Seasonal, High Resolution Nutrient Dynamics in the Northern San Francisco Estuary under Varying Water Year Types

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Despite long-term monitoring efforts, nutrient dynamics, including loading and internal cycling, are not well constrained for the northern San Francisco estuary (SFE). In a system primarily influenced by anthropogenic point sources (i.e. municipal wastewater), it is suggested that improved management with respect to nutrients might achieve the goal of increasing pelagic fish populations through production of lower trophic levels. We hope to further elucidate the nutrient dynamics of the northern SFE through high-resolution spatial and temporal sampling in both spring and fall, with a focus on the amount, type and ratio of target nutrients. We conducted weekly cruises during fall of 2013 and spring of 2013 and 2014, occupying 15 stations between Isleton in the Sacramento River and the Benicia Bridge in Suisun Bay, including Grizzly and Honker (2014 only) Bays. Cruises spanned two drought years with the latter year more extreme. Nitrate (NO3) concentrations increased by 58% from spring 2013 to spring 2014 at the confluence of the San Joaquin and Sacramento rivers, by 55% in Grizzly Bay and by 46% in western Suisun Bay. Grizzly Bay also consistently had the highest measured NO3 concentrations throughout the spring 2014 sampling period (48-56µM). Ammonium concentrations also increased at Rio Vista Bridge (Sacramento River) by 19%. We hypothesize that the nutrient increases are a result of effluent discharge into an unusually low-flow river (i.e. reduced dilution), rather than increases from nonpoint sources via the watershed. The lack of rain during our study reduced the impact of nonpoint nutrient sources while also failing to dilute effluent nutrients to concentrations observed during pre-drought conditions.

Keywords: Nutrients, Phytoplankton, Nitrate, Ammonium, Wastewater, Suisun Bay, Sacramento River

Poster topic: Water and Sediment Quality

Evaluation of South Delta Salinity Sources and Alternatives for Improving EC Compliance

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Salinity (EC) monitoring since 2009 in Sugar Cut and Paradise Cut has documented many periods when the EC was greater than the EC objectives. Tidal elevation and flow measurements in the south Delta were used to calculate daily net channel flows and the daily salt loads added to Old River at Tracy Boulevard. The 15-minute tidal elevation, tidal flow and EC measurements in the South Delta were summarized in graphical "Data Atlas" documents for 2009-2013. The net flow in Old River at Tracy Boulevard is about 10% of the head of Old River flow, because most of the flow is diverted to Grant Line Canal through Doughty Cut. Because the mouth of Paradise Cut and Sugar Cut are downstream of Doughty Cut, the tidal exchange of salt could be increasing the EC in Old River at Tracy Boulevard (EC compliance station). Temporary barriers do not generally change the net flows, but they increase the minimum elevations, reduce the maximum elevations, reduce the tidal flows substantially (50%) and thereby reduce tidal exchange and flushing upstream of the barriers. Several alternatives for reducing the effects on the Old River at Tracy Boulevard EC increments were evaluated. Flushing of Paradise Cut and Sugar Cut with SJR water would not reduce the EC effects; pumping from Paradise Cut and Sugar Cut to the SJR or to Grant Line Canal would reduce the EC effects substantially. Increasing the net flow at Tracy Boulevard (with dredging or installing only the Grant Line Canal barrier) could reduce the EC effects. Relocating the mouth of Paradise Cut and Sugar Cut to Old River upstream of Doughty Cut would reduce the EC increments. Installing a tidal-gate in Old River (open during flood-tides) would provide a net upstream flow to transport all of the salt to Grant Line Canal.

Keywords: South Delta, Tidal Flows, Salinity Objectives, Salt Sources

Poster topic: Water and Sediment Quality

Multi-Purpose Planning Efforts for Phase II of the San Francisco Bay to Stockton Navigation Improvement Study

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The Port of Stockton, its partners Contra Costa County and the Western States Petroleum Association, and the U.S. Army Corps of Engineers (USACE) are leading the effort to develop an integrated, multi-purpose navigation and ecosystem restoration phase (known as Phase II) of the San Francisco Bay to Stockton Navigation Improvement Study. The Phase II project was initially envisioned to have a single purpose of navigation; however, by using dredged sediment to restore emergent marsh in subsided Delta islands, it would also achieve the regionally significant purpose of ecosystem restoration.

To understand potential changes to Delta salinity levels resulting from the project, a three-dimensional hydrodynamic and salinity model was used to simulate salt intrusion under future with- and without-project conditions. The initial modeling effort confirmed that restoration of Big Break would most effectively reduce the salinity impacts associated with channel deepening**.** The second modeling scenarios combined the multi-purpose project (marsh restoration and deepening to -40 and -38 feet mean lower low water in the channel's western and eastern reaches, respectively) with construction of an underwater sill at Dillon Point in Carquinez Strait as a salinity mitigation measure. These scenarios indicated that the sill would effectively offset all of the X2 impacts associated with the multi-purpose project during the period of the year that X2 is greater than 65, and that it would reduce the average predicted chloride concentrations between July 1 and February 1 at all five of the south Delta exports as compared to baseline conditions.

