntrombley@ucdavis.edu, sntrombley@ucdavis.edu, laureen.thompson@wildlife.ca.gov, sarah.estrella@wildlife.ca.gov

The salt marsh harvest mouse (*Reithrodontomys raviventris*, SMHM) is endemic to the marshes of the San Francisco Bay Estuary. Listed as endangered since the 1970's, SMHM have declined throughout much of their range, but in the Suisun Marsh populations are currently thriving. In October 2018, a wildfire burned more than 80% of the vegetation within the trapping grid at a long-term SMHM monitoring site on the Grizzly Island Wildlife Area, Joice Island Unit. The objective of this study was to determine how the SMHM and associated small mammal community respond to such fire events. Initial trapping one week after the wildfire showed that a surprising number of SMHM survived, and capture efficiencies were similar to previous years. Captures of other small mammal species were low, perhaps indicating that SMHM are more resilient to such events. The results of this study will allow managers to better anticipate the response of SMHM to current management practices such as prescribed burns that are used to control invasive vegetation species, helping to improve and maintain resources for the SMHM. This novel insight into the resilience of this endangered species to acute catastrophic events will also allow managers to better implement conservation efforts as wildfires and other catastrophic events become more common with global climate change.

Keywords: salt marsh harvest mouse, endangered species, conservation, management, resiliency

Poster Cluster Title: Saving Salty: How Emerging Research on Salt Marsh Harvest Mouse Ecology - Beyond Habitat Preferences - Can Influence Recovery

Salt Marsh Harvest Mouse Landscape Genetics and Connectivity within the Suisun Bay Area Recovery Unit

Mark Statham[1], Cody Aylward[1], Laureen Barthman Thompson[2], Susan Fresquez[1,2], Ben Sacks[1]

[1]University of California, Davis
[2]California Department of Fish and Wildlife

statham@ucdavis.edu, cmaylward@ucdavis.edu, Laureen.Thrompson@wildlife.ca.gov, smfresquez@ucdavis.edu, smfresquez@ucdavis.edu, bnsacks@ucdavis.edu

Understanding how populations of endangered species are subdivided and which landscape features impede gene flow helps conservation practitioners make informed management decisions. The salt marsh harvest mouse (SMHM) is a state and federally listed endangered species endemic to the coastal marshes of the San Francisco Estuary of California. The largest remaining tracts of historical habitat for the SMHM are found around Suisun Bay, making this area critically important for the conservation of the species. The primary objective of this study was to assess the distribution, population subdivision, genetic diversity, and levels of gene flow among SMHM within the USFWS Suisun Bay Area Recovery Unit (SBARU). The secondary objective was to assess the role played by habitat features and topography in creating population substructure within the SBARU. To address these objectives, we trapped and collected genetic samples from 538 SMHM from 26 locations spread across the SBARU. We used next generation DNA sequencing to develop novel microsatellite markers, and together with published markers, screened SMHM with 20 loci. Using cluster analysis and a population tree we identified a large population across the northern marshes of Suisun Bay, and smaller distinct populations on the Contra Costa shoreline and at Ryer Island. Next, we conducted a landscape genetic analysis to assess which landscape features were associated with population substructure. Across the SBARU we identified that both water and elevation >2m constrained gene flow and mouse movement. This information can be used to help locate other potentially distinct populations of SMHM, both within Suisun Bay, as well as elsewhere across the range.

Keywords: population structure, conservation, management, gene flow, San Francisco Bay

Poster Cluster Title: Saving Salty: How Emerging Research on Salt Marsh Harvest Mouse Ecology - Beyond Habitat Preferences - Can Influence Recovery

What We Know About Salt Marsh Harvest Mice: New vs Historic Knowledge

Laureen Barthman-Thompson[1], Katie Smith[2], Sarah Estrella[1], Melissa Riley[1], Isa Woo[3]

[1]California Department of Fish and Wildlife
[2]University of California, Davis
[3]U S Geological Survey, Western Ecological Research Center

Lbarth.361@gmail.com, ratsmith@ucdavis.edu, sarah.estrella@wildlife.ca.gov, Melissa.Riley@wildlife.ca.gov, iwoo@usgs.gov

The salt marsh harvest mice is a species that has been studied on and off since 1964 (Filser) to present. However, very little information has reached the most important user - the permitting agencies. Here we summarize what was historically known about the salt marsh harvest mouse and what our current knowledge is. This information is instrumental for restoration projects, permits, developing conservation measure and best management practices, and recovery of the species.

Keywords: salt marsh harvest mouse, information, recovery

Poster Cluster Title: Saving Salty: How Emerging Research on Salt Marsh Harvest Mouse Ecology - Beyond Habitat Preferences - Can Influence Recovery

Guess that Mouse

Candice Rose[1], Sadie Trombley[1]

[1]California Department of Fish and Wildlife

candice.rose@wildlife.ca.gov, Sadie.Trombley@wildlife.ca.gov

The Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*) is a federally endangered species that is difficult to distinguish from the Western Harvest Mouse (*Reithrodontomys megalotis*). There are many characteristics used to differentiate the two species, including belly color, ventral tail hair color, tail length, etc. Better identification between the two species can lead to better management and identification of habitat. This poster will provide an overview of key morphological traits used by biologists to identify the Salt Marsh Harvest Mouse and distinguish it from the Western Harvest Mouse. Pictures of mice will be provided for attendees to attempt to correctly identify along with an answer key.

Keywords: Salt Marsh Harvest Mouse, Mouse, Identification, Suisun, Marsh

Poster Cluster Title: Saving Salty: How Emerging Research on Salt Marsh Harvest Mouse Ecology - Beyond Habitat Preferences - Can Influence Recovery

The Native Olympia Oyster Collaborative (NOOC): Synthesizing Lessons Learned and Catalyzing Future Conservation Efforts

April Ridlon[1], Kerstin Wasson[1], Chela Zabin[2], Edwin Grosholz[3], Danielle Zacherl[4], Althea Marks[1], Jeff Crooks[5], Monica Almeida[5], Sarah Ferner[6], Joachim Carolsfeld[7], Jude Apple[8], Fabiola Lafarga de la Cruz[9], Matt Ferner[6], Alicia Helms[10]

[1]Elkhorn Slough National Estuarine Research Reserve
[2]Smithsonian Environmental Research Center
[3]University of California, Davis
[4]California State University, Fullerton
[5]Tijuana River National Estuarine Research Reserve
[6]San Francisco Bay National Estuarine Research Reserve
[7]World Fisheries Trust, British Columbia
[8]Padilla Bay National Estuarine Research Reserve
[9]Centro de Investigacion Cientifica y de Educacion Superior de Ensenada
[10]South Slough National Estuarine Reserve

ctenophores@gmail.com, kerstin.wasson@gmail.com, zabin@si.edu, tedgrosholz@ucdavis.edu, dzacherl@fullerton.edu, theamarks@csu.fullerton.edu, jcrooks@trnerr.org, malmeida@trnerr.org, daviess@sfsu.edu, yogi@worldfish.org, japple@padillabay.gov, flafarga@cicese.mx, mferner@sfsu.edu, alicia.r.helms@state.or.us

The Olympia oyster (*Ostrea lurida*) is a foundation species which creates essential habitat for a host of estuarine species, improves water quality, protects shorelines, and has provided humans with food and cultural value on the west coast of North America for millennia. Yet, populations of this oyster have declined precipitously across most of its range from British Columbia to Baja California, Mexico - down to 1% of historic levels at some locations - and are clearly no longer providing the same ecological functions as more extensive beds did in the past. The Native Olympia Oyster Collaboration (NOOC) is a newly formed network of collaborators engaged in rigorous research and science-based restoration of the native Olympia oyster across 2500 km of coast. We aim to conserve and rebuild populations of native oysters by exchanging critical scientific and methodological information, and by developing and sharing resources to connect and strengthen local and regional restoration efforts. Through our first year of concentrated and fully funded collaboration, we have established the first database of all historic and current Olympia oyster restoration projects on the West Coast. Here, we present a visual and interactive archive of these projects, and share the initial results from our synthesis of lessons learned from these restoration efforts. In addition, we present the educational and outreach resources that we have developed to increase engagement and collaboration among scientists, practitioners, agencies, and community groups that are restoring and conserving populations of this native oyster.

Keywords: Olympia oyster, restoration, conservation

Poster Cluster Title: The Native Olympia Oyster: Status, Ecology, and Restoration

Ecological Interactions at an Oyster Restoration Project: San Francisco Bay Living Shorelines Project

Jeffrey Blumenthal[1,2], Chela Zabin[1,2], Ted Grosholtz[3]

[1]Estuary & Ocean Science Center, San Francisco State University
[2]Smithsonian Environmental Research Center
[3]University of California, Davis

jeffrey.blumenthal@gmail.com, jeffrey.blumenthal@gmail.com, zabinc@si.edu, zabinc@si.edu, tedgrosholz@ucdavis.edu

The San Francisco Bay Living Shorelines Project at Giant Marsh seeks to develop next generation climate adaptation strategies in the face of sea level rise and associated shoreline erosion and other climate changes. Our approach is to integrate multiple habitat types to improve linkages among habitats, promote synergistic effects of habitat features on each other as well as on associated fauna, and to protect shorelines while enhancing habitat and native biodiversity. This multi-habitat project at Giant Marsh integrates habitat restoration of native oyster (*Ostrea lurida*) and native eelgrass (*Zostera marina*) beds with designs that test the use of natural structures to buffer and protect adjacent tidal wetland sites, and areas of the San Francisco Bay shoreline vulnerable to sea level rise and shoreline erosion. For native oyster restoration, we established three treatment zones at Giant Marsh, part of Pt. Pinole Regional Shoreline in Richmond, using artificial reefs made with "baycrete" and oyster shell to enhance Olympia oyster recruitment. The first treatment examines interactions between oysters, eelgrass, and overall community diversity. The second treatment tests the effect of experimentally planted native rockweed (*Fucus distichus*) on oyster recruitment and survival. The third treatment examines the potential of nearshore oyster reefs to attenuate wave energy and reduce marsh erosion while also supporting oysters. The overall goal of this approach is to improve ecological function and ecosystem resilience through the creation and enhancement of a range of biologically rich shoreline habitats, from the subtidal to the estuarine-terrestrial transition zone.

Keywords: living shorelines, oysters, *Fucus*, eelgrass, ecological interactions, restoration, shoreline protection

Poster Cluster Title: The Native Olympia Oyster: Status, Ecology, and Restoration

Impacts of the Invasive Atlantic Oyster Drill on Native Oysters: A Challenge for Restoration

Chela Zabin[1,2], Jeffrey Blumenthal[1,2], Andrew Chang[1,2], Brian Cheng[1,3], Matthew Ferner[2,4], Karina Nielsen[2]

[1]Smithsonian Environmental Research Center
[2]Estuary & Ocean Science Center, San Francisco State University
[3]University of Massachusetts, Amherst
[4]San Francisco Bay National Estuarine Research Reserve

zabinc@si.edu, zabinc@si.edu, BlumenthalJ@si.edu, BlumenthalJ@si.edu, ChangAL@si.edu, ChangAL@si.edu, bscheng@umass.edu, bscheng@umass.edu, mferner@sfsu.edu, mferner@sfsu.edu, knielsen@sfsu.edu

Olympia oysters (*Ostrea lurida*) are the only native oyster on the West Coast of the US. Past overharvesting, pollution, and habitat modification have resulted in steep declines in Olympia oyster populations along the coast. Interest in restoration has increased over past several decades, but restoration faces numerous challenges, including predation by non-native snails (oyster drills), which now occur in several West Coast estuaries, including San Francisco Bay. The Atlantic oyster drill (*Urosalpinx cinerea*) is highly abundant in South San Francisco Bay, where it was at least partially responsible for the failure of two experimental-scale oyster restoration projects. The snail is also present in Richardson Bay, but little was known about its distribution or impacts on oysters there. We mapped the distribution of oysters and oyster drills in Richardson Bay, carried out a field experiment to determine the impacts of the drill on oysters across three tidal elevations, and worked with community members to reduce drill abundance at two sites with the goal of achieving functional eradication. Oysters were present in Richardson Bay at sites in Sausalito and Strawberry, but were absent or nearly so from sites in Tiburon and Belvedere, while drills were absent from Sausalito and Strawberry but present in Tiburon and Belvedere. Dead oysters were present at all study sites and oysters also recruited to all study sites. In field experiments, drills killed all experimental oysters at one tidal elevation, but had a lower impact on oysters in the higher intertidal. Oysters protected from drills by mesh cages survived equally well at all tidal elevations. Despite 467 volunteer hours, resulting in the removal of 31,500 snails, efforts were not successful in reducing drill populations. Until effective control methods can be developed, oyster restoration projects should be located at sites free from oyster drills.

Keywords: oyster, restoration

Poster Cluster Title: The Native Olympia Oyster: Status, Ecology, and Restoration

Current Status of Olympia Oyster Populations in Northern San Francisco Bay and Responses to Environmental Drivers

Andrew Chang[1,2], Anna Deck[2,3], Matthew Ferner[2,3]

[1]Smithsonian Environmental Research Center
[2]San Francisco State University, Estuary & Ocean Science Center
[3]San Francisco Bay National Estuarine Research Reserve

ChangAL@si.edu, ChangAL@si.edu, akdeck@gmail.com, akdeck@gmail.com, mferner@sfsu.edu, mferner@sfsu.edu

The Olympia oyster, *Ostrea lurida*, is a target of restoration efforts in the San Francisco Estuary. A better understanding of population fluctuations could significantly aid restoration outcomes and improve resilience to future climatic changes. We investigated oyster population dynamics using surveys of densities, size distributions, and monthly recruitment at sites along the salinity gradient from San Pablo Bay to Richardson Bay over ten years, spanning recent extreme dry and wet years and also a major marine heat wave. Over ten years, oyster abundance and sizes differed significantly along the salinity gradient, with maximum densities usually occurring in the northern-central portion of the estuary. After a three-year drought, maximum oyster densities in 2009 occurred in brackish waters near China Camp State Park. Two years later, high winter freshwater flow coincided with complete mortality of the oysters in this region, with maximum density of living oysters thereafter occurring downstream of China Camp. Recovery of these populations was slow even with dry conditions from 2013–2016, and the historic wet winter in 2017 again produced widespread oyster mortality toward the northern end of the Bay. Regional temperature and salinity variation were strongly correlated with the timing of the onset and peaks in oyster settlement. The greatest settlement generally occurred in upstream areas, coinciding with maximum adult densities during warmer periods. Following die-offs upstream in wetter years, settlement began later and maximum settlement rates were depressed and shifted downstream. Great fluctuations in North Bay population densities occurred as high settlement, especially in warmer and drier years, was balanced against the inability of local populations to survive wetter winters. The Richardson Bay populations had more consistently high densities, indicating greater long-term survival, despite fluctuating recruitment rates across years, possibly making this area an important buffer against fluctuations in freshwater flow and other environmental changes.

Keywords: oyster, *Ostrea lurida*, salinity, temperature, recruitment, drought, floods, Blob

Poster Cluster Title: The Native Olympia Oyster: Status, Ecology, and Restoration

The Tidal Parr Study Overview

Brett Harvey[1], Calvin Lee[2], Jason Hassrick[2], Lenny Grimaldo[2], Anna Sturrock[3], Rachel Johnson[4], Correigh Greene[4], Joseph Smith[4], Steve Lindley[4]

[1]California Department of Water Resources
[2]ICF Fisheries and Aquatic Science
[3]Center for Watershed Sciences, University of California, Davis
[4]National Marine Fisheries Service, NOAA

brett.harvey@water.ca.gov, jason.hassrick@icf.com, lenny.grimaldo@icf.com, asturrock@ucdavis.edu, rachel.johnson@noaa.gov, correigh.greene@noaa.gov, joe.m.smith@noaa.gov, steve.lindley@noaa.gov

The Tidal Parr Study is a suite of four coordinated studies currently underway to better quantify pre-smolt Chinook Salmon use of and benefits accrued from seldom-sampled marsh and shoal habitats in the San Francisco Estuary between Sherman Island and San Pablo Bay. The Tidal Parr Study was designed to provide quantitative information for decision support models guiding restoration and water resource management policy in the San Francisco Estuary and its watershed. The backbone of the Tidal Parr Study is a Trawl Survey of shallow-water habitat conducted from January to June, 2018 through 2021, to track salmon distributions and habitat associations across a range of outflow conditions. To provide an alternative measure of salmon distribution and habitat use, water samples were collected during the Trawl Survey and analyzed for a Chinook Salmon eDNA Survey. A Cage Study is monitoring somatic growth of hatchery salmon in tidal channels across Suisun Marsh, and on islands and the shoreline of Suisun Bay. Finally, an Isotope Study will examine the origin, migration history, and residence time of trawl-caught salmon, based in part on isotopic signatures derived from caged salmon reared at fixed locations for the Tidal Parr Study, and from other coordinated studies in the Sacramento River, Sutter Bypass, and Yolo Bypass.

Keywords: salmon, California, distribution, habitat, growth, estuary, marsh, restoration, management

Poster Cluster Title: The Tidal Parr Study

Spatial and Temporal Distribution of Juvenile Salmon Rearing in Tidal Marsh of the San Francisco Estuary, CA

Jake Sousa[1], Calvin Lee[1], Jason Hassrick[1], Ramona Zeno[1], Stuart Munsch[2], Joseph Smith[2], Correigh Greene[2], Steve Lindley[2], Lenny Grimaldo[1], Brett Harvey[3]

[1]ICF Fisheries and Aquatic Science
[2]National Marine Fisheries Service, NOAA
[3]California Department of Water Resources

calvin.lee@icf.com, jake.sousa@icf.com, jason.hassrick@icf.com, ramona.zeno@icf.com, stuart.munsch@noaa.gov, joe.m.smith@noaa.gov, correigh.greene@noaa.gov, steve.lindley@noaa.gov, lenny.grimaldo@icf.com, brett.harvey@water.ca.gov

In California's Central Valley, the degree to which pre-smolt salmon rear in the shallow-water marshes and shoals of the upper San Francisco Estuary is poorly understood, partly because this habitat is difficult to sample effectively. Salmon fry and parr have been haphazardly found while sampling for other purposes, but there is a critical data gap regarding the use of these estuarine habitats for rearing. As part of a suite of studies to address these questions, known as The Tidal Parr Studies, we are conducting a three-year trawl survey of fish assemblages to describe variation in juvenile salmon distribution, timing, and abundance in shallow-water estuarine habitats of varying quality, and among years with different levels of freshwater outflow. First-year results under higher than normal outflow found young-of-the-year salmon distributed throughout the study region in habitats where juvenile salmon are seldom sought for or detected by historical and current monitoring programs. Initial catch was composed primarily of fry and parr less than 50 mm fork length, indicating the success of newly designed net gear targeting fish in tidal marsh edge habitat.

Keywords: salmon, California, marsh, estuary, distribution, occupancy, habitat, Chinook, detection, juvenile

Poster Cluster Title: The Tidal Parr Study

Efficient Monitoring of Juvenile Chinook Salmon Distribution and Habitat Use in the San Francisco Estuary Using Environmental DNA (eDNA)

Thiago Sanches[1], Brett Harvey[2], Calvin Lee[3], Andrea Schreier[1]

[1]Genomics Variation Laboratory, University of California, Davis
[2]California Department of Water Resources
[3]ICF Fisheries and Aquatic Science

tmsanches@ucdavis.edu, brett.harvey@water.ca.gov, calvin.lee@icf.com, amdrauch@ucdavis.edu

Although tidal marsh restoration is planned or underway in numerous locations across of the San Francisco Estuary, little is known about pre-smolt Chinook Salmon distribution and habitat use for a large portion of this region. This is partly because catching pre-smolt salmon in tidal marsh is difficult using conventional survey methods, such as trawl and beach seine. To gain a better understanding of the limitations of these methods, and a better understanding of Chinook Salmon distribution and habitat association, we designed a high precision, high throughput eDNA protocol optimized for estuarine waters. We validated our assay in controlled conditions to estimate the detection radius for eDNA and limits of detection and quantification. We then compared eDNA estimates of juvenile Chinook Salmon distribution with estimates from a parallel trawl survey conducted in shallow water habitat of the upper estuary from January to June in 2018 and 2019. We conclude that eDNA sampling is a more efficient tool than trawling for detecting the occurrence of juvenile Chinook Salmon in tidal marsh channels and shoals of the San Francisco Estuary, particularly when the density of salmon is low. Within these habitats, turbidity and dissolved oxygen were the best estimators of Chinook Salmon eDNA detection. We expect broader use of eDNA for assessing Chinook Salmon occupancy will provide managers with more detailed and reliable information for making decisions regarding habitat restoration and resource management in general.

Keywords: salmon, eDNA, marsh, habitat, monitor, distribution, occupancy, estuary

Poster Cluster Title: The Tidal Parr Study

Variation in Somatic Growth of Juvenile Chinook Salmon in Tidal Marsh Habitats of the San Francisco Estuary, CA

Brett Harvey[1], Michelle Nelson[1], Jake Sousa[2], Jason Hassrick[2], Joshua Black[1], Hailey Wright[1]

[1]California Department of Water Resources
[2]ICF Fisheries and Aquatic Science

brett.harvey@water.ca.gov, michelle.nelson@water.ca.gov, jake.sousa@icf.com, jason.hassrick@icf.com, josh.black@water.ca.gov, hailey.wright@water.ca.gov

Estuarine habitat use by juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) migrating through the Sacramento-San Joaquin Delta and San Francisco Estuary, and the benefits that accrue from this habitat use, are arguably the most poorly understood aspects of juvenile salmon life history in California's Central Valley. Yet this information is critical to building effective decision support tools to guide management of water resources and habitat restoration. As part of a three-year suite of studies to address these questions, known as The Tidal Parr Studies, we are conducting a juvenile growth study using enclosures located in shallow-water marsh and shoal habitats across Suisun Marsh and Bay. Results from the first year found clear and dramatic differences in somatic growth rate and survival of juvenile salmon among locations differing in marsh-upland connectivity, tidal exchange, water residence time, and proximity to inputs from managed waterfowl ponds. Ongoing studies will further elucidate drivers of salmon growth to help guide effective marsh restoration.

Keywords: Chinook, salmon, California, growth, marsh, estuary, habitat, restoration

Poster Cluster Title: The Tidal Parr Study

Standardizing Creek Monitoring in Contra Costa County

Helen Fitanides[1]

[1]The Watershed Project

helen@thewatershedproject.org

Long-term, standardized creek monitoring is key to determining the health of creeks and their watersheds. Many community-led creek organizations collect monitoring data sporadically, using different equipment and methods than other nearby groups, which makes it difficult to compare data across watersheds. These groups are an un-tapped resource, especially in areas where the local government lacks the capacity to conduct frequent water quality monitoring. This poster communicates the importance of collaboration among monitoring groups, as well as method standardization and good quality assurance protocols. Since 2016, The Watershed Project has worked to bring together more than 10 diverse organizations in Contra Costa County. We use a standardized protocol developed by the Surface Water Ambient Monitoring Program's Clean Water Team, which makes this program replicable in other California communities. By providing detailed training for monitors and standardizing equipment and methodology, we collect high quality data from over 25 sites that can be compared across the county, as well as be entered in the California Environmental Data Exchange Network (CEDEN). Through this data, we can learn important information about regional and local trends, and inform decision makers. Additionally, the data we collect is provided free to the public via an interactive map through the Water Reporter app, where community members can see the water quality parameters in different areas of their creek, and compare their creek with others in the area. By creating a shared dataset and visualization method, we help improve the connectivity between watershed community groups and provide a platform for future collaborations. We feel that this model of training citizen scientists to collect high quality data, as well as providing a standardized dataset for the public, municipalities and decision makers, is highly transferable and provides multi-layered benefits to both the local community and the environment.

Keywords: creek, monitoring, data, standardize, volunteer, citizen science

Poster Topic: Citizen Science/Volunteer Monitoring

Varied Migratory Strategy and Habitat Use by Bay Area Great Egrets

David Lumpkin[1], Scott Jennings[1], Nils Warnock[1], Emiko Condeso[1]

[1]Audubon Canyon Ranch

david.lumpkin@egret.org, scott.jennings@egret.org, nils.warnock@egret.org, emiko.condeso@egret.org

Great Egrets (*Ardea alba*) are migratory throughout much of their range but are present year-round in the San Francisco Bay Area. The migratory status of this breeding population has not been formally investigated. Great Egrets are generalist predators that use a range of foraging habitats, but much remains to be learned about individual variation in habitat use and movement behaviors. We equipped eight Great Egrets captured as adults on Tomales Bay during 2017 and 2018 with GPS tags in order to better understand the Bay Area population's migratory strategies and habitat use. Data collected thus far indicate that a portion of this population migrates, with four of these birds moving to distinct wintering home ranges in the Central Valley or beyond, while four others spent the winter within their breeding season home ranges. Our data also demonstrate individual variation in habitat use and movement patterns, with some individuals using relatively undeveloped areas while others alternated between low-development and highly urbanized or agricultural landscapes. The importance of eelgrass beds for foraging egrets was also evident; most birds habitually used Tomales Bay eelgrass beds when periods of lower low tides provided extended foraging opportunity there. When higher low tides limited foraging in eelgrass, some egrets flew 10-20 km inland to alternative wetlands for periods of 3-5 days, while others remained in the uplands adjacent to Tomales Bay. The variety of habitat used by Great Egrets shows their adaptability to using altered landscapes as well as their susceptibility to pressures from pollution, urbanization, and habitat alteration in various landscapes. Additionally, egrets with different migratory strategies may be affected differently by climate change or other pressures operating at larger spatial scales than the Bay Area.

Keywords: Great Egret, *Ardea alba*, Migration, Movement, GPS, Telemetry, Habitat

Poster Topic: Citizen Science/Volunteer Monitoring

Lake Merritt Underwater Observatory

Katharine M. Noonan[1,2], Ben Stein[2,3], Kahlil Motley[2], Tamia Proctor[2,3], Angela Ma[2], Adrian Cotter[2,4], David Wofford[2], Khyri Harris[2], Davonte Holland[2,3], Yumang Guintu[5]

[1]Lake Merritt Institute
[2]Lake Merritt Underwater Observatory
[3]Laney College
[4]Community for Lake Merritt
[5]Sofar Ocean

ktnoon@aol.com, ktnoon@aol.com, bn.stn.623@gmail.com, bn.stn.623@gmail.com, kahlilmotley99@gmail.com, tamiatamia34@gmail.com, tamiatamia34@gmail.com, ma.angela99@gmail.com, drainage@gmail.com, drainage@gmail.com, workingchange@yahoo.com, khyri24cur@gmail.com, cooperelon510@gmail.com, cooperelon510@gmail.com, nicole@sofarocean.com

Lake Merritt is a tidal lagoon in the center of a highly urbanized watershed. Since the 1800's it has suffered from trash pollution and poor water quality. It has been a focus of scientific study of marine invasions since the 1960's. Little of this story is known to a larger public. Building and sustaining a volunteer force and city support for managing this body of water is a constant challenge. Supported by a Science Exploration and Education Initiative Grant, OpenROV, and National Geographic's Open Explorer, we used a Trident underwater drone to take videos in both near shore and deeper water locations. The technology allowed us to record communities of organisms and their physical surroundings underwater, and track seasonal and climate-related changes. The project allows people: students, their parents, and the wider public to participate directly in study as they can drive the drone and see for themselves. We observed: 1) It is possible to see common invertebrate and vertebrate species, algae and dumped items such as scooters. 2) Marked differences in algae and visible organisms at different times of year. 3) Different locations in the lake that differ in species richness and species of algae growth. 4) Different amounts of exposed lake bottom. 5) Trash has been found at the bottom in the center of Lake Merritt, but no dead bodies yet. 6) The larger public finds the view unexpected and engaging. Lake Merritt Underwater Observatory shows that underwater drones such as the Trident can reveal details of Lake Merritt's aquatic community -- distribution, seasonal change and human impacts -- that have not been available before. With its video game controller, it easily engages an underserved population of middle school to community college students in authentic exploration and offers opportunities for developing science, leadership and employment skills.

Keywords: Lake Merritt, ROV, exotic species, citizen monitoring

Poster Topic: Citizen Science/Volunteer Monitoring

Lake Merritt Citizen Monitoring Study: Two Years of "Keeping an Eye on Lake Merritt"

Katharine M. Noonan[1], Ben Stein[2], Angela Ma[3]

[1]Lake Merritt Institute
[2]Laney College
[3]University of California at Santa Barbara

ktnoon@aol.com, bn.stn.623@gmail.com, ma.angela99@gmail.com

Lake Merritt is a brackish water tidal lagoon in Oakland CA. From 1962-1972, James Carlton carried out detailed studies of its aquatic life providing an extensive description of species and communities present at that time. A re-survey of the lake was conducted in 2016 by James Carlton of Williams College CN and Andrew Chang of the Smithsonian Environmental Research Center Tiburon CA to see how the lake communities had changed in 50 years. They reported shifts in species, new invasive species, and an increase in species common to higher salinity environments. Lake Merritt Citizen Monitoring Study (LMCMS) was established in 2017 as an iNaturalist project with the goal of involving citizens in continuing to document invertebrate life in Lake Merritt. Observers document the presence of species by uploading geo-tagged smart phone images to the iNaturalist website along with environmental measurements: tide status, water temperature, salinity, pH, dissolved oxygen and water transparency. Since the 2016 re-survey, there have been two very wet winters (2017 and 2019). The prolonged low salinity that occurred in the lake was associated with a slow re-establishment of the biofouling community on the Lake Merritt Boating Center docks. Some species common in 2016 have not been observed by citizen observers (caprellids and some tunicates). Species common to lower salinity waters in the North Bay have been sighted. These casual observations cannot address scientific measurement of species abundance and diversity, but they may offer useful information to researchers who cannot cover the entire Bay shoreline. The observations may help identify target species of interest to ecologists that citizen observers could reliably track. Most importantly, Lake Merritt Citizen Monitoring Study has involved local people in a deeper appreciation of their natural surroundings and a chance to be actively involved in observing seasonal and climatic changes

Keywords: exotic species, citizen science, climate change, iNaturalist, biodiversity, monitoring

Poster Topic: Citizen Science/Volunteer Monitoring

Citizen Science Monitoring of Bacteria in Lake Merritt

Katharine M. Noonan[1], Nariah Garcia[2], Ryan Faulkner[3], Anthony Bald[3], Miriam Valesco[1], David Bille[2]

[1]Lake Merritt Institute
[2]Oakland Emiliano Zapata Street Academy
[3]St. Paul's Episcopal Middle School

ktnoon@aol.com, riah203@icloud.com, rfaulkner@spes.org, abald@spes.org, forest.paws@gmail.com, avey50@gmail.com

The purpose of our research was to investigate the concentration and distribution of E. coli in both the wet and dry seasons in Lake Merritt, a tidal lagoon in the middle of heavily urbanized Oakland CA. Specifically, we asked: how do coliform bacteria and E. coli concentrations vary in Lake Merritt, and what are the associated quantitative and qualitative measures of seasonal rainfall, salinity and proximity to San Francisco Bay tidal input through the Lake Merritt Channel? Students from Oakland Emiliano Zapata Street Academy, St. Paul's Episcopal Middle School, and local citizens collected Lake water samples over five consecutive weeks, during each wet and dry season, from February 21st, 2018 through March 7th, 2019. We followed the Environmental Protection Agency's Volunteer Monitoring of Surface Water for Bacteria protocol (Standard Operating Procedure #1106). The 100 ml water samples were collected from eleven shoreline sites including a major freshwater creek tributary, near and between storm water outfalls and the tidal channel. The E.P.A. Region 9 Laboratory analyzed the samples using the Colilert test and provided the coliform MPN and E. coli results for each date and the geometric mean over five weeks for WET (wet) and DRY (dry) seasons. The results indicated wide variation in E. coli concentrations within same sites and at different sites, similar to findings in other studies in previous years. The E. coli concentrations generally exceeded water quality standards, with reductions of E. coli concentrations near the Bay channel and at higher salinities.

Keywords: Citizen Science, U.S.E.P.A., coliform bacteria, E. coli, Lake Merritt

Poster Topic: Citizen Science/Volunteer Monitoring

Twenty Years of Student Water Quality Data to be Uploaded to Web (San Francisco Estuary Institute's CD3 Program and FlowWest, Inc.)

Katharine M. Noonan[1], Kevin D. Jordan[1], Cristina Grosso[2]

[1]Lake Merritt Institute
[2]San Francisco Estuary Institute

ktnoon@aol.com, kdougjordan@yahoo.com, cristina@sfei.org

Water quality at Lake Merritt is important to ecologists, state and federal regulators (State Water Quality Board and the U.S. Environmental Protection Agency), City and regional managers, conservationists and the general public. Lake Merritt is a tidal lagoon in the center of a highly urbanized watershed. Excessive nutrients from urban run-off and poor tidal circulation have been problems historically, continuing to today. In 1999, Lake Merritt was cited by the U.S. E.P.A. under the Federal Clean Water Act for excessive nutrients leading to low dissolved oxygen and for trash. It has remained on the TMDL 303 (d) list through the latest report in 2016. As a trash hotspot in Oakland, the lake continues to challenge the city's achievement of its Regional Monitoring Program trash reduction goals. Looking to the future, it would be helpful to know recent historical dissolved oxygen levels and other water quality measures levels in the lake and how they varied at different locations, depths in the water column, and seasons. Professional testing is expensive and has been undertaken infrequently at Lake Merritt. Volunteer monitoring programs have been helpful but short-term. Here we present a twenty-year dataset collected by high school students in the Environmental Science Academy at Oakland High School from 1997 to 2016. The dataset has been extended to 2019 by participation of other local student groups as part of Lake Merritt Observatory, a nature-partner program at the Rotary Nature Center on Lake Merritt. Collating and putting the data in CEDEN format would have been impossible without the help of the San Francisco Estuary Institute's Cristina Grosso and Data Services Team, and Bethany Hackenjos and Anne de Graaf of FlowWest, Inc. We hope that with their help local students will continue to monitor Lake Merritt's water quality and present their findings on the web.

