Mercury in the Mix: An In Situ Mesocosm Approach to Assess Relative Contributions of Mercury Sources to Methylmercury Production in the Sacramento-San Joaquin Delta

Jacob Fleck, USGS CAWSC, Sacramento, CA, jafleck@usgs.gov
David Krabbenhoft, USGS, Middleton, WI, dpkrabbe@usgs.gov
Tamara Kraus, USGS CAWSC, Sacramento, CA, tkraus@usgs.gov
Elizabeth Stumpner, USGS CAWSC, Sacramento, CA, ebeauli@usgs.gov
John DeWild, USGS, Middleton, WI, jfdewild@usgs.gov
Jake Ogorek, USGS, Middleton, WI, jmogorek@usgs.gov

Mercury (Hg) contamination is considered one of the greatest threats to the Sacramento-San Joaquin Delta and the San Francisco Estuary ecosystems. This threat is primarily driven by the transformation of Hg by native bacteria into the more toxic and biologically available form, methylmercury (MeHg), in the wetlands and sediment of the Delta. To effectively manage this threat, a quantitative understanding of the relative contribution of the different Hg sources to MeHg formation is needed. While current models indicate that 1-2% of the Hg entering the Delta arrives through atmospheric deposition (wet and dry), it is has been long held that this mercury source is likely very reactive once deposited. On the other hand, mass balance estimates indicate 90% of the Hg entering the Delta arrives adsorbed to suspended particles from tributary discharge, but this source is thought to be less reactive. We conducted an in situ mesocosm dosing experiment where different Hg sources to the Delta (atmospheric, dissolved riverine and suspended sediment) were “labeled” with different stable Hg isotopes and added to mesocosms within four different wetlands. We measured six time points from each mesocosm, one prior to the spike and five after the spike: 30 minutes, 1 day, 3 days, 7 days and 27 days. Preliminary results from this experiment suggest that aqueous Hg sources (Hg introduced with precipitation and filtered river water) is more (10-1,000x) available to methylating microbes than particle bound Hg. Consequently, although direct atmospheric Hg deposition may contribute a small portion of the total Hg loading to the Delta, it may contribute to a substantial portion of the MeHg production within the Delta. These findings suggest that efforts to control MeHg in the Delta should consider the relative contribution of the different Hg sources to MeHg production in addition to the current loads analysis approach.

Keywords: Mercury, Methylmercury Production, Loads, Atmospheric Deposition, Reactive Hg

Poster Topic: TMDL Implementation

Investigation of Oxygen Consuming Materials Effecting a Dissolved Oxygen TMDL in the San Joaquin River's Deepwater Ship Channel near Stockton, CA

William Stringfellow, Lawrence Berkeley National Laboratory (LBNL) and University of the Pacific, wstringfellow@pacific.edu
Shelli Gulati, LBNL and University of the Pacific, sgulati@pacific.edu
Joel Herr, Systech, joel@systechwater.com
Jeremy Hanlon, LBNL and University of the Pacific, jershanlon@gmail.com
Chelsea Spier, LBNL and University of the Pacific, clspier@gmail.com
Ashley Stubblefield, LBNL and University of the Pacific, ashley.a.stubblefield@gmail.com
Michael Jue, University of the Pacific, mjue30@gmail.com
Greg Weisman, LBNL and University of the Pacific, greg.weissmann@gmail.com
Scott Sheeder, Systech, scott@systechwater.com
Ernest Garcia, University of the Pacific, e_garcia6@u.pacific.edu
Mary Kay Camarillo, LBNL and University of the Pacific, mkcamarillo09@gmail.com