The results of this evaluation indicate that a multi-purpose Phase II project would accomplish project objectives, be economically justified, result in minimal residual salinity impacts, and create vital emergent marsh habitat. Accordingly, the Port, its partners, and USACE are continuing to move forward with multi-purpose planning efforts for the Phase II project.

Keywords: multi-purpose navigation, ecosystem restoration, salinity, X2

Poster topic: Water and Sediment Quality

Can San Francisco Bay "Filter" Nitrogen Between the Land and the Sea? The Microbiology and Biogeochemistry of Nitrification in Estuary Waters

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Ammonia oxidation, the first step of nitrification, is the critical link between nitrogen inputs and losses in coastal ecosystems. Since the discovery of ammonia-oxidizing archaea (AOA), research on the microbial ecology of this process has been prolific. AOA, rather than ammonia-oxidizing bacteria (AOB), appear to drive ammonia oxidation in many systems. Some estuaries, however, harbor thriving AOB communities, while AOA outnumber AOB in others. Although understanding their roles in estuarine N cycling is crucial for understanding the effects of coastal nutrient pollution, few studies have investigated these microbes in estuary waters. We determined the role of pelagic nitrification in oxidizing ammonium throughout San Francisco Bay, and characterized the microbial communities responsible for this process, using a combination of stable isotope tracer incubations and functional gene analyses, respectively. Data from one year of monthly measurements at 5 stations along the salinity gradient suggested nitrification was an active but variable process, with rates spanning over two orders of magnitude. Generally, Sacramento River waters and turbid bottom waters in Suisun Bay had the highest rates. Nitrification was generally greater in bottom waters, and was always faster when dark incubation bottles were used. AOA outnumbered AOB in the water column at most stations, and were present in high abundance at both the marine and freshwater ends of the estuary, suggesting multiple sources of microbes to the bay. Our data suggest a fraction of ammonium introduced into the bay is oxidized in the water column, likely by AOA. Interestingly, nitrification in bottom waters of the deeper channels may oxidize a substantial fraction of ammonium released by sediments. This work helps to assess the ability of ammonia-oxidizing microbes in anthropogenically impacted estuaries to transform nitrogen prior to discharge into the ocean, and furthers our understanding of the roles of these microbes in estuary waters in general.

Keywords: nitrogen, archaea, bacteria, nitrification, ammonium, biogeochemistry, microbiology, isotopes, nutrients

Poster topic: Water and Sediment Quality

Relationships between Water Quality Constituents in the Delta and the Influence of Different Sources of Water

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Bay-Delta salinity is generally measured in the field as specific conductance, loosely referred to as electrical conductivity (EC). However, drinking water and other beneficial uses are often best measured in terms of other constituents such as chloride, bromide, sodium, and total dissolved solids. Computer simulations of Delta water quality typically report Delta salinity predictions as EC or practical salinity units, which then requires conversion to the water quality constituent of concern. Water quality grab samples have been used to develop conversion relationships between the key indicators of salinity. These conversion relationships vary spatially throughout the Delta depending on the site-specific contributions from seawater intrusion, San Joaquin inflow or other sources of water. The site-specific contributions to EC from these different water sources vary by water year type and season, but can be quantified as a function of salinity in the western Delta which is strongly dependent on Delta outflow.

A general conversion approach has been developed that first calculates the contribution to EC from seawater using measured or simulated EC at Jersey Point. The seawater EC is then converted to other constituents using conversion relationships developed from Chipps Island grab sample data. EC originating from non-seawater sources is converted using a conversion relationship representative of agricultural drainage water quality. This new approach allows accurate estimation of salinity constituent concentrations from both continuous field EC measurements and computer simulations of EC. The grab sample analysis also gives insights into the influences of seawater intrusion and agricultural drainage within the Delta and how these influences have changed historically and might change in the future. These findings will help scientists and engineers better understand how flows and water quality influence beneficial uses of Delta water.

Keywords: Bay-Delta, salinity, seawater intrusion, agricultural drainage, water quality, chloride, bromide

Poster topic: Water and Sediment Quality

Toward the Remote Sensing of Water Quality and Contaminants in the California Delta

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The California Delta is a highly altered ecosystem largely reclaimed from wetlands for agriculture, and millions of acres of farmland and Californians rely on the Delta for their water supply. The Delta also harbors important habitats for many organisms, including commercial and endangered species. Recently, the Delta Stewardship Council developed a two component mission (coequal goals) to 1) provide a more reliable water supply for California while 2) protecting, restoring, and enhancing the Delta ecosystem. Dissolved organic carbon, turbidity, and contaminants such as methylmercury represent important water quality issues in the context of wetland restoration in the Delta and can threaten the achievement of the coequal goals. Here, we use field measurements of optical properties, chemical analyses, and remotely sensed data acquired with the airborne Portable Remote Imaging SpectroMeter (PRISM ; http://prism.jpl.nasa.gov/index.html) to demonstrate these water quality parameters and the study of their dynamics in the Delta are amenable to remote sensing. PRISM provides high signal-to-noise, high spatial resolution (~2 m), hyperspectral measurements of remote-sensing reflectance in the 350-1050 nm range, and therefore has the adequate resolutions for water quality monitoring in inland, optically complex waters. Remote sensing of water quality will represent a valuable complement to existing in situ water quality monitoring programs in this region and will help with decision-making to achieve the co-equal goals.