Keywords: K-12 environmental education, citizen monitoring, water quality indicators, Lake Merritt

Poster Topic: Citizen Science/Volunteer Monitoring

Effect of Sea Level Rise on Riparian Ecosystems in the Sacramento-San Joaquin Delta

Dylan Chapple[1], Annika Keeley[1], Dan Constable[1], Cory Copeland[1], Kaylee Griffith[1], Ron Melcer[1]

[1]Delta Stewardship Council

Dylan.Chapple@deltacouncil.ca.gov, Annika.Keeley@deltacouncil.ca.gov, Daniel.Constable@deltacouncil.ca.gov, Cory.Copeland@deltacouncil.ca.gov, Kaylee.Griffith@deltacouncil.ca.gov, Ronald.Melcer@deltaconuncil.ca.gov

The Sacramento San Joaquin Delta's ecosystems are highly degraded due to a legacy of reclamation, land conversion, and resulting species declines. Anticipating how ecosystems will be impacted by climate change is important for exploring management options to increase ecosystem resilience and is required by the Delta Plan. Riparian ecosystems support a diversity of plant, bird and other wildlife species as well as critical physical and ecological processes. Their linear nature supports connectivity, they link aquatic and terrestrial ecosystems, and the riparian microclimates provide thermal refugia for wildlife. Once widespread throughout the Delta at the interface between terrestrial and aquatic ecosystems, most riparian ecosystems have been lost and occur in areas below sea level or with limited accommodation space to track sea level rise (SLR). Using digital elevation data and average daily water levels generated under different SLR scenarios (1, 3, and 7 foot SLR), we conduct spatially explicit modeling to assess exposure, sensitivity, and adaptive capacity of these ecosystems to SLR. To determine exposure, we report patch sizes, number of patches, and landscape metrics that indicate the spatial distribution including patch cohesion, interspersion and juxtaposition, and connectance. To evaluate sensitivity of these ecosystems to climate change, we examine the current range of riparian elevations in the Delta (relative to mean sea level) and evaluate the potential impact of SLR on riparian ecosystem persistence. To estimate adaptive capacity, we calculate the area of land available at the elevation range at the ecotone between terrestrial and aquatic systems. Preliminary results show that riparian ecosystems on subsided islands in the legal Delta could decrease by approximately 20% under 1ft SLR, 30% under 3ft SLR, and 42% under 7ft SLR. We identify areas suitable for restoration and assess their potential contributions to connectivity.

Keywords: climate change, sea level rise, riparian, climate vulnerability, GIS,

Poster Topic: Climate Change

Adapting to Rising Tides, East Contra Costa County: Planning for Current and Future Flooding at the Bay-Delta Interface.

Heather Dennis[1], Rachel Wigginton[1], Samantha Cohen[1], Kate Anderson[2], Kaylee Griffith[2], Ron Melcer Jr.[2]

[1]San Francisco Bay Conservation and Development Commission, Adapting to Rising Tides Program
[2]Delta Stewardship Council, Ecosystem Restoration, Land use, and Science Integration Unit

heather.dennis@bcdc.ca.gov, rachel.wigginton@bcdc.ca.gov, samantha.cohen@bcdc.ca.gov, kate.anderson@deltacouncil.ca.gov, kaylee.griffith@deltacouncil.ca.gov, ron.melcer@deltacouncil.ca.gov

The San Francisco Bay-Delta region is known to be vulnerable to rising sea levels, but much of the work on this topic has focused on the Bay, with less effort to address sea level rise vulnerability in the Sacramento-San Joaquin Delta region. The San Francisco Bay Conservation and Development Commission's Adapting to Rising Tides (ART) program is leading a collaboration among the Delta Stewardship Council, Contra Costa County, local governments, and community stakeholders to aid in sea level rise planning for the Delta-influenced area of East Contra Costa County. The study area includes a variety of shoreline types, including urbanized shoreline, tidal marshes, and subsided polders protected by levees. To analyze exposure and adaptive capacity of key assets, we created flood exposure maps that reflect combined flooding from sea level rise-influenced tides and Delta inflows. We applied a three-dimensional model (UnTRIM) to generate changes in water levels driven by sea level rise and storm flooding. The resulting maps can be viewed through a publicly accessible online web viewer (http://eccexplorer.adaptingtorisingtides.org). These maps were utilized in a robust vulnerability assessment that identified areas and assets susceptible to flooding from future sea level rise, river in-flows during storm events, or the combination of the two. Applying the ART program principles, the project leveraged local perspectives on adaptation planning and highlighted the interdependence of all communities and assets in the area. Importantly, our work has revealed the vulnerability of the project area to near-term, temporary flooding from storm events and a corresponding need to prioritize adaptation today to ensure shoreline resilience to both current storm events and future sea level rise. Our work provides valuable insight into vulnerabilities within the Delta and helps integrate the unique issues Delta communities face with ongoing regional sea level rise adaptation efforts.

Keywords: sea level rise, storm events, flooding, vulnerability, adaptation, participatory planning

Poster Topic: Climate Change

Nature-Based Wave Attenuation Options at Dunphy Park

Camila Fishtahler[1], Makayla Freed[1], Nikk Novero[1], Adelaide Robinson[1], Cricket Swannucci[1]

[1]Conservation Corps North Bay

cfishtahler@ccnorthbay.org, mfreed@ccnorthbay.org, nnovero@ccnorthbay.org, arobinson@ccnorthbay.org, Cswannucci@ccnorthbay.org

This project explores possible nature-based alternatives to a traditional breakwater to mitigate impacts of sea level rise in the Dunphy Park area. It also takes inventory of ecologically significant species to be considered as part of any future implementation of such installations. Inventories being presented include Olympia oyster (*Ostrea lurida*) and Eelgrass (*Zostera marina*) surveys indicating current conditions in the area. Dunphy Park is a site on Richardson Bay in Sausalito, CA with many valuable natural resources, including Eelgrass, Olympia oysters, and marine fish and wildlife. These resources will be impacted both by the effects of climate change and by climate change mitigation efforts. In order to address this, different approaches are being considered to preserve habitat and boost resiliency along the shore at the Park. Another goal of the attenuation options project is to educate the public regarding the added ecological value a nature-based solution would provide over the traditional engineered breakwater concept. In taking a nature-based approach to addressing the foreseeable effects of climate change at Dunphy Park, sea level rise could be mitigated while conserving ecosystem services provided by key species and natural processes. The nature-based options proposed for consideration are scientifically designed to enhance habitat and increase adaptability to future sea level rise. For example: a previous study at living shoreline project in San Rafael showed that oyster reefs (shell bag mounds) enhanced eelgrass establishment and growth when planted on the shoreward side (Boyer et al. 2017). Implementation of a nature-based solution will not only dissipate wave energy, protecting communities and the shoreline, but will also improve the quality of habitat with services including water filtration, habitat structure, and carbon sequestration. Through bolstering of native species such as the Olympia oysters and Eelgrass the provision of ecosystem services can increase leading to greater resilience.

Keywords: Living Shoreline, Olympia Oysters, Eelgrass, Shore birds, nature-based solutions

Poster Topic: Climate Change

Assessing the Vulnerability of Bay Delta Communities to Extreme Heat

Amanda DeMarco[1], Kelsey Haydon[1], Lindsay Kammeier[1], Keara Tuso[1]

[1]UC Davis

akdemarco@ucdavis.edu, krhaydon@ucdavis.edu, lakammeier@ucdavis.edu, kbtuso@ucdavis.edu

Extreme heat events in the Delta are expected to increase with climate change. We examined heat vulnerability of cities, towns, and legacy communities in the Delta based on their social and physical variables provided by the California Department of Public Health. These variables were used to rank each Delta community's vulnerability to extreme heat events. This analysis was an initial assessment of vulnerability and additional steps to refine vulnerability are provided. This study was completed with guidance from the Delta Stewardship Council. This work will ideally aid the Delta Stewardship Council's Climate Vulnerability Assessment for the state of California.

Keywords: Climate change, extreme heat, vulnerability

Poster Topic: Climate Change

Linking Vulnerability to Action: Developing an Equitable Approach to Multi-Benefit Adaptation Planning in the San Francisco Bay Area

Jaclyn Mandoske[1], Dana Brechwald[1], Samantha Cohen[1], Rachel Wigginton[1], Emma Greenbaum[1]

[1]San Francisco Bay Conservation and Development Commission (BCDC)

jaclyn.mandoske@bcdc.ca.gov, dana.brechwald@bcdc.ca.gov, samantha.cohen@bcdc.ca.gov, rachel.wigginton@bcdc.ca.gov, emma.greenbaum@bcdc.ca.gov

Regional sea level rise impacts in the Bay Area are uniquely complex and effective solutions will require collaboration among scientists, governments, public and private stakeholders, and communities to mobilize adaptation actions for resilience. The Bay Area has made significant progress on assessing shoreline vulnerability to climate change, but the leap between assessment and coordinated, region-wide action is still a challenge. The San Francisco Bay Conservation and Development Commission's Adapting to Rising Tides Program (ART) has been working towards a shared understanding of regional vulnerability, detailing the significant consequences to the region's economies, environments, and communities living alongside the Bay shoreline, and providing guidance for local governments to create their own assessment processes. But we recognized a gap in planning guidance for using the results of vulnerability assessments to identify and apply appropriate adaptation strategies. In response to this gap, the ART Program developed an "Adaptation Decision Tree" that walks users through a step-wise approach with a series of decisions and options that can support the creation of adaptation pathways. The process highlights the creation of inclusive, coordinated, and equitable multi-benefit solutions based in land use and flood control best practices. Emphasis on the use of adaptation pathways guides jurisdictions to consider longer-term planning horizons and understand actions they can take today to plan for impacts in the future. The Adaptation Decision Tree improves the resiliency of Estuary ecosystems and communities by encouraging coordination with partners across scales, sectors and jurisdictions, and integrating adaptation actions into existing plans and processes. By incorporating best practices for community engagement and emphasizing nature-based shoreline solutions, the Adaptation Decision Tree also supports the region's shift towards inclusive planning and adaptation through habitat restoration and enhancement. These key values will help create a more resilient Bay Area for people and ecosystems now and into the future.

Keywords: sea level rise, adaptation, planning, nature-based solutions, equitable, best practices

Poster Topic: Climate Change

Early-Stage Outcomes at the Innovative Sears Point Tidal Marsh Restoration Project

Stuart Siegel[1,2], Michael Vasey[1,2], Julian Meisler[3], Margot Buchbinder[2], Ryan Anderson[1,2]

[1]San Francisco Bay National Estuarine Research Reserve
[2]San Francisco State University Estuary & Ocean Science Center
[3]Sonoma Land Trust

siegel@sfsu.edu, siegel@sfsu.edu, mvasey@sfsu.edu, mvasey@sfsu.edu, julian@sonomalandtrust.org, mvbuchbinder@gmail.com, randerson5726@gmail.com, randerson5726@gmail.com

Who will win, sea level rise drowning tidal marshes or restored marshes accreting at a pace to match sea level rise? Where sediment supply is rich, marshes might win. One significant Baylands Ecosystem Habitat Goals Update recommendation is start now and do all possible to promote marsh accretion to get ahead of the curve. The Sears Point Restoration Project was planned years ahead of BEHGU and fully reflects that recommendation. Located on the northwest shore of San Pablo with its currently abundant sediment loads, this 970-acre project applied a unique design concept – marsh mounds – to protect the shoreline and promote accretion and early emergent marsh establishment. Breached in October 2015, how well has the project performed in this regard and what lessons has it taught us about climate resilient restoration? The San Francisco Bay National Estuarine Research Reserve is helping the Sonoma Land Trust carry out early monitoring and assessment, and graduate students at the Estuary and Ocean Science Center have undertaken field studies to examine marsh mound efficacy. So far, we have learned: (1) building the intended design matters – the mounds had their tops lopped off early on likely because pre-breach vegetation was omitted; and (2) mounds help promote local accretion to create dispersed foci of emergent marsh elevations that can be planted to jump-start emergent marsh establishment – the Invasive *Spartina* Project did extensive planting in March 2018 and March 2019. Their early erosion eliminated our ability to know if they helped dissipate shoreline wind-wave energy or could self-revegetate. Future tidal marsh restorations need all the lessons learned available to maximize their designs to meet BEHGUs recommendations – locate smart, utilize natural processes, try to get ahead of the degradation curve. Sears Point is gathering the data to offer up some of its lessons learned.

Keywords: climate impacts, integrative applied science, physical processes, habitats and ecosystems

Poster Topic: Climate Change

Refining a Marsh Sea-Level Rise Accretion Model to Incorporate Vegetation Succession and Parameter Uncertainty

Kevin Buffington[1], Chris Janousek[2], Bruce Dugger[2], Karen Thorne[1]

[1]US Geological Survey
[2]Oregon State University

kbuffington@usgs.gov, janousec@oregonstate.edu, bruce.dugger@oregonstate.edu, kthorne@usgs.gov

Ecogeomorphic models encapsulating the dynamic processes that drive coastal wetland development and response to sea-level rise rely on field data to calibrate and provide site- or region-specific projections. These models are based on assumptions regarding feedbacks between soil elevation and organic matter production, with data from Atlantic coast *Spartina alterniflora* marshes often used for calibration. Building on the framework of an existing model (WARMER, Swanson et al. 2014) we developed a new approach that incorporates the functional relationship between elevation and productivity for dominant San Francisco Bay wetland plant species (*Salicornia pacifica, Spartina foliosa, Schoenoplectus acutus, Schoenoplectus americanus, Bolboschoenus maritimus*), San Francisco Bay-Delta site-specific mineral accretion rates, soil porosity, and decomposition rates, and includes a new multi-species module to account for shifts in species composition. We assessed sea-level rise vulnerability across four sites spanning the Bay-Delta salinity and tidal gradient. We compared elevation response and carbon sequestration rates across multiple scenarios of sea-level rise, sediment supply, and salinity and used a Monte Carlo approach to propagate uncertainty for all major model parameter estimates throughout the 100-year projections. We found important differences in end-of-century wetland elevation and carbon storage capacity depending on plant species composition and the first estimates of uncertainty in tidal wetland elevation and carbon sequestration projections. Our work highlights the importance of incorporating region-specific data into model projections to understand sea-level rise vulnerability. While developed with Bay-Delta datasets, our refined modeling framework is broadly applicable to coastal wetlands worldwide to inform management.

Keywords: modeling, tidal marsh, sea-level rise, climate change, scenarios, coastal management

Poster Topic: Climate Change

Margaret A. Davidson Graduate Fellowship: A New NOAA Program to Advance Scientific Understanding and Collaboration in the National Estuarine Research Reserve (NERR) System

Michael Vasey[1]

[1]San Francisco Bay NERR

mvasey@sfsu.edu

This is a congressionally funded two-year fellowship program that will provide $31,000 per year for enrolled students at host institutions. Additional funding of $7,000 is provided to support vessel use and other ancillary research costs. The program will begin in Fall 2020. Applications are due December 20, 2019. The goals of the program are to 1) support the next generation of leaders in estuarine science and coastal management; 2) address critical reserve management priorities through high-quality research; 3) develop a strong network among the fellows that persists after the fellowship well into their careers. Host institution advisors will work with Research Reserve mentors to aid fellows in addressing high priority issues at Research Reserve sites, stressing collaboration in both natural and social science research. Priority issues at the San Francisco Bay NERR are identified as: 1) native oyster population, distribution and variability in the San Francisco Estuary; 2) collaborative approaches to sea-level rise resilience of tidal marshes impacted by a low-lying road at China Camp State Park; 3) identification of fine scale data needs, reference site selection, and integration of existing ongoing data sets for the EPA-funded Wetland Regional Monitoring Program in the San Francisco Estuary; 4) understanding early human occupancy and use in the Research Reserve and how traditional ecological knowledge can be used to guide current land management practices; and 5) current and ongoing human-use impacts to tidal marsh ecosystems in the Research Reserve. For further information, see https://coast.noaa.gov/nerrs/research/davidson-fellowship.html and/or contact Aimee Good at aimee@sfsu.edu.

Keywords: Graduate Fellowship, coastal research, Research Reserve (NERR) System, collaboration, opportunity

Poster Topic: Climate Change

Common Delta Base Map: Delta Aquatic Resources Inventory (DARI)

Cristina Grosso[1], Thomas Jabusch[2], Hildie Spautz[3], Shruti Khanna[3], Jane Schafer-Kramer[4], Elaine Blok[5], Ron Melcer[6], Carol Ostergren[7], Mark Chin[8], Cody Aichele-Rothman[9], Pete Kauhanen[1], Sam Safran[1], Micha Salomon[1]

[1]San Francisco Estuary Institute
[2]Sacramento-San Joaquin Delta Conservancy
[3]California Department of Fish and Wildlife
[4]California Department of Water Resources
[5]US Fish and Wildlife Service
[6]Delta Stewardship Council
[7]US Geological Survey
[8]State Water Resources Control Board
[9]San Francisco Bay Conservation and Development Commission

cristina@sfei.org, Thomas.Jabusch@deltaconservancy.ca.gov, hildegarde.spautz@wildlife.ca.gov, Shruti.Khanna@wildlife.ca.gov, Jane.Schafer-Kramer@water.ca.gov, elaine_blok@fws.gov, Ronald.Melcer@deltacouncil.ca.gov, costergren@usgs.gov, Mark.Chin@waterboards.ca.gov, cody.aichele@bcdc.ca.gov, petek@sfei.org, sams@sfei.org, micha@sfei.org

DARI is the Delta Aquatic Resources Inventory of surface waters, wetlands, and other aquatic resources in the Sacramento-San Joaquin Delta (Delta). The goal of the DARI project is to develop a geospatial inventory of aquatic resources that will be used as a common base map for the Delta. A similar mapping approach used to create the California Aquatic Resource Inventory (CARI) will be applied to provide a map of the aquatic resources and their associated attributes. The final map will be incorporated into CARI and made publicly available through EcoAtlas (ecoatlas.org) and similar platforms. The inventory of aquatic resources created for the Delta will provide a standardized regional approach to wetland classification and mapping to support multiple current efforts in the Delta, including regional watershed restoration planning, tracking, and reporting. Since a goal of this project is to encourage ongoing stewardship, protocols will be established for submitting new or revised data using the CARI Editor Tool and incorporating updates into the DARI base map in the future. Project funding and oversight are provided by USEPA and the California Wetland Monitoring Workgroup. Once completed in 2020, the common Delta base map will provide several benefits, including to establish a baseline of existing aquatic resources in the Delta; inform prioritization of management actions and evaluate the effectiveness of projects; increase the ability to assess and track the amount and quality of wetlands in the Delta to support compliance monitoring and assessment of wetlands projects; increase the capacity for assessing regional and statewide net change in the abundance, diversity, and condition of wetlands as affected by land use; facilitate wetland monitoring and assessment coordination in the Delta region to assess the status and trends in its wetland ecosystems; and encourage ongoing stewardship and updating of DARI with protocols and online tools.

Keywords: mapping aquatic resources, wetland monitoring and assessment, stewardship

Poster Topic: Data/Tools

Improving Water Data Accessibility and Usability Through an Integrated Data Repository and Visualization Portal

Jeffrey Hansen[1], Brian Bergamaschi[1]

[1]US Geological Survey

jahansen@usgs.gov, bbergama@usgs.gov

Timely access to monitoring and scientific water quality and habitat condition data – especially recent and real-time data – is important to support responsive management and to facilitate a greater understanding of temporal dynamics in aquatic habitats of the San Francisco Estuary (SFE). Web-based access to real time and historical data can provide the ability to respond more quickly and in innovative ways to changing conditions in the Estuary. We are attempting to integrate USGS data together with other publicly available data into a single repository where they can be analyzed and visualized together using an on-line visualization portal; this will enhance the value and utility of all of these data. Scientists, managers, and the public will be able to explore hypotheses and test ideas directly in the portal and download the relevant data with the click of a button. Interactive maps and animated time-series visualizations bring data to life and illustrate the ways in which the system is interconnected in many complex and interesting ways. Along with partners and local stakeholders, we hope to improve access to a broad range of data types useful for monitoring aquatic habitat conditions and evaluating biogeochemical processes in the Estuary. We invite discussions with stakeholders and prospective users about how we can best make this tool useful to the SFE community and what data you think should be accessible through the site. We are focusing on the Delta, Suisun, and Bay at this time, and will expand the effort to include data from the contributing watershed over the next several years. Come talk to us to brainstorm how we can help you make best use of the Estuary's significant data resources.

Keywords: Water Quality, Data, Visualization, Tableau, USGS

Poster Topic: Data/Tools

New Resources Supporting Adaptive Management in the Delta: Compilations of Conceptual Models, Uncertainties, and Monitoring Protocols

Annika Keeley[1], Eva Bush[1], Dylan Chapple[1], Karen Kayfetz[1], Madison Thomas[1]

[1]Delta Science Program

annika.keeley@deltacouncil.ca.gov, eva.bush@deltacouncil.ca.gov, dylan.chapple@deltacouncil.ca.gov, karen.kayfetz@deltacouncil.ca.gov, madison.thomas@deltacouncil.ca.gov

Adaptive management, a science-based, structured approach to environmental decision making under uncertain conditions, is required for many conservation projects in the San Francisco Estuary. Two new resources are now available to help project proponents in planning adaptive management: compilations of conceptual models and key uncertainties. Conceptual models summarize the latest scientific understanding about cause-effect relationships. They are critically important for linking goals and objectives to project actions, monitoring, data collection, and research, and can indicate potential consequences of alternative management actions. A centralized repository makes it easy to find and access relevant, up-to-date conceptual models, and may increase the use of these communication tools. An awareness of scientific uncertainties and system-wide management questions provides the opportunity to address areas where significant gaps in knowledge hinder conservation or management actions. The compilations can be searched to identify relevant areas of uncertainty, identify potential outcomes of conservation actions that can be addressed with adaptive management, define monitoring needs, develop performance measures, and assess the likelihood of success for achieving the goals and objectives of conservation projects, programs, and plans. Users may include conservation project proponents, the research community, and funders scoring projects based on the management questions they are addressing. We will explain the purpose of these new resources, identify potential users, describe how the resources can be used, and illustrate the interagency approach that was taken to assemble them.

Keywords: adaptive management, conceptual models, uncertainties, conservation projects, restoration, interagency collaboration

Poster Topic: Data/Tools

Sea the Future: To See Future Flooding Impacts, Find the Tool that Works for You

Brenna Mahoney[1], Dan Hossfeld[2], John Rozum[1], Becky Lunde[1], Melissa Rosa[3], Mary Small[2], Taylor Samuelson[2]

[1]NOAA Office of Coastal Management
[2]California State Coastal Conservancy
[3]Scripps Institution of Oceanography

brenna.mahoney@noaa.gov, dan.hossfeld@scc.ca.gov, John.rozum@noaa.gov, becky.lunde@noaa.gov, mrosa@ucsd.edu, mary.small@scc.ca.gov, Taylor.Samuelson@scc.ca.gov

Sea the Future is a recently released website that was created to help Californians understand the sea level rise and flood visualization web tools that are available for their needs. The number of these tools and the subtle differences among them can be confusing and, in some cases, a barrier to planning for sea level rise. Tools in Sea the Future include those that primarily map sea level rise and flood inundation layers as well those that provide inundation layers in relation to built and natural resources. Sea the Future helps users identify tools based on location or by distinguishing tool features, as well as compare methodologies and features across multiple tools. The website provides summary information and presents similarities and differences among tools. Sea the Future is based on an effort started in 2014 called "Lifting the Fog" Several organizations convened key stakeholders to improve understanding of the different sea level rise visualization tools and to help end-users navigate the different planning tools and data available to them. Out of this process, an informational matrix was developed to compare and contrast tools and models. While the matrix was an excellent first step, the information provided can be overwhelming and difficult for a non-expert to understand. Sea the Future helps make it easier to access this information. We will describe the development of the website, available features, and provide online access to demo the new site. Sea the Future is a collaboration among NOAA Office of Coastal Management, the California State Coastal Conservancy, and the San Francisco Bay Sentinel Site Cooperative.

Keywords: Sea level rise, sea level rise visualization tool

Poster Topic: Data/Tools

A View into the Delta Plan Performance Measures

Scott Navarro[1], Cory Copeland[1], Chris Kwan[1]

[1]Delta Stewardship Council

scott.navarro@deltacouncil.ca.gov, cory.copeland@deltacouncil.ca.gov, Chris.kwan@deltacouncil.ca.gov

The Delta Stewardship Council is unveiling the Delta Plan Performance Measures dashboard; a website to view and access performance measures information and data relevant to Delta Plan strategies and recommendations. Delta Plan performance measures track the progress in meeting the coequal goals of a reliable water supply for California and a healthy Delta ecosystem. Additional performance measures track implementation status in the Delta as an Evolving Place, Water Quality, and Protect People and Property areas of the Delta Plan. The performance measures serve multiple purposes: meet requirements of the Delta Reform Act, are a tool for communicating with Delta managers and interested public, and support adaptive management of the Delta. This session will showcase the structure and key features of the website.

Keywords: Performance measures, website, outreach, data visualization, Sacramento San Joaquin Delta

Poster Topic: Data/Tools

San Francisco Bay-Delta Community Model

Kees Nederhoff[1], Mick van der Wegen[2,3], Lisa Lucas[4], Noah Knowles[4], Patrick Barnard[4], Bruce Jaffe[4], David Senn[5], Mark Stacey[6], Oliver Fringer[7], Rusty Holleman[8]

[1]Deltares USA
[2]Deltares
[3]UNESCO-IHE
[4]USGS
[5]SFEI
[6]UC Berkeley
[7]Stanford
[8]UC Davis

kees.nederhoff@deltares-usa.us, Mick.vanderWegen@deltares.nl, Mick.vanderWegen@deltares.nl, llucas@usgs.gov, nknowles@usgs.gov, pbarnard@usgs.gov, bjaffe@usgs.gov, davids@sfei.org, mstacey@berkeley.edu, fringer@stanford.edu, cdholleman@ucdavis.edu

Over the last few decades, a range of numerical models has been developed to studying the complex hydrodynamics and water quality related issues in the San Francisco Bay-Delta (SFBD). MacWilliams et al. (2016) recognized the models UnTrim, SUNTANS, SCHISM, RMA2 and Delft3D FM as the main multi-dimensional models that span the Bay and Delta. However, there is a limited exchange (possible) between the different models. In part this related to licenses issues and/or due to the protection of intellectual property. This results in double work per model schematization. Delft3D modeling of the SFBD started around 2006. Delft3D Flexible Mesh (FM) is an integrated modeling suite, which simulates two-dimensional (in either the horizontal or a vertical plane) and three-dimensional flow, sediment transport and morphology, waves, water quality and ecology and is capable of handling the interactions between these processes on an unstructured grid. Delft3D-FM is freely available as open-source software which enhances scientific collaboration and makes it possible to combine the unique expertise of researchers worldwide. The proposed next step in open-source modeling is the usage of so-called 'community models'. This means that model schematizations become public domain and therefore creative materials will not be protected by intellectual property laws such as copyright, trademark, or patent laws. Thus everyone can use, change and feedback model developments which results in higher efficiency and more collaboration. The result is that the SFBD community model (http://www.d3d-baydelta.org/) can become a standard tool for integrated modeling suite from hydraulics to water quality and ecosystem. During this poster presentation we will share our experience with the San Francisco Bay-Delta Community Model and how it enabled on range of terrains such as research, consultancy and networking. Open access platforms, subversion management tools and central validation data storage are examples of tools that may stimulate growth of community models

Keywords: process-based modeling, community model, open-source, Delft3D Flexible Mesh

Poster Topic: Data/Tools

New Lidar Informs Mapping in the Legal Delta and Beyond

Carol Ostergren[1]

[1]US Geological Survey

costergren@usgs.gov

Recent (January, 2018) lidar acquisition in the California Legal Delta is supporting multiple scientific investigations across federal, state, and not-for-profit organizations. The collection of this dataset was facilitated by the USGS National Geospatial Program's 3D Elevation Program (3DEP), in partnership with the California Department of Water Resources. Recent Open-Data Executive Orders issued at both federal and state levels set forth a guiding principle of "collect once, use many times," which provides the foundation for the Delta lidar collection and many other lidar collections throughout the nation. This poster provides the information users need to access the lidar data for the Delta, discover other datasets in the San Francisco Bay Area, and to make future elevation data requirements known to both state and federal lidar program managers in California.

Keywords: lidar, Delta, 3DEP, open-data, requirements

Poster Topic: Data/Tools

Starting the Path to Open Data

Jenna Rinde[1], Vanessa Tobias[2], Brittany Davis[1], Melinda Baerwald[1], Rosemary Hartman[1], Sarah Lesmeister[1], Brian Mahardja[2], Brian Schreier[1], Rachel Pisor[1], Shruti Khanna[3], Steve Culberson[4]

[1]California Department of Water Resources
[2]United States Fish and Wildlife Service
[3]California Department of Fish and Wildlife
[4]Interagency Ecological Program

jenna.rinde@water.ca.gov, vanessa_tobias@fws.gov, brittany.e.davis@water.ca.gov, melinda.baerwald@water.ca.gov, rosemary.hartman@water.ca.gov, sarah.lesmeister@water.ca.gov, brian_mahardja@fws.gov, brian.schreier@water.ca.gov, rachel.pisor@water.ca.gov, shruti.khanna@wildlife.ca.gov, steve.culberson@deltacouncil.ca.gov

Open Science is a movement that encourages transparency in all aspects of scientific work, including accessible and open data, metadata, reproducible methods, and open access publishing. The Interagency Ecological Program for the San Francisco Estuary (IEP) is a consortium of scientists that collect large amounts of data on water quality, nutrients, phytoplankton, zooplankton and fish. IEP's Data Utilization Workgroup (DUWG) has made strides in developing an Open Science framework for their programs to utilize in order to make data more discoverable, transparent, and usable. This poster focuses specifically on Open Data, an element of Open Science. The goal of Open Data is to make data broadly accessible to the scientific community by making it easily searchable, available, and citable via an online repository; however, the path starts with proper documentation, which can be daunting. Here, the DUWG describes a pathway for Open Data by providing guidance with data management plans, quality assurance documents, and metadata for data publication. After a comprehensive investigation of data repositories, the DUWG found that Environmental Data Initiative (EDI) met the IEP's Open Data sharing needs by curating and archiving long-term ecological data with rigorous metadata and quality standards. EDI also supports permanent digital object identifiers (DOI) to allow datasets to be easily discovered and tracked. Publishing datasets on EDI meets requirements of the Open and Transparent Water Data Act (AB 1755) while also providing a DOI, versioning, and the ability for data users to link directly to the data repository. This Open Data effort helps data generators to get the credit they deserve for collecting, managing, and sharing data. This poster provides an outline of IEPs Open Data path and resources for scientists who want to get started with publishing their data through EDI.

Keywords: Open Data, Open Science, data

Poster Topic: Data/Tools

Comparison of Arduino Probe Methodology to Existing Field Methods Used for Acid Mine Drainage Research in Leona Creek, Oakland, CA

Masha Soshnin[1], Lizbeth Crispin[1], Reina Kirkendal[1], Annie Pearce[1], Alexis Maxey[1], Shayna Yano[1], Maria-Elena Ramos[1], Karolyn Hernandez[1], Mariyam Muhammad[1], Kristina Faul[1], Lynn Delker[1], Ellen Spertus[1]

[1]Mills College

mnsoshnin@gmail.com, lcrispin@mills.edu, rkirkendall@mills.edu, apearce@mills.edu, almaxey@mills.edu, syano@mills.edu, mramos@mills.edu, khernandez@mills.edu, qmuhammad@mills.edu, kfaul@mills.edu, ldelker@mills.edu, spertus@mills.edu

Acid Mine Drainage (AMD) is the pollution of surface water and creek systems due to mining. Mining exposes rocks with an abundance of sulfides and metals to oxygen and water that allows distribution of dissolved constituents such as hydrogen ions, heavy metals, and sulfates through surface water runoff. We compared the methodology of Arduino probe technology and standard scientific field instruments for pH, flow, air temperature, and conductivity in AMD affected Leona Creek in Oakland, CA. We used Arduino technology, Vernier instruments, and other software technology to make four different probes. The values measured by the Arduino probes and the standard instruments for pH and conductivity were within a 10-12% difference. For flow, the percent difference between instruments was over 100%. Temperature results were inconclusive, but agreement between methods was within about 20%. Additionally, a soil moisture probe for the Mills Farm downstream of Leona Creek was calibrated using a qualitative assessment of water content. These findings show that some of these probes are possible viable alternatives to standard scientific instruments while others may need more refinement and calibration. With improvements, future studies into extreme environments could potentially benefit from the use of Arduino probes through their adaptability and possibility for remote deployment.

