Mercury Pollution in Northern California
Delta Tributaries Mercury Council

SACRAMENTO RIVER watershed PROGRAM

DELTA TRIBUTARIES MERCURY COUNCIL
Tuesday, May 17, 2022

Via GoToMeeting virtual meeting

Facilitator: Stephen McCord, McCord Environmental, Inc. (MEI)
Meeting Summary by: Stephen McCord, MEI

Attendees

Stephen McCord, MEI
Greg Reller, Burleson Consulting
Se Hye Kim, Albemarle
Peggy O'Day, UC Merced
Naivy Rodal, UC Merced
Marc Beutel, UC Merced
Jacob Fleck, USGS
Charlie Alpers, USGS
Mark Marvin-DiPasquale, USGS
Joseph L Domagalski, USGS
Steve Camacho, SWRCB
Lisamarie Windham-Myers, USGS
Stefanie Helmrich, UC Merced
Dulcinea Avouris, UC Merced
Eric Hepler, USGS
Julianna Manning, CV RWQCB
Leah Jones, CV RWQCB
Heidi Oriol, Regional San
Scott Brooks, Oak Ridge National Lab
Charles Salocks, retired
Hope Taylor, Sacramento Co.
Petra Lee, DWR
Debbie Webster, CVCWA
G. Fred Lee, G. Fred Lee & Assoc.
Julianaa Manning, DWR
Edwin Rivas Meraz, UC Merced
Byran Fuhrmann, SePro
Robin Merod, RWQCB
Kristin Byrd, USGS

I. Introductions and Agenda Review

No comments on the summary of the January 25, 2022 meeting.

II. Project Updates & Upcoming Events

Announcements are attributed to Stephen McCord (MEI) unless otherwise noted. Our "live" table of mercury-related projects in the region: https://docs.google.com/document/d/1EzeDOiS-vrM1MsjfNZC18Zoz9XWOSiorPSI3RJxrS9s/edit?usp=sharing.

Mine Site Cleanups

- Albemarle has decided to fund a portion of the cleanup of Elgin Mine, an abandoned mercury mine in the Sulphur Creek watershed. The design, regulatory approval, and cleanup is anticipated to be completed by early 2023.

Mercury Studies and Monitoring Activities

- *Hydrological Processes* recently published "Using dissolved organic matter fluorescence to predict total mercury and methylmercury in forested headwater streams, Sleepers River, Vermont USA". https://doi.org/10.1002/hyp.14572. Contact: James Shanley, jshanley@usgs.gov.
- Peggy O'Day (UC Merced) –PhD students Stefanie Helmrich and Mark Seelos recently defended their mercury-focused dissertations.
- Joe Domagalski (USGS)—UC Davis trying to pilot a hypolimnetic oxygenation system (HOS) in Oaks Arm of Clear Lake; USGS may study mercury cycling concurrently.
- Marc Beutel (UC Merced)—Hodges Reservoir HOS 3 pre-treatment monitoring years & 1 post-treatment, but now reservoir has been drawn down excessively.
- Mark Marvin-diPasquale (USGS)—USGS is involved in a coring study in Lahonton Reservior (NV) prior to a major dredging of the reservoir. USGS is conducting 'DRET' tests to determine how much Hg might be released during dredging operations.

Regional and Statewide Mercury Regulation

- The 2020-2022 integrated report was approved by USEPA in early May 2022. The 2024 report will be initiated soon.
- Robin Merod (RWQCB): Staff are completing the source/loss assessment and evaluating changes for phase two of the Delta MeHg TMDL. Peer review is anticipated in late 2022.
- Steve Camacho (SWRCB): Considering alternative approaches for statewide reservoirs mercury TMDL; focusing on 8-12 pilot studies to identify & quantify promising tools for fish mercury reductions.

