Poster Abstracts

2018 Bay-Delta Science Conference

Abstracts for the Poster session presented at the 2018 State of the Bay-Delta Science Conference are compiled in this document. Abstracts are listed by poster topic or cluster, and then alphabetically. Names of presenting authors are underlined. Asterisks (*) indicate the presenter is competing in the student presentation awards competition.

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Poster Cluster) AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

AQPI: Radar-Derived Quantitative Precipitation Estimation in Complex Terrain over the San Francisco Bay Area

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Weather radar has great advantages in conducting high-resolution precipitation observations over wide areas in a relatively short time span. S-band dual-polarization radar systems (i.e., NEXRAD) form the cornerstones of national severe weather warning and forecasting infrastructure. The Bay Area is covered by two NEXRADs: KMUX and KDAX. However, the KDAX radar is located near Davis, CA, over 80 km from the closest portions of the Bay Area. The KDAX radar beam is also partially blocked at low beam elevation angles. The KMUX NEXRAD is located in the Santa Cruz Mountains, closer to the urban regions of the Bay Area. But KMUX is deployed at an elevation of over 1000 m compared with the valley which is near sea level. The resulting beam height and width are such that this radar cannot be relied upon to accurately resolve precipitation patterns at the urban scale.

As part of the AQPI project, high-resolution high-frequency (C and X band) gap-filling radars are being deployed over the Bay Area to improve precipitation observations and investigate the microphysical characteristics of precipitation over such complex terrain. To date, two X-band radars have already been deployed and collected a substantial set of precipitation measurements that contribute to the development of radar rainfall algorithms. This study presents the real-time rainfall system developed using dual-polarization radar measurements. The product performance is demonstrated through cross-comparison with ground weather reports and rain gauge observations. Results show that rainfall products generated by the AQPI radars have better performance compared to the operational products currently available (i.e., MRMS) in this particular domain. The local water and weather agencies are using these products for urban disaster monitoring and warning operations. The high performance rainfall products also serve as inputs to a suite of distributed hydrologic models for real-time flood applications (described in a separate presentation).

Keywords: AQPI, radar QPE, complex terrain, radar network

Poster Cluster: AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

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When big storms hit California, current technology does not provide forecasters with the detailed information needed to inform reservoir operations, flood protection, combined sewer-stormwater systems and emergency preparedness. Standard weather radars are often unable to give an accurate picture of what is happening in the complex landscape of California's coastal mountains.
The Advanced Quantitative Precipitation Information (AQPI) System is a regional project awarded to NOAA and collaborating partners by the California Department of Water Resources. The AQPI System consists of improved weather radar data for precipitation estimation and short-term nowcasting; additional surface measurements of precipitation, streamflow and soil moisture; and a suite of forecast modeling systems to improve lead time on precipitation and coastal Bay inundation from extreme storms.
AQPI observing assets include a coastal Doppler C-band weather radar along the Sonoma County coast which will point offshore to improve tracking of incoming storms and four gap-filling Xband radar units strategically located to provide high-resolution coverage over-populated and flood prone urban areas throughout the San Francisco Bay region. The radar data will be assimilated by atmospheric models to improve short-term prediction of precipitation. The AQPI System also will improve runoff and coastal flooding predictions in and around the Bay. To address climate change and sea level rise with possibly more extreme storms the System will implement the Coastal Storm Modeling System (CoSMoS). This system will forecast flooding around the San Francisco Bay coastline.
The AQPI System can aid water managers in securing water supplies while mitigating flood risk and minimizing potential water quality impacts to the Bay from storm runoff and combined sewer overflows. The system can be expected to provide benefits exceeding costs by a ratio of at least 4:1. This presentation provides an overview of AQPI, setting the stage for a poster cluster on this topic.

Keywords: Advanced quantitative precipitation information system

Poster Cluster: AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

AQPI: Integrated Flood Forecast Modeling: A Case Study in South Bay of Fluvial and Coastal Flooding

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A forecast model that integrates fluvial and oceanic drivers is necessary for predicting flooding in complex coastal urban environments like San Francisco Bay. The U.S. Geological Survey (USGS) and National Weather Service (NWS) are developing a state-of-the-art flood forecast model for the San Francisco Bay area that will predict watershed and ocean-based flooding up to 72 hours in advance of an approaching storm. The model framework for flood forecasts is based on the USGS-developed Coastal Storm Modeling System (CoSMoS).
For this application, we use the Delft3D-FM unstructured-grid hydrodynamic model to account for oceanic forcing, and the NOAA National Water Model (NWM) for fluvial forcing. Delft3D-FM uses tidal forcing, seasonal water-level anomalies, surge and in-Bay generated wind waves from wind and pressure fields of a NWS forecast model, and tributary discharges from the NWM, to calculate Bay and tributary water levels. The flooding extent is determined by overlaying the resulting water levels onto a 2-m digital elevation model of the study area which best resolves the extensive levee and tidal marsh systems in the region. ;
Here we present initial pilot results of a storm event that occurred in late February 2017 in South San Francisco Bay, in a realistic hindcast and some scenarios with higher bay water level we explore where flooding can be driven by both oceanic and fluvial factors. The results of this presentation focus on the interactions between the Guadalupe River and Coyote Creek with the Bay and the storm impacts in Santa Clara county. Through this hindcast we demonstrate not only the feasibility of predicting flooding on an operational time scale that incorporates both atmospheric, oceanic and hydrologic forcings, but also the importance of doing integrated modeling that is able to capture compound events.

Keywords: coastal flooding, CoSMoS, tidal forcing, storm surge, wind waves

Poster Cluster: AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

AQPI: Benefits of an Advanced Quantitative Precipitation Information System

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A reconnaissance-level regional resource accounting approach was developed to quantify benefits associated with an advanced quantitative precipitation information (AQPI) system being developed for the San Francisco Bay area. The AQPI would provide higher resolution monitoring of rainfall events and longer lead-time forecasts compared to current practice. Investment decisions to implement an operational AQPI system required demonstration that the benefits exceed the costs; hence the benefits assessment. AQPI system costs, which include federal, state and other regional expenditures, were estimated to have initial costs of $66M and $3.3M annual operation and maintenance (O&M); these translate to a present value cost of $90M. An incremental benefits approach was applied that tabulates benefits based on established procedures using available data. Benefits were associated with avoiding flood damages, maximizing water supplies, and enhancing ecological, recreational and transportation services. Taken by category about 48% of the benefits are for flood damage mitigation ($29M/yr) with water supply (32%, $19M/yr), ecosystem (3.3%, $2M/yr), recreation (10%, $6.3M/yr), and transportation (9.4%, $5.8M/yr). These translate to a present value benefit of $449M (at 10 years and 6%) which computes to a best estimate B/C ratio of 5 to 1. Sensitivity analysis indicates a range of B/C up to 9.7 and down to 2.4. Many of the benefits are dependent on appropriate and adequate response by hazards and water management agencies and citizens.

Keywords: precipitation, economics, flooding, water supply, ecology, economic benefits

Poster Cluster: AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

AQPI: Systems Requirements Development Process and Possible Outcomes

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Since 2010 the Physical Science Division (PSD) of the National Oceanic and Atmospheric Administration's (NOAA) Earth Systems Research Laboratory (ESRL) has been working to secure funding and to create the team for developing an Advanced Quantitative Precipitation Information (AQPI) system for the San Francisco Bay (SF-Bay) area. The funding was secured in 2016 and a contract for the development of the AQPI system was put in place between Sonoma County Water Agency (SCWA) and NOAA in the later part of 2017. The process of requirements gathering and development of the AQPI system began with a kickoff meeting in October of 2017. The AQPI system will build on:
+ A decade of work on NOAA–Hydrometeorology research, prototyping, and implementing a statewide state-of-the-art network of precipitation observations.
+ NOAA's research on the next generation of forecast models, observations, and display systems.
+ Ongoing research to develop a coastal storm modeling system in San Francisco Bay by the USGS in Santa Cruz.
+ Operational needs and processes in the SF-Bay area.
This poster focuses on the approach for developing the AQPI system and possible outcomes for operational deployment. The AQPI system will couple the complete process, from observation to forecast to operational use. The AQPI system will evolve over 4 years as requirements are refined based on a rapid prototyping approach of requirements gathering, design, develop, test, evaluate and repeat the process. The development process is not only designed to improve the final system, it also will help improve user understanding of the final system and its products. We are hoping to show how this development and collaboration process is a pathway for becoming a weather ready nation. This effort is focused on hydrology but the same process and collaboration is required for all types of weather events and natural disasters.

Keywords: system design, requirements gathering, design, develop, test, evaluate, user understanding

Poster Cluster: AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

AQPI: Precipitation Forecasts over the San Francisco Bay Area from the High-Resolution Rapid Refresh Model During an Atmospheric River Event on 21-23 Mar 2018

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An atmospheric river event impacted California during 21-23 March 2018, producing heavy rain in the northern San Francisco Bay area. In this presentation, we describe quantitative precipitation forecast (QPF) performance from the NOAA hourly operational 3-km High-Resolution Rapid Refresh (HRRR) numerical weather prediction system. We also compare forecasts from the real-time Experimental HRRR, which represents a more advanced version of the HRRR which will be implemented operationally before the rainy season of 2018-19. ;
Evaluation is conducted against both widely-used quantitative precipitation estimation (QPE) products such as the Stage IV analysis, as well as against trusted rain gauges in the Bay Area. Model forecast differences are attributed to specific changes in the data assimilation configuration as well as the model physics, for both the HRRR and the 13-km Rapid Refresh (RAP) which provides initial and boundary conditions for the HRRR. Among the most significant changes are an increase in the length of the time period during which latent heating is assumed to have occurred in regions of observed radar reflectivity, a change in the vertical coordinate used in the model, and substantial improvements in the formulation of the planetary boundary layer (PBL) parameterization. ;
In the final part of the presentation, ideas for future research aimed at improving QPF in this region through the Advanced Quantitative Precipitation Information (AQPI) project will be discussed. ;

Keywords: precipitation forecasts, high-resolution rapid refresh model, atmospheric river

Poster Cluster: AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

AQPI: California Observing Networks in Support of AQPI and EFREP

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The NOAA Physical Sciences Division has been conducting research on winter storms impacting the U.S. West Coast since the late 1990's. Since the early 2000's, this research has been organized under the umbrella of NOAA's Hydrometeorology Testbed (HMT). Since 2008, HMT has partnered with the California Department of Water Resources (DWR) on projects aimed at improving flood forecasting and mitigation efforts under DWR's Enhanced Flood Response and Emergency Preparedness program. This partnership has led to the installation, operation, and maintenance of a state-of-the-art observing network to monitor the atmospheric and terrestrial conditions that lead to extreme precipitation events as well as other weather related hazards. This observing network also serves as the backbone for the AQPI project, which will enhance observations and short-range predictions of winter storms striking the San Francisco Bay area. This poster will describe this unprecedented observing network and provide examples of how the data have been used to support both DWR and National Weather Service forecast operations.

Keywords: atmospheric observing network, extreme precipitation

Poster Cluster: AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

AQPI: Distributed Hydrologic Modeling for Flood Mitigation

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San Francisco Bay is a highly urbanized estuary and the surrounding communities are susceptible to flooding in inland rivers and creeks that drain to the Bay, and along the Bay shoreline. An integrated forecast system that involves watershed and oceanic drivers is being developed for predicting flooding in Bay area tributaries and estuaries.
This poster focuses on the AQPI watershed flood prediction modeling using the NWS National Water Model (NWM). The NWM is a distributed hydrologic model (DHM) which computes the hydrologic balance on a 250 m grid, aggregates excess precipitation to a 1 km grid, and routes these flood flows using the NHD-PlusV2 stream network. The system updates to include USGS gaged flows (-3 to 0 hrs), along with three forecast configurations (short- (0 to 18 hrs; 1-hr update), medium- (0 to 10 days; 6-hr update) and long-range (0 to 30 days; 1-day update). The DHM can provide a variety of flood forecast products, including hydrographs at any location (peak flow, time-to-peak, duration of high flow), and grid displays of streamflow, soil moisture, streamflow anomaly, snowpack, and ponded water depth. Other anticipated products include grids of flood recurrence levels, at-risk bridge crossings and flood inundation. Various verification analyses are being conducted to characterize DHM accuracy. Coordination with Bay area flood response agencies is intended to help assure that the AQPI system products are acceptable and usable. To this end, we are asking local agency leaders to describe how they currently conduct their flood awareness, warning and response activities; how these procedures could be supported by the DHM products; and to review DHM outputs and recommend how these products could be formulated to support their jobs. Results of these reviews are presented to reflect how users' assessments are informing design of the real-time AQPI system. ;

Keywords: Distributed hydrologic modeling, flood forecast products, users design guidance

Poster Cluster: AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

AQPI: Integrated Water Management Modeling - Case Studies Using Local Models in the San Francisco Bay Area

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The Advanced Quantitative Precipitation Information (AQPI) system is a regional project awarded to National Oceanic and Atmospheric Administration (NOAA) and collaborating partners by the California Department of Water Resources. The AQPI project includes new ground-based observations (e.g. weather radar), advanced numerical atmospheric modeling, and distrbuted hydrological and coastal flooding applications. This study intends to share application instances of the AQPI system with water-related agencies by employing local water management models using the distributed hydrological model forecast flows as inputs.
We present two case studies. The first case study addresses the implementation of a reservoir assimilation scheme through coupling of a reservoir operation simulation model with AQPI distributed hydrologic model (National Water Model, NWM). The Russian River HEC-ResSim model developed by Sonoma County Water Agency (SCWA) and US Army Corps of Engineers (USACE) are used to simulate; reservoir operations. We examine the use of the HEC-ResSim to dynamically update lake/reservoir storage volume states, characterize river reach flows into and out of Lake Mendocino and downstream, and incorporate enhanced reservoir operating rules for the reservoir model options within the NWM.
The second case study is to verify benefits of the AQPI system for streamflow prediction in the Coyote Creek and Guadalupe River watersheds. For this purpose, a local HEC-HMS model built by Santa Clara Valley Water District (SCVW) is used to evaluate the AQPI precipitation products against NEXRAD precipitation products in terms of flood forecasting.
For each of the case studies, we are collaborating with the local water management agencies to review the AQPI hydrological model products, provide guidance on refinements, and document how these products can benefit their organizations in mitigating floods, enhance water supplies and sustain aquatic ecosystems.

Keywords: advanced quantitative precipitation information system, local water management models

Poster Cluster: AQPI: Improved Monitoring and Forecasts of Precipitation, Streamflow, and Coastal Flooding in the San Francisco Bay Area

Poster Cluster) Emerging ideas supporting novel restoration at the margins of the Delta

Food for Thought: Microcosm Feeding Trials Highlight Food Resource Utilization Differences Between Daphnia pulex and magna

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Previous studies of food resource utilization of zooplankton in the California Delta concluded that detritus does not significantly contribute to zooplankton growth. However, use of D. magna as a study organism may have given an incomplete picture of the detrital contribution to native zooplankton biomass as D. magna are rarely found in high abundances in the northeast Delta or floodplains. ;D. pulex is the dominant species of cladoceran found in floodplain habitats in the Central Valley; recent evidence suggests that they utilize detrital food pathways in these habitats. To test growth differences between D. pulex and magna, we used a flow-through microcosm experiment. Pure algal, detrital, and mixed cultures, as well as, field samples from winter inundated rice fields were tested. For each experimental trial, dissolved organic carbon, particulate organic carbon, and chlorophyll-a were measured. ;D. pulex exhibited differential growth between experimental food resources and grew best on algal and field water. Additionally, D. pulex had high growth variability when detritus to chlorophyll-a ratios were high, suggesting that genetic variability may be an important factor for understanding resource utilization in these zooplankton. D. magna demonstrated little difference in growth between food resources. This study highlights the utility of using study organisms represented in habitats under investigation and will be useful for understanding secondary production in the Delta.

Keywords: Daphnia pulex, Daphnia magna, detritus, feeding trials

Poster Cluster: Emerging ideas supporting novel restoration at the margins of the Delta

Complete March Project: Examining How Hydrodynamics and Geomorphology Affect Water Quality and Nutrients in Suisun Marsh

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Geomorphology and hydrodynamics govern water quality and nutrients in tidal marshes on weekly, monthly, and seasonal timescales. However, little is known about how habitat and tides affect food webs in Suisun Marsh. We address this gap by examining linkages between hydrodynamics and lower trophic food webs in the spring and summer of 2017 and 2018, when juvenile fish are rearing. Our methods included hourly sampling of water conducted twice monthly for 24-hour periods to record data on spring and neap tides, coupled with 15-minute continuous water quality sonde data. We studied four slough sites: First Mallard Branch, Sheldrake Slough, Hill Slough, and Peytonia Slough, that differed in length, bank structure, and proximity to emergent marsh. In addition, we studied a managed wetland pond that is slated for tidal marsh restoration. We found that water quality and nutrients differed substantially by habitat type and tide. For example, the ratio of nitrogen to phosphate was more variable in First Mallard, which also had the most variable hydrodynamics. Habitat heterogeneity may support diverse food web structures, which in turn facilitate different life history stages of Suisun Marsh fishes.

Keywords: Hydrology, geomorphology, Suisun Marsh, Water Quality, nutrients, trophic level, tidal

Poster Cluster: Emerging ideas supporting novel restoration at the margins of the Delta

Fish Trends During Drought and Flood from Electrofishing Surveys in the Cache-Lindsey Slough Complex

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California experienced record-setting climate extremes throughout 2011 to 2018. A study of fish, food webs and water quality in the north Delta Arc captured varying fish community composition during this period. Data from boat electrofishing efforts in the Cache-Lindsey Slough complex, illustrate the effects of drought, flood, elevated summer temperatures, and altered precipitation patterns, all of which are long-term changes predicted by California climate change models. Fish catch per unit effort appeared to vary with temperature and water year conditions. Some species, primarily non-native centrarchids and silversides, thrived in the drought conditions, while other species declined and have yet to make a substantial comeback. Such changes in community composition may serve as an indicator of future ecosystem responses to climate change. Our study shows preliminary results for how systems within the north Delta Arc respond to unprecedented climatic trends.

Keywords: Climate Change, Drought, Electrofishing, North Delta Arc

Poster Cluster: Emerging ideas supporting novel restoration at the margins of the Delta

Spatial and Temporal Variability in Water Quality Across Tidal Cycles in a Manipulated Slough Complex of the California Delta

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The Cache-Lindsay Slough Complex stands as a critical refuge for native species in the most highly invaded and altered estuary in the world. Productive terminal tidal sloughs, remnant riparian corridors, emergent wetlands and the proximity of the Sacramento River create unique restoration opportunities. However, the hydrodynamic and geomorphic influences on water quality and productivity of the region remain widely unresolved. Mapping of high-speed continuous water quality sampling in the spring of 2018, across high and low tides along Lindsay Slough, revealed an ecosystem response to a shut-off period of the North Bay Aqueduct. Our sampling showed longitudinal spatial variability increases throughout the tidal cycle in upper Barker slough under natural tidal conditions and in response to rainfall events. This case study demonstrates the effect of water movement and withdrawals on local channels, the potential benefits of implementing brief shut-off periods to promote water quality variables favorable for native fish, and the power of active management to support positive restoration outcomes.

Keywords: water quality, active management, tidal cycles, native fish habitat, restoration

Poster Cluster: Emerging ideas supporting novel restoration at the margins of the Delta

Understanding Fish Outmigration on a Restored Floodplain

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Floodplains are highly productive environments that provide critical rearing habitat and increase growth rates for juvenile Chinook salmon and other native fishes. When the floodplain draws down, there is potential for fish to get stranded. We sought to study what cues prompt fish to leave floodplains. The Cosumnes River presents a unique opportunity to study fish response to environmental cues. The only major undammed river in the Sierra Nevada, the Cosumnes follows a relatively natural flow regime. Restoration in the 1990s reconnected the river to floodplain habitat through levee removal, allowing geomorphic and ecological processes to reestablish and creating an ideal place to study floodplain fish outmigration. We deployed daily fyke net surveys of fish on different floodplain habitats during the entire period of inundation in 2018, allowing us to differentiate between outmigrants and fish that are remaining. We used timing of native fish leaving the floodplain in relation to the hydrograph and water quality sensors to isolate environmental cues. Currently in the Central Valley there are many novel restoration projects focused on floodplain connectivity. Understanding how to maximize benefits to fish and the ecosystem, while avoiding stranding native fish on restored floodplains is a key component to restoration efforts.

Keywords: Novel restoration, connectivity, reconciliation, fish outmigration, environmental cues

Poster Cluster: Emerging ideas supporting novel restoration at the margins of the Delta

Growth Rates of Daphnia magna in Managed Wetlands and Adjacent Tidal Sloughs in Suisun Marsh

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Managed wetlands have the potential to produce zooplankton food for fishes in Suisun Marsh. Spring plankton production may be particularly important for recruitment of native juvenile fishes. Copepods and cladocerans provide the bulk of available food in spring, with copepods contributing the highest densities and the larger-bodied cladocerans often contributing the most biomass. Zooplankton often reach higher densities and biomass in managed ponds than tidal sloughs. However, it is not known whether differences in growth rates, or hydrodynamic exchange explain differences between the two system types. As part of an ongoing spring food web production study, we planted Daphnia magna in fixed enclosures over 5-day in situ incubation periods in both managed wetlands and adjacent tidal sloughs to measure comparative growth rates. In conjunction with in situ incubations, we monitored water quality and collected ambient water from each site daily for exchange in a parallel growth study of Daphnia magna grown in a mixed common garden to separate effects of water quality from effects of tidal flux. In so doing, we will evaluate the effect of water quality, site, and tidal exchange on growth rate and biomass accumulation to further our understanding of how water management can optimize zooplankton production to meet conservation goals.

Keywords: Managed Wetlands, Suisun Marsh, Zooplankton, Daphnia magna, Growth rates

Poster Cluster: Emerging ideas supporting novel restoration at the margins of the Delta

Habitat Use by Juvenile Life Stages of Benthic and Pelagic Fishes in Suisun Marsh

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The Suisun Marsh Fisheries Study has helped demonstrate the importance of tidal wetlands as nursery habitat for native and nonnative juvenile fishes. However, little is known about the fine-scale habitat use by different life history strategies in time and space. We compared the species composition, abundance and distribution of juvenile fishes across tidal cycles and among sloughs with different geomorphology, using catch from otter trawling and minnow trapping, conducted twice monthly throughout the spring and summer of 2017 and 2018. Temporally explicit sampling suggests that both pelagic and benthic juvenile fishes responded to spring-neap cycles. Spatially explicit sampling suggests that the reference study site, which is a 'complete' (or unfragmented) marsh, may have provided relatively important habitat for pelagic juvenile fishes such as Striped Bass (Morone saxatilis), Threadfin Shad (Dorosoma petenense), and American Shad (Alosa sapidissima). Benthic fishes were found broadly across both the reference and comparison ;sites. Overall, our research findings show that different life history strategies exploit variation among habitats and tidal cycles. Understanding how functional habitats favor certain life history strategies can support management decisions to improve habitat restoration and fisheries management.

Keywords: Suisun Marsh, life history strategies, juvenile fishes, abundance, distribution

Poster Cluster: Emerging ideas supporting novel restoration at the margins of the Delta

Poster Cluster) Phytoplankton productivity and blooms in the northern San Francisco Estuary/Delta

Investigating Phytoplankton, Nutrients and Primary Productivity During Fall 2017 in Cache Slough to Suisun Bay

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Our objective is to understand whether and why phytoplankton blooms occur in fall in the northern San Francisco Estuary/Delta (SFE/D). Since the late 1980's phytoplankton blooms have rarely been reported. The lack of plankton is a major factor responsible for the decline of many SFE/D fishes including the endangered Delta Smelt. Understanding what factors may enhance primary productivity and phytoplankton abundance will aid management decisions being made to try new water management strategies to reverse these conditions and benefit Delta Smelt. Historically, years with high spring outflows have been preceded by fall phytoplankton blooms. Following a very wet spring in 2011, during the Fall Low Salinity Habitat (FLaSH) studies a phytoplankton bloom (reaching 30 µg/L) was observed in the lower Sacramento River in late October shortly after a seasonal agricultural flow pulse passed through the Yolo Bypass. Spring 2017 was also very wet and we hypothesized that this may influence bloom occurrence in fall 2017. Our approach was to sample (near surface and at 3m depth) for chlorophyll (a proxy for phytoplankton abundance), nutrients and primary productivity downstream from Cache Slough to Rio Vista to Port Chicago with approximately weekly cruises from September to mid-November. In contrast to 2011, no increased chlorophyll (i.e. bloom) was observed even though flow and light conditions were optimal for productivity. Ammonium and nitrate were higher than 2011 throughout the fall. An adaptive management action is being proposed for the North Delta with a managed fall flow pulse in 2018 to increase downstream primary production. Towards this goal, we plan to replicate our sampling effort in 2018 and compare the results to the non-pulse conditions in 2017.

Keywords: primary productivity, phytoplankton, food web, nutrients, nitrate, chlorophyll

Poster Cluster: Phytoplankton productivity and blooms in the northern San Francisco Estuary/Delta

Understanding the Drivers of Phytoplankton Bloom Formation in San Francisco Bay/ Delta: A Modeling and Historical Data Approach to Bloom Prediction

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An era of adaptive management based experimental ecosystem manipulations has arrived in the San Francisco Bay/Delta driven by the need to bolster failing populations of pelagic fishes. One objective is to enhance the primary productivity as populations may be food limited. The lack of a full understanding of the conditions that foster the growth and accumulation of phytoplankton, i.e. blooming, is an impediment to the planning and execution of these large-scale experiments. Historical studies suggested that low flow rates were required to produce large blooms. A simple nutrient/phytoplankton model predicted bloom formation to occur at certain combinations of flow and ammonium loadings, in agreement with the early findings on flow. An unstructured model, SCHISM, with an embedded biogeochemical model, CoSiNE, has been constructed and validated for the San Francisco Bay. The model links the estuary to the coastal ocean through the coastal CA 3km ROMS and extends landward to Rio Vista. To evaluate flow impacts, the model was simplified and run without grazing or particle sinking, for two contrasting flow conditions; high flow in 2011 and low flow in 2012. The modeled effects of high flow were to 1) eliminate any spring bloom, 2) reduce the magnitude of any summer/fall bloom and 3) force the location of blooms seaward. The modeled blooming spatial and temporal patterns compare well with historical data. Additional model runs to assess the relative importance of grazing and sinking in modulating and terminating blooms will be presented. The SCHISM/CoSiNE model has been validated to the point where it could be useful in planning and evaluating the outcome of large scale experiments.

Keywords: bloom, flow, primary productivity, phytoplankton, food web, nutrients, nitrate, chlorophyll,

Poster Cluster: Phytoplankton productivity and blooms in the northern San Francisco Estuary/Delta

Phytoplankton Productivity and Blooms in the Northern San Francisco Estuary/Delta: Overview

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Low levels of phytoplankton primary productivity and lack of blooms have likely contributed to the decline of many San Francisco Estuary/Delta fishes including the endangered Delta Smelt. Understanding what factors may enhance primary productivity and phytoplankton abundance will aid management decisions being made to develop actions that may reverse these conditions and benefit the Delta Smelt. These posters all report direct observations of primary productivity and algal biomass. Rate measurements help establish if the algae (chlorophyll) are actively growing or have been advected to the site, an important aspect when considering this as a food subsidy. Each poster addresses how a parameter may influence production and blooms and be of benefit, such as increased irradiance, increased (and managed) flow and changes in nutrients. Posters cover primary productivity measurements made in the Yolo Bypass, lower Sacramento River to Suisun Bay during summer and fall and modeling of San Francisco Estuary/Delta blooms.

Keywords: eatuary, blooms, primary productivity, phytoplankton, food web, nutrients, nitrate, chlorophyll

Poster Cluster: Phytoplankton Productivity and Blooms in the Northern San Francisco Estuary/Delta

Yolo Bypass Adaptive Management: Primary Productivity and Nutrient Uptake Rates during Summer 2017

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The Yolo Bypass likely benefits pelagic food availability for Delta Smelt and acts as a food web subsidy for the Sacramento-San Joaquin Delta downstream. The food web benefits of this region may be limited by a lack of flow during dry months but enhanced with increased flow This was demonstrated during the 2016 North Delta Flow Action, when a flow pulse was redirected through the Bypass, down the Toe Drain, south into the CSC and in to the Delta and resulted in increased chlorophyll downstream at Rio Vista. However there were no primary productivity rates measured during this study to evaluate whether the "seed" algae were healthy as they were flushed downstream. In 2017 following the naturally increased flows to the Yolo Bypass we measured primary productivity and chlorophyll along a transect from Knights Landing, along the Toe Drain, into CSC, lower Sacramento River to Decker Island, to observe if the pelagic food web was enhanced in the summer at downstream regions of the lower Estuary (Rio Vista to Suisun Bay). In addition we investigated how the chlorophyll and primary productivity varied between surface and bottom of water column and whether the surface phytoplankton were light limited. Samples collected during 5 campaigns from July to September 2017, from 10 stations along the Yolo to Suisun transect from surface and 3m depth were incubated with 13C labeled bicarbonate and 15N labeled ammonium or nitrate at either 50% or 10% of surface light. These rate data will inform those planning managed flow actions or manipulating water flow by provide knowledge regarding facilitation of increased primary productivity and supply of chlorophyll. Rate measurements help establish if the algae (chlorophyll) are actively growing or have been advected to the site, an important aspect when considering this as a food subsidy.

