To: Rick Humphreys
From: David Evers
Re: Peer review of water quality impacts of suction dredging for gold
Date: 4 May 2011

Please find below my responses to the scientific topics to be addressed by reviewers. My scientific background and expertise is limited to question 2. My response to each question is in italics.

Description of SCIENTIFIC Topics
to be addressed by reviewers

1) Sediment/Turbidity and TSS. Pages 4.2-28 to 4.2-33. Available evidence suggests that individual suction dredges have the potential to re-suspend in-steam sediments, resulting in plumes containing elevated levels of turbidity and total suspended solids (TSS) (e.g., up to 300-340 mg/L).

This question is outside of my area of expertise and I therefore do not have a comment.

2. Mercury. Pages 4.2-33 to 4.2-54. Available evidence suggests that suction dredging has the potential to contribute substantially to:

- **Watershed mercury loading (both elemental mercury and mercury-enriched suspended sediment) to downstream reaches within the same water body and to downstream water bodies.**

Suspended sediments with mercury can travel great distances downstream from point sources (see response for next bulleted question).

- **Methylmercury formation in the downstream reaches of the same water body and in to downstream water bodies (e.g., the Bay-Delta) from dredging caused mercury loading.**

The formation of methylmercury downstream from a point source of mercury is a known, but only recently quantified phenomenon for higher trophic level, terrestrially-based organisms (e.g., songbirds and bats). A recent study on the South River, Virginia found point source related contamination for mercury at levels of significant reproductive concern to 137 km downstream. Therefore, mercury can travel at great distances, and often times not methylate at levels of concern to fish and wildlife until it is deposited in areas that have great abilities to methylate.

- **Mercury bioaccumulation and magnification in aquatic organisms in downstream reaches within the same water body and downstream /water bodies.**

Suspended sediments with mercury can travel great distances downstream from point sources and have an ability to methylate at levels that can create adverse impacts to aquatic and terrestrial organisms (see response for above bulleted question).

- **Increased methylmercury body burdens in aquatic organisms which increase the health risks to wildlife (including fish) and humans consuming these organisms.**

Increased methylation and availability of mercury can have individual and population level impacts to aquatic and terrestrial organisms, including vertebrates such as fish, amphibians, birds and mammals. Based on studies in the eastern United States, piscivores are at high risk to methylmercury contamination and toxicity because they often occupy elevated trophic positions where the biomagnifications of methylmercury can have its greatest impacts. The toxic levels of methylmercury causing significant reproductive impacts in avian piscivores is well established in the Common Loon by Evers et al. 2008 and Burgess and Meyer 2008. Based on these and other studies, the dietary criterion listed in Table 4.2-2 for avian wildlife of 0.02 mg/kg is out-dated and should not be used. Yeardley et al. 1998 used an existing dietary criterion that does not represent actual toxic thresholds for avian piscivores and therefore should not be used as a reference for dietary criteria (e.g., the citation of this paper simply continues that incorrect assertion for a dietary criteria).

Also, the dietary criteria used for avian piscivores should not be used for avian invertivores. Recent evidence demonstrates that avian invertivores are often more sensitive that avian piscivores based on Heinz et al. 2009. Based on recent evidence, invertivores (songbirds and bats) that have a diet originating from wetland habitats can have the ability to be at greater risk to environmental mercury loads vs. piscivores.

Burgess, N.M. and Meyer, M.W. 2008. Methylmercury exposure associated with reduced productivity in common loons. Ecotoxicology 17:83-91.

Evers, D.C., L. Savoy, C.R. DeSorbo, D. Yates, W. Hanson, K.M. Taylor, L. Siegel, J.H. Cooley, M. Bank, A. Major, K. Munney, H.S. Vogel, N. Schoch, M. Pokras, W. Goodale, and J. Fair. 2008. Adverse effects from environmental mercury loads on breeding common loons. Ecotoxicology 17:69-81.

Heinz, G., D. Hoffman, J. Klimstra, K. Stebbins, S. Kondrad, and C. Erwin. 2009. Species differences in the sensitivity of avian embryos to methylmercury. Archives of Environmental Contamination and Toxicology. 56:129-38.

In California, suction dredging frequently occurs in streams that were contaminated with mercury beginning in the Gold Rush. Suction dredgers encounter mercury in the forms of elemental mercury, mercury alloyed with gold (amalgam), and mercury-enriched sediment. Both elemental and reactive mercury are adsorbed onto the sediments. Suction dredgers recover and process amalgam because it contains gold. Suction dredge sluices do not capture 100% of the mercury, amalgam, and gold in sediment that passes through them (losses are in the percent range). In addition, suction dredgers dredge fine grained sediment (i.e., 63 micron and smaller) in mercury contaminated streams is at least 10x higher in mercury that what would be considered background for an uncontaminated stream. Suction dredges do not recover sediment finer than 63 microns.

Suction dredges then release mercury and mercury enriched fine-grained sediment that was formerly buried. This mercury may then be transported to aquatic environments where it can be converted into bio-available methylmercury.

3. Other Trace Metals. Pages 4.2-54 to 4.2-59. Available evidence suggests that while suction dredging has the potential to remobilize trace elements (e.g., cadmium, zinc, copper, and arsenic), the levels of increase:

This question is outside of my area of expertise and I therefore do not have a comment.

4. Trace Organic Compounds. 4.2-59 to 4.2-60. Available evidence suggests suction dredging has the potential to remobilize trace organic compounds if present:

This question is outside of my area of expertise and I therefore do not have a comment.

The Big Picture

Reviewers are not limited to addressing only the specific issues presented above, and are asked to contemplate the following questions.

> **(a) In reading Chapter 4.2 of DFG's in the context of the entire Suction Dredging SEIR, are there any additional scientific issues that are part of the scientific basis not described above? If so, please comment with respect to the statute language given above in the first three paragraphs of Attachment 2.**

The scientific issue of greatest concern is the use of older references that have been superseded by more recent information.

> **(b) Taken as a whole, is the scientific evaluation of the water quality effects of suction dredging presented in Chapter 4.2 of DFG's Suction Dredging SEIR based upon sound scientific knowledge, methods, and practices?**

The scientific evaluation of the water quality effects of suction dredging is generally based on sound scientific knowledge, however, recent scientific studies are not well represented and therefore information presented in this document may not be relevant.

CONCLUSIONS: *The scientific merit of this report is high. However, recent advances in the understanding of mercury transport in riverine ecosystems and the effects of methylmercury in wildlife are not well represented. Recent findings should be recognized as they may have significant ramifications in decision-making. Streams and rivers that have significant wetland areas should be of particular concern for mercury remobilization by suction dredging, even if dredging activities are over 130km upstream.*