Recent & Upcoming Conferences

- The 15th bi-annual International Conference on Mercury as a Global Pollutant (ICMGP; https://www.ilmexhibitions.com/mercury2022/) will be virtual in 2022. Albemarle will be presenting (1) a pilot treatment application of MercLok, updating what was presented to the DTMC in January 2022; (2) a former munitions site in Germany, and (3) poster presentation on a methylmercury bioaccumulation study of worms in sediments.
- Se Hye Kim (Albemarle): Albemarle will be presenting on its MercLok technology at the International Conference on Remediation of Chlorinated and Recalcitrant Compounds on May 22-26, 2022, in Palm Springs.

Grant Funding Opportunities

- None identified

Other News & Updates

- The 2022-2026 Delta Science Action Agenda (SAA) for the Sacramento-San Joaquin Delta (https://scienceactionagenda.deltacouncil.ca.gov/pdf/2022-2026-science-action-agenda.pdf) was recently published. Produced by and for the Delta science community, the SAA prioritizes and aligns science actions to address management gaps and inform

decision-making. The Delta Science Program facilitated a multi-phase, two-year process to co-produce the 2022-2026 SAA with scientists, managers, and those with a stake in the Delta (including DTMC members), to ensure that the top 25 Science Actions were responsive to management needs. The SAA includes some references (direct or as a contaminant) to mercury. Now staff are shifting gears to promoting the implementation of the SAA, through science funding, fostering collaborative efforts and more.

- OEHHA recently issued new fish advisories with safe eating advice for:
    - Prado Lake (San Bernardino Co.): https://oehha.ca.gov/advisories/prado-lake
    - Lake Isabella (Kern Co.): https://oehha.ca.gov/advisories/lake-isabella

Presentations

Three presentations were given.

1 – Seasonal patterns of methylmercury production, release, and degradation in profundal sediment of a hypereutrophic reservoir (Byran Fuhrmann, SePro)

Byran presented on a component of his recently completed dissertation research. Hodges Reservoir in San Diego is hypereutrophic and limited fish tissue data indicated elevated mercury levels. Methylmercury (MeHg) production in the lakebed sediments was the suspected source. A Speece Cone was planned for installation to improve hypolimnetic oxygen conditions and thereby reduce the nutrient source for the excessive primary productivity.

For the first part of the study, water column profiles and sediment samples indicated strong seasonal cycles for dissolved oxygen (loss in the hypolimnion) leading to changes in redox chemistry and associated MeHg production and demethylation. Key seasonal characteristics of the cycling were found to be: highest MeHg production in and release from sediments in spring when redox conditions favored iron-reduction. In summer, sulfate reduction also produced more MeHg in sediments, but the resulting sulfides bound that MeHg. As redox status continued to decrease in summer, methanogenesis led to demethylation. In fall, sulfate reduction in the water column led to increased MeHg production there.

The second part of the study involved sediment-water samples incubated for 2 days before analysis for MeHg (monthly for 7 months). Various samples were treated to identify individual drivers of MeHg production. Aeration decreased MeHg production. Adding a series of metabolism stimulants increased MeHg production when redox status was ideal, whereas adding inorganic Hg did not. Adding sulfate-reduction lowered MeHg production while methanogen inhibitors had the opposite effect, indicating that those bacteria are responsible for MeHg production/demethylation, respectively.

Results point to the potential benefits of hypolimnetic oxygenation, which should maintain aerobic conditions at the sediment-water interface to limit MeHg production in the water column and flux from the sediment bed. Biodilution impacts remain uncertain. Different reservoirs could respond differently owing to the multiple microbial community possibilities and environmental drivers to their production.

For more information: Byran Fuhrmann, 805) 568-4455, byranf@sepro.com.

2 – Evaluating manganese oxide-modified activated carbon (MOMAC) for treatment of mercury contaminated sediments (Edwin Rivas Meraz, UC Merced)

Manganese (Mn) has several oxidation states and is ubiquitous in aquatic systems. The various forms determined by oxidation state have different physical and chemical properties. In particular, Mn can buffer redox conditions and sorb mercury and MeHg. Mn oxides can be reduced at redox levels just above those of iron oxides and sulfate, whose reductions are known to produce MeHg. Activated carbon (AC) can be amended with Mn in various ways as a tool for sorbing MeHg (and other compounds). The material is referred to as manganese oxide-modified activated carbon (MOMAC).