Keywords: Remote sensing, water quality, contaminants, dissolved organic carbon, methylmercury, turbidity

Poster topic: Water and Sediment Quality

Mapping Bathymetric Change as Alviso Salt Pond Restoration Projects Progress

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The potential for localized and regional erosion of sloughs, intertidal mudflats, and channels is a major concern associated with salt pond restoration activities in South San Francisco Bay. In 2010 the USGS collected bathymetry of the far South Bay in the vicinity of the Alviso pond complex to establish baseline bathymetry prior to the breaching of Pond A6 levees and opening of gates at Pond A8 (Foxgrover *et al.,* 2014). Interferometric sidescan swath mapping was used to generate high resolution (1 m cell size) bathymetric grids of the far South Bay extending east of Calaveras Point to where Coyote Creek meets the railroad bridge, and down Alviso Slough to just past the A8 gates. Between October 2011 and November 2013 we have conducted six additional surveys to monitor bathymetric changes in this region as restoration progresses. Thus far, the greatest erosion has occurred within Alviso and Guadalupe Sloughs bay-ward of the southern A6 breaches and significant erosion of the nearby intertidal mudflats has not occurred. These data are critical to the adaptive management of phased restoration plans and have played a key role in determining the configuration and seasonal operation of flood control gates at Pond A8. Our measurements of bathymetric change within Alviso Slough, in combination with analyses of sediment cores by Marvin-DiPasquale and Cox (2007) have enabled a quantification of legacy mercury released by restoration-associated scour (see poster by Fregoso *et al.*), and provide insight into morphological evolution of slough/intertidal mudflat/bay systems as levees are breached and the tidal prism increased.

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

http://pubs.usgs.gov/of/2011/1315/

Keywords: bathymetry, salt pond restoration, South San Francisco Bay

Poster topic: Water and Sediment Quality

Using Bathymetric Surveys to Estimate Mercury Mobilization from Scour within Alviso Slough

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A major concern for restoration of the salt ponds bordering Alviso Slough is mercury (Hg) mobilization from the scouring of buried sediments, a legacy contaminant of the New Almaden Quicksilver mines that were active from 1847 to 1976. The breaching of the Pond A6 levees on December 2010 and the opening and closing of adjustable flood control structures at Pond A8 (June – December 2011, 2012, and 2013), have increased flow velocities in Alviso Slough resulting in sediment scour. The combination of bathymetric change measurements and Hg concentration data allows us to estimate the volume of Hg remobilized. We calculate the spatial distribution and volume of eroded sediment by differencing interferometric swath bathymetric surveys taken from 2011 to 2013 with one taken in 2010 before the levees were breached and A8 gates opened. This data is coupled with total Hg concentrations measured from 200-cm long sediment cores to track the progression of Hg remobilization since initiation of restoration. This study uses three different methods to estimate the total Hg mobilized by sediment scour. Method A divides the length of the slough into four zones, assigns depth-averaged Hg value to each zone and multiplies this by the observed volume of erosion in each zone. Method B uses zone averaged Hg values for each 20 cm sediment depth interval down core and multiplies this concentration by the corresponding observed volume of erosion for each depth interval. Method C uses interpolated values of Hg for each 20 cm depth interval and multiplies each interval by its corresponding observed volume of erosion. Interestingly, there is close agreement between the three methods. The question remains on whether scour, and the accompanying mercury remobilization, will continue at the same rate or slow through time.

Keywords: Mercury, Hg, Alviso Slough, interpolation

Poster topic: Water and Sediment Quality

Changes in Total and Methyl Mercury Concentrations in Water, Sediment, and Biota Resulting from Connectivity of a Post Restoration Tidal Marsh to a Tidal Slough

