OCTOBER 2022

Water Year 2022:
The Drought Continues

California Department of Water Resources
California Natural Resources Agency
State of California

The Drought Continues

Water Year 2022 (October 1, 2021, to September 30, 2022) was a third dry year, although it was not as extreme in terms of temperature or precipitation as was the preceding Water Year 2021. Water Year 2022 wrapped up with 76% percent of average statewide precipitation in comparison to 50 percent of average for Water Year 2021 (period of record for averaging is 1981-present). Water Year 2022 April 1st Sierra-Cascades snowpack, a commonly reported indicator of expected Central Valley water supply conditions, was 37 percent of average; this value was 60 percent of average in Water Year 2021. Runoff in the Colorado River Basin, an important supply for Southern California, continued to be below normal in Water Year 2022, with storage in Lake Mead and Lake Powell, the two largest reservoirs in the United States, continuing to reach new record lows. An October Governor's emergency proclamation expanded prior drought emergency proclamations to cover all of California's 58 counties.

Cover: *Lizard in a field with dead grasses in the distance. Photo credit: Michael Westphal, Bureau of Land Management*

Water Year 2022 illustrated the high variability in California's climate, variability that is becoming increasingly extreme because of climate change. The water year began with an October Category 5 atmospheric river storm in northern California, an event both uncommonly large and uncommonly early in the wet season. The storm set new daily precipitation records for Santa Rosa (7.8 inches) and Sacramento (5.4 inches); earlier in the month Sacramento had set a record for 212 consecutive days with no precipitation. Another wet period ensued in the latter part of December, with the University of California's Central Sierra Snow Laboratory near Donner Pass setting a record with more than 16 feet of snow in December. (Water Year 2022 peak Sierra-Cascades snowpack occurred well before the April 1st date historically considered as the time of maximum accumulation, providing another example of the need to reframe expectations in an era of climate change.) Dry conditions followed the wet end to the calendar year and California experienced its driest January through April on record, with only 25 percent of average statewide precipitation based on records dating back to 1895. The water year wrapped up with an early September heatwave that was notable for both its duration (especially in Northern California) and its intensity, with emergency rolling blackouts to preserve the integrity of the power grid being only narrowly averted. Warm ocean temperatures caused by the prolonged heatwave allowed Tropical Storm Kay to become the tropical storm coming closest to Southern California from the Pacific Ocean in the last 50 years. Kay brought record September precipitation and flash flooding for many areas of Southern California.

Land-falling Atmospheric Rivers

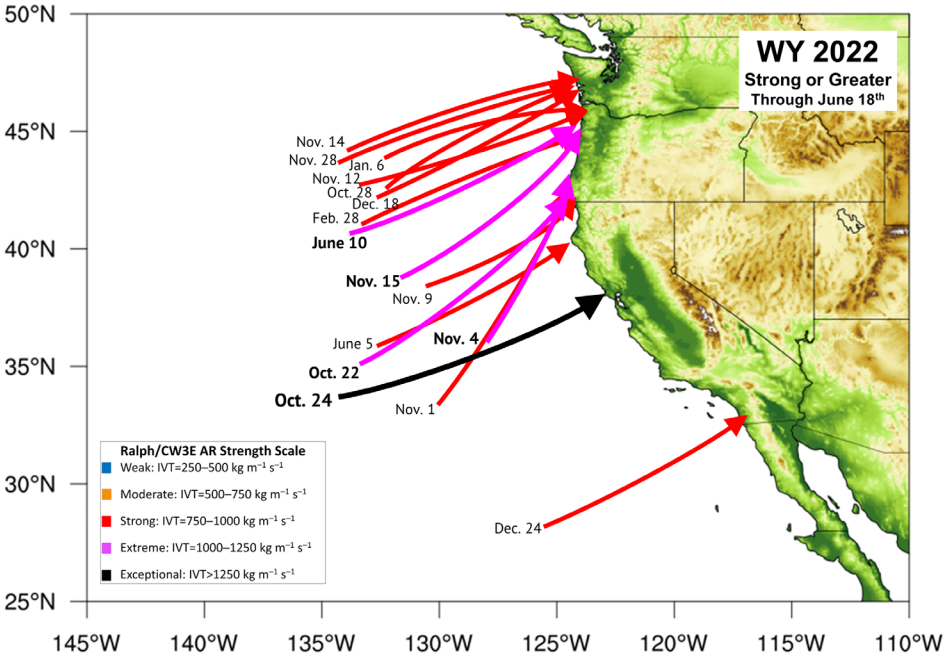
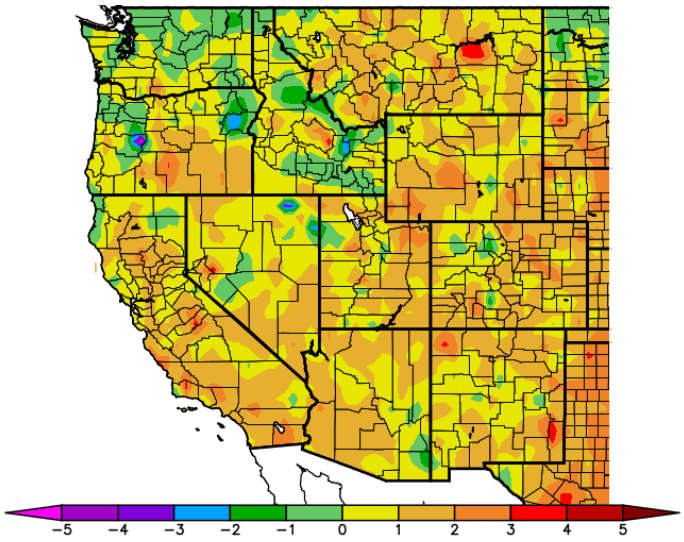