Keywords: primary productivity phytoplankton food web nutrients nitrate chlorophyll

Poster Cluster: Phytoplankton Productivity and Blooms in the Northern San Francisco Estuary/Delta

Light Limited or Shade Adapted? Phytoplankton Productivity and Nutrient Uptake in the Northern San Francisco Estuary

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The availability of photosynthetically active radiation (PAR) is considered the main driver that limits primary production in the San Francisco Estuary (SFE). However, little is known about how it affects phytoplankton nutrient uptake. This project focuses on whether phytoplankton from different parts of the SFE and Delta exhibit nutrient uptake and photosynthetic rate kinetics that reflect the available light of the waters they were sampled from and determines if they are light limited or shade adapted. Kinetics were calculated from rates obtained using incubations of water containing phytoplankton with added 13C labeled bicarbonate or 15N labeled ammonium or nitrate, incubated at six different light levels. Samples for incubations were collected at four locations with different turbidities along a downstream transect from Cache Slough to Suisun Bay during eight cruises from September to November, 2017. At each station, Secchi depth, incoming PAR, beam c (an estimate of turbidity), and concentration of total suspended solids were measured in order to characterize the irradiance conditions. Primary productivity in the SFE is usually not directly measured but is calculated using an empirical model that combines chlorophyll, PAR, and light attenuation to measure phytoplankton productivity. This project provides a useful comparison to the productivity values derived by others from this model and will help to determine the reasons why the SFE has such low primary production. In addition, it describes some of the first nutrient uptake versus irradiance data for the SFE. This study is relevant to aquatic scientists by determining how phytoplankton in nature respond to changing irradiances and sediment load. It may also help explain why the SFE does not exhibit eutrophication, which is typical of other anthropogenically impacted estuaries.

Keywords: phytoplankton, light limitation, nutrients, turbidity, food web

Poster Cluster: Phytoplankton productivity and blooms in the northern San Francisco Estuary/Delta

Poster Cluster) San Jose-Santa Clara Regional Wastewater Facility: A World-Class Utility Service Sustaining Water Quality & Aquatic Life of Lower South San Francisco Bay

Benthic Invertebrate Community Response to Seasonal Dissolved Oxygen Variations and Freshwater Flux in Lower South San Francisco Bay

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San Jose-Santa Clara Regional Wastewater Facility (RWF) discharges 80 to 90 million gallons per day of tertiary treated wastewater to Artesian Slough and Lower Coyote Creek. To assess aquatic and benthic communities near the RWF discharge area, in 2016 the facility expanded upon a long-term water quality monitoring program and incorporated periodic benthic community sampling and assessment. This program has collected bi-monthly baseline information on the aquatic and benthic ecosystem in Alviso Slough, Coyote Creek, and Artesian Slough for two years.

Bi-monthly benthic invertebrate grabs from six stations in Coyote Creek and Alviso Slough and an additional 2 locations quarterly from the effluent channel in Artesian Slough provide valuable information on seasonal benthic diversity and abundance in the area most directly influenced by the RWF discharge. Seasonal variability of water quality parameters including dissolved oxygen and chlorophyll-a, along with benthic community species composition indicate that locations closer to the RWF discharge display higher numbers of organisms per unit area, due largely to an abundance of amphipods. Biological diversity is relatively even among stations with the most upstream and most bay-ward stations showing less diversity and dominated by annelid worms. Chlorophyll-a measurements in the study area indicate the robust benthic community is supported by adequate phytoplankton biomass. Both discrete and high frequency dissolved oxygen measurements in the study area indicate that even as mid-summer dissolved oxygen at times drops below water quality objectives, dissolved oxygen is maintained at sufficient levels that negative impacts to the health of the benthic community are not apparent.

Keywords: Benthic community, water quality, wastewater treatment, dissolved oxygen

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San Jose-Santa Clara Regional Wastewater Facility: A World-Class Utility Service Sustaining Water Quality & Aquatic Life of Lower South San Francisco Bay

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San Jose-Santa Clara Regional Wastewater Facility (RWF), the largest wastewater treatment plant in San Francisco Bay, treats wastewater from a customer base of 1.4 million people, or roughly one-fifth of the entire Bay Area population. Each day, an average of 80 to 90 million gallons of highly treated freshwater effluent flows from the RWF through 2-mile long Artesian Slough, then Lower Coyote Creek and out to Lower South Bay (LSB).

Since 1998, the RWF has treated wastewater to tertiary level standards with very little BOD and TSS, and practically no ammonia remaining in final effluent. The RWF advanced wastewater treatment includes primary treatment, advanced secondary treatment that removes up to 70% nitrogen and 90% phosphorus from raw sewage, and a tertiary filtration step removing more than 99% of most remaining impurities.

Posters in this cluster document results from proactive research projects evaluating the RWF's advanced treatment process removal of non-regulated pollutants and the RWF discharge influence on Bay water quality and biological condition. Posters include a study of pharmaceutical loads entering and leaving the RWF and two posters describing the Bay monitoring program that evaluates ecological conditions along 8 linear miles of tributaries to Lower South San Francisco Bay.

Keywords: San Jose-Santa Clara Regional Wastewater Facility, wastewater treatment

Poster Cluster: San Jose-Santa Clara Regional Wastewater Facility: A World-Class Utility Service Sustaining Water Quality & Aquatic Life of Lower South San Francisco Bay

Phytoplankton and Chlorophyll-a Along a Nutrient Gradient in Lower Coyote Creek, a Tributary to Lower South San Francisco Bay

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High nutrient concentrations (nitrogen and phosphorus) have contributed to eutrophication in many estuaries. The San Francisco Estuary is nutrient-enriched, particularly in the Lower South Bay (LSB) sub-embayment, which has a long hydraulic residence time and receives treated wastewater from three treatment plants, including the San Jose-Santa Clara Regional Wastewater Facility (RWF). Despite elevated nutrient levels, the LSB has not exhibited the undesirable classic signs of widespread or persistent eutrophication.

In 2016, the RWF leveraged a decades old, in-house Bay Water Quality Monitoring program for metals, nutrients, and general water quality, and began monitoring the phytoplankton community and algal biomass in proximity to the treated effluent discharge location in Lower South San Francisco Bay. This poster describes the phytoplankton community and algal biomass measurements along an 8-mile long nutrient gradient of increasing in distance from the RWF discharge. Phytoplankton species composition, chlorophyll-a, and nutrient levels were measured monthly to twice monthly since 2016 at 6 locations along the 8-mile study area.

Results show the majority of phytoplankton were diatoms (72.8%). Water quality shows distinct patterns between the LSB, Coyote Creek, and Artesian Slough. Both nutrient and chlorophyll-a levels increased from bayward stations towards the RWF, while dissolved oxygen levels decreased in the same direction. There was a substantial shift in salinity between the wet year (2017) and 2018. In addition to expected seasonal variations of dominant phytoplankton species each year, the 2017 to 2018 salinity shift corresponds to observed inter-annual variation of the phytoplankton species identified in the wet year vs the dry year.

Currently, only the RWF monitors the phytoplankton community in this area. Data generated by this monitoring will help inform future management and monitoring decisions regarding water quality and ecological condition of the LSB.

Keywords: phytoplankton, chlorophyll-a, nutrients, wastewater treatment, lower south bay

Poster Cluster: San Jose-Santa Clara Regional Wastewater Facility: A World-Class Utility Service Sustaining Water Quality & Aquatic Life of Lower South San Francisco Bay

Pharmaceutical Fate in Wastewater at the San Jose-Santa Clara Regional Wastewater Facility

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San Jose-Santa Clara Regional Wastewater Facility (RWF) participated in a study of Pharmaceutical compounds in Wastewater in 2016 coordinated by the San Francisco Bay Regional Monitoring Program (RMP). The RWF is one of the largest advanced wastewater treatment plants on the west coast and discharges to the ecologically sensitive Lower South San Francisco Bay (LSB).
The facility had participated in two previous studies: a 2006 RMP study of pharmaceutical compounds in influent and effluent, and a 2009 fate and transport study of pharmaceuticals in influent, effluent and solids. These previous studies showed that most quantified pharmaceutical compounds are removed from effluent by more than 90% removal efficiency. However, there were several compounds (Carbamazepine, Azithromycin, Fluoxetine, Ofloxacin, Albuterol, Lincomycin, Erythromycin) that were not efficiently removed by the advanced treatment process.
As a follow-up to the 2006 and 2009 investigations, the facility collected three rounds of 24-hours composite wastewater samples from four process locations (influent, filter influent, filter effluent and final effluent) and reverse osmosis concentrate (ROC) from the Silicon Valley Advanced Water Purification Center (SVAWPC), which is discharged to final effluent. Samples were analyzed for 104 pharmaceutical compounds including antibiotics and antibacterial agents, steroids, analgesics, and other commonly prescribed medications. Out of 104 pharmaceutical compounds analyzed, 23 were not detected or quantified in any samples. Of the 75 compounds quantified in influent, the facility removed half of the compounds with greater than 75% efficiency and a third of the compounds with 25-75% efficiency. Triclosan and Triclocarban were 3.5 and 5 times lower than 2009, likely due to a manufacturer phase out of antiseptic wash products ahead of a proposed 2013 FDA rule banning the compounds by 2016.

Keywords: Pharmaceuticals, wastewater, San Jose

Poster Cluster: San Jose-Santa Clara Regional Wastewater Facility: A World-Class Utility Service Sustaining Water Quality & Aquatic Life of Lower South San Francisco Bay

Poster Cluster) USACE Sacramento Synthesis of the Long-term Datasets Collected by the Sacramento River Bank Protection Program in the Sacramento River Watershed and Delta

Standardized Assessment Methodology

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Repairs to the system of levees protecting the surrounding floodplain of the Sacramento River are needed due to erosion damage that diminishes levee integrity. These repairs alter important nearshore and riparian habitat complexity for listed species. USACE wants to ensure that impacts of the repairs and required mitigation are being correctly quantified.
Much of the area below the water surface where repair materials are placed is designated critical habitat for Chinook salmon and steelhead. The USACE uses the Standardized;Assessment Methodology (SAM) to predict future habitat condition inference during section 7 consultation under the Endangered Species Act with resource agencies for mitigation purposes. The SAM model provides a means to quantify salmonid net habitat gains and losses resulting from the bank repair materials. SAM surveys were conducted on 10-year-old sites to compare the onsite conditions to those predicted by SAM to determine how well the model performed.
The SAM was developed utilizing the best professional judgment of a team of experts utilizing the best science available at the time. SAM predicted conditions are most consistent at predicting results that occur during periods of less extreme flows. Aspect and other values measured in the field can vary from those determined by a desktop evaluation, and this can affect the assessment of the impact of that value to habitat for Chinook salmon and steelhead.
Validating the performance of the SAM can better inform updates to the model and predicting impacts and benefits of mitigation on a site-by-site basis. A better quantification tool improves the analysis of the levee system repairs and can inform engineering applications that occur in riparian and near shore habitats. These lessons can be used to inform model adaptation/development for green sturgeon and possibly other Bay-Delta listed species.

Keywords: SAM, salmon, habitat, mitigation

Poster Cluster: USACE Sacramento Synthesis of the Long-term Datasets Collected by the Sacramento River Bank Protection Program in the Sacramento River Watershed and Delta

Lessons Learned in Vegetation Management on Levee Repair Sites: A Ten Year Retrospective on the Sacramento River Watershed

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The Sacramento River and its watershed stand at the heart of powerful competing interests. This river system must provide water for one of the largest agricultural regions in the nation, a burgeoning human population and a fragile ecosystem with many imperiled inhabitants. The Sacramento River Bank Protection Program (SRBPP) is required to find common ground between the competing needs of flood protection and preserving the remaining ecological function of the system.
From a regulatory standpoint, repair of existing levees requires mitigative approaches to reduce impacts to habitat for species of concern, with designs conceived within the framework of a necessarily altered hydrology due to competing interests for water. Vegetation management on levees is one piece of the puzzle.
The SRBPP has collected vegetation data at levee repair and mitigation sites for ten years. Data collection includes sampling along perpendicular transects along the benches of levees, which includes visually assessing cover, dominant species, and woody species vigor. Analysis of the data leads to information regarding survival of planted species, invasion of non-native species and canopy cover that is used to adjust seeding mixes and planting schemes and palettes.
Our results suggest that hydroseeding has been effective in increasing the abundance of native herbs and grasses in repair sites, survival of native species of all types is significantly impacted by aspect of the repair site, and pressure from non-native species increases over time especially following periods of drought and high temperature stress. However, previous methods to encourage woody species recruitment and survival including willow fascines, shrub and tree plantings have not performed as anticipated.
Further refinement of vegetation management efforts must be created to survive altered flow regimes while remaining resilient in the face of stressors such as non-native plant invasions, and anticipating prolonged droughts in the face of climate change.

Keywords: Vegetation Management; Levees; Invasives; Hydroseeding; Climate Change; Drought; Mitigation; Replanting

Poster Cluster: USACE Sacramento Synthesis of the Long-term Datasets Collected by the Sacramento River Bank Protection Program in the Sacramento River Watershed and Delta

USACE Sacramento Synthesis of the Long-Term Datasets Collected by the Sacramento River Bank Protection Program in the Sacramento River Watershed

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The Sacramento River Bank Protection Program is tasked with repairing the levees that provide flood protection to the Central Valley and Sacramento-San Joaquin Delta. To construct these repairs the US Army Corps of Engineers (USACE) must complete Section 7 and Magnuson-Stevens Act formal consultation with resource agencies, and provide valid analysis that the program has attempted to avoid, minimize or mitigated any possible adverse effects resulting from the project.
Over the last 10 years, monitoring methods and models have been developed with the cooperation of the resource agencies, and utilized as a means to assess potential impacts and needed mitigation. In order to discover ways to improve the program, determine success or means to improve, a more in-depth systemwide analysis was completed to not only dive into each dataset, but to look for relationships that integrating the data might illuminate.
The integration of datasets from vegetation monitoring, benthic macroinvertebrate sampling and Standardized Assessment Methodology (SAM) surveys have demonstrated strong relationships between common values collected in all the data sets.
This data synthesis allows the project designers to examine the common driving forces, and determine how to use it in an adaptive management framework to improve designs and inform decisions.

Keywords: Sacramento River Bank Protection Program, fisheries, vegetation, benthic, habitat

Poster Cluster: USACE Sacramento Synthesis of the Long-term Datasets collected by the Sacramento River Bank Protection Program in the Sacramento River Watershed.

Benthic Sampling of the Lower Sacramento River to Characterize Benthic Communities and Potential Available Food Sources for Green Sturgeon (Acipenser medirostris)

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The United States Army Corps of Engineers (USACE) repairs key levee sections as part of the Sacramento River Bank Protection Project (SRBPP). The southern Distinct Population Segment (sDPS) of the North American green sturgeon (Ascipenser medirostris) is a federally threatened species. The only known spawning grounds for the sDPS A. medirostris are in the Sacramento River basin. The diet of sDPS A. medirostris adults and juveniles migrating through the lower Sacramento River is not known, but is suspected to rely at least in part on benthic macroinvertebrates. Unfortunately, significant data gaps exist for contemporary baseline details about the benthos in the lower Sacramento River.

USACE conducted four benthic sampling events on the lower Sacramento River via petite ponar grabs along five-point cross section transects of the river since September 2016. The sampling protocol includes measuring depth to sample, sediment/substrate characterization, presence/absence of aquatic macroinvertebrates, and classification of sample contents. Sampling occurred between Sacramento River Miles 15 and 85, at a 10-mile interval, and included sampling at SRBPP proposed and current construction sites to characterize baseline and post-construction communities at those sites. This data is compared to historic data from the latest community profile.

A relationship exists between substrate types and macroinvertebrate communities. The location of the sample on the transect relative to the thalweg has a relationship with the paucity and diversity of the community. Vertebrates were found in the petite samples and might serve as a food source for the A. medirostris or other fishes. Corbicula fluminea was found as far upstream as river mile 85.0 on the Sacramento River.

There is a large population of C. fluminea, as well as other invertebrates, but it is unknown if any of these represent potential food sources for A. medirostris and other fish within the Sacramento River and Bay-Delta.

Keywords: Green Sturgeon, USACE, Levee Repair, Benthos, Benthic Communities

Poster Cluster: USACE Sacramento Synthesis of the Long-term Datasets Collected by the Sacramento River Bank Protection Project in the Sacramento River Watershed and Delta

Aquatic/Riparian Invasives

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

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The California Department of Parks and Recreation's Division of Boating and Waterways (Division) is the lead agency of the state for the purpose of cooperating with other state, local, and federal agencies in identifying, detecting, controlling, and administering programs to manage, control, and when feasible, eradicate invasive aquatic plants in the Sacramento-San Joaquin Delta (Delta), its tributaries, and the Suisun Marsh. However, until 2015 each species required legislation to be controlled. Legislative action (AB763; 2013) reformed the mechanism for granting the Division the authority to treat additional invasive aquatic plant species in the Delta, now requiring that the California Department of Fish and Wildlife (CDFW), in consultation with partner agencies, conduct a risk assessment determining whether the aquatic plant is invasive. CDFW utilizes the U.S. Aquatic Weed Risk Assessment (USAqWRA) to assess each species' ecology, reproductive potential, dispersal mechanisms, competitive ability, resistance to management, and actual and potential impacts to navigation and recreation, health and stability, bird habitats, native plants, water quality, the economy, and human health, as specified in Harbors and Navigation Code (HNC) §64.5. Between 2014-17, CDFW assessed 5 species, all determined to be invasive aquatic plants and authorized for treatment within the Delta. In 2018, CDFW completed assessments for alligatorweed (Alternanthera philoxeroides), a new detection in the Delta, and floating pennywort (Hydrocotyle ranunculoides), a native California species. Alligatorweed was determined to be invasive. We modified the USAqWRA for pennywort in order to improve accuracy when assessing a native species under the HNC §64.5 definition. Accuracy of the assessment tool, assessment questions, species scores, and overall findings will be presented. This work's relevance to the Delta is to improve aquatic weed management, resulting in improved access for recreation while protecting its ecological value for native species.

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

Poster Topic: Aquatic/Riparian Invasives

Arundo Mapping, Control, and Habitat Restoration in the Delta

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Arundo donax is a highly invasive plant found throughout the legal Delta, and many other parts of California. This species outcompetes native vegetation, reduces habitat value, consumes extensive quantities of water, and destabilizes banks and levees. The Sacramento-San Joaquin Delta Conservancy (Conservancy) initiated the Arundo Control and Habitat Restoration Program in 2014 with the goal of mapping all Arundo stands in the legal Delta, eliminating them (where possible), and replacing them with restored native habitat (where possible). To begin this project, the Conservancy used funding from The California Department of Water Resources (DWR) to coordinate with the Sonoma Ecology Center (SEC) and the Solano Resource Conservation District (SRCD). Mapping of the entire legal Delta was completed in 2015. This allowed for a prioritization of sites to be accomplished based on habitat value, Arundo concentrations, accessibility, etc. Cache Slough was identified as a high priority area for Arundo control. This area was later extended to include the main stem of the Sacramento River from Ryer Island to Sherman Island, and the Conservancy partnered with the U.S. Department of Agriculture (USDA) – Agricultural Research Service (ARS) to increase funding and coordinate chemical and biological control methods. To date, the project partners have chemically treated approximately 10.5acres of Arundo and have restored approximately 20 acres of native habitat. This project was initially envisioned to occur in two phases, the first a pilot phase (Cache Slough) and the second an expansion to more areas of the Delta. Phase I funding has been expended. We are currently exploring ways to fund and move forward with Phase II.

Keywords: Arundo donax, Invasive Plants, Invasive Species Control

Poster Topic: Aquatic/Riparian Invasives

In the Weeds: Fish Predator Communities and Comparative Predation Risk in two North Delta Flooded Islands Treated and Untreated for Invasive Aquatic Vegetation

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Invasive aquatic vegetation has expanded substantially in the Sacramento-San Joaquin Delta, particularly during the recent prolonged drought. As an ecosystem engineer, SAV alters habitat by reducing turbidity, light penetration, and flow; promoting other non-native species; and reducing open-water habitat. As part of the Delta Smelt Resiliency Strategy, the California Department of Water Resources, the California State Parks Division of Boating and Waterways, UC Davis, and the California Department of Fish and Wildlife are partnering to study the effects of herbicide treatment on vegetation using two heavily infested flooded islands in the Cache Slough Complex: French Island and Little Hastings Tract. The study utilizes a Before-After-Control-Impact design, with Little Hastings Tract undergoing Fluridone herbicide treatment, and French Island not undergoing treatment. As of the spring of 2018, there has not yet been a clear effect of herbicide treatment on the vegetation, though Fluridone may require more than a year to significantly reduce biomass.

This poster presents subcomponents of this larger study, examining differences in the fish community and in predation risk between the sites. Initial electrofishing efforts from 2017 showed high densities of invasive fish species at both sites (~98% of total catch, dominated by Largemouth Bass and Redear Sunfish) and few natives. French Island (untreated site) contains more native species, though this result is not clearly related to herbicide treatment. Preliminary examination of comparative predation via juvenile salmon tethering indicates that overall risk was similar between the two islands during the spring of 2018. Predation increased with warming temperature, and was higher immediately outside of the flooded islands compared to inside. Results from this study will provide information on how efforts to restore habitat for imperiled native fish species through invasive aquatic vegetation control may influence predator-prey dynamics, and whether predation impacts may be affected through such management actions.

Keywords: SAV, predation risk, habitat, invasive species, Delta Smelt Resiliency Strategy

Poster Topic: Aquatic/Riparian Invasives

The Boom of Science: Collecting High Resolution Water Quality Profiles to Understand How Aquatic Vegetation Effects Water Quality and Flow

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The spread of invasive aquatic vegetation in the Sacramento-San Joaquin Delta is having a profound impact on the Delta's natural habitat. These plants have been shown to alter water velocity and increase water clarity, posing threats to native fish species, specifically the endangered Delta Smelt. Aquatic plants can also affect the foodweb by altering nutrient and phytoplankton dynamics, impacting both local and downstream conditions. To better understand the effects of aquatic weeds on Delta habitats, the California Department of Water Resources (DWR), in collaboration with California State Parks Division of Boating and Waterways (DBW) and other agencies, is conducting a multi-year study in the Cache Slough Complex of the northern Delta. As part of this study, two wetland habitats are being compared: (1) Little Hastings Tract which is receiving herbicide treatments and (2) French Island which serves as an untreated control. To enhance the physical, chemical and biological measurements being made at these two sites, we have modified our USGS boat-based flow-through water quality monitoring system such that the intake tube is deployed on a long boom that can be utilized to collect continuous vertical profiles with minimal disturbance. The in situ, boat-based high frequency measurements allow us to map both the horizontal and vertical gradients in water quality with much greater resolution than is possible using fixed station measurements and grab samples. The data obtained from these efforts will help determine whether there are differences between treated versus untreated sites, as well as detect differences across the sites that can be attributed to different densities and types of aquatic vegetation. This information will also be used to validate hydrodynamic models being developed by the DWR and to put water quality data being collected by DWR in into a greater spatial context.

Keywords: aquatic vegetation, water quality, nutrients, invasive species, habitat,

Poster Topic: Aquatic/Riparian Invasives

Bay-Delta Science Programs

California's Fourth Climate Change Assessment: At the Intersection of Science and Climate-Resilient Policy

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Fourth Climate Change Assessment (Fourth Assessment) advances actionable science that serves the growing needs of state and local-level decision-makers from a variety of sectors. It includes research to develop rigorous, comprehensive climate change scenarios at a scale suitable for illuminating vulnerabilities and adaptation strategies in California. The Assessment developed datasets and tools to improve integration of climate projection knowledge into decision-making. Fourth Assessment research projects illuminate vulnerability and resilience options related to water resources, oceans and coasts, forests, wildfires, agriculture, biodiversity and habitat, energy sector and public health. The Fourth Assessment includes more than 40 technical research papers, 9 regional reports, 3 topical reports (oceans & coast, climate justice and tribal and indigenous communities), a statewide report, and a statewide summary brochure. Climate change information relevant to the Bay-Delta can be found in the Assessment's regional reports for the San Francisco Bay area and for the Sacramento and San Joaquin Valleys. Fourth Assessment research that informs Bay-Delta science includes climate and sea level rise projections and impact assessments, natural infrastructure options for adapting to sea level rise, high resolution measurements of subsidence of Delta levees and analysis of compounding impacts of sea level rise, Delta water level estimates (stage-frequency) for combined sea level rise and flooding, changes in water system operations, Delta ecological impacts, carbon sequestration and bio-indicators for ocean acidification and hypoxia. Online tools and models have been developed and enhanced to quantify and visualize potential impacts of climate change. This suite of Fourth Assessment research and tools supports global leadership in navigating the intersection of climate change science and policy.

Keywords: Climate change, climate projections, sea level rise, impacts, adaptation, resilience

Poster Topic: Bay-Delta Science Programs

Swiss Army Performance Measures: How the Delta Plan uses a Suite of Performance Measures to track the California Delta

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The Delta Plan is a comprehensive regulatory and planning document created by the Delta Stewardship Council for California's Sacramento and San Joaquin Delta region. Founded on best available science, the Delta Plan supports the coequal goals of providing a more reliable water supply for the state and enhancing the region's ecosystem while enhancing the Delta as an evolving place. In order to track the success of the Delta Plan, the Delta Stewardship Council has developed a suite of performance measures. The performance measures serve multiple purposes: meet requirements of the Delta Reform Act, be a tool for communicating with the public, and integrate into the adaptive management process. Each measure includes a metric, a baseline, and a target. The metric is a quantitative measurement, the baseline is an empirical starting point for the metric, and the target is a scientifically justified goal with a specific date. This presentation outlines the performance measure structure, discusses trade-offs that need to be considered when developing performance measures, and introduces the broad suite of the Delta Plan outcome and output measures.

Keywords: Performance Measures, Monitoring, Delta Plan, Science Communication, Governance, Integrative Science

Poster Topic: Bay-Delta Science Programs

The 2018 Delta Science Plan Update

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The first Delta Science Plan was completed in November 2013 to address the need for a framework to guide collaborative approaches to develop and communicate shared scientific knowledge that informs policy-makers, managers, and the public in taking action in the Sacramento-San Joaquin Delta.

Since its initial release, several advances have been made in understanding the complex Delta system, collaboration among scientists from different agencies and entities has increased, and communication of science to support decision making has improved. However, challenges still remain including the need for strategies to synthesize information more quickly to be relevant for decision making, integrating social sciences in the efforts to more holistically understand the Delta, creating stronger linkages between the San Francisco Bay, and improving transparency associated with data sharing and decision making.

The purpose of this review and update is to ensure the contents of the Delta Science Plan are relevant to the regional needs of the Delta and that the document is widely accepted as a useful and valuable framework for collaborative science. To ensure continuous engagement from the wider Delta science community and public, the review and update process included early outreach at collaborative science meetings and a public workshop to receive more detailed feedback on the Science Plan. Input received so far includes a need for greater emphasis on mechanisms for collaboration, strategies for increased stakeholder participation, clear principles for good synthesis and science communication to increase trust, and strategies to leverage funding for science.

Keywords: Delta Science Plan, Collaborative science, Delta science strategy

Poster Topic: Bay-Delta Science Programs

Delta Regional Monitoring Program

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The mission of the Delta Regional Monitoring Program (Delta RMP) is to inform decisions on how to protect, and where necessary, restore beneficial uses of water in the Delta, by producing objective and cost-effective scientific information critical to understanding water quality conditions and trends. Beginning in 2015, the Delta RMP has conducted water quality monitoring for pathogens, pesticides, toxicity, mercury, and nutrients. These data are available via the California Environmental Data Exchange Network (CEDEN). In addition, the program has funded important work synthesizing the state of knowledge related to nutrients in the Delta. The first of these reports is Assessment of Nutrient Status and Trends in the Delta in 2001–2016: Effects of drought on ambient concentrations and trends. The authors conclude that spatial and temporal trends in the concentrations of nutrients and nutrient-related parameters are reasonably well understood as are the important sources of nutrients in the Delta. However, much is unknown about nutrient sinks, sources, and processes within the Delta. A second nutrients study, Modeling to Assist Identification of Temporal and Spatial Data Gaps for Nutrient Monitoring, reports on how models can be used to optimize monitoring designs. Using existing hydrodynamic models was a cost-effective way to get information about the likely spatial and temporal variability in water quality. The Delta RMP has also funded an analysis of pesticides and toxicity in the Delta expected to be complete in May 2019. Finally, a pilot study is under consideration for Contaminants of Emerging Concern (CECs). Overall, the Delta RMP seeks to inform a range of often competing interests in an environment that encourages objectivity, consensus-building, and science-based decision making. The reports described here and more information can be found at http://tinyurl.com/DeltaRMP.

Keywords: pesticides, toxicity, nutrients, mercury, pathogens, trends, modeling, DSM2

Poster Topic: Bay-Delta Science Programs

SFEWS Celebrates Its 15th Year!

