

Selenium Antagonism to Mercury

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**Does Methylmercury
Cause Significant
Harm to Fish or
Human Health?**

Modest recreational dredging in California streams would benefit water quality because a sluice box simulates a natural riffle-pool in stretches of a stream. Natural riffle-pools increase turbidity.

Furthermore, there would be increased oxygenation of water (and sediment) thereby providing more and improved habitats for fish and fish-food organisms and creates depressions, temporary pools and refuge.

Overburden and oxygenated water flowing off the end of a sluice box submerges and mixes below the water surface. This turbulent action breaks the surface tension and the dense materials settle out in a short distance.



Oxygenation of sediments by large wood barriers or dredging (and minor diversions or discharges, in the case of dredging) ensures, to a greater extent, that elemental mercury will not methylate to the form more highly bioaccumulated by aquatic biota.

Dr. Del Nimmo, 2011, Peer Reviewer California EIR for suction dredging.

Published peer reviewed articles leave no doubt that Hg contamination in historic mining basins is significant.

Presents doesn't mean toxicity

However, the fact remains that most suction dredgers do not see hot spot's of Mercury. Most report seeing only occasional drops of mercury or amalgamated gold if any.

Humphreys, Fleck, Alpers, and Marvin-DiPasquale have attempted to quantify effects of small-scale suction dredging on mercury. Although they have added bits of information to the data base of known mercury hotspots, this information can not be correlated to effects that suction dredges may have on Hg in the environment.

Rick Humphreys. 2005. Mercury Losses and Recovery, During a Suction Dredge Test in the South Fork of the American River. In House Report, California Water Board.

Charlie Alpers. 2007. CDFG PAC Meeting overview.

M. Marvin-DiPasquale, C.N. Alpers, J.A. Fleck, J.L. Agee, E. Kakouros, Le H. Kieu, E. Beaulieu, and D. Lawler. 2009. Presented at the 19th Annual Meeting of the Northern California Regional Chapter of the Society of Environmental Potential impact of disturbance events on mercury associated with hydraulic mining sediments. Toxicology and Chemistry.

Rick Humphrey's (Ca SWRCB) performed a 4 inch suction dredge study in a mercury hotspot, the most highly contaminate area in California. The purpose was to quantify the ability of a dredge to capture elemental mercury.

**98% of the mercury
was captured in the sluice box**



A 3 inch dredge pilot study showing no impact regarding Hg.

Suction dredge test in the South Yuba River downstream of Humbug Creek, October 11, 2007; C.N. Alpers, USGS.

Following that, a study was designed to evaluate the true impact of an 8 inch dredge in the same area where Humphrey's performed his study.

The BLM refused to allow that study so it had to be re-designed.





Their conclusions were formed from observations made from enclosed containers under high surface tension. It is of concern that their observations were extrapolated from data gathered in a hotspot to represent a real stream environment where they say Hg would float indefinitely.

Even while panning concentrates gold floats until the surface tension is reduced.

Dr. Charles Alper's calculated from data collected from this re-circulation study that "an 8 inch dredge could move more material in a year than nature."

Dr. Charles Alpers, 2009, USGS, statement made before the California Department of Fish and Wildlife, Public Advisory Committee on Suction Dredging.

The simulation used to address the “alleged” problem is flawed. By circulating sediment and water from an excavated depression in a sand and gravel bar is not a simulation.

A valid test is to operate a typical dredge. It must be used in the current of a stream along a stream bank and operated for several hours.

January 2010, EPA reported that “since suction dredge mining creates turbidity in the stream it is likely this action increases oxygenation of the waters and therefore, methylation of inorganic mercury would be less likely to occur in these habitats.”

US EPA, 2010, Biological Evaluation for Small Placer Miners in Idaho National Pollutant Discharge Elimination System (NPDES) General Permit, U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

❖ **"In comparisons between mined and unmined basins, across all sites, fish Hg, as wet weight, was not significantly different between sites in unmined basins and mined basins.**

❖ **Concentrations of methylmercury in bed sediment and unfiltered stream water from sites in unmined basins were not significantly different from those in mined basins;**

❖ **However, total mercury concentrations were significantly higher in bed sediment and stream water from sites in mined basins."**

Noted was that percent of methylmercury (percentage MeHg/THg) in bed sediment and unfiltered water were significantly higher in unmined basins.