Keywords: Acid Mine Drainage, Arduino, Methodology, Probe, California Space Grant Program

Poster Topic: Data/Tools

Building an Integrated Dataset of Zooplankton Monitoring in the San Francisco Estuary

Karen Kayfetz[1], Sam Bashevkin[1], Rosemary Hartman[2], Madison Thomas[1], Christina Burdi[3], April Hennessy[3], Larry Brown[4], Louise Conrad[1], Nicholas Rasmussen[2]

[1]Delta Science Program, Delta Stewardship Council
[2]Department of Water Resources
[3]California Department of Fish and Wildlife
[4]United States Geological Survey

Karen.Kayfetz@deltacouncil.ca.gov, Sam.Bashevkin@deltacouncil.ca.gov, Rosemary.Hartman@water.ca.gov, madison.thomas@deltacouncil.ca.gov, Christina.Burdi@wildlife.ca.gov, April.Hennessy@wildlife.ca.gov, lrbrown@usgs.gov, Louise.Conrad@deltacouncil.ca.gov, Nicholas.Rasmussen@water.ca.gov

Several agencies and programs in the San Francisco Estuary have collected zooplankton data over the past five decades. Although a majority of these datasets are available online, they can be difficult to access and lack standardized formatting, and consequently are challenging to combine and analyze. Combined datasets offer improved spatial and temporal resolution for analysis, allowing researchers to more accurately analyze the distribution of zooplankton across space, time, and different habitats. Our project's aim is to synthesize these datasets by normalizing organizational structures and resolving mismatching metadata among studies. Over time, studies collected a range of taxa which varied in presence/absence and were identified to different taxonomic levels. We resolved these discrepancies by consolidating and standardizing different taxa collected among all datasets. Studies also used different gear types and trawling methods over time. To address these methodological inconsistencies, principle investigators provided information on the sampling and processing techniques used in their studies. A companion report to the integrated dataset is being prepared to document different methods used among programs and the process of combining large datasets from different studies. Our final product is an accessible, online, documented and annotated R code to easily combine and query existing data along with corresponding metadata. We are also building a toolbox, including an R package and Shiny app, to allow researchers to easily query the data. Zooplankton are a vital component of the estuarine food web, and a focus of many marsh restoration efforts. This project supports scientific investigations to improve the Estuary's habitats and living resources (the first goal of the Estuary Blueprint). Our work will influence future zooplankton studies in the San Francisco Estuary by increasing the usability of existing zooplankton datasets, and identifying ways to improve data compatibility and accessibility in the future.

Keywords: zooplankton, synthesis, integrated dataset, data accessibility, metadata, long-term datasets

Poster Topic: Data/Tools

Incorporating Expanded Sampling into an Alternative Abundance Index for the Fall Midwater Trawl Survey

James White[1], Randall Baxter[1]

[1]California Department of Fish and Wildlife

james.white@wildlife.ca.gov, randy.baxter@wildlife.ca.gov

The Fall Midwater Trawl (FMWT) Survey has been conducted near continuously over the past 51 years to assess the abundance and distribution of pelagic fish species throughout the San Francisco Bay/Sacramento-San Joaquin estuary (Bay Delta). Another 22 (non-core) stations were added to the survey 8 to 28 years ago to supplement the original 100 (core) stations sampled since inception of the survey. Relative abundance indices are published annually for the core stations, but this is the first attempt to calculate a similar index for the expanded sampling effort. Here we calculate an alternative index and catch per unit effort (CPUE) which allows comparisons between core and non-core stations and integrates modern estimates of water volume within the Bay Delta. In general, CPUE estimates showed non-core stations contributed either a moderate proportion of total catch over time, or in a single year's catch. The alternative index showed the catch at non-core stations provided additional insight for only a few species over a long time scale. Unusually high catches in specific years highlighted the value of additional catch data in years which would otherwise be considered historically low. Considering that non-core stations represent 18% of the total FMWT stations and contribute valuable insight to abundance and distribution patterns that are otherwise under-reported, the additional sampling effort is certainly a worthwhile endeavor.

Keywords: FMWT, long term monitoring, delta smelt

Poster Topic: Data/Tools

Are Microzooplankton an Intermediate Trophic Link between Cyanobacteria and Copepods in the Northern San Francisco Estuary?

Allison Adams[1]

[1]San Francisco State University

aadams5@mail.sfsu.edu

In the San Francisco Estuary the copepod, *Pseudodiaptomus forbesi* is a key prey species in the food web. However, recent declines in its abundance have raised concern for both this species and the fish that depend on it for food, and have prompted many studies of its diet. *P. forbesi* is known to selectively consume prey that is highly nutritious, including cryptophytes and some species of microzooplankton, and avoid prey that is low in nutrients or too small, such as cyanobacteria. However, the results of a recent study of copepod gut content presented evidence to the contrary: high levels of cyanobacteria, but low levels of cryptophytes. These conflicting results raise the question of how and why *P. forbesi* filled up on cyanobacteria while better food was available. I hypothesize that copepods are not selectively consuming cyanobacteria, rather they are consuming it secondarily, by consuming microzooplankton that have consumed the cyanobacteria. To test my hypothesis, I will conduct an experimental feeding study using copepods collected from the field, cultured cyanobacteria, and cultured rotifers, a type of microzooplankton. I will prepare multiple treatments of copepods, to which I will add separately cyanobacteria, and rotifers that have eaten cyanobacteria. I will then examine copepod guts using fluorescence microscopy methods to reveal the presence and amount of cyanobacteria in the guts. Upon comparison of the feeding treatments, I expect to find a greater amount of cyanobacteria in the guts of copepods in the rotifer treatment than in the cyanobacteria treatment, showing that microzooplankton are an intermediate trophic link between cyanobacteria and copepods. The results of my work will help close a gap in knowledge in the San Francisco Estuary food web, which will support efforts to restore native fish populations

Keywords: San Francisco Estuary food web cyanobacteria copepods microzooplankton trophic link

Poster Topic: Food Webs

Impacts of Periodic Dredging on Macroinvertebrate Prey Availability for Benthic Foraging Fishes

Susan E. W. De La Cruz[1], Laurie A. Hall[1], Isa Woo[1], Alison Flanagan[1,2], Hannah Mittelstaedt[1,3]

[1]U.S. Geological Survey, Western Ecological Research Center, San Francisco Bay Estuary Field Station, Mountain View, CA, USA
[2]Current affiliation: Department of Recovery Ecology, Institute for Conservation Research, San Diego Zoo Global, Escondido, CA, USA
[3]Current affiliation: University of Maine, School of Biology and Ecology, Orono, ME, USA

sdelacruz@usgs.gov, lahall@usgs.gov, iwoo@usgs.gov, alisonmflanagan@gmail.com, alisonmflanagan@gmail.com, hannahnmittelstaedt@gmail.com, hannahnmittelstaedt@gmail.com

Periodic maintenance dredging can impact benthic macroinvertebrate communities that provide prey for many economically important fish species; however, there is limited information about the effects of dredging on macroinvertebrates in San Francisco Bay. In addition, the rate of benthic community recolonization and recovery following dredging is unknown. To evaluate dredging effects on Essential Fish Habitat for benthic foraging fish, we quantified differences in benthic macroinvertebrate biomass between dredged and undredged areas, and we examined the effects of distance from a dredged area and time since dredging on macroinvertebrate biomass. Dredged areas had significantly lower biomass compared to undredged areas, and dredging impacts varied by macroinvertebrate size class and depth, with small macroinvertebrates (0-12 mm) in shallow sediments (0-4 cm) showing the greatest reduction in biomass in dredged areas compared to undredged areas. We observed a significant increase in biomass of early colonizing macroinvertebrate species that were small (0-4 mm) and at the surface (0-4 cm deep) in close proximity to dredged areas, while biomass of larger macroinvertebrates at deeper depths increased with increasing distance from a dredged area. Finally, we found that biomass of every macroinvertebrate size class and depth, except 0-4 mm macroinvertebrates in shallow sediments, increased as the time since dredging increased. Our results indicated that dredging alters the size class and depth of macroinvertebrate communities in San Francisco Bay, thereby reducing the overall prey biomass available for foraging fishes. These findings suggest that the impacts of dredging we measured dissipated over relatively short distances and time periods, such that dredging frequency could be adjusted to reduce disturbance to macroinvertebrate communities and optimize prey availability for target fish species.

Keywords: Dredging, benthic macroinvertebrates, foraging ecology, fishes

Poster Topic: Food Webs

Growth Rates of an Abundant Calanoid Copepod in the Yolo Bypass Floodplain

Austin Gearty[1], Stephanie Owens[1], Toni Ignoffo[1], Anne Slaughter[1], Wim Kimmerer[1], Jared Frantzich[2]

[1]Estuary & Ocean Science Center, San Francisco State University
[2]California Department of Water Resources

agearty@mail.sfsu.edu, steph.owens16@gmail.com, tignoffo@sfsu.edu, aslaught@sfsu.edu, kimmerer@sfsu.edu, Jared.Frantzich@water.ca.gov

Growth rate is a key parameter for understanding copepod population dynamics and their availability as food for fish. We conducted 56 growth rate experiments at four sites between 2015 and 2018 along the eastern boundary canal of the Yolo Bypass Floodplain of the California Delta. Growth rates of juvenile copepods were measured using the artificial cohort method, using imaging techniques to estimate changes in copepod mass during incubation, and water samples were collected to investigate effects of food quantity and quality on growth rate. Growth rates ranged from 0.03 to 0.47 d-1 (median 0.30 d-1), the highest values we have measured to date in the San Francisco Estuary. The positive, saturating relationship between chlorophyll concentration and growth rate provides context to previous studies in other areas of the estuary where growth rate and chlorophyll are persistently low. Habitat restoration and water management are being employed to enhance productivity of the lower food web in the Delta. The Yolo Bypass is an essential habitat for native fishes in the estuary and provides an opportunity to conduct flow manipulation experiments to learn if these actions will support enhanced food production and downstream transport.

Keywords: growth rate, zooplankton, *Pseudodiaptomus forbesi*, Yolo Bypass, Image Analysis

Poster Topic: Food Webs

Demographic and Seasonal Variation in Biofilm Consumption by Migratory Western Sandpipers (*Calidris mauri*)

Laurie A. Hall[1], Susan E. W. De La Cruz[1], Isa Woo[1], Tomohiro Kuwae[2], John Y. Takekawa[1,3]

[1]U.S. Geological Survey, Western Ecological Research Center, San Francisco Bay Estuary Field Station, Mountain View, CA, USA
[2]Coastal and Estuarine Environment Research Group, Port and Airport Research Institute, Yokosuka, Japan
[3]Current affiliation: Suisun Resource Conservation District, Suisun City, CA, USA

lahall@usgs.gov, sdelacruz@usgs.gov, iwoo@usgs.com, kuwae@ipc.pari.go.jp, jtakekawa@suisunrcd.org, jtakekawa@suisunrcd.org

Migratory shorebirds rely on adequate prey at stopover sites to maintain their body condition during migration and to prepare for breeding. To meet their high energy demands, Western sandpipers (*Calidris mauri*) consume protein-rich benthic macroinvertebrates and carbohydrate-rich biofilms, but the contribution of biofilm to sandpiper diets is variable and little is known about seasonal or demographic variation in biofilm consumption. We quantified the contribution of biofilm to the diets of adult and juvenile, male and female Western sandpipers foraging on a tidal mudflat in San Francisco Bay, CA during mid-winter (January/February) and at the initiation of northward migration (mid-April) when their macroinvertebrate prey may become depleted. Stable isotope mixing models that incorporated δ13C and δ15N measured in Western sandpiper plasma, invertebrates (*Crustacea, Mollusca, Oligochaeta, and Polychaeta*), and biofilm indicated that consumption of biofilm increased in mid-April relative to mid-winter, especially in juveniles. Diet composition inferred from mixing models differed significantly among seasons ($p < 0.001$) and demographic groups ($p < 0.001$). Biofilm consumption was greater in mid-April than in mid-winter, and juvenile sandpipers, especially males, consumed the greatest proportion of biofilm. We found that the proportion of biofilm consumed by sandpipers increased with decreasing body mass ($p < 0.001$) and decreasing culmen length ($p = 0.08$), though the latter was not statistically significant, suggesting that birds with smaller body mass and bills are better adapted to forage on biofilm. Because male Western sandpipers have significantly smaller body mass (all $p < 0.004$) and bills (all $p < 0.001$) than females, biofilm consumption may reduce competition for prey among demographic groups. Our results align with previous studies suggesting that migratory Western sandpipers utilize biofilm as a food source. Thus, future efforts to understand seasonal dynamics and enhance biofilm production at stopover sites, like San Francisco Bay, could benefit this species.

Keywords: Shorebirds, biofilm, mudflat, foraging ecology, niche partitioning, stable isotopes

Poster Topic: Food Webs

Now We Know that Delta Aquatic Foodwebs Benefit Significantly from Terrestrial Detrital Material - So Let's Go Find It

Peter Hernes[1], Rachael Dyda[1], Brian Bergamaschi[2]

[1]University of California - Davis
[2]U.S. Geological Survey

pjhernes@ucdavis.edu, rydyda@ucdavis.edu, bbergama@usgs.gov

Mass balance indicates that the lower foodweb in the Delta must be supported in part by non-algal particles. This has been further highlighted by recent research demonstrating the preferential uptake of wetland detrital material by Delta copepods, as well as increased copepod survival by incorporating vascular plant materials into their diet. However, there is a dearth of information about the spatial distribution and temporal variability of non-algal particle concentrations and food quality. In this study, we chemically analyzed a suite of particulate samples collected at selected sites during the annual fish trawl in Fall 2011 through Spring 2012 to assess sources and quality of particulate organic carbon (POC). Secondary measurements included chlorophyll, carbon and nitrogen, and total suspended sediments. Our primary analyte, lignin biomarkers, is uniquely produced by vascular plants and therefore captures land-based and wetland sources of particulate organic matter to the Delta. Higher carbon-normalized yields of lignin, higher syringyl-to-vanillyl ratios, and lower acid-to-aldehyde ratios all indicate higher food quality, and across several months, we observed an increase from east to west (i.e. downstream) in food quality, consistent with significant inputs of wetland-derived material from within the Delta. In combination with particle concentrations, our chemical proxies for food quality can point toward potential hotspots and hot moments for the lower foodweb, and provide a potential tool for maximizing benefits to the foodweb of wetland remediation.

Keywords: Lower foodweb, lignin biomarkers, wetland detritus, non-algal particles

Poster Topic: Food Webs

Phytoplankton Carbon Transfer Across Forty-Three Years in Upper San Francisco Estuary, California

Peggy Lehman[1]

[1]California Department of Water Resources

peggy.lehman@water.ca.gov

Although a decrease in the amount of carbon available at the base of the aquatic food web has been well documented with chlorophyll a concentration within upper San Francisco Estuary, the potential associated change in food quality from change in phytoplankton composition has not. The variation in the phytoplankton community composition and how it impacted carbon transfer within the Delta and Suisun Bay was determined with data from 6 stations sampled at 2-wk to 4-wk over 43-years by the Interagency Ecological Program Environmental Monitoring Program. Ordination analysis combined with ANOSIM analysis (PRIMERe v7) confirmed that the phytoplankton community composition changed among 4 periods within the 43-year period of record and affected both the quality and the size structure of the food resource available over time. Only a dozen phytoplankton genera were responsible for most of the change in carbon during the 43 years and these genera demonstrated the importance of habitat types, particularly planktonic and benthic, to phytoplankton carbon production. Multivariate analysis confirmed the link between the phytoplankton community composition and environmental conditions. These analyses provided insight into the changes in the Delta and Suisun Bay phytoplankton community structure and environmental conditions that can be used to develop management strategies for fishery resource management.

Keywords: phytoplankton, food web, carbon transfer

Poster Topic: Food Webs

Multi-Benefit Projects are Real! Flood Protection, Sea Level Rise Resiliency, and Habitat Enhancement from the San Francisquito Creek Bay to Highway 101 Project.

Kevin Murray[1], Zooey Diggory[2], Gavin Archbald[3], Max Busnardo[3]

[1]San Francisquito Creek Joint Powers Authority
[2]Valley Water
[3]H. T. Harvey & Associates

kmurray@sfcjpa.org, zdiggory@valleywater.org, garchbald@harveyecology.com, mbusnardo@harveyecology.com

The San Francisquito Creek Flood Risk Reduction, Ecosystem Enhancement, and Recreation Improvement Project took over a decade to plan, three years and $47.8 million to construct, and was completed in 2019 by the San Francisquito Creek Joint Powers Authority. The project exemplifies the cross-jurisdictional and multi-disciplinary effort needed to prepare the Estuary's ecosystems and communities for climate change. The project widened the tidal creek channel by constructing setback levees and floodwalls to protect surrounding communities from a 100-year flood during an extreme tide under sea level rise projections. To create the necessary channel capacity, a portion of a golf course was purchased and the creek floodplain was widened by 50-250 feet to restore and create over 15 acres of tidal marsh habitat. A levee was lowered to reconnect the creek mouth to outer Faber Marsh, fostering marsh resilience and further reducing flood risk. High tide refugia habitat for species such as the federally-endangered Ridgway's rail and salt marsh harvest mouse was created by constructing small islands within Faber Marsh, enhancing berms around Faber Marsh, and changing levee vegetation management. Wood structures were installed in the restored channel to facilitate fish passage. Sections of the Bay Trail were improved. The project required the coordination of three municipalities, two flood protection districts, permits from seven federal/state regulatory agencies, and major infrastructure realignment. The project constitutes the first step in a plan to protect more than 5,700 homes and businesses from creek flooding, tidal inundation, and sea level rise. Monitoring shows that the project is on track to provide the targeted habitat improvements. The project provides a built example of multi-objective strategies to adapt the Bay shoreline to increased flood risk with sea level rise while restoring tidal marsh structure and function.

Keywords: constructed project, sea level rise, tidal marsh, creek flooding

Poster Topic: Habitat Restoration

Morphologic Change and Legacy Mercury Remobilization in Alviso Slough, South San Francisco Bay

Amy Foxgrover[1], Mark Marvin-DiPasquale[2], Bruce Jaffe[1], Theresa Fregoso[1]

[1]U. S. Geological Survey Pacific Coastal and Marine Science Center, Santa Cruz, CA
[2]U. S. Geological Survey Water Resources, Earth System Processes Division, Menlo Park, CA

afoxgrover@usgs.gov, mmarvin@usgs.gov, bjaffe@usgs.gov, tfregoso@usgs.gov

Alviso Slough, South San Francisco Bay is the site of an ongoing salt pond restoration project complicated by (1) high sediment demand due to historic ground subsidence and (2) legacy mercury contamination within subsurface sediments of the slough and surrounding ponds. Due to concerns regarding mercury remobilization, restoration was required to proceed in a cautious, methodical manner and a tidal control structure was placed in the upper slough to gradually allow an increase in flows between the pond complex and the slough. To quantify the amount of legacy mercury remobilized within the slough's subsurface sediments since restoration began, we developed a technique of combining high-resolution, biannual measurements of bathymetric scour with mercury concentration measurements from 12 deep sediment cores. Seasonal bathymetric surveys revealed an overall trend in erosion rates of summertime lows and wintertime highs. Morphologic change was influenced not only by restoration actions, but also seasonal variability in discharge from the Guadalupe River and larger-scale sediment transport patterns south of the Dumbarton Bridge. We estimate that 52 kg (±3) of mercury was remobilized since restoration began in 2010, with the highest remobilization rates occurring in the mid and upper slough over the winters of 2014/2015 and 2016/2017. While erosion in the lower slough has decreased over time, the middle and upper sloughs were still actively eroding as of our last bathymetric survey in March 2017. Scour of the mid and upper sloughs will likely continue to remobilize mercury in the future and should remain a primary concern for Phase II restoration actions.

Keywords: marsh restoration, salt ponds, mercury, legacy contaminant, sediment cores, bathymetry

Poster Topic: Habitat Restoration

Assessing Restoration Success at the Coyote Creek Field Station, CA

Liam Healey[1], Iris Stewart-Frey[1], Miranda Wittmond[1], Sarah Hibbs[1], Josh Scullen[2], Dan Wenny[2], Yiwei Yang[2]

[1]Santa Clara University
[2]San Francisco Bay Bird Observatory

lhealey@scu.edu, istewartfrey@scu.edu, mwittmond@scu.edu, shibbs@scu.edu, jscullen@sfbbo.org, dwenny@sfbbo.org, ywang@sfbbo.org

In the San Francisco Bay Area, riparian habitats, which provide important refugia for native and migratory bird species, have been significantly altered by human activities, with 95% of their historical extent lost. With continued urban development, riparian habitat restoration is imperative for future land management practices, and assessments of long-term restoration success are needed. The Coyote Creek Field Station (CCFS), located in Milpitas at the southern end of the Bay, has for over 35 years recorded bird capture rates along 46 transects running through four different habitat groups. These four habitat groups consist of unaltered mature riparian habitat, two restored riparian habitats (one restored in 1987 and another in 1993), and a managed flood-control channel. We seek to assess whether the restored habitats at the CCFS are functioning similarly to that of the mature riparian habitat. Our analysis uses weekly bird capture rates and yearly vegetation surveys from 1996-2014. Species richness, diversity, and abundance for both bird and vegetation data for three different time periods (1996-1998, 2004-2006, and 2012-2014) were compared for each of the four habitats. In addition, we examined how migratory types and key riparian dependent focal species of birds have changed between the three time periods in each habitat group. Our results show that restored habitats exhibited higher vegetation species richness, diversity, and abundance than the mature habitat in the earlier time periods, but all three indices declined by the later period to values very similar to that of the mature habitat. With respect to bird species, the restored habitats are similar to the mature habitat, but in all habitat groups many of the native indicator species have substantially declined from the earliest period. The results from this analysis could aid in informing management decisions and provide guidance for future riparian habitat restoration in the Bay Area.

Keywords: Riparian Habitat Restoration, Focal Bird Species, Vegetation Trends, Coyote Creek,

Poster Topic: Habitat Restoration

Wings Landing Tidal Habitat Restoration Project

Ryan Lopez[1], Forest Halford[1], Skip Moss[1], Alexandra Margulies[1], Tom Taylor[1]

[1]Natural Resources Group, Inc.

rlopez@natural-resources-group.com, fhalford@natural-resources-group.com, smoss@natural-resources-group.com, amargulies@natural-resources-group.com, ttaylor@natural-resources-group.com

Wings Landing, a 267-acre privately owned duck club in Suisun Marsh, will be restored from managed to intertidal marsh to benefit smelt and salmonid fish species. The project would partially offset impacts associated with the State Water Project and Federal Central Valley Project. The Project Site is within Delta Smelt critical habitat, is contiguous with ~4,000 acres of marsh restoration projects and habitat preserves, is bordered by three tidal channels (Peytonia, Boynton, and Suisun sloughs), and contains elevations ideal for marsh restoration (2-5ft NAVD88). Restoration design was informed by topographic and vegetation mapping, historic conditions, stakeholder feedback, and best available science. UC Davis scientists found that invertebrates produced onsite facilitated 3x growth in Chinook Salmon fry. Restoration design was improved though hydrodynamic modeling (velocity, salinity, particle tracking, etc.) to adjust onsite residence time and velocities. Particle tracking model results showed onsite food production (Chlorophyll A, invertebrates) would be transported throughout Suisun Marsh into Suisun and Honker Bays. The project is currently in permitting, with construction planned in 2020. Following construction, ownership of the project site will be transferred to DWR for long-term management.

Keywords: Marsh, smelt, salmonids, restoration, habitat

Poster Topic: Habitat Restoration

Habitats and Highways: Integrated Habitat Restoration and Transportation Planning in Northern San Pablo Bay

Julian Meisler[1], Kendall Webster[1], Jeremy Lowe[2], Renee Spenst[3]

[1]Sonoma Land Trust
[2]San Francisco Estuary Institute
[3]Ducks Unlimited

julian@sonomalandtrust.org, kendall@sonomalandtrust.org, jeremyl@sfei.org, rspenst@ducks.org

From the Napa Sonoma Marshes to Hamilton wetlands, thousands of acres of tidal wetland restoration are underway along the northern arc of San Pablo Bay. Yet much remains to be done in advance of accelerated sea level rise and it must begin by 2030. Some of the most expansive opportunities occur in Sonoma County where conservation organizations are actively planning large-scale conservation and restoration in the diked agricultural baylands of lower Sonoma Creek and the Petaluma River. With collective restoration opportunities exceeding 10,000 acres, this work is occurring simultaneous to and in cooperation with planning for the eventual redesign of State Route 37 and possibly the arrival of passenger rail service. Both highway and rail infrastructure travel through diked and existing baylands and present significant barriers and opportunities. Successful restoration and resilient infrastructure will depend on integrated and mutually beneficial planning between non-traditional partners.

Keywords: restoration, planning, sea level rise, transportation

Poster Topic: Habitat Restoration

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

Hildie Spautz[1], Diane Mastalir[1], Sakura Evans[1], Mitsuko Grube[1], Steve Rodriguez[1], Vicki Lake[1], Matt Wells[1]

[1]California Department of Fish and Wildlife

hildegarde.spautz@wildlife.ca.gov, Diane.Mastalir@wildlife.ca.gov, Sakura.Evans@wildlife.ca.gov, Mitsuko.Grube@wildlife.ca.gov, Steven.Rodriguez@wildlife.ca.gov, Vicki.Lake@wildlife.ca.gov, Matt.Wells@wildlife.ca.gov

Numerous stressors have contributed to the decline in condition and function of the San Francisco Bay/ Sacramento-San Joaquin Delta (SF Estuary). To contribute to reversing the impacts of these stressors, the California Department of Fish and Wildlife (CDFW) is implementing six statewide competitive grant programs to support multi-benefit ecosystem conservation projects and Delta science. As of July 2019, CDFW has awarded $210.4 million for 182 projects statewide, including $62.3 million for 49 projects in the SF Estuary. The Wetlands Restoration for Greenhouse Gas Reduction Program supports projects that restore or enhance natural ecosystems to reduce greenhouse gas emissions and provide ecological co-benefits. Air Resources Board's Cap-and-Trade Program funds this grant program as part of its overall greenhouse gas reduction strategy. In response to the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1), CDFW is implementing the Watershed Restoration Grant Program (statewide) and the Delta Water Quality and Ecosystem Restoration Grant Program. These grant programs provide funding for projects that contribute to the objectives of the California Water Action Plan, State Wildlife Action Plan, Delta Plan, Delta Science Plan and Science Action Agenda, and California EcoRestore, and the fulfillment of CDFW's Mission. In response to the California Drought, Water, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018 (Proposition 68), CDFW is implementing three statewide grant programs for projects that: improve a community's ability to adapt to the unavoidable impacts of climate change; improve and protect coastal and rural economies, agricultural viability, wildlife corridors, or habitat; develop future recreational opportunities; or enhance drought tolerance, landscape resilience, and water retention in accordance with statewide priorities. SF Estuary projects are eligible for funding from the Rivers and Streams Restoration Grant Program and Habitat Improvement Grant Program. For more information and to apply: www.wildlife.ca.gov/Explore/Organization/WRGB

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

Poster Topic: Habitat Restoration

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

Natalie Washburn[1], Steve Carroll[1], Don Brubaker[2]

[1]Ducks Unlimited, Inc.
[2]San Pablo Bay National Wildlife Refuge

nwashburn@ducks.org, scarroll@ducks.org, don_brubaker@fws.gov

Tidal marsh restoration in the San Francisco Estuary often occurs on diked baylands that have subsided several feet below sea level. When breached, they may take decades or, in the face of sea level rise, may never accumulate sufficient sediment to support tidal marsh habitat. In order to accelerate formation of habitat at one such restoration site in San Pablo Bay, the project is incorporating the beneficial use of dredged material. The Cullinan Ranch Restoration Project is a 1,500-acre tidal marsh restoration located on the San Pablo Bay National Wildlife Refuge (Refuge). In January 2015, 1,210 acres of the site was breached to the tides. The remaining 290 acres are being managed by the Refuge and Ducks Unlimited (DU) for beneficial use of dredge material. The goal is to expedite tidal marsh habitat by increasing ground elevation 6 feet through the import of 3 million cubic yards of dredged sediment. To date, the project has imported 840,000 cubic yards of sediment. The material has been imported and placed using different techniques: truck, mechanically by barge, and hydraulically by barge. Import by truck proved effective for small quantities moved over short distances. While this method allowed for exact placement within the project site, the site location made it impractical at a large scale. Mechanical placement from a barge was efficient in importing large quantities of sediment, but restricted spatially and necessitated the relocation of the material, which proved difficult and costly. Hydraulic placement has proven to be the most scalable, although this method requires the most specialized equipment, extensive site preparations, and substantial onsite water management. In 2019, DU expects to hydraulically import an additional 150,000 cubic yards of dredge sediment. Project success requires well-coordinated planning and partnership with dredgers, regulatory agencies, and conservation entities throughout the San Francisco Estuary.

Keywords: wetland restoration; subsidence; sediment; dredge material

Poster Topic: Habitat Restoration

Recycled Reefs Restore Native Oysters and Keep Defunct Crab Pots Out of Landfills

Makayla Counselman[1], Casey Harper[1]

[1]The Wild Oyster Project

makayla@wildoysters.org, casey@wildoysters.org

Our Project Blueprint supports the following goals: Blueprint Goal 1: Sustain and improve the Estuary's habitats and living resources. Blueprint Goal 2: Bolster the resilience of Estuary ecosystems, shorelines, and communities to climate change. Blueprint Goal 3: Improve water quality and increase the quantity of fresh water available to the estuary. After crab pots are refurbished and filled with oyster shell, volunteers of the Wild Oyster Project will deploy donated defunct crab pots at designated locations in the intertidal zone, located by GPS coordinates. Three crab pots will be placed in each of the following three sites: Islais Creek - 100' southwest of the fishing pier near 3rd Street Bridge Pier 96 Shoreline South shoreline of Heron's Head Park in Hunters Point Crab pots will be deployed parallel to the shoreline, at the 0' tide line or -1' tide line, depending on the site characteristics To avoid subsidence, crab pots will be placed on top of wooden pallets, which will degrade over time Two crab pots will be placed on top of one pallet, with one crab pot stacked on top of the lower crab pot Crab pots will be wired together to maintain relative configuration and deter movement/removal by people Wooden pallets and/or crab pots may need to be weighted (with rocks) to stay on the bottom Metal signs will be attached to the top of the highest crab pot with wire, reading "Native Oyster Garden, a project of The Wild Oyster Project" Crab pots are 36" diameter, Pallets are 48" x 40" Monitoring will be conducted twice every 3 months by students and citizen scientists. MONITORING/DATA COLLECTION GOALS Air temperature data (°C) Water temperature data (°C) Salinity level data (ppt) pH level data Oyster abundance/density data (per 10 cm2) Oyster size frequency data (millimeters) Species richness data

Keywords: Olympia oysters, native, estuary, bay, recycled shell, community engagement, monitoring

Poster Topic: Habitat Restoration – Aquatic Species

Understanding the Physical and Biological Processes that Influence Aquatic Habitat Quality for Delta Smelt and Other Imperiled Fish Populations: The Role of the Benthos 2017

Kelly Shrader[1], Francis Parchaso[1], Sarah Pearson[1], Janet Thompson[1]

[1]U.S. Geological Survey

kshrader@usgs.gov, parchaso@usgs.gov, spearson@usgs.gov, jthompso@usgs.gov

Filter feeding by the bivalve *Corbicula fluminea* has been shown to control phytoplankton population growth in the Sacramento River Delta and may be responsible for food limitations in pelagic species. Bivalve grazing can both limit primary production at phytoplankton source locations and its transfer of primary producers between habitats. Additionally, seasonal and interannual differences in freshwater flow result in seasonal and episodic changes in benthic community composition. The benthic community response – as measured by magnitude and duration of the change – to substantial rainfall in Water Year 2017 is unknown. Our objectives are to extend our knowledge of the ecological function of filter-feeding bivalves in the Delta ecosystem including: (1) understand how bivalve grazing rate could influence the loss of phytoplankton in the Delta through time, and (2) identify seasonal and spatial patterns in bivalve abundance and community structure following a substantial increase in freshwater to the system. The benthos was sampled throughout the Sacramento River Delta from Ryer Island through the Cache Slough Complex and the northern Deepwater Ship Channel in spring-fall 2017. *Corbicula* biomass, recruitment, and grazing rate were estimated at all 84 locations and served as indicators of habitat favorability and potential impact on restoration success. Benthic species were enumerated and identified to the lowest taxonomic level. Across regions, bivalve biomass and grazing rate fluctuated throughout the sampling period with lows usually in March and highs during summer. Bivalve recruitment peaked during summer then declined in October, yet the timing of summer peaks varied between regions. Benthic community total abundance was highest during summer in many regions. Increases in benthic community abundance were associated with higher representation of amphipods, while decreases in abundance were associated with higher representation of bivalves. At most regions, amphipods were dominant during summer while bivalves dominated in spring and fall.

