Summary of the MeHg Panels of the 2004 CalFed Science Conference

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Mercury (Hg) can become an environmental problem when sulfate-reducing anaerobic bacteria, in the presence of organic substrates, form methylmercury (MeHg), a highly toxic compound that endangers wildlife and people by accumulating in their food.

The spatial and temporal variation in MeHg production is mainly a function of the availability of inorganic mercury to methylating bacteria. Typically only a small percentage (e.g. < 5 %) of total inorganic mercury is available for methylation. The amount of MeHg that actually becomes available for bioaccumulation depends on many environmental factors operating at different spatial scales, from watersheds to microbes. Scientists are working to prioritize these factors for management actions.

Methylmercury production and ultimate bioaccumulation might be managed through source reduction and land use practices, including strategic habitat restoration designs. The strategy for solving the problem calls for integrated mercury investigations to build a scientific foundation for restoration, environmental management, assessment, and eventual reduction of mercury-related risks in the Bay-Delta ecosystem.

Scientists and managers need to work together to determine the importance of methylmercury production relative to other potential problems in river and wetland restoration. Scientists are striving to explain the different effects of alternative designs and management practices so managers can optimize the benefits of restoration projects.

Most of the mercury sources in the ecosystem are well documented. Mercury ore (native mercury, cinnabar, and metacinnabar) was mined in the Coast Ranges of California and used at placer and hardrock gold mines in the Sierra Nevada and Southern Klamath Mountains. The legacy deposit of mercury from gold mining operations are concentrated in the Central Sierra, whereas the mercury mines are much less numerous but distributed more uniformly throughout the Central Coast Ranges. Newer sources, such as atmospheric deposition, urban run-off, and effluent from wastewater treatment plants also contribute to the mercury problem in the Bay-Delta ecosystem. The relative importance of the legacy and newer mercury sources is unknown.

Methods have been developed to identify and manage mercury-laden soils and sediments within mining sites. The identification and management of such sediments are based on knowledge about mining operations and mercury behavior that can be transferred from one site to another to improve remediation and restoration efforts. In general, mercury is associated with very fine sediments deposited from historical gold and mercury mines. Settling ponds and fine-grained lenses of material that may cover older tailings contain significant quantities of fine-grained material. Course sediments that have been piled as tailings generally contain a smaller proportion of fine-grained material. The distribution of mercury from mining sources in the major watersheds is not known well enough to estimate potential yields, except in a few watersheds. Some upstream sources of mercury have been identified that can be quarantined or cleaned. Estimates of the effects of local remediation on the overall mercury load need further evaluation.

Mercury that has moved from mining sites into aquatic systems can be methylated in the water column or in oxic-anoxic boundary layers of sediments. Downstream transport and redistribution of mercury from contaminated sources may cause a higher degree of reactivity and potential for oxidation and methylation. Existing understanding of pathways and rates of bioaccumulation in aquatic environments permits coarse forecasts of exposure due to changes in MeHg inputs. This will help quantify the relationship between source reduction and risks to wildlife and people. Managing the problem in aquatic systems has largely focused on provision of fish-consumption advice for sport fishes to reduce human exposure, and on identifying upstream sources of mercury that can be quarantined or cleaned.

Mercury that has moved into anoxic environments with abundant organic material, such as lake bottoms, streams, and wetlands can present significant health risks and management challenges. Mercury extraction from these environments is ecologically disruptive. High rates of methylation in these environments depend less on mercury concentrations than on other factors, including sediment chemistry, salinity, hydroperiod, and microbial community composition, any of which can vary greatly at small scales of space and time. Depending on habitat characteristics, a greater or lesser proportion of the methylmercury produced in these environments will be available for uptake and transfer into wildlife and people.

Development of a comprehensive monitoring program, focused on the fish that people and wildlife target for consumption, including assessment of untested water bodies and ongoing trend monitoring at representative index locations, will provide the key overall performance measure for the system and its constituent regions. Linked biosentinel monitoring, using appropriate lower trophic level fish and invertebrates, will provide sensitive measures of spatial and temporal variability in methylmercury exposure, which can be used to help identify sources and track the outcomes of individual restoration and remediation projects.

Resource managers need to know how the mercury problem can be managed. One obvious need is to see if methylation and subsequent bioaccumulation are due to isolated hotspots or more ubiquitous and manageable factors, such as wetland types, plant cover types, substrate types, or hydrological regimes. The effects of such manageable factors on methylation rates and net bioaccumulation merit scientific study.

Resource managers and scientists should work more closely together to develop habitat designs and management practices that could minimize the mercury problem. Sharing responsibilities for proposal writing, research, and adaptive management will nurture the needed collaboration.