Although THg concentrations in unfiltered water were higher as a group from streams in mined basins, MeHg concentrations were not as high relative to those unmined basins. Water from unmined basins low in THg was high in MeHg.

For elemental mercury to become methylated, one has to have ...

dissolved organic carbon, undisturbed sediments, anoxic conditions, sulfate-reducing bacteria, phosphorus indirectly influencing carbon, oxygen, sulfur and iron cycles, and warm consistent temperatures.

None of these interconnecting factors are likely happening in the streams where suction dredging has – or will occur.

Selenium's ability to moderate and protect against mercury toxicity.

Current thinking

Ensuring that normal selenoprotein synthesis is maintained.

There is no doubt that methylmercury can cause great harm. An extreme example of this occurred in Minimata, Japan where inhabitants were exposed to 27 tons of Hg waste dumped in the bay but with no corresponding shift in selenium levels.

“A large body of evidence has been published that indicates supplemental dietary selenium moderates or counteracts mercury toxicity,”

“Mercury exposures that might otherwise produce toxic effects are counteracted by selenium, particularly when the Se:Hg molar ratios approach or exceed 1.”

Selenium has a high affinity to bind with mercury, blocking mercury from binding to other substances, such as brain tissue.

The bond formed is irreversible.

“ All higher animal life forms require selenium-dependent enzymes to protect their brains against oxidative damage.”

**At high exposures Se and Hg
can each be individually toxic,
but evidence supports the
observations that
co-occurring Se and Hg
antagonistically reduce
each others toxic effects**

Parizek et al. "The protective effect of small amounts of selenite in sublimate intoxication." *Experientia*. 1967 Feb 15;23(2):142-3.

Peterson, S. A. et al, 2009, How Might Selenium Moderate the Toxic Effects of Mercury in Stream Fish of the Western U.S.?, *Environmental Science and Technology*., 3919–3925

In 1978, scientists from Sweden were reporting that “mercury is accompanied by selenium in all investigated species of mammals, birds, and fish,” adding that it

“seems likely that selenium will exert its protective action against mercury toxicity in the marine environment”

In 2000, a group of Greenland scientists published the results of mercury and selenium tests performed on the muscles and organs of healthy fish, shellfish, birds, seals, whales, and polar bears.

**They found that,
“selenium was present in a substantial surplus compared to mercury in all animal groups and tissues”**