Keywords: benthos, community, phytoplankton, grazing, biomass, recruitment, *Corbicula*, sloughs

Poster Topic: Habitat Restoration – Aquatic Species

Establishing a Pre-Restoration Benthic Invertebrate Community Baseline for the Tule Red Tidal Restoration Project

Isa Woo[1], Ryan Beshai[1], Alison Fisher[1], William Chan[1], Kristen Steed[1], Susan E. W. De La Cruz[1]

[1]U.S. Geological Survey, San Francisco Bay Field Station

iwoo@usgs.gov, rbeshai@usgs.gov, afisher@usgs.gov, wchan@usgs.gov, ksteed@usgs.gov, sdelacruz@usgs.gov

The Tule Red Tidal Restoration Project is among the first Delta restorations under the Fish Restoration Program Agreement (FRPA) with the goal of contributing to the recovery of native fish populations by increasing quality food resources and rearing habitat. Benthic invertebrate communities often provide valuable prey resources to native fishes. To determine a pre-restoration benthic invertebrate community baseline, USGS collected benthic cores from the Tule Red mudflat, the adjacent planned Roaring River breach area, and at a reference mudflat in Honker Bay during October 2018. Cores were collected over two spatial scales (dispersed transects with points ≥50m apart, dense transects with points 25m apart) such that potential post-restoration effects can be evaluated at broad and fine scales. Dense transects were located at the planned Tule Red breach and a similar site in Honker Bay. *Spionid polychaetes*, *oligochaetes*, and bivalves such as the overbite clam (*Potamocorbula amurensis*) were present at all sites, though we found considerable variation in community composition between sites. At Tule Red and Roaring River, *Spionid polychaetes* were the most common, followed by *P. amurensis* and other bivalves; *oligochaetes* and amphipod crustaceans were also common. Honker Bay, however, was characterized predominantly by nematodes, *Tanaid* crustaceans, *Spionid polychaetes* and *oligochaetes*. The Asian clam, *Corbicula fluminea* was present in the Roaring River and Honker Bay sites, but not at Tule Red. Overall, we found the greatest diversity in Honker Bay (15 taxa identified), followed by Roaring River (10 taxa identified) and the Tule Red mudflat (9 taxa identified). Additional benthic infauna samples (January and April 2019), bathymetry data, and stable isotopes samples are currently being analyzed. Our results will provide a baseline to assess post-restoration effects on the benthic community, and therefore on native fish, at Tule Red, and ultimately will help inform future restoration practices in the Delta.

Keywords: Benthic invertebrates, Restoration, Suisun Bay, Community

Poster Topic: Habitat Restoration – Aquatic Species

Understanding the Physical and Biological Processes that Influence Aquatic Habitat Quality for Delta Smelt and Other Imperiled Fish Populations: The Role of the Benthos 2018

Sarah Pearson[1], Kelly Shrader[1], Emily Zierdt Smith[1], Francis Parchaso[1], Janet Thompson[1]

[1]U.S. Geological Survey

spearson@usgs.gov, kshrader@usgs.gov, ezierdtsmith@usgs.gov, parchaso@usgs.gov, jthompso@usgs.gov

Declining phytoplankton biomass and the resulting stress on the food web has been suggested as one contributor to the decline of Delta Smelt and other fish species in the San Francisco Estuary (SFE) and the Sacramento-San Joaquin River Delta ecosystem. Filter feeding by the bivalves *Corbicula fluminea* and *Potamocorbula amurensis* has been shown to control phytoplankton population growth in the SFE and Delta and both may be partially responsible for the reduction in food for pelagic species. Our objectives were to extend our knowledge of the ecological function of filter-feeding bivalves in the Delta ecosystem including: (1) understand how bivalve grazing rate could influence the loss of phytoplankton in the Delta through time, and (2) identify seasonal and spatial patterns in bivalve abundance and community structure following a substantial increase in freshwater to the system. Seventy-one stations in seven designated geographical regions throughout the Sacramento-San Joaquin Delta, including the Cache Slough complex and Suisun Bay were sampled during spring-fall 2018. Stations were selected based on areas where the bivalves were likely to change distribution or biomass because of changing salinity, phytoplankton biomass, and/or phytoplankton composition. Species were enumerated and identified. Biomass estimates, and grazing rates were calculated. Overall, *C. fluminea* biomass and grazing rate was highest in spring and fall and in higher flowing, regions of sloughs. The sloughs had higher recruitment compared to other regions. *P. amurensis* and *Macoma petalum* were present throughout the Ryer Island region, but amphipods were the most abundant taxa, being the top ranked taxa in 4 of 7 regions.

Keywords: Benthos, Grazing rates, *Corbicula*, *Potamocorbula*

Poster Topic: Habitat Restoration – Aquatic Species

Understanding the Physical and Biological Processes that Influence Aquatic Habitat Quality for Delta Smelt and Other Imperiled Fish Populations: The Role of the Benthos 2016

Emily Zierdt Smith[1], Sarah Pearson[1], Francis Parchaso[1], Janet Thompson[1]

[1]U.S. Geological Survey

ezierdtsmith@usgs.gov, spearson@usgs.gov, parchaso@usgs.gov, jthompso@usgs.gov

Filter feeding by the bivalves *Corbicula fluminea* and *Potamocorbula amurensis* has been shown to control phytoplankton population growth rate in the Sacramento-San Joaquin Delta and may be responsible for food limitations in pelagic species. Bivalve grazing can limit both primary production at phytoplankton source locations and its effective transfer of primary producers between habitats. The Sacramento Delta was seasonally sampled to monitor changes in benthic community composition and bivalve dynamics. Our objectives are to extend our knowledge of the ecological function of filter-feeding bivalves in the Delta ecosystem including: (1) understand how bivalve grazing rate could influence the loss of phytoplankton in the Delta through time, and (2) identify seasonal and spatial patterns in benthic community abundance and composition during 2016 drought conditions. The Sacramento Delta was sampled from eastern Suisun Bay to the northern Deepwater Ship Channel and into San Joaquin River east of Webb Tract in spring-fall 2016. Stations were selected from the California Department of Water Resources-established Generalized Random Tessellation Stratified stations due to their proximity to ongoing studies. Bivalve biomass, recruitment, and grazing rate were estimated at all stations. Benthic species were enumerated and identified to the lowest taxonomic level. *C. fluminea* and *P. amurensis* biomass, recruitment, and grazing rate were higher in fall compared to spring. Total benthic community abundance was highest during fall in most regions. In regions west of the Confluence, the increase in abundance was associated with a higher representation of bivalves. However, in regions east of the Confluence, increases in abundance were associated with increases in amphipods or bivalves depending on the subregion. An increase in abundance in the Sacramento River was mostly attributed to an increase in amphipods. Comparatively, the increased abundance of benthic organisms in the lower San Joaquin River was associated with a higher number of bivalves.

Keywords: benthos, community, phytoplankton, grazing, biomass, *Corbicula*, *Potamocorbula*, drought

Poster Topic: Habitat Restoration – Aquatic Species

Restoration Success: Avian Richness and Abundance in Restored San Francisco Bay Tidal Marsh Habitat, Based on Citizen Scientist Point Count Surveys.

Daniel Edelstein[1]

[1]Consulting Avian Biologist

danieledelstein@att.net

This project documented avian richness and abundance at a restored tidal marsh adjacent to San Francisco Bay previously devoid of suitable habitat for waterfowl and shorebirds, based on Sonoma Land Trust initiated point count surveys. Restoration design added physiographic and vegetation features at the site to promote roosting, foraging, and nesting success. Eight annual point count surveys at 12 prescribed stations included data collection support from more than 40 citizen scientists under the direction of a consulting Avian Biologist. Survey dates/times occurred during high and low tides to ensure representative avian observations. Results from the 2016-2018 surveys yielded sightings of eight avian guilds among tidal marsh, tidal mud flat, upland levee, beach, rocky shoreline, open water, and tidal panne habitats. Shorebird family members represented 36 % of total avian species observed, followed by diving ducks, 17 %; dabbling ducks, 14 %; gulls, 11 %; raptors, 11 %; grebes, five %; rails, three %; and American Avocet/Black-necked Stilt, three %. Two years of survey data suggests that the restoration is a success with the site now providing: 1) essential "wayside" habitat for migrating and overwintering avian species; 2) increased nesting niches for several waterfowl species; 3) robust plant succession from hand plantings that are likely to soon attract additional common and rare nesting avian species (including listed species such as Ridgway's Rail and California Black Rail); and 4) the California Avian Database Center with valuable information to assist the planning and implementation of management actions at other nearby restoration projects.

Keywords: Habitat, Restoration, Sonoma, Waterfowl, Shorebirds, ducks, stilts, raptors

Poster Topic: Habitat Restoration - Avian

Restoring Tidal Marsh Transition Zones - Grasses for Rails?

Megan Elrod[1], Julian Wood[1], Nadav Nur[1], Leia Giambastiani[1], Josh Nuzzo[1], Donna Ball[2], David Thomson[3]

[1]Point Blue Conservation Science
[2]Save The Bay
[3]San Francisco Bay Bird Observatory

melrod@pointblue.org, jwood@pointblue.org, nnur@pointblue.org, lgiambastiani@pointblue.org, jnuzzo@pointblue.org, dball@savesfbay.org, dthomson@sfbbo.org

Successful tidal marsh restoration in San Francisco Bay has increased wildlife populations and improved ecosystem function, and the transition zone, or tidal marsh to upland ecotone, is now in the forefront as a critically important restoration component. However, there is a knowledge gap in how tidal marsh-dependent wildlife use and benefit from transition zones, even as much effort has been made in restoring these areas. Point Blue, in partnership with restoration practitioners in San Francisco Bay, initiated a study to quantify the benefits of restoring transition zones, and to develop restoration recommendations for habitat for the endangered California Ridgway's Rail (*Rallus obsoletus obsoletus*) and other tidal marsh dependent species. In the pilot study, data was collected at 16 marsh sites covering San Pablo, Central and South San Francisco Bay and included restored and non-restored areas, and naturally-sloped ecotones and levees. Findings from the pilot study included a positive response of tidal marsh birds to grass species cover and to the percent cover of dense vegetation within transition zones. Ridgway's Rails specifically showed a positive response to maximum vegetation height and transition zone width. The amount of grass cover, however, was positively correlated to transition zone width, ($r = +0.529$, $P < 0.001$), therefore these covariates require further investigation through experimental design. To address the need for an experimental study, Point Blue's STRAW Program (Students and Teachers Restoring a Watershed) is restoring transition zones to test specific features, including grass cover, which may improve benefits to rails and other tidal marsh birds. Continuing to test restoration design using the suite of transition zone specific monitoring protocols, this study will fine-tune recommendations to restoration practitioners looking to enhance tidal marsh habitat along the entire shoreline of San Francisco Bay.

Keywords: restoration, tidal marsh, Ridgway's Rail, transition zone, birds

Poster Topic: Habitat Restoration - Avian

If You Build it They Will Come: California Ridgway's Rail at North Creek Marsh Within the Eden Landing Ecological Reserve

Jeanne Hammond[1], Jen McBroom[1], John Krause[2]

[1]San Francisco Estuary Invasive Spartina Project and Olofson Environmental, Inc.
[2]California Department of Fish and Wildlife

jeanne@olofsonenvironmental.com, jen@olofsonenvironmental.com,
john.krause@wildlife.ca.gov

The Invasive Spartina Project (ISP) conducts annual surveys for secretive marsh birds at a subset of sites around the Bay. In 2019, ISP biologists detected four California Ridgway's rail at one of our habitat enhancement sites, North Creek Marsh. North Creek Marsh, a former salt pond, was restored to tidal action in 2006. This is the first time rails have been detected at the site since we first began conducting call count surveys in 2011. Other restoration sites around the Bay have had similar success in recent years. Sonoma Baylands was restored to tidal action in 1996, rails were first detected there in 2009, and 35 rails were detected at the site last year. Island Pond A21 was restored to tidal action in 2006 and rails were first detected there in 2015. North Creek Marsh is unique among these restoration sites because native *Spartina foliosa* was locally extirpated by the hybrid *Spartina* invasion and the site required the reintroduction of *S. foliosa* to become suitable for breeding rails. This past winter we completed the eighth planting season of the ISP program to rapidly enhance habitat for California Ridgway's rail (*Rallus o. obsoletus*) in tidal marshes affected by the invasion and subsequent removal of non-native *Spartina*. After removal of non-native *Spartina*, natural recruitment of some native species has been very successful (e.g., perennial pickleweed, *Salicornia pacifica*). However, two key components of rail habitat, marsh gumplant (*Grindelia stricta*) and native Pacific cordgrass (*Spartina foliosa*), did not recolonize and/or recruit into some sites as quickly. To encourage rapid habitat enhancement focusing on these two species, ISP and partners designed and installed plantings aimed at establishing dense, strategically-located patches of vegetation that would benefit nesting, foraging, and roosting rails, as well as provide high tide refuge.

Keywords: California Ridgway's rail, habitat restoration, *Spartina foliosa*

Poster Topic: Habitat Restoration - Avian

Canvasback Movement Patterns and Resource Selection in the San Francisco Bay Delta

Aliya McCarthy[1], Susan De La Cruz[1], Stacy Moskal[1], Mason Hill[1], Cliff Feldheim[2]

[1]U.S. Geological Survey, Western Ecological Research Center, San Francisco Bay Estuary Field Station, PO Box 158, Moffett Field, CA 94035-0158
[2]California Department of Water Resources, Suisun Marsh Program, 3500 Industrial Blvd. Sacramento, CA 95691

ammccarthy@usgs.gov, sdelacruz@usgs.gov, smoskal@usgs.gov, mhill@usgs.gov, Cliff.Feldheim@water.ca.gov

The San Francisco Bay Delta ecosystem is an integral wintering area for several waterfowl species, including canvasback (*Aythya valisineria*), which comprise 55% of diving ducks counted in the estuary. Little is known about diving duck seasonal movements and habitat use throughout the estuary, but this information is critical given on-going and projected habitat changes in the region. Our study is designed to evaluate diving duck use of Bay Delta habitats with the ultimate goal of identifying management regimes that may benefit these species. As part of this comprehensive study, we evaluated canvasback movement and resource selection during the winters of 2017, 2018, and 2019. We captured 63 adult canvasbacks in the Bay Delta using baited swim-in traps and fitted them with GPS-GSM tracking devices that provide high resolution location estimates. We used continuous-time stochastic Brownian bridge movement models to evaluate canvasback movements across winter and during spring migration. To examine resource selection, we calculated composite 95% and 50% kernel utilization distributions and key habitat associations were quantified and compared using the composite home ranges. We used logistic regression to model habitat covariate effects and estimate the parameters for exponential resource selection models. Initial results suggest that in 2018, individuals used a full spectrum of Bay and Delta habitats including shallow shoals, tidal marshes, managed marshes, and static deep-water ponds, and transitioned inland towards freshwater habitats during spring months. Whereas, in 2017 canvasback use of estuarine habitats was more limited and individuals moved inland to the Central Valley in early winter, potentially as a result of historic freshwater availability. Given cyclical drought conditions, planned tidal wetland restoration and diminishing freshwater flows to this region, information on diving duck ecology in the Bay-Delta can improve our understanding of how projected habitat changes may influence these species in the future.

Keywords: canvasback, estuary, GPS-GSM, habitat, movement, resource selection, San Francisco Bay

Poster Topic: Habitat Restoration - Avian

Waterbird Response to Physical Island Characteristics at Salt Pond SF2

Stacy M. Moskal[1], Susan E. W. De La Cruz[1], Laurie A. Hall[1], John Y. Takekawa[1], Lacy M. Smith[1], Cheryl Strong[2], Scott A. Shaffer[3]

[1]U.S. Geological Survey, Western Ecological Research Center, San Francisco Bay Estuary Field Station
[2]U.S. Fish and Wildlife Service
[3]San Jose State University

smoskal@usgs.gov, sdelacruz@usgs.gov, lhall@usgs.gov, jtakekawa@suisunrcd.org, lacymsmith@aggiemail.usu.edu, cheryl_strong@fws.gov, Scott.Shaffer@sjsu.edu

Thousands of migratory and wintering waterbirds in San Francisco Bay Estuary rely on habitat in former salt production ponds. In particular, shorebirds tend to use these ponds for roosting and additional foraging opportunities at high tide when adjacent mudflats are inundated. The South Bay Salt Pond Restoration Project plans to restore 50-90% of ponds to tidal marsh while maintaining waterbirds in a smaller footprint of managed ponds. Thus, in 2009-2010, the restoration project constructed 30 islands in Pond SF2 to increase the area of shallow foraging and roosting habitat. To assess the response of waterbirds, we examined avian abundance in relationship to physical characteristics and orientation of these newly created islands. We conducted weekly waterbird surveys from October to May 2010-2012 and used a Geographic Information System to measure island spatial characteristics, including island elevation and area as well as island distance to the highway, the adjacent mudflat, and the nearest levee. We modeled abundance of the most common guilds, small shorebirds and dabblers, in relationship to island features, including island connectivity, using generalized linear mixed models. Islands supported the greatest abundance of both guilds at high tide and in the morning compared to low tide and afternoon respectively. Islands closer to mudflats and farther from highways supported a greater abundance of dabbling ducks but not small shorebirds. Elevation, distance to levee, and island area did not affect either guild's abundance. Connectivity models indicated that waterbird abundance positively influenced conspecific abundance on adjacent islands within 100 m or less. Our research demonstrated that waterbirds use islands immediately post construction and identified several island characteristics that supported higher bird abundances. This information can help guide future island construction and restoration efforts aimed at optimizing managed pond habitat for waterbirds.

Keywords: Salt Ponds, SBSPRP, waterbirds, connectivity, islands

Poster Topic: Habitat Restoration - Avian

Migration Timing and Spatial Distribution of Phalaropes in South San Francisco Bay

Max Tarjan[1], Yiwei Wang[1], Rachel Tertes[2], John Krause[3]

[1]San Francisco Bay Bird Observatory
[2]US Fish and Wildlife Service
[3]California Department of Fish and Wildlife

mtarjan@sfbbo.org, ywang@sfbbo.org, rachel_tertes@fws.gov, john.krause@wildlife.ca.gov

The South Bay Salt Pond Restoration Project (SBSPRP) is restoring historic salt evaporation ponds to a mix of tidal marsh habitat and managed ponds to improve wildlife habitat, flood risk management, and public access in South San Francisco Bay. Sustaining baseline populations of wildlife requires evaluating wildlife response to the actions of this multi-decade restoration project. Over a decade of waterbird counts show that most waterbird species groups doubled or tripled in abundance by 2017 relative to SBSPRP baselines, which were established prior to implementation of project restoration and enhancement actions. However, phalarope counts have declined by 66% since years prior to restoration project activities. Less frequent summer surveys during phalarope migration may make current survey methods inadequate for capturing phalarope use of the SBSPRP area. Understanding apparent phalarope declines within the SBSPRP and how they relate to broader population trends will require targeted surveys during the peak phalarope season and/or evaluation of external datasets. We identified the timing of phalarope migration and characterized space use in South San Francisco Bay using monitoring data and publicly available phalarope sightings on the citizen science platform eBird. The datasets were complimentary, as each had unique limitations in geographic coverage due to focus and cost (SBSPRP monitoring) and public access restrictions (eBird). Red-necked and Wilson's phalaropes were the most commonly reported phalarope species in both datasets. Wilson's Phalarope were reported during one peak that clustered in late summer, whereas Red-necked Phalarope showed one peak in spring and were present for a more prolonged period in late summer to early fall. Both species showed similar preferences for select sites, suggesting that surveys could target specific areas. Targeted surveys would allow managers to assess the validity and causes of the apparent decline of phalaropes in a large-scale tidal marsh restoration project.

Keywords: phalarope, migration, restoration, citizen science, space use, waterbird

Poster Topic: Habitat Restoration - Avian

Title: Project Support for Restoration in the Delta: Providing Resources to Promote Coordination in Restoration, Planning and Implementation

Eva Bush[1], Karen Kafetz[1], Annika Keeley[1], Dylan Chapple[1], Madison Thomas[1]

[1]Delta Stewardship Council Science Program

eva.bush@deltacouncil.ca.gov, karen.kayfetz@deltacouncil.ca.gov, annika.keeley@deltacouncil.ca.gov, dylan.chapple@deltacouncil.ca.gov, madison.thomas@deltacouncil.ca.gov

A multitude of ecosystem restoration and multi-benefit projects are currently being planned and implemented in the San Francisco Estuary at a variety of scales, furthering the CCMP goals of improving habitats, increasing resilience and benefitting water quality. Some projects have the support and resources of large agencies while others are pressed for resources and encounter challenges complying with State and Federal regulations requiring adaptive management. The Delta Conservation Adaptive Management Strategy, published in spring of 2019 by the Interagency Adaptive Management Integration Team, contains a suite of actions meant to support the use of adaptive management by conservation projects. One of the actions is to convene a project support group, modeled after the Suisun Marsh Adaptive Management Advisory Team. The purpose of this action is to create a venue in which project proponents can receive feedback from relevant State and Federal agencies in an efficient manner that crosscuts individual agency missions. In this venue, project proponents have a chance to discuss the project with participating agencies to resolve any issues they may have, and receive advice on options they could explore at early stages in project development. Agencies may provide useful templates and checklists at this point, and point projects to relevant conceptual models, regional monitoring, and data management resources. This venue benefits both the project proponents in need of technical assistance and the regulatory agencies, who can coordinate in real time to efficiently and effectively promote the use of science-based adaptive management.

Keywords: restoration, adaptive management, conservation, permitting, outreach

Poster Topic: Habitat Restoration - Delta

Utilizing a Public-Private Partnership to Restore Native Fish Habitat in the Yolo Bypass: The Yolo Flyway Farms Restoration Project

Carl Jensen[1], Chris Campbell[2]

[1]ICF
[2]cbec ecoengineering

carl.jensen@icf.com, c.campbell@cbecoeng.com

In conjunction with the California Department of Water Resources (DWR), Reynier Fund, LLC, ICF, and cbec ecoengineering designed, permitted, and constructed a 278-acre tidal marsh restoration project in the Lower Yolo Bypass near the Cache Slough Complex to benefit native fish, including delta smelt (*Hypomesus transpacificus*) and winter- and spring-run salmonids. Yolo Flyway Farms represents the first project to be completed under a 2016 RFP released by DWR seeking complete 'turn key' tidal marsh restoration projects to partially fulfill mitigation obligations associated with the ongoing operation of the State Water Project, which delivers irrigation water to Central and Southern California. The design development and entitlement of each project is overseen by the multi-agency Fish Agency Strategy Team, or FAST, which is tasked with approving mitigation for the ongoing need. The Yolo Flyway project was designed to take advantage of the large areas of the site that were at an ideal intertidal elevation for tidal marsh restoration that would contribute to the food web of the Cache Slough Complex quickly and without large amounts of earthwork. Construction of the project began in August 2018 and was completed in September 2018. DWR, in conjunction with the California Department of Fish and Wildlife, will begin collecting monitoring data at the site in 2019.

Keywords: engineering, design, permitting, construction, tidal, marsh, restoration, mitigation, monitoring, intertidal

Poster Topic: Habitat Restoration - Delta

Assessing Terrestrial-Aquatic Connectivity and Adaptive Capacity of Delta Restoration Projects

Kaylee Griffith[1], Ron Melcer Jr.[1], Daniel Constable[1], Kate Anderson[1], Cory Copeland[2]

[1]Delta Stewardship Council, Ecosystem Restoration, Land Use, and Science Integration Unit
[2]Delta Stewardship Council, Performance Management Unit

Kaylee.Griffith@deltacouncil.ca.gov, Ronald.Melcer@deltacouncil.ca.gov, Daniel.Constable@deltacouncil.ca.gov, Kate.Anderson@deltacouncil.ca.gov, Cory.Copeland@deltacouncil.ca.gov

Nearly two centuries of modification of the California Bay-Delta estuary have severed connections between ecosystems, making the system and its human inhabitants vulnerable to environmental variability and climate extremes. Restoration efforts in the Legal Delta and Suisun Marsh have picked up in the last decade, but the majority of restoration projects omit core characteristics of true ecological restoration, and instead preserve the current status or mitigate for other projects' impacts. In particular, restoration projects in the region neglect linkages between terrestrial and aquatic systems- a 2017 synthesis by the Delta Stewardship Council found that over two thirds of restoration projects do not currently connect to tidal waters. Improving connections between ecosystem types within restoration projects will boost their bang-for-the buck: land-water connectivity and transition zones promote exchange of materials between food webs, serve as transit corridors and refuges for resident and transient species, bolster habitat heterogeneity, and provide opportunities for communities to adapt with climate change. For this analysis, we investigated whether Delta restoration areas (107,526 acres across 178 projects) had land-water connectivity pre-construction, how this connectivity will change with completed restoration (all Delta projects and a California EcoRestore subset), and whether levee configuration permits potential upland migration of restored vegetation. We used restoration planning information from EcoAtlas, validated restoration status with fine-scale vegetation maps (CDFW VegCAMP 2019), confirmed recent past hydrologic connectivity with global surface water imaging (European Commission's Joint Research Centre), and explored upland transgression potential with a levee dataset digitized in-house from new 2017 LiDAR imagery (USGS). We anticipate that results will inform future restoration planning with terrestrial-aquatic connectivity and climate impacts in mind. Projects that re-establish diverse natural communities and focus on restoring natural processes are multi-benefit: they are self-sustaining, provide critical ecosystem services to people, and promote long term resilience to future perturbations.

Keywords: Delta, Suisun Marsh, restoration, connectivity, vegetation, resilience, adaptive capacity, planning

Poster Topic: Habitat Restoration - Delta

Delta Conservancy Proposition 1 Projects and Connections

Aaron N.K. Haiman[1], Brian N. Keegan[1], Thomas Jabusch[1], Laura B. Jensen[1]

[1]Sacramento-San Joaquin Delta Conservancy

aaron.haiman@deltaconservancy.ca.gov, brian.keegan@deltaconservancy.ca.gov, thomas.jabusch@deltaconservancy.ca.gov, laura.jensen@deltaconservancy.ca.gov

The Sacramento-San Joaquin Delta Conservancy (Conservancy) is a lead state agency in the implementation of ecosystem restoration in the Delta. The Conservancy works collaboratively and in coordination with local communities leading efforts to protect, enhance, and restore the Delta's economy, agriculture and working landscapes, and environment for the benefit of the Delta region, its local communities, and the citizens of California. In 2014, voters approved the Water Quality, Supply, and Infrastructure Improvement Act (Prop 1). Prop 1 identifies $50 million for the Conservancy "for competitive grants for multibenefit ecosystem and watershed protection and restoration projects in accordance with statewide priorities" (Water Quality, Supply, and Infrastructure Improvement Act of 2014: California Water Code: Sec 79730 and 79731). The Conservancy's Prop 1 Grant Program (Grant Program) has three priorities: ecosystem protection, restoration and enhancement; water quality; and water-related agricultural sustainability. These priorities closely align with Estuary Blueprint Goal 1: Sustain and improve the Estuary's habitats and living resources; Goal 2: Bolster the resilience of Estuary ecosystems, shorelines, and communities to climate change; and Goal 3: Improve water quality and increase the quantity of fresh water available to the Estuary. To advance the Grant Program's three priorities, the Conservancy funds projects that are complex, requiring intersections across diverse groups of partners, stakeholders, and experts. To date, the Conservancy has awarded four cycles of grants, and this poster reviews the projects that have been awarded and the diversity of organizations that have come together to plan and execute them. It also highlights the intersections between restoration, agriculture, government, and resource management organizations that occur in the planning and execution of these projects.

Keywords: Proposition 1, Restoration, Water Quality, Sustainable Agriculture, Grant Program

Poster Topic: Habitat Restoration - Delta

Living Shorelines at Giant Marsh: Early Lessons from Eelgrass Restoration

Margot Buchbinder[1], Melissa Patten[1], Katharyn Boyer[1]

[1]Estuary & Ocean Science Center, San Francisco State University

mbuchbin@sfsu.edu, mvpatten@sfsu.edu, katboyer@sfsu.edu

Living shoreline projects seek to create biologically rich and diverse subtidal and low intertidal habitats that restore ecological function while protecting shorelines. The Giant Marsh living shorelines project on the Richmond shoreline of San Francisco Bay (Point Pinole Regional Park) is a multi-partner collaboration building on lessons learned from a previous living shoreline project sited across the bay in San Rafael. Here we focus on the eelgrass portion of the Giant Marsh project, which incorporates an experimental design in which eelgrass (*Zostera marina*) has been planted alone and in combination with native oyster substrate (reef balls topped with Pacific shell bags). The experiment addresses whether the density of plantings affects success of eelgrass establishment and expansion, a question that has not been tested in San Francisco Bay. Additionally, the project tests whether oyster reef presence, which was shown to result in flow attenuation of up to 30% at the San Rafael project, affects the success of restoration plantings, and at what distance from the reef this success can be achieved. Oyster reefs were installed in April 2019, and eelgrass plantings were installed in May and June 2019, with quarterly monitoring of plantings for eelgrass establishment and density first occurring in August 2019. Early results show the influence of planting density and oyster reef presence on eelgrass establishment success, and over time we will evaluate effects on other important functions and services, including fish and invertebrate habitat, ocean acidification, and carbon storage. Results of these experimental manipulations will help to guide eelgrass restoration methodologies in future living shorelines projects across San Francisco Bay.

Keywords: living shorelines, habitat restoration, eelgrass, oyster, subtidal, planting density

Poster Topic: Habitat Restoration - Vegetation

Mix or Match? Multiple Sources of Eelgrass in Restoration May Hedge Bets in Highly Variable San Francisco Bay

Melissa Patten[1], Margot Buchbinder[1], Keith Merkel[2], Katharyn Boyer[1]

[1]San Francisco State University
[2]Merkel & Associates

mvpatten@gmail.com, mvbuchbin@sfsu.edu, KMerkel@merkelinc.com, katboyer@sfsu.edu

Eelgrass (*Zostera marina*) is valued in temperate estuaries throughout the world for services including stabilizing sediment and providing habitat for invertebrates, fishes, and birds. In San Francisco Bay, its leaves provide spawning surfaces for Pacific herring and hiding places for juvenile Dungeness crabs. Eelgrass beds have been damaged in the bay due to fill, boating activity, and pollutants, including oil spills. We have been conducting experiments to determine how best to restore eelgrass, most recently to enhance habitat for herring, which were injured in the Cosco Busan Oil spill. Restoration efforts beginning in 2014 were designed to include experimental tests of donor source, replicated across sites and years. Following site selection using a habitat suitability model, we use small "test plots" to further test site suitability, then expand plantings into multiple 25x75 meter half-acre plots in which rows of transplants differ by donor (one of three natural eelgrass beds where the plants were collected), or contain a mix of all donor sources. Preliminary results of annual monitoring show strong effects of both donor source and year. At a restoration site near Sausalito, plants from the closest natural bed have resulted in the greatest spatial coverage in some years. However, in other years, another source from across the bay is resulting in the greatest coverage, suggesting that conditions in a particular year (e.g., water temperature and salinity) matter to which donor establishes best. Interestingly, the mixture of sources is proving best at hedging bets, as it always contains the source that is most successful in a given year. In addition to spatial metrics, we are evaluating whether source and year interact to influence other characteristics, including densities, flowering rates, and invertebrate use. These data will inform future recommendations on whether to mix or match donors with site conditions in eelgrass restoration.

Keywords: eelgrass, *zostera marina*, habitat restoration, donor source,

Poster Topic: Habitat Restoration - Vegetation

Scaling Volunteer Opportunities: Mobile Nursery Operations and Corporate Partnerships

Kenneth Rangel[1]

[1]Save The Bay (San Francisco)

krangel@savesfbay.org

Save The Bays Habitat Restoration Team grows an average of 45,000 native plants annually to support restoration of the Upland-Marsh Transition Zone, a vital wetland ecotone that provides high tide refugia for wetland dependent species, some of which are threatened or endangered. Last year, Save The Bay's restoration program engaged 6,000 volunteers to support this work through transplanting, harvesting, and installing 45,000 seedlings and rhizomes at our restoration sites. Volunteer programs are typically hosted at Save The Bay's nurseries or restoration sites spread geographically across the Bay Area. In 2018, we developed a model for implementing large scale, off-site nursery volunteer programs at corporate campuses as part of a coordinated development strategy. We held two off-site corporate nursery programs in the summer of 2018, at the campuses of Autodesk and IBM, where we transplanted a combined total of 14,701 seedlings (roughly one third of our annual transplanting workload). We share our strategies for adapting our typical Habitat Restoration Program to facilitate the work of larger groups of volunteers at offsite corporate campus locations. We demonstrate how this allows us to engage larger corporate and community groups in Save The Bay's mission while simultaneously accomplishing organizational fundraising, outreach, and restoration goals.

