

CLIMATE CHANGE

Climate change increases rare earth elements in Colorado's Snake River

A new study suggests lower stream flows as a primary culprit.

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The confluence of the upper Snake River (left), where the naturally-occurring acid rock drainage from the local geology creates the characteristic rusty red coloring, and pristine inflows from Deer Creek. Researchers here are studying how climate change is releasing more rare earth metals, often found in conjunction with acid rock drainage, into rivers.

Courtesy of Garrett Rue

The Snake River begins high in the mountains of Colorado, with one of its headwaters near Loveland Pass. It weaves its way downstream through rocky fields to a wetland valley before cutting through Keystone and eventually dumping into the Dillon Reservoir. The river is important to the region: It supplies drinking water for Denver and is a popular fly-fishing spot.

But the Snake could be heading for troubled waters: According to a recent study, climate change-driven changes in its hydrology are releasing more rare earth elements. It's a finding that could have broader implications for water quality across the West.

The [study](#), published last month in the journal *Environmental Science & Technology*, found that higher levels of rare earth elements — a group of chemically similar metals — are ending up in Colorado's water supply due to lower stream flows caused by drought and a shrinking winter snowpack.

Lower stream flows mean that metals are not as diluted as they've been in the past. While previous research has connected this phenomenon to an increase in zinc concentrations, the latest study is the first to look at rare earth elements.

“It's definitely the first (study) to link increasing concentrations of rare elements with climate change-driven changes in hydrology,” said study author Diane McKnight, an engineering professor at the University of Colorado Boulder. “I don't know of any other study that really looks at what's the pattern of rare earth elements in a watershed at the scale of the Snake River, going all the way down to the drinking water supply.”

Rare earth elements are ubiquitous today, used in cellphones, hard drives and solar panels. They occur naturally as a group of 17 metallic elements. While studies show that they're toxic to small aquatic organisms and microbes, “we don't have a big grasp on whether or not that extends to humans,” said lead author Garrett Rue, who was a master's student at University of Colorado Boulder when the research was done. “These effects are understood at the bottom of the food web, but it's very difficult to scale up what that means for fish or more complex biological life.”

Rare earth elements are not considered a known toxicant by the Environmental Protection Agency; their concentrations aren't monitored and no water quality standards have been set for them. Because they're often found in acid mine drainages along with metals of concern, such as zinc and lead, it's hard to isolate them and identify their effects. But their increasing use in medical products like MRI tracers means that rare earth elements are re-entering the ecosystem in the form of wastewater, prompting a renewed push to understand them.

Documenting the increasing concentrations of rare earth elements together with the recent climate-driven changes in hydrology is important work, other experts in the field say.



Gary Martinez peers into a tunnel at Pennsylvania Mine that was officially plugged in 2014. An 18-foot-thick bulkhead of steel-reinforced concrete will help reduce the amount of heavy metals, such as zinc, that drain into Peru Creek and upper sections of the Snake River. Researchers have found that the area still contains high levels of rare earth metals.

Ben Trollinger/Summit Daily News via AP

“As things dry up more and more, surface water and groundwater can be affected over the long haul, with water quality becoming worse,” said Kirk Nordstrom, a retired U.S. Geological Survey scientist who studied acid mine drainage extensively. (Nordstrom was not involved in the Snake River study.) “That’s something that almost nobody addresses, but this paper does that. Rare earth elements are a hot topic these days and nobody has data quite like they have in this paper.”

The study, which used samples that spanned almost four decades, revealed a range of one to hundreds of micrograms per liter of the elements throughout the Snake River. The mere fact that researchers found concentrations high enough to warrant measuring in micrograms means that the river has an unusually high amount of rare earth elements. Concentrations in larger rivers are usually so small they’re measured in nanograms.

“They tend to be in the parts per trillion range, and we’re seeing them now in the parts per billion range,” Rue said. “That unit is 1,000-fold higher.”

Scientists also found that the elements are building up in stream insects at levels similar to toxic lead and cadmium.

The highest concentrations were found near the headwaters and in areas receiving acid mine drainage from abandoned mines. Acid mine drainage occurs because rocks that contain certain minerals oxidize when exposed to air and water. The resulting chemical reaction creates sulfuric acid, which dissolves metals like iron and pulls rare earth elements out of rocks.

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This happens naturally across the West in areas rich in pyrite, but mining compounds the problem by disturbing large amounts of rock and soil. Study authors noted that more than [40%](#) of the West’s headwaters in the West are contaminated by acid mine or rock drainage, particularly in states with mining histories like Colorado, Nevada, Utah, California and Montana.

“Acid mine drainage is a problem that people, whether they’re aware of it or not, are surprisingly impacted by,” Rue said. “In Colorado, many of our major rivers start in the mountains. And many of those mountains were mined.”

The Snake River runs past Keystone Ski Resort — where summer visitors sometimes [fish](#) for trout, which have to be stocked because high zinc levels make it impossible for them to survive in the river on their own — before it empties into [Dillon Reservoir](#), an important drinking water source for the city of Denver.

“These are legitimate concerns. And they should be treated as such,” Rue said. “What happens in the headwaters manifests downstream.”

Kylie Mohr is an editorial intern for High Country News writing from Montana. We welcome reader letters. Email her at kylie.mohr@hcn.org or submit a [letter to the editor](#). See our [letters to the editor policy](#).

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Note: This story has been updated to correct that the Snake River joins the Blue River; it dumps into the Dillon Reservoir directly. Also, it does not cut through Breckenridge but through Keystone.

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