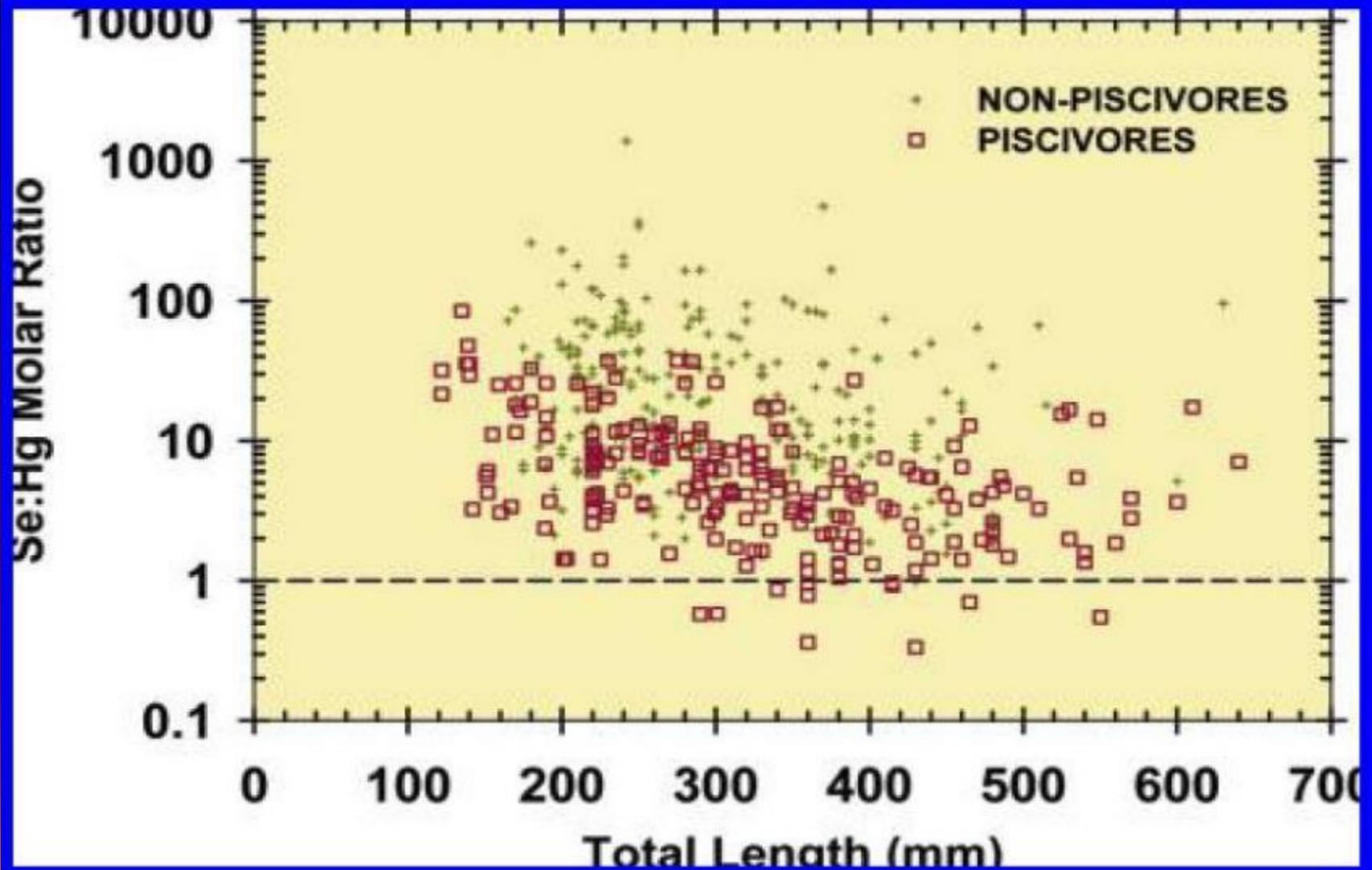
In 2001, Researchers at Laurentian University in Ontario reported that selenium deposits, from metal smelters into lake water, greatly decreased the absorption of mercury by microorganisms, insects, and small fish.

Suggesting a strong antagonistic effect of Se on Hg assimilation.

