Scientists target mercury in Cache Creek

Elizabeth Case, Davis Enterprise, 2-15-15

Just northeast of Woodland, a half-mile from the intersection of Interstate 5 and Highway 113, Charlie Alpers assembles his team.

It's a typical Sacramento Valley morning: The tule fog hangs low and thick, obscuring Cache Creek, its riparian forest and neighboring farms. Alpers, a U.S. Geological Survey chemist, and his two technicians are investigating the presence of mercury in the Cache Creek settling basin, which collects debris from the creek before it washes into the Yolo Bypass.

Peter Bennett, a hydraulic technician for USGS, hefts a Hargis Core, a tube-shaped sampling tool, down the edge of the levee to the bank of the creek, site number 2497. The water is stagnant and the trees are bare. Bennett pulls out a coaster-sized dirt patty and hands it to Holly Pearce, a geology student at Sacramento State University. She cleans out leaves and sticks, then stuffs it into a glass jar and passes it off to Alpers.

Alpers is testing 90 plots around the basin to better understand how mercury falls out or concentrates as debris settles out of the creek. He is primarily concerned with the formation of methylmercury, a toxic byproduct of bacteria that digest iron and sulfide.

Methylmercury is the stuff that gets into algae, then insects, fish and finally humans. It's a neurotoxin responsible for a host of symptoms, including blindness, deafness and intellectual disabilities.

California is the perfect storm for mercury contamination. The coastal ranges churned out mercury for a century, generating 90 percent of the nation's production. Much of that mercury was shipped to the gold mines in the Sierra Nevada, where it was used to purify ore into precious metal.

Alpers has been working on mercury in California for more than 20 years. Currently, he's leading the project on mercury measurement in the Cache Creek settling basin, hoping he can provide the data needed to prevent further biological contamination. Cache Creek is responsible for 50 percent of the mercury that flows into the Sacramento River, and subsequently the Sacramento-San Joaquin Delta.

Built by the U.S. Army Corps of Engineers in the 1930s, the basin slows the flow of Cache Creek by widening its channel, which captures most of the heavy debris, like tree branches, rocks and clumps of dirt. This maintains the floodway integrity of the Yolo Bypass.

Alpers and his team are testing 90 sites along the creek's path through the basin to determine where and how the mercury settles out of the water — if at all. So far, Alpers said — cautioning that the work has not been peer-reviewed — it seems like the main finding is that mercury concentration increases downstream, regardless of whether the land is riparian or agricultural.

This is because upstream, large pieces of sediment fall out of the water as it loses energy and slow down. This debris contains little mercury: A majority of the element seems to be trapped in the silt — superfine particles that hang suspended in turbulent water.

Total mercury, though, isn't really the crux of the problem. Mercury enters the food chain only when it becomes methylated. When certain bacteria that thrive in oxygen-deprived environments (like flooded fields) digest iron and sulfur, they also interact with mercury, binding it to three hydrogen atoms and one carbon — a methyl group.

Methylmercury enters the food chain by binding tightly to cysteines, which are present in some proteins. As larger members of the food chain eat smaller, contaminated food sources, the concentration of methyl mercury amplifies. By the time humans get around to eating a fish, mercury is a million times more concentrated than in the water.

“Mercury is unique in that there are very few pathways in which we can rid the body of it,” said Josh Ackerman, another scientist with USGS who is working with Alpers to understand how mercury makes its way up the food chain.

Ackerman installed 300 bird boxes along the creek’s banks. House wrens and swallows nest in the box, and then Ackerman tests one egg from each nest for methylmercury, which can cause abnormal mating and caretaking behaviors in birds.

This information is useful for Alpers because house wrens, who use a majority of the boxes, forage nearby. The concentration of mercury in their eggs is indicative of the mercury in the insects in the nearby area.

Mercury decontamination was required by the Clean Water Act, which passed in 1969. But cleanup is a complex process, compounded by the reality that there remain little data on where the mercury comes from, what provokes methylation and how regulatory agencies can prevent mercury from entering the food chain.

For each body of water or region contaminated by a pollutant, the Clean Water Act requires states to determine the total maximum daily load (TMDL), which essentially determines how much of a pollutant can be present before the water is poisoned.

“The first rule is do no harm,” Alpers said.

Part of the reason mercury is so difficult to clean up is because regulatory agencies have to ensure that any effort to remove mercury from the system doesn’t accidentally increase the creation of methylmercury.

One of the potential solutions is to use a coagulant that binds the tiny silt particles that seem to be concentrated with mercury into larger chunks that then drop out of the water in the settling basin. These efforts are being led by Yamiko Hanneberry, a professor at UC Davis, and Tamara Kraus, a scientist at USGS.

“It’s a much more difficult issue than pesticides, or copper from brake pads, which are easy to clean up,” said Rik Rasmussen, manager of the mercury TMDL section of the State Water Resources Control Board.

Pesticides and copper from brake pads have identifiable sources; mercury does not. Mercury can be generated through industrial processes, occur naturally in mines, or be carried along through the air, deposited far from where it originated.

Because of these difficulties, one of the main steps taken by the state is to warn consumers away from eating too much fish. However, this method puts immigrants, anglers and tribes at risk, said Fraser Schilling, a professor at UCD.

“Under the (Clean Water Act), the state is supposed to clean up the problem. What they’ve done is tell everyone to eat less fish,” Schilling said.

And the total maximum daily load for mercury in state waters is based on the recommended fish consumption, which are exceeded by many communities of people who live along the delta.

Schilling is largely concerned with the lack of information about these at-risk populations. The state has not conducted comprehensive studies on mercury levels in blood or the frequency of symptoms related to mercury poisoning in communities that catch and eat much of their fish.

“I think it’s a fairly typical case where science produces information to make undesirable regulation inevitable,” he said. “The more information we have, the more impacts we have to deal with. But you can’t walk away from it.”