

Will California Get Enough Rain to Fill Its Pricey New Reservoir?

The \$4 billion project is designed to draw water from the Sacramento River — but only during major storm surges.

Visual: Composite visual by Undark; images via Getty and Unsplash

BY BECKI
ROBINS
([HTTPS://UNDARK.O](https://undark.org)
AUTHOR/BECKI-
ROBINS/)

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IN JANUARY, a series of storms pummeled California, causing floods, mudslides, and widespread power outages. In just three weeks, 32 trillion gallons (<https://www.washingtonpost.com/weather/2023/01/20/california-storms-statistics-damage-precipitation/>) of water fell on the state. Then, in March, another series of storms hit, triggering additional destruction: As much as 7 feet (<https://www.cbsnews.com/news/california-snow-winter-storm-residents-trapped/>) of snow landed on mountain communities, causing roofs to collapse and stranding residents in their homes while emergency crews worked to deliver food and medicine.

All that precipitation helped replenish

([https://www.usatoday.com/story/news/nation/2023/02/21/drought-ca-reservoir-winter-storm-water-](https://www.usatoday.com/story/news/nation/2023/02/21/drought-ca-reservoir-winter-storm-water-levels/11305018002/)

[levels/11305018002/](https://www.usatoday.com/story/news/nation/2023/02/21/drought-ca-reservoir-winter-storm-water-levels/11305018002/)) reservoirs, but much of it drained into the ocean as runoff. Some residents and farmers saw a missed opportunity to capture and store much-needed water at a time when California and several other Western states are grappling with water shortages

(<https://www.cnbc.com/2023/01/31/colorado-river-shortage-states-miss-deadline-for-deal-on-water-cuts.html>).

To conserve water and mitigate flood risk, the Golden State has historically relied on more than 1,000 reservoirs, or artificial lakes, most of them created by the damming of rivers.

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(<https://undark.org/2020/09/07/aquifer-supreme-court/>)

Reservoirs collect water during wet periods and then release it when needed. This is useful in places like California, which has long experienced dramatic swings

(<https://www.latimes.com/california/story/2023-01-16/skelton-california-flood-management-climate->

[change#:~:text=Cycles%2520of%2520drought%2520and%2520of](https://www.latimes.com/california/story/2023-01-16/skelton-california-flood-management-climate-change#:~:text=Cycles%2520of%2520drought%2520and%2520of) between drought and flood conditions. But dams bring a host of human and ecological downsides (<https://news.mongabay.com/2022/04/the-worlds-dams-doing-major-harm-but-a-manageable-problem/>), including habitat

fragmentation, which can be devastating (<https://undark.org/2018/04/23/delta-smelt-california-endangered/>) to migratory fish populations and other species.

California's state and local agencies hope a different kind of reservoir will help manage water and limit impacts on remaining aquatic habitat. This reservoir will be located off-river in what's now a grassy, sparsely inhabited valley about 80 miles northwest of Sacramento. Named for the small community it will eventually inundate, the Sites Reservoir will divert water from the Sacramento River during high flow conditions via two existing canals and a new pumping station.

Once completed, Sites will be among the largest (<https://www.capradio.org/articles/2017/08/24/supporters-of-building-californias-7th-largest-reservoir-want-prop-1-funding/>) reservoirs in California. The \$4 billion project, funded by local agencies, voter-approved (<https://www.enr.com/articles/53316-california-reservoir-with-estimated-39b-cost-gains-funding-approval>) water projects, and the federal Bureau of Reclamation, is slated to break ground in 2025.

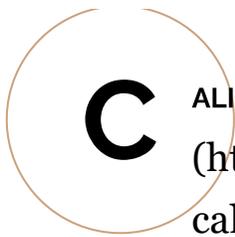
Making the wrong decision now could take dollars away from other potentially more sustainable projects and

*undermine public faith in
policymakers' ability to address
water shortages.*

The Sites Reservoir won't solve all of the state's water woes, said Ali Forsythe, the project's environmental and permitting manager. She and other proponents view the new infrastructure as an important piece of a broader water management strategy, but the project is opposed by several California tribes and numerous environmental groups, who say the reservoir is likely to divert too much water from an already degraded <https://www.fs.usda.gov/research/treesearch/27933>) Sacramento River. This could threaten native fish populations, including endangered salmon.