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San Francisco Estuary and Watershed Science (SFEWS) is an academic, peer-reviewed electronic journal that addresses the extraordinarily complex and often problematic water resources issues in California. SFEWS is the primary publication outlet for applied research about the San Francisco-San Joaquin Delta and San Francisco Bay, a place where resource-management issues of national significance represents a major part of the habitat of the endangered Delta Smelt, while also providing the water supply for 8% of the population of the U.S. Limited access to the scientific literature among agencies and stakeholders has long been cited as an impediment to science-based policy. SFEWS has addressed this challenge for 15 years as an open access journal charging neither authors nor readers to submit manuscripts or access articles. Articles published in SFEWS continue to have influence beyond the local scientific community and serves as a high-impact resource for policy makers, providing the basis for high-quality, credible science to improve our understanding of the Bay-Delta. As such, it is the major source of peer-reviewed science that can be used to support water forward-looking policy decisions for the 7th largest economy on earth. Now celebrating its 15th year of publication, SFEWS has achieved several milestones. Since October 2003, SFEWS has published 196 articles in 46 issues among 15 volumes, generating more than 230,000 downloads to access its peer-reviewed scholarly content. SFEWS has been operated for 15 years by 5 editorial staff since 2003. In 2017, Scopus ranked SFEWS 55th of 183 journals in the Water Science and Technology category for 2016, a remarkable rise from rank 120th of 179 in 2014. Since 2009, the California Digital Library's eScholarship ranked SFEWS: 1st most accessed scholarly content sourced from the John Muir Institute of the Environment, 3rd sourced from UC Davis, and 3rd sourced from UC campus-wide.

Keywords: electronic journal, open access, peer-reviewed research, credible science, policymaking

Poster Topic: Bay-Delta Science Programs

Regional Conservation Investment Strategy Program

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On September 22, 2016, the Governor signed Assembly Bill 2087 establishing the California Department of Fish and Wildlife's (CDFW) new Regional Conservation Investment Strategies (RCIS) Program. The RCIS Program enables voluntary, non-regulatory regional conservation strategies to provide comprehensive, cohesive, and connected regional conservation through philanthropic investments and advance mitigation. The RCIS Program consists of three components: regional conservation assessments (RCAs), regional conservation investment strategies (RCISs), and mitigation credit agreements (MCAs). MCAs create credits that may be used as compensatory mitigation for impacts under the California Environmental Quality Act, the California Endangered Species Act, and the Lake and Streambed Alteration Program. The RCIS Program uses a science-based approach to identify and prioritize conservation and habitat enhancement actions to help California's declining and vulnerable species by protecting, restoring, and reconnecting their habitats, and facilitating adaption and resilience to climate change, invasive species and other stressors. These actions may include land protection, habitat restoration, installation of wildlife crossings, removal of fish passage barriers, and other actions. This poster will provide a summary of the RCIS Program and its benefits and uses, the status of submittals to date, how it relates to other CDFW conservation planning instruments, and funding opportunities.

Keywords: regional, conservation, mitigation, assessment, strategy

Poster Topic: Bay-Delta Science Programs

Bay-Delta Watershed

From the Sierra to the Sea: The Ecological History of the San Francisco Bay-Delta Watershed

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In 1998, The Bay Institute (TBI) produced the seminal report, From the Sierra to the Sea: The Ecological History of the San Francisco Bay-Delta Watershed (STS). The report, produced with the support of water managers and government agencies, described the aquatic ecosystems of the Bay watershed's montane uplands, Central Valley lowlands, Delta, pelagic waters, and nearshore coastal waters as an integrated whole. STS provided landscape-scale analyses of: 1) natural ecosystem structure, function, and organization; 2) transformations of the watershed; and 3) ecological responses to human-induced changes, and concluded with recommendations for building a practical framework for ecosystem restoration and management. Twenty years later, TBI is reissuing STS with an afterward describing major changes since the report was first published. Many watershed impacts continue to worsen, such as increasing water diversions from and decreasing freshwater flows to the estuary, which are associated with declining fish populations, degraded water quality, and the spread of invasive species. Exports from the Delta accelerated, while upstream diversions stabilized, peaking around 1998. One of the most dramatic changes is the frequency of reversed Old and Middle River flows (OMR) more negative than -10,000 cfs. Prior to 1998, reverse flows of this magnitude rarely occurred (19 days total since the export pumps began operating), but since 1998 these extreme reversals of OMR flow occurred 29 days per year, on average. On the other hand, many habitat restoration projects have been implemented since 1998, many more are planned, and our scientific understanding of species' and ecosystem needs has improved dramatically over the past two decades. The update also reflects new understanding of future threats to the Bay and its watershed; projections of a warmer climate and sea level rise as well as the need for sustainable water management now play a dominant role in planning and decision-making.

Keywords: watershed, ecology, history, landscape, impacts, restoration, threats, sustainability, water management

Poster Topic: Bay-Delta Watershed

Water Budgets for the Delta Watershed

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One of the coequal goals named in the California Water Code is “providing a more reliable water supply for California.” Achieving this goal requires better matching supply and demand. However, in a region as geographically and hydrologically variable as California, quantifying supply and demand can be a daunting task. We explore the datasets available for creating water budgets in the Delta watershed, and examine what they tell us about where our actions can improve water supply reliability. We also describe the large variability of water supplies (in both space and time), and discuss its implications for Delta water users.

Keywords: water budget, reliability, evapotranspiration, precipitation, streamflow, data

Poster Topic: Bay-Delta Watershed

High School Student Researchers Investigate E.coli in Lake Merritt

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The purpose of our research was to investigate the concentration and distribution of E. coli during the wet season in Lake Merritt, a tidal lagoon in the middle of heavily urbanized Oakland CA. Specifically, we asked: what were the effects of rainfall, salinity and proximity to San Francisco Bay tidal input and various fresh water inputs on E. coli levels.
Students from Oakland Emiliano Zapata Street Academy and local citizens collected sampled over five consecutive weeks, from February 21, 2018 through March 21, 2018. We followed the Environmental Protection Agency's Volunteer Monitoring of Surface Water for Bacteria protocol (Standard Operating Procedure #1103). The samples were collected from eleven shoreline sites including a major fresh water 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 results for each date and the geometric mean over five weeks.
The results indicated wide variation in E. coli concentrations within sites and at different sites, similar to findings in other studies in previous years. . The concentrations generally exceeded water quality objectives, with reductions of concentrations near the Bay channel and at higher salinities.

Keywords: E. coli, tidal lagoon, salnity

Poster Topic: Bay-Delta Watershed

Perceptions of Flood Risk and Management of the Delta Levee System

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The goals of the 2009 Delta Reform Act are to reduce risks to people, property, and state interests in the Delta; provide a more reliable water supply for California; protect, restore, and enhance the Delta ecosystem, and protect and enhance the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. These are, clearly, very disparate goals and it has been a challenge to simultaneously implement them all. Over 1,800 km of earthen levees define the islands and tracts of the Delta, and two-thirds of the levees are privately owned and are below the standard for federal assistance if they fail. Flood risk from levee failure remains a contested frame for decision-making, contributing to conflict over the best approach to management of the region. Whose responsibility is it to manage flood risk on private lands in the Delta? This is a complex social and political question, the answer to which stakeholders can – and do – disagree. This study uses the Q methodology to explore the structure and content of a diverse group of stakeholders' subjective beliefs of flood risk and flood management in the Delta. The findings of this study reveal distinct views on the resilience of local communities, societal accountability of present conditions, and the Delta as a whole. This study also elucidates nuanced perspectives on the sustainability of the Delta's levees and the viability of mitigation and adaptation as conditions in the Delta change. Reconciling long held distrust is likely to be an ongoing challenge. However, uncertainty of future conditions may ultimately function to open conversations to include alternative perspectives and actions, and thus inform policy that "protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place" (CA Water Code section 85054).

Keywords: perspective, flood, risk, perception, levee, delta, place, trust, adaptation

Poster Topic: Bay-Delta Watershed

Data

Accelerating Knowledge Discovery through Emerging Technology

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Problem statement: Environmental management and decision making in the Delta are often delayed due to lack of data availability, analysis and communication. Decision makers and managers often have to deal with either outdated data or insufficient data to make time-sensitive changes related to environmental management.

Approach: Explore new technologies to complement traditional science and research, accelerating data collection and insights needed to make efficient and timely management decisions.

Results: Incorporate modern methods of science and research methodologies using advanced technologies and instrumentation for collection, storage, management and analysis of data to accelerate knowledge discovery.

Conclusions/Relevance: Machine learning techniques and lightweight unmanned aerial vehicles are revolutionizing environmental monitoring. In the past, investigating vegetation and wildlife status required extensive surveys of the area. Now, unmanned aerial vehicles can access hard-to-reach places and quickly capture vegetation types, area and wildlife count, and activity based on high-resolution images. Results derived from these new techniques are even more precise than estimates made by traditional means. Automated animal identification performs at the same 96.6% accuracy level of human volunteers, saving approximately 8.2 years of human labelling effort on a 3.2- million-image dataset.

Leveraging artificial intelligence and machine learning to manage issues related to the natural resources will provide insights that will accelerate our pursuit of understanding and managing the Delta's natural resources.

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https://www.ua-magazine.com/4-ways-machine-learning-protects-environment/#.WoSplUqnGUl

Keywords: Machine learning, environmental monitoring, advanced technologies, knowledge discovery, management decisions

Poster Topic: Data

Development of a Web-Based Remote Sensing Water Quality Application

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Using the BayDeltaLive.com platform this project advances the capability of multiple stakeholders in California's water resources to routinely access and utilize Earth observations-based water quality products to support operational or institutional decision-making related to water management practices. Our project is based on the intersection between water quality parameters used in our partners' respective organizations and the data products that can be derived from remote sensing data sets. Based on this, the three main project objectives are: (1) develop and/or strengthen existing algorithms from various platforms for the identified water quality products; (2) centralize and, in some cases, automate processing for, water quality products for access through the Bay Delta-Live ((BDL) baydeltalive.com) web application; and (3) iteratively work to develop a suite of decision dashboards that encompass specific use cases or management use scenarios.

Keywords: remote sensing, visualization, water quality, web, delta operations

Poster Topic: Data

Bay Delta Live Constituent Tracker

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Bay-Delta Live (baydeltalive.com) is a web-based water information decision support tool that serves a robust scientific community with the goal of expanding open and transparent sharing of information essential in understanding the complex and dynamic hydrodynamics and water quality conditions of the Sacramento-San Joaquin Bay Delta. Bay-Delta Live provides information from multiple sources using enhanced visual interfaces. This collaborative portal is used by resource managers, scientists, conservationists, policy makers, academics, and other local community members. BDL is supported through contributions from both federal and state agencies.
Our intent is to extend the usefulness of the data presently collected at current monitoring stations for management decisions: to provide a regional scale perspective on how the system is functioning that obviates the need to examine dozens of time series plots. This map based visualization will combine velocity data with constituent data already being collected at the same station to provide spatial maps registered to a constant point in tide (at slack water), that, when strung together over the 14 day spring/neap cycle, will provide estimates of the tidally averaged (net) movement of constituent fields.

Keywords: data, visualization, constituents, bay delta, real time data, web, tides

Poster Topic: Data

Quality Assurance for Environmental Programs

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Problem: Quality assurance (QA) is a critical, but underleveraged part of many environmental science studies. A robust QA program ensures data is collected to meet data quality objectives and builds the foundation for scientific activities. To maximize effectiveness, QA should be implemented across a project's life cycle, from initial planning through publication. By documenting data quality objectives, sample collection processes, and how data is reviewed and qualified, QA ensures standards are being met and that collected data is of known quality.
Approach: QA can be implemented at any level, from a single project to an entire Agency through training, guidance, and implementation of standard procedures.
Results: We will present our lessons learned in building and maintaining a QA program in a state agency. We will share approaches that we have found to be effective for evaluating laboratory, field, and real-time water quality data.
Relevance: Effective QA enhances consistency, reproducibility, transparency, validity, and confidence in data quality which are necessary for today's science programs. Implementing QA planning and quality control procedures is additionally helpful in making decisions about data quality throughout the life of a project, and in providing documentation to answer questions about how data was handled, long after a project is completed, such as in litigation. This poster will examine the necessary components of QA programs.

Keywords: Quality Assurance, standard procedures, Quality Control,

Poster Topic: Data

Fish – Other Fishes

Modeling the Effects of Varying Disturbance Frequency and Magnitude on Population Persistence in Predator-Prey Systems

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Human activities are rapidly and significantly transforming environments, altering historic ecosystem disturbance regimes. Estuaries are particularly vulnerable to disturbances due to resource use and other human activities. Anthropogenic disturbances can alter the physical environment and disrupt ecosystem function, leading to both direct and indirect population impacts. While the effects of disturbance frequency and magnitude on species diversity and competitive interactions have been studied, their effects on predator-prey interactions have not been investigated. To address this, we developed simple dynamic models to examine the effects of varying disturbance frequency and magnitude on prey population persistence in predator-prey systems. We then extended this analysis to a more realistic model of eastern oysters (Crassostrea virginica) and their predator, the southern oyster drill (Stramonita haemastoma), to assess how disturbances, characterized by changes in estuarine salinity and temperature, affect the predator-prey interaction. Initial results reveal that increasing the frequency of disturbance increases the probability of prey population extinction more than increasing magnitude. Additionally, effects differ depending on predator-prey dynamics and whether the disturbance affects population abundance or demographic rates. The findings of this study will further understanding of the effects of varying disturbances on interacting populations and aid managers in improving long-term population outcomes. This work is relevant to San Francisco Bay-Delta management because these models can be used to aid management of local bivalves such as the Olympia oysters (Ostrea lurida). Currently, restoration and conservation efforts are threatened by the Atlantic oyster drill (Urosalpinx cinerea), an invasive predatory gastropod. These predators are limited by physical disturbances and gradients, and their impact on Olympia oyster populations will likely be exacerbated by climate change. Oysters provide habitat and invaluable ecosystem services, so it is critical to restoration and conservation management to examine how varying disturbances impact both short-term and long-term population outcomes.

Keywords: disturbance; synergisms; population modeling; predator-prey; competition; global sensitivity analysis

Poster Topic: Fish - Other Fishes

Abundance and Rearing Distribution of Age-0 Pacific Herring During Wet and Dry Years: Are We Missing Inland Spawning Activity?

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Pacific Herring (Clupea pallasi) support an important fishery in the San Francisco Bay during winter when adults move from coastal waters into the estuary for spawning. Spawning typically occurs over submerged objects (SAV, pilings, etc) in shallow areas around South and Central Bay. Pacific Herring spawning in the upper San Francisco Estuary, inland of Caquinez Straits, has been overlooked as a potential spawning region; however our research shows that larval and juvenile herring are abundant in the upper estuary during drier water years when two-layer gravitational circulation is weak. Thus, the mechanism for larval herring rearing in the upper San Francisco estuary could be found in localized spawning activity. In this study, we examined larval and juvenile herring abundance and distribution across the longitudinal axis of the estuary between Central Bay and the western Delta during 2016 (January to April) and 2017 (January to August). We also examined habitat use differences in shallow and channel habitats (surface and deep) to provide any insights into how rearing habitat may facilitate retention or upstream selective stream transport. During 2016, which was a dry year at the end of a prolonged drought, larval Pacific Herring were relatively abundant in shallow habitats in the inland regions of estuary east of Carquinez Straits. In contrast, during the wet year 2017, larval Pacific Herring were distributed mostly seaward of Carquinez Straits with high abundances in shallow habitats. Overall, our research suggests that age-0 Pacific Herring rear across broad regions over the estuary, suggesting they are not limited by geography or habitat space, but by more dynamic factors such as annual hydrology.

Keywords: Pacific Herring, Rearing Habitat, Fisheries, Larval Fish, Herring Spawn

Poster Topic: Fish - Other Fishes

Free Room and Board: Parasite Abundance on Crangon shrimp in the San Francisco Estuary.

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CDFW's San Francisco Bay Study has collected Caridean shrimp, including several species of the native Crangon, from the San Francisco Estuary since 1980. Shrimp were collected using an otter trawl towed monthly at stations from South Bay to western Delta and returned to the lab for processing, where species, sex, length, and presence of the parasitic bopyrid isopod Argeia pugettensis was recorded. A. pugettensisinfests 4 species of Crangon, but primarily C. franciscorum and C. nigromaculata. Parasitism is denoted by a bulge in the shrimp's carapace where a female parasite settles onto the left or right branchial chamber of the host. With this unique data set, trends in parasitism by species, sex, size, year, and season were analyzed from 1983 to 2016. Preliminary analysis of parasitism rates showed an apparent parasite preference for female (1.8%) over male C. franciscorum (0.4%). However, there was no strong parasite preference for female or male C. nigromaculata(1.9% vs. 2.1%, respectively). While the annual rate C. franciscorum parasitized was cyclic and never exceeded 3.6%, there was a steady increase in parasitism of C. nigromaculatabeginning late 1990s. From 1983 to 1998, less than 0.1% were parasitized annually, but over 6% were parasitized annually by 2013. Overall, C. franciscorum was much more abundant in the estuary than C. nigromaculata, but C. nigromaculata had a higher rate of parasitism (1.7% vs. 0.8%). Increased A. pugettensis infestation rates could have consequences on a trophic level, as parasitism reduces a shrimp's size and reproductive ability and thus reduces the amount of food (shrimp) for fishes, birds, and mammals. With further analyses, this study aims to increase our understanding of the A. pugettensis - Crangonrelationship and its role within the San Francisco Estuary ecosystem.

Keywords: Caridean shrimp. Argeia pugettensis. Parasite.

Poster Topic: Fish - Salmon

Identifying the Presence of Estrogenic Compounds in the Yolo Bypass Wildlife Area Using a Fluorescent Bioassay

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The goal of this study is to assess xenoestrogen presence and effect on fish in the Yolo Bypass Wildlife Area (YBWA). Xenoestrogens (XE) are synthetic or natural compounds that imitate estrogen, and are regularly detected in the San Francisco Bay Delta waters. XEs are sourced predominantly from wastewater effluent, and agricultural and urban runoff following storm/flood events. XEs act as endocrine disrupting compounds (EDCs), which include pesticides (e.g., pyrethroids) utilized in the YBWA region that have potential to impact fish developmental, neurological, and reproductive processes.
To investigate the presence of XEs in the YBWA, I utilize a transgenic estrogen receptor reporter zebrafish, called Tg(5xERE:egfp) as a bioassay. The Tg(5xERE:egfp) fish functions via five tandem estrogen response elements driving the production of enhanced green fluorescent protein (EGFP), which make the fish fluoresce in a dose-dependent manner in the presence of elevated XE;concentrations. I have also developed a highly sensitive quantitative PCR assay to measure EGFP mRNA when signals are below the limit of visible fluorescence.The Tg(5xERE:egfp) fish are used to detect levels of XEs in extracts from Passive Organic Chemical Integrative Samplers (POCIS) deployed at inflows to the YBWA. Alongside this, non-target chemical analysis will be performed using Liquid Chromatography/Mass-Spectrometry Quadripole-Time-of-Flight (LC/MS-Q-TOF), so as to identify not only known estrogen mimicking pesticides, but also their degradation products, and numerous other compounds present in these complex mixtures.
Because the YBWA is a vital habitat for spawning, rearing, and/or migratory paths for many fish species, understanding the presence of contaminants and their effect on fish in this area will serve to inform conservation, restoration, and stewardship efforts in the YBWA.

Keywords: Endocrine disrupting compounds, pesticides, zebrafish bioassay, Yolo Bypass Wildlife Area

Poster Topic: Fish - Other Fishes

Ecology of Bluegill Lepomis macrochirus, Redear Sunfish Lepomis microlophus, and Tule Perch Hysterocarpus traskii in the Cache Slough Complex

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Native littoral fishes of the Sacramento-San Joaquin Delta (Delta) have declined precipitously. This includes extinction (Thicktail Chub Gila crassicauda), extirpation (Sacramento Perch Archoplites interruptus), and near-disappearance from long-term monitoring surveys (Hitch Lavinia exilicauda, Sacramento Blackfish Orthodon microlepidotus). Causes of the declines are likely myriad, and include habitat loss, hydrologic alterations, and negative interactions with non-native species. In most regions of the Delta this has led to littoral fish communities dominated by non-native species, with native species so rare that it is difficult to evaluate the impact of interactions between the two. The Cache Slough Complex in the northwest Delta is a mosaic of diverse habitat types (e.g., tidal marshes, intertidal mudflat, dredged channel, remnant lowland riparian forest) and boasts a diverse fish community, including a higher proportion of native littoral fishes than other Delta regions. Here, we evaluate the spatial overlap of Tule Perch (Hysterocarpus traskii), a persistent native species, with Bluegill (Lepomis macrochirus) and Redear Sunfish (Lepomis microlophus), two non-native species thought to contribute to the decline of other native species via competition, as well as their habitat associations and diets.

Keywords: Tule Perch, Bluegill, Readear Sunfish, Ecology, Community, Cache Slough Complex

Poster Topic: Fish - Other Fishes

Fish - Salmon

Monitoring the Impacts of Pathogens at Increasing Water Temperatures in Chinook Salmon in the Sacramento-San Joaquin Delta

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Understanding host–pathogen interactions in anadromous fishes is challenging as individuals experience diverse environmental conditions and undergo significant physiological changes while being exposed to many types of infectious pathogens. Pathogenicity and disease progression are closely linked with environmental water temperatures which are predicted to increase within the San Francisco Estuary system in the near future. Outmigrating juvenile salmonids utilize this habitat at a critical developmental stage, and pathogen infection can negatively impact their development, growth, and long-term survival. To investigate how changes in temperature impact the pathogenicity and host response to pathogen infection, we transplanted 640 caged juvenile fall-run Chinook salmon (Oncorhynchus tshawytscha) to two locations in the delta in April of 2017 and 2018 (Twitchell Island and Windmill Cove). After two weeks of field exposure to the local pathogen communities, fish were returned to the laboratory and incubated for three weeks at 15 (field temperature), 17, or 19°C to assess how temperature impacted pathogen infection as well as host physiological responses to infection. We isolated both DNA and RNA from gill tissues and assessed the presence or absence of 47 known salmonid pathogen species utilizing a previously-validated DNA screening technique on the Fluidigm microfluidics system. We then assessed changes in salmonid host gene expression in a suite of 30 genes associated with either pathogen infection or generalized stress response. Temperature-induced altered pathogenicity coupled with altered genetic responses to that pathogenicity may impact fish physiology, life histories, and subsequent long-term survival of salmonids. Results from this experiment may help us better understand how both pathogenicity and salmonid responses to infection may change in a warming San Francisco Estuary.

Keywords: Chinook salmon temperature pathogen gene expression

Poster Topic: Fish - Salmon

SacPAS: Real-time Decision Support Tool for Central Valley Salmonids

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Problem Statement: Fisheries management in the Central Valley involves numerous monitoring and assessment efforts. Data, especially information that is used for real-time operations and management decisions, should be easily interpretable and easily accessible to everyone who is interested.

Approach: The work, funded by Reclamation and in collaboration the Columbia Basin Research group at the University of Washington, is continuing to develop a decision-support system that links a real-time data management system with models to forecast the progress and movement of salmon from spawning through smolt migration. Our immediate focus has been on winter-run Chinook salmon, but already there are applications which will be useful across multiple CVP-operated rivers.

Results: The project has established a website (http://www.cbr.washington.edu/sacramento/) with extensive operational queries and alert functions and models to predict egg emergence and smolt migration. The website tracks the status and trends of many important metrics (e.g., take of listed species, floodplain habitat, temperature, pulse flows, salmon egg incubation period, and redd dewatering). In 2016-2018, the website tracked Sacramento Valley flood weir overtopping during the spring. Also, the website was used to look at spring temperature modeling and potential impacts to winter-run Chinook salmon and results were compared to inform decision making on summer temperature management planning. Finally, temperature analyses on CVP tributaries provides real-time exceedance results. These types of results will be demonstrated at this poster to illustrate the utility of SacPAS for linking data and science to in-season management.

Conclusion/Relevance: SacPAS is a valuable decision-support and coordination tool for supporting ESA-listed fish management in the Central Valley.

Keywords: web services, Chinook salmon, real-time operations, data sharing

Poster Topic: Fish - Salmon

Inducible Stress Tolerance in Juvenile Chinook Salmon: Coping with Repeated Stressors in the San Francisco Bay Delta

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As global climate change progresses, increased temperatures and instances of hypoxia (low environmental dissolved oxygen) are two possible stressors that may occur more frequently in the San Francisco Bay Delta. Both stressors can be detrimental to juvenile Chinook salmon that pass through these habitats during their migration to the ocean. We investigated whether tolerance to acute warming and hypoxia is affected by repeated exposures to these stressors. We examined the potential for a hardening response where exposure to one stressor improves tolerance to a subsequent stressor of the same type, as well as cross tolerance where exposure to one stressor improves tolerance to a different type of subsequent stressor. One group of juvenile Chinook salmon were first tested for upper thermal tolerance. Within that group half were tested again for upper thermal tolerance and half were tested for hypoxia tolerance. The second tests occurred after either a 24 or 72-hour recovery period to assess the effect of time between exposures. A second group of Chinook were initially tested for hypoxia tolerance followed by a second hypoxia tolerance test or a thermal tolerance test either 24 or 72 hours later. Preliminary results suggest a slight heat hardening response occurs 72 hours after initial thermal exposure with limited support for cross tolerance to a subsequent hypoxic exposure. Hemoglobin concentrations, which influence the amount of oxygen carried in the blood, showed a small increase 72 hours after the initial thermal tolerance stress as a potential coping response. Juvenile salmon may tolerate repeated stressors better when there is more time to recover between exposures compared to repeated stressors that occur within 24 hours of each other. These results will provide a better understanding of how juvenile salmon cope with two types of repeated acute stressors they may encounter in their environment.

Keywords: Chinook salmon, hypoxia, climate change, conservation physiolgoy

Poster Topic: Fish - Salmon

Routing Management for DWR's Salmon Protection Technology Study

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The 2009 National Marine Fisheries Service (NMFS) Biological Opinion, requires the State Water Project (SWP) and Central Valley Project (CVP) operations to comply with Reasonable and Prudent Alternative Action IV.1.3 to reduce diversion of juvenile salmonids into the central and south Delta. Thus, DWR initiated planning for the Salmon Protection Technology Study (SPTS), a 5-year salmon protection technology implementation program and evaluation in the Sacramento River, which will evaluate engineering solutions to improve salmon survival and maintain water supply reliability. The final project plan details will be based on the best available science and engineering.
One of modeling tools that DWR has used to evaluate juvenile salmon routing options is the North Delta Routing Management Tool (NDRMT). The NDRMT is a statistical spreadsheet-based model with empirical functions for calculating fish entrainment. The NDRMT predicts the entrainment of out-migrating fish into the Interior Delta for a range of flows under varying conditions. This poster will provide an overview of the methods and results that DWR engineers prepared using the NDRMT to conduct project planning work for SPTS.

Keywords: DWR USGS NMFS Bay-Delta Central-Delta NDRMT SPTS Salmon Salmonids Survival

Poster Topic: Fish - Salmon

Evaluating a Terminal Harvest Program in the San Francisco Bay to Stabilize Harvest and Minimize Straying of Hatchery Fall-Run Chinook

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Five Central Valley salmon hatcheries produce fall-run Chinook to mitigate for lost habitat and to supplement fisheries harvest. Scientific review of hatchery operations has recommended all hatchery produced salmon be released on-site (i.e., at or near the hatchery of origin) to minimize straying of returning adults and the potential for them to spawn. On-site releases often provide poor smolt to adult survival, which has led managers to allow large-scale hatchery releases directly into San Francisco Bay (or other off-site locations), despite high stray rates harmful to wild and ESA listed stocks. New management strategies are needed that can produce abundant hatchery fall-run Chinook for harvest while also minimizing staying and the proportion of hatchery salmon found on the spawning grounds of Central Valley rivers. Terminal Harvest (TH) programs is one such management strategy shown to be effective in minimizing straying while stabilizing harvest (used in Oregon, Washington and Alaska). TH programs typically involve holding and acclimating hatchery juveniles or smolts for a few weeks at a carefully selected site that adults will home back to for “clean-up” via a terminal fishery. We have completed an evaluation of a potential pilot TH program for the San Francisco Bay Area. Simulation analyses indicate a Bay Area TH program could achieve very high smolt-to-adult survival (providing more fish for harvest) while keeping staying rates very low. Final site selection will depend on a more detailed assessment of logistical challenges, as well as avoidance of non-target species impacts. Working with local stakeholders and recreational fishing representatives, the implementation of this study will not only provide data on the potential benefits of a TH program for oceanic harvest but will also evaluate the benefits to local communities for unique and new fishing opportunities as adults return to TH sites.

Keywords: fall-run Chinook, hatchery, terminal harvest, straying

Poster Topic: Fish - Salmon

Effect of Acute Temperature Change on Specific Dynamic Action in Fall-Run Chinook Salmon Juveniles (Oncorhynchus tshawytscha)

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Climate change is forecasted to increase water temperatures in the Sacramento San-Joaquin River Delta. Because environmental temperature dictates many physiological processes in ectotherms such as fishes, climate change may have profound effects on the physiological performance and energy expenditure of native fishes such as the Chinook salmon (Oncorhynchus tshawtscha). Aerobic scope, the difference between the maximum metabolic rate and standard metabolic rate can be considered a fish's energy budget available for all life functions and activity. For a fish to grow, much of this aerobic capacity must be allocated to ingestion, digestion, absorption, and assimilation of a meal, collectively described as specific dynamic action (SDA). SDA is a crucial part of fish energy budgets and is strongly affected by water temperature. For Chinook salmon, acute temperature effects on SDA are not known, and may encompass a significant portion of a fish's aerobic scope at the thermal tolerance extremes. To investigate this, we acclimated juvenile Chinook salmon (mass: 27.6 ± 3.8 g, fork length: 13.3 ± .5 cm) to 19℃ and we measured aerobic scope and SDA at 13, 16, 19, 22, and 24℃ to determine the proportion of aerobic capacity that Chinook salmon dedicate to SDA at different temperatures. Individuals at 24℃ appear to consume oxygen more quickly but over a shorter duration than those at 13℃. However, acute temperature change does not affect the overall magnitude of SDA. This suggests that warmer temperatures may not affect the energy expenditures necessary for digestion in Chinook salmon. However, there is evidence of other salmonids taking advantage of habitat heterogeneity in temperature by moving from cold, nutrient-rich waters for feeding, to warm, nutrient-poor waters to digest, suggesting that there may be evolutionary advantage in digesting a meal quickly.