To maintain agriculture production and water supplies, large-scale landscape and hydrologic modifications have been made in the Sacramento-San Joaquin Delta, leading to loss of ecosystem function. In the San Joaquin River (SJR) and estuary, discharge of oxygen demanding substances, eutrophication, low flows, and channel deepening have combined to create regional anoxic conditions, negatively impacting critical fish habitat. The Deep Water Ship Channel (DWSC) located on the SJR adjacent to Stockton, has had intermittent low DO conditions for decades. As a result of the low DO impairment, the State Water Resource Control Board has implemented a total maximum daily load (TMDL) for oxygen-consuming substances in the SJR at Stockton and defined DO impairment as when DO concentration falls below water quality criteria. As part of the TMDL, studies were conducted to identify sources of oxygen demanding substances to the river and investigate how to better allocate responsibility for DO impairment. In this study, a combination of direct measurements and results from model simulations using the WARMF and Link-Node models were used to examine the causes of DO impairment in the DWSC. Major sources of oxygen demand include demand from the SJR upstream of the DWSC, Stockton's wastewater treatment facility (WWTF), and urban tributaries. The Link-Node model was also used to examine the DO impairment caused by dredging the river at Stockton to over 30 feet deep (i.e. the DWSC). By comparison to baseline simulations which include all factors, oxygen impairment attributable to each factor was quantified. Model results suggest that WWTF improvements have reduced the contribution of the WWTF to the DO impairment and that the role of the DWSC in promoting impairment may be underestimated. Import of phytoplankton from the SJR is important, but impacts appear moderated by the lack of flow associated with low DO events.

Keywords: TMDL, San Joaquin River, Dissolved Oxygen

Poster Topic: TMDL Implementation

EPA Actions to Accelerate Bay-Delta Water Quality Improvement through TMDL Implementation

Valentina Cabrera-Stagno, U.S. EPA Region 9, cabrera-stagno.valentina@epa.gov
Debra Denton, U.S. EPA Region 9, denton.debra@epa.gov
Erin Foresman, U.S. EPA Region 9, foresman.erin@epa.gov
Sam Ziegler, U.S. EPA Region 9, ziegler.sam@epa.gov

EPA published the San Francisco Bay Delta Action Plan (Bay Delta Action Plan) in August 2012 and identified the following seven priority activities to advance the protection and restoration of aquatic resources and ensure a reliable water supply in the San Francisco Bay Delta Estuary:

- Strengthen estuarine habitat protection standards
- Advance regional water quality monitoring
- Accelerate water quality restoration through Total Maximum Daily Loads
- Strengthen selenium water quality criteria
- Prevent pesticide pollution
- Restore aquatic habitats while managing methylmercury
- Support the development of the Bay Delta Conservation Plan

This poster discusses EPA's efforts to accelerate water quality improvement and minimizing the negative impacts to aquatic life from contaminants and other stressors in the Bay Delta Estuary by working with California Water Boards to strengthen implementation of Total Maximum Daily Load (TMDLs) water quality improvement plans.

TMDLs are an important catalyst for restoring impaired water quality and protecting aquatic life. There are nine adopted TMDLs in the Bay Delta Estuary watershed that address contaminants (pesticides and selenium) and stressors (low dissolved oxygen) considered potential contributors to aquatic ecosystem collapse and abrupt fish population declines.

Although TMDLs in the Bay Delta Estuary have succeeded in reducing pollutant loads, they also illustrate challenges to fully attaining water quality standards. Therefore, EPA is supporting efforts to strengthen TMDL implementation that include:

- Assess TMDL implementation progress
- Expand the use of watershed plans and decision tools
- Develop tracking and accounting tools

This poster is focused on our work assessing water quality improvement progress by implementing TMDLs.

Keywords: TMDL, Water Quality Restoration, Protecting Aquatic Life

Poster Topic: TMDL Implementation

A Real-time Monitoring System to Track, Predict and Map the Distribution of Buoyant Pollutants in San Francisco Bay

Dale Robinson, San Francisco State University, dhr@sfsu.edu
Clinton MacDonald, Sonoma Technology, Inc., Clint@sonomatech.com
Chris Raleigh, San Francisco State University, christopherdraleigh@gmail.com
Tim Dye, Sonoma Technology, Inc., Tim@sonomatech.com
Jim Pettigrew, San Francisco State University, jimp@sfsu.edu
Newell Garfield, San Francisco State University, garfield@sfsu.edu