Adding to the complexity are questions about how climate change will affect California going forward. Intense storms could continue to affect the region, or they might not. In a storm-battered future, an additional reservoir might be incredibly useful. Absent frequent storm surges, though, the large and expensive Sites Reservoir might remain perpetually empty. Making the wrong decision now could take dollars away from other potentially more sustainable projects and undermine public faith in policymakers' ability to address water shortages.

“If Sites doesn't live up to its billing,” said Doug Obegi, a senior attorney for the Natural Resources Defense Council, “it could end up being a white elephant in terms of ratepayer and taxpayer money.”



CALIFORNIA HAS ALWAYS been prone to drought (<https://www.ppic.org/publication/droughts-in-california/>), and scientists say a warming climate is contributing to the state's water shortages by increasing evaporation, which causes more rain and less snow. With less snowpack melting in the spring and summer, when demand for water is high, it's tricky to properly manage reservoirs. Scientists and conservationists believe the shortage is compounded when industries (<https://www.foodandwaterwatch.org/2022/02/24/california-water/>) divert too much water in order to drill for fossil fuels and grow thirsty crops like almonds and pistachios.

In 2022, 76 of 414 (https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Water-Use-And-Efficiency/Urban-Water-Use-Efficiency/Annual-Water-Supply-and-Demand-Assessment/FINAL-DWR-2022-AWSDA-Report-to-SWB_11-22-22.pdf) urban water suppliers in California said they were expecting shortages in the upcoming year. And in a report (https://wsm.ucmerced.edu/wp-content/uploads/2023/01/Economic_Impact_CA_Drought_Vo21.pdf) prepared for the California Department of Food and Agriculture, researchers estimated that the state's irrigated farmland shrank by 563,000 acres in 2021 and 752,000 acres in 2022, as farmers were forced to leave fields unirrigated and

unplanted. In total, crop revenue losses in those years cost the state's economy around \$1.3 billion and \$1.7 billion, respectively.

Sites will have distinct advantages over more traditional forms of water storage, said Forsythe.

More reservoir capacity might help, but adding dams to California's already over-dammed rivers is not a politically or ecologically viable option. A dam acts as a physical barrier, preventing migrating fish from traveling up or downstream. Dams along the Sacramento River have cut off Chinook salmon from around 43 percent of their rearing habitat and migration corridors.. "That's been a huge problem in California," said Cyril J. Michel, a scientist at University of California, Santa Cruz's Institute of Marine Sciences. This fragmentation, he said, is a large reason why local salmon populations "aren't what they used to be."

The 384-mile-long Sacramento River (<https://www.nature.org/en-us/get-involved/how-to-help/places-we-protect/sacramento-river-1/>) provides more than a third of the water stored in the state's reservoirs. California's largest reservoir, Shasta Lake, is located on the upper Sacramento River, and nine miles downstream, Keswick Dam helps control water flow from a power plant situated just below Shasta Lake. Further south is

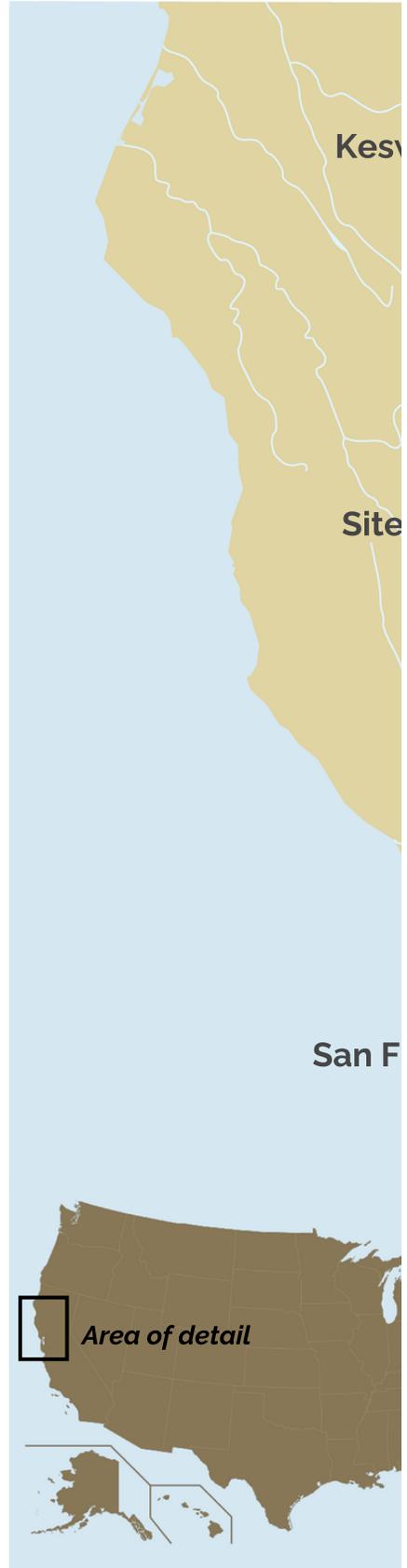
the California Delta, which lies at the intersection of the Sacramento and San Joaquin Rivers. This region is the epicenter of water politics.

