Key Uncertainty: Will the scour of Alviso Slough resulting from tidal marsh restoration of associated salt ponds increase the bioavailability of methymercury?

Background and Rationale

The cross-section area of a tidal marsh channel at any point along its length is a function of the volume of water (i.e., the tidal prism) that usually passes that point in the channel during ebb tide (Dyer 1995). If the tidal prism decreases, the channel will get smaller. If the tidal prism increases, the channel will get larger (Dedrick 1979). A change in cross-section area can result from a change in channel width, depth, or both (Collins et al 1987; Coates et al.1989; Leopold et al. 1993).

The reclamation of tidal marshland (i.e., the construction of levees and other structures to isolate the marshland from the tides) represents a loss of tidal prism for the channels that drained the marshlands before they were reclaimed. One result of large-scale reclamation of tidal marshland is therefore a major decrease in the size of the remaining tidal channels. For example, the reclamation of tidal marshland along Alviso Slough in South Bay to create salt ponds caused the slough to narrow and shoal (Dedrick 1993). Conversely, the proposed restoration of these lands as tidal marsh will increase the tidal prism of Alviso Slough, causing it to scour and enlarge. The amount of scour can be predicted from empirically-derived correlations between tidal channel size and tidal prism (Orr and Williams 2002), and from models that relate increases in tidal prism to increases in shear stress against the channel bed, which causes scour.

Sometime during the first quarter of the 20th century, the Guadalupe River was diverted into Alviso Slough (Collins and Grossinger 2005). The Guadalupe watershed contains abundant mercury ore (cinnabar of HgS) that was mined intensively within the watershed as the tidal marshes were being reclaimed. It is likely that the sediments that have accumulated in Alviso Slough during and since the period of mining and reclamation bear large amounts of mercury (Beutel and Abu-Saba 2004).

Mercury (Hg) is dangerously toxic to wildlife and people. The organic form of mercury (methylmercury or MeHg) is an especially powerful neurotoxin that readily accumulates in food chains. Minamata disease, or methyl mercury poisoning, is characterized by peripheral sensory loss, tremors, and loss of memory, hearing, and vision (NRC 2000). Methymercury can be created from elemental mercury under low levels of oxygen (anoxia) in the presence of organic carbon and sulfate-reducing bacteria (NRC 2000, Wiener et al. 2003). These conditions exist in the sediments of tidal marshes and other estuarine environments.

The scour of Alviso Slough can increase habitat for aquatic resources, decrease the need for dredging (Goals Project 1999), and help sustain the adjoining tidal marsh. But the circulation of mercury-bearing sediments in Alviso Slough due to its scour might increase the risk of mercury accumulation in associated food webs. A study of the distribution of mercury within the predicted scour zone of Alviso Slough is therefore warranted.

Study Design Concepts

- Study Population: The sediments of the tidal reach of Alviso Slough that are likely to be scoured due to the restoration of adjoining tidal marshland, based on scour predictions provided by the Project Consultant Team.

- Study Site: Alviso Slough between the Alviso Yacht Club and San Francisco Bay.

- Parameters Measured: depth below sediment surface, total mercury, methylmercury, reactive mercury, total carbon, sulfur, Ph, conductivity, magnetic susceptibility, soil density, grain size.

- Study Design: The measured parameters will be profiled over depth in each of 15 5-cm diameter sediment cores 2-m long taken with a piston-corer; one core is taken at each of three stations for each of five cross-channel transects evenly spaced along the Study Site; the stations at each transect represent the left bank, mid-channel, and right bank of the scour zone. All cores will be photographed and x-rayed. Half of each core will be archived for further study if needed.

Time Frame for Study: One-time study conducted in fall-winter 2005-06.

Estimated Study Costs: $60,000-$70,000

Management Options

This study will determine whether or not the scour of Alvisio Slough due to the restoration of adjoining tidal marshland is likely to increase the bioavailability of mercury. If large loads of mercury are discovered within the zone of predicted scour, then the managers of the slough and adjacent lands will have alternative responses, including:

- Conduct additional studies to further elucidate the extent of the potential problem (this might involve taking more cores to better describe the distribution and quantities of legacy mercury, and/or linking the core studies to sediment transport studies to assess the fate of any mobilized mercury);
- Adjust the amount of tidal marsh restoration to prevent the amount of scour that might mobilize the legacy mercury (the mercury may be concentrated at great enough depths that some marsh restoration and concomitant scour is allowable);
- Remove the mercury-bearing sediment that is likely to scour and place it away from the biosphere (it may be possible to use the sediment with a safety cap to help fill deeply subsided salt ponds slated for tidal marsh restoration);
- Proceed with tidal marsh restoration and monitor for increased bioaccumulation in sentinel species (provides no preventive measures, however); and
- Not restore tidal marsh along Alviso Slough (precludes major land use objective).

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