San Francisco Estuary drains 40% of the total area of California and supports a large surrounding metropolitan population. Waters of this large urbanized estuary are subjected to episodic discharges of buoyant pollutants, which include floating debris (plastics, derelict fishing gear), oil, and dissolved or suspended contaminates (organic chemicals, heavy metals, bacteria) carried within low-density water releases (sewage and storm drain outfalls). Buoyant pollutants can harm marine animals, leach toxic pollutants, endanger human health, pollute shorelines, and damage wetland habitats, while hurting recreation, business, and tourism in the process. Over 30 water bodies around the Bay Area have been identified as heavily impacted by floating pollutants and have been placed on the state's list of impaired waters.

The ultimate solution to the problems of buoyant pollutants is to eliminate their introduction into the environment, which involves documenting the mode, seasonality, and sources of pollutants. In the short-term there also is a need to mitigate the impacts of buoyant pollution released to the environment. To plan and implement these efforts requires knowledge of the transport, concentration, and distribution of buoyant pollutants once introduced into bay surface waters.

Our project aims to develop the science and systems for continuous and real-time water monitoring to identify, track and predict trajectories of buoyant pollutants, determine shoreline areas likely to be impacted, and identify waters in the estuary where buoyant pollutants tend to concentrate. The project leverages existing current mapping and water quality technology combined with leading data analysis and visualization tools. Potential project outcomes include using project outputs as planning and management tools for public health warnings, to help guide development, restoration, and disaster mitigation decisions, and to minimize environmental and economic impacts of floating pollutants. We will present the results of a pilot study from our project conducted in central San Francisco Bay.

Keywords: Oil Spills, Outflows, HF Radar, Water Quality, Buoyant Pollutants, Monitoring

Poster Topic: Water Quality

Continuous Monitoring of Dissolved Oxygen in San Francisco Bay

Maureen Downing-Kunz, USGS, mokunz@usgs.gov
Greg Shellenbarger, USGS, gshellen@usgs.gov
David Schoellhamer, USGS, dschoell@usgs.gov
Tara Schraga, USGS, tschraga@usgs.gov

Since passage of the 1972 Federal Clean Water Act, reported dissolved oxygen (DO) concentrations in San Francisco Bay (Bay) are routinely above the 5mg/L standard important for supporting biota, with few reported episodes below this concentration. However, long-term monitoring efforts have measured DO only in the main channel of the estuary by research vessel, and only at weekly to monthly sampling intervals. For this study we conducted the first high temporal resolution deployment of dissolved oxygen sensors in both the main channel and the perimeter of the Bay. Four optical DO sensors were deployed near bottom and sampled every 15 minutes for a year: two in the main channel (depth>12m) and two in the estuary perimeter (depth<5m). Main channel sites included one in the upper estuary near the primary freshwater inflow and one in the lower estuary near the ocean boundary; estuary perimeter sites included one at the mouth of a tidal creek in Central Bay and one in a tidal slough in South Bay. The resulting time series for main channel sites showed DO concentrations which always exceeded 5mg/L, whereas during spring, summer, and fall the tidal slough exhibited sustained hypoxic conditions (<3mg/L) and the tidal creek daily minima dropped below 5mg/L. Compared to sites in the main channel, those along the estuary perimeter demonstrated greater variability in DO concentrations at seasonal, tidal, and especially diurnal time scales. At the tidal slough site, DO concentrations varied at the spring/neap time scale, with consistently lower concentrations during neap tides indicating tidally varying transport and system metabolism. These time series are the first to concurrently document the contrasting DO patterns in the main channel versus the shallow periphery of the Bay, with results highlighting the value of high temporal resolution sampling and the importance of measurements in the shallow habitats.