Keywords: Chinook salmon, SDA, aerobic scope

Poster Topic: Fish - Salmon

Salmon Protection Technology Study

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As a result of the 2009 National Marine Fisheries Service (NMFS) Biological Opinion, the State Water Project (SWP) and Central Valley Project (CVP) operations is required to comply with Reasonable and Prudent Alternative Action IV.1.3 to reduce diversion of juvenile salmonids into the central and south Sacramento-San Joaquin Delta. Currently, the presence of Federal endangered salmon species in the south Delta result in significant SWP and CVP operations curtailments, even though the science that links SWP and CVP operations curtailments to improved salmon survival is not well developed.
To help improve salmonid populations and maintain water supply reliability, the California Department of Water Resources (DWR) and U.S. Bureau of Reclamation (USBR);are developing the Salmon Protection Technology Study (SPTS) project. The SPTS project entails the installation and operation of barriers at north Delta junctions with the intent to alter juvenile salmonid migratory patterns toward routes with higher survival, while minimizing hydraulic changes.
The project includes planning and conducting a 5-year salmon protection technology implementation program and evaluation in the Sacramento River using a Bio-Acoustic Fish Fence (BAFF), Floating Fish Guidance Structure (FFGS), and/or Infrasound Fish Fence (IFF) at locations that will provide the largest resource benefit. The current project plan includes installing a BAFF at Georgiana Slough and an FFGS and/or IFF at Steamboat Slough and/or Sutter Slough. The final project plan details will be based on the best available science and engineering. An evaluation of the effectiveness of these technologies will provide the basis for DWR and USBR to recommend to NMFS future actions beyond SPTS that could further enhance salmonid populations and provide SWP and CVP water supply reliability.

Keywords: Salmon
Juvenile Salmonids
Fish Barriers
Non-physical Barriers
Delta

Poster Topic: Fish - Salmon

Using Aerial Photography to Monitor Salmonid Redds on the Lower American River

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Salmon spawning surveys can provide critical management information regarding habitat use, population estimates, and interannual variation in run size. These data can also support restoration prioritization, allowing managers to direct their actions and funding to maximize benefits to salmon population recovery efforts. During redd construction, female Chinook salmon disturb and "clean" gravel, making redds visually distinguishable as light patches against the darker background of the river bed. Currently, the most commonly-used methods for collecting redd distribution data are on-the-ground and fly-over visual surveys. However, these methods can be expensive, and their utility may be limited if they are not linked to spatial data. In this study, we describe a method for mapping Chinook salmon (Oncorhynchus tshawytscha) redds using geo-rectified aerial photography and present an application of this method using imagery collected from the lower American River between 1991;and 2017. Using spatially explicit redd data has several advantages over traditional methods, including improved standardization, increased ability to compare spawning distribution over time and space, and ability to link the data with hydraulic models.

Keywords: spawning surveys, monitoring methodology, Chinook salmon, GIS, aerial photography

Poster Topic: Fish - Salmon

Evaluation of Predation Management Strategies for Central Valley Salmonids using Simulations

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Identifying the specific mechanisms related to in-river mortality is a difficult and time-consuming process complicated by the numerous extrinsic (e.g., water quality, predator density, anthropogenic habitat alteration) and intrinsic (e.g., behavior and life history, density-dependent effects) factors that influence species survival. Computer simulations provide an in-silico platform for integrating species-specific biological characteristics with management strategies because they allow users to test various scenarios and evaluate outcomes prior to implementing management strategies. Simulations are also useful in the planning phases of projects to help identify sources of uncertainty, direct sampling efforts, and sometimes reveal possible unintended consequences. Using an open-source dynamic programming platform we developed a user-friendly simulation tool for investigating management actions geared towards reducing in-river mortality. Simulations are based on a user-defined mortality-scape (i.e., the extent, magnitude, and timing of observed mortality along a stretch of river) through which individuals must pass. This allows the simulations to be customizable to a variety of conditions and systems. Mortality and survivorship results are visualized using three-dimensional surface plots and two-dimensional contour plots. Within the Central Valley, there is a lack of information regarding predation effects on juvenile salmon. Therefore, we focused on the specific question of how to best manage mortality due to predation in rivers. We applied the simulations to a hypothetical population of outmigrating juvenile fall-run Chinook salmon (Oncorhynchus tshawytscha) to compare two frequently proposed strategies for alleviating predation pressure; (1) widespread suppression to decrease the numerical abundance of predators across the reach, and (2) localized removals of predatory fishes or habitat engineering fixes at mortality 'hotspots'. From a planning perspective, the tool will allow for prioritization of actions based on the numbers of juvenile Chinook salmon expected to survive under these hypothesized conditions.

Keywords: Simulation, Predation, Chinook salmon, Management, Predator suppression,

Poster Topic: Fish - Salmon

Movements of Adult Fall-Run Chinook Salmon in the Toe Drain of the Yolo Bypass

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Much of the fisheries research conducted in the Yolo Bypass focuses on periods of seasonal inundation, examining its potential as floodplain rearing habitat and an upstream source of primary and secondary production to the San Francisco Estuary. Little research has been conducted investigating the effects of agriculturally driven fluctuations in discharge from the Yolo Bypass during the late-summer and fall, a time of year that is typically characterized by low flows. The upper portion of the Toe Drain, which connects with the Sacramento River only during short windows of high flows, presents migrating fish with barrier to upstream passage. Using acoustic telemetry we investigated adult fall-run Chinook salmon movements in the perennially wetted Toe Drain of the Yolo Bypass during their spawning migration. An attractant pulse of discharge from the Toe Drain during the migratory window may represent an ecological trap (i.e.. delayed or truncated migration) due to passage impediments, high water temperatures, etc. The median residence time of the tagged fish in the Toe Drain was 17 days (range: 0-52 days), and included several instances of fish moving through locations with perceived passage concerns. Twenty percent of tagged fish were detected on receivers near spawning habitat in Putah Creek, a small stream with several ongoing restoration projects. Another twenty percent were last detected in the Toe Drain presumably perishing without reaching suitable spawning habitat. The remaining fish exited the Toe Drain and continued their upstream migration, returning to a wide variety of Central Valley rivers after visiting the Toe Drain. Understanding salmon movement behavior in response to relatively small fluctuations in summer and fall outflows, when the Bypass is not typically inundated, may have important implications for reducing rates of straying and stranding for adult fall-run Chinook salmon.

Keywords: salmon, migration, telemetry, Yolo Bypass, Toe Drain, Chinook

Poster Topic: Fish - Salmon

SacPAS Fish Model: A Series of Web-Based, Linked Models of Salmonid Spawning and Migration to Characterize the Movement of Water and Juvenile Fish through the Sacramento River System to the Head of the San Francisco Bay Delta

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Problem Statement:Careful consideration of the limited water resources in the Central Valley is necessary for making good management decisions to protect the region's endangered salmonids. Online scenario-based models can provide rapid, accessible insight into the impact of environmental conditions on the spawning, growth and migration of Chinook.

Approach: Using a series of connected models and river data, we project the emergence timing, downstream migration and survival of juvenile Chinook from redd deposition in the upper Sacramento to juvenile passage at Verona Beach. These models can be run sequentially with one model feeding inputs to the next, or they can be run independently.. Historical data, or user-chosen inputs on redd timing, flow and temperature impact the survival and movements of these fish.

Results: Our user-configured online models at http://www.cbr.washington.edu/sacramento/migration/are designed to predict the impact of various operational and ecological changes on winter Chinook spawning, migration and survival. They have the potential to inform resource managers on the possible effect of proposed and planned operational scenarios on winter Chinook migration and survival.

Conclusion/Relevance: Modeling operational scenarios and predicting their effects on salmonid migration and survival are essential tools for managing the Central Valley's water resources. Insight into the complex relationships among flows, temperatures and fish ecology can help optimize operational decisions relative to conflicting demands.

Keywords: Chinook, Emergence, Migration, Survival Modeling, Adaptive Management, Web-Based

Poster Topic: Fish - Salmon

Fish – Salmon - DJFMP

How Does Temperature Effect CPUE of Beach Seines Used for Long Term Monitoring of Littoral Habitats as Part of the Delta Juvenile Fish Monitoring Program?

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Delta Juvenile Fish Monitoring Program (DJFMP) has been using Beach Seines to collect data on near-shore fish populations since 1976. criteria for selection of Seine sites was accessibility, practicality of sampling, and spatial distribution throughout the delta and bay, not random site selection, which has been a concern for many scientists who question the utility of the data (IEP Science Advisory Group Review 2013). Use of Beach Seines is limited to open areas free of obstructions (aquatic vegetation, rocks, logs, etc.) and having a shore with appropriate slope for pulling the net in, which raises suspicion about under-representing the majority of littoral areas in the delta and the fish found in that habitat. Another concern is that some environmental variables may also make beach seining relatively ineffective certain times of the year. We are interested in answering the question "When water is cold will fish move slightly deeper and out of range of a 1.2-meter max-depth beach seine?" By analyzing DJFMP beach seine data from 2005-present we see a significant and positive trend in Catch Per Unit Effort (CPUE) as temperature increases. Across all DJFMP seine sites and species caught CPUE averaged just 5.51 when water temperature was less than 6 C, and steadily increased incrementally, averaging 28.81 when water temperature was above 28 C. Seventy-two percent of the time that "no catch" was recorded after seining, the water temperature was less than 20 C. It is important to identify potential issues in the data when attempting to estimate fish populations using long-term monitoring. DJFMP is currently electrofishing as a pilot study to evaluate that methods ability to estimate littoral fish populations in the delta. Boat electrofishing will also likely be more effective at catching fish that are slightly deeper than a beach seine can effectively sample.

Keywords: Beach Seines, Seines, Long Term Monitoring, Littoral, Habitat, Fish, Temperature

Poster Topic: Fish - Salmon - DJFMP

Assessing the use of Alternate Beach Seine Sites for the Delta Juvenile Fish Monitoring Program

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The Delta Juvenile Fish Monitoring Project (DJFMP) has been beach seining and trawling for long-term fisheries monitoring since the 1970's. Using beach seines allows the DJFMP to capture, identify and enumerate fish species that utilize shallow, open water habitats. While beach seine data is useful, it is limited in the type of habitat it can sample. Current DJFMP beach seine sample locations, used for decades, were first selected because the habitat was considered acceptable for seining. Criteria used for initial selection included: open water with gravel, sand, mud or pavement substrates with little to no aquatic vegetation. However, passive restoration of these locations has reduced and in some cases eliminated sampling sites, creating conditions that characterize the site unable to seine (code 4). In the spring and summer of 2015 and again in 2017, all seine sites were visited to determine usability. If a site had been given a code 4 over 60% of the time, it was determined that an alternate site should be located. These "alternate seine sites" were selected based on their proximity to the original site and contained similar or comparable substrate and habitat conditions. We identified thirty alternate sites between all regions. Each site was sampled to determine ease of sampling. Location of each alternate site was mapped using a handheld GPS unit. The DJFMP is also currently involved in a pilot study to evaluate the use of a boat electrofishing unit to supplement beach seining. Using a device like electrofishing that can capture fish in various substrates, and levels of vegetation present, would be a valuable addition to current littoral habitat sampling and improve the accuracy of fish population assessments for the Bay-Delta.

Keywords: Beach, Seining, Seine, Long-term, Fish, Monitoring

Poster Topic: Fish - Salmon - DJFMP

Fish – Smelts

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

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We tested an immersion-administered, fluorescent dye (SE-Mark™) for marking Longfin Smelt (LFS) that on average were 33 mm fork length. SE-Mark™ (calcein) can be used on live fish, binds to bony tissue, and is easily visible when viewed under 495/515 nm wavelength light. Caclein may be a viable method for mass marking fish 40mm fork length, which are difficult to distinguish, for mark/recapture experiments.

Keywords: Longfin Smelt, Skinner Fish Facility, Calcein, Mark, Recapture

Poster Topic: Fish - Smelts

Wakasagi Status and Intersections with Delta Smelt

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Wakasagi (Hypomesus nipponensis), a non-native congener to the endangered Delta Smelt (Hypomesus transpacificus), was introduced into multiple California streams and reservoirs as forage for salmon and trout between 1959 and 1973. Wakasagi has since expanded distribution ranges to the San Francisco Bay-Delta and can negatively influence Delta Smelt through hybridization. In this study we examine the distribution, habitat association, and gear efficiency for Wakasagi in the San Francisco Bay-Delta to better understand the role Wakasagi play in the Delta ecosystem. We described the distribution of Wakasagi by examining bycatch in datasets from the Delta Juvenile Fish Monitoring Program (beach seines), Feather River and Yolo Bypass Fish Monitoring Programs (rotary screw traps), and the Enhanced Delta Smelt Monitoring Program (Kodiak trawls, [EDSM]). Annual abundance of Wakasagi is greater in the upper watersheds including Feather River; however, there are considerable numbers of Wakasagi found in the Lower Sacramento and North Delta regions. While abundance of Wakasagi in the Delta regions (specifically the North Delta) tend to fluctuate, abundance in the Yolo Bypass has steadily increased with the highest catch in 2017. Increased abundance of juvenile Wakasagi in Yolo Bypass may create competition for resources with Delta Smelt as they have similar diets and phenology. Closer examination of 2017 EDSM data showed Wakasagi and Delta Smelt occupy different regions within the Delta. Wakasagi were found mainly in the North Delta, whereas Delta Smelt were most prevalent within West Delta and least prevalent in the North Delta. Calculated detection probability of Wakasagi was also greater than Delta Smelt in the EDSM survey which is likely driven by the low population abundance of Delta Smelt in 2017. Our results indicate the presence of Wakasagi is greater than originally thought; however, it is unclear why larger establishment in the Delta has not occurred.

Keywords: Wakasagi, distribution, abundance, habitat association, Delta Smelt

Poster Topic: Fish - Smelts

Otoliths and Isoscapes: Reconstructing Thermal Life History of California's Endangered Delta Smelt

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Delta Smelt (Hypomesus transpacificus) are endemic to the San Francisco Estuary and despite concentrated recovery efforts are nearing extinction in the wild. They exhibit a diverse life history with both resident and migratory contingents, allowing them to utilize different salinity habitats across this highly variable estuary. However, water temperature is also a likely driving force of their habitat use and may limit their recovery even in years with high freshwater outflow. Oxygen isotope analysis of otoliths (fish ear bones) can be used to quantify the response of Delta Smelt to changes in water temperature by providing a life-long archive of environmental conditions that a fish has experienced. We validated in situ oxygen (δ18O) isotope analysis for Delta Smelt otoliths and reconstructed thermal life history at fine temporal scales. We then developed an estuary-wide oxygen isoscape based on multiple years of water samples to apply this tracer to wild fish. This new tool will help in our understanding of the temperature response of Delta Smelt and will provide new insights into the resilience and habitat utilization of this critically-endangered fish.

Keywords: Delta Smelt, Otoliths, Oxygen isotopes, Isoscapes

Poster Topic: Fish - Smelts

Higher Yolk Sac Absorption in Delta Smelt Larvae Reared in Saline Water Than in Freshwater

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Climate change is forecasted to increase salinity of the San Francisco Estuary (SFE), threatening to alter the habitat of the endemic and endangered delta smelt (Hypomesus transpacificus). While studies suggest that post-larval delta smelt exhibit a relatively high tolerance to salinity, little is known of the salinity tolerance of its larval stages, which are thought to develop in freshwater habitats within the SFE. To unveil how salinity affects the development of larval delta smelt, we reared delta smelt in three salinities (0.4 [freshwater], 4, and 8 ppt) from fertilization to 5 days post-hatch (dph). We measured yolk sac volume and total length of larvae at 5dph and found that larvae reared in freshwater had significantly larger yolk sac volumes (0.023±0.002 mm3) than those reared in 4 and 8 ppt (0.011±0.001 and 0.015±0.001 mm3, respectively), but there were no significant differences in total lengths among the treatments (freshwater: 5.4±0.1; 4ppt: 5.6±0.1; 8ppt: 5.4±0.03 mm). This suggests that larvae reared in 4 and 8ppt may be expending more energy to withstand the higher salinity environment than those reared in freshwater. Our results are consistent with field observations suggesting that freshwater habitats are optimal for the development of larval delta smelt. We additionally begin to explore the hypothesis that larvae reared in higher salinities expend more energy by recording the development of ionocytes through embryonic and larval development using immunohistochemistry.

Keywords: delta smelt, salinity, development, larvae

Poster Topic: Fish - Smelts

Fish – Striped Bass

Synthesis of Long-Term Monitoring Information on Striped Bass (Morone saxatilis) in the Central Valley to Describe Range-Wide Distribution and Identify Monitoring Gaps

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Understanding the spatial ecology of fishes is key to developing effective management strategies, yet syntheses of basic abundance and distribution data are lacking for most fish species in the Delta and surrounding watersheds. In recent years, information on non-native predator populations has been identified as a critical knowledge gap for understanding impacts of predation on salmonid recovery and assessing potential management actions. Of all the non-native predators in the Delta, the striped bass (Morone saxatilis) has received the most monitoring attention. Since the 1960s, Age-0 striped bass have been steadily declining, but a similar decline is not apparent among adults. While numerous monitoring programs gather data on striped bass, these data are rarely summarized and examined across programs and the whole population range. Furthermore, it has been ten years since the Pelagic Organism Decline report synthesized information on striped bass in the Bay-Delta. Using striped bass as a 'test' species, we synthesized abundance and distribution data on Age-0, sub-adult, and adult striped bass from monitoring programs (e.g., trawls, fish salvage, weir passages) in the tributaries, Delta, and Bay for a wider perspective on their spatial ecology. We developed simple graphical analyses to visualize changes in their distribution through time, and we describe the spatial and temporal overlap of striped bass distribution with sensitive species. Weir passages in the San Joaquin tributaries indicate that adult striped bass may utilize riverine habitats more frequently than previously recognized. We also identify gaps in current monitoring; for example, information is lacking on sub-adult striped bass. Our summary can help managers update and expand the POD conceptual model of striped bass in the Central Valley, which demonstrates the value of these assessments. Similar syntheses should be conducted regularly for all aquatic species of management concern.

Keywords: striped bass, distribution, monitoring, synthesis

Poster Topic: Fish - Striped Bass

Are Smaller Striped Bass a Bigger Risk for Juvenile Chinook in an Altered System?

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A better understanding of predator impacts on populations of special-status has been cited as a key aspect for planning conservation efforts within the Sacramento - San Joaquin Delta (Delta) (Grossman 2013, Moyle 2016). Predation studies and plans which assume predator effects are equal for all members of a species may not fully account for ontogenetic shifts in diet and presence when predicting these effects. The 2009 National Marine Fisheries Service (NMFS) Biological Opinion requiring the Department of Water Resources (DWR) to develop methods to reduce the levels of predation at state water pumping facilities has prompted ongoing studies of predator behavior and impact on special-status fish entrained into the facilities. Predation studies within Clifton Court Forebay suggest differential risk to migrating juvenile Chinook salmon (Oncorhynchus tshawytscha) especially with respect to striped bass (Morone saxatilis); smaller striped bass (i.e. 46cm) appear to be more abundant than larger striped bass during the Chinook migration season (December to June) and may be more likely to encounter and consume juvenile Chinook salmon. This poster synthesizes some preliminary findings of this ongoing work, along with past studies, and discusses how this data could potentially be used to focus predation reduction efforts and diminish predator impacts on special-status species, like Chinook salmon, in an altered system such as the Clifton Court Forebay.

Keywords: Predators, Bass, Salmon, Synthesis, Management, Delta, Diet, Abundance

Poster Topic: Fish - Striped Bass

Fish – Sturgeon

Analyzing Spatial Distribution of White Sturgeon Across an Environmental Gradient in the Upper San Francisco Estuary, California, USA

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Tidal wetlands provide measurable benefits to many native and non-native species, but there is relatively little information detailing White Sturgeon (Acipenser transmontanus) use of tidal wetlands. We sought to address this data gap by studying the habitat use by White Sturgeon along a tidal wetland-shoal-deep water habitat gradient in the upper San Francisco Estuary. We sampled White Sturgeon using setlines at Ryer Island in Suisun Bay seasonally for 18 months. Preliminary results indicate that White Sturgeon were rarely encountered within the Ryer Island wetland but were common and abundant in the surrounding shoals and deep channel habitats in all seasons. This poster also includes additional sampling evaluating diel habitat use across these habitat strata. The information generated from this effort will provide insight on how to approach habitat restoration to benefit native species such as White Sturgeon.

Keywords: White sturgeon, tidal wetlands, habitats

Poster Topic: Fish - Sturgeon

Juvenile Green Sturgeon Interactions with a Model Fish Protection Louver

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The flow of water within the San Francisco Bay Delta has been altered by anthropogenic factors, including water diversions. In addition to changing flow patterns, diversions pose direct mortality threats to organisms in proximity to pumping intake facilities, including the Central Valley Project (CVP) and the State Water Project (SWP). The degree to which these pumping facilities may negatively impact species of concern is dependent upon the interaction between operational parameters and the physiology and behavior of the target species. This study investigates the efficiency of a model louver simulating conditions at the fish protective facilities of the SWP and the CVP. Using the model louver system, we conducted experiments quantifying the bypass efficiency and behavior of age-0 green sturgeon. While the bypass efficiency of the louver has been tested for other fish species, its efficiency for green sturgeon is not known. We conducted experiments under various combinations sturgeon size (range 6 – 34 cm) and operational parameters, including sweeping velocity (range: 0.3 – 0.9 m sec-1), temperature (12˚C - 19˚C), and photophase. In addition, we quantified the hydraulic field created by the louver face. The data indicate that sturgeon size was a strong driver of louver efficiency, with poorest efficiency observed for the smallest size class. Within this size class there was a positive relationship between the rate of entrainment through the louver and the sweeping velocities, and a negative relationship between frequency of non-entraining contact with the louver face and sweeping velocities. For the larger size classes, very few fish were entrained, and sweeping velocities positively correlated with the proportion of fish entering the bypass channel. Analysis of these results could provide insight into the design and operation of louver facilities in order to enhance conservation of green sturgeon.

Keywords: Green Sturgeon, Water Diversion, Fish Protection Efficiency, Hydraulics, Behavior, Entrainment

Poster Topic: Fish - Sturgeon

Aerobic Metabolism of Green Sturgeon, Acipenser medirostris, Reared at Different Temperatures and Feed Rates

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Rapid environmental change is altering the thermal landscape of aquatic systems around the world. Warming thermal regimes influence the intrinsic physiology of ectotherms as well as their extrinsic ecological demands. Threatened species may be most at-risk due physiological limitation and rapid ecological change. The southern DPS of green sturgeon, native to the San Francisco Bay-Delta system, is listed as threatened due to loss of spawning habitat but may also be sensitive to elevated water temperatures through both direct (thermal physiology) and indirect (food availability) effects. We sought to understand how food availability and acclimation temperature influences the aerobic metabolic performance of juvenile green sturgeon. Larval green sturgeon were reared for several weeks at two acclimation temperature and under two ration levels. Aerobic scope measurements revealed that the metabolic capacity of green sturgeon juveniles is robust to both feed ration and acclimation regime, highlighting the physiologically tolerant nature of this ancient species. Effective management of the southern DPS of green sturgeon in the under future climate projections will require a thorough understanding of the species thermal physiology. This work seeks to fill an important knowledge gap regarding bioenergetic state and thermal capacity for this unique species.

Keywords: Green Sturgeon, Aerobic Scope, Acclimation, Feed Restriction, Central Valley

Poster Topic: Fish - Sturgeon

Fish Infrastructure

The Cost of Doing Business: The Monetary Value of Fish Salvaged from the Central Valley Project's Tracy Fish Collection Facility

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The Bureau of Reclamation's Tracy Fish Collection Facility (TFCF; Byron, California), an integral component of the federal Central Valley Project, was established in 1957 to separate fish from water pumped south at the C.W. "Bill" Jones Pumping Plant (formerly Tracy Pumping Plant). The function of the TFCF is to collect (salvage) fish and return them to the confluence of the Sacramento-San Joaquin River Delta away from the influence of the export pumps in the South Delta. The facility salvages between 0.5 and 12 million fish annually with higher salvage occurring during wet water years. For example, in the wet years 2011 and 2017, over 8.5 million and 2.1 million fish were salvaged and released, respectively. Without the TFCF, millions of fish would be lost to the pumps annually, loss that should be translated into a monetary amount. Using size class and hatchery information to determine cost of replacing non-listed species instead of salvaging them, yields a monetary amount well over $US 10 million for 2011 and $US 4 million for 2017. These monetary amounts only represent the cost for an established hatchery to produce each species, but not the environmental nor reintroduction costs. We calculated this cost information for wet, normal and dry years.

Keywords: Tracy Fish Collection Facility, Cost, Value, Replacement

Poster Topic: Fish Infrastructure

Renovation Progress at the UC Davis Fish Conservation and Culture Laboratory

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Renovation progress at the UC Davis Fish Conservation and Culture Laboratory

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In response to the population decline of Delta Smelt (Hypomesus transpacificus), the Fish Conservation and Culture Laboratory (FCCL) was developed in 1995 as a way to create a methodology for culturing Delta Smelt. Since then, the FCCL has created laboratories on a small scale without any major planning. This has led to several laboratories being housed in temporary structures with deficiencies in electrical service, emergency power, and water pumping and treatments. The permanent structures are also lacking in the areas of biosecurity, environmental regulations, workplace safety standards, and access compliance. In 2009, members from the CA Dept. of Fish and Wildlife and Dept. of Water Resources conducted an infrastructure review. It was suggested that office buildings be renovated, and the temporary structures be removed. Improvements are necessary to support ongoing activities involving Delta Smelt. Had the FCCL continued without any improvements, the future of Delta Smelt would have remained the same. With the promise of new laboratories and equipment, refuge and research efforts can be significantly improved. Fish production abilities will also be increased (both for research and refuge populations). Therefore, construction was started in early 2018, and progress is ongoing with a completion date by the end of 2018. Upon completion, the FCCL will have an enhanced ability to conduct research, maintain the refuge population of Delta Smelt, and to yield relevant, high quality scientific data for various projects.

Keywords: Delta Smelt, Fish Conservation and Culture Lab, Renovation

Poster Topic: Fish Infrastructure

Fish Passage: Intersection of Fish and the Natural and Built Environment

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The Bay-Delta ecosystem is dynamic environment which can present many challenges for water and fisheries managers. One method for monitoring in this dynamic environment is the use of acoustics. HTI and Vemco are familiar names in acoustic technologies. Both have developed acoustic telemetry systems that have been used to monitor fish movement and behavior in all types of aquatic systems in the natural and built environment. Applied in the Bay-Delta ecosystem, this intersection of fish and the natural and built environments demands answers to fish passage questions utilizing tools that can provide precision in the movement and position of aquatic organisms in space and time.

Drawing on our collective expertise and in partnership with users, we collaborated on building a very small (0.3 g) acoustic tag that optimizes the best available technologies. This innovative technology will provide cross-platform functionality to expand the environments for sampling, purpose and useful extent of the data.

In a parallel effort, we integrated a cross-platform graphical user interface. The graphical interface is a visual representation of the data which provides information beyond simple presence/absence detection data. With a universal graphical interface, fish behavior such as fish passage and predator avoidance may be assessed with a single hydrophone/receiver which can be difficult to interpret when limited to reviewing and analysis in spreadsheets and numerical format only.

Field testing of this new cross-platform tag is currently underway. In this poster, we present a wide variety of laboratory and field test results. Ultimately, this innovative technology will guide sound management decisions in the Bay-Delta estuary.

Keywords: fish passage, behavior, acoustic, telemetry, tagging

Poster Topic: Fish Infrastructure

Fishery Agency Strategy Team

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The Fishery Agency Strategy Team, referred to as the FAST, is a team that emerged from the implementation of a Memorandum of Agreement between the California Department of Fish and Wildlife (CDFW), California Department of Water Resources (DWR), U.S. Bureau of Reclamation (Reclamation), National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and the State and Federal Contractors Water Agency (SFCWA) regarding the early implementation of habitat projects for the Central Valley Project (CVP) and State Water Project (SWP) coordinated operations and Bay Delta Conservation Plan (BDCP). The purpose of the FAST is to assist in the planning of habitat projects associated with the Biological Opinions (BiOps) and Incidental Take Permit (ITP) for the water projects. The FAST is comprised of at least one technical representative from CDFW, NMFS, USFWS, and Reclamation and identifies the expected benefits of proposed habitat projects in meeting restoration objectives. The FAST representatives collectively make the initial assessments on the specific types and amounts of habitat credits a project is likely to yield. Early technical assistance is provided to DWR, SFCWA, and their consultants as they develop a Prospectus. Each habitat project is required to develop a Prospectus, which identifies projected credits. Questions regarding the FAST process can be directed to Heather Swinney (USFWS), Douglas Hampton (NMFS), Jim Starr (CDFW), and Ian Smith (Reclamation).

