



CALFED Progress Report
California Sea Grant College Program

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Project Information

ProjectNo_2C R/SF-22 StartDate_3a June 1, 2007 EndDate_3b August 31, 2011
 ProjectTitle_4 Mercury interactions with algae: effects on mercury bioavailability in the San Francisco bay delta

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Additional Research Mentors and Community Mentors

Additional Research Mentors_8

Additional Community Mentors_9

Project Objectives: Please type your responses, and answer the questions in a style appropriate for laymen.

ProjectObjectives_10

The goal of this project is to understand the factors controlling mercury bioavailability to phytoplankton and organisms at the base of the food chain in the San Francisco Bay estuary and Delta. The first year of this project focused on the effects of dissolved organic matter (DOM). DOM in the Delta comes from a variety of sources, including natural production in wetlands, agricultural run-off, and inputs from wastewater treatment plants. My first-year results showed that DOM decreased methylmercury bioavailability to phytoplankton, presumably because DOM bound the MeHg and limited its bioavailability.

In the second year of this project, I looked at DOM in combination with other factors, such as Cl⁻ concentrations. Also in the second year, I also expanded my original interest beyond phytoplankton, to include a trophic transfer experiment with amphipods. That expansion allowed me to address the question of whether the effects that I had observed with phytoplankton would be transferred up the food chain when amphipods consumed the phytoplankton. The question was relevant to my overall goal of trying to predict processes affecting MeHg bioavailability within the San Francisco Bay Delta.

To complete this project, I need to finish writing up the results thus far and submit them for publication. I am also planning a field-study to validate and synthesize the laboratory results.

Summary of progress in meeting each of these goals and objectives

ProgressSummary_11

To address the objectives, I ran a series of intensive laboratory experiments using radiolabeled methylmercury (Me²⁰³Hg) to track the partitioning of methylmercury between the aquatic and biological phases. Those nine experiments looked at how bioavailability was affected by the following parameters:

- 1) Presence/absence of DOM and presence/absence of other trace metals
- 2) Concentration of DOM from a single site
- 3) Equilibration time between the DOM and MeHg prior to the addition of algal cells and a comparison of two different sites
- 4) Geographic variability of DOM collected from different sites in the San Francisco Bay Delta
- 5) Composition of the hydrophilic versus the hydrophobic fraction of the DOM
- 6) Type of DOM (labile vs. refractory vs. cysteine)
- 7) Cl⁻ concentration
- 8) Trophic transfer (water to phytoplankton to amphipods)
- 9) Distribution of Me²⁰³Hg within the algal cells

In addition to the experiments, I have completed the data analysis for many of the studies. For the data analysis, I used a repeated measures design because concentrations of Me²⁰³Hg in phytoplankton and water were measured repeatedly in the treatments at 2, 5, 10, 24, 48, and 72 hours. To analyze experiments with multiple dependent variables (time points) and multiple independent variables (e.g., DOC and equilibration time), I ran a repeated measures multivariate analysis of variance (MANOVA) in SYSTAT for each experiment.

These experiments will provide the data for three papers. The first paper is almost ready for submission and will be entitled, "Dissolved organic matter reduces algal accumulation of methylmercury." The second paper will look at factors affecting MeHg bioavailability within the San Francisco Bay Delta. The third paper will look at trophic transfer of MeHg.

I have presented results from these experiments at several conferences, including the Regional Monitoring Program (RMP) annual mercury meeting in 2010, the Society of Environmental Toxicology and Chemistry (SETAC) annual meeting in 2009, the State of the

Estuary Conference in 2009, and the American Society of Limnology and Oceanography (ASLO) meeting in 2009.

PROJECT MODIFICATIONS: Please explain any substantial modifications in research plans, including new directions pursued. Describe major problems encountered, especially problems with experimental protocols and how they were resolved. Describe any ancillary research topics developed.