Keywords: Dissolved Oxygen, Water Quality, Continuous Monitoring

Poster Topic: Water Quality

Concentrations of Pesticides Entering the San Francisco Bay-Delta through the Sacramento and San Joaquin Rivers, 2012-2013

James Orlando, U.S. Geological Survey, jorlando@usgs.gov
Michelle Hladik, U.S. Geological Survey, mhladik@usgs.gov
Megan McWayne, U.S. Geological Survey, mmcwayne@usgs.gov
Corey Sanders, U.S. Geological Survey, csanders@usgs.gov

Current-use pesticides pose a threat to aquatic organisms in the San Francisco Bay-Delta. During a year-long study, water samples were collected twice per month from sites representing the two major river inputs to the Delta: Sacramento River at Freeport and the San Joaquin River near Vernalis, and analyzed for over 100 pesticides and degradates. Thirty six pesticides or degradates were detected during the study (15 herbicides, 11 fungicides, 6 insecticides and 4 degradates). The average number of pesticides detected in Sacramento River samples was six, while the San Joaquin River samples contained an average of nine pesticides. The most frequently detected compounds were the herbicides diuron (75%), hexazinone (100%), metolachlor (63%), and simazine (64%), the fungicides, azoxystrobin (82%) and boscalid (50%), and the herbicide degradates 3,4-DCA (95%) and DCPMU (43%). Insecticides were detected infrequently during the study. Pesticide concentrations ranged from less than the method detection limits to near 1 microgram/liter (hexazinone). In nearly all samples, herbicides accounted for the majority of the total, per sample, pesticide burden. For those compounds detected at both sites, average and maximum concentrations were generally greater in San Joaquin River samples. Pesticide detections and concentration trends showed seasonal patterns consistent with the timing of pesticide applications in the Sacramento and San Joaquin river watersheds. Results from this study show that mixtures of current-use pesticides enter the Delta throughout the year from the Sacramento and San Joaquin rivers. These data represent the most current and comprehensive survey of current-use pesticides entering the Delta, and will be of value to scientists and resource managers working to understand the role of contaminants and the toxicity of pesticide mixtures to species of concern in the region.

Keywords: Pesticides, Water Quality, Herbicides, Insecticides, Delta

Poster Topic: Water Quality

Fifteen Year Volunteer Water Quality Monitoring Project at Lake Merritt

John Nguyen, Oakland High School, johnnguyen528@yahoo.com
Andrew Saephan, U.C. Berkeley, koachio.saephan@gmail.com
Joyce Yee, U.C. Riverside, joyce199509@gmail.com
Daniel Tam, Oakland High School, mistahtam@gmail.com
Jacqualin Luu, Oakland High School, luujacqualin@gmail.com
Shi Ying Pang, Oakland High School, shiyingpang1@gmail.com
Min-Juan Cen, U.C. Berkeley, marinacen56@gmail.com
Bing Qi Luo, Oakland High School, Bingqiemail@gmail.com
Mercedes Hawkins, Oakland High School, cedeshrec@gmail.com
Danh Tran, U.C. Davis, xxterankhuxx@gmail.com
Thanh La, U.C. Berkeley, thanh847@gmail.com
Shannon Voong, Oakland High School, shannon2709@gmail.com

Water quality at Lake Merritt is important to ecologists, state and federal regulators (State Water Quality Board and the U.S. Environmental Protection Agency), City and regional managers, conservationists and the general public. Lake Merritt is a tidal lagoon in the center of a city of 400,000 people, the center of a 4,650 acre highly urbanized watershed. Excessive nutrients from urban run-off and poor tidal circulation have been problems historically, continuing to today. In 1999, Lake Merritt was cited by the U.S. E.P.A. under the Federal Clean Water Act for excessive nutrients leading to low dissolved oxygen and for trash. It has remained on the TMDL 303 (d) list through the latest report in 2010.

Until 1995, the Alameda County Flood Control District supported monthly water testing from several lake stations and made annual reports. However since then, only short-term professional testing from single sensors has been carried out. Measure DD was passed by Oakland Residents in 2002 in an effort to improve water quality at the lake and make it more accessible to water recreation and to native species. A restoration of the shoreline as a demonstration mudflat and other projects are underway. In looking to the future, it would be helpful to know recent historical dissolved oxygen levels and other water quality measures levels in the lake and how they vary at different locations, depths in the water column, and seasons.