For this study, sediment chambers were treated with various formulations and doses of AC and Mn, and monitored over time for MeHg production. Surface Area Analysis, Electron Microscopy, X-Ray Absorption Spectroscopy, X-ray Photoelectron Spectroscopy and X-Ray Diffraction were used to identify how and in what form Mn adsorbed to the AC. While >80% synthetic MnOx is as Mn(IV), the MOMAC had about half that content mixed with many other forms.

The redox behavior was distinct between MOMAC and MnOx. Higher pH could improve longevity of the MOMAC and thus its long-term effectiveness. AC can sorb reduced Mn(II), slowing the reduction of Mn(IV) to buffer redox status.

For more information: Edwin Rivas Meraz, erivasmeraz@ucmerced.edu.

3 – Mercury from SPACE—Use of high-resolution in-situ and remote sensing for monitoring mercury in the San Francisco Bay-Delta—Mark Marvin-DiPasquale, Lisamarie Windham-Myers, Jacob Fleck, Brian Bergamaschi, Charles Alpers (USGS); Erin Hestir, Dulcinea Avouris (UC Merced)

This project studied how to combine discrete sampling, boat-based flow-through sensors, fixed continuous sensors, and satellite imagery—combining the most useful and unique information from each into a more spatially and temporally complete picture of mercury (and other) conditions than any one tool could provide. In particular:

- Discrete sampling provides accurate mercury concentrations.
- Satellites work great spatially on clear days when passing periodically for mapping organic matter (filtered dissolved organic matter, or fDOM) and turbidity.
- Boats are spatially discrete and accurate for field conditions and some chemicals.
- Fixed stations are temporally high quality and dense for field conditions.

The focus was on filtered and particulate total mercury and MeHg. Four continuous stations were used, and discrete samples were collected there and elsewhere every ~6 weeks covering a range of tidal conditions, and concurrent with satellite passes.

For statistical modeling tiers were used to develop predictive models:

1) Satellite data (spatially comprehensive)—Maps of seasonally predicted mercury concentrations were produced from satellite imagery for fDOM and turbidity.
2) Continuous site data (temporally comprehensive)—Fifteen-minute time series data from the four sensor stations were similarly converted to mercury concentrations. Extreme wind events, upstream reservoir releases, tides, and seasonal effects were all captured.

3) Boat mapping (spatially comprehensive along the tracks)—Data from 33 sample sites were expanded to cover the full boat track. Results compared well to satellite maps.
4) Continuous sensors and boat mapping—Results over four season and four mercury forms compared well between Tiers 2 and 3, indicating that satellite data alone can be good predictors of mercury concentrations most of the time.

Seasonal harmonics were accounted for, and a stepwise regression using fixed linear models was employed. The selected (most parsimonious) model had the highest correlation with discrete sample data. Extreme outliers were excluded. Filtered and particulate concentrations were added to estimate total mercury and MeHg concentrations.

Next steps are to perform additional validation and checking against other datasets (such as hindcasting to Delta Regional Monitoring Program data) and to document the work.

This presentation is not available for distribution. For more information: Mark Marvin-DiPasquale, mmarvin@usgs.gov.

III. Meeting Wrap-Up

Agenda items suggested for the next meeting included:

- Measuring mercury loads across a tidal wetland inlet (Petra Lee, DWR)
- Due Diligence in the Sierra Nevada Gold Country (Carrie Monohan, TSF)
- The CASCaDE Project (www.cascade.wr.usgs.gov) is a combined hydrodynamic and water quality model that was employed to evaluate the physical components (the model does not include a mercury cycling submodel) of mercury transport and dilution in the Bay-Delta estuary. (Robin Stewart and Lisa Lucas, USGS)
- Mercury cycling model (Stefanie Helmrich, UCM)
- Mercury components of 2022-2026 Delta Science Action Agenda for the Sacramento-San Joaquin Delta (Henry DeBey & Dylan Stern, Delta Council)
- Update and overview of USFS mine site cleanup activities (Rick Weaver, USFS)

Next Meeting Date: Tentatively October 2022 (online).