Most of the water that flows from the Delta, called “Delta outflow,” is not captured for human use; instead, it leaves the river and eventually ends up draining into the San Francisco Bay. Sites Reservoir states it would like to capture and store some of that water for future use. And Forsythe says that an off-stream reservoir offers a potentially less-disruptive alternative to on-stream reservoirs. Off-stream reservoirs still get their water from a river, but they don’t create a barrier. Instead, they divert water using pumps, pipes, and aqueducts.

Sites will have distinct advantages over more traditional forms of water storage, said Forsythe. “It’s a reservoir, so there’s still that physical footprint, but it’s not blocking salmon migration,” she said, adding that Sites will only divert limited amounts of water to avoid disrupting the natural variability in the flow of the Sacramento River.

The Sacramento

More than a third of the water in the Sacramento River. But most of it is reserved for human use. The Sites Reserv



Sources: [California Water Commiss](#)

California already has a few off-stream reservoirs, including one in the San Francisco Bay Area and another farther south, in the Central Valley. Southern California's Diamond Valley Lake Reservoir, completed in 2000, offers an example of the kind of impact an off-stream reservoir can have in a drought year. In 2021 (<http://crb.ca.gov/wp-content/uploads/2021/08/20210820-ed-report.pdf>), while Lake Powell — a reservoir on the Colorado River that supplies water to millions of southern California homes — was at just 32 percent capacity, Diamond Valley was at 79 percent. That helped around 400,000 Southern California households make it through the driest part of the year.

Another off-stream reservoir might prove useful in a warming climate. While the current snow year has set records (<https://water.ca.gov/News/News-Releases/2023/April-23/Snow-Survey-April-2023>), overall, scientists think (<https://agupubs.onlinelibrary.wiley.com/doi/pdfdirect/10.1029>), there's less snow in California's future and more dry periods broken up by brief, fierce rainstorms, similar to those seen in January and March. "Sites is really looking at diverting during those high flow conditions," said Forsythe.

In March, Sites hired an outside firm to create a data analysis tool which Sites used to estimate the amount of water that could have been captured during the 2023 storms if the reservoir had been

operational. The tool indicated that Sites could have diverted enough water to support between 500,000 and 1 million households for a year.



OPONENTS ARE SKEPTICAL that Sites will be able to sequester water without harming native species. The health of fish populations like endangered salmon often tracks with the amount of water flowing in a river or stream, said Obegi, so the water that Sites plans to divert is water that “would otherwise naturally have flowed downstream and contributed to habitat for the species and increased their abundance and survival.”

Sites proponents say that because the reservoir will only divert water during high flow times, it won't be taking water critical for fish habitat. Flow rate, proponents say, is one of the most important considerations when it comes to salmon migration.

A 2021 study

(<https://esajournals.onlinelibrary.wiley.com/doi/10.1002/ecs2.3>

that looked at how streamflow affects tagged juvenile salmon in the Sacramento River found that higher flow equals better survival. Salmon “evolved to migrate during storm events because typically conditions are colder,” said Michel, the paper's lead author. “The water is more turbid, which tends to help minimize predation. Water velocities are faster, which makes their migration quicker and easier.”

