

# Where did Sierra snow go this spring? Not into California rivers and water supplies

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California's severe drought was made worse this year by a shocking surprise.

Every year, much of the [drinking water](#) that flows through the taps of millions of Californians begins in the Sierra Nevada. Snow and rain fall on the vast mountain range during the winter months, and the [water](#) moves downhill into streams, rivers and reservoirs in the spring and summer.

But this year, in a trend that startled [water managers](#), much of that runoff simply vanished.

State water planners say that 685,000 acre-feet of water that they had forecast as runoff in the Northern Sierra—or 40% more water than the city of Los Angeles uses in a year—failed to arrive. After two years of extreme drought, the ground was so dry that the water soaked in before making it down the mountain. Warmer-than-normal temperatures in April and May also caused significant amounts to evaporate.

"The snowpack was disappearing and the rivers weren't rising," said Sean de Guzman, chief of

snow surveys and water supply forecasting for the California Department of Water Resources in Sacramento. "A lot of our forecasts were off."

The expected water never made it to reservoirs, which now sit far below historic averages. That lack of runoff is contributing to water shortages in cities and farms across the state.

"We have 100 years of data saying if you have this much snow, you would expect this much runoff," de Guzman said. "But that fell apart this year."

The snowpack provides nearly a third of California's water supply for cities and farms, including filling the Hetch Hetchy system and the Sacramento-San Joaquin River Delta that are critical water sources for the Bay Area.

The Northern Sierra, with the most precipitation, is the most important part.

In an average year, about 6.3 million acre-feet of runoff comes from the Northern Sierra, according to the Department of Water Resources. This, spring, following two very dry winters, state forecasters predicted 2.3 million would run off. But only 1.6 million arrived. An acre-foot is the amount of water it takes to cover an acre of land one foot deep.

Put another way, the missing 685,000 acre-feet is 223 billion gallons, or more than twice as much water as every home, business and farm in Santa Clara County uses in a year.

The Sierra snowpack is gone now. Apart from a few tiny pockets at high elevations, it has melted.

Earlier in the spring, the situation looked bad, but not terrible.

On April 1, the statewide Sierra snowpack was 59% of its historical average for that date, with the Northern Sierra doing somewhat better, at 66%.

Then came the [warm weather](#). By May 1, the snowpack fell to just 22% of normal for that date. And by June 1, it was at 0%.

Last year showed a similar pattern.

But two years ago, in 2019, there were massive amounts of snow. The April 1 snowpack then was 154% of normal. Squaw Valley Ski Resort near Lake Tahoe, which received more than 700 inches of snow that winter, kept its ski runs open until the Fourth of July weekend. This year, skiing closed two months earlier, in May.

Water experts say that climate change is causing more wild swings in the state's rain and snow patterns. Hotter temperatures are making drought conditions worse by drying out soils, trees, grasses and bushes, which increases fire risk. But when there are big winter storms that come off the Pacific Ocean, they are able to carry more moisture, because more water vapor evaporates into them due to the warmer temperatures.

California's water system was mostly built between the 1930s and the 1960s, for a climate that doesn't exist any more.

"The warming temperatures that we are experiencing as the global climate warms are pushing our water systems beyond the resiliency that's built into them," said Roger Bales, a distinguished professor of engineering at the University of California, Merced.

Anticipating how much cities and farms should expect each year is becoming more difficult also.

"We're starting to see a lot the tools that we've used in the past to help us forecast water start to break down," de Guzman said, "because they can't take into account the effects of [climate change](#) and how dry the soils are, and other factors."

Bales, former director of the UC Sierra Nevada Research Institute, said that as temperatures continue to warm and runoff patterns become less predictable, California will need to store more water in wet years for dry years—not just for human use but also to keep salmon and other species alive.

Most of the main sites for dams on rivers are already taken, while others are politically unfeasible (think Big Sur or in national parks), he noted. But existing off-stream reservoirs can be expanded, huge amounts of water can be stored in underground aquifers, and cities can capture and reuse storm water, he said.

"Expect more changes," Bales said. "We aren't entering a new normal. We are entering a period of change."

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