BDCP Chapter 5: Effects Analysis
Appendix D: Toxins

Toxics Comments Main Issues summary

Many of the toxins in this chapter are inherent problems in the Delta not caused by the PP. However, it is possible that where problems exist in the Delta, water operations and habitat restoration may alter the fate, transport or accumulate these toxins in the estuary food web including the target species. The EA must identify any such areas of concern and describe how foreseeable changes to toxins would likely affect covered species.

My understanding of the purpose of the EA technical appendices is to present the methods for the EA. The appendix, as written, is mostly conceptual modeling and "results" with very little methods. In areas where results are presented, the effects of the PP are intermixed with assumed outcomes of other contaminant regulatory efforts. The appendix makes repeated references to modeling performed as part of the EIS/EIR.

The conclusions of those models are presented but with no details on methods or assumptions. The discussion directly follows the EIS/EIR analysis results with the statement that the quantification of the effects of water operations is "not possible given the lack of current information current concentrations and distributions." What models were investigated and found not useful and why? Are quantitative models available or not? If they are available but not used, reason should be given as to why they were unusable for the EA but appropriate for the EIS/EIR.

There is, overall, a lack of useful detail. The Toxins analysis suffers from a lack of graphical conceptual models for individual constituents. Each constituent behaves differently in biogeochemical cycling. The lack of consideration of the behavior of the constituent in the environment is evident in the level of complexity of the analyses. Specifically, the environmental fate discussions do not adequately analyze how water operations and habitat restoration move and modify the constituents in the Delta. How will the PP affect the speciation and timing of toxic constituents? Further illustrations of this problem are described below.

Because loading and concentrations of contaminants can vary with hydrology, analysis should take water year type into consideration. Full descriptions of hydrodynamics, variation in constituent behavior with water years, wetland management and effect on increased residence times on chemical constituents are needed.

The discussion of pollutant sources is incomplete and too general. Please revise to include a more thorough description of both point and non-point sources for toxic constituents and the contributions from each watershed. Where is each chemical constituent coming from? Are inputs still being made and are they increasing or decreasing? Please include loading to proposed wetland restoration areas and the Delta.

For example, how do contribution of pyrethroids from non-point runoff from agriculture and urban stormwater vs. the input of Sacramento Regional Wastewater Treatment Plant outfall?

Quantitative modeling for each of the relevant constituents is a large undertaking. Believability of the appendix improves when modeling options are discussed and the rationale for the elimination of quantitative models is presented. What models are available (there are lots out there for mercury and selenium)? Why where they determined to be inappropriate or impractical? The conceptual models are a reasonable alternative in circumstances where quantitative models are not available. What is needed for a conceptual model to be adequate is a detailed narrative of each constituent's behavior within the Delta for each water year type and how the PP will change the behavior and its interaction with covered species, their prey and their habitat.

USFWS Note: Microcystis was previously present with these analyses. Where is it now?

1. Selenium

What will inundation of restoration marshes do to sequestered and incoming selenium? How will it change Se speciation and bioavailability? Speciation is particularly important in determining how much loading is required to result in dangerous concentration in the food web (Lemly and Smith 1987; Skorupa et al. 1996) as different species of selenium have differing bioavailability. Particulate forms of Se are particularly important in the role of bioaccumulation. How will the project affect them? We recommend the development of a graphical conceptual model to aid in answering these questions (see Figure 2, Lemly and Smith 1997)

Will wetland restoration concentrate, make bioavailable and bioaccumulate more Se than the agricultural land it is replacing?? What logic or analytic steps were used to make and defend this conclusion?

Mercury

Summary of major mercury facts needed for a suitably accurate BDCP analytical framework

1. The DRERIP Mercury Conceptual Model is available at: http://science.calwater.ca.gov/pdf/drerip/DRERIP_mercury_conceptual_model_final_012408.pdf
   This model was developed by several of the key researchers of mercury dynamics in the San Francisco Estuary watershed (Alpers et al. 2008). The Service provides the following to fill out a conceptual background for BDCP's EA.