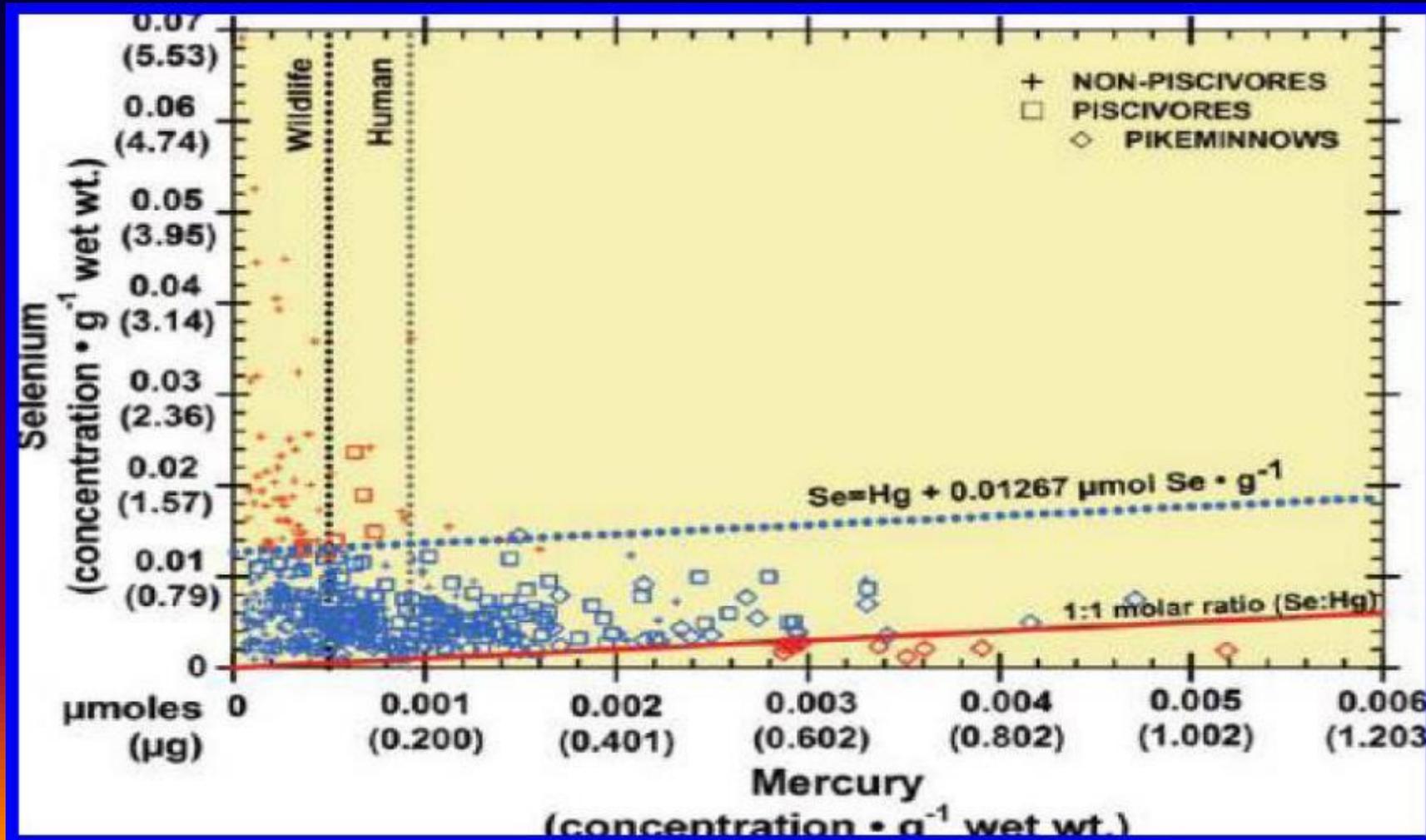
In 2009, Peterson's group collected 468 fish representing 40 species from 130 sites across 12 western U.S. states. Samples were analyzed for whole body Se and Hg concentrations. The fish samples were evaluated relative to a wildlife protective Hg threshold of 0.1 ug Hg/g wet weight, and the current tissue based MeHg water quality criteria for the protection of humans 0.3 ug Hg/g wet weight and presumed protective against Hg toxicity where the

Se:Hg molar ratios are greater than 1.

