Testimony Before State Water Resources Control Board
Delta Flow Criteria Informational Proceeding

Other Stressors-Water Quality: Direct Toxicity Ammonia/Pyrethroids

My name is Cameron Irvine. I have a Masters degree in Ecotoxicology and over 15 years of experience as a scientist dealing with aquatic resources, toxicity testing, and Delta issues. My specific Delta expertise has been developing, reviewing, and participating in toxicity studies evaluating ammonia and effluent effects to delta smelt, and pyrethroids toxicity in effluent. My resume is provided as a statement of qualifications accompanying this testimony.

Although there has been much recent discussion about the potential effects of contaminants, often referred to as "other stressors", there is no concrete evidence that ammonia or pyrethroids from SRCSD treated wastewater discharged into the Sacramento River are adversely affecting sensitive species. Methods are currently under development and data are being developed to answer questions of the potential for toxicity from ammonia and pyrethroids from SRCSD effluent, but these data are currently inadequate for making risk management decisions and should not play a role in determining delta flow criteria.

Cameron Irvine
CH2M HILL
2485 Natomas Park Dr., Suite 600
Sacramento, CA, 95833
(916) 286-0475 x34475
cirvine@ch2m.com
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Background

Direct toxicity to Delta species has been considered a potential cause of the Pelagic Organism Decline (POD) for many years, although no direct causal relationships have been found. Contaminant investigations continue to be developed and the wealth of information is growing. However, the unsettled science does not form the basis for any management decisions at this time. This is why several entities (i.e., The National Academy of Science review of Delta Sustainability, State Water Board's review of the Bay Delta Plan, and CalFED's review of ammonia effects in the Delta) agree that more research is needed to assess the impacts of stressors on the POD, and that these factors are secondary to flows.

Purpose of Testimony

The purpose of this testimony is to highlight key studies and findings pertaining to the potential for toxicity in the Delta from constituents discharged by the Sacramento Regional County Sanitation District (SRCSD) at the Sacramento Regional Wastewater

Treatment Plant (SRWTP) so that the State Board may have confidence in the decision to exclude these data when determining the volume and timing of Delta exports and other Delta flow criteria.

Scientific Evidence that should be Considered by the SWRCB

Ammonia

Recent investigations have focused on the potential for a link between the POD and several toxicants; particularly ammonia, and pyrethroids to a lesser degree. Of particular interest have been toxicity testing method developments at the UC Davis Aquatic Toxicology Lab (ATL). The ATL designed and is continually refining delta smelt acute toxicity testing methods that have provided insight on the sensitivity of delta smelt to ammonia and other toxicants. However, due to these developing methods it is not necessarily appropriate to compare data among years, and it is wise to consider past data in light of the most recent understanding. For example, early delta smelt testing in 2006 used static renewal methods that allowed ammonia to accumulate in the exposure beakers. This testing artifact led to premature conclusions about the sensitivity of smelt to ammonia that were largely addressed in 2007 when flow-through bioassays began to be used (Werner et al. 2008a). The subsequent recognition that delta smelt are highly sensitive to low turbidity and low conductivity (EC) led to the inclusion of additional controls in 2008 and 2009 testing so that there are currently controls for 1) low EC, 2) low turbidity, and 3) low EC/low turbidity in addition to 4) a hatchery water control. An additional control for 5) antibiotics also began with the use of medications to help increase control survival. The performance or lack of appropriate controls for each test should be carefully considered in the evaluation of delta smelt toxicity data.

Larvae delta smelt, one of the species of concern for the POD, are reported to be as sensitive to ammonia as salmonid species, which are considered the most sensitive fish species (Werner et al. 2009 a,b). Because rainbow trout are protected by the National Recommended Water Quality Criteria for ammonia/ium (USEPA 1999), delta smelt will also be protected by these criteria. Despite ambient ammonia concentrations not exceeding USEPA acute or chronic criteria, there have been variable survival rates reported for delta smelt exposed to ambient Delta surface water (Reece et al. 2009). As mentioned above, reports that chronicle method development and try to interpret environmental data should be interpreted with caution. Correlations do not indicate causation, especially in ambient samples were many parameters are not measured. Analyses have also reported that in 2007 "*Turbidity and EC/salinity were the two most important factors determining survival of delta smelt larvae overall*" (Werner et al 2008b). The cause of variable toxicity results continues to be investigated, although species sensitivity testing (where serial dilutions of ammonia in culture water, or in river water) support the conclusion that ammonia toxicity does not occur at ambient concentrations (Reece et al. 2009; Seyfried 2009; Werner et al. 2009a,b).

Pyrethroids

Pyrethroid insecticides are commonly used in agriculture and urban settings, and have been suspected to be the cause of infrequent toxicity to *Hyalella azteca*, a particularly sensitive epibenthic invertebrate, in delta surface water samples (e.g., Werner et al. 2008b and Reece et al. 2009). Increased mortality in Delta surface water was infrequently observed and only accounted for 2% of samples in 2006-2007 (Werner et al. 2008b) and 0.5 % of samples in 2008 (Reece et al. 2009).