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From mid-1800's to early 1900's, over 90% of Suisun Bay tidal marsh were reclaimed for agriculture and subsequently have been managed as seasonal wetlands for waterfowl hunting. Currently, planning efforts to restore 65,000 acres of Delta and Suisun tidal habitat are in final stages of development. The 70-acre Blacklock tidal marsh restoration site, located in northeast Suisun Marsh, was restored by the California Department of Water Resources. This study is the first effort at estimating the impact on mercury cycling of converting a diked, managed wetland with seasonal water exchange to tidal marsh with unrestricted daily tidal inundations. The goals of this study were to estimate changes in total mercury and methyl mercury concentrations in fish, sediment and water before and after restoration. Field sampling took place January, 2005 to September, 2009. Unfiltered aqueous methylmercury post breach (0.101 to 0.768 ng L^{-1}) were significantly lower ($t_{(2),\,8} = 6.19$; $p < 0.05$) than pre-breach (1.03 to 1.67 ng L^{-1}). Unfiltered aqueous total mercury were similar pre and post-breach (5.18 to 13.5 ng L^{-1}). Methylmercury sediment were higher and more variability between sample locations within the restoration site during year one post-breach (2.42 to 3.69 ng g^{-1} dry) relative to years 2 and 3 post-breach (1.48 to 1.85 ng g^{-1} d/w). Mercury in Inland Silverside (*Menidia beryllina*) post-breach decreased significantly from 0.163 ± 0.039 ug g^{-1} w/w to 0.038 ± 0.023 ug g^{-1} w/w. Greater connectivity of tidal wetlands with surrounding tidal sloughs resulted in decreased methylmercury concentrations in water, sediment, and fish. Wetland biogeochemistry in a daily inundated tidal regime did not support mercury methylation at levels observed for the site when it had a seasonal wetland inundation regime. It is hoped that scientific knowledge gained as a result of this restoration will aid future restoration efforts in the Bay-Delta.

Keywords: Mercury cycling, Wetlands, Mercury, Methylmercury, Wetland Restoration

Poster topic: Water and Sediment Quality

Using Mesocosms to Test the Effect of Land Management Practices on Monomethylmercury Production in Freshwater Seasonal Wetlands

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Managed freshwater seasonal wetlands are well suited for the production of monomethylmercury (MMHg). Wetting and drying cycles created by water management promote growth of wetland vegetation for waterfowl food during the summer growing season. After fall floodup of the fields this vegetation decomposes creating anoxic conditions and an abundant carbon source utilized by MMHg producing microbes. This results in hot moments of MMHg production after floodup and increased MMHg loads from seasonal wetlands. In this work, we determine the effect land management practices have on MMHg production. A manipulative study was conducted during the fall (October-November) of 2012 in a 20 hectacre seasonally flooded wetland located in Yolo Wildlife Area, CA. Polycarbonate cylindrical mesocosms (0.75 m diameter, 0.6 m tall), were placed over 6 differing land management treatment types: disc, simulated cattle grazed, mowed with vegetation removed, mowed with vegetation left in place, scraped with all vegetation removed, and natural undisturbed. Each treatment had n = 5 replicates. Samples were collected for determination of mercury speciation and ancillary measurements. Sampling occurred bi-weekly or weekly over a period of thirty days. Dissolved MMHg concentrations peaked in all treatments by day 16 of the experiment. Comparison of treatments was done on a mass dissolved MMHg basis. Natural and mowed treatments were similar (2.2 and 2.1 µg MMHg respectively). Simulated grazing treatments (1.4 µg MMHg) resulted in 36% reduction in MMHg relative to the natural treatment. Cleared (0.36 µg MMHg), disced (0.51 µg MMHg), and mowed with vegetation removed (0.88 µg MMHg) produced significantly less MMHg than the natural undisturbed treatment. Our results indicate specific management practices of seasonally flooded freshwater wetlands can reduce the net production of MMHg and potentially reduce loads to surrounding water.

Keywords: mercury, wetlands, methylmercury, wetland management

Poster topic: Water and Sediment Quality

The Delta Regional Monitoring Program: Connecting Water Quality Management and Science in the Delta

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The severity and complexity of the Delta's ecosystem management challenges have highlighted the importance of comprehensive information on its condition. The Delta Regional Monitoring Program (RMP) is intended to help address this need by better defining water quality issues of regional concern. The successful implementation of the Delta RMP is based on several key factors. The current Delta RMP has focused on a bottom-up structure, working with regulated stakeholders to improve the coordination among Water Board-mandated monitoring efforts and to identify efficiencies in existing monitoring requirements to support regional collaborative monitoring. A second key aspect was collaboratively defining water quality management questions that would be supported by all program participants. Starting small and focused, and building the program in several consecutive phases is another key factor to successful implementation. Therefore, initial priorities of the program were narrowed to improve the understanding of the spatial and temporal distribution of prioritized water quality constituents (i.e. mercury, nutrients, pathogens, and pesticides). The Delta RMP program structure has evolved from an ad-hoc participatory process to a more formal representative committee process that underscores the program's potential to serve as an effective forum for collaboratively defining and solving water quality issues in the Delta. Monitoring is expected to begin in 2015. We describe 1) the program structure as the result of a collaborative effort of regulators, the regulated community, and other agencies and organizations based on shared management questions; and 2) the monitoring implementation plan, including how the proposed monitoring approaches and sites were selected, plans for sharing information, and possible avenues for future coordination with additional partners.