Keywords: restoration, nursery, propagation, partnership, volunteer

Poster Topic: Habitat Restoration - Vegetation

Bird Nests as Botanical Time Capsules for Lost Habitat

Alex Rinkert[1], Justen Whittall[2]

[1]San Francisco Bay Bird Observatory
[2]Department of Biology, Santa Clara University

arinkert@sfbbo.org, jwhittall@scu.edu

Transitional habitat between the tidal marsh and adjacent uplands of the San Francisco Bay estuary is important to many threatened species. This habitat is above the normal high tide line and is only rarely inundated by saltwater during annual extreme tidal events. Unfortunately, all transitional habitat in this estuary has been lost or severely modified by drastic changes in land use. Few herbarium specimens were collected in this habitat before degradation and only one habitat description exists from the early 1900's, limiting the effectiveness of ongoing restoration efforts. Fortunately, bird nests were collected in transitional habitat by early naturalists which may serve as botanical time capsules. By focusing on birds restricted to nesting in transitional habitat in the estuary, we aim to reconstruct some of the plant species from this lost habitat. Morphological and anatomical analysis of nest materials does not provide the species-level detail we seek in reconstructing transitional habitat. Instead, we used a molecular approach by extracting DNA, then amplifying and sequencing the nrITS region from two nests (contemporary Savannah Sparrow and 10 year-old Song Sparrow nest). After comparing sequences to those in Genbank, we identified three plant species from the two nests (*Cardamine hirsuta*, *Festuca microstachys, Elymus triticoides*). Future studies utilizing additional contemporary and historical bird nests will inform ongoing restoration efforts which rely on knowing the plants in transitional habitat surrounding the San Francisco Bay over the past 100 years.

Keywords: bird nest, restoration, transitional habitat, Song Sparrow, Savannah Sparrow, nrITS

Poster Topic: Habitat Restoration - Vegetation

Factors Affecting Endangered Suaeda californica Establishment and Use in High Tide Refuge in San Francisco Bay

Kelly Santos[1], Melissa Patten[1], Peter Baye[2], Katharyn Boyer[1]

[1]Estuary & Ocean Science Center, San Francisco State University
[2]Annapolis Field Station, Annapolis, CA

ksantos7@mail.sfsu.edu, mvpatten@sfsu.edu, botanybaye@gmail.com, katboyer@sfsu.edu

Suaeda californica (California sea-blite) is a federally endangered, salt-tolerant, succulent coastal wetland shrub that occurs in a narrow high tide zone along sandy salt marsh edges or estuarine beaches. The original native San Francisco Estuary (SFE) population became completely extirpated around 1960. Plant material from Morro Bay was used to propagate and reintroduce juvenile *S. californica* to San Francisco Bay in 1999, and roughly 30 total plants have survived until now in three locations. As these low numbers hardly represent a restored population of *S. californica*, and the plants have not successfully self-recruited from seed, research is needed to understand the best methods to restore *S. californica* populations. The objectives of this project are to 1) determine the effects of abiotic conditions, including freshwater availability and organic matter, on the germination and growth of *S. californica*; and 2) evaluate the efficacy of "arbors" (various configurations of wooden branches as support) to enhance height growth of *S. californica*, which might enhance high tide refuge for endangered animals such as the Ridgway's rail (*Rallus obsoletus*) and the salt marsh harvest mouse (*Reithrodontomys raviventris*). Preliminary results show that *S. californica* seeds have a higher germination rate when exposed to fresher water conditions and that experimental arbors do increase the height and size of plants in an SFE salt marsh. Understanding factors that promote *S. californica* reproduction, germination, and growth will aid future larger scale reintroduction efforts for this endangered plant while capitalizing on its potential to provide high tide cover for endangered and other wildlife in the face of sea level rise.

Keywords: Endangered species, rare plants, tidal marsh restoration, high tide refuge

Poster Topic: Habitat Restoration - Vegetation

Beyond Containers: Scaling Up Native Plant Species Propagation Methods for Large Acreage Wetland Restoration Projects

Rebecca Wynd[1], Jessie Olson[1], Donna Ball[1], Peter Baye[2]

[1]Save The Bay
[2]Coastal Ecologist, PhD

rwynd@savesfbay.org, jolson@savesfbay.org, dball@savesfbay.org, botanybaye@gmail.com

Around San Francisco Bay, project sites nearing 18,000 acres of wetland and tidal marsh have been acquired and identified for restoration. The design of many of these projects include large transition zone/ecotone habitats, a habitat type fundamental in protecting against sea level rise, providing wildlife refugia, and increasing biodiversity. Building upon novel propagation methods successfully undertaken at the Oro Loma Horizontal Levee Demonstration project in 2015, Save The Bay is seeking to scale-up and apply these techniques to larger acreage transition zone project sites. Save The Bay has historically grown the majority of plants in our nursery facilities using containers, which limits the size of projects we are able to complete due to cost, nursery capacity, and labor. The Oro Loma project results demonstrated the benefits of large-scale onsite propagation, the success in using rhizomatous native species in revegetation, and the advantage of including a native, annual seed mix as a temporary cover crop. We are applying lessons learned from this project to scale up propagation methods to vegetate several new projects, including a 44 acre seasonal wetland and alkali wet meadow project in partnership with the Coastal Conservancy in Bel Marin Keys, a 25 acre transition zone project as part of the South Bay Salt Pond Restoration Project, and a 3 acre transition zone project at Bair Island within the Don Edwards National Wildlife Refuge. After an initial year of data collection on the annual seed mix at Bair, two years experimenting with an "in-ground" farm nursery at Bel Marin Keys, and one year growing rhizomatous species in raised beds at the South Bay Salt Pond Restoration site, we share our successes and challenges from these projects, in order to aid other practitioners in developing informed methods for vegetating large project sites while minimizing cost and labor.

Keywords: habitat, restoration, native plants, propagation, revegetation, transition zone, plant community

Poster Topic: Habitat Restoration - Vegetation

Geographical Distribution and Patterns of Spread for Marine and Estuarine Non-Indigenous Species in San Francisco Bay

Karen Bigham[1]

[1]California Department of Fish and Wildlife, Marine Invasive Species Program

karen.bigham@wildlife.ca.gov

The Marine Invasive Species Program (MISP) is responsible for analysis of shipping vectors responsible for the introduction of non-indigenous species (NIS) into California's coastal waters. MISP has collaborated with the Smithsonian Environmental Research Center (SERC) and Molecular Ecology Laboratory at Moss Landing Marine Labs (MLML) to undertake an extensive program to analyze spatial and temporal patterns of NIS invasions in marine and estuarine waters of California. The monitoring program included statistically robust field sampling, DNA-assisted taxonomic analyses, and data analysis. The surveys primarily focused on 10 estuaries or bays and high-salinity waters along the California open coast. Three communities were surveyed: hard substrate, soft-sediment, and plankton. A combination of traditional morphologically-based taxonomy and molecular detection methods were used to identify the organisms collected. For each morphological voucher, corresponding molecular vouchers were also collected to verify species-level identity and build the DNA library. In this poster, we present Phase II results from surveys of four estuaries (Humboldt Bay, Marina del Ray, Port Hueneme, and San Francisco Bay), a culmination of a 5-year sampling program. We will present analyses of geographical distribution and patterns of spread for marine and estuarine NIS in San Francisco Bay; the mechanism(s) of introduction and spread; and changes in the patterns (rate, spread, prevalence, richness) of NIS in response to ballast water management strategies.

Keywords: Invasive Species, marine, San Francisco, DNA, species richness, spread

Poster Topic: Invasive Species

Vessel Patterns in California

Chris Scianni[1], Lina Ceballos-Osuna[1], Nicole Dobroski[1], Maurya Falkner[1], Jonathan Thompson[1], Raya Nedelcheva[1]

[1]California State Lands Commission

chris.scianni@slc.ca.gov, lina.ceballos@slc.ca.gov, nicole.dobroski@slc.ca.gov, maurya.flakner@slc.ca.gov, jonathan.thompson@slc.ca.gov, raya.nedelcheva@slc.ca.gov

The State Lands Commission's (Commission) regulates commercial vessel arrivals at California ports to prevent the introduction of nonindigenous species (NIS). The Commission collects ballast water management and hull husbandry data from vessel-submitted reporting forms. The analysis of these data is a powerful tool to assess potential risk of NIS introductions via ballast water discharge and biofouling. In addition, the Commission uses this information to continuously develop new management strategies to improve the protection of California waters. This poster will present an overview of the patterns observed between July 2016 and June 2018 regarding vessel arrivals, ballast water discharges, and compliance rates with an emphasis on San Francisco Bay and other Northern California Ports.

Keywords: nonindigenous species, NIS, biofouling, ballast water, discharge

Poster Topic: Invasive Species

Floods, Droughts, and Blobs: Environmental Influences on Estuarine Community Composition and Introduced Species Success

Andrew Chang[1], Gail Ashton[1], Christopher Brown[1], Lina Ceballos[1], Jeffrey Crooks[1], Stephen Foss[2], Stacey Havard[1], Natasha Hitchcock[1], Erica Keppel[1], Kristen Larson[1], Linda McCann[1], Michelle Marraffini[1], Katherine Newcomer[1], Michele Repetto[1], Sharon Shiba[2], Brian Steves[1], Brianna Tracy[1], Gregory Ruiz[1]

[1]Smithsonian Environmental Research Center
[2]California Dept Fish and Wildlife

ChangAL@si.edu, ashtong@si.edu, cwbrown@csum.edu, ceballosl@si.edu, jcrooks@trnerr.org, Steve.Foss@wildlife.ca.gov, havards@si.edu, hitchcockn@si.edu, keppele@si.edu, larsonk@si.edu, mccannl@si.edu, michelle.marraffini@pg.canterbury.ac.nz, newcomerk@si.edu, michele.repetto@temple.edu, sharon.shiba@wildlife.ca.gov, stevesb@si.edu, tracyb@si.edu, ruizg@si.edu

Invasions by non-native species are well-known drivers of significant ecological change worldwide. Yet ecological communities are also strongly controlled by environmental conditions. Thus despite considerable available information on marine invasions in the San Francisco Bay region, it remains challenging to detect new invasions and estimate actual changes in invasion patterns, such as rate and spread. These data are key to understanding invasion processes and informing management and policy aimed at prevention of new invasions and responses to existing invasions. How do invasion patterns in the San Francisco Bay change over time, and how are they related to environmental changes? We conducted repeated, standardized surveys of fouling communities throughout the San Francisco Estuary over a twenty-year period spanning a wide range of environmental conditions, including two major droughts, several wetter winters, and a major marine heat wave. Non-native species were prevalent throughout the estuary, but achieved greater dominance following dry winters. Community composition at any given site during the summer (May to October) was predicted by environmental conditions, especially the previous winter's precipitation (linked to salinity levels) and mean temperatures. Rarefaction analyses and richness estimators indicate that the number of species detected varied both as a function of the number of sites sampled in a given year and with environmental conditions, suggesting that standardized sampling across a broad range of conditions over time is needed. For years in which at least ten were sampled, an asymptote in estimated richness was reached, indicating statistically sufficient sampling to estimate the true richness of the community. In addition, several southern species were detected during a recent marine heat wave, suggesting a possible role of shifting conditions in facilitating potential new invasions. This large set of data allows us to better understand the influence of physical characteristics on invasion patterns in the San Francisco Estuary.

Keywords: invasions, salinity, temperature, diversity, climate change, community assembly

Poster Topic: Invasive Species

Nutria in the Delta

Aaron Haiman[1], Valerie Cook-Fletcher[2]

[1]Sacramento-San Joaquin Delta Conservancy
[2]California Department of Fish and Wildlife

Aaron.Haiman@deltaconservancy.ca.gov, Valerie.Cook-Fletcher@wildlife.ca.gov

Nutria (*Myocastor coypus*) is a highly invasive, rapidly reproducing, rodent native to South America. When introduced populations become established, nutria can dramatically alter habitats by consuming wetland vegetation and converting wetlands into open water. They also burrow and cause extensive damage to levees and other infrastructure. In March 2017, a pregnant nutria was discovered in a managed wetland in Merced County. Over the next year, additional nutria began to be detected in the Merced and San Joaquin River watersheds. These detections led to an emergency response effort to survey for and eradicate the species from the State. The California Departments of Fish and Wildlife (CDFW) and Food and Agriculture (CDFA) have been the primary agencies involved in this effort, with early funding coming from the Sacramento-San Joaquin Delta Conservancy (Delta Conservancy), Wildlife Conservation Board, and U.S. Fish and Wildlife Service. Nutria have now been confirmed in over 150 sites, with over 630 nutria removed, and though the geographic extent of the nutria population has been primarily in the central area of the San Joaquin Valley, a concerning spread that has been documented is the intrusion of nutria into the legal Delta. Following the establishment of a dedicated eradication program and an additional funding support from the Delta Conservancy, CDFW is vastly expanding their efforts to detect and remove nutria from throughout the area of infestation. The release and tracking of Judas nutria (sterilized, satellite-GPS-telemetered nutria) is expected to be a critical component of these efforts, particularly in seeking out previously undetected populations and dispersing nutria within the Delta. This poster details the nutria infestation in the Delta, explores some of the consequences for the Delta ecosystem and infrastructure should nutria go unchecked, and explains the efforts underway to eradicate the population, particularly focusing on the Judas nutria project.

Keywords: nutria, invasive species

Poster Topic: Invasive Species

Delta Conservancy: A Partner for Invasive Species Control and Ecosystem Restoration in the Delta

Thomas Jabusch[1], Aaron Haiman[1], Laura Jensen[1]

[1]Sacramento-San Joaquin Delta Conservancy

thomas.jabusch@deltaconservancy.ca.gov, aaron.haiman@deltaconservancy.ca.gov, laura.jensen@deltaconservancy.ca.gov

The Delta is among the world's estuaries most invaded by nonnative species: at least 185 nonnative species are currently present and new species will likely arrive. Although many nonnative species will likely remain in the Delta, harmful ecological, economic, and human health impacts can be minimized by preventing new introductions and controlling existing ones. The Sacramento-San Joaquin Delta Conservancy's (Conservancy) 2017-2022 Strategic Plan includes an objective to continue implementing an invasive species control program and other on-the-ground projects to protect, restore, or enhance Delta habitat. The Conservancy is advancing this objective in three ways: by catalyzing interagency collaboration, by securing funding to spur removal efforts, and by granting bond funds to related projects. There is no singular lead entity for managing invasive species in the Delta, and therefore agency coordination is critical. To serve this need, the Conservancy has assumed a leading role in the Delta Interagency Invasive Species Coordination (DIISC) Team, which provides a forum for agency collaboration. A second key aspect of mitigating the impacts of invasive species is securing funding and collaborating with partners that provide local stewardship for control activities and restoration projects. With California Department of Water Resources funding, the Conservancy contracted with the Solano Resources Conservation District and Sonoma Ecology Center to pilot Arundo control and habitat restoration in the Cache Slough Complex. The third component of managing invasive species is the availability of funding and resources when they are needed, where they are needed. The Delta Conservancy's Proposition 1 Ecosystem Restoration and Water Quality Grant Program (Prop 1 program) provides funding for the study, control, or elimination of Nutria, nonnative Phragmites, and other invasive species. We describe 1) recent activities of the DIISC Team, 2) the Arundo Control and Restoration Program, and 3) relevant projects funded by the Conservancy's Prop 1 program.

Keywords: alien, eradication, communication, revegetation, native, chemical, biological, integrated, local stewardship

Poster Topic: Invasive Species

Effects of Climate Change on Eelgrass (Zostera marina) Herbivory by an Invasive Grazer in San Francisco Bay

Christian Tettelbach[1]

[1]San Francisco State University

ctettelbach@mail.sfsu.edu

Eelgrass (*Zostera marina*), a seagrass native to San Francisco Bay, is an integral component of the estuarine ecosystem. However, despite the abundance of ecosystem services offered by these plants, their habitat continues to be threatened by human induced stressors. One such stressor is the invasive amphipod *Ampithoe valida*, which has the potential to negatively impact eelgrass growth and physiological condition through direct herbivory. This represents a significant behavioral diversion from *Ampithoe* across their native range, where individuals exclusively consume eelgrass-associated epiphytes and macroalgae. While this eelgrass-mesograzer interaction has previously been studied in San Francisco Bay, it is unclear how the relationship will vary under climate change conditions. In order to assess the future impact of *Ampithoe* herbivory, I will conduct a mesocosm experiment to examine the effects of ocean acidification, increased temperature, and *Ampithoe* on eelgrass. During the experiment eelgrass growth and mortality will be monitored, in addition to physiological characteristics such as carbon, nitrogen, phenolic content, and fiber content. A subsequent feeding assay will seek to highlight any changes in herbivory rates not quantified in the mesocosm experiment. While the impact of *Ampithoe* on San Francisco Bay eelgrass is noticeable today, it has the potential to escalate under ocean acidification and warming scenarios. Understanding the combined effects of pH and temperature on eelgrass and *Ampithoe* can help us to better inform management and conserve eelgrass habitat in the context of climate change.

Keywords: Eelgrass, Climate Change, Ocean Acidification, Increased Temperature, Invasive Species, Herbivory

Poster Topic: Invasive Species

Cultivating Adult Environmental Learning: Place-Based Learning at Lake Merritt

Carli Baker[1]

[1]Western Governors University

cbak161@wgu.edu

Humanity is quickly approaching a tipping point that will determine the course of our natural world for generations to come. As the National Environmental Education Foundation states, “the scale and pace of change demands systems to provide citizens –young and old– with the information, skills, and tools they need to navigate a far more uncertain world...everyone must understand and experience that they can be part of the solution” (NEEF, 2015, p.10). Many individuals and organization view environmental literacy as a primary method of providing individuals with the information and experiences needed to tackle our current environmental crises. Environmental literacy is more than just knowledge of environmental phenomena, it encompasses the skills needed to address environmental problems, feelings about the environment and our place in our environment, our relationships with the natural world, and the environmentally-conscious behaviors we exhibit. However, to date, most environmental literacy initiatives have been aimed at children, leaving a large portion of our community without ample resources to develop environmental literacy in their adult lives. In order to address this need, a pilot environmental literacy field trip program has been organized by environmental educator Carli Baker as part of a master's capstone in Curriculum and Instruction. This 8-hour instructional unit aims to increase personal connections to our local environment through immersive activities at Lake Merritt that utilize popular environmental education instructional techniques, modified for an adult audience. Through developing relationships to the natural world and introducing participants to the unique ecology of Oakland's tidal lagoon, this study aims to increase adult environmental literacy and provide a blueprint for future educational endeavors aimed at budding adult environmentalists. This pilot will be completed in August 2019, and the initial results of the research study will be available by September 2019.

Keywords: environmental education, citizen science, adult education, environmental literacy, place-based learning

Poster Topic: Public Education, Outreach, and Access

Explore Alameda County Watersheds

Cynthia Butler[1], Janet Sowers[2], Sharon Gosselin[3], Carla Schultheis[4]

[1]Alameda County Resource Conservation District
[2]Fugro USA Land, Inc.
[3]Alameda County Flood Control and Water Conservation District
[4]San Francisco Public Utilities Commission

cynthia.cleanwater@gmail.com, j.sowers@fugro.com, sharon@acpwa.org, Cschultheis@sfwater.org

The Alameda County Watershed Map is a project of the Alameda County Flood Control and Water Conservation District, in collaboration with the San Francisco Public Utilities Commission, Fugro Consultants, and the Alameda County Resource Conservation District, and is an interactive, online map of every watershed in Alameda County that lets professionals, educators and outdoor enthusiasts explore and learn more by downloading KMZ watershed map files to your personal Google Earth Pro. These interactive maps let you compare the historical and present-day watershed features, zoom in on creeks and follow them to the Bay, and learn more about restoration projects and other features and points of interest. In addition to the Google Earth watershed map, you can use the ACFC&WD Explore Watersheds website to learn more about the hydrology, geology, and wildlife found in our local watersheds. From Berkeley to Fremont to Livermore, the online map has interactive, clickable watersheds with a quick overview and printable maps. "Learn More" pages for each watershed include an overview of the watershed, features, creeks and waterbodies, flora, fauna, hydrology and geology, subwatersheds, restoration efforts, recreation opportunities, ways to get involved and more.

Keywords: Alameda County, Watersheds, Education, Map, Google Earth, Explore

Poster Topic: Public Education, Outreach, and Access

The State of Bay-Delta Science: An Ongoing Effort to Synthesize and Communicate Our Knowledge of the Bay-Delta System

Maggie Christman[1], Sam Bashevkin[1], Kate Melanson[1]

[1]Delta Science Program, Delta Stewardship Council

maggie.christman@deltacouncil.ca.gov, sam.bashevkin@deltacouncil.ca.gov, kate.melanson@deltacouncil.ca.gov

Synthesizing our ever-evolving understanding of the Bay-Delta system and communicating the complex results to policy- and decision-makers are critical elements of effective management of the Bay-Delta. One way to bridge the communication gap is by utilizing a strategy that allows for communication among the diverse set of audiences that comprise the Bay-Delta community of stakeholders, including scientists, policymakers, managers, regulators, the governor, the legislature, and the public. The State of Bay-Delta Science (SBDS) is a synthesis and communication effort intended to inform science and policy audiences about the state of science in the Bay-Delta system. As a key element in the overall Delta Science Strategy, which also includes the Delta Science Plan and Science Action Agenda, the specific goals of SBDS are to synthesize the state of science conducted on topics of high management concern, communicate information appropriately and effectively to various Delta stakeholders, and foster a deeper connection between science conducted in the Delta and policy or management decisions. The first two editions of SBDS were produced in 2008 and 2016 and featured topical papers ranging from contaminants in the Delta to levee stability, and from Delta food webs to recent discoveries about salmon migration. Moving forward, future editions of SBDS will be released more frequently (approximately every 2 years), feature articles synthesizing information concerning a central theme, and focus on more effectively communicating to the diverse set of stakeholders that make up the Delta community. This poster will provide an opportunity for interaction and feedback on potential future topics, themes, and communication venues to explore through SBDS.

Keywords: Delta, synthesis, science, communication, bay, decision-making, estuary, management, outreach

Poster Topic: Public Education, Outreach, and Access

SFEWS: Open by Design

Lauren Muscatine[1]

[1]University of California, Davis

ldmuscatine@ucdavis.edu

Once your paper has been accepted by an academic journal, how do you make the data underlying your research available? If you have not already adopted data management practices to support current mandates (e.g., Plan S, AB 1755) and make your data open and available, consider that affiliated universities and journal publishers have services that can support this effort. Through its association with the California Digital Library's eScholarship Publishing group, the academic journal San Francisco Estuary and Watershed Science is not only designed to deliver open-access research through its quarterly publication, but also to provide researchers access to a general-purpose, curated data repository that makes the data underlying these scientific publications discoverable, freely reusable, citable, and integrated with that research. SFEWS's open access publishing platform is boosted by underlying open data repository services, now through DASH and soon through Dryad, that serve to increase discoverability, innovation, and open science collaborations. These data services optimize your data deposit for FAIR-ness, making your data Findable, Accessible, Interoperable and Reusable. By using these services, your data is associated with your ORCiD ID, and receives a permanent identifier (DOI), a formatted citation, and statistics on views and downloads. Put simply, SFEWS is and will always be, an academic journal that is open by design.

Keywords: open access, open data practices, FAIR, data sharing, AB1755, journals

Poster Topic: Public Education, Outreach, and Access

Engaging and Empowering Stewards of the Future

GianCarlo Onorati[1]

[1]Save The Bay

gonorati@savesfbay.org

Save The Bay mobilizes 5,000 Bay Area residents each year to protect and restore the San Francisco Bay for future generations both as advocates in their community and volunteers on the shoreline. Through multiple offerings and program customization, Save The Bay ensures that students and community members of diverse backgrounds, beliefs, identities, and abilities have access to our programs. While we strive to increase access to all parts of our Habitat Restoration Program, the focus and impact of increasing access is most notable in our educational field trips. In the 2018-19 school year, Save The Bay engaged over 2,400 students - half of which come from schools with at least 40% Free and Reduced Lunch participation. We share how we directly address challenges of access (cost, transportation, availability, language and learning styles) and provide solutions to bridge the gap that often prevents underrepresented students from participating in outdoor education programs. We also share aspirations for our program curriculum as we continue to address challenges of access and teacher resources. Understanding that engaging a citizenry more representative of our Bay Area communities will foster a larger, more empowered generation of environmental stewards.

Keywords: Access, outdoor education, community program, ELD, learning modalities, habitat restoration

Poster Topic: Public Education, Outreach, and Access

Delta Mercury Exposure Reduction Program (MERP)

Kirt Sandhu[1], Shakoora Azimi-Gaylon[1], Laura B. Jensen[1]

[1]Sacramento-San Joaquin Delta Conservancy

kirt.sandhu@deltaconservancy.ca.gov, shakoora.azimi-gaylon@deltaconservancy.ca.gov, laura.jensen@deltaconservancy.ca.gov

Many fish caught in the Sacramento-San Joaquin Delta (Delta) contain methylmercury (mercury) and other contaminants. The Delta Mercury Exposure Reduction Program (Delta MERP) is a multi-year effort to reduce human exposure to mercury from eating fish caught in the Delta. To protect the public's health, the Office of Environmental Health Hazard Assessment issued fish consumption advisories for the Delta which provide guidance on the types and amounts of Delta fish that can be safely eaten. The objectives of Delta MERP are to raise awareness of how to eat fish safely and increase understanding of fish contamination issues in the Delta. Delta MERP is part of the Delta Mercury Control Program that, together with the methylmercury Total Maximum Daily Load (TMDL) load reduction goals, protect the people who eat fish by reducing methylmercury exposure and its potential health risks. These objectives align with Estuary Blueprint Goal 4: Champion the Estuary by informing anglers of fish consumption recommendations and maintaining the Delta as a premiere fishing location. Because it will take many years to lower mercury levels in fish, Delta MERP encourages actions that will reduce mercury exposure. The Delta MERP's past and current actions include: • Provide small grants to fund community-based projects that target disadvantaged populations • Develop multilingual educational materials • Provide community grants to integrate MERP messages into existing programs • Hold community stakeholder meetings to foster collaboration • Conduct outreach to communities through group meetings and community events • Provide training to communities to raise awareness and understanding of fish contamination issues • Collaborate with local programs to share Delta MERP educational messages This poster illustrates these actions and provides an overview of the Program as a whole. The program is funded by State agencies, wastewater dischargers, local storm water agencies, and land managers in the Delta.

Keywords: MERP, Mercury, Fish Consumption, Outreach, Education

Poster Topic: Public Education, Outreach, and Access

Ravenswood Bay Trail Connection

Karine Tokatlian[1]

[1]Midpeninsula Regional Open Space District

ktokatlian@openspace.org

The Midpeninsula Regional Open Space District's (District) Ravenswood Bay Trail Project (Project) will close a critical 0.6 mile gap in the San Francisco Bay Trail (Bay Trail) by linking Ravenswood Open Space Preserve (OSP) with University Avenue in East Palo Alto and Menlo Park. The Project will extend the existing Bay Trail at University Avenue by approximately 3,000 feet to connect with the existing Bay Trail in Ravenswood OSP, thereby establishing a new multi-use segment of multi-use trail and raised redwood boardwalk. Completing this 0.6 mile gap will open 80 miles of continuous Bay Trail. The Project contributes to the Association of Bay Area Governments' Bay Trail Plan to develop a 500-mile shoreline walking and bicycling path that will eventually encircle the Bay. Project impacts will be mitigated onsite and include high-tide habitat enhancement to benefit the salt marsh harvest mouse and California Ridgeway's rail. Two high-tide refuge islands will be constructed in Cooley Marsh and native vegetation will be planted in segments of salt marsh upland transition zone along the existing levee trail. Ultimately, the Project will achieve Estuary Blueprint Goals 1 and 4 by providing public access opportunities for commute and recreation, providing outreach and education through interpretive signage, providing opportunities for wildlife viewing and environmental appreciation, and improving wetland habitat for federally protected marsh dependent species.

Keywords: public access, Bay Trail, restoration, island, Ridgeway's rail, harvest mouse,

Poster Topic: Public Education, Outreach, and Access

"Coastal Science Allies" Champion Research, Stewardship, and Education Focused on Building Resilience and Collaboration to Enhance the San Francisco Estuary

Michael Vasey[1,2] Karina Nielsen[2], Andy Chang[3,2], Aimee Good[1,2], Sarah Ferner[1,2], Christine Metzger[1,2], Erin Blackwood[2], Rebecca Johnson[2], Adria O'Dea[2], Linda McCann[3,2], Greg Ruiz[3,4], Anson 'Tuck' Hines[3,4]

[1]San Francisco Bay National Estuarine Research Reserve
[2]San Francisco State University, Estuary & Ocean Science Center
[3]Smithsonian Environmental Research Center (SERC)
[4]Edgewood, Maryland

mvasey@sfsu.edu

On December 7, 2018, the President of San Francisco State University (SFSU), Provost of the Smithsonian Institution, and Director of the NOAA Office for Coastal Management signed a Memorandum of Understanding to formally partner on various activities intended to enhance the conservation of the San Francisco Estuary. The three-way partnership, an expansion of a previous collaboration with the Smithsonian, will allow these organizations to better coordinate their efforts so they can pool resources and launch new initiatives in research, education and public engagement. The hub of this new partnership is the Estuary and Ocean Science (EOS) Center in Tiburon, CA, where representatives of all three organizations are situated. Research and educational activities focused on partnering with the Richardson Bay Audubon Center and Sanctuary are good examples of this partnership in action. The EOS Center and SF Bay NERR support the long-running Bayshore Studies program that provides docent-led education activities centered at that location. SERC, the SF Bay NERR, and faculty and graduate students from the EOS Center are engaged in a number of key research projects involving native oysters, impacts of introduced oyster drills, and eelgrass research. Another good example - the Coastal Science Allies to joined with Mission Blue, a global marine conservation organization, to designate San Francisco Bay as a Mission Blue Hope Spot on April 28, 2019. The Hope Spot recognizes the importance of marine biodiversity in the SF Bay and will focus on building greater collaboration around the conservation of this important dimension to the San Francisco Estuary. Stay tuned!

Keywords: Coastal Allies Partnership, coastal research, marine biodiversity, collaboration

Poster Topic: Public Education, Outreach, and Access

The Effects of Abiotic and Biotic Factors on the Decomposition Rates of Dominant Plant Species in Sacramento-San Joaquin Delta

Mishal Durrani[1], Karen Arroyo[1], Dennis Baldocchi[1], Alex Valach[1]

[1]University of California, Berkeley

mishaldurrani@berkeley.edu, arroyok32@berkeley.edu, baldocchi@berkeley.edu, valach@berkeley.edu

The declining peat levels and hence the low surface elevation of the Sacramento-San Joaquin Delta compared to sea-level has been a major concern. Decreasing peat levels and rising sea-levels collectively inflict pressure on the levees that were built around the Delta islands decades ago, increasing the risk of failure. Levee failure threatens local communities, agriculture, and the freshwater supply of 30 million Californians. Pilot projects have restored portions of the Delta next to levees to wetlands to help prevent further soil loss whereby inundation protects the peat layer from oxidizing and reduces CO2 emissions. Additionally the high net biomass production from emergent macrophyte vegetation, such as *S. acutus* (tules) and *Typha spp*. (cattails) rebuilds new peat layers ultimately to their previous levels; the rates of soil accretion depend on the decomposition of local vegetation. We investigated the biotic and abiotic factors that affect the rate of decomposition of the two dominant plant species, as well as the impact of the plant species and litter type. Understanding the magnitude of the effect of these factors allows us to calculate the decomposition rates and the time it would take for the land surface to be restored to its previous elevation. We used a litter bag experiment to test four types of treatments and their combinations: tule, cattail, standing dead, and fresh litter. The bags were deployed for 3 and 6 months before being analyzed. Here we present our results of the decomposition rates, the impact of the C and N content of the litter and other drivers, as well as estimates of the accumulation of the peat layer.

Keywords: Macrophyte, Vegetation, Delta, Wetland, Decomposition, Subsidence, Peat

Poster Topic: Sediment

Update of Erosion and Deposition in San Francisco Bay

Theresa Fregoso[1], Bruce Jaffe[1]

[1]US Geological Survey

tfregoso@usgs.gov, bjaffe@usgs.gov

The USGS has spent five decades developing and interpreting the historic bathymetric Digital Elevation Models (DEMs) of San Francisco Bay. These DEMs were based on surveys conducted from the 1850s to 1990s by NOAA's Office of Coast Surveys and its predecessor, the US Coast and Geodetic Survey. Analysis of these DEMs have provided valuable insight into historic patterns of sediment deposition and erosion, pathways of sediment and sediment-bound contaminants within the Bay and subembayments, and sediment budgets. In 2014 and 2015 the Ocean Protection Council (OPC) contracted for new bathymetric surveys of large portions of San Francisco Bay. A total of 93 bathymetric surveys were conducted, using both interferometric sidescan and multibeam sonar systems. This data, along with recent NOAA, USGS, and California State University Monterey Bay surveys can now be combined to create a revised bathymetric DEM of San Francisco Bay (including South Bay, Central Bay, San Pablo Bay, and Suisun Bay). Analysis of these surveys and comparison with USGS DEMs based on earlier surveys will provide an update on the quantities and patterns of erosion and accretion in the Bay over the past 25 to 35 years. Results from this comparison can be used to assess how the Bay has responded to changes in sediment supply from the Delta and tributaries. This will provide managers with data for making decisions on a variety of issues, including exposure of legacy contaminated sediment and strategies for beneficial dredge disposal, which will help sustain and improve the Bay's habitats and living resources.

