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Disturbed Waters: A Montana chemist searchers for the source of a persistent poison

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In December 2008, when Montana's great Clark Fork River tested its historic banks for the first time in 100 years, a crowd of hundreds gathered to watch the removal of Milltown Dam at the confluence of the river with the Big Blackfoot. After a century of pollution from Butte's copper mines, the river was undergoing the nation's largest-yet restoration project, the Upper Clark Fork River Superfund Complex.

But in a windowless laboratory a mile away, University of Montana chemist Langner had troubling news. Toxic methylmercury flowed through the river at concentrations of concern, undetected and undermining the project. It didn't come from Butte, but from a mysterious source closer to Langner's Missoula lab. This story follows Langner's journey as he searches for the surprising source of the toxin, and his struggle to get it cleaned up.

Disturbed Waters

A Montana chemist searches for the source of a persistent poison

The archway spans the gravel road. It bears the name of a ranch and its family. “Private Property,” it says.

Brakes whistle underfoot as Eliza slows to a stop. I twist against the passenger side window for a view of Fred Burr Creek beyond a colonnade of ponderosa pines.

Along the valley, September yellow cottonwoods and tamaracks glow against the gray horizon and black mountainsides. The Flint Creek Range, a stark crop of regolith that once attracted gold and silver miners by the thousands, now attracts skiers and anglers.

“Do you want me to keep driving?” Eliza asks.

“No,” I say. Trespassing is the last thing I want to do. “There was an access point just back there,” I say, looking toward Fred Burr Creek. If the road can’t get us to the mill, maybe the creek can.

Regardless of who owns this streambed, the state of Montana allows the public to recreate in the stream. But this protection is limited to water-related recreation. Fishing, swimming and boating are fine, but hiking or wading a streambed simply to reach a destination is considered trespassing if the landowner has denied access. If we see a “No Trespassing” sign, we’ll have to turn back. Until then, we’ll wade.

Fred Burr Creek is surprisingly cold, deep and gritty. From bank to steep bank, it’s thigh-deep. We pick our way slowly, clinging to riparian growth on the creek’s edges for balance, tripping over logs and stones. Eliza laughs when the creek snakes us immediately back toward my car. The course is oxbow, looping endlessly as it leads us up the narrow valley.

“This might take a while,” I say apologetically, though I know Eliza doesn’t mind. A good friend with a strong sense of adventure, she’s made it clear that helping me find the mill is her idea of fun. I’m beginning to relax and enjoy myself, too. I feel like we’ve already made it.

Nine months before, on a weekend drive through Philipsburg, Montana, I saw a flier taped up inside a countryside cafe that advertised an upcoming Q&A with a prominent chemist. Curious about the researcher’s business in this small out-of-the-way community, I attended. It was worth my while. The chemist had discovered that a potent neurotoxin was polluting this community’s waterways. In fact, he had traced the major source of the toxin to a single building, an abandoned silver processing mill.

Now, I'm pursuing the source of the toxin myself. After months of interviews, research, imagination, and just a little bit of creek wading, I'm finally about to see Rumsey Mill.

Eighty miles downstream, Montana's Clark Fork River flows through its historic channel as it enters Missoula through Hellgate Canyon.

After a century of heavy metal pollution, the river is undergoing one of the nation's largest watershed restoration projects to date on the U.S. Environmental Protection Agency's Upper Clark Fork River Superfund Complex.

In the late 1800s, while Butte was blooming into the world's largest copper fount with 10,000 miles of mining passageways being excavated underneath the city, proportionately vast mining wastes laden with metals like arsenic, copper, lead and zinc were funneled into the Clark Fork River. In the 1950s, open-pit strip mining replaced underground mining, creating the 40-billion gallon Berkeley Pit and one of the largest tailing dumps in history.

Even before 1900, fish had all but vanished from the upper Clark Fork. By the time Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act in 1980, and the Clark Fork's first Superfund designations began a year later, it seemed like the damage had been done to the once-pristine river.

Now, decades of work later and over a billion dollars spent or designated, the Clark Fork River is beginning to look like the great trout river it once was.

The December 2008, removal of Milltown Dam at the river's confluence with the Big Blackfoot River restored the Clark Fork to its historic banks for the first time in 100 years. This was, for many, the most tangible representation of this era of change. Despite the chilling weather, a crowd of hundreds gathered to watch as the river first trickled and then surged through its remembered geography.

Heiko Langner wasn't among them. The University of Montana chemist should have had reason to celebrate. His work, after all, followed the toxins of the Clark Fork and methods of their removal. But in a windowless laboratory a few miles away, he had troubling news.