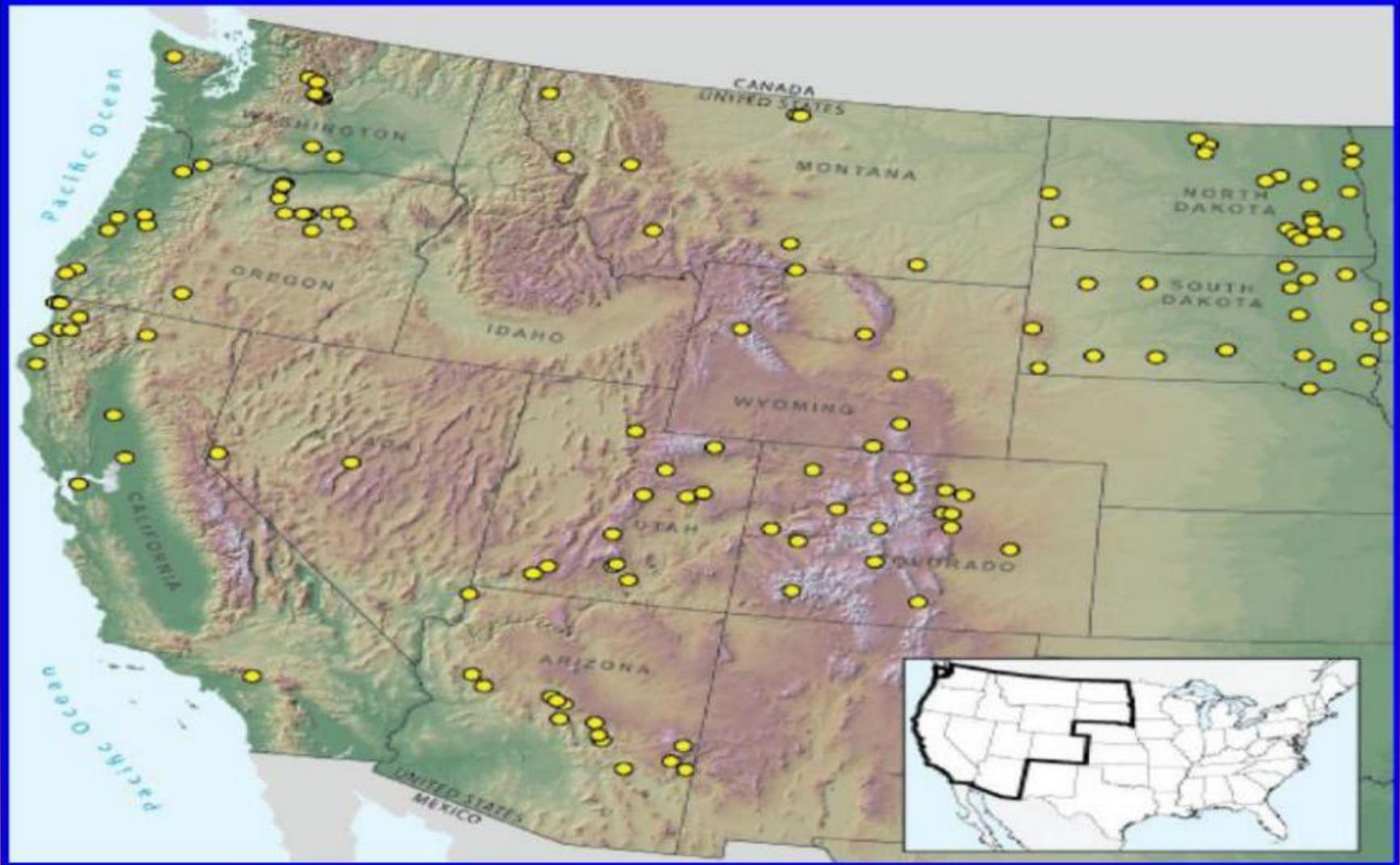
Molar ratio of selenium to mercury relative to fish size. The horizontal dotted line is the Se:Hg, 1:1 line.



Selenium and mercury concentrations in whole fish tissue.



Location of probability based sites where fish tissue samples were collected for Hg and Se analysis.



Results showed 97.5% of the freshwater fish in the survey had sufficient Selenium to potentially protect them and their consumers against mercury toxicity.

Peterson's study included data for samples collected in California which, in all cases, contained proportions of mercury to selenium that were adequate to protect fish, wildlife and human health.

The California results were 100% protective.

“Mercury toxicity only occurs in populations exposed to foods containing disproportionate quantities of mercury relative to selenium.”

Ralston, Nicholas. Physiological and Environmental Importance of Mercury-Selenium Interactions. United States Environmental Protection Agency National Forum on Contaminants in Fish. September 19, 2005.

Selenium
is the key to understanding mercury
exposure risks.

**OEHHA says no one in
California has ever
been sick or died of
Mercury poisoning
from eating sport fish.**

Hg warnings in fish continue to be published for public awareness.

Current mercury advisories focus only on the mercury levels in fish. They do not account for the beneficial nutrients or the selenium– mercury interactions.

40 years of research illuminates the conclusion of 100's of journal articles that indicate mercury is not a threat to the environment or human health if the molar ratio of Selenium:Mercury meets the defined criteria.

Current studies show that 95-100% of the US has adequate selenium to be protective of human health.

Where there is adequate selenium in the environment methyl mercury is non-Toxic and will not cause harm to fish or human health.

Anyone have a concern for the 5% not protected by adequate selenium?

Ocean fish

Sportfish

Why then has Sierra Fund asked for and received millions of dollars in grant money to educate the public on the hazards of Hg and to dredge up Hg from Combie Reservoir?

-They may not be well educated on Hg's affinity for Se.

-Scaring the public brings support and more money to fund other projects.

-and support to ask for millions to dredge Combie.