Keywords: bathymetry, interferometric, DEMs, multibeam

Poster Topic: Sediment

Inferring Sediment Transport Pathways and Fluxes from Bathymetric Change

Bruce Jaffe[1], Amy Foxgrover[1]

[1]US Geological Survey

bjaffe@usgs.gov, afoxgrover@usgs.gov

Knowledge of sediment transport pathways and fluxes is vital for effective management of wetlands, sediment contamination, dredging, and other sediment-related phenomena that affect estuarine ecosystems. In theory, the patterns and quantities of bathymetric change can be analyzed to infer sediment transport pathways and fluxes. For example, in a closed system, localized elevation change measured between two bathymetric surveys suggests sediment was transported from areas of erosion to areas of accretion. The average flux of sediment is the volume of sediment accreted (eroded) divided by the time between surveys. However, in nature, multiple transport pathways and external sediment inputs and sinks complicate extracting information on the pathways and rates of sediment movement from bathymetric change. To test whether this approach can produce meaningful information in a natural system, we use a series of six bathymetric surveys collected from the 1850s to 1980s in South San Francisco Bay, California. To simplify the analysis, we averaged bathymetric change in four regions, each approximately 10 km in the along-channel direction, which is NW-SE, and spanning the width of the bay. The pattern of net bathymetric change through time in the four regions is striking. All regions are in sync, alternating between being more accretional and erosional. The volume of erosion in the northerly regions is balanced by the volume of accretion in the southernly regions for most change periods. From this we infer an average net north-to-south sediment transport in South San Francisco Bay, with a rate of about 300,000 cubic meters per year for most change periods. Time-varying sediment input at the northern boundary could explain the observed alternation between more accretional and erosional periods. This study demonstrates that analysis of bathymetric change can be used to infer sediment transport pathways and rates and to better inform sediment-related management decisions.

Keywords: sediment transport legacy contaminants mercury dredging mudflats

Poster Topic: Sediment

Towards Embayment-Scale Sediment Flux Measurements in San Francisco Bay

Daniel Livsey[1], Maureen Downing-Kunz[1], David Schoellhamer[1]

[1]USGS California Water Science Center

dlivsey@usgs.gov, mdowning-kunz@usgs.gov, dschoell@usgs.gov

Lower South Bay suspended-sediment flux data are being collected from 2018 to 2019 as part of a two-year investigation conducted by the USGS California Water Science Center in cooperation with the Regional Monitoring Program for Water Quality in San Francisco Bay. Lower South Bay suspended-sediment flux monitoring and research began at Dumbarton Bridge in 2009 due to the importance of sediment supply to the success of the nearby South Bay Salt Ponds Restoration Project and transport of sediment-bound contaminants. Recent work on suspended-sediment flux measurements at Dumbarton Bridge has focused on reducing uncertainty in flux estimates by accounting for flocculation (i.e., aggregation of sediment particles into "flocs") in the water column. Flocculation can greatly affect estuarine sediment flux estimates. Compared to previous work (Shellenbarger et al., 2013), in which flocculation was not considered, net suspended-sediment flux reversed direction from seaward for 2009-2011 and 2013-2016 to landward. Accounting for flocculation in suspended-sediment flux measurements entails a correction to point measurements of suspended-sediment concentration (SSC) based on floc settling-velocity estimates as proposed by Livsey et al. (in review). In-situ measurements of floc settling velocity collected during 2018 agree very well ($R^2>0.95$) with settling-velocity estimates used to correct suspended-sediment flux measurements, further validating the correction proposed by Livsey et al. (in review) for sediment flux data from 2009-2011 and 2013-2016. Flocculation is hypothesized to affect suspended-sediment flux measurements primarily by changing the vertical distribution of sediment in the water column, which affects the relationship between SSC measured at a point and cross-sectionally-averaged SSC used to compute suspended-sediment flux. Results of this work are directly applicable to Lower South Bay and suggest flocculation should be considered for suspended-sediment flux monitoring and modeling throughout San Francisco Bay and other estuaries.

Keywords: Sediment Flux; South Bay Salt Ponds; Sediment Supply; South Bay

Poster Topic: Sediment

SediMatch: Match Available Sediment with Opportunities for Beneficial Reuse

Sandra Scoggin[1], Brenda Goeden[2], Caitlin Sweeney[3], Cristina Grosso[4], Lorenzo Flores[4], Gemma Shusterman[4], Shira Bezalel[4]

[1]San Francisco Bay Joint Venture
[2]San Francisco Bay Conservation and Development Commission
[3]San Francisco Estuary Partnership
[4]San Francisco Estuary Institute

sscoggin@sfbayjv.org, brenda.goeden@bcdc.ca.gov, Caitlin.Sweeney@sfestuary.org, cristina@sfei.org, lorenzof@sfei.org, gemmas@sfei.org, shira@sfei.org

SediMatch is a collaborative program of the San Francisco Bay Joint Venture (SFBJV), the San Francisco Bay Conservation and Development Commission (BCDC), the San Francisco Estuary Institute (SFEI), the San Francisco Estuary Partnership (SFEP), and others to bring together the wetland habitat restoration, flood control, and dredging communities to discuss challenges and find mutually beneficial strategies to increase reuse of dredged sediment at habitat restoration sites. The program goals include to 1) create healthy habitats while maximizing beneficial reuse of sediment; 2) develop an easily accessible database where sediment needs can be matched with surplus sediment; and 3) provide opportunities for collaboration. These three goals combined will help our region keep up with sea level rise and create resilient shorelines. They align with and support maximizing beneficial reuse of dredged sediment as described in the Long Term Management Strategy for Placement of Dredged Material in the San Francisco Bay Region (LTMS) Program. With funding from the USEPA, a multi-agency and stakeholder workgroup guides the development of a web tool to help match available sediment with opportunities for beneficial reuse. The tool allows users to identify potential sediment matches and can assist with project planning. Visit the SediMatch Web Tool at sedimatch.sfei.org. The Baylands Ecosystem Habitat Goals Climate Change Update (BEHGU) recommends using dredged sediment to accelerate the rate and scale of wetland restoration. At a broader scale, data collected through SediMatch has the potential to contribute to the understanding of sediment distribution and movement throughout the estuary system, helping scientists better target their research and assisting managers with decision making related to current and future conditions.

Keywords: dredged sediment, beneficial reuse, habitat restoration, wetlands

Poster Topic: Sediment

Using LiDAR to Examine Soil Subsidence and Accretion in Sac/SJ Delta

Robert Shortt[1]

[1]UC Berkeley

robert_shortt@berkeley.edu

This study employs LiDAR-derived elevation information to reconstruct the canopies of restored wetlands in the western Sacramento/San Joaquin Delta region. Subsidence is a major threat to levee strength and stability, and wetlands have been shown to halt and even reverse soil subsidence caused by aerobic microbial respiration within the area's native high carbon peat soils. The accretion of soil relies on deposition and decomposition of plant litter, which behaves differently in rehabilitated wetlands, which are contained away from Springtime flooding which might displace their litter. this study will compare several LiDAR datasets from different points in time to show aggregated rates of soil accretion or subsidence, as well as the shifting dynamics of litter accumulation within five disparate rehabilitated wetlands. I will be using data collected from the UCB Biometeorology Lab's network of eddy covariance towers, as well as recent lab studies on litter decomposition rates, to compare the carbon balance of each ecosystem with levels of observed subsidence/accretion.

Keywords: LiDAR, wetlands, eddy flux, levee strength, flood risk

Poster Topic: Sediment

Trends in Benthic Sediments in San Pablo and Grizzly Bays

Lukas WinklerPrins[1,2], Jessica Lacy[2], Andrew Stevens[2], Rachel Allen[1,2]

[1]University of California, Berkeley
[2]USGS Pacific Coastal & Marine Science Center

lukas_wp@berkeley.edu, lukas_wp@berkeley.edu, jlacy@usgs.gov, astevens@usgs.gov, rallen@contractor.usgs.gov, rallen@contractor.usgs.gov

Decision-making pertaining to dredging, primary production, contaminant transport, and marsh resilience in the Bay relies upon an accurate understanding of how sediments move throughout the system and between the bayfloor and the water column. Models of how the bed erodes, accretes, and consolidates often assume static values for sediment properties. However, properties such as grain size and bulk density change with hydrodynamic conditions across both tidal and seasonal time spans. To capture temporal variations in sediment properties within the shallows of Grizzly and San Pablo Bays, we conducted six surveys between June and August, 2019. Within each bay, we collected box cores that preserved the sediment-water interface, allowing us to then take six small cores using 2.5" diameter syringes. Each syringe core was sectioned to depth ranges of 0-0.5cm, 0.5-1cm, 1-2cm, 2-3cm, 3-4cm, and 4-5cm. Then, each section analyzed for bulk density, grain size distribution, and percent carbon. Initial results show that at both sites, sediments are predominantly (95% or greater) mud. Initial results show increasing bulk density with depth in both bays (suggesting compaction), higher variance of bulk density and grain size closer to the sediment-water interface in both bays, and slightly coarser sediments in Grizzly Bay. This work is part of a larger study, in collaboration with the USGS California Water Science Center and Water Mission Area, investigating temporal changes in benthic infauna, critical shear stresses, erodibility, and hydrodynamics at the two field sites. By end-of-study, our data will show how sediment properties vary during spring-neap tidal cycles, in response to strong winds, and over the Delta's falling hydrograph. Our results will improve numerical and conceptual models of sediment and water dynamics across the entire system and advance understanding of the controlling processes, allowing the community to manage towards a healthier Bay.

Keywords: benthos, sediment, mud, seasonal, consolidation, north bay, erodibility, mobility,

Poster Topic: Sediment

Pinole Creek Fish Passage Project

Lisa Anich[1], Bert Mulchaey[2]

[1]Contra Costa Resource Conservation District
[2]East Bay Municipal Utility District

lanich@ccrcd.org, bert.mulchaey@ebmud.com

Pinole Creek's population of steelhead/rainbow trout (*Onchorynchus mykiss*) is a subpopulation of the federally threatened Central California Coast Steelhead. In 2016, the Pinole Creek Fish Passage Project modified a culvert and flood control channel at Interstate Highway 80 (I-80), greatly improving access for steelhead trout to nearly seven miles of quality spawning and rearing habitat in upper Pinole Creek Watershed. Pinole Creek flows through dual box culverts under I-80 approximately 1.5 miles upstream from San Pablo Bay. The project modified one culvert and a short downstream reach. At the upstream end of the culvert is a low-flow notch with baffles. At the culvert outlet, training walls guide streamflow to a sill which increases flow depth. In the channel downstream of the culvert, an engineered rock chute improves flow conditions for fish passage while maintaining flood protection. Although Contra Costa Resource Conservation District led the project's construction, completion of the fish passage is the fruition of more than a decade of collaboration among many dedicated partners. East Bay Municipal Utility District (EBMUD) has committed to five years of post-construction monitoring. To date, three years of monitoring are complete. The preferred monitoring method is spawning surveys in Pinole Creek upstream of I-80 during the peak fish migration period. Surveys enumerate redds and determine whether they were constructed by resident or anadromous fish. Project success will be evaluated by comparing observed increase in the number or annual frequency of steelhead redds to baseline conditions. To date, the documentation of redds of anadromous origin during post-construction monitoring indicate that the project is functioning as designed for fish passage. EBMUD will conduct two more years of surveys for the final evaluation of project success.

Keywords: fish passage, barrier, culvert, freshwater, restoration, steelhead, habitat, monitoring

Reference #: 0366_0537_000036

Poster Topic: Species and Communities - Aquatic

Epifaunal Community Recovery in San Francisco Estuary Eelgrass (Zostera marina) Beds After Extended Low Salinity

Geana Ayala[1]

[1]Estuary and Ocean Science Center, SF State

gsayala@gmail.com

Severe weather events are predicted to increase in intensity and frequency in the future with climate change, and their effects on community composition and ecosystem functioning in estuaries is poorly understood. The San Francisco Estuary (SFE) experienced a record wet period in early 2017, when heavy rainfall reduced surface salinities drastically for several months. The impact of this extended period of low salinity on organisms in the seagrass beds of the SFE is unknown. Yet this seagrass, eelgrass (*Zostera marina*), is an important habitat-forming species worldwide, hosting a diverse community of leaf-dwelling (epifaunal) invertebrates important to food webs and in some cases to the health of the eelgrass itself. In the SFE, this community was comprised of a mix of native and introduced species, with a range of relative abundances and roles, prior to the low salinity period. I conducted quarterly surveys in six SFE eelgrass beds beginning in July 2017 to quantify changes in invertebrate community composition as well as shoot density, biomass of algae on leaves (epiphytes), sediment characteristics, and other potentially-related environmental factors. Following the low-salinity period, I observed large changes in the invertebrate community compared to pre-2017 data, including the disappearance of two key native species, Taylor's sea hare (*Phyllaplysia taylori*) and the isopod *Pentidotea resecata*. These species feed on eelgrass epiphytes, increasing light availability to eelgrass and linking primary production to higher trophic levels. At the same time, multiple introduced invertebrates became abundant. Tracking invertebrate community reassembly over space and time will allow me to determine whether this low salinity period had extended influence on community composition and thus functioning of the eelgrass beds. My research will help to inform our understanding of the role of extreme events in the conservation of important foundational habitats, especially as climate changes intensify.

Keywords: Mesograzer, seagrass, amphipod, invasive species, epiphytes, climate change, storms, estuary

Poster Topic: Species and Communities - Aquatic

Long-Term Trends of Dungeness Crab (*Cancer magister*) Population Dynamics in the San Francisco Estuary

Emily Campbell[1], Kathy Hieb[1]

[1]California Department of Fish and Wildlife

emily.campbell@wildlife.ca.gov, kathy.hieb@wildlife.ca.gov

The San Francisco Estuary (SFE) is an important nursery habitat for age-0 Dungeness crab (*Cancer magister*) which utilize SFE resources to rear and mature. In this study, we quantified Dungeness crab distribution and abundance for nearly four decades in order to understand long-term trends in population dynamics as it relates to environmental influences. Dungeness crab were collected by otter trawl from a research vessel from 1980 to 2019 from channel and shoal stations within the San Francisco Estuary. From 1980 to 2019, Dungeness crab recruitment to SFE was episodic and cyclic, often with strong year classes followed by poor year classes, or no recruitment. This pattern was evident in recent years, with 2013 showing extremely high recruitment, followed by several years with poor recruitment. It has been well documented that ocean conditions, including upwelling, ocean temperature, and currents are important factors controlling Dungeness crab recruitment. We looked at the relationship between the spring transition date, which is a measure of when the upwelling season starts, and annual Dungeness crab abundance within SFE. Strong year classes generally corresponded with years that had colder winter ocean temperatures and favorable ocean currents that retain larvae within the Gulf of the Farallones. In addition, higher Dungeness crab abundance occurred when the spring transition date occurred earlier in the year; however, this trend was not consistent. Long-term monitoring studies such as the San Francisco Bay Study are crucial for understanding environmental influences on our valuable Dungeness crab in the San Francisco Estuary.

Keywords: San Francisco Estuary, Dungeness Crab, Upwelling

Poster Topic: Species and Communities - Aquatic

Temporal Patterns in Richness and Relative Abundance for Early Life Stages of Fishes in the Upper San Francisco Estuary

Gonzalo Castillo[1], Trishelle Tempel[2], Steve Slater[2], Brian Mahardja[1], Morgan Gilbert[1]

[1]U.S. Fish & Wildlife Service
[2]California Department of Fish & Wildlife

gonzalo_castillo@fws.gov, Trishelle.Tempel@wildlife.ca.gov, Steve.Slater@wildlife.ca.gov, brian_mahardja@fws.gov, morgan_gilbert@fws.gov

Long-term changes in the pelagic ecosystem of the Upper San Francisco Estuary (USFE) have revealed marked changes in richness and relative abundance (RA) of native and introduced species. Yet, temporal community patterns for larval-juvenile stages of fishes in the USFE have been reported mostly for selected species and areas in previous decades. We utilized the 20 mm Survey conducted by the California Department of Fish and Wildlife in the USFE from mid-spring to early-summer 1995 to 2017, and compared the overall temporal changes in richness and RA for early life stages of native and introduced fishes over three periods: pre-pelagic organism decline (pre-POD 1995-2001), POD (2002-2011) and extended drought (2012-2017). A total of 69 fish taxa were collected from 1995 to 2017 (35 native, 29 introduced, and 5 of unknown origin). During 1995 to 2017, the summed mean RA across all introduced taxa (600/104 m3) was higher compared to native taxa (383/104 m3) and taxa of unknown origin (0.48/104 m3), with about half of the summed RA of introduced taxa comprised by the introduced *Tridentiger spp*. No trends in species richness were suggested for native and introduced taxa over the three periods. Among the four dominant taxa of each origin per period, two native (Longfin Smelt and Pacific Herring) and four introduced (*Tridentiger spp*., Striped Bass, Yellowfin Goby and Threadfin Shad), were found consistently across all periods. Although the summed mean RA declined similarly during the POD period for native (43%) and introduced taxa (42%), a steeper decline in summed RA was observed during the extended drought period for native taxa (34%) than introduced taxa (15%). These results suggest that extended drought impacts superimposed on long-term habitat degradation for early life stages of fishes could have more detrimental influence on the overall abundance of native species than introduced species.

Keywords: Fish, Community, Early life stages, Abundance, Richness, Native, Introduced

Poster Topic: Species and Communities - Aquatic

Modeling Fluvial Habitat Connectivity for Migratory Fish

Daniel Constable[1], Ron Melcer[1]

[1]Delta Stewardship Council

daniel.constable@deltacouncil.ca.gov, ron.melcer@deltacouncil.ca.gov

Watershed and fluvial connectivity is an important measure for understanding the accessibility of habitat for migratory fish, including high elevation headwater streams that could serve as refugia under a changing climate. Measuring connectivity and fragmentation – from dams, unscreened diversions, or other barriers – can help assess accessibility to suitable habitat under future scenarios. Resolving fish passage at barriers is important for the survival of several listed species, including salmonids and other migrant species that travel through the Bay-Delta system. Our work uses a network analysis to quantify impact of select barriers on access to upstream river reaches for long-range migrant fish traveling through and upstream of the Bay-Delta system.

Keywords: connectivity, fish migration, aquatic habitat, Bay-Delta, Sierra to the Sea

Poster Topic: Species and Communities - Aquatic

Critical Windows in Chinook Salmon Development: Differential Sensitivity to Warming and Hypoxia During Early Development

Annelise Del Rio[1], Gabriella Mukai[1], Benjamin Martin[2], Rachel Johnson[2], Nann Fangue[1], Joshua Israel[3], Anne Todgham[1]

[1]University of California Davis
[2]National Oceanic and Atmospheric Administration
[3]Bureau of Reclamation

amdelrio@ucdavis.edu, gnmukai@ucdavis.edu, benjamin.martin@noaa.gov, rachel.johnson@noaa.gov, nafangue@ucdavis.edu, jaisrael@usbr.gov, todgham@ucdavis.edu

Conditions within salmon redds, or nests, can be highly variable. With the progression of global climate change high temperatures and hypoxia, low dissolved oxygen, may occur more frequently within the gravel rearing environment. Management strategies for salmon embryo survival in the Sacramento River largely focus on releases of cold water from the Shasta Dam during the incubation period. During drought or warming events, the supply of cold water can become limited and water releases may have to be more carefully timed. We examined how elevated temperature and hypoxia as single and combined stressors affected developing Chinook salmon. Exposures lasted either from fertilization through hatching or for short periods during embryonic development to test the effect of exposure timing. We measured growth, hatching success, developmental time, and metabolic performance at two embryonic stages. Hatching success was lowest in the chronic warm hypoxia exposure and the late warming and hypoxia exposure, suggesting the combination of stressors is most detrimental to survival, with greater sensitivity during later stages in embryonic development. Embryos reared in hypoxia also developed more slowly and took longer to hatch compared to normoxic treatments. Determining developmental windows of increased sensitivity to stressors can inform effective and efficient water management policies to support salmon embryo survival.

Keywords: salmon, physiology, climate change, hypoxia, temperature

Poster Topic: Species and Communities - Aquatic

The Value of a Non-Traditional Long-Term Data Set: Sampling at a Former Naval Dry Dock

Stewart DesMeules[1]

[1]WRA, Inc.

desmeules@wra-ca.com

Problem statement: 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. Approach: The fish rescue and relocation efforts were designed, permitted and implemented successfully, and continue presently. Unique approaches and fish exclusion devices were used, and careful thought was put into the process, so it allowed the dry dock operations to continue while still excluding protected fish species. Conclusions: This case study has management implications for other large-scale fish rescue and relocation operations in the precedent it sets for other similar projects. The data gathered over the nine-year period of work represent a unique long-term data set within the San Francisco Estuary, with potential to be utilized by a host of users. Results: The result of this work has been a non-traditional long-term data set collected over a nine-year period. This poster will present a summary of the unique fish sampling location, trends in fish assemblages over the nine-year period, fish rescue and relocation techniques, and the value in seeking out non-traditional data sources from private and industrial locations to compliment or subsidize regional monitoring efforts.

Keywords: dataset, fisheries, monitoring, steelhead, longfin smelt, marine, permitting, regulations,

Poster Topic: Species and Communities - Aquatic

A Comprehensive Look at a Multi-Year Study Using Various Methodologies to Capture Endangered Delta Smelt

Kate Erly[1], Brynn Perales[1], Denise Barnard[1], Catherine Johnston[1]

[1]U.S. Fish and Wildlife Service

kate_erly@fws.gov, brynn_perales@fws.gov, denise_barnard@fws.gov, catherine_johnston@fws.gov

In April 2017, the U.S. Fish and Wildlife Service's Enhanced Delta Smelt Monitoring Program (EDSM) began sampling for postlarval-juvenile Delta Smelt *Hypomesus transpacificus* within the upper San Francisco Estuary. Using identical gear as the California Department of Fish and Wildlife's historical 20-mm survey, the objective was to obtain distribution and abundance estimates of endangered Delta Smelt post-larvae and juveniles using a stratified random sampling design. During the 2017 sampling season, EDSM struggled to achieve its objectives due to low catch numbers. In 2018 EDSM shifted focus, concentrating on exploring sampling methods in different habitats to inform the best approach to monitoring the increasingly rare Delta Smelt. EDSM developed and tested four gear types to sample various water depth strata; 1) a larval beach seine net, 2) paired Manta nets, 3) a 20-mm net sampling the surface of the water, and 4) a 20-mm net sampling mid-depth. However, we were constrained to 3 days of sampling leading to inconclusive results. In 2019 EDSM increased larval sampling effort throughout the months of April and May and added a fifth sampling method in shallow water, light trapping. This poster will discuss the pros and cons of each sampling method and the findings for the past three years.

Keywords: Delta smelt, postlarval-juvenile, endangered, gear types, sampling methods, *Hypomeus transpacificus*

Poster Topic: Species and Communities - Aquatic

Stream Temperature in Lagunitas and Walker Creek Watersheds

Emma Goodwin[1]

[1]Watershed Stewards Program; SF Bay Regional Water Quality Control Board

Emmargoodwin13@gmail.com

Problem statement: What problem are you trying to solve? Approach: How did you go about solving or making progress on the problem? Results: What are your main findings? Conclusions: What are the scientific and management implications of your findings? This study evaluates continuous temperature data from the summers of 2016 and 2017 in the Lagunitas Creek Watershed and the Walker Creek Watershed to assess potential water temperature impairment. Temperature criteria must be met in all life stages for salmonids to persist, as temperatures help to signal upstream and downstream migrations, allow the fish to spawn, and allow their eggs to incubate. Elevated temperatures can cause both direct and indirect negative impacts on fish such as reduced immune system function, increased potential for exhaustion, reduced dissolved oxygen concentrations in the water, etc. Lagunitas and Walker Creek Watersheds provide crucial habitat to federally endangered coho and chinook salmon, and federally threatened steelhead trout. This study analyzed temperature data to focus further monitoring efforts in these watersheds. In the Lagunitas Creek watershed, exceedances were found only in Nicasio and San Geronimo Tributaries. There are no anadromous fish where the exceedances exist above Nicasio Reservoir, but San Geronimo Creek is a key spawning and rearing habitat for salmonids, and should be monitored further. In the Walker Creek watershed, there were unexplained exceedances close to Tomales Bay, and minor exceedances on Chileno Creek. Further monitoring efforts should address tributaries such as Chileno and Salmon Creek, as they have low riparian cover and high grazing pressure, so they are at risk for temperature exceedances. Tributaries in both Walker and Lagunitas watersheds have the potential to become better-quality habitat for salmonids, and should be continually monitored in order to drive restoration and improvement.

Keywords:

Poster Topic: Species and Communities - Aquatic

Occupancy Modeling to Examine Imperiled Delta Smelt Habitat Use

Catherine Johnston[1], Lara Mitchell[1], Denise Barnard[1]

[1]U.S. Fish and Wildlife Service

catherine_johnston@fws.gov, lara_mitchell@fws.gov, denise_barnard@fws.gov

Delta Smelt *Hypomesus transpacificus* are an imperiled fish species endemic to the upper San Francisco Estuary, where human-induced habitat changes have driven their decline over the last three decades. Various ongoing monitoring efforts collect information on Delta Smelt population abundance and distribution to inform water operations decisions. One such program is the Enhanced Delta Smelt Monitoring Program (EDSM), which was initiated by the U.S. Fish and Wildlife Service in 2016. EDSM focuses on providing real-time data to help managers understand and respond to population patterns of Delta Smelt, but the dataset can also be useful in evaluating habitat use and behavior patterns of this endangered fish. Using the EDSM dataset, we examined patterns of Delta Smelt catch relating to habitat and flow characteristics. We used occupancy modeling, examining Delta Smelt catch as a function of variables including tide stage, outflow, tidal velocity, depth, and distance from shoreline. Examining Delta Smelt habitat use via the EDSM dataset enables us to maximize the value of the monitoring dataset to glean information about this increasingly rare species.

Keywords: Delta Smelt, endangered, monitoring, habitat use, occupancy modeling, environmental drivers

Poster Topic: Species and Communities - Aquatic

Recent High-Resolution Eelgrass Mapping with Side-Scan Sonar and Visual Ground Truth by Local Scientists, in Variable Central San Francisco Bay

Christopher Kitting[1,2], Jenerro Lockhart[2], Shoko Furuya[1,2]

[1]California State University East Bay
[2]Alluvion Environmental Consulting

chris.kitting@csueastbay.edu, chris.kitting@csueastbay.edu, jenerro.lockhart@alluvionbc.com, furuyashoko12@hotmail.com, furuyashoko12@hotmail.com

Environmental monitoring guards against environmental risks, and can uncover limits on valuable resources. Local ecological work emphasizes bay subtidal environments, here seeking LIMITS on variable eelgrass distributions and abundance. In summer-fall 2015, 2016, and 2018, Alluvion's sidescan sonar and ground truth surveys mapped eelgrass in each of three established, protected study areas, well after Oakland's new bridge construction. These surveys detected modest increases in eelgrass closest to the new Bridge, compared with 2015 and earlier surveys. Consistently, no eelgrass remained in Clipper Cove study area, 3 km west, based on sonar and underwater imagery at high tide, and direct observations from shore at lowest tides. Clipper Cove eelgrass, without construction activities, had been declining since year 2000. Footprints of Canada geese at low tide during the 2015 survey suggest that cause of overall eelgrass losses there, as observed elsewhere. In 2015, we also observed a large power boat beached on the final eelgrass patch in Clipper Cove (outside the study area buoys) with subsequent eelgrass patch disappearance, then slight recovery in 2018. Nearby Coast Guard Cove eelgrass appeared more constant, in recent years, until some recent thinning by August 2018. Silt loads or algae also could have led to losses of this light-limited underwater vascular plant. Elevated silt loads on eelgrass have not been detected here. Drift and epiphytic algae remained patchy or rare except being common at Clipper Cove. Protecting especially vulnerable eelgrass areas, including marker buoys to warn boaters, appeared to be effective in helping preserve these vulnerable, legally protected plants. Avoiding high silt loads into San Francisco Bay, and other such protections of vulnerable, shallow eelgrass areas, can be difficult. But it is worthwhile and rewarding to take precautions to increase eelgrass areas persisting or even expanding throughout San Francisco Bay, despite concentrations of diverse human activities.

Keywords: San Francisco Bay, Eelgrass Sonar/Visual Mapping, Monitoring Habitat Protection

Poster Topic: Species and Communities - Aquatic

How the Enhanced Delta Smelt Monitoring (EDSM) Survey Can Improve Juvenile Chinook Salmon Monitoring in the San Francisco Estuary

Brian Mahardja[1], Lara Mitchell[1], Michael Beakes[2], Denise Barnard[1], Catherine Johnston[1], Pascale Goertler[3], Cory Graham[1], Gonzalo Castillo[1]

[1]U.S. Fish and Wildlife Service
[2]U.S. Bureau of Reclamation
[3]California Department of Water Resources

brian_mahardja@fws.gov, lara_mitchell@fws.gov, mbeakes@usbr.gov, denise_barnard@fws.gov, catherine_johnston@fws.gov, pascale.goertler@water.ca.gov, cory_graham@fws.gov, gonzalo_castillo@fws.gov

A scientifically robust and accurate monitoring network is required in order to effectively manage a species. The Enhanced Delta Smelt Monitoring program (EDSM), a spatially and temporally intensive sampling effort for the endangered Delta Smelt (*Hypomesus transpacificus*), was initiated in late 2016 to better assess the abundance and distribution of the species. Although Delta Smelt abundance and distribution is the primary focus of EDSM, its bycatch data can be leveraged to monitor other species of concern such as Chinook Salmon (*Oncorhynchus tshawytscha*). Here we conducted a synthesis of juvenile Chinook Salmon data collected from various monitoring programs in the San Francisco Estuary to better understand how EDSM can complement the existing juvenile Chinook Salmon monitoring network. We used salmon catch data from two contrasting water years, 2017 and 2018, ranging from San Pablo Bay to the lower Sacramento and San Joaquin Rivers. With a few exceptions, we found negligible fish size bias in the Kodiak trawl gear used by EDSM when compared to other monitoring programs in the San Francisco Estuary. Through the use of occupancy modeling, we also demonstrated that detection probability of juvenile Chinook Salmon by the EDSM Kodiak trawl is comparable to those used primarily to monitor this species such as midwater trawl and beach seine. EDSM covers a wide spatial scale and has been conducted every week from late summer to early spring using stratified random sampling design with repeat visits that allow for proper detection probability estimates. As such, its data can support real-time management decisions of Chinook Salmon with some adjustments to its protocol (i.e., extension of the Kodiak trawling into the summer months, genetic identification of listed salmon runs).

Keywords: salmon, smelt, fish, monitoring, estuary, bay, trawl

Poster Topic: Species and Communities - Aquatic

20+ Years of Fisheries Restoration in the Alameda Creek Watershed

Jeff Miller[1], Ralph Boniello[1]

[1]Alameda Creek Alliance

jeff@alamedacreek.org, ralph@alamedacreek.org

Over the past two centuries the Alameda Creek watershed has been dramatically transformed. More than half of the watershed has been converted to urban development, three major dams now capture most of the watershed's runoff, and many creeks flow through artificial channels. As habitat is altered or lost the watershed's native cold water fish have declined - particularly salmonids, which have been most impacted by flow changes and the construction of in-stream migratory barriers. More than a dozen agencies and watershed stakeholders have worked since 1999 as partners in the Alameda Creek Fisheries Restoration Workgroup to provide fish passage, improve stream flows, and restore stream and riparian habitat along Alameda Creek and its tributaries. Eighteen fish passage projects have been completed in the watershed since 2001, and construction began in 2019 on a critical fish ladder in the lower creek that will allow ocean-run steelhead to access the entire watershed. The Workgroup has conducted flow and temperature studies as well as assessing and modeling past, present and future steelhead habitat. A peer-reviewed assessment in 2000 concluded that suitable habitat exists in the Alameda Creek watershed to support steelhead spawning and rearing. Annual monitoring by water agencies and volunteers shows that native rainbow trout and landlocked steelhead trout still occupy portions of the watershed, and that wild adult steelhead still try to migrate upstream after winter storms. Projects undertaken by members of the Workgroup will soon allow steelhead trout to reach up to 20 miles of spawning and rearing habitat that had previously been inaccessible. Potential future efforts to improve habitat include the construction of a low-flow migratory channel in lower Alameda Creek, a connection to restored estuarine habitat in former salt ponds at the mouth of the creek, and restoration of stream and riparian habitat in the Sunol Valley.

Keywords: Alameda Creek Watershed; Habitat Restoration; Anadromous Salmonids, Steelhead Trout

Theme Choice #1: Species and Communities - Aquatic

Western Pond Turtle Movement and Habitat Use in Suisun Marsh

Melissa Riley[1,2], Mickey Agha[2], Brian Todd[2]

[1]California Department of Fish and Wildlife
[2]University of California, Davis

melissa.riley@wildlife.ca.gov, melissa.riley@wildlife.ca.gov, magha@ucdavis.edu, btodd@ucdavis.edu

The Western Pond Turtle (*Actinemys marmorata*) – a native freshwater turtle in California – is a species of special concern, as determined by the California Department of Fish and Wildlife. In other parts of its range like Washington, *A. marmorata* is state listed as endangered due to habitat loss and shell disease. In the Suisun Marsh, Solano County, CA, observational data has shown that *A. marmorata* is widespread; however, little is known about their population status and habitat requirements in this part of their range. Due to its central location in the San Francisco Bay Estuary, Suisun Marsh provides important habitat for many fish and wildlife species including *A. marmorata*. Suisun Marsh consists of a matrix of tidal and managed brackish water wetlands, with 5,000–7,000 acres of tidal restoration planned within the next 30 years. As changes like tidal restoration and predicted sea level rise occur in Suisun Marsh, as well as the San Francisco Bay Estuary, it will be increasingly important to track how freshwater species like *A. marmorata* respond. The objective of this study was to track the movement and habitat use of *A. marmorata* using mark-recapture and GPS/GSM tracking technology in order to understand how A. marmorata will respond to future changes in Suisun Marsh. Preliminary results show that populations are large and healthy. In addition, A. marmorata is using a variety of aquatic and terrestrial habitats within tidal and managed wetlands, such as muted tidal ditches, ponds, as well as mud banks and wetland levees. Insights gained from this project will aide managers in efforts to conserve A. marmorata, especially in response to impending changes that may occur due to sea level rise and the conversion of managed wetlands to tidal marsh.