2. As the Toxins Appendix notes, most of the ongoing mercury load (> 50%) is coming from Cache Creek, which is not a Project stream. The rest of the mercury that can become

bioavailable is either already in the Delta sediments and methylated in existing wetlands (not a Project effect) or is mobilized and transported into the Delta from tributary streams, particularly during high flow events. For the most part, *managed* Project flows probably only cause "decimal dust" variation in mercury loading.

3. The main thing the BDCP is proposing that might increase MeHg accumulation in target or nontarget species is converting farmland to wetlands and enhancing some existing wetlands and floodplains. The places this may have the biggest influence on MeHg accumulation are the Cache Creek and Cosumnes River confluence regions where mercury monitoring of fishes has shown elevated body burdens (Slotton et al. 2002; Davis et al. 2008; Henery et al. 2010).

4. The BDCP is also proposing more frequent Yolo Bypass inundation, which might generate more MeHg production (Alpers et al. 2008), but the plan proposes to flood with Sacramento River water which may decrease MeHg accumulation rates for fishes using the bypass relative to what they would accumulate when only west-side streams are flooding the bypass (Henery et al. 2010).

5. That said, MeHg generation can already be moderate to high in managed wetland, rice field, and other irrigated ag soils in the region (Table 2 of Alpers et al. 2008), so it is not a certainty that land use changes proposed by BDCP will increase the MeHg burden in the ecosystem over baseline levels.

6. The accumulation of MeHg by fishes does not always spatially match the ambient production of this toxin (Slotton et al. 2002). MeHg body burden will probably reflect fish feeding history (Matta et al. 2001; Hammerschmidt and Sandheinrich 2005; Deng et al. 2008). Planktivores (like the smelts) generally accumulate less than benthivores (like sturgeon and splittail). The same is true for selenium accumulation.

7. Young Chinook salmon and the local biosentinel species Mississippi silverside are opportunists with regard to truly planktonic (crustacean zooplankton) versus quasi-benthic (small insect) prey. This may explain some of the spatial variation that has been reported regarding their bioaccumulation of MeHg (Slotton et al. 2002; Henery et al. 2010).

8. Chironomid midges are the major MeHg vector food item in Clear Lake (Suchanek et al. 2008). Chironomids are a major Chinook salmon food source in Yolo Bypass (Sommer et al. 2001) where they emerge from sediments upon flooding (Benigno and Sommer 2008). Chinook salmon in Yolo Bypass have higher MeHg body burdens - up to twice as high as in the Sacramento River (but both groups are in the 0.01 ug/g order of

magnitude). This is lower than the 0.1 order of magnitude body burdens carried by piscivorous sport fishes in the region (Davis et al. 2008), and well below the ca. 1-10 ug/g order of magnitude levels of MeHg burden associated with abnormal behavior etc. in trout species (citations in Matta et al. 2001).

9. The effects of dietary MeHg have also been studied on multiple generations of mummichogs (Matta et al. 2001). The 0.01 ug/g order of magnitude body burden was not found to affect survival, egg production, fertilization success, fish weight, or the performance of the F_1 and F_2 offspring. Fish diets containing ca. 10 ug/g MeHg order of magnitude in the prey were found to cause readily observable problems for both mummichogs (Matta et al. 2001) and splittail larvae (Deng et al. 2008).

10. The draft appendix is using an inappropriate conceptual model regarding egg exposure to MeHg. The primary source of exposure is maternal transfer – not absorption through the egg membrane. The major source of MeHg to fish *eggs* is maternal transfer due to the food eaten by females *only during egg development* (Hammerschmidt and Sandheinrich 2005). This means that delta smelt foraging near Yolo Bypass or splittail foraging in Yolo Bypass and the Cosumnes River immediately prior to spawning are likely to accumulate comparatively high levels of MeHg in their eggs. The Mississippi silverside biosentinel results for the San Joaquin River (Slotton et al. 2002) also suggest that splittail moving up the SJR to spawn will also have comparatively high egg MeHg concentrations. These are all significant spawning locations for splittail and they use them to greatest degree and success during high flows when MeHg accumulation is highest. This is pretty decent evidence that splittail production is limited to much greater extent by spawning habitat availability among years than MeHg toxicity.

