Public Comment
Selenium TMDL North San Francisco Bay
Deadline: 2/12/16 by 12:00 noon

Robert C. Kaufman, PhD
Ann G. Houck MS
PO Box 27 Douglas City, CA 96024
530-908-2386
bc3kaufman@gmail.com
gwyneth.houck@gmail.com

RECEIVED
2-12-16
SWRCB Clerk

Jeanine Townsend, Clerk to the Board
State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95812-2000
Sent Via e-mail to: commentletters@waterboards.ca.gov

Re: Comment Letter—Selenium TMDL, North San Francisco Bay

To whom it may concern:
San Francisco Baykeeper commented on the selenium TDML limits proposed by the San Francisco Regional Water Quality Control Board. Contained within their comments are references to data that we generated under the CALFED science funded-program: "Quantitative Indicators And Life History Implications Of Environmental Stress On Sturgeon." This research program was a collaborative effort of UC Davis research laboratories overseen by lead investigators: Drs. Dietmar Kueltz, Serge Doroshov, Silas Hung, Joseph Cech, Jr., and Marty Gingras. This research looked specifically at the intra- and interspecies response in white and green sturgeon exposed to dietary exposure, in varying concentrations, of selenomethionine (SeMet) and methylmercury (MeHg). Larval and juvenile life stages of both species were used in this research.

In comment 5.2 (Appendix D) the SF Baykeeper posed a question concerning numeric fish tissue targets for selenium, and their suitability to ensure protection of fish species.

The staff response to this comment includes the following two statements:

The updated criteria now include white sturgeon data, which makes the draft criteria directly applicable to selenium-sensitive fish in the North Bay.

Therefore, the TMDL numeric target is protective of the most sensitive species in the North Bay, the white sturgeon.

The staff report makes the following citation and conclusion (Appendix C, page 24):

High variability in observed selenium bioaccumulation rates led Tashijan et al. (2006) to conclude that juvenile white sturgeon were relatively less sensitive to selenium toxicity than other fish species. In laboratory experiments they showed that even *dietary concentrations exceeding 190 μg/g-dw did not affect the survival of sturgeon (the mean survival rate was 99±0.43 percent).*

We agree with the conclusion that white sturgeon are relatively insensitive to selenium exposure compared to other fish species. The inclusion of white sturgeon tissue data does add applicability to the proposed standards but may not be protective of the most sensitive species in the North Bay given that white sturgeon are less sensitive than other species of fish, including green sturgeon, to SeMet. The data generated in the CALFED study not only corroborated that white sturgeon are relatively insensitive to selenium but demonstrated that green sturgeon show a marked difference, and sensitivity, in their response to selenium exposure. After an 8-week exposure to dietary levels of 80 and 40 mg/kg SeMet green sturgeon mortality was 8% and 22% respectively with no mortality in the white sturgeon juveniles fed identical diets. These data document marked differences between these two sturgeon species and brings into question the suitability for using white sturgeon as a surrogate for green sturgeon response to SeMet exposure.

Additionally, unexposed green sturgeon growth rate, as juveniles, is nearly twice that of white sturgeon while exposure to SeMet suppressed the growth of green sturgeon at all dietary concentrations ≥ 20 mg/kg SeMet. White sturgeon growth rates were less affected and after an 8 week exposure to the 20 mg/kg SeMet diet there were no observed difference from control diet response in white sturgeon while a 50% reduction in growth was observed in green sturgeon. These stark differences in the two sturgeon species suggest that dietary exposures, approaching levels of Se found in benthic prey species in the North Bay, have the potential for adverse effects in green sturgeon juveniles and call into question the suitability of using white sturgeon as a surrogate for green sturgeon.

Current data suggest that the Sacramento River and North Bay represent the only identified spawning and juvenile rearing areas for the sDPS green sturgeon. Green sturgeon's ability to tolerate higher salinities is size dependent and data suggest that GS juveniles rear in the estuary for a period of 1-4 years but supporting data is sparse and mostly speculative. Suppression of green sturgeon rapid juvenile growth rate, via SeMet exposure, may delay time to salinity tolerance and impact out migration to the ocean environment. Extended residence within the North Bay further increases the duration of exposure to SeMet and other contaminants in this sensitive species. This may have a direct impact on the recruitment of juveniles into the green sturgeon population reducing the number of individuals available to mature to spawning adults.