Two years earlier, he had teamed up with biologists to monitor ospreys perched in nests on the Clark Fork's banks. For three summers, they had banded ospreys in about 20 nests along the river and its tributaries. Then each fall the birds had migrated.

Ospreys migrate to spend their winters in warmer waters; then they usually return to their home rivers each spring. But for at least two years now, the Clark Fork birds were not returning. Instead, new ospreys were reproducing along the river each year and then moving on.

Now Langner had completed his first analysis of blood samples from the Clark Fork's osprey chicks. Toxic methylmercury flowed through their veins at concentrations at levels of concern.

The toxin, it appeared, flowed under the radar through the Clark Fork River, where it undermined the river's remarkable recovery and threatened not only ospreys, but a whole ecosystem and the people who fished it.

Langner is a chemist, not a biologist. But he's also a birder. So when University of Montana biologist Erick Greene visited his office in 2006, it didn't take Langner long to sign on to a project studying a river's chemistry through its birds.

The massive Clark Fork Superfund complex had attracted Langner to Missoula. The cleanup of its floodplains was underway, shipping 3 million tons of poisoned sediment away to containment ponds.

"But are we really interested in that?" Langner asks me one spring morning when I visit his lab. "What we're interested in is the effects of contaminants on us, the effects on the ecosystem. And the logical place to test for that would be the ecosystem itself," he says. "Specifically, ospreys."

From algae and grains of sand at a river's bottom to aquatic insects and fish, a river is a unified system. Organisms get eaten by other organisms, which in turn get eaten by other organisms. It all flows up the food chain, to the top, where it ends up in an eager beak.

"And you are what you eat," Langner says, shrugging his shoulders.

And what you eat depends on where you eat. Osprey chicks, in particular, have bodies nourished exclusively by a small length of river and the fish it supports. If there are contaminants in the ecosystem, there will be contaminants in the osprey chicks. And there were -- but not the contaminants Langner was expecting.

When results of the first blood samples came in 2008, he was surprised.

"Those main contaminants everybody had been talking about--copper, zinc, arsenic, cadmium, lead -- it turns out that none of those contaminants seems to be affecting the ospreys directly...What we were finding instead was real high concentrations of mercury," he says.

Though it wasn't on the public's radar as a priority for the upper Clark Fork cleanup, Langner had also tested the osprey blood for mercury, a metal that was often used in silver- and gold-mining operations.

"If there's only one contaminant that really prevents us from being able to eat a lot of fish, it's mercury," he says. "But to my knowledge, nobody had been looking very hard for sources of mercury in the Clark Fork. Historically, the analytical techniques for mercury weren't all that great."

But finally, the ospreys revealed the truth. Mercury levels in the chick blood was several times higher near Missoula than in equivalent Montana habitats. These levels put them in the same ballpark as industrial populations reported to have reproductive and behavior problems as a result of mercury poisoning.

With decades of effort and hundreds of millions of dollars invested in the Clark Fork Superfund effort, it seems incredible that such a toxin could remain under studied.

"But mercury has kind of a complicated bio-geo-chemistry," Langner says. "It's very different from other contaminants."

The mercury that was used in mining operations, or deposited atmospherically through the burning of coal, is mainly inorganic, elemental mercury -- good old Hg.

"And that's toxic, make no mistake about it. But there are other forms that are a lot more toxic," he says.

These come next.

In the environment, elemental mercury can be transformed through several steps to produce methylmercury.

"And that is the actual really toxic form of mercury," Langner says. It takes very little methylmercury in the water to become a lot of methylmercury in the blood.

That's because methylmercury is very good at bioaccumulating. As organisms take in food, they process what is useful and excrete what is not. But much of the methylmercury stays inside, collecting in their tissues. And as organisms eat again and again during their lifetimes, they accumulate a lot of that methylmercury in their bodies.

And then there's biomagnification. If an insect has a given amount of mercury in its tissues, a small fish will gain much of that mercury each time it eats an insect -- and because it will eat many insects, it will take in several times more mercury than the insect had accumulated in its body while losing comparatively little. As this process is repeated up the food chain, mercury levels get higher and higher.

"So mercury concentrations in those higher tiers of the food chain are not just a little bit higher than in the invertebrates or in the algae or in the sediments, they are orders and orders higher than in the lower tiers of the food chain," Langer says.

"Then here come the ospreys, or the humans, that eat fish, and mercury concentrations can become very high in those upper level predators. That's why the dangerous mercury concentrations [in the river sediments] are fairly low compared to those other contaminants. Even though it's a very potent toxin, mercury concentrations have never stuck out," he continues.