Keywords: western pond turtle, movement ecology, habitat use, habitat restoration

Poster Topic: Species and Communities - Aquatic

Sink or Swim: The Risks and Rewards of the Pescadero Intermittent Estuary/Coastal Marsh Complex for Threatened Central California Coast Steelhead

Pat Samuel[1], Eric Huber[1], Jon Jankovitz[2]

[1]California Trout
[2]California Department of Fish & Wildlife

psamuel@caltrout.org, ehuber@caltrout.org

The Pescadero intermittent estuary in San Mateo County is the largest estuary between San Francisco Bay and Elkhorn Slough and provides critical habitat for federally threatened Central Coast steelhead (*Oncorhynchus mykiss irideus*) and federally endangered tidewater goby (*Eucyclogobius newberryi*). Pescadero lagoon is a bar-built system with a sandbar typically forming during the late summer/early fall in normal water years. Beginning in the mid-1990s, acute fish kills were observed when the sandbar breached and the lagoon drained. Continuous water quality monitoring performed since 2003 has captured acute anoxic events of varying severity at the time of bar breaching. Despite poor water quality in the closed state and significant fish mortality during the transition closed to open states, mark recapture studies performed during lagoon closure suggest juvenile steelhead depend on the estuary for nursery habitat. Water quality monitoring during the 2012-2016 drought indicated that surface water dissolved oxygen in the estuary dropped to hypoxic levels at night due to prolonged drought-induced sandbar-closed conditions. Standardized steelhead catches in 2014 dropped from approximately 40 steelhead/haul in June 2014 to only 0.17 per haul in July 2014, and no steelhead were captured in October 2014. Toxic sulfide levels in water sampled in June 2014 were thousands of times higher than those considered safe for aquatic life by the EPA. These catch data are in stark contrast to 2011-2013, when 36 steelhead/haul were captured between July and October. Monitoring and experimental lagoon management suggests that while artificial breaches might reduce fish mortality, it may only provide temporary alleviation of water quality problems. As drought conditions, eutrophication, and water withdrawals intensify in in the future as California's climate changes, active management of lagoon system dynamics may be necessary to conserve anadromous *O. mykiss irideus* populations in California's bar-built estuaries.

Keywords: steelhead, estuary, lagoon, breaching, management, hypoxia, sulfide, Pescadero

Poster Topic: Species and Communities - Aquatic

Habitat Assessment Using Acoustic Telemetry

Maggie Watts-Peterson[1], Kevin Kumagai[1], Colleen Sullivan[1], Sam Johnston[1]

[1]HTI-Vemco USA, Inc. part of Innovasea

maggie.watts-peterson@innovasea.com, kevin.kumagai@innovasea.com, colleen.sullivan@innovasea.com, sam.johnston@innovasea.com

Measuring the importance of estuarine habitats requires information about the species that occupy them. Information about behavior, movement and interactions of these organisms will improve understanding of how they utilize these habitats through time. Until recently, acoustic telemetry has provided incomplete information about these behaviors due to the large positional errors and limits on the number of targets that could be tracked simultaneously. A positioning system with processing techniques that allow simultaneous tracking of multiple targets with high precision is being used to discern fine-scale movement and behavior of estuarine species. This system has been used to:

- Evaluate Chinook salmon smolt estuarine habitat preference;
- Compare behavioral differences in salmonids;
- Evaluate predator-prey dynamics;
- Evaluate a before-after-control-impact assessment of habitat enhancement efforts.

This information can be used to help identify potential factors affecting estuarine survival, identify predator hotspots and monitor change.

Keywords: Fish behavior, acoustic telemetry, habitat, tag, fish movement, species interaction

Poster Topic: Species and Communities - Aquatic

Managing the Suisun Marsh for Waterfowl and Fish

Cliff Feldheim[1], Cory Overton[2], Mike Casazza[2], John Durand[3]

[1]CA DWR Suisun Marsh Branch
[2]Western Ecological Research Center, USGS, Dixon Field Station
[3]Center for Watershed Sciences University of California, Davis

Cliff.Feldheim@water.ca.gov, coverton@usgs.gov, mike_casazza@usgs.gov, jrdurand@ucdavis.edu

The Suisun Marsh (Marsh) is comprised of 158 duck hunting clubs (approximately 52,000 areas of managed wetlands) and has long been recognized for its importance to waterfowl throughout the Pacific Flyway. The Marsh also supports more than 50 species of fish including at least 10 Special Status species. In 1974, the state Legislature passed the Suisun Marsh Preservation Act which declared the need to preserve waterfowl carrying capacity. Since 1974, 7 species of wintering waterfowl have shown significant population declines in the Marsh (24 to 83%), and the total number of dabbling ducks are down 60%. Since 2014, we have deployed solar powered cell-tower GPS transmitters on 13 species of waterfowl. Tagged waterfowl wintering in the Marsh selected breeding sites as far west as arctic Siberia and east through the Central Canadian Arctic. For all ducks captured in Suisun, either before the breeding season or during the winter, 50% of the winter was spent in the Sacramento Valley. Waterfowl breeding in the Marsh have been shot by hunters in 26 states, 4 Canadian Providences, and in Mexico. On the DWR-owned Meins Landing duck club we are evaluating managed wetland operations that could benefit Special Status fish by draining nutrient rich water from the duck club into adjacent tidal waters. DWR's Roaring River Distribution Facility, which provides water for up to 15,000 acres of managed wetlands, will have operations adjusted to facilitate the distribution of nutrient rich water from duck clubs into Montezuma Slough and Grizzly Bay. Understanding how waterfowl use the Marsh, what foods they eat, and the habitats they need will be the foundation for determining, and mitigating, any impacts waterfowl and duck hunting clubs may encounter from implementing actions to benefit Special Status fish and ultimately facilitate implementation of fish food production actions across the Marsh.

Keywords: waterfowl duck club management native fish.

Poster Topic: Species and Communities - Avian

Behavioral Response of Waterbirds to Large-Scale Watercraft Disturbance in San Francisco Bay

Tanya Graham[1], Laurie Hall[1], Susan De La Cruz[1]

[1]US Geological Survey, San Francisco Bay Estuary Field Station

tgraham@usgs.gov, lahall@usgs.gov, sdelacruz@usgs.gov

Many factors affect waterbird sensitivity to watercraft disturbance. Effects can vary by species, densities, foraging conditions, and the type of disturbance, and much remains to be learned about how these factors can interact to influence waterbird responses. Waterbirds disturbed by watercraft may decrease time spent foraging and resting and increase time spent alert, all of which can have consequences to energetics or reproductive fitness. During summer and fall 2012-2013 San Francisco hosted the 34th America's Cup sailboat races. Events drew nearly 1-million visitors, many of whom viewed the races aboard watercraft. As the location and timing of events overlapped with waterbird breeding and migration seasons, we examined the effect of events on waterbird behavior. We conducted 1,330 three-minute focal observations of individuals from four guilds (cormorants, grebes, gulls, other seabirds) on event/non-event days, weekdays/weekends, in summer/fall and spring. We assessed the effects of event/non-event, weekday/weekend, season, and their interactions on six behaviors (alert, diving, flying, foraging/drinking, resting/preening, swimming) for each guild using a Permutational Analysis of Variance in the Vegan package in R (R Core Team 2019). Behavior differed among seasons for cormorants, grebes, and other seabirds (p

Keywords: waterbirds, disturbance, spectator event, watercraft, cormorants, grebes, gulls, seabirds

Poster Topic: Species and Communities - Avian

Breeding Waterbirds in San Francisco Bay: How Have Populations Changed Over the Past 18 Years?

C. Alex Hartman[1], Joshua T. Ackerman[1], Carley Schacter[1], Mark P. Herzog[1], Cheryl Strong[2], Max Tarjan[3], Rachel Tertes[2], Yiwei Wang[3], Nils Warnock[4]

[1]U.S. Geological Survey
[2]U.S. Fish and Wildlife Service
[3]San Francisco Bay Bird Observatory
[4]Audubon Canyon Ranch

chartman@usgs.gov, jackerman@usgs.gov, cschacter@usgs.gov, mherzog@usgs.gov, cheryl_strong@fws.gov, mtarjan@sfbbo.org, rachel_tertes@fws.gov, ywang@sfbbo.org, nils.warnock@egret.org

San Francisco Bay is recognized as a site of hemispheric importance to shorebirds, supporting more than 500,000 shorebirds, and over one million waterbirds annually. A key migration and overwintering site, San Francisco Bay also provides critical breeding habitat for many waterbirds. South San Francisco Bay, in particular, has historically supported the largest Pacific coast breeding populations of American avocets (*Recurvirostra americana*) and black-necked stilts (*Himantopus mexicanus*), and approximately 30% of the Pacific coast breeding population of Forster's terns (*Sterna forsteri*). All three species rely on managed ponds for nesting habitat, with >70% of avocet and tern nests occurring on islands within these ponds that surround the bay's margins. Yet, the phased conversion of historic ponds into mixed open-water tidal marsh habitat and the construction of new nesting islands in remaining ponds as part of the South Bay Salt Pond (SBSP) Restoration Project, has changed the availability of waterbird nesting habitat. In May of 2019, we performed a comprehensive survey of breeding avocets, stilts, and terns throughout South San Francisco Bay. For this survey, we used a protocol similar to a 2001 survey of avocets and stilts previously published. The results of this study will provide an updated assessment of the breeding population size, distribution, and habitat use of three of the most abundant breeding waterbird species in South San Francisco Bay. Furthermore, by repeating the design and methods of the 2001 survey, we will evaluate changes in breeding population size and distribution over an 18-year period that includes restoration actions associated with the first phase of the SBSP Restoration Project. These data will inform management decisions and provide guidance for future phases of the South Bay Salt Pond Restoration Project.

Keywords: waterbirds, breeding, pond restoration, habitat use, population size, shorebirds, terns

Poster Topic: Species and Communities - Avian

Wetland Availability and Quality for Ducklings in Suisun Marsh

Sarah H. Peterson[1], Joshua T. Ackerman[1], Carley Schacter[1], Mark P. Herzog[1], C. Alex Hartman[1], Cliff L. Feldheim[2], Michael L. Casazza[1]

[1]U.S. Geological Survey
[2]California Department of Water Resources

sepeterson@usgs.gov, jackerman@usgs.gov, cschacter@usgs.gov, mherzog@usgs.gov, chartman@usgs.gov, Cliff.Feldheim@water.ca.gov, mike_casazza@usgs.gov

Suisun Marsh, within the San Francisco Bay Estuary, is an important breeding site in California for dabbling ducks within the Pacific Flyway. Relatively high densities of breeding hens nest within upland fields at the Grizzly Island Wildlife Area and subsequently travel with their broods to suitable summer wetland habitats for brood-rearing. As one of the largest brackish marshes in the western United States, the salinity levels of wetlands within Suisun Marsh can vary extensively. Growth rates of young ducklings can be impaired when subject to salinity levels > 2 ppt, and salinity levels > 12 ppt may be lethal to ducklings. We used satellite imagery to map the extent of wetland habitat available to ducklings in Suisun Marsh during 2016 – 2019. We measured conductivity and temperature in available wetlands at three times during each duck breeding season (early April, late May, and mid-July). We summarized the available summer wetland area and water quality of these habitats for both wetlands managed by the state of California Department of Fish and Wildlife and those managed by private land owners. Additionally, we showed the number of nesting hens (GPS transmitters) and duckling broods (VHF transmitters) that utilized these summer wetland habitats. The simultaneous management of upland nesting habitat with summer wetlands containing lower salinity levels is important to maintain the high breeding densities of ducks within the Suisun Marsh.

Keywords: conductivity, salinity, water management, waterfowl, Suisun Marsh, ducklings

Poster Topic: Species and Communities - Avian

Seasonal and Annual Variation in Body Condition Among Four Diving Duck Species Wintering in the San Francisco Bay

Mason Hill[1,2], Susan De La Cruz[1], John Eadie[2], Michael Casazza[3], Joshua Ackerman[3], Cory Overton[3], Cliff Feldheim[4]

[1]Western Ecological Research Center, USGS, San Francisco Bay Estuary Field Station
[2]University of California Davis
[3]Western Ecological Research Center, USGS, Dixon Field Station
[4]California Department of Water Resources, Suisun Marsh Program

mhill@usgs.gov, mhill@usgs.gov, sdelacruz@usgs.gov, jmeadie@ucdavis.edu, mcasazza@usgs.gov, jackerman@usgs.gov, coverton@usgs.gov, Cliff.Feldheim@water.ca.gov

As the largest estuary on the Pacific Coast of North America, San Francisco Bay (SFB) is a critically important waterfowl stop-over and wintering area. Diving ducks account for up to 75% of the waterfowl observed during the midwinter survey in SFB and adjacent managed ponds. This region is characterized by cyclical drought, increasing urbanization, non-native species invasions, and intensive water management. Consequently, diving ducks using this system are subjected to frequent changes in the quantity and quality of available habitat and associated prey. Waterfowl body condition can be a useful metric for measuring the quality of wintering ground habitat that can be linked to reproductive success and survival. Thus, our objective was to assess seasonal and annual variations in body condition of the four most abundant diving duck species (Canvasback, Greater and Lesser Scaup, and Ruddy Duck) in SFB. During November through April of 2017 - 2018 and 2018 - 2019 we collected 307 diving ducks to assess body condition using proximate analysis of moisture, lipid, protein, and mineral content. Initial generalized linear mixed models suggest that moisture and lipid content of all four species fluctuates seasonally, with some of the lowest values occurring in March when individuals should be maximizing endogenous reserves for migration and breeding. Understanding the factors driving these trends will be critical for optimizing restoration and management of habitat that can benefit diving ducks wintering in SFB.

Keywords: Body Condition, Diving Ducks, Waterfowl,

Poster Topic: Species and Communities - Avian

Diet and Nesting Trends of Two Sympatric Terns Breeding in the San Francisco Bay

David Riensche[1], Meredith Elliott[2]

[1]East Bay Regional Park District
[2]Point Blue Conservation Science

driensche@ebparks.org, melliott@pointblue.org

The Hayward Regional Shoreline, located along the eastern side of the San Francisco Bay, provides nesting habitat for two sympatric terns. The endangered California Least Tern (*Sternula antillarum browni*) nests near a newly established Forster's Tern (Sterna forsteri) colony on a separate island. Their diets overlap slightly. *Kleptoparasitism* by the larger Forster's Terns on California Least Terns has been observed at this location. Diet trend data, gathered by us by collecting dropped fish at the colonies of species in 2015 and 2016, showed they forage on members of the *Gobiidae*, *Engraulidae*, and *Atherinopsidae* families. There was a significant difference between diets of the terns, with silversides (*Atherinopsidae*) making up a much larger proportion of the prey of California Least Terns than of Forster's Terns. To understand the effect of possible kleptoparasitism by Forster's Terns on California Least Terns, we collected reproductive success data at both colonies. This site-specific information on the California Least Tern nesting activities and diet choice during the breeding season supports recovery plan tasks that are consistent with preserving and managing habitat for this endangered species. There was no significant difference in nesting or fledgling success between these two colonies. Although kleptoparasitism may affect the individual fitness of a single bird in terms of time and energy spent avoiding parasitism, and the need for additional foraging attempts to make up for these losses, we found no evidence indicating aerial theft by Forster's Terns resulted in reduced food availability for California Least Tern chicks, or affected California Least Tern productivity at this site.

Keywords: California Least Tern, diet, Forster's Tern, reproduction

Poster Topic: Species and Communities - Avian

Long-Term Water-Quality Monitoring in San Francisco Estuary: Effects of Varying Freshwater Inflow and Other Factors on Estuary Water Quality

Maureen Downing-Kunz[1], Paul Work[1], Daniel Livsey[1]

[1]U.S. Geological Survey

mokunz@usgs.gov, pwork@usgs.gov, dlivsey@usgs.gov

Estuarine water-quality parameters such as specific conductance (related to salinity), temperature, and suspended-sediment concentration (related to turbidity) define habitats and ecosystems and affect estuary-related economies. Freshwater inflow and other factors affect spatial and temporal variability in these parameters. This study presents an analysis of a long-term water-quality monitoring network located in San Francisco Estuary (SFE). The network comprises instruments equipped with specific conductance, temperature, turbidity, and depth sensors sampling every 15 minutes located throughout SFE. Using statistical analyses, of up to 28 years of continuous water-quality data from five stations, we investigated the effect of several factors—freshwater inflow, ocean temperature, air temperature, wind speed, and solar radiation—on observed water-quality parameters through Water Year (WY) 2018. At all stations, the greatest annual mean values of specific conductance (salinity) and water temperature occurred during WY 2014-2015; this period coincides with the recent California drought, during which freshwater inflow to SFE from the Sacramento-San Joaquin Delta (Delta) was low and air temperature was high. Using a multiple-linear regression modeling approach, we determined that one or both of land air temperature and ocean temperature were dominant factors in observed SFE water temperature during the warmest months (Jul-Sep); land air temperature dominated at stations further from the ocean boundary, while ocean temperature dominated at stations nearest the ocean boundary. Freshwater inflow to SFE had a small effect on interannual variability in SFE water temperature but was the dominant control on interannual variations in specific conductance for all sites. These results demonstrate the effect of freshwater inflow on the estuary 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 estuary will provide insight on potential effects from future droughts or other reductions in Delta flow.

Keywords: water-quality, estuary, freshwater inflow, salinity, temperature, drought

Poster Topic: Water Quality - General

Selenium Loads from Palo Alto Creeks to the Lower South Bay

Diego Martinez Garcia[1], Samantha Engelage[1]

[1]City of Palo Alto

Diego.MartinezGarcia@CityofPaloAlto.org, Samantha.Engelage@CityofPaloAlto.org

In June 2016, the U.S. Environmental Protection Agency (EPA) proposed lower selenium water quality criterion for the San Francisco Bay and Delta. Various regional evaluations have found that selenium bioaccumulation in the Lower South Bay is limited despite concentrations routinely exceeding the recently proposed criterion. Despite the low bioaccumulation, the higher water column concentrations remain of concern to many regulators. Potential sources of selenium to the Lower South Bay include municipal wastewater treatment plants, closed mercury mines, limestone quarries, creeks and rivers. The main objective of this study was to better understand natural sources of selenium to the Lower South San Francisco Bay from the Palo Alto watershed. The Palo Alto watershed contains numerous freshwater point sources including the Regional Water Quality Control Plant (a municipal wastewater treatment plant) and four creeks. Wet and dry season samples were collected in Matadero, Adobe, San Francisquito, and Barron creeks in 2019. Data was used to determine if there is a statistically significant difference between selenium concentrations during the wet and dry season. Creek selenium loading was also compared to that discharged from the Regional Water Quality Control Plant. Additionally, this study extended the historic time series for selenium sources in our region summarizing information on other potential sources of selenium including the Regional Water Quality Control Plant. Results from this study help to characterize the natural contribution of selenium to the Lower South Bay and how it compares to the municipal wastewater treatment plant load.

Keywords: Selenium, wastewater treatment, creeks, water quality.

Poster Topic: Water Quality – General

Bioswale Trees: Tree Growth and Soil Conditions in Bioswales Over a 5-Year Period

Igor Lacan[1]

[1]UC Cooperative Extension

ilacan@ucanr.edu

Although urban trees provide documented ecological services and benefits, their planting in street-side bioswales is hampered by concerns over their survival in this novel environment. To evaluate tree growth and health and assess any limitations on trees posed by the potentially unsuitable bioswale substrate, I repeatedly measured 102 bioswale trees in five Bay Area cities (Berkeley, Burlingame, El Cerrito, San Carlos, San Jose) and Portland (OR), and have recorded soil moisture in nine bioswales with in-situ dataloggers over the 2015-2019 period. Soil moisture results show that prolonged waterlogging was not found in any of the bioswales (including Portland), but also indicate consistently low summer moisture, with substrate tension frequently dropping to the permanent wilting point. Results suggest that this challenge can be managed with irrigation, but any disruption will be immediately problematic because of the low water-holding capacity of the substrate. Unexpectedly, other soil parameters (P, K, organic matter, pH, and salinity) did not differ significantly between bioswale substrate and the adjacent native soil; substrate texture did, with bioswales dominated by the sand fraction (median 75% by volume). Tree growth differed among eight species evaluated, with these inter-species differences exceeding those between the same species in bioswales and in the control environment (parkstrips). Growth was slow (approx. 1 cm of DBH yearly), although tree condition was good (median score 4 out of 5; using the Luley 4-element visual scale). No bioswale-specific tree problems were found, but two species (*Fraxinus* 'Leprechaun', and *Prunus avium*) were found unsuitable because of species-specific defects. The overall findings indicate that a wide palette of trees could be used in bioswales, although the species' growth rates will differ, and that – aside from low summer moisture, which is likely the critical factor limiting tree growth – soil conditions are not prohibitive to tree installation in bioswales

Keywords: green, infrastructure, rain, garden, biotreatment, mix, arboriculture, root, sensor, fertility.

Poster Topic: Water Quality - Stormwater Runoff

An Integrated Approach for Estimating Directly Connected Impervious Areas in Ungauged Basins

Anneliese Sytsma[1], Colin Bell[2], Bill Eisenstein[1], Matt Kondolf[1]

[1]University of California, Berkeley
[2]Colorado School of Mines

anneliese_sytsma@berkeley.edu, cdbell@mines.edu, weisenstein@berkeley.edu, kondolf@berkeley.edu

Directly connected impervious area (DCIA) - the proportion of impervious areas that are "directly connected" to urban drainage systems – are reported to be a better indicator of hydrologic response, stream alteration, and water quality than total impervious area. Distributed stormwater controls, if sited appropriately, will play an important role in meeting stormwater management goals while significantly reducing DCIA. However, most methods for quantifying and identify DCIA require major assumptions regarding the definition of 'connection', potentially over-simplifying the role that climate, slope, soils condition, and (im)pervious geometry play in determining connectivity. This study presents a new conceptual model and methods for identifying and quantifying DCIA while accounting for landscape and storm variability. The conceptual model separates impervious surfaces into three categories - physically connected (Aphys), indirectly connected (Aic) (impervious that drains to pervious), and rooftop area (Ar). We modeled Aic connectivity in PySWMM, the python API for SWMM5. Simulations spanned two parameter sets: (1) a set of urban soil/slope/rainfall scenarios; and (2) im(pervious) geometric relationships (area, width, pervious fraction). PySWMM results were used to train and test a classification regression tree to predict infiltration and connectivity based on these parameters. To enable diffusion of these methods into practice, we developed an ArcGIS tool to extract the impervious surface categories and apply connectivity fractions, then applied the tool to the Upper Petaluma River Watershed in Sonoma County, California. The results show that Aic connectivity is highly sensitive to soil infiltration rate and pervious fraction, while the classification regression tree provides excellent fidelity with PySWMM outcomes. This research represents an important step forward for integrating spatial heterogeneity into stormwater modeling and planning. Specifically, these methods can be used to more accurately identify DCIA in urban watersheds, which can in turn be used to more efficiently prioritize locations for distributed stormwater controls.

Keywords: Directly connected impervious, stormwater runoff, distributed stormwater controls, geospatial tools

Poster Topic: Water Quality - Stormwater Runoff

Development of Dissolved Oxygen Criteria in Suisun Marsh

Sujoy Roy[1], Jennifer Flippin[1], Jerry Diamond[1], Barbara Baginska[2], Kevin Lunde[2]

[1]Tetra Tech Inc.
[2]San Francisco Bay Regional Water Board

sujoy.roy@tetratech.com, jennifer.flippin@tetratech.com, jerry.diamond@tetratech.com, Barbara.Baginska@waterboards.ca.gov, kevin.lunde@waterboards.ca.gov

Suisun Marsh, in the northern reaches of San Francisco Bay, is the largest tidal wetland in California, which supports a high diversity of aquatic life in its mix of open water sloughs and managed wetlands. Managed wetland discharges into sloughs and limited tidal flushing have affected dissolved oxygen (DO) levels in some open waters of Suisun marsh, with adverse effects on aquatic life. To address this impairment, the San Francisco Bay Water Board has adopted a Total Maximum Daily Load (TMDL) for Suisun Marsh which includes new DO water quality objectives. This is the first effort since 1975 to refine DO water quality objectives in the San Francisco Bay region, and may have broader application for other tidal marshes on the California coast. This poster describes the process used to develop DO criteria in the marsh, based on several refinements of EPA's Virginian Province approach. From the list of fish and invertebrate species present in the marsh, we identified surrogate species with toxicological data on DO effects. Surrogate species selection was a key step since published toxicological studies on DO are not available for all local species. We defined DO criteria for chronic and acute exposure time frames (day, week, and month). This work also made use of continuous DO data from reference stations, collected over a decade, and data on fish abundance in the marsh from monthly trawls conducted over 17 years to evaluate naturally attainable expectations for DO. The new DO objectives are intended to protect against the adverse effects of low DO on survival, growth, reproduction, and behavior of fish in the marsh and to accommodate both spatial and temporal aspects of low oxygen events. Recent DO data collected across the marsh are compared to the new criteria.

Keywords: TMDL, dissolved oxygen objectives, acute exposure, chronic exposure

Poster Topic: Water Quality - TMDL Implementation

Testing Managed Wetlands BMPs for Improving Water Quality and Achieving TMDL Objectives in Suisun Marsh

Stuart Siegel[1], Steve Chappell[2], Sujoy Roy[3], Philip Bachand[4], Dan Gillenwater[5], Barbara Baginska[6], John Takekawa[2]

[1]San Francisco Bay National Estuarine Research Reserve
[2]Suisun Resource Conservation District
[3]Tetra Tech
[4]Bachand & Associates
[5]Gillenwater Consulting
[6]San Francisco Bay Regional Water Quality Control Board

siegel@sfsu.edu, schappell@suisunrcd.org, sujoy.roy@tetratech.com, philip@bachandassociates.com, dan@gillenh2o.com, Barbara.Baginska@waterboards.ca.gov, jtakekawa@suisunrcd.org

Suisun Marsh, in the northern reaches of San Francisco Bay, California, is a mosaic of over 100,000 acres of diked managed wetlands, tidal wetlands, bays and sloughs, and adjacent uplands, and supports a high diversity of resident and migratory terrestrial and aquatic wildlife species. Dead end sloughs in Suisun Marsh have historically experienced episodic low dissolved oxygen (DO) and high methyl mercury (MeHg) events, adversely affecting aquatic life and other beneficial uses. As a result, the Regional Water Quality Control Board added Suisun to the Clean Water Act Section 303(d) impairment list. To help address these problems, the State Board funded an investigation from 2007-2011 that identified a variety of best management practices (BMPs) that were implemented and monitored in selected managed wetlands over 2015-2018 under a USEPA grant. BMPs included structural and operational modifications and were coordinated by the Suisun Resource Conservation District. Water quality effects on wetland discharges and sloughs were field measured from 2016-2018 focused on Peytonia and Boynton sloughs. Monitoring included continuous wetland and slough stage and water quality (temperature, DO, conductivity, and pH) and discrete grab sampling for organic carbon, biochemical oxygen demand in water and sediment, and MeHg. Data collected through this project, combined with previous monitoring data, indicate that slough water quality has improved since BMP implementation, and DO levels—a key metric for aquatic beneficial uses—are generally higher than the new TMDL chronic and acute objectives. Modeling described observed changes in water quality across Peytonia and Boynton sloughs under a range of mixing conditions. In addition, modeling explored the extent of DO improvement achievable through more extensive BMP implementation; in general significant improvements are possible, but limited by the level of tidal flushing in the upstream ends of sloughs and physical and environmental constraints.

Keywords: Water quality, dissolved oxygen, methylmercury, BMPs, TMDL, Suisun, managed wetlands

Poster Topic: Water Quality - TMDL Implementation

Evaluation of Automated Raman Analysis for Monitoring Microplastics in Environmental Samples from the San Francisco Estuary

Jackelyn Lang[1], Swee Teh[1], Jenessa Gjeltema[1]

[1]University of California, Davis

jblang@ucdavis.edu, sjteh@ucdavis.edu, jgjeltema@ucdavis.edu

Microplastics are a contaminant of emerging concern due to their high production volume, ubiquitous presence, persistence in the environment, and potential for toxicity to a variety of species, including humans. As efforts increase to better define and understand the risks posed by microplastic contamination in the upper San Francisco Estuary, establishing accurate and precise methods of identification and characterization of particles is imperative. Techniques for sample collection, preservation, transport, and analysis must be harmonized to facilitate production of meaningful data and comparable results. Raman microspectroscopy is one method of non-destructive particle identification and characterization that is particularly useful for analyzing particles in the biologically relevant 1 – 20 um size range. This study evaluated automated Raman microspectroscopy as a method for monitoring microplastics in environmental samples from the estuary. Microplastic standards were subject to different factors related to sampling, processing, and analytical techniques. Samples were evaluated with a Horiba Xplora Plus Raman confocal microscope outfitted with 532 and 785nm lasers using automated analysis. Particle spectra from each sample were compared to control samples to determine the effect of each factor on the quality of results produced. This data was used to determine whether automated Raman analysis can be used to routinely screen estuary samples for the presence of microplastics. In the near future, we propose to use automated Raman microspectroscopy as a tool to monitor environmental samples for microplastics contamination in the San Francisco Estuary.

Keywords: Microplastics, Contaminant, Raman, Spectroscopy

Poster Topic: Water Quality – Emerging Contaminants

The Effects of Copper Exposure on the Olfactory Organ of Delta Smelts: From Tissues to Behavior

Pedro Alejandro Triana Garcia[1], Swee Teh[2]

[1]Aquatic Health Program, Integrative Pathobiology Graduate Group, University of California, Davis.
[2]Aquatic Health Program, University of California, Davis.

trianagarcia@ucdavis.edu, sjteh@ucdavis.edu

Delta Smelt (*Hypomesus transpacificus*) is native to the San Francisco Bay-Delta and currently is listed under the category of critically endangered by the International Union for conservation of Nature (IUCN). Copper is widely used in agricultural, industrial and boating practices, and its effects on the sensory systems of fish have been well documented. However, these effects have not been documented for *Osmerid* species. We studied the effects of copper (CU+2) exposure on the olfactory rosette of Delta Smelts and correlated these changes with functional impairment using behavioral endpoints. We included olfactory rosettes for histological analysis from 6 fish in a control group, 5 fish exposed to 5 µg CU+2/L and 3 fish exposed to 80 µg CU+2 /L for 96 hours. In addition, after exposure to 5 µg CU+2/L we tested 10 fish for behavioral responses to alarm cues and compared the same response to the non-exposed group. We used changes in swimming speed as a behavioral endpoint. Fish in the 80 µg CU+2/L treatment were not tested due to low survival. Copper exposure affected the olfactory epithelium in a dose-dependent manner. The control fish had a well-conserved sensory epithelium and few apoptotic cells. In contrast, the groups exposed to 5 and 80 µg CU+2/L had increased amounts of apoptotic cells, lack of surface structures (sensory cilia), and a thinner sensory epithelium. Functionally, the fish from the control group, responded in a greater proportion to the alarm cues by sudden changes in speed, dashing and freezing behaviors, in contrast, the fish exposed to 5 µg CU+2/L did not show any of these behaviors when exposed to alarm cues. A 96 hours copper exposure at low environmentally relevant concentrations can impair the detection of odorants in Delta Smelts, in consequence, causing alterations in pivotal behaviors for survival as the alarm response.

Keywords: Delta Smelt, Copper, olfactory rosette, alarm behavior, histopathology, odorants.