Staff response to comment 5.6:
We have evaluated the most recent scientific information and data, and conducted modeling to evaluate the impact of current loads on water quality and beneficial uses

in the North Bay (see Staff Report). We found no compelling evidence to suggest that the existing loads adversely affect green sturgeon or that white sturgeon cannot serve as a surrogate for green sturgeon. The Commenter points to one particular study by Kaufman et al. (2008)[1] *and provided the Water Board with other references to support their comments.*
We have considered the study by Kaufman et al. (2008) in the Background and Impairment Assessment section of the Staff Report. In this study, the authors tested effects of selenium on green and white sturgeon bioenergetics and concluded that green sturgeon exhibited greater sensitivity to selenium at the dietary dose of 20 µg SeMet/g. We do not dispute the sensitivity of green sturgeon to selenium. However, selenium concentrations and dose spacing (0, 20, 40, 80 µg SeMet/g) used in the experiment were too high to be applicable to the conditions in the North Bay and to accurately determine the toxicologically significant thresholds. Furthermore, the study focused on predator avoidance and reduced swimming performance rather than reproductive end points, which are the key for protection of fish. Experts suggest (Chapman et al. 2009)[2] *that reproductive effects have been linked to observed reductions in the populations of sensitive fish species in waterbodies having elevated concentrations of selenium, and, therefore, they provide a sound basis for the fish tissue criterion compared to non-reproductive endpoints.*

Our portion of the UC Davis CALFED science funded-program, focused on sturgeon bioenergetics and predator avoidance. However, it represents only a portion of the data generated in this study. I have referenced a few of the salient results of this study but would like to point out that in both life stages utilized in these experiments, larvae and juveniles, exhibited statistically significant differences between white and green sturgeon responses. The results of some of the SeMet study endpoints, larval exposure, growth, growth rate, mortality, swimming performance, and predator avoidance all document the greater sensitivity of green sturgeon compared to white sturgeon. Staff response (Appendix D, pg.16, response 5.6) indicate that there is no disagreement that green sturgeon show a greater sensitivity to SeMet exposure when compared to the relatively insensitive white sturgeon. The lowest dose of SeMet used in this study is at a concentration that has been found in the North Bay and the data suggest that NOEC and LOEC levels are much lower than 20 mg/kg SeMet. These data suggest that white sturgeon would not be suitable as a surrogate species.

Adoption of reproductive indices to protect species inhabiting selenium-contaminated waters is prudent for species that spend all, or a majority of their lifespan in these waters. While applicable to white sturgeon there is little to no overlap between the two sturgeon species given green sturgeons subadult and adult oceanic life history. Pre-spawn green sturgeon adults enter the system in late winter and rapidly migrate through the system to the available upper reaches of the Sacramento River. Larvae and juveniles migrate down river to the estuary where they rear and grow for 1-4 yrs. until they reach a saltwater tolerant size. At this point out migration to the ocean occurs. Green sturgeon spend a majority of their life in the ocean environment with some movement into estuaries along the west coast, USA. Once sexually mature, sDPS green sturgeon adults migrate into the Sacramento River system every 3-5 yrs to spawn. Post spawn adults often spend several months within the Sacramento River near their spawning sites. Increased river flows in the fall trigger an ocean-bound migration. Generally, white sturgeon, are primarily an estuarine species spending the majority of their life in the estuary with little to no ocean forays. This raises the question of the proposed criteria having any applicability at all to protect the listed sDPS green sturgeon population.

Tracking and monitoring studies have demonstrated that returning green sturgeon adults spend little time within the North Bay thus limiting their exposure and tissue burdens of SeMet for maternal transport to eggs. SeMet exposure as juveniles, 1-4 yrs or more, within the contaminated estuary is the greater concern. While the available data on SeMet exposure and response in white and green sturgeon are limited they do exist and should be included in the development of protection criteria. All data collected to date support a single conclusion that green sturgeon are much more sensitive, to SeMet, than the more resistant white sturgeon. Currently, there are no available SeMet NOEC or LOEC for juvenile green sturgeon across the range of Se concentrations found in the North Bay at this date. Given the marked differences in responses between white and green sturgeon we support a more stringent tissue burden criteria that will be protective for juveniles of the sDPS population of green sturgeon that spawn and rear in the Sacramento-SF Bay watershed.

Sincerely,

Robert C. Kaufman

Robert C. Kaufman, PhD

Ann G. Houck

Ann G. Houck, MS