Before 2008, the University of Montana and Montana Department of Environmental Quality didn't have instruments sensitive enough to accurately detect such a dilute toxin in the sediments. But now Langner had hard evidence that it was there--and there was something peculiar about it. Osprey chicks had the highest mercury concentrations in the western half of the upper Clark Fork, upstream of Missoula. Downstream the values remained high but gradually diminished. But in the eastern half of the Clark Fork, near the prominent sources of mining contamination, mercury values were relatively low.

In 2009, Langner recruited University of Montana geology master's student Molly Staats to figure out why that was. Staats took sediment samples from the upper Clark Fork River and its major tributaries and analyzed them for mercury.

Beginning at the river's source near Butte, she found fairly low concentrations in most of the tributaries and along the Clark Fork River, until its confluence with Flint Creek. But in Flint Creek, and after its confluence with the Clark Fork, the concentrations spiked sixfold.

"Concentrations of mercury were off the charts. It looked like lower Flint Creek mercury concentrations in fine sediments were between like 10 and 25 milligrams per kilogram, which is almost astronomic, for a stream like that," he says. "So Molly established pretty clearly that the main source for mercury was in Flint Creek."

After that, Langner and his team applied for state funding to pinpoint exact mercury sources, but they never received it. Instead, in 2013, a Flint Creek area group called Granite County Headwaters received a grant through Montana's Natural Resource Damages Program to assess contaminants in its watershed. The headwaters group and NRDP contracted Langner to sample sediments along Flint Creek and about 20 of its tributaries.

Again, the source was clear. About 80 percent of the mercury in Flint Creek was coming from Fred Burr Creek, a small tributary that flows into Flint Creek just a few miles upstream of Philipsburg.

“After we knew that Fred Burr Creek had these astronomically high mercury concentrations, of course we were curious where it came from,” says Langner. “So I sampled Fred Burr Creek wherever I could.”

Langner started near the stream’s confluence with Flint Creek, taking samples from public access points a short distance up Fred Burr Creek. These samples showed higher-yet levels of mercury. Farther upstream, near the creek’s source on Forest Service land, his samples showed little detectable mercury. What lie in between was a cluster of ranches and private parcels, one of which contained the remains of a huge silver processing plant called Rumsey Mill.

To extract silver and gold from their ore, turn-of-the-century miners would “stamp” it, using mill-powered machines to crush the rocks into powder. Then, miners would mix the powder with liquid mercury, which would bind with bits of crushed silver, and then, being heavier than the ground rock, sink through it. The powdered rock would be scraped off the top, the amalgamation would be heated to evaporate the mercury and silver would be left.

“I suspect that a lot of leftover mercury is sitting there in the river sediments or close by and providing a constant source of mercury to the watershed,” Langner says. If his research is accurate, around 80 percent of the mercury in Flint Creek and the Upper Clark Fork River comes from a single mill.

“Which is good, after all, because that is a comparatively easy cleanup,” he says. “There were hundreds and hundreds of silver or gold mines in the area, and there were probably also hundreds of places where they processed ores and where they used mercury, so chances were that the mercury could be originating from all these little mines, but that doesn't seem to be the case.”

“I don’t think we should be in the water,” Eliza says. It’s raining now. We’ve been hiking Fred Burr Creek for over an hour and, though we haven’t seen a “No Trespassing” sign, we’re soaked, scraped and numb. But Eliza isn’t talking about that. She’s looking at the horizon, where veins of lightning have appeared. Above us, the sky is gathering a supernatural kind of darkness.

It takes a loud crack of thunder to stop us. At once, we scramble out of the water, up Fred Burr Creek’s steep bank, and crouch by a small cluster of short pines. They aren’t much in the way of shelter, but they aren’t going to fall and crush us, either.

It begins to rain harder. Lightning and thunder are coming regularly now, and we're soaked to the teeth. When I think it can't possibly rain any harder, it does. And then it hails. And powerless like this, I can do nothing but laugh. Through the hail, I can tell Eliza's laughing too, though I can barely hear her.

Philipsburg, the seat of southwestern Montana's Granite County, evokes the Old West. Brick buildings that were previously hotels and plank facades lining Granite Street once housed hoards of prospectors, but these days tourists come to ski, fish, and visit the famous candy and gem shops.

Twenty miles to the west of Philipsburg, Rock Creek's rainbow, brown, and westslope cutthroat trout draw fly fishermen from around the world; fifty miles to the south, the famous Big Hole River draws anglers for the same great trout and the last surviving population of fluvial Arctic grayling in the lower 48.