Forsythe said the project will divert water only when the flow rate exceeds 10,700 cubic feet per second, the number Michel and his co-authors identified in their 2021 paper. “At that threshold, we see that survival really increases by a lot,” Michel said. And, Forsythe added in an email to Undark, water would not be diverted at all if it would cause the flow rate to fall below that critical number.

Still, it’s not as simple as waiting for a specific flow rate and then switching the pumps on. Sometimes when there’s a major storm event, there’s a big increase in the number of migrators, according to Michel. “If Sites is going to operate where they’re going to be pulling water during the storm events, they might be having a proportionally larger impact on salmon because there’s so many moving downstream at that point,” he said. To prevent this, Michel added, there should be a window of a few days to allow the bulk of migrators through before pumping begins.

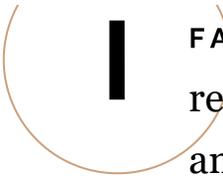
Opponents think the reservoir can only safely divert water in very wet years, which wouldn’t be cost-effective, and no one really knows how many wet years are on the horizon.

A well-managed off-stream reservoir could even have benefits for native fish, proponents say, by complementing existing on-stream reservoirs, particularly large, deep ones that contain a lot of cold water, like Shasta. Salmon thrive in cold water, and rivers are increasingly experiencing periods where water temperatures exceed the threshold that supports their survival.

“Because California and the whole West is warming, the way that we can provide cold water is through managed reservoirs,” said Sarah Null, associate professor of watershed sciences at Utah State University. Water managers at Shasta can selectively remove water from the colder parts of the lake, but there is only a finite amount of cold water. Rather than sending cold water to users that don’t need it, exchanges with off-stream reservoirs could occur instead. “We can then keep some cold water in the reservoir so that when we need it for salmon in August and September, we have it. And those are the things that we can’t really do right now.”

But even that idea isn’t without controversy. In 2021, the authors of a UC Davis study (<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0256286>) concluded that there isn’t enough cold water in California’s reservoirs to make much of a difference to salmon.





I FALL GOES WELL, Forsythe said, each year Sites will release enough water to support 640,000 people, and a little more than 100,000 acre-feet (<https://www.watereducation.org/general-information/whats-acre-foot#:~:text=An%2520average%2520California%2520household>) of water for agriculture and the environment, depending on yearly precipitation. But there are lingering questions about whether the reservoir will be able to do that, given its plans to divert most of its water during few-and-far-between storm events. Opponents think the reservoir can only safely divert water in very wet years, which wouldn't be cost-effective, and no one really knows how many wet years are on the horizon. Ron Stork, on the policy staff for Friends of the River, an organization that opposes the reservoir, said he worries about the loss of California prairies and the sacrifice the Sacramento river is being asked to make for the sake of what could ultimately become a “bathtub ring.”

This uncertainty was reflected in a 2019 paper (<https://doi.org/10.1111/1752-1688.12745>) published in the Journal of the American Water Resources Association. According to the authors' models, “expanding surface storage capacity rarely provides sizable economic value in most of California,” primarily because a bigger reservoir can't hold extra water when there isn't any extra water. This may be especially true going forward,

the researchers noted, given climate change and California's projected transition to a hotter, drier climate.

"The worst-case scenario is that water users and taxpayers pony up \$4 or \$5 billion to pay for this project," said Obegi, "and then it doesn't pencil out because there's not enough water to fill the reservoir."

There are alternative water storage strategies, but there's no magic bullet. Some conservation and environmental policy groups (<https://www.ppic.org/publication/groundwater-recharge/>) say California should focus on less expensive forms of water storage, such as groundwater recharge: a human-driven process of putting water back into depleted aquifers. But Null, who supports this alternative, says groundwater recharge can be tricky because it requires water rights to divert water. And like reservoirs, recharge requires investment, infrastructure, and a water source.

Ultimately, everyone agrees that California's warming climate will make it necessary for the Golden State to change the way it manages its water. "The value of storage and particularly offsite storage is in these rare and intense wet periods," said Null. "Trying to capture and store more of that water in the few and far between wet periods is, I would say, the name of the game for water management in the West."

Becki Robins is a California native who loves exploring her state's hidden places. Her favorite writing combines science with history, travel, and humor. Her work has appeared in Science News, Science News for Students, SciShow, and Grunge.com.

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