Environmental Science Academy at Oakland High School has conducted weekly volunteer monitoring of Lake Merritt from 1997 to the present from September to June. The accumulated water quality data provide a baseline with which to compare future improvements and climatic changes.

Keywords: Volunteer Monitoring, Measure DD, Dissolved Oxygen, Salinity, Temperature, pH, Clarity

Poster Topic: Water Quality

Using Biosentinels to Assess Mercury Risk in Wetland Restoration Projects

April Robinson, San Francisco Estuary Institute, april@sfei.org
Darell Slotton, U.C. Davis, dgslotton@ucdavis.edu
Jay Davis, San Francisco Estuary Institute, jay@sfei.org
Josh Collins, San Francisco Estuary Institute, josh@sfei.org

Methylmercury contamination in food webs is one of the primary water quality issues in the San Francisco Bay. Wetlands have been shown to be important sites of MeHg production and there is concern that wetland projects may result in increased Hg bioaccumulation. Biosentinel monitoring can be used to provide a direct link between marsh projects and the protection of marsh wildlife at risk of mercury contamination. Here we present data from the first year of a two-year project that uses a region-wide approach to monitoring wetland restoration in San Pablo Bay. Our data showed concentrations above levels of concern in most species. The design for this project was developed with input from a Science Advisory Group consisting of experts in biosentinel monitoring for mercury and the ecology of potential biosentinel species. The approach and sampling plan were also vetted with local stakeholders, who expressed interest in the following four management questions:

1. *What is the current potential for impairment of beneficial uses due to methylmercury in each major habitat of interest in the North Bay intertidal habitat restoration projects?*
2. *How will the status of impairment due to methylmercury in each major habitat of interest change over a timescale of years in response to the project?*
3. *How do the status and trends in impairment due to methylmercury at this project compare to status and trends in impairment in other project and non-project wetlands in the region?*

4. *Will tidal marsh restoration introduce a problematic amount of methylmercury into the Bay?*

Biosentinel data can answer these management questions in a cost-effective way.

Keywords: Mercury, Biosentinels, Monitoring

Poster Topic: Water Quality: Mercury

Past to Present: The Use of Bivalves to Reflect Past Methylmercury Concentrations and Develop New Directions for the Future of San Francisco Bay

Heather M. Foslund*, University of San Francisco, hmfoslund@usfca.edu
Allison C. Luengen, University of San Francisco, aluengen@usfca.edu

Long-term trends in methylmercury (MeHg) concentrations in bivalve tissues were assessed using museum specimens. There are no long-term studies on the concentrations of MeHg in organisms at the base of the food chain. To fill this gap, museum bivalves (*Musculista senhousia* and *Potamocorbula amurensis*) were analyzed from the California Academy of Sciences (CAS) and United States Geologic Survey (USGS), which were preserved in formalin or ethanol. Thus, we examined the effects of preservation on MeHg concentrations in tissues. In our preliminary analyses, MeHg concentrations increased slightly after 1 week of preservation, but more time points are needed. In our analysis of the southern reach of estuary, MeHg concentrations in *M. senhousia* collected from the Dumbarton Bridge, were highest in October 1975 (median= 231.3 ng/g_{dw}) but declined in the early 1990s (median= 37.7 ng/g_{dw}). Methylmercury concentrations in *P. amurensis* collected from the Dumbarton Bridge remained constant between 1991 and 1994 (median= 62.1 ng/g_{dw}), but they were 3-4 times higher than *M. senhousia* when the two species were collected on the same day. High mercury loadings at the Dumbarton Bridge may have led to the concentrations measured in bivalves in the 1970s, and subsequent regulations may have led to the observed declines. In contrast to the South Bay, data from San Pablo Bay in the northern reach of the estuary found that MeHg concentrations were similar in *M. senhousia* (median= 78.6 ng/gdw) and *P. amurensis (*median= 57.2 ng/gdw) collected on the same day in 2001. We are currently analyzing stable isotopes to determine if feeding niche could be attributed the changes in MeHg concentrations. The use of museum bivalves may elucidate historical trends in the estuary and mobilize future directions in understanding the influence loadings and ecology have on MeHg bioavailability at the base of the food chain.