Keywords: Beneficial uses, Status and trends, Regional water quality, conditions, Toxicity

Poster topic: Water and Sediment Quality

Ibuprofen Exposure Reduced Reproductive Output in Adult Inland Silversides

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Ibuprofen is a nonsteroidal anti-inflammatory drug (NSAID) that is has been detected in surface waters at concentrations up to 2.5 mg/L. Ibuprofen has a relatively short half-life and therefore is not persistent in the environment; however its continual introduction into the aquatic environment via municipal wastewater effluent can lead to some fishes experiencing chronic exposures in areas affected by wastewater. Ibuprofen has previously been shown to affect fecundity in both vertebrate and invertebrate species, and is therefore a contaminant of concern that is ubiquitous within the Sacramento-San Joaquin Delta. In this study, we used inland silversides (*Menidia beryllina*; 66 days old), a fish species that is a useful indicator of contaminant exposure in estuaries throughout North America, and for which we have a recently-sequenced transcriptome. We determined physiological effects of sublethal, chronic exposure to ibuprofen on gene expression and reproductive output. Acute 96-hr exposures were used to identify the effects of ibuprofen on survival, which was 98-100% after 96 hr for concentrations as high as 18.8 mg/L and subsequently decreased at higher concentrations. Juvenile fish were then exposed to one of three ibuprofen exposure treatments (0.025, 0.25 and 2.5 mg/L), along with an experimental control group, for 14 days. Genomic assessments used to determine the effects of ibuprofen, identified impacts on reproductive pathways, the immune system, and osmoregulation. Additionally, expression of hormone receptors was non-monotonic, with greater effects at the lowest exposure concentration. Our results show that at relatively low concentrations, chronic exposure to ibuprofen induces detrimental cellular responses in *M. beryllina*. We detected these cellular responses at concentrations that resulted in reduced reproductive output in adult *M. beryllina*, which suggests a potential link to whole organismal impacts from exposure to ibuprofen.

Keywords: Inland Silverside, Ibuprofen, Water Quality, Sewage

Poster topic: Water and Sediment Quality

Potential for In Situ Coagulation in Conjunction with Constructed Wetlands to Reduce Total and Methyl Mercury Concentrations, Loads and Bioavailability

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With the recent passage of the Delta methylmercury (MeHg) surface water TMDL, there is a need to develop management practices that will reduce the export of MeHg from both point and non-point sources. Coagulation with metal based salts is a practice commonly employed by drinking water utilities to remove particles and dissolved organic matter (DOM) from solution. Because dissolved Hg is associated with particles and DOM, it follows that Hg should also be removed during the coagulation process and end up associated with the organo-metal precipitate, termed floc. The effectiveness of iron- and aluminum-based coagulants for removing both inorganic and methyl mercury (IHg and MeHg, respectively) from solution was demonstrated in laboratory studies conducted on agricultural drainage waters of the Sacramento-San Joaquin Delta: dissolved concentrations of MeHg decreased by 80% while IHg decreased by 97% following coagulation. To test the field application of this technology, nine wetland treatment cells were constructed in the central Delta. This replicated field experiment includes three inflow waters treatments: (1) iron sulfate addition, (2) polyaluminum chloride addition, and (3) untreated controls. Water entering and exiting these treatment cells was sampled monthly over a 1-year period for total Hg and MeHg in both the dissolved and particulate aqueous phases. Initial results confirmed that coagulant addition is removing Hg (total and methyl, particulate and dissolved) from solution and sequestering it in the floc. Seasonal effects on DOM concentration and other factors appear to effect whether passage through the wetland cells alters surface water Hg concentrations. Related studies will examine whether the presence of the floc affects the production and fate of MeHg within the wetland cells. If proven effective, coagulation–either alone or in association with constructed wetlands–may be a feasible technique to reduce surface water Hg and MeHg concentrations and bioavailability.

Keywords: mercury, dissolved organic carbon, coagulation, constructed wetlands, TMDL

Poster topic: Water and Sediment Quality

Sacramento-San Joaquin Delta Improved Continuous Monitoring Network for Water and Habitat Quality

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Monitoring and observing factors such as nutrient availability, mixing and other biogeochemical parameters contributing to the overall habitat conditions in the Delta are essential for understanding the conditions under which pelagic organism recovery might become favorable. Water quality and nutrient supply dynamics are influenced by many very complex physical and biogeochemical factors. Thus, nutrient cycling (e.g., nitrogen and phosphorous) interactions are generally influenced by other factors such as suspended sediment and plankton dynamics. Our monitoring system allows the simultaneous measurement and assessment of these types of habitat factors and processes with physically descriptive properties such as flow, atmospheric pressure, wind speed, slope, and position in the Delta.