Keywords: Habitat Restoration, FAST, delta smelt, longfin smelt, salmon, tidal marsh

Poster Topic: Fish Infrastructure

An Exploratory Analysis of Entrainment Aboard the Essayons Hopper Dredge in the San Francisco Bay

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Dredging the navigational channels in the San Francisco Bay is an essential duty, and fish entrainment via dredgingis widely reported but poorly quantified. The concernbecomes particularly dire when rare or endangered species are involved, as the ecological impact is unknown and mitigation methodology is unavailable or unproven. Two species of concern are the Delta Smelt, which is listed as endangered under the California Endangered Species Act (CESA), and Longfin Smelt, listed as threatened under CESA. Previous monitoring indicates that these species among others are entrained during dredging events, but a quantitative interpretation is lacking. Recently, development of a quantitative framework has begun with sampling aboard the hopper dredge Essayons. To collect samples, crew members opened a valve, diverting a portion of the dredged material into a sampling basket where they were able to sift through and identify entrained species. The crew also monitored the hopper and removed fish with a net when possible. Daily reports – including information such as entrained fish and invertebrate species and counts, tidal regime, water temperature, and salinity during each sampling period – were analyzed in conjunction with dredge operational data retrieved from the National Dredging Quality Management Program (DQM) in a preliminary attempt to determine effects on entrainment of factors such as sampling duration, dredging time and location, vessel speed over ground, etc. Exploratory analysis suggests that time of year, speed over ground, and tidal regime may be significant however, these findings are weakly supported. To enhance support, additional sampling should be conducted with more rigidmethods. The findings of this analysis will be used to guide future monitoring in the bay and refine sampling procedures to improve the quantitative assessment of the effects of dredging operational changes. This may allow for the development of dredging guidelines to minimize fish take in the future.

Keywords: Dredging smelt fish entrainment bay USACE

Poster Topic: Fish Infrastructure

Food Webs

Phytoplankton Blooms in the North Delta in Water Year 2017

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There is considerable interest in assessing the occurrence, magnitude, and duration of phytoplankton blooms that occur year to year because of recent declines in phytoplankton productivity in the San Francisco Estuary and Delta. We will present our analysis of chlorophyll-a concentration data for water year (WY) 2017. In contrast to the prior year, WY 2017 was not particularly productive. There was much speculation that greater blooms would occur in WY2017 because the historically-high flows of WY 2017 caused a “washout” effect, where slower growing phytoplankton species are displaced and fast-growing diatom species are presumed able to re-establish more quickly. Another idea was that displacement of clams in the high flows of WY 2017 would reduce grazing pressure on phytoplankton stocks and thus allow phytoplankton populations to reach sufficient densities for blooms to form. Neither phenomenon resulted in widespread occurrence of blooms in WY 2017.
Two periods of elevated chlorophyll did occur in the confluence area of the Sacramento and San Joaquin Rivers in WY2017. These may in whole or in part be a consequence of lower grazing pressure. However, the location of these blooms – in deep tidal channels where grazing is limited – suggests that is not the case. Strikingly, the largest chlorophyll concentrations observed in the Lower Sacramento River in WY 2017 resulted from seaward transport of productivity produced within the Yolo Bypass rather than in situ de novo production such as that which occurred in WY 2016. We therefore conclude that WY 2017 was, like WY 2015, a relatively unproductive year in the north Delta despite conditions of ample light and nutrients sufficient to support bloom formation. Preliminary analysis for WY 2018 will also be presented.

Keywords: nutrient, continuous monitoring, nitrate

Poster Topic: Food Webs

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

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Periodic, shallow-water maintenance dredging is necessary to maintain waterways, but can remove patches of habitat and disturb benthic macroinvertebrate communities that provide important prey resources for many economically and ecologically important fishes. In San Francisco Bay (SFB), the extent to which dredging disrupts benthic macroinvertebrate communities is unclear. The goal of this study was to evaluate potential dredging impacts on macroinvertebrate prey resources in demersal fish foraging habitat within Central SFB. Benthic cores were collected from periodically dredged (every 1-3 years) and undredged areas at six shallow (3.96 m MLLW), soft-bottom (silt/clay) locations in Central SFB during summer and winter over two years. To assess potential dredging impacts, we evaluated macroinvertebrate prey abundance, biomass, and two measures of prey accessibility. We assumed prey accessibility is limited by macroinvertebrate size (i.e., fish gape size dictates the size of prey consumed) and the depth at which prey occurs in the sediment (i.e., foraging strategies determine if fish can access upper or deep sediments). To examine prey accessibility, we divided benthic samples into shallow (0-4 cm) and deep (4-10 cm) core sections, and categorized macroinvertebrate prey into size classes. Our analyses included a combination of univariate mixed models and multivariate, community level techniques. Preliminary results suggest macroinvertebrate abundance differed between dredged and undredged areas and by sediment depth. Our results provide previously unavailable information about potential dredging impacts on macroinvertebrate prey availability for SFB demersal fishes. In addition, our sampling strategy provided information about the vertical distribution of macroinvertebrate prey within the sediment where most of the abundance and biomass was concentrated in the upper 0-4 cm. This information can be used to inform future efforts concerned with examining dredging impacts on demersal fish foraging habitat within SFB or elsewhere.

Keywords: San Francisco Bay; fish prey accessibility; dredging; benthic; macroinvertebrate; disturbance

Poster Topic: Food Webs

Egg Production in the Calanoid Copepod Pseudodiaptomus forbesi

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The calanoid copepod Pseudodiaptomus forbesi is an important food source for native larval fish in the northern San Francisco Estuary (SFE). Recently however, grazing by the Asian clam Potamocorbula amurensis and predation by the introduced copepod Acartiella sinensis in the low salinity zone (LSZ) has restricted the geographical distribution of P. forbesi to primarily freshwater regions. This distribution includes the Cache Slough Complex (CSC), an area with potential for restoration where growth rates of P. forbesi are generally higher and more responsive to phytoplankton biomass than previously observed in open waters of the estuary. Stimulating primary productivity is proposed to increase available food for zooplankton and thereby food for delta smelt. A recent study showed a positive relationship between chlorophyll concentration and copepod growth in the CSC, with the maximum growth rate occurring at above ~10 µg L-1 Chl a (see Owens et al. talk, 2018 BDSC). Egg production is the manifestation of growth in adult female copepods, but is only weakly correlated to Chl a in freshwater (e.g., Yolo Bypass), and low throughout the estuary. We are exploring the weak relationship of egg production to Chl a through experiments designed to separate the influence of food from the confounding influences of mating and female age and condition. This study is relevant to Bay-Delta management because understanding the environmental factors that affect the population dynamics of P. forbesi relates to its availability as a food source for higher trophic levels.

Keywords: copepods, cache slough complex, egg production, laboratory

Poster Topic: Food Webs

Just Add Water: Effect of Flow on Zooplankton Community Composition in the Cache Slough Complex

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Water year 2017 was the second-wettest year on record for California, ending a prolonged drought and inundating broad swaths of managed Central Valley floodplain, particularly the Yolo Bypass. When flooded, the Yolo Bypass provides important floodplain habitat for native fishes and dramatically influences conditions downstream in the Cache Slough Complex. One benefit to these native fishes is enhanced secondary productivity, with high densities of invertebrates rapidly responding to newly inundated floodplain. These zooplankton blooms are rapid and ephemeral, and the impact of dynamic floodplain conditions on zooplankton communities in downstream habitats difficult to predict. Through sampling of zooplankton communities and densities across a range of habitats in the Cache Slough Complex before, during, and after the Yolo Bypass inundation of 2017 we assess the impact of Yolo Bypass flooding and draining on regional zooplankton community dynamics and compare results to a previous dry year.

Keywords: zooplankton, phytoplankton, yolo

Poster Topic: Food Webs

Ingestion of the Diatom Aulacoseira sp. by Pseudodiaptomus forbesi During a Bloom Event

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In 2016 a large bloom of the diatom Aulacoseira occurred in the upper San Francisco Estuary. We investigated the feeding and reproductive response to the bloom of the copepod Pseudodiaptomus forbesi, which makes up ~half the food of the endangered delta smelt in the low-salinity region of the estuary. Copepods were collected on four transects during May and June 2016 from the Sacramento Deep-Water Ship Channel to Suisun Bay. We used quantitative polymerase chain reaction (qPCR) to determine the number of copies of the selected gene of Aulacoseira in the guts of adult female copepods, and converted copy number to approximate consumption rates using literature estimates of residence times of DNA in copepod guts. Copepods contained between 10–200 Aulacoseira cells day-1 which corresponds to roughly 300–7000 pg C copepod-1 day-1. These consumption rates were then compared to the amount of food needed to support growth of P. forbesi as previously measured in the region. Using literature values of gross growth efficiency for similar copepods, we estimate that an individual P. forbesi female would need to consume ~3 µg carbon d-1. Thus, consumption of Aulacoseira would make up at most % d-1 of the P. forbesi diet. It appears that Aulacoseira is not an important food item for this copepod, perhaps because the diatom chains are too large for the copepods to ingest easily. Moreover, the abundance of P. forbesi from zooplankton monitoring data showed little response to this bloom event. As efforts to increase the abundance of food for pelagic fish in the estuary continue, scientists and managers should be aware that not all diatoms are suitable food for copepods, and effects of blooms like this may not propagate into fish.

Keywords: Aulacoseira, Pseudodiaptomus forbesi, Phytoplankton Bloom, Feeding, Estuary, Growth Rate, Abundance

Poster Topic: Food Webs

Does Higher Zooplankton Abundance in a Managed Wetland Translate to Enhanced Food Supply for Fish in the Open Waters of San Francisco Estuary?

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Food limitation and fish declines in the San Francisco Estuary have prompted efforts to find ways to enhance the food supply for fish populations. Suisun Marsh is part of the longfin smelt rearing habitat, making its tidal marshes and managed wetlands promising locations for foodweb subsidies to the open waters of the estuary. Our work investigated the abundance of zooplankton in a managed wetland (Lower Joice Island, 2016−2018) and a tidal marsh (First Mallard Branch, 2017−2018), as a first step in assessing the potential of these locations as sites of zooplankton export. We sampled Lower Joice Island during initial draining in February and final draining after re-flooding in March−May. Water and net samples were taken every 1-2 days, day and night, in draining channels and adjacent Suisun and Montezuma sloughs. Chlorophyll in waters on Lower Joice Island was higher than in surrounding sloughs, particularly in April 2017. Total zooplankton abundance exceeded most values in adjacent sloughs and were typically higher at night than day. Eurytemora affinis and cyclopoid copepods were the most common taxa; ostracods were sometimes abundant in island samples, although rare in surface tows in adjacent sloughs. We conducted one 12-h and two 24-h studies in First Mallard Branch, collecting hourly water and zooplankton samples. Total zooplankton abundances were higher at night, due in part to the appearance of vertically migrating taxa (e.g., mysids, amphipods, harpacticoid copepods). Zooplankton fluxes at First Mallard Branch were generally seaward during lower low tides at night, and landward during higher tides during the day.
Relevance: Managed wetlands may offer a mechanism through which to subsidize open water food resources to fish. This contribution will depend on flooding and draining conditions, volumes of water in the wetlands relative to surrounding open-water areas, water residence times, local predators, and the specific zooplankton taxa present.

Keywords: zooplankton fluxes, Suisun Marsh, managed wetland, tidal marsh, foodweb, SFE

Poster Topic: Food Webs

New Molecular Isotopic Tools to Understand the Modern and Past Food Webs of the San Francisco Bay and Delta

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The food web of the modern-day San Francisco Bay/Delta (SFBD) is powered predominantly by phytoplankton; however, this phytoplankton-dominated system may not have always been in place. It has been hypothesized that terrestrial organic matter from the adjacent wetlands once fueled the SFBD's food web prior to human alteration of this landscape. Yet, it remains a challenge to assess the effects of land-use changes on the relative importance of primary producers to the historic and ancient SFBD food web. The carbon (δ13CAA) and nitrogen (δ15NAA) isotope values of individual amino acids isolated from shell and tissues of filter feeders represent a major advancement in isotope ecology as they allow for the direct quantification of trophic structures and shifting nutrient sources, as well as the balance of primary producers at the base of food webs. Here, we report the first measurements of δ13CAA and δ15NAA isolated from estuarine benthic filter feeders — the invasive Potamocorbula amurensis and Corbicula fluminea — from several seasons and regions throughout the SFBD. Specifically, we assessed how the dynamic spatial and temporal variability of productivity and geochemistry in the SFBD were translated into the δ13C<sub>AA and δ15NAA of these estuarine species. We found strong spatial andtemporal signatures related to variations in hydrology in δ13CAA and δ15NAA of muscle tissue from P. amurensis andC. fluminea. These data suggest that the application of δ13CAA and δ15NAA from shell materials may be a viable method to reconstruct historic and ancient food webs in the SFBD and other estuaries.

Keywords: Stable isotopes, compound-specific isotope analysis, trophic structure, invasive species

Poster Topic: Food Webs

Influences of Water Quality and Environmental Conditions on the 2016 Microcystis Bloom in the San Francisco Estuary

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Blooms of the cyanobacterial harmful algal bloom (CHAB) species, Microcystis aeruginosa, can have detrimental effects on the Delta ecosystem and human by deteriorating water quality conditions, producing toxins that can cause health issues to humans and wildlife, and inhibiting recreational use. Because of the potential long-term impacts of Microcystis blooms to the San Francisco Estuary (SFE), a pilot monitoring program for Microcystis in 2016 was initiated. Sampling was conducted monthly from June to November 2016 at ten stations throughout the central and southern Delta and confluence of the Sacramento-San Joaquin River. The purpose of this study was to sample for Microcystis concurrently with the monthly discrete water quality monitoring program conducted by the Department of Water Resources Environmental Monitoring Program Section. The Microcystis biovolume and microcystin concentration were quantified, and the correlations between water quality and environmental conditions and the Microcystis biovolume were analyzed. Information gained from the study would be useful for providing baseline information as well as status and trends on HABs in the Delta, synthesis efforts, future large-scale management projects, and more.

Keywords: microcystis, water quality, cyanobacteria

Poster Topic: Food Webs

Macrophyte Isotopic Composition in Relation to Particulate Organic Matter in a Restored Tidal Wetland

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The role of free-floating particulate organic matter (POM) in estuarine food webs is widely recognized. This POM provides important support for local and advectively connected food webs, but there are crucial uncertainties as to the ultimate sources of POM carbon. POM is a mixture of pelagic phytoplankton produced in situ, re-suspended benthic algae, and fragments of macrophyte tissue in varying stages of decay. The Liberty Island Conservation Bank is a small, restored tidal wetland in the Cache Slough Complex, and is characterized by a diverse macrophyte community and moderate phytoplankton densities. We identified dominant emergent and submersed macrophyte species and used stable isotopes of carbon, nitrogen, and sulfur across multiple stages of growth and decay to tease apart the relative influences of these different carbon contributors, and thus the relative importance of their contributions to POM-dependent consumers.

Keywords: Food webs, macrophyte, decomposition, stable isotopes

Poster Topic: Food Webs

Insects

Development of a Non-Invasive Sampling Technique to Improve Insect Monitoring

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The valley elderberry longhorn beetle (Desmocerus californicus dimorphus; VELB) is federally threatened and endemic to riparian habitat throughout the Central Valley of California, including along major tributaries of the Bay Delta system. Monitoring this species is incredibly challenging due to low occupancy levels coupled with minimal detection rates. Current survey methods focus on estimating the number of adults emerging annually by counting new exit holes in elderberry stems. However these methods are limited by infrequent beetle occupancy and the visually indistinguishable exit holes produced by VELB and other xylophagous insects. In order to improve VELB detection probability, we developed a non-invasive field protocol that utilizes VELB frass (feces) and/or exuviae collected from larval exit holes for genetic analysis. In 2016 and 2017, 535 shrubs were surveyed and 206 exit holes were found with 77 containing beetle material for collection. Samples were classified as being new (beetle emergence the year of collection) or old (beetle emergence prior to the year of collection). Genomic DNA was subsequently extracted from beetle material and purified in order to decrease PCR inhibitors. Sequence data collected from VELB museum specimens were used to design VELB-specific DNA barcoding primers that could be used to distinguish VELB frass from that of other species. Preliminary results suggest that it is possible to extract DNA from material;found in exit holes, however analysis is ongoing to determine if this DNA originates from VELB. This non-invasive sampling technique has the potential to aid managers and monitoring programs by increasing the detection probabilities of various elusive insect species of conservation concern.

Keywords: VELB, DNA barcoding, non-invasive sampling, monitoring, frass

Poster Topic: Insects

Marine Invasive Species

Marine Invasive Species in San Francisco Bay Poster Presentation

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

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

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

In this poster, we present results from surveys of 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.

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

Keywords: invasive, non-native, ballast, water, marine, estuarine, species

Poster Topic: Marine Invasive Species

Measuring Effects of Transit and Salinity Conditions on Biofouling Communities Attached to an Atypically-Operating Ship

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A prolonged period in port can lead to the accumulation of organisms on wetted surfaces of ships, a process known as "biofouling". Ships that stay in port for long periods of time are defined as atypically-operating and carry a larger fouling burden. This is both an environmental issue, as it could lead to the transfer of marine invasive species, and a huge economic issue as a thin layer of biofilm alone can reduce a ship's fuel efficiency by 12%. Thus, there is a need for quantitative analysis of the impact that transit effects have on these biofouling communities on atypically-operating vessels once the ships resume operation. Our data is essential to informing management, policy, and industry on potential methods and rationale for mitigating biofouling growth on atypically-operating ships.

We followed an atypically-operating vessel on its summer voyage to observe its biofouling communities to understand the changes these organisms underwent during resumed transit. We collected biological samples throughout the voyage and repeatedly utilized Remotely Operated Vehicles (ROV's) at ports to determine percent cover, stress, survivorship, and species composition of biofouling communities and how these changed with respect to salinity. Additionally, we submerged settlement panels coated in anti-fouling paint at different time intervals to simulate the growth on atypically-operating ships. We then subjected these fouling organisms to salinity conditions that ships experience when transiting from different areas in and out of SF Bay. This panel work allowed our research to be applicable to other ships and oceanic conditions.

This interdisciplinary;research provides insight and scientific rationale behind the new vessel biofouling regulations implemented in California waters, as well as a potential management tool for proactively mitigating fouling communities on atypically-operating vessels with respect to salinity.

Keywords: biofouling; microfouling, macro fouling; salinity; atypically-operating; ships

Poster Topic: Marine Invasive Species

Pesticides/Herbicides

Pesticide Monitoring in Surface Waters of the Sacramento Valley

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The California Department of Pesticide Regulation (CDPR) regularly monitors surface water throughout the state of California for the presence and concentration of pesticides. CDPR's Northern California agricultural monitoring program encompasses large areas of the Bay-Delta ecosystem and includes major inputs to the San Francisco Estuary. While CDPR has monitored periodically in the Bay-Delta or at its major inputs for many years, only recently did the yearly monitoring program return to the region. The objectives of this yearly pesticide monitoring program is to: 1) prioritize pesticide monitoring candidates, 2) determine the presence and concentration of selected pesticides in surface waters and sediments of selected monitoring regions, 3) analyze chemistry data to evaluate potential impacts on aquatic life by comparing concentrations to U.S. EPA aquatic life benchmarks, 4) analyze spatial correlations between observed pesticide concentrations/detection frequencies and region-specific pesticide uses, and 5) assess multiple years of data to characterize patterns and trends in detection frequencies and benchmark exceedances. CDPR surface water monitoring in 2017 occurred at 10 sites in the Sacramento Valley in July and September. Samples were analyzed for 37 chemical compounds including pyrethroid and organophosphate insecticides, dinitroaniline and triazine herbicides, strobilurin fungicides, the rice herbicides propanil and thiobencarb, and the neonicotinoid imidacloprid. The most frequently detected pesticides were azoxystrobin and thiobencarb. Among the pesticides detected, bifenthrin, diflubenzuron, permethrin, and S-metolachlor/metolachlor exceeded their associated lowest U.S. EPA aquatic life benchmarks. In 2018, CDPR has continued monitoring at 8 of the 10 sites monitored in 2017. Grab samples will be collected in May, July and September and analyzed for the same suite of pesticides as in the 2017 samples. In addition, sediment samples collected in July will be analyzed for pyrethroids; water samples from May and September will be tested for toxicity using the surrogate species Hyalella azteca and Chironomus dilutus.

Keywords: pesticides, surface water, monitoring, Sacramento Valley, water quality

Poster Topic: Pesticides/Herbicides

Comparison of Water Quality, Cyanotoxin Concentrations, and Biodiversity of Primary Producers Between Wet and Dry Years

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Drought conditions may severely impact the aquatic environment because of elevated levels of contaminants from both natural and anthropogenic sources. Blooms of harmful cyanobacteria are a major concern because cyanobacteria produce toxins, which deteriorate water quality and negatively impact the aquatic ecosystem. In addition, herbicides used to control vascular plants (e.g. fluridone) may also affect water quality and the structure and function of aquatic ecosystems. In this project, we are addressing the following questions: 1) Does the biodiversity and abundance of cyanobacteria and phytoplankton vary spatially and temporally in response to successive drought conditions?; 2) Does the mixture of contaminants in the ambient water during summer cyanobacteria blooms affect the health and survival of key lower food web species (copepods) as well as Delta Smelt?; and 3) Does the application of the herbicides to control aquatic vascular plants affect the growth of cyanobacteria and phytoplankton? To address these questions, we are investigating the biodiversity of primary producers by shotgun metagenomic sequencing analysis, quantifying the abundance of key organisms by qPCR, and measuring cyanotoxin concentrations. We are also performing toxicity testing using fish embryos (Delta Smelt and Medaka) and two copepod species, Eurytemora affinis and Pseudodiaptomus forbesi to field water samples. In addition, we assess toxicity of herbicides on cyanobacteria, green algae, and diatoms. In our presentation, we report data from 2017 survey, and also discuss differences between drought and wet years for selected field data and endpoints. Our data are beneficial to Bay-Delta management as we provide baseline data from wet year (2017) and water quality issues observed in drought years (2014 and 2015).

Keywords: Drought; Water quality; Contaminants; Cyanotoxins; Cyanobacteria; Biodiversity; Copepods; Fish embryos

Poster Topic: Pesticides/Herbicides

Herbicide Toxicity Testing of Laboratory Phytoplankton and San Francisco Estuary Isolates in Standard Flasks and High Throughput 96-Well Plate Assays

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Invasive aquatic weeds are a growing problem in the delta. They block the passage of boats, change water and sediment flow, and impact habitat quality for native species. Herbicides are one method being used to control these aquatic plants. However, other primary producers such as cyanobacteria and phytoplankton are present, within and downstream of the areas, where herbicides are applied. The sensitivity of many of these algae to herbicides is unknown. We conducted toxicity testing using species found in the delta: Microcystis (cyanobacteria), Thalassiosira (diatom) and Chlamydomonas (green algae). We determined at what concentrations the herbicides glyphosate, imazamox and fluridone inhibit the growth of these three species in flasks and in 96-well plate setups. With both methods, we found all three species were more sensitive to fluridone than to glyphosate and imazamox. Of the three species, Chlamydomonas was the least sensitive to all of the herbicides. Fluridone was the only chemical that inhibited growth at concentrations that could potentially be applied for controlling aquatic weed growth. ;These results demonstrate that the ability of contaminants to inhibit algal growth varies depending on the species and the contaminant. Therefore, in addition to factors such as temperature and nutrients, contaminants can also impact primary producer growth and species composition. The 96-well plate setup can be used to test more species and contaminants at the same time. This can help identify contaminants that may have more impact on primary producers and therefore impact food quality and availability in the ecosystem.

Keywords: aquatic plants, herbicides, contaminants, fluridone, algae, phytoplankton, cyanobacteria, microcystis, toxicity

Poster Topic: Food Webs

Pesticide Patterns During Summer and Fall North Delta Flow Pulses

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In 2011 and 2012, agricultural drainage flows through the Yolo Bypass Toe Drain appeared to be a major factor responsible for the first fall plankton blooms in over twenty years in the Delta. These findings led the Natural Resources Agency to include North Delta flow pulses through the Yolo Bypass as one of several Delta Smelt Resiliency Strategies to improve summer and fall food availability. Towards this goal, in the summer of 2016, DWR along with other State and Federal agencies, collaborated with local water agencies and landowners on a novel water management strategy to generate a flow pulse through the Yolo Bypass Toe Drain and evaluated its potential benefits and/or detriments to the local and downstream plankton community spatially and temporally. To examine the potential effects of pesticides in agricultural return flows, we investigated the timing, concentrations, and spatial distribution of over 160 current-use pesticides in water and suspended sediment. Our basic approach was to collect and analyze water samples before, during and after seasonal flow pulses at a series of sites in the Yolo Bypass and downstream into the Cache Slough Complex during 2016 and 2017. We detected pesticides at every sample site during both years with higher concentrations at the upstream sites. In the surface water samples, there were 12 detections from 4 different pesticides that exceeded chronic toxicity benchmarks for fish or invertebrates. Pesticide levels showed a moderate increase at the downstream Yolo Bypass sites during the 2016 summer flow pulse, but did not exceed pesticide toxicity benchmarks. A long-term trend in the Delta has been the decline in primary and secondary productivity with numerous contributing factors including pesticides. It is our intention that these findings will help understand the role of pesticides in food web dynamics to inform future management strategies.

Keywords: Yolo Bypass, flow pulse, pesticides, agricultural runoff, toxicity, fish, invertebrates

Poster Topic: Pesticides/Herbicides

Remote Sensing

Rapid Drone Deployment for Remote Sensing of Abrupt Environmental Change

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The 2017 water year resulted in a cascade of unplanned, yet not unexpected levee failures in the Delta providing an opportunity to test the utility of Unmanned Aircraft System (UAS) rapid deployment for the purposes of assessing, monitoring, and understanding the impacts of levee breaches on geomorphology of Delta islands and water quality of affected waters through high spatial and temporal remote sensing. February 10, 2017 resulted in a levee failure along perimeter of the McCormack Williamson Tract near the confluence of the Mokelumne and Cosumnes Rivers. Subsequent levee breaches were engineered in several locations to reduce catastrophic flood hazard and flooded approximately 1600 acres of agricultural land slated for future restoration. We deployed an array of UAS platforms with high resolution spectral sensors in tandem with transects of in situ water quality sonde data. Rapid deployment of UAS for environmental monitoring was found to be variable in quality and utility in such dynamic, mixed terrain with tidally influenced inflow, outflow, and high residence time aquatic environments. Coupled with high resolution satellite imagery, however, these localized data were useful for calibration and validation purposes. Post-cessation LIDAR flights provided additional clues to the longer-term evolution of geomorphic events of this working landscape and its potential future as restored habitat. The unexpected monitoring opportunity yielded critical lessons including the value of adaptable, reliable UAS and the impacts of moving water on data collection that will allow the development of refined techniques for the next, inevitable breaches in the region. Ultimately, these high resolution, easy-to-deploy technologies can provide valuable, fast-turnaround data for engineers, land managers, and government agencies to improve the quality of response as well as understand the longer-term impacts of breaches on landscape morphology.

Keywords: levee, monitoring, drone, geomorphology, restoration, breach, LIDAR, unmanned vehicle

Poster Topic: Remote Sensing

Using UAS Gathered Hyperspectral Imagery to Map and Predict Traits of Invasive Species in the Sacramento-San Joaquin River Delta

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Spread of invasive species is internationally recognized as one of the most severe threats to biodiversity. Aquatic ecosystems like the Sacramento-San Joaquin River Delta are the most vulnerable to invasion by exotic due to their extensive use for recreational and industrial activities, connectivity through water corridors, and general mobility of aquatic species. In the Delta, invasive plants not only have detrimental effects on the ecosystem but have significant economic impacts as well. Managers need up-to-date, reliable information on invasive species to make decisions to prevent spread and minimize economic and ecological impacts. Remote sensing has the potential to provide detailed species mapping over a study region. The current method for mapping invasive species in the Delta involves annual or biannual snapshots taken from hyperspectral imagers mounted on aircraft. This greatly impedes the monitoring of invasive plants because many spread rapidly. Unmanned aerial systems (UAS) equipped with hyperspectral imagers offer high spectral and high spatial resolution, with the capability of making repeat measurements with ease, which eliminates this obstacle. Previous studies have been successful in estimating plant biochemical composition using spectral reflectance data in a lab setting. This is a pilot study to evaluate the capability of using a UAS mounted hyperspectral imager to map invasives and estimate their biochemical compositions. The high spatial and high spectral resolution data gathered will help create more accurate maps and predict patterns of spread, enabling land managers to make informed decisions regarding invasive species in the Delta.

Keywords: unmanned aerial systems, UAS, drone, hyperspectral, remote sensing, invasive species

Poster Topic: Remote Sensing

Improvements in Water Quality Mapping using Hyperspectral Remote Sensing

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The water quality of estuarine ecosystems is being altered by human activities such as dredging, water pumping and land use/land cover changes, and natural processes including varying flow rates and changes in biological processes. Remote sensing instruments such as high spectral and spatial resolution optical systems enable measurements of water quality parameters needed to establish baseline conditions, improve modeling efforts, and support management decisions. The San Francisco Bay-Delta is subject to rapid changes in water quality due to complex natural processes and water management regimes that vary annually. Mapping and understanding the range of general water quality conditions, such as turbidity, is of key importance to helping endangered species like the Delta Smelt thrive. Current instruments used for turbidity mapping include medium spatial resolution optical satellites and in situ monitoring stations. This study aims to provide more spatially explicit maps by using; airborne hyperspectral imagery (AVIRIS-NG). Such instrumentation also offers improvements over current methods because the high spectral resolution allows for targeted band selection during algorithm development, and thus can more accurately map varying turbidity conditions. This study demonstrates the potential for using hyperspectral instrumentation to map water quality parameters in the Delta which can be used in the future to support management decisions. In addition, the maps created during this study can be paired with vegetation maps derived from the same imagery to better understand the dynamics between water quality and aquatic vegetation in the Delta.

