Appendix Q. Wetland Studies

This appendix summarizes recent studies on potential methods to control mercury or methylmercury into or coming out of a wetland. None of these methods are formally established best management practices, but best management practices could be developed in the future from such studies.

Q.1 Types of Wetlands

Wetland can be subdivided into two general categories: natural or managed, although the distinction is not always clear. Both natural and managed wetlands can be further categorized as either permeant (flooded all year) or seasonal (flooded for part of the year).

Managed seasonal wetlands may include areas used to grow rice during the summer and used for water fowl habitat in the winter, which are often managed for hunting purposes. These areas also provide habitat for many other wildlife species. Wetlands used to grow crops, such as rice, are also known as agriculture wetlands. Discharges from these agriculture wetlands are usually regulated by the Water Boards' Irrigated Lands Regulatory Program. The requirements for dischargers in that program should take into account nearby mercury impaired waters.

"Natural wetlands" can be said to include wetland projects that provide ecological benefit (vs. agricultural benefit). The project may be undertaken to offset destruction of wetlands by development elsewhere in California. These wetland projects can: 1) establish (create) new wetlands where they did not exist before, 2) enhance existing wetlands, or 3) restore wetlands where they used to exist, or the project may have other goals. Definitions for these terms may be found in the U.S. Army Corps of Engineer's Final 2015 Regional Compensatory Mitigation and Monitoring Guidelines (U.S. Army Corps of Engineers 2015). Discharges of dredged or fill materials to waters of the United States or waters of the state are regulated under the State Water Board's Water Quality Certification and Wetlands Program under Clean Water Act section 401 (33 U.S.C.1341). In the future, dischargers of dredged or fill materials also will need to adhere to the requirements of the wetlands protection policy, which is being currently developed by the State Water Board.

Q.2 Possible Means to Control Mercury in Wetlands

Mercury controls can be subdivided into two categories. 1) Methods that aim to reduce methylmercury in fish *in the wetland* or 2) methods that aim to reduce mercury and methylmercury *coming out of the wetland* into downstream waters. Ideally methylmercury should be reduced in both areas to protect wildlife in the wetland and downstream habitat, but some proposed approaches/ studies have focused on only one of these aspects.

Q.2.1 Treatment Ponds

Slow flowing ponds can be constructed to treat the discharge from an agricultural wetland to remove mercury/methylmercury. Slow flowing open water areas encourages setting of suspended sediments. Settling can reduce methylmercury because methylmercury is often transported with sediments and organic material in the water. The mechanism of mercury / methylmercury removal is likely more complex that mere settling of solids. Extended water residence time appeared to preferentially enhance methylmercury degradation and storage (Windham-Myers 2014a). Open water also promotes photolysis of methylmercury, converting methylmercury to inorganic mercury (Fleck et al. 2014). Additionally, coagulants may be added to finishing ponds to help remove methylmercury from the outflow of a wetland, before discharging into a downstream water body (Ackerman et al. 2015).

Q.2.2 Open Water Areas in a Wetland

Similar to the treatment ponds described above, maintaining open water areas within a more natural wetland can help remove mercury. The difference here is that reduction of methylmercury takes place in the wetlands, not just in the out flow from the wetland.

Q.2.3 Seasonal vs. Permanent Wetlands (Reduce Wetting and Drying/ Water Level Fluctuation)

Seasonal wetlands, which can be used for agriculture part of the year, that will be heavily managed and experience a great number of wetting and drying cycles have been found to generate more methylmercury. On the other hand, permanent wetlands may be a sink for methylmercury (Ackerman & Eagles-Smith 2010, Alpers et al. 2014, Windham-Myers et al. 2014b).

Q.2.4 Outflow Management at Specific Times

Settling ponds can be constructed to treat the discharge of an agricultural wetland before discharging to a downstream water body. Wild rice wet harvesting and winter flooding of white rice fields are specific practices that increased methylmercury export, both presumably related to increased labile organic carbon and disturbance. Outflow management during these times could reduce methylmercury exports (Bachand et al. 2014). Alpers et al. 2014 found methylmercury concentrations in the Yolo Bypass that were among the highest ever recorded in wetlands. The highest methylmercury concentrations in unfiltered surface water were observed in drainage from wild rice fields during harvest (September 2007), and in white rice fields with decomposing rice straw during regional flooding (February 2008). Again, management of the outflow at critical times may be able to reduce methylmercury export to downstream waters.

Sediment controls

Sediment controls can limit the transport of mercury or methylmercury out of a wetland (see Settling Ponds, above). Any project that disturbs soil, which could be washed into downstream waters, likely will already be issued a Water Board permit that includes sediments controls. Sediment controls may be included to meet water quality objectives for sediment in downstream waters. Depending on the project, such controls may be an acceptable means to control mercury.

Alteration of management procedures
The use of new agricultural management practices could reduce the generation of methylmercury in the wetland. For example, Alpers et al. 2014 found the highest methylmercury concentrations in drainage from wild rice fields during harvest (September 2007), and in white rice fields with decomposing rice straw during regional flooding (February 2008). Other procedures could perhaps be used to remove the rice straw; however growers must abide by other mandates. In the past rice straw was burned, but burning the straw is now severely restricted to protect air quality.

Based on the summaries above, any practice that reduces the amount of wetting or drying a that occurs infield, or any a means to increase slow moving open water could potentially reduce the production of methylmercury in the wetland.

Q.2.5 Minimize the Delivery of New Mercury to the Wetland
If the wetland is receiving water that is high in mercury, the best way to decrease methylmercury to the wetland could be to minimize the input of inorganic mercury or methylmercury into the wetland. This decreases the amount of mercury in the water flowing into the wetland, which may be difficult for a wetland project to accomplish, but reducing upstream mercury sources may be achieved through the implementation of a Total Maximum Daily Load (TMDL) or through other projects that reduce sediment transport or air emissions of mercury..

Q.2.6 Ongoing Studies of Wetlands
The Central Valley Regional Water Board is currently working with non-point source dischargers and scientists to explore management practices that can reduce mercury methylation in the environment as part of the Sacramento-San Joaquin Delta methylmercury TMDL. New management practices to control methylation in wetlands may be developed in the future. Much of the information summarized above was the result of those studies.

Another area of study is the South Bay Salt Ponds Restoration Project in San Francisco Bay. The wetland restoration design for this project is attempting to reduce the potential for mercury methylation and other contaminant problems. The project design includes monitoring and studies to measure methylmercury production.

References

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