And then there's Flint Creek, which flows out of the mountains of the same name and through Philipsburg on its way to the Clark Fork River. Also home to several species of trout, Flint Creek makes an excellent destination for catch-and-release anglers. But Montana Fish Wildlife and Parks limits consumption of fish from Flint Creek to a few per month. It seems that while higher-than-normal mercury levels in the Clark Fork had managed to keep under the radar, fish biologists knew something was up. In fact, a 1974 study by University of Montana chemist Wayne Van Meter tested mercury levels in trout tissues across the Upper Clark Fork Basin, and found that Flint Creek's tributary Fred Burr Creek contained the most contaminated trout in the whole watershed.

Fred Lurie moved to Philipsburg when he quit teaching at Indiana University 20 years ago. He describes himself as a physicist-turned-fisherman, a change which prompted his move. Lurie is a catch-and-release angler: He fishes for the sport of it, not the food. But he says there are others who supplement their incomes with fish from the local streams -- including from regulated Flint Creek.

"There are some people who pay no attention to regulations," Lurie tells me over a cup of coffee.

This is a dangerous game, and one that players might never know they're losing. If methylmercury is poisoning those who choose to ignore the warnings, resulting in reduced brain function and IQ, it may not be to a noticeable extent.

"I don't think there is really an idea of how dangerous it can be and how difficult it is to tell whether or not you are being affected. You know, maybe you have a B student for a child that could have been an A student," says Tom Mullen, another Philipsburg transplant from Wyoming.

"And the people who've been here, I hear them talk about playing with mercury when they were kids," he says.

Philipsburg was founded in 1867, a few years after silver was discovered in the Flint Creek range, and grew at a rate of one house per day to reach a population of 1,500 before the year's end. Between January and May of 1892, one Philipsburg mining company processed about 9,500 tons of silver ore, calling for an import of more than 11 thousand pounds of mercury during those five months.

Now, with hundreds of abandoned silver mines and stamping mills in the Flint Creek Range, locals are left with the remains of that process, including the mercury.

"The main target is the central nervous system," says Julie Hart, a toxicologist at Montana Tech in Butte, 70 miles upstream of Flint Creek's confluence with the Clark Fork River. This means that mercury poisoning can result in anything from a slight dip in IQ to cerebral palsy. "And a big concern we have is its ability to cross the placental barrier." So unborn children of pregnant women are at elevated risk for developmental delays and neurological effects.

But this can be avoided: "It really depends on how much humans are consuming," she says. In other words, it depends on how closely anglers are following Montana Fish Wildlife and Parks' guidelines.

Of course, it's not just humans who enjoy southwestern Montana's world-class fishing.

Western Montana is famous for its wildlife. Alongside Yellowstone's bison and wolves and Glacier National Park's grizzlies and wolverines, birds draw hundreds of tourists a year to see the trumpeter swan, the sage grouse and the sandhill crane.

Many of Montana's charismatic birds are, like ospreys, fish-eaters. From the tiny kingfisher to the dinosaurian great blue heron, a host of fish-eating birds calls the Upper Clark Fork River and Flint Creek home.

And that's just birds.

River otters, like ospreys, eat exclusively fish. But unlike ospreys, they don't migrate every year. Since otters are more or less stuck year-round in a given watershed, they may be even more sensitive to water pollution than birds. Moreover, otters tend to eat larger, more contaminated fish than birds.

As otter populations in Western Montana rebound from heavy historical trapping, concerns are being raised as to how heavy metals may affect them.

Between 2008 and 2011, University of Montana biologist Kerry Foresman and the rest of his team looked for river otters, as well as any signs of them, on the upper Clark Fork River and its major tributaries. Team members traveled the watershed, stopping every quarter mile. They walked the banks looking for otter tracks, feces or any other evidence, including the animal itself. They set up hair snares with baiting scent to attract any nearby otters. A snare would catch a few hairs off the curious animal, leaving evidence of its passing.

To their delight, the team found signs indicating a small but healthy population of river otters on the Clark Fork and many of its major tributaries.

“But we didn't identify any otter signs at all in the Flint Creek drainage -- no tracks, no scat, no activity whatsoever,” Foresman tells me when I visit his office on a recent morning.

His study did not look into environmental conditions, so he can’t say why this would be. But mercury may play a part. “From a lot of other studies that have been done, there’s obviously a strong correlation between heavy metal accumulations and negative impacts on species like otters and mink,” he says.

In winter of 2013, chemist Heiko Langner was in trouble. Winter comes fast in Montana, and he was rushing to complete sediment sampling on the major tributaries to Flint Creek before they froze over.