Currently, five continuous water-quality monitoring sites are located in the northern Delta on the lower Sacramento River. These sites are co-located with existing flow monitoring stations. The water-quality monitoring sites provide a flow network that monitors pH, temperature, dissolved oxygen, conductivity, nitrate, dissolved organic material, chloropyhll-a, phycocyanin and turbidity. 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: http://waterdata.usgs.gov/ca/nwis/uv/.

Stations are maintained and serviced at regular intervals at which time sensors are cleaned and checked against calibration standards. Data from the sensor network are verified against discrete samples taken both monthly and intensively over periodic ebb to flood tidal cycles.

These data are useful for understanding nutrient supply dynamics and provide valuable information on algal productivity food web dynamics and other aspects of pelagic habitat quality.

Statement of Relevance to water and environmental policy and management: The sensor network continuously monitors nutrients (nitrate, phosphate), algal pigments, dissolved oxygen, turbidity and DOM continuously, allow for developing, testing and refining hypotheses related Bay-Delta management.

Keywords: Continuous monitoring, habitat network integration, water quality

Poster topic: Water and Sediment Quality

In Stream Nitrate Dynamics in the Presence and Absence of Effluent in the Sacramento River, CA

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Research suggests that both the amount and form of dissolved inorganic nitrogen (nitrate versus ammonium) in water affects the abundance, health, and species of phytoplankton in the Bay-Delta, which subsequently impacts food stocks for pelagic organisms. Effluent releases from the Sacramento Regional Wastewater Treatment Plant (SRWWTP) contribute high concentrations of ammonium to the Sacramento River just downstream of Freeport Bridge. Understanding the rate at which this ammonium is converted to nitrate (nitrification) may help us unravel controls on phytoplankton health. Data for this study were collected from in-situ monitoring stations at Freeport Bridge, located 0.2 km upstream of SRWWTP's effluent outflow, and at Walnut Grove, located just upstream of the Delta Cross Channel. Both stations report river velocity and nitrate every 15 minutes, along with standard water-quality measurements. Effluent flow data were provided by SRWWTP. These data allow us to model net nitrification rates in the Sacramento River along this 29-km stretch between the two stations. Based on the period of record to date (September 2013 to June 2014), we calculated water travel times between monitoring stations and net changes in nitrate concentration. We assumed that effluent contained negligible amounts of nitrate and that there were no other nitrate inputs along this river reach. Additionally, four wastewater holds by SRWWTP occurred during the study, allowing for evaluation of changes in nitrate concentration in the absence of wastewater. Preliminary results demonstrate that due to biogeochemical transformations that occur during travel, wastewater is an important source of nitrate to the Delta.

Keywords: nutrients, ammonium, nitrogen, nitrate, ammonia, effluent, wastewater

Poster topic: Water and Sediment Quality

Water Quality Monitoring in the Cache Slough Complex

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The Sacramento – San Joaquin Delta is a major water conveyance hub for both the State Water Project and Central Valley Project. Biological Opinions for both projects have called for the restoration of 8,000 acres of tidal wetlands to protect Delta Smelt. Furthermore, mitigation efforts as part of the Bay Delta Conservation Plan are proposing 60,000 acres of wetland restoration. Much of this restoration is likely to occur within the Cache Slough Complex because (i) Delta Smelt already exist within the Complex, (ii) the area is the best preserved part of the Delta, and (iii) ground elevations are favorable for tidal wetland restoration even with sea level rise. However, with these large land use changes being proposed, no pre-restoration baseline water quality data exists.

To help address this issue, the Department of Water Resources (DWR) in cooperation with the Solano County Water Agency began to look at what existing monitoring was being done in the Cache Slough Complex and what areas are most likely to be restored. DWR began an adaptive biweekly monitoring program for the Cache Slough Complex starting in September 2013. The main goal of the monitoring program is to document baseline water quality conditions, including drinking water constituents within the Cache Slough Complex.

While the study is still ongoing, preliminary results show that local and regional tributaries to Cache Slough are an important source of nutrients, organic carbon, and phytoplankton to the system. However, in dry years such as Water Year 2014, these nutrients are often short lived. Both the data and results of this study will help to document baseline conditions within the Cache Slough Complex, and provide an important source of data for water managers, scientists, and engineers.