Modifications_12

There are no substantial modifications to the radiotracer laboratory studies although, as I mentioned in the objectives, the scope of the laboratory studies has been extended slightly to include two additional experiments on trophic transfer and cellular distribution. Those experiments were funded by the Sacramento Regional County Sanitation District after funding from CALFED was suspended at the end of December 2008.

The suspension of CALFED funding has resulted in some changes to this project. First, as I mentioned above, I expanded the laboratory studies, and, accordingly, I plan to push out the field work and extend it out over a longer time-frame. This change was due to both interesting laboratory results and lack of CALFED funding for field sampling.

In winter 2009, while CALFED funding was suspended, I accepted a tenure-track position as an Assistant Professor at the University of San Francisco (USF). I will now use my new lab at USF as my base of operations for completing the field sampling portion of this project. The new time-frame for the field sampling now depends on availability of CALFED funding. Currently, CALFED funding has been guaranteed only through June 2010. The major way in which this project will be impacted by my new position at USF is that I will need more time to complete the research. In fall of 2009, I filled out a budget justification to transfer the CALFED award to USF and request an extension of the project until 08/31/2011.

BENEFITS AND APPLICATIONS: Suggest the relevance of these new findings to management. Describe any accomplishment, that is significant effects your project has had on resource management or user group behavior. CALFED is looking for "management cue" (see <http://science.calwater.ca.gov/pdf/soemgmtcues.pdf>).

BenefitsApplic_13

My results can be applied to CALFED's management cue of understanding contaminant accumulation patterns and processes to refine management strategies. My results show an inverse relationship between Me203Hg accumulation and DOM concentration for all types of organic matter, indicating that MeHg bound to DOM is not readily bioavailable. This relationship can be used as a tool to manage MeHg bioavailability within the San Francisco Bay and Delta.

While more research is needed to meet the objective of understanding food web-contaminant pathways, this work is an important first step in quantifying pathways of MeHg accumulation. I found that amphipods assimilate 65 - 70% of the MeHg in their prey, regardless of the amount of DOM. Pending verification from field studies, this result has the potential to be applied to food web pathways throughout the Delta.

This work is also relevant to CALFED's management cue on restoration of habitats and processes. For example, one of the proposed changes in the Delta is restoration of 10,000 ha of agricultural areas to wetlands. One concern with the wetland restoration is that previous research has linked wetland habitats with higher MeHg concentrations. My research brings up an important additional factor to consider: the bioavailability of that MeHg. In wetlands that produce high concentrations of DOM, any additional methylation of mercury that occurs in the wetland may be mitigated by its limited bioavailability once bound to DOM.

PUBLICATIONS: List any publications, presentations, or posters that have resulted from this funded research. Give as many details as possible, including status of paper (e.g., in review; in press), journal name, conference location and date of presentation. Please note (as outlined in the conditions of the award) that each fellow is required to submit an abstract for an oral or poster presentation at each State of the Estuary conference and CALFED Science Conference during the duration of the fellowship.

Publications 14

Luengen, A. C. (2010). Factors affecting the bioaccumulation of methylmercury at the base of the food web (oral presentation). Regional Monitoring Program Annual Mercury Meeting. David Brower Center, Berkeley, CA, January 27, 2010.

Luengen, A. C., Fisher, N. S., and Bergamaschi B. A. (2009) Dissolved organic matter reduces the bioaccumulation of methylmercury by phytoplankton (oral presentation). Society of Environmental Toxicology and Chemistry North America 30th Annual Meeting, New Orleans, Louisiana, November 19 – 23, 2009.

Luengen, A. C., Fisher, N. S., and Bergamaschi B. A. (2009) Trophic transfer of MeHg in a simple food chain (poster). Ninth Biennial State of the San Francisco Estuary Conference, Oakland, California, September 29 – October 1, 2009.

Luengen, A. C., Fisher, N. S., and Bergamaschi B. A. (2009) Effects of organic matter on methylmercury accumulation by phytoplankton. American Society of Limnology and Oceanography Aquatic Sciences Meeting 2009. Nice, France, 25 – 30 January, 2009.