Keywords: Water quality, turbidity, delta smelt, hyperspectral, remote sensing, algorithm improvement

Poster Topic: Remote Sensing

Novel Approaches to Vegetation Mapping in Muddy Places: Take to the Air!

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In many of the tidally inundated habitats throughout the San Francisco Bay-Delta, traditional vegetation field mapping techniques have severe limitations. Tidal influence, soft sediments in mudflats, and dense emergent vegetation pose field access challenges. To improve data quality and allow for more accurate extrapolation and classification in these relatively inaccessible environments, Stillwater Sciences has developed a habitat mapping methodology using remotely sensed aerial imagery vegetation interpretation. Methods include collecting nadir perspective and low-altitude aerial images, georeferenced ground-control points, and field verification sample points. The resulting aerial imagery and surface are used for conducting visual interpretation using heads-up digitizing techniques. We have calibrated these methods on projects in the lower reaches of the Napa River and on both Winter and Chipps islands in the western Delta. Results indicate that the use of high-resolution aerial imagery from small unmanned aircraft systems results in cost-savings and allows for easily repeatable vegetation sampling, especially in areas with challenging access. The methodology has multiple applications from coarse habitat mapping, to alliance-level vegetation typing, species-specific invasive weed mapping, and monitoring the success of invasive weed control efforts.

Keywords: vegetation mapping, drone, invasives, restoration, habitat

Poster Topic: Remote Sensing

Calculating a Performance Measure for Floodplain Inundation in the Yolo and Sutter Bypasses

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Native fish populations in California have significantly decreased over the past several decades, with anadromous fish populations that migrate through the Sacramento-San Joaquin Delta (Delta) particularly hard hit. The Yolo and Sutter flood bypasses provide an alternate route for the outmigration of native juvenile fish during periods of high flow and also generate rich food resources. The 2013 Delta Plan calls for restoration of more natural, functional flows in the Delta to help restore ecological processes. The area and duration of floodplain inundation has been proposed as one measure of functional flows to achieve this goal.
As part of an update to Delta Plan performance measures, a target has been proposed for at least 17,000 acres of inundation within the Yolo Bypass for at least 14 days in two out of three years, and at least 21 days in one out of two years, by 2030. However, measuring the achievement of this target is currently limited by the availability of two-dimensional-hydrological models in select areas, such as the Yolo Bypass. In this study we examine a method to leverage remote sensing data from Landsat and Sentinel sensors to calculate this performance measure. This approach would allow the performance measure to be scaled up to both the Yolo and Sutter bypasses as well as other areas of high value habitat.

Keywords: performance measure, Yolo bypass, Sutter bypass, functional flows, floodplain

Poster Topic: Remote Sensing

Restoration - Tidal Wetlands

Mineralogical Controls on Soil Carbon in the Sacramento-San Joaquin Delta

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Peatlands worldwide are drained due to their agricultural productivity, leading to the loss of soil carbon (C) through organic matter oxidation and subsequent land subsidence. Soil biogeochemical characteristics such as reactive mineral concentrations and redox dynamics can play an important role in C storage and loss in these ecosystems. A prime example is the Sacramento-San Joaquin Delta, which contains both;iron (Fe)-rich mineral soils and organic-rich peat soils. Reactive minerals, such as poorly-crystalline Fe oxides, are thought to protect soil C from decomposition. However, recent studies show that under fluctuating oxidation-reduction (redox) conditions microbial reduction of redox-active Fe species may be an important mechanism of C loss. Delta soils typically experience fluctuating redox conditions through agricultural irrigation and water table management. We sampled different soil types and land uses across the Delta to characterize C in relation to Fe pools. Samples were analyzed for total C and N, pH, soil moisture, hydrochloric acid extractable Fe(II) or Fe(III), and citrate-ascorbate and ammonium-oxalate extractable Fe and aluminum(Al). These extractions characterize the Fe species present, including oxidized, reduced, poorly-crystalline, and organic matter-associated forms. In flooded soils, soil C was negatively correlated with Fe(II) (R2= 0.89) but positively correlated with soil moisture(R2=0.82), suggesting microbial Fe reduction may stimulate C oxidation. In drained soils, C was positively correlated with ammonium-oxalate extractable Al(R2=0.85 to 0.89) and Fe(II):Fe(III) ratios(R2=0.31 to 0.61) across depths. These Fe(II):Fe(III) ratios, a proxy for reducing conditions, and extractable Al concentrations suggest anoxic microsites and organo-Al complexes may protect soil C from oxidation in drained soils. These;findings contribute to our understanding of the relative importance of Fe;biogeochemistry and fluctuating redox conditions on C cycling in Delta;soils. Elevated redox-active;Fe concentrations may limit C sequestration in flooded;soils but organo-Al complexes could protect;remaining soil C from;oxidation in drained soils.

Keywords: Soil Carbon, oxidation-reduction, redox, Iron, mineral and organic soils

Poster Topic: Restoration - Tidal Wetlands

Advancing Performance Measure Reporting for New and Continuing Landscape Restoration Projects

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Both the Delta Plan and Proposition 1 call for careful tracking of restoration efforts and reporting on performance measures. Nevertheless, sharing data related to restoration projects across agencies in a coordinated fashion remains a challenge.

The Advancing Performance Measure Reporting project will help to address those very urgent needs. The project team will develop new capabilities to improve performance measures reporting for wetland restoration projects associated with the Proposition 1 Grant and other programs in California. As part of the project implementation, scientists and resources managers from state and federal agencies and other organizations provided valuable feedback on tracking and reporting needs. Feedback and suggestions from the agency staff were used to redesign Project Tracker. This project enhances the functionality of EcoAtlas to collect information on the expected goals of a project and report information including outcomes and outputs in a consistent way across programs and agencies.

The project will improve data access and availability by exchanging and synchronizing wetland restoration project data between EcoAtlas (www.ecoatlas.org), a system used by the Sacramento-San Joaquin Delta Conservancy (SSJDC) and a wider audience in the Delta, and Delta View (http://deltacouncil.ca.gov/deltaview), an internal system used by the Delta Stewardship Council. Through past efforts, the SSJDC's project tracking database has been replaced by EcoAtlas, which includes important geospatial capabilities, habitat classifications, a broader complement of wetland project tracking information, and accessibility by other agencies and the public. This project will improve the integration of EcoAtlas and DeltaView by reducing duplicative project accounting, while creating new reporting features that can effectively serve the needs of many Delta-based organizations.

Keywords: Perfomance measure reporting, project tracking, data sharing

Poster Topic: Restoration - Tidal Wetlands

Choose Your Own Delta Restoration: An Interactive Look at Future Delta Landscapes for Restoration Scenario Planning

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The Delta Reform Act requires "taking into consideration the physical changes that have occurred in the past and the future impact of climate change and sea-level rise" for restoration planning. Re-establishment of tidal marsh is critical to restoring food web function and increasing the extent of habitat for fish and wildlife within the Sacramento – San Joaquin Delta and Suisun Marsh (Delta). Land subsidence, sea-level rise, and urbanization significantly constrain where tidal reconnection is possible in the future. We use new information on sea-level rise, island and water elevations, levee failure probability, regional subsidence estimates, and land-use projections to identify potential restoration constraints. A poster with an interactive display allows users to explore Delta landscape factors and see them change through 2100. Our results suggest that strategic subsidence reversal and levee maintenance allow for greater intertidal marsh restoration opportunities within a landscape experiencing significant land-use pressures.

Keywords: Delta Landscape, Subsidence, Subsidence Reversal, Sea-Level Rise, Restoration

Poster Topic: Restoration - Tidal Wetlands

Patterns of Vegetation Growth Supporting Key Ecosystem Services in Freshwater Wetlands

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Current wetland restoration efforts in the San Francisco Estuary focus on ecosystem services critical to long-term wellbeing of local populations. The provision of these ecosystem services is partially driven by plant productivity, which notably promotes carbon sequestration, soil retention, and faunal diversity and abundance. To predict a wetland's capacity to support these services over time, project managers need to identify factors impacting vegetation productivity and lateral expansion in a variety of wetland types. To address this need, we used a time series of high resolution aerial images to track patterns of vegetation growth in a restored freshwater wetland of the Sacramento-San Joaquin Delta. We applied an object-based analysis to this time series to delineate vegetated patches and produce land cover maps for 2014, 2016, and 2018. We compared the extent and geometry of individual patches from one year to another for measuring the rate and direction of their lateral growth. Preliminary results revealed a significant relationship between the initial size of vegetated patches and their growth rate, with smaller patches growing faster than larger ones. This may expose a threshold effect potentially attributable to the accumulation of dead material in older patches increasing competition for light and limiting patch expansion. We also observed a significant inverse relationship between growth rate and distance to the nearest vegetated patch, which may point to vegetated patches altering hydrologic flows and the transport of seeds within the site. Our results provide critical base data to help project managers identify initial restoration designs most likely to support the vegetation growth needed to perform a suite of ecosystem services.

Keywords: wetland, restoration, object-based analysis, patch dynamics, ecosystem services, lateral expansion

Poster Topic: Restoration - Tidal Wetlands

TidalTrend – A Tool to Distill Large Tidal Datasets for Analysis and Visualization

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In the Sacramento-San Joaquin Delta;scientists across disciplines understand, on a conceptual level, the ubiquitous effects that hydrodynamic forcing has on water quality and biological organisms. However, while hydrodynamic signals are visually intuitive over short time periods, rigorous methods to quantify them over long durations are needed. Currently, accounting for complex and dynamic tidal factors can be extremely challenging, and in many cases researchers lack the quantitative understanding and software tools to appropriately take these factors into account. This can limit the usefulness of hydrodynamic data to properly understand the effects of tidal forcing on water quality constituents and biological organisms. To help facilitate the cross-disciplinary use of tidal data we have developed TidalTrend; a software tool that categorizes hydrodynamic data (for example, stage, velocity) into discrete and normalized values, generating parameters more suitable for statistical analyses and data visualization. TidalTrend uses a series of algorithms to characterize individual data points within multiple timescale domains including semidiurnal, diurnal, spring-neap, daily, and seasonal cycles. Incorporating these simultaneous cyclical dynamics can help researchers discern the specific drivers of various tidally influenced processes.

Keywords: Tidal Phase, Spring Neap Statistics, Discreet Analysis Visualization Software Tools

Poster Topic: Restoration - Tidal Wetlands

Dutch Slough Tidal Marsh Restoration Project: Large-scale Habitat Restoration in the West Delta

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The Dutch Slough Tidal Marsh Restoration Project, located in the city of Oakley, will restore approximately 1200 acres of diked and subsided farmland to tidal marsh and transitional habitats. The project demonstrates an approach for large scale tidal wetland restoration in the West Delta. Our poster highlights the use of historic ecology to develop a pallet of simple design features that can be applied across a large site to create an ecologically complex restored landscape.
Significant design features include a dense network of excavated tidal channels based on historic channel morphology and hydraulic geometry relationships for the West Delta, habitat berms of varying sizes that provide habitat diversity and wave dissipation within the marsh area, and gradually varying shallow slopes along the site perimeter to support a gradual transition between the tidal marsh and adjacent uplands and provide room for future marsh migration with sea-level rise. Special attention was given to connections to adjacent tidal channels to reduce connectivity between the restored marsh and nearby deep-water habitats that are frequently occupied by invasive predatory fish.
Revegetation efforts at Dutch Slough will include planting emergent marsh vegetation in low marsh areas and a variety of high marsh, riparian, and scrub/shrub plant communities. The project will be implemented using a phased approach to address the challenge of establishing emergent marsh vegetation at lower elevations in the tide frame. Monitoring at nearby sites shows that in sheltered areas, emergent marsh vegetation will persist at lower marsh elevations once established. Tules are being grown in on-site nurseries for out-planting in clusters across the site prior to breaching. The site will be managed for 2-3 years following planting to support the expansion of planted marsh vegetation and establishment of higher transitional vegetation. The site will be breached to the tides following the vegetation management period.

Keywords: Dutch Slough, tidal marsh, restoration, engineering design, revegetation

Poster Topic: Restoration - Tidal Wetlands

Mapping Habitat Restoration Opportunity Areas for the Delta Plan Ecosystem Amendment

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Guiding Delta and Suisun Marsh ecosystem restoration depends fundamentally on understanding the geography of the land-water interface. Topography and land use define the "land" and water heights controlled by tides, river flows, and major water infrastructure operations define the "water" parts of the interface. The "Habitat Types Based on Elevation" map in the 2013 Delta Plan (its Figure 4-6) supports the Delta Stewardship Council's (Council) current policy basis for restoration. The Council is considering an update of this map as part of an amendment to Chapter 4 of the Delta Plan. The map updates incorporate new and revised datasets from external sources, including LiDAR topography, land cover data, local government land use plans, and sea level rise projections. The most significant of these updates is the incorporation of hydrodynamic model results of tidal datums throughout Suisun Marsh and the Delta, developed by Tom, Enright, and Siegel in 2009. The 2013 map split Suisun Marsh and the Delta into four general tide range zones based on a 2007 analysis of tidal datums at all 12 National Ocean Service (NOS) Delta stations published at that time (stations existed only in the central and west Delta) along with several Suisun NOS stations. This original approach identified its oversimplification at the system margins and along the major river corridors due to absence of NOS stations, and the associated potential inaccuracy of habitat restoration opportunity in these areas. In the 2018 map update, the results of the 2009 tidal datum modeling, which address these shortcomings, are used to split the system into more spatially-accurate tide range zones for determination of potential habitat restoration and sea level rise accommodation areas. The 2018 map contains some notable departures from the 2013 version, which will help inform the designation of restoration priorities in the updated Delta Plan.

Keywords: Delta Plan, tidal datums, restoration planning, sea level rise

Poster Topic: Restoration - Tidal Wetlands

From Tesla's to Tules: Using Imaging Sonar and Machine Learning to Passively Monitor Tidal Wetland Fishes

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Imaging sonars are being used to passively monitor fish movement, abundance, and behavior in tidal wetland environments of the Sacramento-San Joaquin Delta. This approach offers several advantages over traditional techniques including the ability to non-invasively monitor untagged fish movement across dark, turbid, and other challenging conditions. Moreover, this technique can be used continuously for long periods of time, allowing scientists to assess the effects of multi-scale tidal dynamics on fish habitat use. However, while field data collection is relatively straightforward, transforming raw acoustic files into quantitative results is extremely time consuming and requires highly skilled and experienced staff . Currently, we are focused on streamlining these procedures using modern computing approaches. Here, we illustrate the benefits of machine learning (utilizing convolutional neural networks and computer vision) for automated fish detection and tracking. Our approach will allow scientists, for the first time, to efficiently analyze the voluminous data collected using imaging sonars. Ultimately, this advancement will help establish a novel technique for monitoring and research of tidal wetland fishes.

Keywords: convolutional neural networks, computer vision, imaging sonar, ARIS

Poster Topic: Restoration - Tidal Wetlands

A Regional Monitoring Program for Tidal Wetlands in San Francisco Bay

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Tidal wetlands habitat in San Francisco Bay supports a diverse assemblage of wildlife, including at-risk species and commercially important fishes and shellfish. For the people of the region, tidal wetlands provide a buffer against sea level rise and storm events, increased water quality, carbon storage capacity, and aesthetic and cultural benefits. Through much of the modern history of the San Francisco Bay Area, these habitats have been lost to development, but restoration efforts across the region have worked to reverse this trend. Despite this progress, forecasts of accelerated sea level rise give new urgency to tidal marsh restoration. In addition, regional scientific syntheses, regional environmental plans, new public funding for restoration, and efforts to coordinate environmental review and permitting reinforce this urgency.

The Wetlands Regional Monitoring Program (WRMP), funded by an EPA Wetlands Program Development Grant, is engaging the regional community of tidal marsh scientists, community advocates and managers to establish a foundational tidal marsh monitoring program for the San Francisco Bay Area. The WRMP program development process will identify the science and technology, institutional relations, governance structure, and budget necessary to address key questions shared by the environmental regulatory and management community about tidal marsh protection and restoration. The WRMP consists of a core team, responsible for managing the grant and assuring its success; a steering committee representing San Francisco Bay institutions most responsible for science-based tidal marsh protection, stewardship and restoration; and a scientific advisory team representing the breadth and depth of scientific and technological expertise needed to assure the highest possible value of the WRMP content, with input from community-based technical workshops. Through a collaborative process, the WRMP's monitoring plan will inform management of the Bay and it's wetlands, fulfil permitting requirements for wetland restoration work, and allow comparison of restored sites with ambient conditions.

Keywords: Wetlands Monitoring Baylands Restoration Permitting Management Regional Collaborative Marsh

Poster Topic: Restoration - Tidal Wetlands

Comparing Fish Communities across Habitats in Suisun & Grizzly Bays

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Ryer Island is a small, isolated tidal wetland located between Suisun and Grizzly Bays, California. It is the site of research by the U.S. Geological Survey–California Water Science Center exploring the effect of physical and biological processes on habitat quality within and adjacent to the tidal wetlands. While this research has provided much information on the distribution of fish species and communities with regards to different habitat types, the small spatial extent of the survey may limit broader inference. Since the San Francisco Estuary is home to a particularly extensive network of fish monitoring programs, data from those programs can provide context for localized findings at Ryer Island. To assess the broader applicability of insights gleaned from sampling across small-scale habitat gradients at Ryer Island, we compare results from 2016–17 U.S. Geological Survey sampling efforts with sampling conducted by overlapping state (California Fish and Wildlife Bay Study) and university (University of California, Davis Suisun Marsh Fish Study) monitoring.

Keywords: Fish Community, Suisun Bay, Grizzly Bay, Ryer Island, TIdal Wetland

Poster Topic: Restoration - Tidal Wetlands

Habitat Restoration Inventory Dataset

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This poster describes the effort of DES and DIRWM to create a Habitat Restoration dataset including EcoRestore, Conservation Strategy, San Joaquin River tributaries, and other datasets. The purpose is to align habitat restoration data across DWR in a user friendly way, generate useful reports and share real-time project information, as well as to streamline the data entry process for project managers.

Keywords: EcoRestore, Conservation Strategy, San Joaquin tributaries, habitat, restoration

Poster Topic: Restoration - Tidal Wetlands

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

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Who will win, sea level rise drowning tidal marshes or restored marshes accreting to match sea level rise? Where sediment supply is rich, marshes might win. One of several Baylands Ecosystem Habitat Goals Update recommendations is to 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 an extensive planting in March 2018. We lost the ability to know if they helped dissipate shoreline wind-wave energy or could self-revegetate, their tops were eroded away too rapidly. 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: sediment accretion, marsh restoration, climate resilience, spartina

Poster Topic: Restoration - Tidal Wetlands

Multi-Benefit Restoration of the Grizzly Slough Floodplain (Cosumnes River Preserve)

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The lower Cosumnes River provides great opportunity for multi-benefit ecosystem restoration. This area retains naturally variable hydrological processes, intact sediment supply, remnant riparian forests, and an elevation gradient from subtidal to uplands that can provide resilience to rising sea level. The Grizzly Slough Floodplain Restoration Project will restore seasonal wetland and riparian habitat, enhance the landscape corridor between Delta and tributaries, and provide wildlife-friendly agriculture. The Project will restore natural flooding to the site (489 acres) by breaching a levee on Grizzly Slough and excavating a channel network from the breach. Hydrodynamic modeling calibrated to high flow events projected inundation frequencies ranging from intertidal in the lowest areas of the site, to 1 in 10 years in the highest areas. The expected hydrologic regime is appropriate for tidal freshwater wetlands, transitioning to seasonal wetlands and then riparian forest above MHHW. The channels will be graded to maintain tidal flows, with no floodplain ponding that could strand salmonids. Native vegetation will be established by natural recruitment and planting. The floodplain's long-term trajectory will be riparian forest. Returning natural hydrologic processes will also enhance existing riparian and incidentally benefit prior riparian mitigation areas. The project is designed to provide multiple benefits, within the constraints of local land use, ownership and infrastructure. A new setback levee with one-way drainage culverts will maintain equivalent flood protection for farm lands to the south. An agricultural zone (157 ac) will be established on higher elevation and enhanced to allow cultivation of irrigated crops (corn) to benefit sandhill cranes. Long-term management will be accomplished as part of the Cosumnes River Preserve, with funding from the agricultural lease. Species to benefit include floodplain-rearing juvenile Chinook salmon and Sacramento splittail, riparian-nesting Swainson's hawk, and foraging sandhill cranes. The project will also enhance landscape connectivity between the Delta and eastside watersheds.

Keywords: Restoration, floodplain, riparian, cottonwood, agriculture, sandhill crane, flooding

Poster Topic: Restoration - Tidal Wetlands

Managing the Methane Problem in Restored Wetlands

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Wetland restoration in the Bay-Delta provides many benefits including soil accretion, carbon sequestration, wildlife habitats to support biodiversity, and water quality improvements. Building nutrient rich soils, reversing land subsidence, and capturing atmospheric carbon by inundating previously farmed land and allowing natural vegetation to return comes at cost. The loss of revenue to the farmer, as well as increased methane emissions, a potent greenhouse gas, can reduce the net benefits of this land-use practice. Carbon cap and trade deals help to offset the financial losses. The resulting methane emissions, however, can diminish the usefulness of the wetland in reducing its contribution to global warming. Although Delta marshes sequester carbon quickly, the methane emissions are some of the highest measured from wetlands.

Previous studies have shown that periodic drying of the marsh can greatly decrease methane emissions without reducing carbon uptake by plants. By temporarily lowering the water table and allowing oxygen to enter the soil, methane production is inhibited. This reduction in emissions seems to last for several weeks after re-flooding has occurred. Intermittent drawdowns of the water level during the summer months when methane emissions peak could potentially dampen the annual methane budget and tilt the system towards a net carbon dioxide equivalent sink from a small source. Not only would this management technique provide climate benefits, but it would increase profits gained from carbon cap and trade activities.

Using eddy covariance towers to monitor a suite of environmental factors and continuous methane fluxes at two well established wetlands on Twitchell Island, we are conducting water drawdown experiments over a two year period. We present site comparisons, the effects of drawdown episodes on methane emissions, as well as evaluate the conditions for optimum results, and suggest management practices specifically for Delta wetlands.

Keywords: Restored Wetlands, Global Warming Potential, Methane, Management Practices

Poster Topic: Restoration - Tidal Wetlands

Hydrospatial Analysis of Floodplain Restoration and Hydroclimate Change

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Floodplain environments and their ecosystems are degraded by multiple interacting factors of change and threatened by future change, including hydroclimatic change. Supporting functional floodplains is a core challenge for sustaining freshwater ecosystems globally, and is a problem well-represented in the Bay-Delta. The development of appropriate restoration and flow management strategies requires improved understanding – at relevant spatial and temporal scales – of how landscape and flow regime interact to affect floodplain inundation patterns, or the floodplain hydrospatial regime. To address these issues, this multi-dimensional and multi-metric approach uses 2D hydrodynamic modeling output to quantify floodplain inundation conditions in space and time for daily streamflow time series. These methods were applied to a recent levee-removal floodplain restoration site along the lower Cosumnes River, California. Quantified metrics relate to inundation extent, depth, velocity, duration, timing, frequency, connectivity and heterogeneity, as well as physical habitat availability for the floodplain fish species, Sacramento splittail. Floodplain patterns under pre- and post-restoration conditions and for historical and future flow scenarios were evaluated and compared. Results reveal the magnitude and direction of hydrospatial responses to restoration depends on flow scenario, floodplain position, and metric, demonstrating the value of spatiotemporally explicit quantification. Levee-removal restoration primarily affected metrics at intermediate flood flows, while metrics under future flow scenarios reflected the relative influence of increased winter peak flows and reduced intermediate spring floods. Restoration appeared to dampen the relative effects of future flow scenarios. Overall, results demonstrate that the interaction of flows and landscape mediates floodplain responses to hydroclimatic change, suggesting that floodplain restoration can be used to mitigate climate change impacts. Hydrospatial analysis provides needed information to refine restoration and climate change expectations, offers decision-support tools for scenario analysis, and generally informs planning and management targeting diverse, productive, and resilience ecosystems into the future within the Bay-Delta and beyond.

Keywords: floodplain, climate change, flood regime, spatiotemporal, modeling, restoration, Cosumnes River

Poster Topic: Restoration - Tidal Wetlands

Restoration - Vegetation

From Containers to Tractors: Looking to Farming for an Unconventional Method to Scale Up Plant Propagation for Vegetating Large Ecotone/Transition Zone Restoration Projects

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Around San Francisco Bay, project sites totaling 15,000 acres of tidal marsh have been identified for restoration. The design of many of these projects includes large transition zone/ecotone habitats, a habitat type fundamental in protecting against sea level rise, providing wildlife refugia, and increasing biodiversity.
Building on novel methods successfully undertaken at the Oro Loma Horizontal Levee Demonstration Project, a constructed ecotone slope and pilot project at the Oro Loma Sanitary District in San Lorenzo, CA, Save The Bay is seeking to scale-up and apply non-traditional native plant propagation and revegetation techniques to even larger acreage transition-zone project sites on which we work. 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.
Save The Bay is applying lessons learned from the Oro Loma project to scale up propagation methods to vegetate several new large projects, including a 55-acre seasonal wetland and alkali wet meadow project in partnership with the State Coastal Conservancy at Bel Marin Keys in Novato, CA and another at Ravenswood in Menlo Park, as a component of the South Bay Salt Pond Restoration Project. At the Bel Marin Keys project, we have moved further way from the traditional container nursery and constructed an “in-ground nursery”, growing locally-collected, rhizomatous native plant material in a style that mimics farming. By capitalizing on the natural inclination of a specific suite of resilient and vigorous moist grassland/bayland ecotone species, and our ability to amplify their populations using farming techniques, we share how we can significantly pare down the cost and labor and provide a method for other practitioners to mimic in vegetating large project sites.

Keywords: Ecotone, transition zone, restoration, propagation, native plant species, pilot, experiment

Poster Topic: Restoration - Vegetation

Life History of Cirsium hydrophilum var. hydrophilum (Asteraceae), a Federally Endangered Tidal Wetland Species

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We are investigating the population dynamics of the federally endangered California endemic tidal marsh species, the Suisun Thistle, Cirsium hydrophilum (Greene) Jeps. var. hydrophilum (Asteraceae) with the objective of enhancing populations. Our initial approach is to assess seed production, dispersal and recruitment at Rush Ranch Open Space in Solano County. We have directly examined seed production and predation, indirectly measured seed dispersal, and have established permanent transects to monitor seedlings and rosettes. Our main finding so far is that Suisun Thistle has issues with seed production, being somewhat limited by seed maturation and predispersal seed predation. Distribution patterns of adults and rosettes suggest recruitment is limited by light near channels and by salinity away from channels along a gradient of light and salinity conditions. The results of this work will inform the greater restoration efforts for these brackish marsh areas for successful persistence of these populations in the face of myriad effects associated with global climate change and sea level rise. Monitoring of these populations and habitat, as well as exploring relevant aspects of life history and population ecology is necessary in developing a comprehensive management plan for these areas.

Keywords: Suisun Thistle, endangered species, population dynamics, recruitment, seed dispersal, ecology

Poster Topic: Restoration - Vegetation

Restoration Programs

California EcoRestore

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The Delta is a highly changed and engineered environment supporting threatened and endangered species, the state's agricultural industry, and water supply for millions. Both the federal and state government have a stake in achieving habitat and ecosystem restoration in the Delta. A key aspect of the Governor's California Water Action Plan is advancing ecosystem restoration to benefit native fish and wildlife species recovery. Building on the goals set in California's Water Action Plan, the California EcoRestore initiative will coordinate and advance at least 30,000 acres of critical habitat restoration in the Delta in five years (by 2020). This means breaking ground on projects and helping to alleviate implementation barriers during the planning and permitting phases. The initiative aims to address the Delta's legacy impacts, as well as effects from the ongoing operation of the state and federal water projects. Driven by world-class science, and guided by adaptive management, this initiative has pursued habitat restoration projects with clearly defined goals, measurable objectives, and financial resources to help ensure success. California EcoRestore's initial goal is to advance Delta habitat restoration associated with existing mandates, pursuant to federal biological opinions, as well as additional habitat enhancements. A broad range of habitat restoration projects are being pursued, including projects to address aquatic, sub-tidal, tidal, riparian, flood plain, and upland ecosystem needs, as well as fish passage improvement in the Yolo Bypass and other key locations. 2018 will be the most significant year yet for the initiative in terms of making progress on the ground, as multiple projects are scheduled to start construction. These efforts will offer opportunities for learning through adaptive management and monitoring, and creating a strong foundation to build from as more projects and coordinated habitat restoration efforts are planned and implemented in the Delta.

