Delta Stewardship Council
A CALIFORNIA STATE AGENCY

INFORMATION ITEM

Lead Scientist Report

Summary

Mercury contamination is one of the major water quality and human health threats in the Delta, and the Central Valley Regional Water Quality Control Board is responsible for imposing limits on different sources of its bioavailable form. Previous studies revealed that the Yolo Bypass is a major contributor to mercury in the Delta but did not elucidate why. In this Department of Water Resources-funded study, the investigators use controlled experiments to test whether decaying vegetation in the Yolo Bypass is responsible for its high bioavailable mercury loads. The findings confirmed the hypothesis, showing a strong relationship between the amount of decaying vegetation and bioavailable mercury concentrations. Disking treatments, which effectively bury vegetation by turning over surficial sediments, greatly diminished bioavailable mercury production, suggesting a management strategy, albeit one that may be impractical to pursue over large scales.

Effects of vegetation on methylmercury concentrations and loads in a mercury contaminated floodplain

Wesley A. Heim, David Bosworth, Carol DiGiorgio, Mark Stephenson, Gary Gill, Effects of vegetation on methylmercury concentrations and loads in a mercury contaminated floodplain, Science of The Total Environment, Volume 901, 2023, 165864, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2023.165864.
(https://www.sciencedirect.com/science/article/pii/S0048969723044893)

Mercury from legacy gold and mercury mines in the Delta's watershed remains a persistent challenge for water quality in the Delta. Microbial processes that break down organic matter in sediments can modify elemental mercury into methylmercury, which is bioavailable (i.e., readily taken up by organisms) and increasingly concentrated at upper levels of the food web. This potent neurotoxin threatens human health when consumed in fish and is therefore regulated under the Clean Water Act. The Central Valley Regional

Water Quality Control Board is required to adopt a Total Maximum Daily Load (TMDL) for mercury as part of its Basin Plan Amendment. (Basin Plans provide the foundation for all Central Valley Regional Board regulatory actions, more information can be found here: https://www.waterboards.ca.gov/centralvalley/about_us/program_overview/#basinplanning.) The TMDL allocates required reductions in methylmercury to major sources, with a phased, adaptive management approach that allows regulated entities to conduct studies to determine the feasibility of load reductions.

In 2021 the Delta Science Program (DSP) convened a peer review panel to evaluate the Central Valley Regional Water Quality Control Board's Delta Mercury Control Program and the underlying basin characterization and control reports for tidal wetlands and open water, including the Yolo Bypass. The review report found gaps in the scientific understanding of methylmercury dynamics in these ecosystems but noted that flooded agricultural soils within the Yolo Bypass are the largest source of methylmercury to the Delta. However, the mechanism behind the Yolo Bypass' contributions remained unclear.

In the spotlighted study, funded by DWR, the research team from San Jose State University, DWR, and Pacific Northwest National Laboratory, conducted controlled laboratory and field experiments to evaluate whether decaying vegetation was responsible for the Yolo Bypass' high methylmercury contributions. The hypothesis was grounded in an understanding of the relevant microbial biogeochemistry: as vegetation decomposes, plant matter is broken down into small organic molecules that could provide ideal substrate (i.e., "food") to sustain microbial metabolism (i.e., energy-generating processes). Under certain conditions (i.e., defined by the particular biogeochemical environment within the sediment), these microbial processes "tag" elemental mercury with an organic functional group that makes the mercury readily absorbed by organisms.

To test their hypothesis, the researchers excavated large blocks of intact sod-containing sediment and put them into outdoor containers (called mesocosms) that were co-located at a DWR laboratory facility adjacent to the Yolo Bypass, where they could all experience identical light and meteorological conditions. Replicate mesocosms were collected from grazed and ungrazed pasture within the Yolo Bypass, as well as grazed pasture in which the soil had had been disked (i.e., mechanically turned over). The experiments revealed that the vegetated pastures (both grazed and ungrazed) produced significantly higher amounts of methylmercury than the disked pastures.

In a second set of laboratory experiments, the research team tried to better understand the relationship between vegetation and methylmercury production and isolate contributions from vegetation versus sediment. They incubated homogenized sediment

with and without varying amounts of dried grass and compared the findings to a control incubation with water only and one with vegetation only. They found that there was a clear increase in methylmercury production as the amount of vegetation increased, and the combination of sediment (i.e., the primary source of the microbes) and vegetation produced the highest amounts of methylmercury.

These results highlight one of the challenging tradeoffs involved in managing a complex system like the Yolo Bypass. As addressed in recent Lead Scientist Reports, flooding of the Yolo Bypass produces many benefits for zooplankton production and juvenile salmon rearing in vegetated parts of the floodplain. However, this study indicates that this same action may also impede the ability of water resource managers to meet targets for methylmercury load reductions. Consistent with this finding, the 2021 review panel for the Basin Control Study concluded that methylmercury targets for the agricultural areas of the Yolo Bypass are unlikely to be met without upstream load reductions. Still, a path forward may be to conduct field experiments that evaluate whether partial vegetation load reduction may produce an acceptable balance between benefits for food webs and fish as well as water quality.

Delta Science Program Activities

Salinity Management Workshop series working group

As a part of the Salinity Management Workshop series, the Delta Science Program hosted two virtual focused working group meetings on August 23 and 25 to explore human dimensions of salinity management in the Delta. These working groups helped inform the direction of upcoming social science research to better understand the broad range of people impacted by salinity management and their perspectives, values, and priorities. Participants joined small group discussions and shared their perspectives on the impacts of salinity in the Delta, provided input on possible salinity management actions, and identified groups of people whom the research team should reach out to for interviews.

Water Temperature Modeling Platform Peer Review

The Delta Science Program hosted a public meeting for a peer review of the US Bureau of Reclamation's Water Temperature Modeling Platform on September 12-14. This is the second of two peer reviews on this topic; the previous midterm review occurred in July 2022. Temperature management is a key parameter for protection of species with specific cold water needs and is one of the most complex subjects related to Central Valley Project (CVP) operation. The 2019 Biological Assessment Proposed Action includes an action for Reclamation to collaboratively develop a new temperature model. This model, referred to

as the Water Temperature Modeling Platform, can provide suggestions for operations and short- and long-term monitoring to assist resource managers of major Central Valley Project reservoirs with balancing water resources for downstream uses as well as instream temperature needs.

The peer review panel reviewing the Water Temperature Modeling Platform has five hydrological and engineering experts from across the United States. The public meeting featured two days of presentations by Reclamation staff on the modeling platform's design and development, followed by a third day in which the initial findings from the peer review panel were presented. The panel members will provide comments to improve the process of developing and implementing water temperature modeling tools and a framework for the CVP. A final report of the panel's review will be available in early November.

By the Numbers

Science Program staff will summarize current numbers related to Delta water and environmental management. The summary (Attachment 1) will inform the Council of recent counts, measurements, and monitoring figures driving water and environmental management issues.

List of Attachments

Attachment 1: By the Numbers

Attachment 2: Visual Summary of Article

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