California drought: Sierra snowpack measuring is a lot more complex than it looks

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As California caps what may be its driest January on record, Frank Gehrke will lead a bevy of surveyors on Thursday to a predetermined spot on Echo Summit in an exercise that has become a monthly downer in the documentation of the state's historic drought.

As a thirsty state anxiously stands by for the results, the crew will drive some aluminum rods into the snow to measure how deep it is then weigh the white powder to calculate its water content.

At least that's how the monthly winter ritual will play out on the nightly news. But the photo-op belies the complexity of the coordinated effort to size up the state's snowpack around the clock.

Frank Gehrke, chief of California Cooperative Snow Surveys Program for the Department of Water Resources, left, pulls the snow depth survey pole from the snow pack as he conducts the first snow survey of the season at Echo Summit on Dec. 30, 2014. (Rich Pedroncelli-Associated Press)

Today, snow sensors scattered through the Sierra, satellite imagery and aerial flybys augment the 106-year-old "manual survey." The technology helps to provide a clearer update of California's water conditions that water agencies depend on to perform the increasingly crucial job of managing our diminishing water supply for the rest of the year.

"I think they'd be amazed," Gehrke, chief of California's Cooperative Snow Surveys Program, said of his predecessors. "The capabilities are much greater than anyone could have imagined back then."

What won't amaze Gehrke this year is the predictability of Thursday's results. This year, the Sierra snowpack -- which usually provides 30 percent of California's water -- is critically low, less than 30 percent of normal for this time of year, the snow sensors show. December's storms began filling up reservoirs, but they were too warm to turn rain into an abundance of snow.

The public sees only one of the many manual surveys done last week and this week, when a small army is fanning out to over 200 sites across the Sierra range to extract "snow cores." The teams are part of a cooperative of 53 municipalities, public utilities, federal agencies, water districts, irrigation districts and private companies with vested interests in predicting the spring melt of mountain snow into California rivers and reservoirs.

The snow cores the teams collect and weigh will reveal the amount of frozen water held in the mountains. Their main tool, a hollow metal cylinder, differs little from what their predecessors used over a century ago to sample the snow. "The manual snow surveys program are still the backbone of our water supply forecasting," Gehrke said.

Like dozens of other water providers, the San Francisco Public Utilities Commission, the Bay Area's primary water supplier, relies on the snowpack data to predict the amount of snow melt that will flow into Hetch Hetchy Reservoir.

In years when the snowpack is robust, the agency will pump water from Hetch Hetchy to other reservoirs or directly to Bay Area customers in anticipation of the aquatic glut, said Steve Ritchie, the agency's assistant general manager for water. In a normal year, Hetch Hetchy fills three times. But after three years of drought, Hetch Hetchy is down to 55 percent full. And it would have been a lot more empty if Bay Area residents hadn't done such a good job conserving, Ritchie said.