A recent publication by Weston and Lydy (in press) describes the results of a study designed to identify pyrethroid sources in the Delta. The authors report that pyrethroids were sometimes found at or near their detection limit in SRWTP effluent samples, and that toxicity identification evaluation (TIE) methods were consistent with a pyrethroid cause of toxicity. However, it is important to note that tests with SRWTP effluent did not show any correlation between pyrethroid concentrations and effects ($r^2 = 0.004$). For this reason it is not clear what the relative contribution of pyrethroids were to the observed toxicity in any of the 100 percent effluent samples. Complete TIE testing to determine the proportion of toxicity from pyrethroids or other constituents was not conducted.

Weston and Lydy (in press) calculated a "rough approximation" of the pyrethroid loading in the Sacramento River from SRCSD discharge, but the considerable uncertainty associated with this estimate was understated. Detected pyrethroid concentrations reported in SRCSD effluent samples were quite variable among events, and for individual pyrethroids during each event (Irvine 2009). Measured concentrations were also at or near reporting limits where the associated error is highest. Measurement error rates are demonstrated by the variable (±30%) ability of the analysis method to recover known quantities of pyrethroids spiked into quality assurance/quality control samples. Measurements were also based on single grab samples collected during each event. Load calculations compound these potential errors by multiplying them by the millions of liters discharged each day.

Finally, there is no potential for toxicity in the Sacramento River due to pyrethroids discharged in SRCSD effluent. Recent pyrethroid studies have shown that toxicity can occur at extremely low levels. However, the levels of pyrethroids detected in SRCSD effluent are not of sufficient magnitude to cause toxicity to the most sensitive species in the Sacramento River (< 1 ng/L summed pyrethroids). These low ambient concentration estimates were supported by the toxicity data in ambient samples from the Sacramento River by Weston and Lydy (in press) and by the rare instances of *H. azteca* toxicity reported by Werner et al. (2008b) and Reece et al. (2009). Dilution series bioassays by SRWTP (conducted by Pacific EcoRisk) also demonstrated that effluent toxicity was attenuated in effluent concentrations much higher than the percent of effluent in the Sacramento River after accounting for dilution (Irvine 2009).

Summary

There is strong evidence that adverse effects are not occurring in the Sacramento River due to constituents in SRCSD discharge.

- Ambient ammonia concentrations in the Sacramento River have never exceeded EPA acute or chronic toxicity values.
- Recent studies have repeatedly shown that ambient ammonia concentrations are well below those acutely toxic to delta smelt.
- Recent pyrethroid studies have shown that toxicity can occur at extremely low levels. However, the levels of pyrethroids detected in SRCSD effluent are not of sufficient magnitude to cause toxicity to the most sensitive species in the Sacramento River.

Current research and publications conclude that other stressors associated with SRWTP effluent do not cause adverse effects in the Sacramento River and Delta. The SWRCB can be confident that these "other stressors" do not need to be considered in its Delta flow criteria determination. While more research may be needed to understand the potential for chronic effects from contaminants, the available information does not support that chronic effects are occurring.

References

Irvine, C. 2009. 2008/2009 Summary of Don Weston's (UC Berkeley) 2008/2009 Pyrethroid Source Evaluation Study Results from SRWTP Effluent. Draft Technical Report. Prepared for the Sacramento Regional County Sanitation District. 2 July.

Reece, C., D. Markiewicz, L.Deanovic, R. Connon, S. Beggel, M. Stillway, and I Werner, I.L.2009. Pelagic Organism Decline (POD): Acute and Chronic Invertebrate and Fish Toxicity Testing in the Sacramento-San Joaquin Delta 2008-2010, Progress Report III. 29 September.

Seyfried, R. 2009. Sacramento Regional Comments on Acute Toxicity of Ammonia/um and Wastewater Treatment Effluent - Associated Contaminants on Delta Smelt – 2009, Draft Report (10/30/09). Letter to Stephanie Fong, Central Valley Regional Water Quality Control Board. 30 November.

United States Environmental Protection Agency (USEPA). 1999. 1999 Update of Ambient Water Quality Criteria for Ammonia. Office of Water. EPA-822-R-99-014.

Werner, I., C. Irvine, and C. Foe. 2008a. The Effects of Wastewater Treatment Effluent-Associated Contaminants on Delta Smelt. Ammonia Toxicity Sampling and Analysis Plan. 28 July.

Werner, I., L.Deanovic, D. Markiewicz M. Stillway, N. Offer, R. Connon, and Susan Brander. 2008b. Pelagic Organism Decline (POD): Acute and Chronic Invertebrate and

Fish Toxicity Testing in the Sacramento-San Joaquin Delta 2006-2007. Final Report to the California Department of Water Resources, Sacramento, CA. 30 April.

Werner, I., L.Deanovic, M. Stillway, and D. Markiewicz.et al. 2009a. Acute Toxicity of Ammonia/um and Wastewater Treatment Effluent-Associated Contaminants on Delta Smelt, Final Report. 3 April.

Werner, I., L.Deanovic, M. Stillway, and D. Markiewicz. 2009b. Acute Toxicity of Ammonia/um and Wastewater Treatment Effluent-Associated Contaminants on Delta Smelt – 2009. Draft Report. 30 October.

Weston, D.P., and M.J. Lydy. In press. Urban and Agricultural Sources of pyrethroid insecticides to the Sacramento-San Joaquin Delta of California. Environmental Science & Technology.