Control of Mercury Methylation in Wetlands through Iron Addition

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To restore aquatic habitat, significant effort is being directed to the restoration of wetlands. However, wetland restoration can exacerbate mercury bioaccumulation in fish and wildlife by providing an environment that is conducive to mercury methylation. This project is investigating the potential for decreasing mercury methylation by amending wetland sediments with iron.

Methylmercury (MeHg) is a potent neuron-toxin that affects both human health and wildlife, and its formation in the anoxic sediments of wetlands has led to mercury contamination in aquatic ecosystems. Elevated levels of mercury, which exists primarily as MeHg in biota, are responsible for over 75% of the fish consumption advisories issued in the United States. Mercury is of special concern in California due to elevated concentrations caused by historical mining practices. The primary objective of this research project is to develop a novel method of restoring and constructing wetlands that will minimize MeHg production in wetland sediments without sacrificing natural habitat potential.

Since the 1780's, California has lost an estimated 91% of its wetland acreage, and it has only been over the past few decades that policy and management decisions have been made to reverse this trend (e.g., the proposed restoration of over 15,000 acres of salt marsh within the San Francisco Bay). Wetlands are extremely beneficial eco-systems to California as they serve as essential habitat for a variety of wildlife species, including the federally endangered California clapper rail, offer flood protection, and improve water quality. However, wet-lands support high levels of MeHg pro-duction, and as a result, the restoration of these essential habitats may exacerbate the mercury problems that already exist within the food web.

This project is studying a method of re-ducing mercury methylation rates by add-ition of ferrous iron to wetland sediments to control the availability of sulfide. As sulfide concentrations decrease, sulfate-reducing bacteria produce less MeHg because the concentration of dissolved, bioavailable mercury decreases. In a previous research project, we showed that this approach decreases net MeHg production in sediment slurry systems. This project will test the efficacy of iron addition under conditions more closely approximating those encoun-tered in wetlands using laboratory micro-cosms collected from tidally influenced estuarine wetlands around the San Fran-cisco Bay. In addition to studying the effect of the iron amendment on MeHg production, we are also evaluating the role that certain species of wetland plants play in MeHg production by altering the conditions of the sediments surrounding their roots, and how plant/sediment interactions are affected by iron amendment. The results of this study will determine if an iron amendment has the potential to be an effective control of MeHg production in wetlands, as well as to illus-trate if certain plant species can be selected for in the restoration of wetlands to help reduce the potential exacerbation of the MeHg problem.

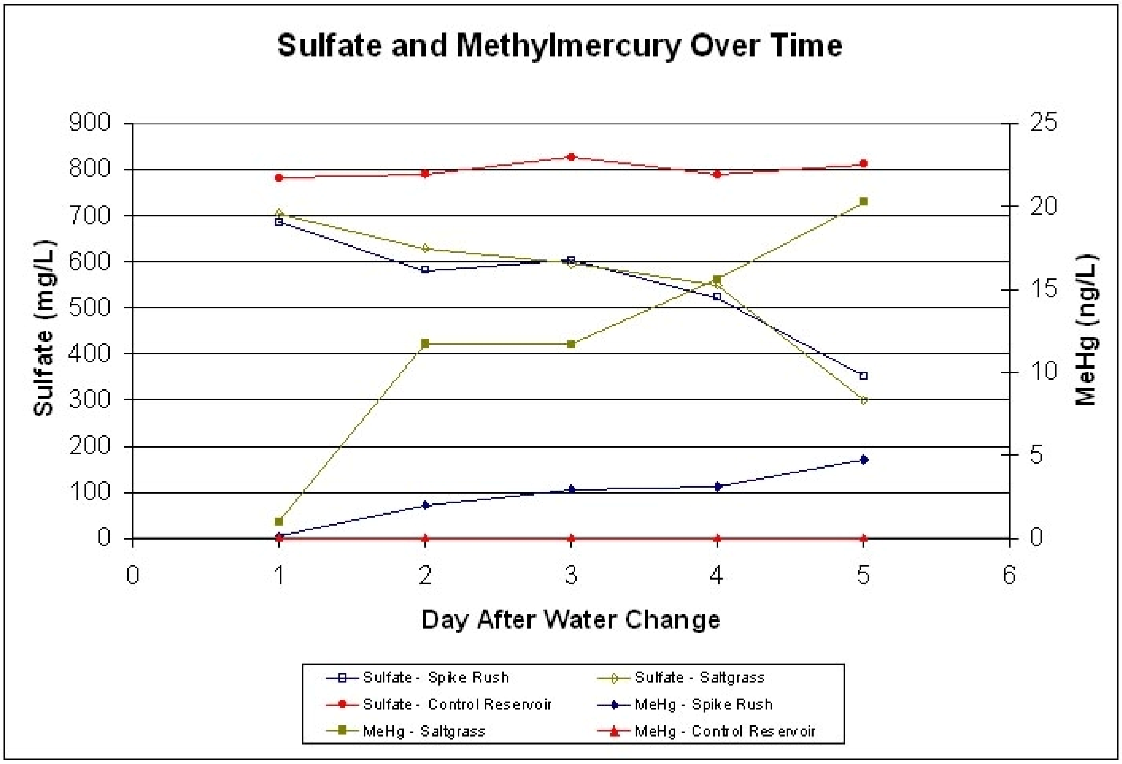

Figure 1: Relationship between sulfate reduction and methylmercury concentrations in wetland microcosms. These data indicate a strong relationship between the activity of sulfate-reducing bacteria and the production and export of methylmercury.

During the first year of the project, a microcosm system was designed and tested under operating conditions that simulate tidal cycles. Two potential field sites were identified and sediment cores with intact plant systems were collected for the microcosms. Pickleweed (*Salicornia virginica*), a halophytic salt-marsh plant that will serve as our initial species of interest, was collected from the tidally influenced high marsh plain of the Gambinini Marsh site along the Petaluma River in Sonoma county. Two additional plant species (saltgrass and a spike rush) were collected from Lower Joyce Island in the Suisun Resource Conservation District. The microcosms were grown and monitored over time for a variety of chemical parameters. These preliminary studies indicate that the microcosm system is able to support plant growth and an active sulfate-reducing microbial community, which is capable of producing substantial quantities of MeHg (Figure 1). The full-scale system of 12 pickleweed microcosms collected from Gambinini Marsh will go online during late summer 2007. After the completion of these experiments, we will conduct similar studies using different wetland plant species common to the tidal marshes of San Francisco Bay, such as saltgrass (*Distichlis spicata*) and cordgrass (*Spartina* spp.), to evaluate their individual effects on MeHg production relative to their controls without above-ground vegetation and in comparison to the effect of pickleweed.

Collaborative Efforts

Mark Marvin-DiPasquale, of the USGS, is collaborating with us on experimental design and interpretation of data.

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