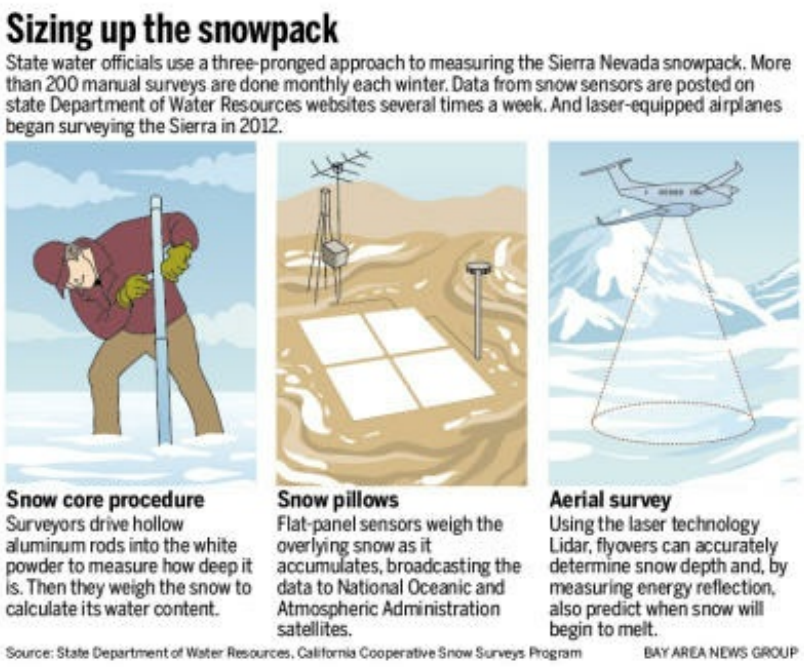
Snowpack records stretch back to 1909, when the snow surveys began near Lake Tahoe. The first surveyors used snow sampling techniques pioneered by James E. Church, a humanities professor at the University of Nevada at Reno. California agencies and utilities quickly recognized the value of a yearly snowpack record and immediately pooled their efforts to sample the Sierra each winter.

Early in the 20th century, most snowpack surveys occurred only in April, as winter snowfalls subsided and the spring melt began. But the large dam and reservoir projects of postwar California necessitated more frequent samplings.

Reservoir operators found it difficult to balance the competing demands of flood control and water supply as they decided just how much water to keep behind high dam walls.

"Operators wanted more than just one number a year," Gehrke said.

By 1955, there was interest in automating at least parts of the snowpack survey. But it took nearly two decades for accurate snow sensors to roll off the factory floor. These flat-panel sensors, known as "snow pillows," weigh snow as it accumulates over the winter months.



A NOAA satellite monitoring station in Virginia compiles snow pillow data for the California Department of Water Resources, which puts it all online.

There are currently more than 130 snow pillows spread across hundreds of miles -- which Gehrke calls "pretty sparse."

The automated stations require continual maintenance. Indeed, only 103 were fully functional as of Monday.

"The Sierra Nevada can be pretty harsh," said Dave Rizzardo, chief of the department's snow surveys section. "You stand in a meadow at 9,000 feet every day for a year, and let's see how you look."

In addition to the punishing climate causing electronic malfunctions, snow pillows have been incapacitated by avalanches and fallen trees. Bears have torn them out of the ground, and "mice like to chew on our cords," Rizzardo said.

But help has also come from the heavens above. The cooperative, in partnership with NASA and the Jet Propulsion Laboratory in Pasadena, began limited aerial surveys of snowpacks in the central and southern

Sierra in 2012.

The cooperative currently uses a Beechcraft King Air 90 twin-engine turboprop outfitted with laser-emitting sensors to map snowpacks near Hetch Hetchy Reservoir. By comparing the data collected by flyovers to baseline contours mapped the previous summer, scientists can calculate the height of the snowpack.

"You can determine snow depth very, very accurately" from the air, Gehrke said.

The aerial survey uses the same technology, called Lidar, that Apollo astronauts used to map the moon and the California Highway Patrol uses to zero in on the one speeding car in a group of vehicles and clock how fast it's going.

Lidar helps predict when the snow will begin to melt by measuring the energy it reflects. The fresher the snow, the smaller the crystals and the more of the sun's energy they'll reflect. By reflecting, instead of absorbing the light, the crystals stay colder and melt more slowly.

"How the snowpack melts is very important to our supply," said Ritchie of San Francisco's PUC.

If the data show that the snow will be melting quickly, reservoir operators can pre-release water from the dam to capture as much runoff as possible. But this year, that scenario is unlikely because of the huge water deficit.

The cooperative expanded its Lidar flights in 2014 to include parts of the Merced and Kings River watersheds. Despite the promise of the Lidar flights, costs will keep the state dependent on data collected by surveyors and automated stations.

"The dream would be to expand those," Rizzardo said, "but it's an expensive endeavor."

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