11. MeHg concentrations in Bay-Delta Mississippi silversides are highest in wet years; MeHg in Corbicula clams is elevated in the low-salinity zone and MeHg production is elevated in floodplains and wetlands (Slotton et al. 2002). Ubiquitously, these are habitats and in the case of the low-salinity zone, flow-landscape interaction conditions that are associated with native fish production (Meng et al. 1994; Sommer et al. 1997; Meng and Matern 2001; Feyrer et al. 2007; Hobbs et al. 2010).

12. Thus, it is also reasonable to conclude that appropriate habitat conditions for native fishes in general are more limiting than MeHg exposure and bioaccumulation.

13. This is not intended to dismiss the potential for mercury toxicity in the Valley. The reproduction of clapper rails is currently impaired by mercury contamination (Schwartzbach et al. 2006). However, this has not been demonstrated for Forster's terns, American avocets and black-necked stilts (Ackerman et al. 2007; 2008); the latter

studies linked foraging site fidelity to mercury bioaccumulation. Thus, the best approach for BDCP is to incorporate site-specific monitoring of mercury bioaccumulation into its habitat restorations to determine if its actions generate detectable changes in potential toxicity to locally occurring wildlife.

2. Copper

How will water operations and restoration affect the prevalence of each species of copper, bioavailability, etc.?
The NOEC for dissolved copper are 150 µg/L for zooplankter *Eurytemora affinis* and 41.4 for µg/L delta smelt (Werner et al. 2010).
Copper has been shown to be important to salmonids olfaction with impairment at low concentrations. Baldwin et al. suggests olfactory inhibition in juvenile Coho salmon between 1.0-20.9 µg/L. Toxic thresholds for receptor pathways were found at 2.3-3.0 µg/L over background. Additional research showed that predator avoidance behaviors of juvenile Coho were significantly impaired by copper at concentrations as low as 2 µg/L (Sandahl et al. 2007). These experimental thresholds underline the importance of copper changes in the Delta and the necessity of qualitative modeling in wetland areas used by juvenile salmonids such as Yolo Bypass.

3. Ammonia

As stated in the appendix, water exports will reduce dilution of WWTP effluent below the intakes. Will the PP result in increased dilution of Stockton WWTP effluent? Will it increase residence times for WWTP nutrients in the Delta?
Although Sacramento River ammonia concentrations do not exceed AWQC, research suggests that phytoplankton uptake inhibition may be occurring downstream in Suisun Bay as a result of current effluent loads. Adequate data is available to model ammonia concentrations in the Sacramento River and downstream into Suisun Bay and to estimate the change due to lower Sacramento River flows due to the proposed North Delta Diversions.
Nitrogen uptake inhibition in phytoplankton in Suisun Bay has been documented at 4 micromoles/L (Dugdale et al. 2007). How will the project affect concentrations of ammonia/ammonium with reduced Sacramento River dilutions with and without 2010 permit compliance?
Again, analyze what the effects of the PP are independent of other pollution control efforts. The WWTP upgrade is at least 10 years away and the permit is under appeal. Thus, ammonia conditions may be affected by water exports. Analyze project effects and regulatory effects separately.
Connon et al. (2011) found a NOEC of 5.0 mg/L NH_4Cl for delta smelt. Sublethal exposures of delta smelt altered gene transcription associated with cell membrane

integrity, neurological and muscular function supporting theories that exposure to ammonia results in cell membrane destabilization which could affect membrane permeability and increase uptake resulting in synergy with other toxics. Toxicological evaluations of ammonia on two species of zooplankton important to delta smelt (*Pseudodiaptomis forbesi* and *Eurytemora affinis*) provide relevant toxicity thresholds (Werner et al 2010; Teh et al. 2011).

4. Pesticides

Conversion from Ag to wetland represents a reduction of pesticide use but not elimination of their use entirely (e.g. mosquito control).
Changes in water residence times and flushing flows in the Delta will affect toxicity in benthic sediments.

5. Conclusions on effects on covered fishes

Provide precise and relative comparisons of current and PP environmental conditions. For example, in D.6.2 levels of copper in through much of the Delta are "not extremely high." Copper disrupts salmonid olfactory function at the microgram per liter level. How does this relate to the "not extremely high" values at present and in the future with the PP?