Keywords: Methylmercury, Trends, Bioaccumulation, Tissues, Ecology, Loadings

Poster Topic: Water Quality: Mercury

Treatment of Surface Waters with Metal Based Coagulants to Reduce Total and Methyl Mercury Concentrations, Loads, and Bioavailability

Tamara Kraus, USGS California Water Science Center, tkraus@usgs.gov
Jacob Fleck, USGS California Water Science Center, jafleck@usgs.gov
Yumiko Henneberry, TetraTech, Yumiko.Henneberry@tetratech.com
Elizabeth Stumpner, USGS California Water Science Center, ebeauli@usgs.gov
David Krabbenhoft, Wisconsin California Water Science Center, dpkrabbe@usgs.gov
Paul Randall, U.S. EPA Office of Research and Development, randall.paul@epa.gov

With the recent passage of laws regulating concentrations and loads of mercury (Hg) and methylmercury (MeHg) in surface waters, there is a need to develop management practices that will reduce their inputs 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 (IHg) and MeHg, respectively, from solution was recently 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 water treatments: (1) iron sulfate addition, (2) polyaluminum chloride addition, and (3) untreated controls. Water entering (post-treatment) and exiting (after passage through) these treatment cells was sampled monthly over a 1-year period for total Hg and MeHg in both the aqueous dissolved and particulate phases. Initial results confirm that coagulant addition is removing Hg (total and methyl) from solution and sequestering it in the floc. Seasonal factors, such as changes in DOM concentration, appear to affect the efficiency of the treatment removal. Related studies will provide information about the biogeochemical processes occurring within the wetland cells in the presence and absence of the flocculated material. If proven effective, coagulation—either alone or in association with constructed wetlands—may be a feasible technique to reduce surface water IHg and MeHg concentrations and bioavailability.

Keywords: Mercury, Methylmercury, Remediation, TMDL, Coagulation, Wetland, Organic Matter, Carbon

Poster Topic: Water Quality: Mercury

Applying Sediment Quality Assessment Protocols to San Francisco Bay Samples

Ellen Willis-Norton, San Francisco Estuary Institute, ellenwn@sfei.org
Ananda Ranasinghe, Southern California Coastal Water Research Project, anandar@sccwrp.org
Darrin Greenstein, Southern California Coastal Water Research Project, darring@sccwrp.org
Steven Bay, Southern California Coastal Water Research Project, steveb@sccwrp.org
Karen Taberski, San Francisco Bay Regional Water Quality Control Board, ktaberski@waterboards.ca.gov

The California State Water Board recently adopted a set of narrative sediment quality objectives (SQOs) alongside a standardized assessment framework to determine the impact of chemical contamination on benthic communities. The SQO assessment framework was applied to samples from the San Francisco Bay Regional Monitoring Program's 2008 through 2012 sediment cruises and to samples taken in 2011 from two known toxic hotspots in San Francisco Bay's creek channels. The framework uses multiple lines of evidence (chemistry, toxicity, and benthic community composition) to assign a station assessment based on the severity of biological effects and the potential for chemically mediated effects. The goal of the study was to determine spatial and temporal trends in sediment quality throughout the Bay. The two creek channels, Mission Creek and San Leandro Creek, remain clearly impacted, with the extent of the contamination lower in samples closer to the creek mouths. Unlike the two toxic hotspots, severe impacts on the benthic community were not observed in the open Bay. Although over half of the Bay was listed as impacted (54%), the level of contaminant related impacts was either small or uncertain for 75% of the affected area. Sediment quality differed between subembayments, with San Pablo Bay possessing the best sediment quality and South Bay and Suisun Bay exhibiting the poorest sediment quality. For all of the subembayments, sediment quality was driven by biological effects (primarily toxicity) rather than chemical exposure. The SQO assessments indicate that sediment quality may have improved over time, with the number of impacted sites decreasing from 82.5% in 2000 to 54% from 2008 through 2012. Overall, the narrative SQOs provided a general spatial and temporal picture of sediment quality in San Francisco Bay.