Keywords: Water Quality, Cache Slough Complex, Wetland Restoration

Poster topic: Water and Sediment Quality

Nutrient Trends in the Sacramento and San Joaquin Basins: A Comparison to State and Regional Water-Quality Policies

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Non-point source (NPS) control strategies were initiated in California in the late 1980's under the authority of the Porter-Cologne Act and eventually for the development of total maximum daily load (TMDL) plans. Most of the NPS TMDLs developed for California's Central Valley region (CV) were related to pesticides. Efforts to reduce pesticide loads and concentrations began in earnest around 1990. The NPS control strategies either encouraged or mandated the use of best management practices (BMPs). Although TMDLs were largely developed for pesticides, the resultant BMPs would likely have affected the runoff of other potential pollutants (specifically, nutrients). This study evaluates the effectiveness of agricultural NPS control strategies implemented in California's CV between 1990 and 2013 by comparing surface-water nutrient concentration and load trends between two periods. In general, use of BMPs was encouraged during a "voluntary" period (1990 to 2004) and mandated during an "enforcement" period (2004 to 2013). Nutrient water-quality data were obtained from U.S. Geological Survey National Water Inventory System (NWIS) and the California Environmental Data Exchange Network (CEDEN). Nutrient concentrations, loads, and trends were estimated by using the recently developed Weighted Regressions on Time Discharge and Season (WRTDS) model. Sufficient total phosphorus (TP) and nitrate (NO3) data were available to compare the voluntary and enforcement periods for seven selected CV sites within the lower Sacramento and San Joaquin River basins. For six of the seven sites, flow-normalized mean annual concentrations of TP and NO3 decreased at a faster rate during the enforcement period than during the voluntary period. Concentration changes during similar years and ranges of flow conditions suggest that BMP's designed for pesticides, reduced nutrient loads. Results show that enforceable NPS policies, such as for pesticides, and accelerated BMP implementation, have also resulted in reduced loads of nutrients in Central valley rivers.

Keywords: nutrients, modeling, nitrogen, phosphorus, BMP's, trends

Poster topic: Water and Sediment Quality

Potential Benefits of C-N-S Isotopes of Dissolved Organic Matter (DOM) for Pelagic Organism Decline (POD) and Habitat Studies in the San Francisco Estuary (SFE)

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The current IEP conceptual model for POD recognizes that multiple environmental drivers and ecological processes contribute to habitat degradation and POD. Our recent SFE studies have investigated sources of nutrients and organic matter, linkages between nutrients and algae, and their effects on habitat quality. However, our OM characterization has focused almost exclusively on causes of spatial and temporal changes in POM (as a proxy for algae), not DOM, sources and quality. But from a broader foodweb perspective, the bioavailable POC and DOC pools are similar -- and the N concentrations of DON, NH4, and NO3 are roughly sub-equal – in the SFE. Hence, DOM may be an important but largely overlooked source of energy supplying estuary heterotrophic demand.

C-N-S isotope values of POM samples across the SFE suggest huge differences in sources and quality of the OM, with S and N isotopes especially useful for quantifying OM from Cache Slough. We hypothesize that analysis of DOM for C-N-S isotopes will prove similarly useful as a tracer of sources and processes. Hence, we propose to add C-N-S isotopes of DOM to our isotope toolbox for addressing various POD and habitat quality-oriented questions in the SFE. DOM isotopes have proved extremely useful for quantifying DOM from different Delta habitats in our previous drinking water quality projects where DOM was extracted with XAD resins. We have recently developed a new and easier PPL resin method for extracting and analyzing DOM samples for C-N-S isotopes to facilitate routine collection and analysis of DOM isotopes as part of aquatic monitoring programs. In anticipation of this method development, we have archived water from most SFE samples collected for isotopic analysis since 2005. This poster will briefly describe the new method and present examples of environmental puzzles where C-N-S analysis of archived DOM samples might prove illuminating.

Keywords: DOM, organics, isotopes, POD, foodweb, WWTP, PPL extraction

Poster topic: Water and Sediment Quality

Putah Creek Watershed Mercury Project

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This study was designed to determine the relative contribution of total mercury and methylmercury from upstream historical mining districts to the impairment of Lake Berryessa. The third and fourth historically largest mercury-producing mining districts in California are located within three tributary watersheds north and west of Lake Berryessa. Downstream of the lake, Putah Creek drains into the Yolo Bypass, tributary to the Sacramento-San Joaquin Delta. Lake Berryessa and the Delta are water bodies listed as impaired by mercury through Section 303(d) of the Clean Water Act. Water and sediment samples were collected October 2012 through May 2014, when precipitation was lower than the long-term average. Primary findings include: (a) Each tributary contributes total mercury (in water and sediment) and/or methylmercury (in water) to Lake Berryessa; (b) Tributary reaches with elevated mercury concentrations ("hot spots") are near or downstream of historic mercury mines; (c) Non-anthropogenic contributors, including geothermal springs and groundwater influx from shallow aquifers, may contribute a substantial percentage of mercury and methylmercury to surface water. Implications of relevant scientific findings for Bay-Delta management include: (a) The Putah Creek Watershed has elevated total mercury and methylmercury concentrations that originate upstream of Lake Berryessa; (b) Putah Creek, through its connectivity with the Yolo Bypass, is a contributing source of mercury and/or methylmercury loads to the Bay-Delta; (c) Identification of hot spots will assist in the prioritization of abandoned mine cleanups to reduce mercury impacts to the Delta; (d) Data collected on mercury and methylmercury in water and sediment contribute to the larger data pool for developing mercury TMDLs and Coast Range watershed characterizations; and (e) Better insight into mercury sources and transport in the Putah Creek Watershed will be helpful to Bay-Delta managers working to balance multiple habitat and water-quality concerns in the Yolo Bypass and Delta.