To slow things even more, he had been denied permission to take samples from homeowners along that road marked "Private Property." In addition to the parcel containing Rumsey Mill, one of these parcels sat at the confluence of Fred Burr Creek with Flint Creek, a pivotal spot for determining where the mercury was coming from.

Phillipsburg resident Tom Mullen volunteered to help secure permission for the last few samples. When he and another local asked to access the Fred Burr Creek confluence property, they said it was to go fishing. They then collected the needed samples and passed them on to Langner without telling him they misrepresented their reasons for accessing the creek.

Langner put these samples in his data, which was published online by the Natural Resources Damage Program. The owner of the confluence property saw the report, and complained to

Langner and the NRDP. She was angry that the samples had been taken from her property without her knowledge. This trespass was a major breach of trust for her, a third-generation Philipsburg rancher.

Langner replied to her e-mail, apologizing for the miscommunication. But he also went on to write, “What concerns me even more than this particular incident is your deep distrust in our motivation and the fact that it can be dangerous for you and your children to ignore the mercury problem around the streams on your property...I felt sad when I read your letter. I believe education and good communication can resolve many if not most of the problems we are facing these days.”

Finding this reply condescending, the landowner complained to NRDP a second time. And in early spring of 2014, Langner lost his contract to research mercury for the Granite County watershed group. Several months later, for unrelated reasons, he accepted a job in Dubai.

“Here’s the guy who did the real ground work for our streams’ health, but he’s on the other side of the earth right now,” says Philipsburg resident Tom Mullen when I visit his creekside home on a recent afternoon.

Still, Langner’s research remains. Mullen believes others will use that research to capture state attention and clean up Rumsey Mill. “I think it will happen, but it will probably be 10 to 20 years before that,” he says.

If it happens, it will be thanks to the Granite County Headwaters Watershed Group.

“The local watershed group are the ones who have really done a lot of work. They’re multigenerational residents, most of them, and they’re very talented because they have all these different types of expertise,” says Noor Parwana, an independent contractor who’s working with the group to help them apply for research grants. “So they're just gonna go ahead and take that ball and they’re gonna run.”

But running with the ball will not be an easy task.

Tom Henderson, project manager of the Montana Department of Environmental Quality Abandoned Mines Program, explains that with little funding, states are forced to be extremely choosy about which mining reclamation projects they undertake.

“Every state, including Montana, will tend to have more problems than the amount of money that comes in the door to fix the problems, which is why every state has a prioritization system,” he says. “There's certainly more environmental problems associated with abandoned mine lands than there will ever be funding to take care of. To be honest, I’m just working with problems on the top of the list, and those keep us plenty busy.”

With more than 300 sites on Montana's list of known retired mines, it's only the rare problem that gets addressed.

Take the Upper Clark Fork River Superfund Complex. Instead being abandoned altogether or sold to amenity owners, the former holdings of Butte's powerhouse copper enterprise Anaconda Company were sold to the multinational mining conglomerate ARCO. Then, and only after decades of litigation, the state of Montana was able to settle with ARCO for a total of $412 million, helping to fund one of the largest restoration projects in history.

“But a lot of these historic mining operations were fly-by-night, and there are no financially solvent companies responsible,” says Carol Fox, former director of Montana's NRDP.

The decades-long ARCO lawsuit was a was an exception, not only because there was a company to find liable, but also because of the enormity of the contamination on the Clark Fork River. Rumsey Mill, lost in the state's long cleanup backlog, is both smaller in terms of contamination and more complicated in terms of finance. But for these reasons, Langner contends that it be a priority.

“It undermines this huge effort in the Clark Fork,” he says. “If the community around Philipsburg really got together and supported or helped clean up some of the point sources for mercury in the area, they wouldn’t only help themselves, they would actually help everybody who lives downstream from them.”

Eliza stands up as the hail gives way to rain. I check my phone’s map again while lightning flashes on the horizon. We’re not even halfway there.

There’s nothing to see, really. On the little screen, the satellite image of Rumsey Mill is nothing but a pale swath between trees. It’s a bare piece of ground, with maybe the odd pile of bricks here and there. But that’s exactly what draws me.

Downstream, there’s plenty to see. Hundreds of people are hard at work planning, testing, removing, digging, replacing, replanting -- sculpting a new beginning for a great western trout river. A generation of young scientists is taking inspiration and education, while anglers and recreators are returning to the Clark Fork River. And somewhere up here, a hidden pile of bricks threatens all that.

I point my water-logged feet toward the car. For now, Rumsey Mill eludes us.