Keywords: EcoRestore, ecology, habitat restoration, aquatic, sub-tidal, tidal, riparian, flood plain

Poster Topic: Restoration Programs

An Investigation of the Partnerships and Intersections Involved in Delta Conservancy Proposition 1 Projects

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The Sacramento-San Joaquin Delta Conservancy (Conservancy) is a lead state agency in the implementation of ecosystem restoration in the Delta. 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 (Proposition 1). Proposition 1 identifies $50 million for the Conservancy "for competitive grants for multibenefit ecosystem and watershed protection and restoration projects in accordance with statewide priorities" (Water Quality, Supply, and Infrastructure Improvement Act of 2014: California Water Code Sections 79730 and 79731). The Conservancy's Proposition 1 Ecosystem Restoration and Water Quality Grant Program has three priorities: ecosystem protection, restoration and enhancement; water quality; and water-related agricultural sustainability. These priorities, and the complexity of the projects that qualify within them, encourage and require intersections across diverse groups of partners, stakeholders, and experts. The Conservancy has awarded three cycles of grants. This poster explores the diversity of organizations that come together to plan and execute these projects, and the many stages a project goes through from panning to execution. We will use a small number of projects as specific examples. These examples highlight many of the intersections between restoration, agriculture, geography, and resource management that occur in the planning and execution of these projects. These examples will also illustrate the human collaboration between groups across a range of age, economic, educational, and experiential demographics that can be facilitated during the planning and execution of these types of projects.

Keywords: Proposition 1, Ecosystem Restoration, Water Quality

Poster Topic: Restoration Programs

Accelerating Recovery of Listed Species: Expedited Permitting for Habitat Restoration in the Bay-Delta

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One of the most challenging aspects of habitat restoration in the Bay-Delta area is addressing the complex web of environmental regulations. There is also significant new funding for habitat restoration available and even more potential funding through bond measures on the 2018 ballots - which will lead to an increase of projects in the coming years. However, this funding generally does not come with the necessary permits to get the work done– which can delay project implementation.

To help address this problem, Sustainable Conservation worked with the National Oceanic and Atmospheric Administration's Restoration Center (NOAA RC) and Environmental Science Associates, as well as the U.S. Army Corps of Engineers (Corps) and US Fish & Wildlife Service (FWS) to submit a programmatic Biological Assessment (BA) to the National Marine Fisheries Service for habitat restoration projects in the Central Valley and Bay-Delta area. NMFS will then produce a programmatic Biological Opinion (BO) (due out in 2018) under Section 7 of the federal Endangered Species Act for approximately 20 commonly implemented project types that could impact NMFS' trust species.

NMFS' recovery plans recognize efficient permitting of priority restoration projects as an important step in implementing the plans and getting needed projects constructed. If an applicant proposes a restoration action covered under this programmatic BO, the project can receive authorization from NMFS much more quickly. NMFS programmatic BOs in coastal California have made approvals 10 times faster and reduce review time by several months. When completed, this authorization will give applicants the opportunity to plan, design, and implement restoration projects more quickly and with more funding for on-the-ground work. However, it is important to understand the detailed project description, environmental and species protection, and other requirements of these front-loaded permits, and be willing to communicate early with regulatory agencies in a cooperative relationship.

Keywords: programmatic permitting, authorization, consultation, habitat restoration, water quality, species

Poster Topic: Restoration Programs

Delta Conservancy Proposition 1 Ecosystem Restoration and Water Quality Grant Program Overview

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The Sacramento-San Joaquin Delta Conservancy Proposition 1 Grant Program promotes intersections of a range of groups, stakeholders, and communities by its most basic structure. The 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 (Proposition 1). Proposition 1 identifies $50 million for the Conservancy "for competitive grants for multibenefit ecosystem and watershed protection and restoration projects in accordance with statewide priorities" (California Water Code Sections 79730 and 79731). The Conservancy's Proposition 1 Ecosystem Restoration and Water Quality Grant Program;has three priorities: ecosystem protection, restoration and enhancement; water quality; and water-related agricultural sustainability. These priorities, and the complexity of the projects that qualify within them, encourage and require intersections across diverse groups of partners, stakeholders, and experts. The Conservancy has awarded three cycles of grants. This poster provides a high-level overview of the program. It includes a breakdown of the types of habitats that comprise these projects, illustrates the geographic distribution of $29 million in funds awarded and 21 project locations within the various Delta counties, and explores the types and numbers of organizations that partner on these projects. ;

Keywords: Proposition 1, Ecosystem Restoration, Water Quality

Poster Topic: Restoration Programs

The Delta Plan Ecosystem Amendment -- Incorporating Science into Restoration Planning for the Delta

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The Delta Stewardship Council is preparing an amendment to the Delta Plan – Chapter 4, including its policies, recommendations, and performance measures addressing the protection, restoration, and enhancement of the Delta ecosystem. An overarching objective of this amendment is the integration of best available science on climate change, sea-level rise, and restoration approaches which re-establish ecological resilience within the working landscape of the region. Council Staff have developed a process by which science synthesis papers and technical analyses directly support proposed changes to the Delta Plan's policies, recommendations, and are incorporated in the metrics, baselines, and targets of performance measures. Each of these steps have undergone technical peer review and received feedback from public and inter-agency stakeholders. Synthesis papers summarize over 600 journal articles and technical reports on climate change, ecosystem conditions, and conservation and restoration science as they relate to the Delta landscape. Technical analyses include 1) mapping regions appropriate for subsidence reversal and future tidal marsh restoration with new tidal datum, terrain, and sea-level rise guidance, 2) updating the 2007 VegCAMP land cover mapping dataset, and 3) developing a quantitative understanding of science-based and resilient ecological restoration potential using the principles described in SFEI's report titled "A Delta Renewed". Collectively, these works provide regional considerations of watershed hydrology, constraints due to sea-level rise, urbanization, and subsidence, which are then used to inform issues of scale, connectivity, complexity, and redundancy facing guiding design and prioritizing restoration. Key ecological objectives of the Delta Plan amendment of Chapter 4 are to re-establish food web function, support recovery of threatened and endangered species through tidal marsh and riparian restoration, and ensure that restoration actions are implemented in a way that anticipates the effects of climate change and sea-level rise.

Keywords: sea-level rise, food web, vegetation mapping, restoration, resilience

Poster Topic: Restoration Programs

Sediment Dynamics

Deposition Rates of Floodplain Sediment in the Cache Creek Settling Basin based on Vertical Profiles of Cesium-137 and Mercury

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Cache Creek Settling Basin (CCSB), a 1600-hectare leveed area near Woodland, California, was constructed in 1937 and expanded in 1993 to trap sediment prior to transport into Yolo Bypass, a flood conveyance in the Sacramento River system. Cache Creek contributes about 30% of the annual mercury (Hg) load to the Sacramento-San Joaquin Delta, despite representing only about 2% of the annual flow (Wood et al., 2010). California Department of Water Resources (DWR), which maintains the CCSB, needs to understand sediment CCSB deposition rates to evaluate options for maintaining or improving trap efficiency of sediment and Hg. During 2011-12, floodplain sediments were drilled by USGS at 15 locations within the CCSB to about 30 ft (9 m) depth. Radioactive cesium-137 in fallout from atmospheric testing of nuclear weapons peaked in 1963, providing a useful dating tool. Depth of maximum Cs-137 was 74-145 cm at six locations (avg. +/- std. dev. 105 +/- 29 cm). Corresponding deposition rates for 1963 to 2011-12 were 1.7 to 2.9 cm/yr (avg.+/- std. dev. 2.1 +/- 0.5 cm/yr). Detailed depth profiles of Hg at three drill sites indicate a transition from Hg concentrations typically less than 100 ng/g (interpreted as prior to modern mining, or pre-1850) to greater than 100 ng/g (post-1850) at depths from 300 cm to 480 cm. Deposition rates for 1850 to 2011-12 (based on Hg) were very similar to rates for 1963 to 2011-12 (based on Cs-137) at each site: 1.9 vs.1.7 cm/yr; 3.0 vs. 2.9 cm/yr, and 2.5 vs. 2.5 cm/yr. These estimates of sediment deposition rates in the CCSB are being used by DWR to develop preliminary designs for CCSB modification to enhance future trap efficiency of sediment and Hg, which would benefit the Delta ecosystem by lowering Hg loads.

Keywords: Cache Creek, floodplain, sediment, deposition rate, mercury, cesium-137, mining, dating

Poster Topic: Sediment Dynamics

Historical Sacramento-San Joaquin River Delta Bathymetric Change Analysis: A Pilot Study

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The bathymetry of the Sacramento-San Joaquin Delta affects the flow of water and sediment throughout the system and is a basic control on levee stability, habitat distribution, and water quality. Delta bathymetry is dynamic, responding to both natural forces and human activities. Assessment of future Delta conditions is aided by understanding how its bathymetry has changed in the past. This pilot study explores historic bathymetric change in the Delta. The earliest comprehensive surveys that covered a large portion of the Delta were conducted in the 1930s by the US Coast and Geodetic Survey, the precursor to NOAA. These historic surveys are compared to recent surveys conducted by the California Department of Water Resources and others, to document how sedimentation and erosion have changed the Delta. We selected regions for the pilot study based on availability of data, critical habitats, and importance to modelers who are trying to predict future changes to the Delta. As the Delta is altered though natural processes or through human development, understanding how the bathymetry has changed will help improve predictive models of the system.

Keywords: Bathymetry, historic, Delta

Poster Topic: Sediment Dynamics

Sediment Transport in San Pablo Bay: Uniting Field Observations and Models

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Fine sediment transport controls primary productivity, affects water quality, and impacts the formation and erosion of fringing wetlands in San Francisco Bay. Despite its importance, predicting sediment transport remains a technical challenge because of the interplay between fluid flow and particle behavior. Numerical models of sediment transport require external input of parameters such as bottom roughness, bed erodibility, and settling velocity, yet these values are often selected through model calibration rather than based on physical observations. Through field measurements and model development, we aim to improve numerical modeling of sediment in San Francisco Bay.
We collected data in San Pablo Bay over 16 months, and found that bottom roughness, bed erodibility, and settling velocity changed on seasonal, spring-neap, and tidal timescales. In particular, the onset of winter storms caused a decrease in bed roughness, freshwater inflows yielded a more erodible bed, and slack water periods allowed for larger flocs to form.
With these field results in hand, we move towards testing them in numerical models and working to make sediment transport models more mechanistic and predictive. We focus on the implications of spatial and temporal variation of sediment transport parameters including the ones named above, and on incorporating cohesive sediment modules into Delft San Francisco Bay sediment transport models. Here, we present the implications of our field observations for numerical modeling, and our approach for advancing sediment transport models in San Francisco Bay. Improving numerical models of sediment transport in ways that include this spatial and temporal variability will allow managers to make more informed decisions about sediment disposal, better predictions of Bay response to decreasing sediment supply, and more specific plans for current and future marsh restorations.

Keywords: sediment transport; numerical models; San Pablo Bay

Poster Topic: Sediment Dynamics

Intertidal Mudflat Size Response to Changes in Sediment Supply

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Estuarine mudflats provide valuable habitat for unique ecosystems and critical feeding area for migratory bird species. Together with adjacent salt marshes they attenuate waves, providing a natural defense against storms. Mudflats evolve morphologically in response to changes including hydrodynamic forces, sediment supply, and sea level rise. In the San Francisco Estuary, analysis of a series of historical bathymetric surveys show there was about a 50% overall reduction in intertidal mudflat area from the 1850s to the late 1900s, although each region behaved differently through time. In the North Bay (Suisun and San Pablo bays) deposition of massive amounts of hydraulic mining debris from the Sierra Nevada Foothills shoaled the shallow subtidal and increased intertidal mudflat flat area temporarily. The seven-fold increase in sediment supply during the hydraulic mining period resulted in a 30-60% increase in intertidal mudflat area from 1850s to 1880s. With the end of hydraulic mining in 1884, sediment supply to the North Bay decreased by a factor of 5 and the extent of intertidal mudflats correspondingly decreased by a factor of 2 over the following 60 years. The South and Central bays did not receive as much of the hydraulic mining debris as the North Bay because they are not as close to the hydraulic mines and did not experience the temporary increase in intertidal mudflat area, although because sediment. Additional research relating the spatial and temporal patterns of historical sediment supply to intertidal mudflat area in the San Francisco Estuary will improve the ability to forecast how future changes in sediment supply will affect intertidal mudflats. Because of sea level rise, which affects hydrodynamic forces and sediment transport, numerical models that account for the affect of these factors on intertidal mudflat area are also needed for more accurate forecasts of future conditions.

Keywords: sediment mudflat evolution intertidal flats

Poster Topic: Sediment Dynamics

Muddy Waters: Turbidity Variability in the Yolo Bypass Floodplain

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The turbidity in the Delta has experienced a long-term decline, and is one of several factors that has been linked to the pelagic organism decline. The Yolo Bypass and Cache Slough Complex (CSC) is one region of the Delta that still provides relatively high turbidity year-round. This is important as higher turbidity has been identified as an important habitat preference for many native Delta fishes, including the endangered Delta Smelt and is likely one contributor to its year-round residency in the CSC. More importantly, the transport of sediment and suspended particulate organic and inorganic matter are important components to estuary and floodplain aquatic ecosystems. Although, there function within the Deltas floodplains, freshwater tidal sloughs and marshes is still poorly understood. In 2013, the Department of Water Resources (DWR) installed a water quality sonde below Lisbon Weir in the Yolo Bypass to provide continuous monitoring data on seasonal variance of multiple water quality parameters that includes turbidity. This data is further supplemented with discrete measurements collected daily at a larger spatial extent as part of the IEP Yolo Bypass Fish Monitoring Program and the biweekly collection of water samples analyzed for total suspended solids (TSS). This long-term data set has allowed us to gain a better understanding of the seasonal and water year variance of turbidity and TSS within the Yolo Bypass floodplain and how that compares to the adjacent Sacramento River. In addition, DWR also performed continuous water quality spatial mapping of the floodplain throughout the extended 2017 flooding period to provide insight into temporal lateral variability, deposition, and downstream transport. It is critical that we better understand the seasonal mechanisms that cause the high turbidity, especially as water and resource managers plan to alter hydrology through the development of future restoration projects in this region.

Keywords: turbidity, Yolo Bypass, TSS, floodplain

Poster Topic: Sediment Dynamics

Water Quality - Ag Drainage

Dissolved N Species Concentrations in Agricultural Drainage in the Sacramento-San Joaquin Delta

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The Sacramento-San Joaquin Delta (the Delta), in central California, is ecologically and economically important. The Delta supports drinking and agricultural water needs for over 20 million people in California and provides critical habitat for a range of endemic species and migratory birds. The Delta is comprised of 57 islands, which are sinking due to ongoing land subsidence. Many of these islands now reside below sea level and have been leveed to prevent flooding. Water infiltrating through these levees must be pumped off-island back into the Delta. This discharge has the potential to contain elevated levels of dissolved N from agricultural land use practices, which can affect important ecological processes, such as primary productivity, in receiving waters. The dissolved N content of water pumped off Delta islands is poorly constrained, however.

In June 2017, we started monthly sampling of dissolved inorganic and organic N concentrations in agricultural drainage and adjacent waterways on Staten Island in the Delta to characterize seasonal changes in N species concentrations. Total dissolved N concentrations reached minima in summer and maxima in winter. The dominant dissolved form of N was typically organic N. Regardless of the dominant N species, total dissolved N concentrations were always elevated relative to surrounding river water. Constraining dissolved N species concentrations delivered to Delta surface waters is important as both may play a role in the larger ecological functioning of the Delta.

Keywords: water quality, nitrogen, islands, land use practices

Poster Topic: Water Quality - Ag Drainage

Variability in Dissolved Inorganic and Organic C Concentrations in Agricultural Drainage in the Sacramento-San Joaquin Delta

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The Sacramento-San Joaquin Delta (the Delta) consists of over fifty islands with organic rich soil that are mainly used for agriculture. Due to microbial respiration of organic C in the soil of these islands, many have experienced subsidence, with some island elevations nearly 25 feet below sea level. While previous studies have focused on dissolved organic C (DOC) content in agricultural drainage due its effect on exported water quality and its role in island subsidence, the dissolved inorganic carbon (DIC) content of these waters has been largely ignored. DIC is a product of microbial respiration that represents an important part of island C cycling and can affect receiving water chemistry. To assess the magnitude of agricultural drainage DOC and DIC loads, we began monthly sampling of agricultural drainage and adjacent waterways on Staten Island in the Delta in June 2017. Staten Island is predominantly farmed land bordered by the North and South Forks of the Mokelumne River. In all months sampled to date, dissolved C concentrations in agricultural drainage are significantly enriched relative to surrounding waterways. DIC and DOC concentrations in agricultural drainage also show strong seasonal variability, with summer minima and winter maxima. Due to annual variability in Mokelumne River discharge, preliminary data indicate that agricultural drainage from Staten Island may be an important contributor of dissolved C during low flow periods. These findings will be relevant to a variety of stakeholders and resource managers due to the fundamental role of C in both Delta biogeochemistry and land management practices.

Keywords: carbon, water quality, islands, loads

Poster Topic: Water Quality - Ag Drainage

Characterization of Redox Sensitive Elements in Agricultural Drainage in the Sacramento-San Joaquin Delta

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Millions of people depend on the Sacramento-San Joaquin Delta (the Delta) for its ecosystem services, recreational uses, and drinking water resources. Shifts in water quality in the Delta continue to threaten these beneficial uses, however. Constraining the biogeochemical drivers of water quality in the Delta is difficult as effluent from a variety of anthropogenic activities discharge directly into its waterways. Currently, the largest anthropogenic control on Delta biogeochemical parameters is thought to be municipal wastewater treatment plant (WWTP) effluent. While previous estimates of agricultural drainage discharge rival those observed from major WWTPs discharging into the Delta, little work has been done to characterize agricultural drainage biogeochemistry in the Delta.

To address this gap in knowledge, we commenced monthly sampling of agricultural drainage and adjacent waterways on three islands in the Delta for a suite of biogeochemical parameters in June 2017. Preliminary data indicate that agricultural drainage on all islands sampled is enriched in dissolved C and N content relative to surrounding waterways. Additionally, we observe seasonal variations in agricultural drainage biogeochemical parameters indicative of redox shifts on Delta islands, which appear to be linked to on-island changes in land and water use. Characterization of the drivers of these redox shifts on Delta islands is important for understanding the major controls on agricultural drainage nutrient and trace element exports. More broadly, this work will benefit efforts aimed at understanding the dominant processes controlling the biogeochemistry of the Delta.

Keywords: trace elements, carbon, nitrogen, anthropogenic inputs, islands

Poster Topic: Water Quality - Ag Drainage

Water Quality - Biofiltration

Fate of Heavy Metals in Urban Stormwater Biofiltration Systems

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Urban stormwater runoff picks up heavy metals from roads and buildings before flowing into rivers and streams during precipitation events. This runoff can have numerous negative effects on aquatic ecosystems. Biofiltation systems are a popular, low impact practice using soil, plants, and microbial communities to mitigate heavy metals from stormwater. Biofiltration removes heavy metals from stormwater through sorption, uptake, and degradation processes. California rose, deer grass, sedge, rush, and blue sage are commonly planted in Northern California biofilters because they are native to this area, and have adapted to wet winters and dry summers. To determine the efficacy of heavy metal removal from storm runoff these five plants and a control were tested in triplicate biofilter columns in a greenhouse using synthetic stormwater. Eighteen biofiltration columns were built out of PVC pipe and filled with layers of pebbles, sand, local loam soil, and mulch. Local storm water was analyzed to inform the composition of the synthetic stormwater applied to test columns. Total metal concentrations (Cu, Pb, Ni, Cd, Cr, and Zn) were measured in the synthetic stormwater before and after filtering through the biofilters. Heavy metal content was analyzed in the plant shoots and roots and the top and bottom inch of the soil before and after six applications of synthetic stormwater. This research can be used to inform management practices of biofiltration systems, including disposal of heavy metal plant and soil waste.

Keywords: Stormwater, biofiltration, heavy metals

Poster Topic: Water Quality - Biofiltration

Do Stormwater Biofilters Treat Urban Runoff?

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Stormwater biofilters are vegetated systems designed to decrease sediment and pollutant loads in urban runoff. Despite the rapid implementation of biofilters as stormwater management solutions, their pollutant removal efficiency is rarely assessed. Biofiltration systems in northern California were monitored for their ability to retain nutrients, sediments, metals, and petroleum hydrocarbons from storm runoff. Concentrations of constituents of concern in stormwater displayed a large spatial and temporal variability. While biofilters removed heavy metals, ammonium (NH4+), and petroleum hydrocarbons efficiently, they only partially retained nitrate and phosphate during early-season storms and acted as a source of nutrients during spring storms. These results highlight an important seasonal variability for biofilter performance and indicate that plants are important controls of nutrient removal by biofiltration. A detailed monitoring of inflows and outflows in a local bioswale was implemented and showed promising preliminary results to enable pollutant load calculations. This monitoring effort of biofiltration systems is particularly relevant to identify key maintenance practices that ensure the long-term resilience of this type of green infrastructure.

Keywords: stormwater, biofiltration, nutrients, heavy metals, hydrocarbons, flow, monitoring

Poster Topic: Water Quality - Biofiltration

Effects of Additives and Saturation Depth on Nutrient Retention in Urban Stormwater Biofilters

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One way to increase the health of the estuary is to intercept contaminants commonly found in urban storm runoff before they can enter a waterway and affect the ecosystem. Biofiltration systems are useful for improving water quality as they can reduce pollutant levels, suspended sediment loads, and the amount of discharge that enters surface waters. There are many aspects of a biofilter that may affect how much of a pollutant is retained, such as plant choice and media type. This research delves into possible options to maximize the reduction of nutrient loads of stormwater runoff by 1) adding media additives (zero valent iron, rice hull biochar, walnut shell biochar, wood chip biochar, and water treatment residuals), and 2) altering the depth of the saturated zone. Synthetic stormwater modeled after stormwater samples collected in Chico, CA was added to biofilters and the resulting water was analyzed for nutrients to determine if biofiltration systems can quantitatively remove nutrients from stormwater. Nutrients are the focus of this study as they are commonly associated with urban-influenced water and have a profound effect on downstream aquatic ecosystems by promoting eutrophication. The nutrients of focus were ammonium, nitrate, and phosphate and were analyzed using spectrophotometry. By removing nutrients from upstream waters, biofiltration systems can help improve the health of the Sacramento-San Joaquin River Delta.

Keywords: Biofiltration, stormwater, nutrients, nitrate, biochar, water treatment residuals, zerovalent iron

Poster Topic: Water Quality - Biofiltration

Water Quality - Contaminants

Evaluating Water Quality Improvements Efficacy in Suisun Marsh Sloughs of Managed Wetland BMPs

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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, leading to a Clean Water Act Section 303(d) impairment listing by the San Francisco Bay Regional Water Quality Control Board (RWQCB). In response, Siegel et al. (2011) created conceptual models of DO and meHg processes in managed wetlands and receiving sloughs using their 2007-2008 empirical data, from which they developed a suite of best management practices (BMPs) for managed wetlands aimed at reducing impairment. BMP implementation started in 2009 and has expanded since. A in-progress study intensively monitored 2016 and 2017 water quality conditions in Peytonia and Boynton sloughs, both with a history of water quality impairment, to characterize managed wetland discharge and receiving slough water quality in response to BMP implementation. Monitoring included continuous slough water quality (temperature, DO, conductivity, and pH) and discrete grab sampling for organic carbon, biochemical oxygen demand in water and sediment, and meHg. Wetland and slough hydrology were monitored via pressure transducers. In parallel, the RWQCB has continuous water quality monitoring in Goodyear and lower Cordelia sloughs where low DO problems have also occurred. Findings help explain slough biogeochemical processes in relation to wetland discharges. Year-to-year changes allow us to assess BMP efficacy. These data show that slough water quality has improved with BMP implementation though problems still occur. These data are also being used to develop a modeling framework for evaluating potential water quality response to different scenarios of BMP implementation, in support of implementing the Total Maximum Daily Load program the RWQCB recently adopted. This study is the first systematic field effort to test BMP efficacy in Suisun Marsh sloughs and provide support to managers and regulators for identifying specific BMPs for broader implementation.

Keywords: Water quality, dissolved oxygen, methylmercury, best management practice

Poster Topic: Water Quality - Contaminants

War on Drugs in a South Bay POTW

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The presence of contaminants of emerging concern (CECs), like pharmaceuticals, in America's surface waters has caused the public and regulators to be concerned about possible environmental consequences. Previous studies have hypothesized that the major source of pharmaceutical CECs in surface water bodies is via patient excretion into sanitary sewer systems and through wastewater treatment effluent discharge. A 2009 study found that 18 of 39 pharmaceutical CECs analyzed for were detected in Lower South San Francisco Bay. San Francisco Bay Area wastewater treatment plants were not originally designed to remove pharmaceutical CECs; however a previous study conducted on two South San Francisco Bay wastewater treatment plants found that some incidental removal of certain pharmaceutical CECs does occur. To further understand the fate of pharmaceutical CECs as they pass through a tertiary wastewater treatment plant, the City of Palo Alto Regional Water Quality Control Plant (RWQCP) collected grab samples in 2009 and 2016 from the influent, effluent and recycled water streams. Samples were analyzed for pharmaceutical CECs using high performance liquid chromatography coupled with a mass spectrometer per EPA Method 1694. Data were used to
1. update pharmaceutical CEC removal efficiencies in light of changes in RWQCP processes;
2. evaluate temporal changes in service area pharmaceutical CECs entering the RWQCP; and
3. compare pharmaceutical CECs after undergoing different disinfection processes (i.e., sodium hypochlorite versus ultraviolet disinfection).
The results from this study will be used for future pollution prevention activities and understanding risks to receiving water ecosystems. Additionally, results can be used by treatment plant managers in better understanding the impacts of different disinfection processes on pharmaceutical CECs.

Keywords: pharmaceuticals, wastewater, treatment plants, contaminants, southbay

Poster Topic: Water Quality - Contaminants

Spatial and Temporal Trends in Cu, Pb, and Zn in North San Francisco Bay Sediments: 1993-2017

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Sediment samples from North San Francisco Bay (SFB) were collected monthly from December 1993 to September 2017 at four stations located west of Rio Vista and East of Point Pinole. Samples were sieved to 64 um to eliminate grain-size bias and analyzed for Cu, Pb and Zn. The purpose of this study was to characterize the long-term metal trends and use the ERL/ERM to evaluate the potential effects to the North SFB. Copper concentrations were variable in North Bay sediments and ranged from ~25-100 ug/g. While Cu concentrations were near the regional background of 40 ug/g at station 8.1 (Martinez Bay, long-term average of 39.9 ± 4.9 ug/g), concentrations at the adjacent upstream station (4.1, Chips Island) were approximately 36% higher (long term average of 54.3 ± 9.6 ug/g). During the course of this study, Cu concentrations at all stations were below the ERM (effects range median) of 270 ug/g but above both the regional background and the ERL (effects range low) of 34 ug/g. Zinc sediment concentrations were also variable and ranged from ~80-180 ug/g. All stations generally fell; below the ERL of 150 ug/g and most stations were near or above the regional background of 100 ug/g. Lead concentrations ranged from ~5-50 ug/g, and were generally lower than the ERL of 46.7 ug/g but higher than the 10 ug/g regional background level. Average long-term lead concentrations in sediments at station 12.5 (San Pablo Bay, 22.1 ± 11.6 ug/g) were twice the average of the other three stations (10.0 ± 1.6 ug/g). This spatial and temporal assessment of Cu, Zn and Pb concentrations in North SFB sediments provides important baseline data with which to monitor long-term changes in potential metal contamination to San Francisco Bay.

Keywords: Sediment, Copper, Lead, Zinc, Trends

Poster Topic: Water Quality - Contaminants

Toxic Underground: Emergent Pathways of Groundwater Contamination in the San Francisco Bay

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The encroachment of groundwater upon buried hazardous artifacts and materials introduces a pressing dimension of predicted overall water quality decline within the discourse of sea level rise adaptation in the San Francisco Bay. As groundwater advances in a lens above saltwater, it will infiltrate brownfields, unlined dump sites, underground storage tanks, and oil and hazardous material pipelines, likely damaging these infrastructures from hydrostatic pressure and eventually saltwater corrosion. Contaminants susceptible to groundwater migration will exchange with wastewater lines, traveling directly into houses and businesses. Resources, such as freshwater and arable land, will become even more limited as toxic groundwater rises and emerges, heightening pressure on those communities that need access to both. Given the documented pattern of industrial development and waste disposal in close proximity to low income neighborhoods and communities of color, there will be a disproportionate burden of groundwater pollution on these populations.
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This research illustrates geographic patterns of vulnerability to groundwater contamination in the San Francisco Bay. Methods employ descriptive analysis and illustration, geospatial data collection, and predictive modeling to map, define, and project impacts. Through case study in West Oakland, I examine the spatial extents of groundwater emergence and toxicity under three elevations of sea level rise. As a landscape designer, I offer strategies of mitigation through design, positing landscape architecture and planning as critical practices in negotiating the interface between contaminants, water, and communities. As new research connecting the projective consequences and geographies of groundwater pollution with opportunities for landscape adaptation, it signals a critical and timely alert to local efforts to protect water quality, and prompts further examination of groundwater impacts as a pretext to sea level rise planning and management in the Bay-Delta.