Keywords: Putah Creek Watershed, Lake Berryessa, mercury, methylmercury, Yolo Bypass, Delta

Poster topic: Water and Sediment Quality

Assessing Habitat Quality using New Optical Methods Developed for In-Situ, Real-Time Detection of Habitat Quality Indicators

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Aquatic habitat quality in the Sacramento Delta is a function of many biogeochemical and hydrologic processes involving nutrients, suspended sediment, temperature, pH, dissolved oxygen, light attenuation and physical attributes such as type of substrate, water depth and current velocity. Together, these habitat attributes can affect the aquatic food web. For example, algal dynamics affects: trophic structure, community structure, fish abundance, and other habitat features.

In conjunction with the California Department of Fish and Wildlife's (CDFW) fish collection programs in the Delta, we collected water samples and made in-situ measurements of turbidity, conductivity, pH, dissolved oxygen, temperature, Chlorophyll and FDOM at 73 stations including stations at Suisun Bay, Grizzly Bay, Montezuma Slough, Cache Slough, Sacramento River and the Deep Water Ship Channel. Sampling and measuring of in-situ parameters were done at the same time of day and same location as CDFW's fish sampling programs. Preliminary analysis of data has shown spatial and interannual variability, as well as a large tidal dependency of important water quality variables. We will present initial results from these studies that analyzed and compared water quality parameters over time and space in the Delta.

Keywords: Water quality, delta

Poster topic: Water and Sediment Quality

Understanding the Relationships Between TKN, SKN, NH3, and NO3 Discharged into San Francisco Bay

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In order to better understand nutrient loading into San Francisco Bay, the San Francisco Bay Region of the California Water Quality Control Board required dischargers under NPDES permits to collect effluent samples for nutrient (N and P) analyses. During the two year study, some discrepancies were observed between Total and Soluble Kjeldahl Nitrogen (TKN, SKN) analyses, with SKN>TKN. To provide our clients with the best expected data possible, contradictory results were re-analyzed. In most cases, the re-analysis did not support the original analysis, with TKN results increasing and SKN results decreasing in concentration from the original analysis. A common factor observed among these samples was NO_3 concentrations >10 mg/L. This TKN<SKN result discrepancy was commonly observed (>30% sampling events received per client) at seven out of 27 clients whom submitted samples to Caltest for analysis. Concentrations of NO_3 >10 mg/L was observed in other samples; however, nitrogen speciation was as expected (TKN>SKN and TKN>NH3). Re-analysis of unorthodox samples, on average, occurred about 24 days after initial collection, suggesting a change in the acid (H_2SO_4) preserved matrix. High nitrate (>10 mg/L), inorganic salts and solids, as well as organic matter are known interferences for kjeldahl digestion; however, due to the nature of this study, NO_3 was the only interferent analyzed. Additional studies/analyses would be necessary to determine other interfering compounds in order to improve the kjeldahl digestion and provide better data to the Regional Board regarding nitrogen speciation input into SF Bay.

Keywords: Nutrients, Nitrogen, Speciation, Wastewater

Poster topic: Water and Sediment Quality

Developmental Effects of Fipronil on Japanese Medaka (*Oryzias latipes*) Embryos using a 96-Well Plate Exposure Method

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Fipronil, a phenylpyrazole insecticide found in common-use household products, has been detected at levels of 0.13-12.6 µg/L in urban runoff. A high-throughput 96-well plate developmental toxicity bioassay was developed to evaluate toxicity of fipronil. Japanese Qurt Medaka (*Oryzias latipes*) embryos (<24 hour old) were exposed to 0.1, 1, 10, 100, and 1000 µg/L fipronil. All embryos were initially exposed in beakers containing various pesticide solutions then moved to a 96-well plate on day 3 of the exposure where they were separated by sex. Embryos were continuously exposed for 16 days or until hatching. Exposure to fipronil decreased hatching success. An analysis of hatching date comparing sexes revealed that both sexes experienced delayed time to hatching. Pericardial edema, a sublethal endpoint, was observed in larvae as low as 10 µg/L. These results suggest that sublethal effects can occur in developing aquatic vertebrates following exposure to environmentally relevant concentrations of fipronil. Fipronil and its degradates were some of the most commonly detected pesticides in a 2008-2011 Sacramento, San Francisco Bay, and Orange County surface water survey. Detections of fipronil in all water samples were above the lowest US EPA aquatic benchmark. Such detections paired with data from this study mark fipronil as a contaminant of concern for the San Francisco Bay and Sacramento-San Joaquin River Delta.

Keywords: Fipronil, Japanese medaka embryos, hatching success, pericardial edema, hatching time

Poster topic: Water and Sediment Quality