Times Standard

Not My Fault: What happens when dams come down

Lori Dengler for the Times-Standard
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Site of the former Copco Lake in February 2024 after drawdown (Juliet Grable, Jefferson Public Radio).

In January, draining the reservoirs behind the Klamath Dams began. Iron Gate Reservoir, Copco Lake, and the Boyle Reservoir are now largely empty as blasts opened holes in culverts beneath Copco #1 and the John C. Boyle dams and the outlet tunnel below Iron Gate was opened.

"The Klamath River flows free," ran some headlines. Well not exactly. Keno and Link River dams in Oregon upstream near Klamath Falls will not be removed. Iron Gate, Copco #1, and J.C. Boyle still stand, although the reservoirs behind them are largely empty. Until the dams are completely removed (slated for this spring/summer), the flow is still impacted by the dam structures, causing erosion and ponding. Constriction and acceleration as the water flows through narrowed passageways can lead to cavitation.

Cavitation occurs when irregularities in the bed lift the water. The resulting negative pressure causes bubbles of water vapor to form. These cavitation air bubbles quickly collapse sending out bursts of very high-pressure. The area impacted by each burst is small, but the sheer number of bursts can erode surfaces water is flowing over. The process cascades with small damage quickly creating new irregularities and new bubbles.

Five years ago, this is what happened at Oroville dam. It was a heavy rainfall year and water had to be released on the spillways. Cavitation produced a large crater in the middle of the spillway, forcing the Department of Water Resources to reduce outflow, causing the reservoir to rise and the evacuation or 180,000 people living downstream.

Cavitation likely contributed to the demise of young salmon on February 29 (Times-Standard 3/5/24). Hatchery fry were released upstream of Iron Gate and the newly opened outlet tunnel created the perfect conditions for cavitation. As the fish moved through the tunnel, they were exposed to a zone of water supersaturated with bubbles. Known as Gas Bubble Disease, the air bubbles quickly impact fish metabolism. Older fish can withstand the short onslaught of air, but these fish were too young.

The California-Oregon Power Company (now Pacific Power) established Copco #1 in 1922. J.C. Boyle and Iron Gate followed in 1958 and 1964. Dams don't only hold water back, they accumulate sediment. The USGS estimates 13 to 15 million cubic yards of silt, clay, and fine sand have accumulated in the three reservoirs. What will happen to these deposits now?

There are three approaches to answering this question: modeling, what happened in past dam removal projects, and studying naturally produced sediment inputs like landslides. The largest dam removal project previous to the Klamath was the Elwha and Glines Canyon Dams on Washington's Elwha River near Port Angeles. Removed in 2011 and 2014 as part of the Elwha River Ecosystem Restoration Project, it is considered a success in improving salmon migration access and costal ecosystems.

One can't apply the Elwha experience to the Klamath. The geology, the topography, and the sediment characteristics are very different. The Elwha is a steep coastal river that drains the Olympic Mountains carrying gravel and sand; the middle portion of the Klamath is relatively low gradient flowing over basalt basement rock. The USGS estimates over 85% of the sediment consists of clay and silt-sized particles. There is only a small amount of sand and no larger gravel or cobbles.

Advances in numerical modeling provide confidence that we have a good idea of what will happen on the Klamath. Model accuracy was shown in the Elwha case and in numerous other studies of sediment dispersal.

Clay and silt are easily incorporated into the river flow and are transported as suspended load. Drawdown of the reservoirs was deliberately begun at this time of year when flows are high, and this fine sediment could readily be washed down river. To give the river an added boost, NOAA Fisheries and the Bureau of Reclamation are releasing water from the upstream Link and Keno dams to double the river flow. Over the next two months, these week-long pulses will help flush the accumulated sediment downstream.

I've been interested in the Klamath Dam project for decades, but the impetus to write about it was triggered by a talk given by Jenny Curtis last Monday. Jenny, a Humboldt Geology alum, is the USGS scientist in charge of tracking physical changes post dam removal. Over the next five years, Jenny and her team will be closely watching and measuring how the Klamath responds.

The primary focus of Jenny's team is what happens to the sediment. They will look at sediment in the water, where it is being deposited, where it came from, and how the channel and vegetation changes. A key point is trying to distinguish the added contribution of the stored sediment behind the dams from the natural sediment load.

Turbidity is a proxy for suspended sediment in the water. Six turbidity stations were established in collaboration with the Yurok and Karuk tribes to measure sediment changes before, during, and after dam removal. To track physical changes in the channel and adjacent riparian zone, cross sections and channel profiles will be measured and combined with remote sensing imagery. Repeat sampling of sediments at different locations throughout the basin will be compared with a pre-removal baseline.

I am most intrigued by distinguishing the reservoir sediments from the background river sediments. How can you separate reservoir clays and silts from natural sources? It's a story straight out of a CSI episode. Clays have a distinct chemistry and structure depending on their origin. There is also a telltale secondary fingerprint provided by diatoms.

Diatoms are nature's gift to a geologist. These one-celled microalgae have delicate tests, exoskeletons made out of silica. Diatoms are incredibly important to life on earth, producing nearly half of earth's annual oxygen supply. They live in waters everywhere - the deep ocean, near shore, estuaries, brackish water, lakes, and rivers. There are upwards of 12,000 different species, each adapted to a particular environment. How do you tell them apart? Each test is unique and can be identified by the skilled micropaleontologist and traced back to its place of origin.

The flushing of the reservoir sediment is unlikely to pose any risks. The sediment itself is not toxic; the composition has been exhaustively tested and the level of contaminants is not considered a concern for human health. The river turbidity will increase, but not likely above the highest levels caused by historic floods. There will be no massive sediment pile migrating downstream; the river flow will just winnow it away.

I'll check back with Jenny next year to see what actually happened.

Note: USGS description of the dam removal project and monitoring efforts is at https://www.usgs.gov/centers/california-water-science-center/science/klamath-dam-removal-studies

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