Delta Science Fellows Annual Report
California Sea Grant College Program

ConfirmationNumber 20100831152223

Printed: 8/31/2010 3:37:13 PM

ProjectYear_2A: 1st | ProjectNo_2C: R/SF-41

TypeReport_2B: Annual Report

Preparer Information

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Project Information

ProjectNo_2C: R/SF-41 | StartDate_3a: July 1, 2009 | EndDate_3b: June 30, 2011

ProjectTitle_4: Pilot-scale evaluation of an iron sediment amendment for control of mercury methylation in tidal wetlands

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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

Previous research has demonstrated the potential for an exacerbation of methylmercury (MeHg) effects that may accompany an increase in restored wetland acreage within the Bay-Delta. However, limited research has been conducted into evaluating MeHg control mechanisms that could be implemented during wetland restoration. This work intends to evaluate the efficacy of using an iron sediment amendment to control net methylmercury production in tidal wetlands of the Bay-Delta using test plots in a tidal wetland along the Petaluma River to address the following objectives.

Aim 1. To determine the effect of an iron amendment on net MeHg production in an actual wetland environment. The principle behind the iron amendment has been demonstrated in laboratory systems, but not yet under actual conditions within an existing tidal salt marsh.

Aim 2. To evaluate the long term effect of iron cycling on sulfur chemistry. Iron has a finite capacity to remove porewater sulfide, so it is necessary to determine if it is possible to induce in situ cycling of iron via FeS(s) oxidation. Additionally, the mobility of iron within the sediments needs to be evaluated to determine if a single dose could be effective or if a repeated dosing regime would be necessary.

Aim 3. To determine the effect of wetland vegetation on net MeHg production. Wetland plants have the ability to alter the biogeochemistry of the rhizosphere and selecting for certain species may provide an additional control.

Summary of progress in meeting each of these goals and objectives

ProgressSummary_11

Field work was begun during July 2009, and six test plots were established in the high marsh plain (dominated by pickleweed, Sarcocornia pacifica) of an existing tidal salt marsh near Petaluma, CA. Within each plot, 3 porewater samplers were installed at a depth of 2.5cm, and a monitoring program was begun to follow changes in concentrations of iron, sulfur, and methylmercury over time. Additionally, sediment cores were collected from areas near the test plots, and sediment samples were regularly collected from the top 3 cm of the test plots.

Aim 1. An iron amendment was added to two test plots in October 2009. Results following the amendment were inconclusive, as a seasonal decrease in concentrations in the control plots occurred at the same time, making it hard to detect any changes in the amended plots.

Aim 2. Iron and sulfur concentrations have been measured regularly since the plots were established. Iron concentrations increased in the experimental plots following iron addition and porewater concentrations stayed elevated for a few weeks, suggesting that the iron was not immediately flushed from the system. Additionally, during early summer 2010, iron concentrations increased in all plots, but were higher in the amended plots than found in the controls, suggesting that some of the amended iron has the potential to stay in place for at least half a year.

Aim 3. Research has been carried out at a single field site, with monoculture growth of pickleweed within the test plots, so comparisons have not been made between species at this time. Seasonal changes have been found within the porewater measurements that follow the senescence and reemergence of pickleweed growth, however, however, these patterns also follow seasonal changes of rainfall and temperatures, which make it hard to infer any direct effects of vegetation.

The field site was found to have relatively high concentrations of iron in the porewater and low concentrations of sulfide. This pattern was also found in sediment core samples collected over the top 20 cm depth of sediment, where sediment iron concentrations were typically high and sulfur mineral concentrations were low. These findings indicate that native iron cycling is an important process in the marsh, and iron oxidation and reduction are likely to be occurring simultaneously with sulfate reduction. Since high MeHg concentrations were measured in the porewater during July 2009, an incubation experiment was conducted to evaluate the potential for iron-reducing bacteria to have a major role in the production of MeHg. Sediment slurries (50% sediment/50% slough water collected during high tide) were spiked with Hg(II) and incubated for 7 days. Three conditions were studied: an abiotic control with formaldehyde added to kill the bacteria, a non-sulfate reducing incubation with MoO4 added to inhibit sulfate reduction, and a

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

Problems encountered have included seasonal changes in porewater MeHg concentrations potentially masking any effect of our initial iron amendment. Additionally, a cool and foggy summer has resulted in lower measured porewater concentrations in summer 2010 than were measured in 2009. This has stalled the research as we are waiting for field concentrations to increase to a level where changes due to the iron amendment would be more clearly evident.

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. Delta Science is looking for "management cues" (see http://science.calwater.ca.gov/pdf/soemgmtcues.pdf).

BenefitsApplic_13

At this point in the project, the results are not yet relevant to management decisions. However, the project has the potential to provide valuable information to parties involved in wetland restoration and management if the iron amendment is shown to be able to reduce MeHg production in tidal wetlands.

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 Delta Science Conference during the duration of the fellowship.

Publications_14

P.D. Ulrich and D.L. Sedlak. "Decrease in net methylmercury production following an iron amendment to tidal wetland sediments" Goldschmidt 2010 Conference, Knoxville, TN, June 2010. Oral presentation.

P.D. Ulrich and D.L. Sedlak. "Assessment of the Potential for Using Iron Amendments to Decrease Net Methylmercury Exports from Tidal Wetlands in San Francisco Bay" Bay-Delta Science Conference 2010, Sacramento, CA, September 2010. Accepted Oral Presentation.

COOPERATING ORGANIZATIONS: List those agencies and/or persons who provided financial, technical or other assistance to your project since inception. Describe the nature of their collaboration.

CoopOrganiz_15

N/A

AWARDS: List any special awards or honors that you, or mentor or members of the research team, have received during the duration of this project.

Awards_16

N/A

KEYWORDS: List keywords that will be useful in indexing your project.

Keywords_17

Tidal marsh, wetland sediments, mercury, methylmercury, iron amendment, sulfur cycling, iron cycling

PATENTS: List any patents associated with your project.

Patents_18

N/A

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Additions: Additional information can be added here. Please begin the text with the number of the question you are adding to.

Additions_19