Keywords: Sediment Quality Objectives, Contaminants, Moderate Toxicity, Multiple Lines of Evidence

Poster Topic: Water Quality: Sediment

In Situ Measurements of Suspended Sediment Diffusivity by 3D Particle Tracking

Rachel Allen*, University of California, Berkeley, rachelallen@berkeley.edu
Ian Tse, University of California, Berkeley, ian.tse@berkeley.edu
Evan Variano, University of California, Berkeley, variano@berkeley.edu

San Francisco Bay often appears brown. Its high suspended sediment concentrations give it the potential to move and mix large amounts of sediments from one environment, such as an urban stormwater outflow, to another, such as a wetland undergoing restoration. These sediments can carry with them persistent, bioaccumulative and toxic chemicals such as PCBs, mercury, or emerging contaminants.

To predict sediment fate, almost all physical models describe the transport of suspended sediment with the advection-diffusion equation, which requires knowledge of the water currents and the diffusivity of sediment. Methods for estimating diffusivity to use in the model are not typically satisfying, and there remain fundamental questions about the accuracy and applicability of the typical approximation methods.

We have developed a new tool that measures diffusivity directly, and we deployed it for the first time near the Berkeley shore. This region has highly active sediment and is important for transfer of sediment-associated contaminants, and allowed us to begin to investigate the relationships between wind, waves, tides and turbulence with sediment diffusivity. This proof-of-concept deployment gives us valuable preliminary information about sediment and contaminant transfer at the margins of the Central Bay. It also provides the foundation for future investigations of the behavior of sediment diffusivity in different environments and the underlying theory of solute diffusivity in real-world conditions.

Keywords: Suspended Sediment, Diffusivity, Transport, Particle Tracking

Poster Topic: Water Quality: Sediment

Impacts of Endocrine Disrupting Chemicals on *Menidia beryllina*, a Resident Fish in the Sacramento-San Joaquin Delta

Bryan Cole, Bodega Marine Laboratory, University of California, Davis, bjcole@ucdavis.edu
Richard Connon, University of California, Davis, reconnon@ucdavs.edu
Susanne Brander, University of North Carolina, Wilmington, branders@uncw.edu
Gary Cherr, Bodega Marine Laboratory, University of California, Davis, gncherr@ucdavis.edu

Populations of pelagic organisms in the SSJ Delta have been declining for several decades. The aim of this project, funded by the Delta Science Council, is to determine to what extent endocrine disrupting chemicals (EDCs) may be responsible for this pelagic organism decline. EDCs are chemicals that are typically used for one purpose, such as certain types of herbicides and pesticides, but also interfere with the natural process of hormone signaling or function. Such a disruption can have wide-ranging impacts on animal populations and development, and the situation in the Delta is made significantly more complicated due to the mixture of chemicals from run-off as well as wastewater as well as unrelated changes in environmental conditions can all impact endocrine function. As a model species for this study, we have chosen the Inland Silverside, *Menidia beryllina*, a non-native fish that can tolerate a wide range of salinities and environmental conditions, making it an excellent choice for studying EDCs in the Delta. In this study we have monitored the changes in gene expression and protein translation in both wild populations and lab-reared Silversides throughout the seasons. Incorporation of this temporal aspect into the study is crucial to understanding the impacts of EDCs because the types of chemicals input into the Delta change as different crops are grown. We have found that there are changes in hormonally regulated gene and protein expression in Silversides in the Delta, and there is the potential for an impact on fish populations.