Poster Topic: Water Quality – Emerging Contaminants

Bottom-up Controls on Phytoplankton Community Composition in Lower South Bay

Jaylyn Babitch[1], Eric Dunlavey[1], Bryan Frueh[1], Anne Hansen[1], Ryan Mayfield[1], Simret Yigzaw[1]

[1]City of San Jose

jaylyn.babitch@sanjoseca.gov, eric.dunlavey@sanjoseca.gov, bryan.frueh@sanjoseca.gov, anne.hansen@sanjoseca.gov, ryan.mayfield@sanjoseca.gov, simret.yigzaw@sanjoseca.gov

The Lower South Bay (LSB) contains relatively high concentrations of inorganic nitrogen in the form of nitrate (NO3), nitrite (NO2), and ammonia (NH3), as well as phosphates (PO4). These nutrients are received from San Francisco Bay tidal water, urban runoff, and wastewater treatment facilities, including the San Jose-Santa Clara Regional Wastewater Facility (SJ-SC RWF). While phytoplankton in San Francisco (SF) Bay have traditionally been considered primarily light-limited, concern is growing over the potential effects the elevated nutrient levels may have on SF Bay phytoplankton bloom dynamics and community composition. Since 2016, the SJ-SC RWF has conducted monthly to bi-weekly monitoring at six stations in LSB for NO3, NO2, NH3, PO4, hydrographic parameters (e.g. temperature, salinity, pH, Secchi depth), as well as phytoplankton abundance and taxonomic identification. This poster presents multivariate analyses that aim to identify the major bottom-up environmental drivers of phytoplankton community composition and abundance of major taxa at varying distances from the SJ-SC RWF outfall. From 2016 to 2018, approximately 170 phytoplankton genera from 8 divisions were identified among the monitoring stations. Preliminary analyses using the BIOENV routine in Primer v. 7 show that at stations farther from the SJ-SC RWF outfall, phytoplankton community composition is best explained by the combination of NO3+NO2 and Secchi depth (Rho=0.46 and 0.41 for two stations, respectively). Stations nearer the outfall show only weak relationships between community composition and NH3 (Rho=0.12 and 0.21 for two stations, respectively). These preliminary results suggest that while nutrients may not strongly control the phytoplankton community, different nitrogen forms may have distinct effects along environmental gradients, and turbidity becomes more important with increasing distance from wastewater discharge. Seasonal and spring-neap tidal cycle influences are also being investigated.

Keywords: phytoplankton, community, bottom-up, nutrients, Lower South Bay

Poster Topic: Water Quality – Nutrients

Oral Toxicity of Purified Microcystin – LR in Mallards

Swee Teh[1], Yih Tyng Bong[1]

[1]University of California, Davis

sjteh@ucdavis.edu, ybong@ucdavis.edu

Freshwater harmful algal blooms (HABs) are becoming an increasing concern worldwide due to their ability to produce a vast variety of cyanotoxins. Among them, the most potent and commonly detected cyanotoxin in California, is microcystin, particularly the microcystin-LR (MC-LR) congener. Some wild bird mortality events associated with blooms have been reported but establishing causal relationships between microcystin exposure and observed effects is difficult due to the presence of at least 80 different microcystin congeners, unknown exposure dosages and intervals, and strong potential for concurrent exposure to multiple toxins. To understand the effects of microcystin-LR in aquatic birds, this project investigated acute oral toxicity of purified MC-LR in ducks via single-dose exposure. No mortality was observed at the end of the study. All treated animals showed weight loss, and only the duck that was exposed to a lower dose showed significant decreased ambulation. Aspartate aminotransferase (AST), an indicator of liver and muscle damage in the high-dose duck was 800-fold higher than all the other treated animals in this study. MC-LR was localized along bile canaliculi, kidney proximal tubule, and testicle seminiferous tubules via immunohistochemistry. Histopathology and periodic acid-Schiff staining showed structural alteration in the basement membrane of kidney proximal tubules and testicle seminiferous tubules, indicated nephrotoxicity and reproductive toxicity. Total microcystins (free and tissue-bound) were detected via gas chromatography in liver, kidney and testicles, but not pectoral muscle and feather. Mallard ducks seemed to be resilient to acute MC-LR exposure and were able to recover after two weeks, but histopathology results indicated that there might be detrimental long-term effects. This study is the first to look at the effects of MC-LR in mallard ducks in a laboratory setting, and the findings suggested that exposure to MC-LR at a lower dose and its longer-term effects warrant further investigation.

Keywords: Microcystin, harmful algal bloom, HAB, cyanobacteria, cyanotoxin, wildlife, pathology, toxicology

Poster Topic: Water Quality – Nutrients

Using High Frequency Observations to Characterize Spatial Variability in Nutrients and Phytoplankton Production in San Francisco Bay

Ariella Chelsky[1], Taylor Winchell[1,2], Elizabeth Stumpner[3], Bryan Downing[3], Brian Bergamaschi[3], David Senn[1]

[1]San Francisco Estuary Institute
[2]Denver Water
[3]US Geological Survey

ariellac@sfei.org, taylorwinchell@gmail.com, taylorwinchell@gmail.com, estumpner@usgs.gov, bdowning@usgs.gov, bbergama@usgs.gov, davids@sfei.org

Observations over the past 40+ years indicate that South San Francisco Bay (SSFB) generally experiences low phytoplankton productivity despite its highly-enriched nutrient status. However, shifts in SSFB's fall productivity since the late 1990s have led to increased scientific investigation of the effects of elevated nutrient levels in the system, with a focus on identifying protective nutrient loads. Over the past 4 years, we have installed a network of high frequency moored sensors at sites in SSFB's channel and along its broad eastern shoal, which measure a suite of environmental variables (e.g. chl-a, nitrate and water velocity) at 15 minute intervals. Channel mooring and shoal mooring data were analyzed to explore bloom dynamics and characterize factors influencing productivity in these adjacent habitats. Chl-a concentrations and calculated gross primary production rates were often substantially higher along the shoal than in the channel, indicating that that the shoals can be important hot spots of production. A distinct inverse relationship between chlorophyll and nitrate was evident during shoal bloom events, and sustained drops in nitrate to

Keywords: Gross primary production, high frequency sensors, water quality, dissolved oxygen

Poster Topic: Water Quality – Nutrients

Monitoring Benthic Invertebrate near treated Wastewater Discharge in the Lower South Bay

Ryan Mayfield[1], Eric Dunlavey[1], Jaylyn Babitch[1], Bryan Frueh[1], Anne Hansen[1], Simret Yigzaw[1]

[1]City of San Jose

ryan.mayfield@sanjoseca.gov, eric.dunlavey@sanjoseca.gov, jaylyn.babitch@sanjoseca.gov, bryan.frueh@sanjoseca.gov, anne.hansen@sanjoseca.gov, simret.yigzaw@sanjoseca.gov

The Lower South Bay (LSB) contains relatively high concentrations of inorganic nitrogen in the form of nitrate (NO3), nitrite (NO2), and ammonia (NH3), as well as phosphates (PO4). These nutrients are received from San Francisco Bay tidal water, urban runoff, and wastewater treatment facilities, including the San Jose-Santa Clara Regional Wastewater Facility (SJ-SC RWF). As a wastewater discharger in the LSB, the SJ-SC RWF was interested in investigating the influence of nutrients from its treated effluent discharge on the local environment. One avenue of investigation we initiated in 2016 was through the initiation of an ecological monitoring program that included sampling for benthic invertebrates and chlorophyll. Bi-monthly grab samples were taken at 6 stations in the Alviso Marsh area. These data provide useful information on phytoplankton biomass along with benthic diversity and abundance in waters located near wastewater discharge. This information provides ongoing baseline ecological measurements of the abundance of phytoplankton growing in a nutrient enriched estuary, and how the phytoplankton supports and may be controlled by the benthic community. Chlorophyll monitoring showed an increase in the vicinity of the treated wastewater, however, this is confounded by the nearby discharge of a former salt pond, which has a very long hydraulic residence time and produces high densities of phytoplankton. There was no clear relationship between chlorophyll and benthic invertebrate abundance. The majority of the invertebrates sampled were Arthropods (*Americorophium* and *Cyrpideis*) comprising 60%, followed by Annelids (*Strebliospio*) at 35%. Invertebrate abundance increased substantially in the vicinity of treated effluent discharge as well as species richness.

Keywords: Lower South Bay, nutrients, phytoplankton abundance, benthic community

Poster Topic: Water Quality – Nutrients

Nitrification Rates in South San Francisco Bay

Anna Rasmussen[1], Chris Francis[1]

[1]Stanford University

arasmuss@stanford.edu, caf@stanford.edu

San Francisco Bay is a highly nitrogen (N) polluted estuary containing two distinct ecosystems, often referred to as North and South Bay. South San Francisco Bay is a tidal lagoon with longer residence times and high inputs of ammonia from wastewater treatment plants. Despite the importance of nitrification for conversion of ammonia to nitrate, nitrification rate measurements are limited in this portion of the Bay. Generally, nitrification is carried out by two functional guilds of organisms: ammonia-oxidizing archaea (and bacteria) and nitrite-oxidizing bacteria. Microbial sequence data from South San Francisco Bay indicates that ammonia-oxidizing archaea were very abundant in the autumn of 2012 and 2013 and nitrite accumulated up to 10 μM, indicating that ammonia and nitrite oxidation may have become decoupled. While geochemical and molecular data suggest ammonia-oxidizing archaea may have bloomed in South San Francisco Bay, nitrification rates during these apparent blooms are lacking. From 2018 to 2019, nitrification rates were measured on cruises approximately quarterly via stable isotope incubations onboard the USGS-operated R/V Peterson during water quality monitoring cruises. Incubations were set up by the addition of 15N-ammonia to 450mL of bay water in gas-tight foil bags at 4 stations (30, 27, 24 and 18) along the channel in South Bay. Water was subsampled immediately after 15N-ammonia addition and 6 hours later in order to calculate nitrification rates based on the conversion of 15N-ammonia to 15N-nitrite+nitrate. In the Fall of 2018, ambient nitrite concentrations reached up to 12 μM, indicating high rates of ammonia oxidation. Pelagic microbial biomass was also collected on 0.2 μm filters from these stations for nucleic acid extraction and use of qPCR to measure ammonia oxidizer abundances.

Keywords: nitrification, archaea, bacteria, ammonia-oxidation, Nitrogen, molecular biology, South Bay

Poster Topic: Water Quality – Nutrients

Exploring Methods to Study Nitrifiers in South San Francisco Bay

Benji Reade Malagueño[1], Anna Rasmussen[1], Chris Francis[1]

[1]Stanford University

benjilrm@stanford.edu, arasmuss@stanford.edu, caf@stanford.edu

Nitrification—the microbial oxidation of ammonia to nitrite and then nitrate—is a critical step in the nitrogen cycle, linking N2 fixation and denitrification pathways, as well as producing nitrogen compounds that are readily available for primary producers like phytoplankton and plants. Given that the San Francisco Bay ranges from seawater salinity near its mouth to brackish wetlands and fresh river water in other areas, studying nitrification rates is key to understanding nitrogen-cycling in such a complex ecosystem. Furthermore, greater knowledge of the Bay's nitrification patterns facilitates efforts to both manage the Bay's significant nitrogen influx and bolster the estuary's resilience to eutrophication. Currently, nitrification rate measurements in South San Francisco Bay are limited. In this study, we used stable isotope tracer methods to measure nitrification rates in South San Francisco Bay while onboard the USGS R/V Peterson. Incubations were set up by adding 15N-ammonia to gas-tight restek bags containing 450mL of bay water. These bags were subsampled immediately after addition of ammonia, after 6 hours, and after 22 hours to measure 15N-NO3 accumulation. During subsampling, we filtered ~50mL of water from each incubation bag through a 0.2µM filter. Filters were flash-frozen in liquid nitrogen and saved in order to assess the nitrifying populations over the incubation period. We later extracted nucleic acids from the filters and utilized qPCR to analyze ammonia-oxidizing archaea and bacteria populations, investigating whether the microbial abundances in the bags changed over the incubation period and whether incubation communities are representative of the Bay.

Keywords: Nitrification, archaea, bacteria, ammonia-oxidation, nitrogen, molecular biology, South Bay

Poster Topic: Water Quality – Nutrients

A Conceptual Model for the Transport of *Microcystis aeruginosa* and microcystin Between Water, Sediments, and Bivalves in the San Francisco Estuary

Jenna Rinde[1], Amalia Kokkinaki[1]

[1]University of San Francisco

jennarinde@outlook.com, akokkinaki@usfca.edu

Microcystis aeruginosa is a fluorescent cyanobacterium found in surface freshwater but has become a threat to coastal environments like the San Francisco Estuary, due to freshwater inputs. *Microcystis* blooms are a concern since they can create toxins called microcystins, which have the ability to bind to sediments and bioaccumulate. Most research in the San Francisco Estuary has focused on *Microcystis* in its planktonic state, or on the microcystins' eco-toxicological impacts. However, little is known about the transport pathways of *Microcystis* and microcystins in the San Francisco Estuary. Microcystins were recently detected in California mussels and sea otters in coastal environments indicating the need to understand how microcystins transport across all environmental compartments. To better understand the distribution of Microcystis and microcystin in the San Francisco Estuary, a literature review was conducted to identify pathways of transport between the water column, sediments and bivalves. A conceptual model was created and used to study how environmental factors can affect microcystin transport in an estuary, and how such environmental factors can lead to harmful *Microcystis* blooms. The processes affecting microcystin distribution in the water, sediment and biotic phase were synthesized within an integrated qualitative framework that spans the winter and summer period. The model factors in the behavior of *Microcystis* in its different life stages, such as the fact that *Microcystis* overwinters in the benthic environment. The developed model identifies linkages between the *Microcystis* present in different environmental compartments in the San Francisco Estuary and is used to propose a monitoring framework that will allow us to gain more insight on bloom triggering mechanisms and indicators and, most importantly, to develop tools to expand on existing capabilities to predict blooms.

Keywords: water quality, sediment, bivalve, management, environmental monitoring

Poster Topic: Water Quality – Nutrients

Constituent Fluxes of Chlorophyll-a and Nitrate from a Shallow Shoal in San Francisco Bay

Elizabeth Stumpner[1], Brian Bergamaschi[1], Tamara Kraus[1], Bryan Downing[1], Paul Stumpner[1], Ariella Chelsky[2], David Senn[2]

[1]U.S. Geological Survey
[2]San Francisco Estuary Institute

estumpner@usgs.gov, bbergama@usgs.gov, tkraus@usgs.gov, bdowning@usgs.gov, pstump@usgs.gov, ariellac@sfei.org, davids@sfei.org

Numerous physical and biogeochemical factors exert control on primary production in estuaries. Factors like nutrients, suspended sediment, tides, and currents have typically been studied within the San Francisco Bay during monthly cruises or at fixed stations that are limited to deep channels where ease of access and infrastructure security is greatest. However, shoals in the San Francisco Bay make up the largest habitat by area and have the potential to support higher rates of phytoplankton growth and nutrient transformation. Collecting high-frequency measurements on shoals allow us to more accurately assess aquatic conditions and constrain models to inform managers about biogeochemical processes. We present chlorophyll-a and nitrate flux data collected on a shoal north of the San Mateo Bridge where water-quality measurements (sampling at 1 Hz for 30 seconds every 15 minutes) are made 1-meter below the surface near a bottom-mounted acoustic doppler current profiler (sampling at 1 Hz for 400 seconds in 0.25 m vertical bins every 15 minutes). The along stream velocity on the shoal is NNW and SSE representing on-shoal and off-shoal directions, respectively. We observed that peak phytoplankton biomass typically coincides with the neap to spring transition and can correspond to nitrate concentrations

Keywords: nitrate, chlorophyll-a flourescence, constituent flux, shoal, high-frequency measurements

Poster Topic: Water Quality – Nutrients

The Response of Phytoplankton Productivity to Agricultural Flow Releases in the North Delta

Frances Wilkerson[1], Sarah Blaser[1], Jessica Wison[1], Jared Frantzich[2], Ted Sommer[2], Brittany Davis[2]

[1]Estuary and Ocean Science Center, RTC, San Francisco State University
[2]CA Department of Water Resources,

fwilkers@sfsu.edu, sblaser@sfsu.edu, jwilson5@sfsu.edu, Jared.Frantzich@water.ca.gov, Ted.Sommer@water.ca.gov, Brittany.E.Davis@water.ca.gov

Lack of phytoplankton blooms is a major factor responsible for the decline of many San Francisco Estuary/Delta fishes including the endangered Delta Smelt. Managing agricultural return waters to the North Delta has been proposed to promote primary productivity and increase phytoplankton biomass downstream. In fall 2011 a diatom bloom occurred in the lower Sacramento River after a seasonal agricultural flow pulse passed through the Yolo Bypass. In summer 2016 irrigation water released into the Yolo Bypass also resulted in increased chlorophyll (phytoplankton) downstream at Rio Vista. A concern is whether this chlorophyll is associated with elevated primary productivity, therefore making it useful as a food subsidy or whether it is advected. To determine the effects of agricultural flow releases on primary productivity, we measured carbon and nitrogen uptake rates, and chlorophyll before, during and after the 2018 North Delta Flow Action; a managed augmented flow pulse in late summer using drainage water from rice-fields near the Colusa Basin. Unexpectedly, there was no increase in chlorophyll near Rio Vista, although there was some increase in the lower Bypass. Using 2017 (with no Action) for comparison, 2018 productivity rates were low even though the water was less turbid. Nutrient concentrations in 2018 indicated that that levels of nutrients leaving the upper Yolo Bypass were low, as was water that was used to increase the flow, suggesting that nutrients were insufficient for a bloom to occur downstream. Additionally, there was an early flow discharge by the rice farmers before the Action and the initial chlorophyll seed stock was low. These results suggest that in future flow actions, the water quality of the managed source water being used to increase flow needs to be evaluated and we propose use of short-term grow-outs/bioassays using the agricultural flow water.

Keywords: phytoplankton, productivity, flow, nutrient, chlorophyll

Poster Topic: Water Quality – Nutrients

From Trash to Data: Using Bycatch to Gain Insight into Trash Trends

Emma Davidson[1], Justin Dummitt[1]

[1]US Fish and Wildlife Service

emma_davidson@fws.gov, justin_dummitt@fws.gov

The Lodi U.S. Fish and Wildlife Service conducts year-round fish sampling efforts throughout California's San Francisco Bay-Delta (Delta). Each week's sampling covers between 51 and 56 nearshore sites and between 38 and 43 trawl sites. These sites range from the western edge of the San Francisco Bay, to Colusa on the Sacramento River, to the confluence of the Tuolumne and San Joaquin rivers, covering a total area of approximately 3800 square kilometers. Through this sampling, the monitoring crews frequently collect trash as bycatch and dispose of it appropriately. We began using the citizen-science based trash collection phone application Litterati in December of 2018. Using this application we get photos of individual pieces of trash, identify type, method of collection, and GPS location. Within the first seven months, over 800 pieces of trash were collected, with over 50% being plastic. The majority of the trash recorded to date was collected as bycatch during normal sampling. A percentage of the trash bycatch is able to be paired with sampling effort, allowing for CPUE estimates that can inform and show relative trash abundance trends over space and time.

Keywords: trash, bycatch, fisheries, water quality

Poster Topic: Water Quality – Trash

A New Map of Oakland's Creeks

Mike Perlmutter[1], Deidre Martin[1], Jennifer Stern[1]

[1]Oakland Public Works

mperlmutter@oaklandca.gov, dmartin@oaklandca.gov, jstern@oaklandca.gov

Oakland has an extensive network of creeks that flow from the hills to San Francisco Bay. Parts of Oakland's creeks have been culverted in underground pipes to accommodate urban development. Some Oakland creek segments still flow wild and free, and some culverted stretches are being daylighted and restored. In the heavily urbanized Oakland landscape, creeks are some of the last remnants of wild habitat, and they serve as critical wildlife refuges, migratory stopovers, and corridors between open spaces and parks. Oakland's creeks also carry all the water, and all that's washed down with it (such as sediment and pollutants) from the city to the bay through more than 12,000 storm drain inlets. The City of Oakland has developed a new map of these creeks, printed and distributed as a Creek to Bay Day promotional bandana, and now as a large format poster in English, Spanish, and Chinese for field and classroom educational use. At the State of the Estuary Conference, The City of Oakland will present these maps alongside a poster detailing Oakland's key trash management actions. Find out more information at www.oaklandcreeks.org.

Keywords: Oakland, creek, map, urban, watershed, education

Poster Topic: Water Quality – Trash

Trash Management in Oakland

Kristin Hathaway[1], Jennifer Stern[1], Ben Livsey[1], Jeff Roubos[1], Mike Perlmutter[2], Deidre Martin[2]

[1]City of Oakland Public Works Watershed and Stormwater Management
[2]City of Oakland Public Works Environmental Stewardship

khathaway@oaklandca.gov, jstern@oaklandca.gov, blivsey@oaklandca.gov, jroubos@oaklandca.gov, mperlmutter@oaklandca.gov, dmartin@oaklandca.gov

The City of Oakland, coordinates and implements a multi-faceted trash management strategy to maintain quality of life for Oaklanders, and reduce trash entering San Francisco Bay. Oakland's main challenge is large volumes and geographic spread of trash. In fiscal year 2018/19, illegal dumping alone accounted for over 45,000 cubic yards of trash dumped throughout Oakland. This poster will give an overview of Oakland's trash management actions, and the volumes of trash being prevented from entering San Francisco Bay. Lessons learned from Oakland's approach may serve as guidance to other cities in tackling their trash management challenges, especially homelessness and illegal dumping issues. The poster will showcase the innovative and comprehensive approach Oakland has taken to meet trash reduction requirements for a diverse city of its size and population. The City's trash management includes trash capture systems, street sweeping, illegal dumping enforcement and removal, homeless encampment management, material source control (such as bans on plastic bags, Styrofoam, and straws), business improvement districts, an excess litter fee ordinance, an education and outreach campaign focused on preventing illegal dumping, and a volunteer program. The City's combination of trash management actions has reduced trash entering the storm drain system and our local waterways, and helped the City meet our clean water compliance goals. Each of these actions on their own could not adequately address Oakland's trash management, though taken together, they collectively account for a greater trash reduction percentage each year. Furthermore, the enhanced efforts of collaboration and partnering between the City of Oakland, our residents, other agencies, and the business community improves quality of life and public safety for all. If accepted, we would request our poster be displayed adjacent to the poster being proposed by Oakland's Environmental Services Division showcasing Oakland's newest creek maps, as this provides a reference for local waterways

Keywords: Oakland, trash, water quality, illegal dumping, homeless, volunteer, outreach

Poster Topic: Water Quality – Trash

Review of the Sacramento San-Joaquin Delta Conservancy's Efforts on Trash Clean-Ups in the Delta

Brian N. Keegan[1], Aaron N.K. Haiman[1], Laura B. Jensen[1]

[1]Sacramento-San Joaquin Delta Conservancy

brian.keegan@deltaconservancy.co.gov, aaron.haiman@deltaconservancy.ca.gov, laura.jensen@deltaconservancy.ca.gov

For more than seven years, the Sacramento-San Joaquin Delta Conservancy (Conservancy) has led trash clean-ups along Delta waterways to remove refuse from an ecosystem that has tons of trash move through it every day. The Conservancy's clean-up efforts align with Estuary Blueprint Goal 1: Sustain and improve the Estuary's habitats and living resources, and with Blueprint Goal 3: Improve water quality and increase the quantity of fresh water available to the estuary. The Conservancy partners with a diverse group of stakeholders – comprised of multiple levels of government, non-profits, private companies, the education sector, local communities, and the media – to lead annual clean-ups at four different locations across the Delta. Trash removal helps limit microplastics, carcinogenic chemicals, and other pollutants in this integral part of the California water supply. However, current efforts cannot remove most of the garbage that flows into the Delta before it breaks down or flows into the ocean. In the seven years that the Conservancy has worked on this issue, the amount of trash removed annually has remained relatively constant. During this time, the Conservancy has worked to find and develop a tool that can be used to accurately measure the amount and type of trash that moves through the Delta. This poster will give a qualitative overview of challenges and lessons learned, trash tracking tools with different levels of current use and future promise, and next steps for impactful trash removal in the Delta.

Keywords: Trash, Delta Waterway Cleanup, Citizen Science, Volunteer, Litter

Poster Topic: Water Quality – Trash

Illegal Dumping Removal and Prevention from Contra Costa Agricultural Lands

Ben Weise[1]

[1]Contra Costa Resource Conservation District

bweise@ccrcd.org

In partnership with local farmers and ranchers, and with funding from the CalRecycle Farm and Ranch Solid Waste Cleanup and Abatement Grant Program, the Contra Costa Resource Conservation District (CCRCD) is working to remove illegally dumped waste from agricultural lands. Removing this waste is beneficial to farms and ranches, but also helps to sustain and improve the San Francisco Estuary's habitats, living resources, water quality, and quantity available to the Estuary. Illegal dumping is a problem all too common on agricultural lands that are often remote and difficult to monitor. In Contra Costa County, the County removes illegally dumped waste from public lands, roads, and rights-of-way. On private lands, the responsibility for waste cleanup is left to the landowners. More often than not, this results in waste accumulation as farmers and ranchers are unable to remove the waste due to cost, regulations, or unfamiliarity with how to remove hazardous waste such as paint and tar or bulk waste like automobiles or motorboats. The waste is usually piled on parts of the property that are not used for farming operations—these areas are usually out of sight, so as not to attract more illegal dumping, in locations near farm residences/buildings or adjacent to waterways near creeks or levees. Through CalRecycle's Farm and Ranch Solid Waste Cleanup and Abatement Grant Program, the CCRCD receives funds to help remove this waste and construct prevention measures. Since 2018, the CCRCD has received $81,625 from CalRecycle to remove over 150 automobile and construction equipment tires, 120 tons of construction debris, household waste, green waste, and soil that otherwise would have remained on the land, slowly breaking down into our creeks, rivers, and eventually, the San Francisco Estuary.

Keywords: Illegal Dumping, Agriculture, Water Quality, Hazardous Waste, Soil Quality

Reference #: 0366_0537_000054

Poster Topic: Water Quality – Trash

Delta Science Plan 2019: Vision, Principles, and Approaches for Integrating and Coordinating Science in The Delta

Yumiko Henneberry[1]

[1]Delta Science Program

yumiko.henneberry@deltacouncil.ca.gov

The first Delta Science Plan (Plan) was released in November 2013 to address the need for a regional guide for collaborative approaches to develop and communicate scientific knowledge that informs policy-makers, managers, and the public in taking action in the Sacramento-San Joaquin Delta. Since the Plan's initial release, scientists have advanced their understanding of the complex Delta system, increased collaboration among peers in different entities, and improved science communication to support decision-making. The purpose of the review and update of the Delta Science Plan is to ensure that the document is relevant to the current regional science and communication needs. The update process was a collaborative effort involving input from the Delta Science community, public, and the Delta Independent Science Board. The 2019 Delta Science Plan is organized into thematic chapters that identify actions and lead implementing organizations actions to achieve the vision of One Delta, One Science - a science community working together with decision-makers to build a common body of scientific knowledge. The Plan addresses many challenges that go beyond the Delta and provide benefits for the San Francisco Bay-Delta Estuary. This includes the need to be more forward-looking by acknowledging climate change as a major driver of change, and the need for more investigative science that supports key management needs to allow managers to better anticipate and prepare for large-scale changes. The importance of the social sciences is also highlighted and the critical role different disciplines play in promoting effective resource management and increasing the appreciation of how human values are directly linked to environmental processes.

Keywords: Delta science, collaboration, natural resource management, climate change, transparency, communication

Poster Topic: Watershed Management

Water Management in Suisun Marsh Controls Resilience to Fire Disturbance

Scott Jones[1], Charles Schutte[2,3], Brian Roberts[2], Karen Thorne[1]

[1]U.S. Geological Survey, Western Ecological Research Center, Davis, CA
[2]Louisiana Universities Marine Consortium, Chauvin, LA
[3]Rowan University, Department of Environmental Science, Glassboro, NJ

sfjones@usgs.gov, cschutte@lumcon.edu, cschutte@lumcon.edu, broberts@lumcon.edu, kthorne@usgs.gov

Hydrologic regime and salinity exert strong control on tidal wetland ecological function by altering soil biogeochemistry and influencing plant community dynamics. In Suisun Marsh, hydrology and salinity of many former tidal wetlands are manipulated to provide seasonal habitats for migratory waterfowl. Management intervention can shift ecosystem function directly, but indirect impacts on emergent ecosystem processes such as resilience are less well known. To better understand how tidal wetland resilience is influenced by water management, we used a natural experimental approach using fire disturbance. We quantified marsh platform elevation, soil properties and biogeochemical processes, and vegetation community responses to the Branscombe Fire that burned portions of Suisun in October 2018. We measured paired burned-unburned patches in both tidally-influenced and managed seasonal wetlands. In these mineral-rich marshes, marsh platform elevation was resistant to fire disturbance, but managed wetlands were 1 m lower than tidal wetlands initially. Non-managed tidal wetlands released a pulse of nitrate (> 100 mg N-NO3- kgdw-1) and retained their ability to carry out nitrification immediately after fire. Managed wetlands, however, had significantly lower pre-disturbance soil nitrate concentrations than tidal wetlands (< 1 mg N-NO3- kgdw-1 and 5 mg N-NO3- kgdw-1, respectively), and did not release nitrate after the fire disturbance; managed wetlands also lost the ability to carry out nitrification after fire. Six months following the fire, the burned tidal wetland plant community was similar in alpha diversity and community composition to unburned tidal wetlands. In contrast, there was little to no plant community recovery in managed wetlands, with barren soils commonplace. Overall, 6 months after fire disturbance the non-managed tidal wetlands recovered quickly and appeared to be highly resistant and resilient to fire disturbance, while managed seasonal wetlands were not.

Keywords: biogeochemistry, Suisun Marsh, resilience, fire, management, nutrients, plant community

Poster Topic: Watershed Management

Fine-scale Update to the Vegetation and Land Use Classification and Map of the Sacramento-San Joaquin River Delta

Ron Melcer[1], Kate Anderson[1], Jason Schwenkler[2], Brian Kreb[2], Erik Fintel[2], Todd Keeler-Wolf[3], Rosalie Yacoub[3], Rachelle Boul[3], Diana Hickson[3]

[1]Delta Stewardship Council
[2]Geographic Information Center – CSU Chico
[3]California Department of Fish and Wildlife

Ronald.Melcer@deltacouncil.ca.gov, Kate.Anderson@deltacouncil.ca.gov, jschwenkler@csuchico.edu, bkreb@csuchico.edu, efintel@csuchico.edu, Todd.Keeler-Wolf@wildlife.ca.gov, Rosalie.Yacoub@wildlife.ca.gov, Rachelle.Boul@wildlife.ca.gov, Diana.Hickson@wildlife.ca.gov

The Vegetation and Land Use Classification Map of the Sacramento-San Joaquin River (Hickson and Keeler-Wolf 2007) has played a vital role in wildlife and natural lands conservation and management, and is now among the principal tools involved in land management planning. The map has provided a landscape-scale understanding of the spatial structure of and distribution of vegetation for the Delta region. It also provides a baseline condition useful in the future evaluation of changes in these metrics. The current map is based upon 15 year old imagery. To update this important dataset, land cover was mapped within the boundaries of the Sacramento-San Joaquin Delta using 2016 National Agricultural Imagery Program aerial imagery. Vegetation assemblages were classified using the National Vegetation Classification System (NVCS), with resolution at the alliance level, and a minimum mapping unit of 1.0 acres. For agricultural lands, crop type was classified using the 2016 LandIQ Delta Land Use Map. The updated fine-scale map documents existing conditions for the vegetation and agricultural crops present in the Delta during 2016. This map can be used to quantify the extent, distribution, and connectivity of land cover and land use types, or overlaid with other data sets such as soils, hydrology, and/or climate data to conduct species distribution modeling. To date, the updated map has been incorporated in an assessment of salmon rearing habitat within the Delta, the Delta Aquatic Resources Inventory (DARI), and the development of regulatory policy, recommendations, and the performance measures in an amendment to the Delta Plan Ecosystem Chapter. Shifts in natural land cover types, aquatic vegetation, and agricultural land use are observed between the 2007 map and this update. Regular updates to the map on a 5 year interval would provide meaningful data to the scientific, management, and policy development users.

Keywords:

Poster Topic: Watershed Management

Conserving Watersheds and Riparian Networks From Headwaters to the Estuary: The Bay Area Conservation Lands Network 2.0 Science Expansion:

Tom Robinson[1], Stuart Weiss[2]

[1]Bay Area Open Space Council
[2]Creekside Science

tom@openspacecouncil.org, stu@creeksidescience.com

The health of the Estuary depends on upland watersheds and riparian networks that deliver water and sediment, receive spawning anadramous fish, and provide wildlife connectivity. The Conservation Lands Network (CLN), launched in 2011 and updated in 2019 as CLN 2.0 Science Expansion, is a vision and strategic process for protection and stewardship of 2.5 million acres of uplands (50% of the Bay Area) by 2050. The climatic and geologic complexities of the uplands produce biodiverse ecosystems from redwood forests to semi-deserts, interspersed with urban and agricultural lands supporting 7 million people, and connected by a network of riparian systems. The riparian network, although greatly disrupted, still supports nearly all of the original native fish, mammals, birds, amphibians, reptiles, and invertebrates, at least in some places. The CLN 2.0 riparian strategy recognizes that all riparian zones are important as engines of biodiversity, and considers several new data sources to inventory and conserve the systems. Stream valleys – the channels and adjacent lands that support key processes such as channel migration - are delineated by geomorphology as opposed to linear stream features with arbitrary buffers. Higher priority stream reaches and watersheds are identified by fish diversity, but all undeveloped stream valleys are included in the CLN. Headwaters are delineated by watershed-specific elevation zones. Estimates of groundwater recharge and runoff from the Basin Characterization Model quantify available water supply for both aquatic biodiversity and people. By conserving large connected swaths of upland watersheds and the riparian zones connecting recharge, runoff, sediment, and wildlife to the Estuary, the CLN is a framework for maintaining the biodiversity and ecological integrity of our region in a rapidly changing environment.

Keywords: Watersheds, riparian, land conservation, regional planning

Poster Topic: Watershed Management