COPPER CONTROLS (C.13)

C.13.e Studies to Reduce Copper Pollutant Impact Uncertainties

This MRP provision requires Permittees to conduct or cause to be conducted technical studies to investigate possible copper sediment toxicity and technical studies to investigate sub-lethal effects on salmonids. These uncertainties regarding copper effects in the Bay are described in the amended Basin Plan's implementation program for copper site-specific objectives. Compliance will be achieved through continued participation in the RMP, whose Multi-year planning process addresses these gaps through two elements guided by the Exposure Effects Work Group (EEWG):

A workshop focusing on causes of moderate sediment toxicity in San Francisco Bay will be held in fall 2012. This will be the second in a series of workshops on stressor identification that were recommended by EEWG advisers after review of the limitations of conventional approaches to Toxicity Identification Evaluation. A presentation to the May 2012 EEWG meeting that covers the background and objectives for the workshop is at http://www.sfei.org/sites/default/files/Day1_Item5_Bay_ToxWorkshop.pdf

A study of the olfactory effects of copper on salmonids in salt water. This study is being completed in 2012. As described in the update in Appendix A11, preliminary tests suggest that copper is less toxic to olfactory physiology in seawater-phase juvenile salmonids than in freshwater. NOAA will confirm these results in an RMP project report for EEWG review in late 2012; additional work on the effects of varying salinity will be conducted in 2013 with non-RMP funding.

June 29th, 2012

MEMORANDUM

To: Exposure and Effects Workgroup

From: David Baldwin
Environmental Conservation Division
NOAA Northwest Fisheries Science Center

Re: Status Update on the Impact of dissolved copper on the olfactory system of seawater-phase juvenile salmon

Numerous studies have shown that exposure to low-levels of dissolved copper can be toxic to the olfactory system of juvenile salmon. Many regulatory thresholds for environmental copper concentrations are now meant to be protective of salmon olfactory toxicity. An example is the site-specific objectives (SSOs) for copper in the San Francisco Estuary. These objectives are meant to protect seawater-phase salmon (post-smolts) within the estuary from copper olfactory toxicity. However, the available copper olfactory toxicity data is from freshwater-phase juvenile salmon (pre-smolts). The olfactory toxicity of copper to post-smolts is not known and, therefore, there is an uncertainty about whether the SSOs are protective for salmon within the estuary.

NOAA Fisheries' Northwest Fisheries Science Center (NWFSC) has begun experiments designed to address this data gap. A pilot range-finding study was conducted in late summer/early fall of 2011. Preliminary indications from these results indicate that the threshold for copper olfactory toxicity in seawater with low dissolved organic carbon (DOC) may be well above 100 ppb. If this is the case, current SSOs would protect post-smolt Chinook salmon from copper olfactory toxicity. A more detailed experiment, however, is needed to confirm those results. To that end, a 2012 NOAA study funded by the Regional Monitoring Program (RMP) has begun at the NWFSC. This experiment will increase the number of fish tested at each copper concentration and, if appropriate, test higher levels of DOC. As of June, the fish are being smolted. Data collection will begin in July and is expected to be complete in September.

This study will be based on previous NOAA studies that measured copper olfactory toxicity in freshwater-phase juvenile salmon (Baldwin et al. 2003; Sandahl et al. 2007; McIntyre et al. 2008). Briefly, the impact of copper exposure on the sensitivity of the salmon olfactory system to odors will be measured using direct electrophysiological recordings (electroolfactograms; EOGs) from the olfactory epithelium. Odor-evoked EOGs will be obtained from fish using a standard

odorant, the amino acid L-serine. Fish will be either unexposed to copper (controls) or exposed for a short period (30 minutes; copper concentration will vary as needed). Copper-induced changes in the sensitivity of the olfactory system will be measured as a dose-dependent reduction in the amplitude of the odor-evoked EOGs. The objective will be to determine whether copper concentrations in the range of the SSOs are likely to cause olfactory toxicity. The initial exposures will use the ambient seawater at the Mukilteo Field Station, which has relatively little dissolved organic carbon (DOC < 2 mg/L). In freshwater, DOC is known to reduce copper toxicity (McIntyre et al. 2008), so if copper olfactory toxicity is observed additional DOC concentrations will be tested to determine the impact of elevated DOC on the olfactory toxicity of copper in seawater. Water samples will be analyzed by an outside lab (Pacific Northwest National Laboratory) to determine the copper complexation capacity (as well as the concentrations of copper and DOC) for comparison with SF Bay waters.

A draft report of the results will be provided to the San Francisco Estuary Institute and RMP by November 1st, 2012. The draft report will be circulated for review by the EEWG and TRC. The comment period will December 15th. Comments will be incorporated by January 15th and a final report will be available January 30th 2013.

Citations:

Baldwin, D. H., J. F. Sandahl, J. S. Labenia, and N. L. Scholz. 2003. Sublethal effects of copper on coho salmon: Impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system. Environmental Toxicology and Chemistry **22**:2266-2274.

McIntyre, J. K., D. H. Baldwin, J. P. Meador, and N. L. Scholz. 2008. Chemosensory deprivation in juvenile coho salmon exposed to dissolved copper under varying water chemistry conditions. Environmental Science & Technology **42**:1352-1358.

Sandahl, J. F., D. H. Baldwin, J. J. Jenkins & N. L. Scholz. 2007. A sensory system at the interface between urban stormwater runoff and salmon survival. Environmental Science & Technology **41**:2998-3004.