Keywords: Endocrine Disrupting Chemicals, Pelagic Organism Decline, Pesticides

Poster Topic: Water Quality: Emerging Contaminants

Emerging Contaminants in the San Francisco Estuary: Pharmaceuticals and Personal Care Product Ingredients

Rachel Eastman, San Francisco Estuary Institute, rachele@sfei.org
Rebecca Sutton, San Francisco Estuary Institute, rebeccas@sfei.org
Margaret Sedlak, San Francisco Estuary Institute, meg@sfei.org

Pharmaceuticals and personal care product ingredients (PPCPs) are detected frequently in US waterways, creating concern for their potential to impact wildlife as well as humans. PPCPs can enter waterways through wastewater treatment plant (WWTP) effluent, stormwater, and groundwater. Forty-six Bay Area WWTPs likely provide the primary pathway for these contaminants to enter the Bay. The Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) has monitored select PPCPs in Bay surface water, sediment, and biota since 2002. In 2006, the RMP analyzed South Bay surface water for 39 pharmaceuticals, 18 of which were detected at levels comparable to those observed in similar studies of receiving waters. A 2010 follow-up study of five sites located throughout the Bay found that out of the 104 PPCPs analyzed, 31, 10, and 17 were detected in water, sediment, and mussels, respectively. Concentrations of PPCPs in Bay samples were generally an order of magnitude or more below concentrations expected to elicit toxic effects in aquatic organisms. However, a few exceptions deserve special attention, including plasticizers bis(2-ethylhexyl) phthalate and butylbenzyl phthalate, and the antibiotic sulfamethoxazole. In general, the majority of toxicity data currently available for PPCPs are based on acute effects studies, and the potential for sub-lethal effects, as well as those triggered by chronic exposures or exposures to mixtures of contaminants, remains a concern. The RMP is considering future studies that will expand the number of PPCPs analyzed in Bay samples following an evaluation of recent data on aquatic toxicity and detections in similar ecosystems.

Keywords: Pharmaceuticals, Personal Care Products, Phthalates, Sulfamethoxazole, Emerging Contaminants

Poster Topic: Water Quality: Emerging Contaminants

Transcriptome Sequencing and Gene Expression Analysis for the Health Assessment of Inland Silversides

Ken Jeffries, UC Davis, kmjeffries@ucdavis.edu
Susanne Brander, University of North Carolina Wilmington, branders@uncw.edu
Nann Fangue, UC Davis, nafangue@ucdavis.edu
Richard Connon, UC Davis, reconnon@ucdavis.edu

The San Francisco Estuary (SFE), along with the Sacramento/San Joaquin River Delta system, in California is heavily influenced by anthropogenic activity. Additionally, the SFE is one of the most invaded ecosystems in the world. Because many of the small-bodied native fishes in the SFE are listed as threatened or endangered, we have begun using the non-native inland silverside (*Menidia beryllina*) as an indicator species in the system. The inland silverside is an estuarine fish species approved by the US EPA for toxicity testing. We have sequenced the transcriptome of the inland silverside and have been developing molecular tools that include qPCR assays and a 44,000 feature oligonucleotide microarray (Agilent Technologies) to assess the cellular effects of exposure to ecologically-relevant stressors in the SFE. We conducted single-compound 14-day exposure studies on inland silversides using environmentally-relevant concentrations of ibuprofen and bifenthrin, emerging contaminants of concern in the SFE. Ibuprofen is a nonsteroidal anti-inflammatory drug (NSAID) that is continually introduced to the aquatic environment via wastewater effluent. Bifenthrin is a pyrethroid pesticide that is demonstrated to have estrogenic and anti-estrogenic effects on fish and is commonly detected in rivers that feed into the SFE. Both of these compounds are commonly detected in the aquatic environment at low concentrations and can elicit complex physiological responses in fishes. Preliminary data show that ibuprofen increased the expression of hormonally-responsive genes associated with hormone (estrogen, androgen and thyroid) receptors in inland silverside; however these responses were non-monotonic. Bifenthrin exposure resulted in decreased expression of those same genes suggesting an overall anti-estrogenic effect. We used newly developed molecular tools to show that even at low environmentally-relevant concentrations, chronic exposure to ibuprofen and bifenthrin elicit cellular responses in the inland silverside that potentially affect reproductive output, and therefore may cause physiological responses in numerous wild fishes in the SFE.

Keywords: Inland Silverside, Ibuprofen, Bifenthrin, Microarray, qPCR, Transcriptome sequencing, Contaminants

Poster Topic: Water Quality: Emerging Contaminants