Keywords: Groundwater contamination, sea level rise, West Oakland, landscape design

Poster Topic: Water Quality - Contaminants

Water Quality - Nitrogen

Annual and Interannual Variation in Nitrate Concentrations in the North Delta and Lower Sacramento River

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Nitrogen, an essential nutrient for all living organisms, is most commonly found as nitrate in rivers and estuaries. Aquatic systems that support large human populations consequently receive elevated nutrient inputs from agriculture, wastewater, and urban runoff, and thus are often affected by excessive nitrate levels, which can have deleterious ecological effects. The USGS has been continuously monitoring nitrate concentrations in surface waters using in situ high frequency sensors at a number of stations in the lower Sacramento River and northern Delta for several years. We will present a comparison of the temporal trends and concentrations for water years 2015-2017. For all years, an increase in nitrate concentration occurs following the onset of rains. This period of elevated nitrate typically exhibits a gradual decline into spring, further drawdown during summer, and modest rise in fall. Although all years had these general temporal trends, there were pronounced differences between water years (WY) in nitrate concentration magnitude.

In WY 2015, summer concentrations at Lower Cache Slough and Liberty Island were in the vicinity of 0.4 mg-N/L, while concentrations at the Sacramento River at Decker Island hovered near 0.6 mg/L. Up-river concentrations measured at Freeport and Walnut Grove on the Sacramento River were far lower – near 0.1 mg-N/L. During WY 2016, while the up-river sites remained similar, the concentrations observed at the downstream stations were approximately a third of the prior year's value. Under the much wetter conditions of WY 2017, the up-river concentrations were again similar, but the down-river concentrations were halved. With the supply concentrations significantly attenuated, the values observed at the long residence time stations in the northern reaches of the Cache Slough Complex frequently approach the limits of detection for the instrumentation. Our results demonstrate how nitrate concentrations are driven by river discharge as well as ecosystem demand.

Keywords: nutrients, continuous monitoring, nitrate

Poster Topic: Water Quality - Nitrogen

Improving Benthic Nutrient Flux Rate Determinations Using Real-Time, Field-Based High Frequency Measurements.

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Understanding sources, sinks, and transformation rates of nutrients (e.g. nitrate, ammonium, dissolved organic nitrogen, phosphate) in the Bay-Delta is key to understanding their effects and identifying effective management strategies. Studies using the mass balance approach suggests that processes occurring within the Delta significantly alter nutrient concentrations and forms. While nutrient exchange between the water column and the benthos is assumed to be important, available information on sediment fluxes is limited and wide ranging, indicating there are large uncertainties in our understanding of uptake, release, and transformation in sediments.
We have developed an approach for quantifying sediment/water interactions using an isolation chamber sealed into the benthic surface. Isolated water captured within the chamber is pumped through a closed loop system that continuously measures nitrate, ammonium, and dissolved organic matter (FDOM), along with ancillary measurements (e.g., temperature, turbidity, chlorophyll, dissolved oxygen). Establishing the rate of change in constituent concentration over time permits us to calculate fluxes into or out of the sediment. Further, the chamber is outfitted with LED lights, permitting us to assess the extent to which photosynthetic processes affect rates.
Preliminarily tests in a wetland on Decker Island on the Sacramento River showed a measurable efflux of nitrate out of the benthos over a 30-minute period; this contrasts with previously reported measurements that showed low to negative efflux rates. The observed rate at Decker could be influenced by high water column nutrient concentrations. In future deployments, measured benthic flux rates will be related to sediment and site characteristics, such as bulk density, sediment organic content, temperature, vegetation type and abundance, and the presence of clams. Variability between sites will highlight biological, physical, and environmental processes that influence nutrient cycling. Improving our knowledge about benthic rates will aid the development of biogeochemical models and thus system management.

Keywords: Benthic Flux, High Frequency Measurements, Nutrients, Management Strategies

Poster Topic: Water Quality - Nitrogen

Mapping Nitrogen Concentrations in the Delta: Results From a Newly Developed Continuous Flow-Through Ammonium Analyzer

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The concentration and form of dissolved inorganic nitrogen (DIN; sum of nitrate/nitrite and ammonium) in Delta waters is believed to directly impact phytoplankton productivity, the occurrence of harmful algal blooms and associated toxins, and the growth of aquatic vegetation, all of which have repercussions on beneficial uses (e.g., food web, drinking water quality, recreation, etc.). To date, information about nitrate and ammonium concentrations in the Delta predominantly relies on approximately monthly collection of discrete samples, and much of these data are limited to well-mixed main channels. This approach misses spatial and temporal variability and thus may not provide adequate information to identify specific sources, understand drivers, and develop effective responses. Over the last few years, the deployment of high frequency, in situ nitrate sensors has greatly increased the information we have about nitrate in the Delta. However, comparable information about ammonium – and thus calculation of DIN – has not been available. To address this need, the USGS Biogeochemistry group has worked in collaboration with Timberline Instruments of Boulder, Colorado, to modify their benchtop TL-2800 to meet the specific needs of our boat-based water quality mapping operations. This has enabled us to collect ammonium concentration data in situ continuously (1 measurement recorded per second) in conjunction with nitrate and other measurements (temperature, dissolved oxygen, conductance, etc.). Here we present data collected from the past year across the Delta and into Suisun Bay. Measurements completed at Cache Slough Complex in the North Delta yielded ammonium concentrations ranging from as low as 0.5 µM in the Stair Step to 20 µM in the Sacramento River. Additional cruise tracks covering the central and southern Delta, as well as data collected from tidal wetlands and areas dominated by aquatic vegetation, are providing us with a more complete understanding of nitrogen cycling in the Delta.

Keywords: dissolved inorganic nitrogen (DIN), nitrate in situ, ammonium in situ

Poster Topic: Water Quality - Nitrogen

Operating a Continuous Monitoring Network for Water Quality in the Sacramento-San Joaquin Delta to Understand Drivers of Habitat Quality

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Simultaneous measurement of chemical, physical, and biological parameters in the Delta is essential for understanding drivers of habitat quality and identifying conditions under which pelagic organism recovery might become favorable. In particular, water quality – including temperature, salinity, turbidity, dissolved oxygen, and nutrient concentrations – is influenced by numerous physical and biogeochemical factors that vary across time and space. While many of these parameters are key drivers of pelagic primary production (phytoplankton abundance and species composition), they are in turn also affected by biological processes (e.g., uptake, photosynthesis). Currently, the USGS California Water Science Center's Biogeochemistry Group runs a network of 12 continuous water-quality monitoring sites in the northern Delta, lower Sacramento and San Joaquin Rivers, and Suisun Bay. These sites are co-located with existing flow monitoring stations. The water quality monitoring sites provide a network that monitors pH, temperature, dissolved oxygen, specific conductance, nitrate, dissolved organic material, chlorophyll-a, phycocyanin, and turbidity. These stations also have the capability of incorporating additional high frequency sensors, such as those for phosphate, ammonium, and phytoplankton taxa. These water-quality measurements, taken every 15 minutes, are telemetered in real-time to USGS data servers. The quality controlled data are then made publicly available via the USGS NWIS Web: https://waterdata.usgs.gov/nwis. Stations are serviced and calibrated at regular intervals, and data from the sensor network are verified against discrete samples taken both monthly and more frequently over periodic ebb to flood tidal cycles. These data are useful for understanding nutrient supply dynamics and provide valuable information on algal productivity and other aspects of pelagic habitat quality. We show here several examples from the last 5 years that highlight how these stations are providing insights into drivers of nutrient concentrations and phytoplankton blooms.

Keywords: water-quality, habitat, monitoring, biogeochemistry, phytoplankton, algae, nutrients, chlorophyll, primary production

Poster Topic: Water Quality - Nitrogen

Deployment of In Situ, High Frequency Ammonium Analyzers in the Northern San Francisco Bay Delta, CA

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Many methods for measuring nutrient concentrations in water require personnel to collect and process discrete samples manually. Sampling programs limited to few visits are seldom able to characterize spatial and temporal trends with sufficient resolution. The USGS Biogeochemistry Group has been testing the use of high frequency, in situ, wet-chemistry ammonium sensors alongside their existing real-time water quality monitoring stations. The group has field tested two prototype Sea-Bird Coastal Cycle-NH4 instruments at 1-hour sampling frequency. [1]
The Cycle-NH4 instruments were deployed side by side for a 3-week period in October 2016 and for a 2-week period in August 2017 to evaluate their reagents for field stability and ammonium measurements for reproducibility and accuracy. Grab samples of river water were collected during each deployment for laboratory analysis. In October 2016, the instruments reported values similar to each other and to the lab for approximately one week before one instrument began drifting due to irregular microfluidic pumping and prematurely running out of reagent. The second instrument maintained good correlation with lab data throughout the deployment. In August 2017, the instruments reported similar values and trends. One instrument ran out of reagent 5 days before the end of the deployment while the other instrument maintained good correlation with lab values for the duration of the deployment. Reagents were shown to be stable throughout the deployments.
In all deployments, the 1-hour time-series data clearly demonstrated tidal variations in concentration. Preliminary data show that these instruments can be capable of automating;meaningful measurements of ammonium for moderately lengthy deployments. Further development and refinement will provide new continuous-monitoring tools for waters where nutrient loading is dynamic or of special concern.

[1] Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Keywords: ammonium, high frequency, nutrients, water quality monitoring

Poster Topic: Water Quality- Nitrogen

Nitrate Concentration-Discharge Relationships in the Sacramento River and Northern Delta: Insights from High Frequency Data

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Examination of concentration-discharge (C:Q) relationships is useful for understanding hydrologic and biogeochemical processes because it highlights relationships, or lack thereof, to transport. C:Q relationships are often used in models to estimate concentrations and loads because in most cases constituent concentrations are sparse (monthly) while discharge data is collected at high frequency (15-minute). The utility of using high frequency data for constituent concentration to calculate loads has been previously established; higher resolution data is particularly important when the time-scale of interest in on the order of days-to-months, as opposed to detecting trends across years. With several years (2014-2017) of high frequency (15-minute) nitrate concentration data available for a number of stations in Sacramento River and northern Delta, it is useful to compare C:Q relationships to assess trends not only between water years but also over shorter timescales (months, events), and between sites.

Several interesting observations are available from examination of the simple linear C:Q relationship for the Sacramento system. There is no general C:Q relationship for nitrate in either the positive direction – indicating increased loading from the upper watershed during higher flows – or in the negative direction – indicating dilution of inputs like wastewater during higher flows. While water year 2015 did have a modest positive relationship at Freeport, the lack of relationship in other years and at the other stations suggests that upstream flows are not a major control on nitrate concentrations in the lower Sacramento River and north Delta. We suspect that water residence times – which vary temporally as well as spatially – are sufficiently long to permit alteration of the input signals by biogeochemical processes such as uptake, nitrification and denitrification. The use of high frequency nitrate concentration data is thus expected to improve our ability to model nitrate concentrations and loads in the Delta.

Keywords: nitrate, water quality, discharge

Poster Topic: Water Quality - Nitrogen

Nitrogen and Phosphorus Nutrients at Hood

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This poster describes the results of the "Limnology of the State Water Project - Nutrient Budget Study: Nutrients at the Hood Water Quality Station" report. The main objectives were develop comprehensive, high-quality datasets of nutrient constituents and flow at selected stations throughout the SWP system, and analyze the data to determine long-term and seasonal trends in constituent concentrations, flow, and loads at the Hood stations. The nutrients included in the analysis are Ammonia, Nitrate, Nitrate+Nitrite, Total Kjeldahl Nitrogen, Total Nitrogen, Total Phosphorus, and Dissolved Orthophosphate.

Keywords: nutrients, nitrogen, phosphorus, Hood station

Poster Topic: Water Quality - Nitrogen

Operation Baseline: Leveraging a planned large-scale step change in nutrients

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As the Sacramento Regional wastewater treatment plant (Regional San WWTP) will undergo upgrades between 2019 and 2021 that will reduce total effluent nitrogen inputs to the Sacramento River by about 65%, the dominant form of nitrogen will shift from ammonium to nitrate. The resulting changes may alter nutrient biogeochemistry, phytoplankton biomass and species composition, the growth and distribution of aquatic macrophytes and the occurrence of harmful algal blooms (HABs), all of which in turn affect key Delta aquatic habitats. To address this, the Delta Stewardship Council, Delta Science Program is funding collaborative pilot studies that will inform our understanding of N dynamics and how wastewater-N enters the foodweb and affects aquatic ecosystems. The intent of these collaborative pilot studies is to develop methods for collecting supplementary 'baseline' data representing conditions prior to Regional San's WWTP upgrade. The pilot studies also aim to increase the understanding of how wastewater-derived nutrients affect Delta aquatic ecosystems and improve our monitoring tools. Quantifying N fluxes (sources and sinks) and transformation processes will provide key information needed to model nutrient concentrations and cycling at a larger scale, as well as develop linkages to phytoplankton and zooplankton growth rates and community composition. Gaps in our knowledge about the role nutrients play in the Bay-Delta's ecosystem and water quality processes hinder management and decision-making and the nutrient changes may affect valuable resources such as fisheries, recreation and drinking water quality. The Science Action Agenda identified this important science action: Implement studies to better understand the ecosystem response before, during, and after major changes in the amount and type of effluent from large point sources in the Delta including water treatment facilities. The Delta Science Program pursued this action by convening academic experts, Regional San, and others to begin the Operation Baseline initiative.

Keywords: Operation Baseline, water quality, nitrogen, ammonium, nitrate, phytoplankton, zooplankton, biogeochemistry

Poster Topic: Water Quality - Nitrogen

Water Quality - Salinity

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

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The recent (2012-2015) drought in California was the most severe in recent history. Reduced freshwater flows during drought periods cause increased demand on surface- and ground water reservoirs and allow coastal ocean waters to intrude further inland in the San Francisco Bay-Delta Estuary. For this study we analyzed up to 27 years of continuous records of specific conductance (a proxy for salinity) and temperature collected in the lower estuary from Suisun Bay in the north to South Bay in the south. Instruments equipped with specific conductance and temperature sensors recording every 15 minutes were deployed at seven fixed locations throughout the lower estuary. Five of the locations were deep enough to deploy instruments at two depths in the water column to assess vertical variations, for a total of 12 instruments and 154 sensor-years of data. During water years (WY) 2014 (1 Oct 2013 through 30 Sep 2014) and 2015 (1 Oct 2014 through 30 Sep 2015), record-high 15-min values were observed at several specific conductance and temperature sensor locations. Additionally, at all locations, the greatest annual mean values of specific conductance and temperature occurred during WY2014-2015. In this analysis, spatial trends are presented and the relative influence of conditions of the atmosphere, freshwater inflow, and ocean boundary are assessed to understand mechanisms contributing to the record-high values across the lower estuary. The quantity of record-high values observed during WY2014-2015 is unprecedented for this dataset and demonstrates both the effect of drought 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 outflow to the lower estuary.

Keywords: water quality; drought; estuary; water temperature; salinity

Poster Topic: Water Quality - Salinity

Variability in San Francisco Bay and Delta Salinity and Its Relations with Delta Inflows and Coastal Water Level

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Problem statement: The health of the San Francisco Bay and Delta ecosystem is closely related to the salinity of its waters, which in turn is largely controlled by Delta freshwater inflows and coastal water level. Understanding the variability in historical salinity as well as its relationships with upstream freshwater inflows and downstream salty water level is critical in guiding predictive model development as well as Delta operations.
Approach: This study examines nine-decades (1922-2012) of historical salinity data (i.e., X2 position) which was recently put together and quality controlled. The coefficient of variation (CV) of the salinity is determined for the entire study period, pre-water project period (1922-1967), post-water project period, and 30-year moving windows. The partial correlations (PC) between salinity and Delta inflows and coastal water level observations are investigated next in the same periods. Finally, the trends of the CV and PC time series (in the moving windows) are analyzed to illustrate how the variability and correlations evolve with time.
Results: Results indicate that salinity in winter/ spring has an upward trend in variability (more variable), while summer salinity tends to be less variable. On annual scale, however, an increasing trend is significant. Results further show that the salinity is negatively (positively) correlated with Delta inflows (coastal water level). The correlation with Delta inflow is stronger in magnitude. The correlation with coastal water level has an increasing tendency (being stronger), while it is the opposite for the correlation with Delta inflows.
Conclusions/Relevance: From a scientific perspective, the study provides critical information to build/enhance predictive models to improve salinity predictions based on forecast inflows and coastal water levels. From a practical standpoint, the study provides useful information for water resources managers and operators. They can capitalize on the relationship identified and its trend to guide their operations and planning practices.

Keywords: Bay-Delta, salinity, coastal water level, Delta inflow, variability, trend

Poster Topic: Water Quality - Salinity

Water Quality - Turbidity

Compound Specific Isotope Analysis of Particulate Organic Matter and Heterotrophs Surrounding McCormack-Williamson Tract

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Our results from bulk isotopic analyses of suspended particulate organic matter (POM) from the Cosumnes/Mokelumne watersheds were highly variable in C and N isotopic composition during a high rainfall year (W.Y. 2017). The isotopic compositions of POM were consistently correlated to both river discharge and water temperature, emphasizing the role of local water chemistry and river conditions in determining POM composition. This variability, however, obviates bulk analysis for precisely determining the sources of OM comprising POM, and the degree to which POM fuels secondary production. Therefore, we expanded upon this work by measuring compound specific isotope compositions of amino acids, including higher plants, POM, zooplankton, and fishes to determine the relative contribution of allochthonous and autochthonous organic matter to the food web.
A comparison of the d13C of amino acids confirms that POM at our stations was not comprised of unaltered higher plants. The absolute range of δ13C from higher plants (mean range= 34‰) was significantly greater than that measured in POM (mean range=23‰), which suggests algal or decomposed plant matter are more likely components of POM, similar to the findings of Kendall et al. (2001). Analyses of selected native and non-native, fishes collected during water year 2017 were also conducted to investigate possible differences in their resource utilization and trophic position. Amongst native and non-native fishes, amino acid δ15N had a high degree of similarity and were more similar to those of zooplankton, rather than higher plants. Glutamic acid-Phenylalanine N isotopic differences, which are used to calculate trophic levels, within fishes and zooplankton do not support the presence of an allochthonous source of nitrogen to consumers. Overlapping resource utilization suggests that both the native and non-native fishes may be competing for similar high quality food items.

Keywords: carbon, river, POM, nitrogen, fish, nutrient, biogeochemistry, delta, stable isotope

Poster Topic: Water Quality - Turbidity

High-Resolution Water-Quality Mapping in the Sacramento-San Joaquin Delta and San Francisco Estuary

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Water-quality measurements collected over fine temporal and spatial scales can help improve our understanding of biogeochemical processes in hydrologically complex environments. Real-time water-quality stations operated by the U.S. Geological Survey and other agencies are providing temporally rich data, and high-resolution water-quality mapping using a boat configured with flow-through monitoring tools can complement these data. Here we present results from three water-quality mapping events to convey how this method can spatially resolve different sources and sinks of nutrients and phytoplankton, such as agricultural drains, wastewater effluent, and wetlands. We will present high-resolution data collected during a Yolo Bypass flooding event in March 2017, a phytoplankton bloom near the Sacramento-San Joaquin River confluence in August 2017, and an event characterized by high suspended sediment concentrations following spring storms in March 2018. Mapping in the Yolo Bypass revealed strong east-west gradients in phytoplankton biomass and differentiation of inflow water masses that has also been observed by the California Department of Water Resources. The data collected during the 2017 bloom near the confluence showed the geographic extent of the bloom and that it was actively photosynthesizing, with no indication that the bloom was transported from outside of that region. The gradient of turbidity observed in March 2018 was used to calibrate and validate models for suspended sediment derived from Landsat-8 and Sentinel-2 satellite imagery. Real-time mapping of water-quality constituents has the potential to provide valuable information about key processes occurring in dynamic systems to better inform those making water-management decisions, improve calibrations of remote sensing data, and constrain production and cycling rates.

Keywords: water quality, high-resolution, mapping, Yolo Bypass, turbidity, phytoplankton, bloom

Poster Topic: Water Quality - Turbidity

Delta Turbidity Transects: Summary of Water Year 2017

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Turbidity is a key habitat condition associated with the occurrence of endangered Delta Smelt, particularly during upstream spawning migrations (Grimaldo et al. 2009, Sommer and Meija 2013, Bennett and Burau 2015), and for this reason turbidity (≥ 12 NTU) is an environmental trigger for actions regulating water project operations in the 2008 US Fish and Wildlife Service (USFWS) Biological Opinion. In recent years, due to difficulty in detecting Delta Smelt in traditional trawl surveys, turbidity distribution in the south Delta has been used to estimate the upstream limit of Delta Smelt distribution and to assess risk for scenarios of water project operations during Delta Smelt spawning migrations (USFWS 2016). To assist these assessments and to inform management decisions intended to minimize fish entrainment at the state and federal south Delta pumping facilities, the California Department of Water Resources (DWR) has conducted turbidity transects in the Old and Middle Rivers since WY 2015. This mid-channel turbidity monitoring provides an important supplement to the existing continuous water quality station network in the central and south Delta.
Since WY 2015, turbidity transects have run from late December, following the first winter system flush, through early March, in keeping with the rainy season and Delta Smelt migration period. Transects are typically conducted twice a week based on altering turbidity conditions and recommendations from the Smelt Working Group. The Smelt Working Group is a team of federal and state agency biologists organized by the USFWS and tasked with advising management on Delta Smelt biology and entrainment risk. The Smelt Working Group's general advice to management is to manage pumping in order to minimize turbidity intrusion into Old River, using turbidity transects to gage this effort.

Keywords: Transect,Turbidity, South Delta, Delta Smelt

Poster Topic: Water Quality - Turbidity

Waterfowl

Diving Duck Body Condition in the San Francisco Bay Estuary

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Diving ducks account for up to 75% of waterfowl observed during midwinter in San Francisco Bay (SFB) and adjacent salt ponds. ;Population estimates of several North American diving ducks species have been highly variable, with some species showing long-term continental declines (greater scaup – Aythya marila, and lesser scaup – A. affinis). In SFB, species such as canvasback (A. valisineria) declined from peak numbers of 60,000 in the 1960s to less than 20,000 in the 2000s. ;In contrast, continental ruddy duck (Oxyura jamaicensis) populations are thought to be stable or increasing; however, adequate data for population estimates are largely lacking for this species. Poor winter and spring habitat quality has been hypothesized as one explanation for declines in diving ducks species, suggesting that changes in the quantity and quality of habitats have resulted in poorer body condition and reduced reproductive success and survival. ;During the winter of 2017 – 2018, we collected 141 diving ducks (canvasback, greater and lesser scaup, and ruddy duck) in the SFB estuary to assess the proximate body condition (moisture, lipid, and protein content) from fall arrival in November 2017 until spring departure in April 2018. ;We developed indices of body condition using proximate analyses as well as morphological measurements from collected individuals, live birds measured for our capture and banding program, and hunter harvests. ;As body condition can be among the most important determinants of breeding propensity in diving duck species and availability of food is hypothesized as a main limiting factor for waterfowl during winter, understanding when these shortcomings occur, and under what conditions is critical.

Keywords: Diving Ducks, Body Condition, Proximate Analysis

Poster Topic: Waterfowl

Duck, Duck, Goose! - The Suisun Marsh Waterfowl and Managed Wetland Research Program

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The Suisun Marsh has long been recognized for its importance to waterfowl throughout the Pacific Flyway. 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 (up to 83%) in Suisun, and the total number of dabbling ducks are down as much as 60%. Within the Suisun Marsh and Delta, white geese (Anser caerulescens, Anser rossii) and Greater White-fronted Geese (Anser albifrons) (collectively, arctic nesting geese) have declined by more than 50%. While arctic nesting geese have declined in their use of the Delta, their numbers have increased dramatically in the Central Valley initiating concern for increased competition with wintering dabbling duck populations. Ongoing telemetry of multiple species of dabbling ducks indicates a clear reliance on Central Valley habitats by Suisun-marked waterfowl during a significant portion of the year. Given warming arctic conditions and rising goose populations it will be critically important to understand waterfowl habitat use, foraging ecology, and the role Suisun Marsh resources play in the annual life cycle of Pacific Flyway waterfowl. In addition, a multi-partner effort will be needed to understand the mechanisms and impacts related to goose populations and the habitats on which they rely. Since 2014, we have deployed solar powered cell-tower GPS transmitters on 13 species of waterfowl, including a pilot study in 2017-18 with 40 transmitters on 3 species of arctic nesting geese. Even with robust data on arctic nesting goose population trajectories, timing of colony specific migrations, habitat use, and foraging ecology, developing management actions to mitigate the impacts to wintering dabbling ducks from increasing arctic nesting goose populations may require cooperation across Flyways and Continental partnerships which have been unprecedented prior to this effort.

Keywords: Suisun Marsh Waterfowl Climate Change

Poster Topic: Waterfowl

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

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The South Bay Salt Pond Restoration Project is the largest tidal marsh restoration effort on the North American Pacific coast. The Project's goal to restore 50-90% of former salt ponds to tidal marsh, balances the habitat requirements of threatened marsh species with those of waterbirds that forage and roost on mudflats and managed ponds. To inform future management actions designed to sustain waterbirds, we evaluated waterbird and macroinvertebrate responses to experimentally manipulated water depth and salinity in managed ponds at Eden Landing Ecological Reserve in South San Francisco Bay. We observed 39 species of waterbirds from 11 guilds. The abundance of guilds differed among salinity treatments; small shorebirds were most abundant at high salinities (80 – 120 ppt), medium shorebirds were most abundant at moderate salinities (40 – 80 ppt), and dabbling ducks were most abundant at low salinities (40 ppt). Overall, small shorebirds were the most abundant guild, and were strongly influenced by the water depth and exposure of created sediment foraging mounds in the ponds. We did not detect a relationship between foraging small shorebird abundance and macroinvertebrate biomass on sediment mounds, perhaps because biomass in the newly configured ponds was eight times less than on adjacent mudflats. The diets of foraging shorebirds differed from macroinvertebrate availability in all three salinity treatments (percent similarity indices 60%). Total macroinvertebrate biomass was weakly affected by water depth, with the greatest biomass observed at a depth of 12 cm. This depth is inaccessible to most small and medium shorebirds, suggesting that predation may play a role in limiting macroinvertebrate biomass at shallower depths. Our results support the idea that managing ponds at different salinities and at water depths that maximize the accessibility of mounds could maintain high abundances of foraging and roosting birds from a broad suite of guilds.

Keywords: Waterbird foraging ecology, Managed ponds, macroinvertebrates

Poster Topic: Waterfowl

Seasonal Distribution and Densities of Dabbling and Diving Ducks in the Napa-Sonoma Marshes Wildlife Area

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Due to the heavy loss of wetlands in the San Francisco Bay-Delta Estuary, former coastal salt pond complexes now provide essential habitat for wintering and migrating waterbirds. In particular, the Napa-Sonoma Marshes Wildlife Area (NSMWA), comprised of a network of managed and restoring former salt ponds, supports a high diversity and abundance of dabbling and diving ducks. To understand how dabbling and diving ducks are using NSMWA during the nonbreeding months, we used our comprehensive 19 year (1999- 2018) dataset, comprised of monthly high tide waterbird and water quality surveys in each restoring and managed pond. ;Using ArcMap 10.4, we mapped mean seasonal distribution and densities for abundant diver species (greater and lesser scaup, Aythya marila and A. affinis; canvasback, A. valisineria; and ruddy duck, Oxyura jamaicensis) and dabbling (northern shoveler, Anas clypeata; northern pintail, Anas acuta; American wigeon, Anas americana; and mallard Anas platyrhynchos) duck species. ;We compared distribution among species and between guilds based on year, pond type (managed vs tidal), annual precipitation, and water quality. ;This mapping exercise elucidates how waterfowl use and distribution has changed across years at NSMWA, and helps identify seasonal and environmental factors that drive habitat use by each species.

Keywords: distribution, mapping, Napa-Sonoma Marshes Wildlife Area, wetlands, waterfowl

Poster Topic: Waterfowl

Canvasback Movement Patterns and Space Use in Suisun and San Pablo Bays: 2016-2018

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Suisun Bay and Marsh are integral components of the San Francisco Bay Delta ecosystem and have a long history of waterfowl use. Diving ducks, including canvasback (Aythya valisineria) are numerous in Suisun throughout winter. Previous work has demonstrated exchange of diving ducks between Suisun and other SFB sub-bays; however, what drives movement among these sub-bays is unclear. In addition, little is known about habitat use or food availability for Suisun diving ducks. Our study evaluated diving duck use of Suisun with the ultimate goal of identifying management regimes that may benefit these species. As part of this comprehensive study, we evaluated canvasback movements and space use during winter 2016, 2017, and 2018. We captured 55 canvasback in Suisun Bay and Napa-Sonoma Marsh and fitted them with GPS-GSM tracking devices that provided high resolution location estimates. We used continuous-time stochastic Brownian bridge movement models (package BBMM in R 3.0) to evaluate canvasback movements across winter and spring migration. We calculated fixed kernel densities at the collective and individual level to evaluate space use. Initial results show differential movement and use patterns between the three study years. In 2016, individuals used a full spectrum of Suisun habitats including shallow shoals, tidal marshes, managed marshes, and static deep-water ponds, and transitioned inland towards freshwater habitats during spring months. In 2017, canvasback use of Suisun habitats was limited and individuals moved inland to the Central Valley in early winter, potentially as a result of historic fresh water availability. In 2018, canvasback use of Suisun was also limited, with most birds using Napa-Sonoma marshes or moving inland. Given cyclical drought conditions, planned tidal wetland restoration and diminishing freshwater flows to this region, information on diving duck ecology in Suisun can improve our understanding of how projected habitat changes may influence these species in the future.

Keywords: waterfowl, telemetry, suisun bay, san pablo bay

Poster Topic: Waterfowl