

Attenuating Selenium Loads and Ecotoxic Risk in Hypersaline Drainage Systems by Combining Picoplankton Volatilization of Selenium and Macroinvertebrate Harvest

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EXECUTIVE SUMMARY:

The ecotoxic risk of Se remains a major problem for the sustainability of the San Joaquin Valley's agricultural drainage disposal systems for over two decades. No practical solution to this problem has been implemented to date. Whether the option being in-farm drainage management (IFDM), reverse osmosis, or anaerobic biological reduction systems, no single system has demonstrated all of the three targeted outcomes, i.e. attenuation in Se ecotoxic risk, reduction in total Se load, and low cost. It is clear that given the complexity of the Se problem, a combination of remediation strategies may be required.

Our past research has uncovered evidence that algal volatilization of Se can be underlying the lack of Se buildup in the hypersaline TLDD drainage evaporation basins and that coupling Se volatilization with brine shrimp harvest can reduce both total and bioavailable Se loads. The high Se volatilization capacity of hypersaline drainage waters appears to be associated with the abundance of ultra-small algae ("picoplanktons"), which are not grazed by brine shrimp and accumulate less Se in the biomass than other algal species. Such extant process occurring at TLDD basins is inherently low cost and has the promise of minimizing Se ecotoxic risk. In order to sustain the process and to apply to other drainage systems, a better understanding of the relationship between water chemistry, algal community, and brine shrimp growth is needed.

Thus, this proposal has the following two objectives: 1) To continue monitoring the Se and algal status in hypersaline TLDD basins where brine shrimp are being harvested so that the algal composition involved in Se volatilization and in sustaining brine shrimp harvest is better defined; 2) To test the efficacy of the combined process in a pilot system established at the Red Rock Ranch on the west side of the SJV so that the water chemistry for optimizing the growth of Se-volatilizing picoplanktons and of algae that sustain brine shrimp population can be discerned.

We will fulfill the 1st objective by measuring Se status in hypersaline TLDD waters, microalgae, and brine shrimp, Se volatilization capacity of the waters, and algal composition. These data will be compared with the harvest yield of brine shrimp and with data acquired from previous years to see if the lack of buildup in total and bioavailable Se continues to persist.

To accomplish the 2nd objective, we will manipulate the water chemistry in the hypersaline cell of the pilot drainage system at the Red Rock Ranch and measure the effect on algal composition, harvest yield of brine shrimp, Se status in algae and brine shrimp, as well as Se volatilization capacity of the water. We will also analyze for proteinaceous Se and selenomethionine forms in algae and brine shrimp so that the ecotoxic potential of the hypersaline system can be better evaluated.

If successful, this work will generate practical and sustainable means for managing hypersaline drainage waters in reducing both Se load and ecotoxic risk. Such system can be deployed alone or in combination with other options where Se-laden hypersaline waters are generated.