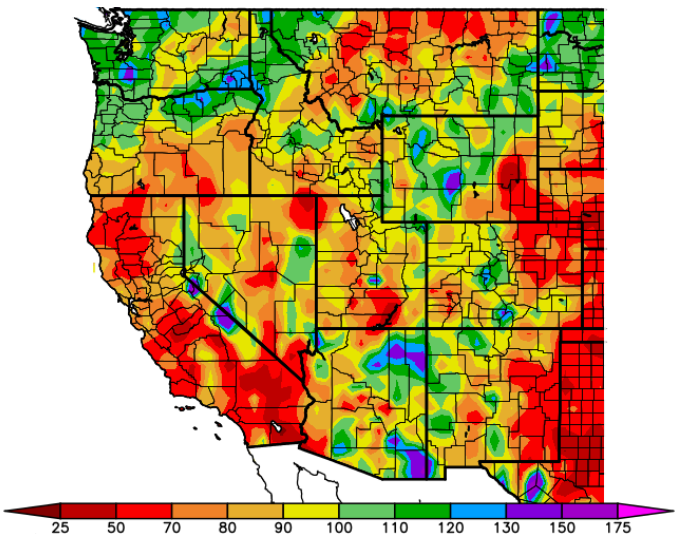
Figure credit: University of California, San Diego

Average Temperature Departure from Average



Generated 9/30/2022 at Western Regional Climate Center (WRCC) using provisional data.
Figure credit: Western Regional Climate Center

Percent of Average Precipitation



Generated 9/30/2022 at Western Regional Climate Center (WRCC) using provisional data.
Figure credit: Western Regional Climate Center

All recent water years have been above the long-term average for statewide temperatures. Water Year 2022 was not record-breaking in terms of annual statewide temperatures, but the September heatwave set many high temperature records in California and illustrated the role of climate change in making extremes more extreme. As shown in the table of selected locations where stations were reporting 110 degrees or greater, the broad geographic scope of high temperatures was particularly notable. This event was a preview of conditions that are expected to become increasingly common in the future.

The current three-year dry period continues the theme of aridity California has been experiencing in the 21st century, including the three-year drought of 2007-2009 and the five-year one of 2012-2016. The latter drought was ended (for most, but not all, of the state) by a Water Year 2017 that was California's second wettest

September Heatwave Temperatures

(Degrees Fahrenheit)

Record Temperatures	Locations
134	Death Valley
125	Needles
124	Blythe
123	Palm Springs
121	Chino, Red Bluff
120	El Centro, Lake Cachuma, Lake Henshaw, Lemoore, Orland, Whiskeytown, Woodland
119	Ojai, Redding
118	Barstow, Calistoga, Coalinga, Elsinore, Ontario, Palmdale, Ramona, Riverside
117	Chico, Healdsburg, Paso Robles, San Luis Obispo, Ukiah
116	Cloverdale, Fullerton, Gilroy, Merced, Oroville, Sacramento, Sonora
115	Bakersfield, Escondido, Madera, Pasadena, Stockton
114	Fairfield, Fresno
113	Los Angeles
111	Long Beach, San Diego
110	San Rafael, Santa Cruz

Data credit: Western Regional Climate Center

Statewide Average Temperature Ranks

September 2021- August 2022, Period 1895-2022

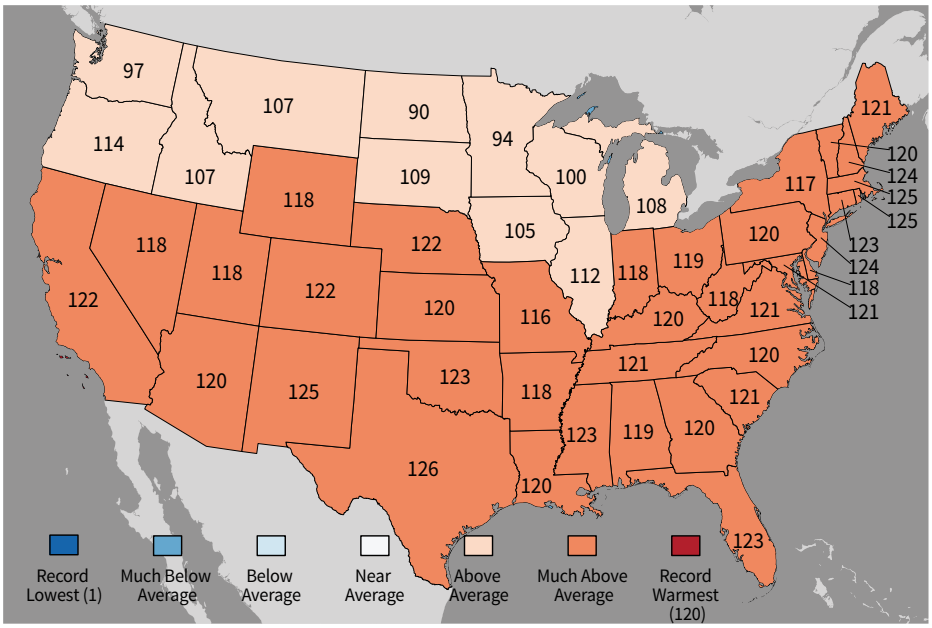


Figure credit: NOAA

Annual California Runoff, in inches

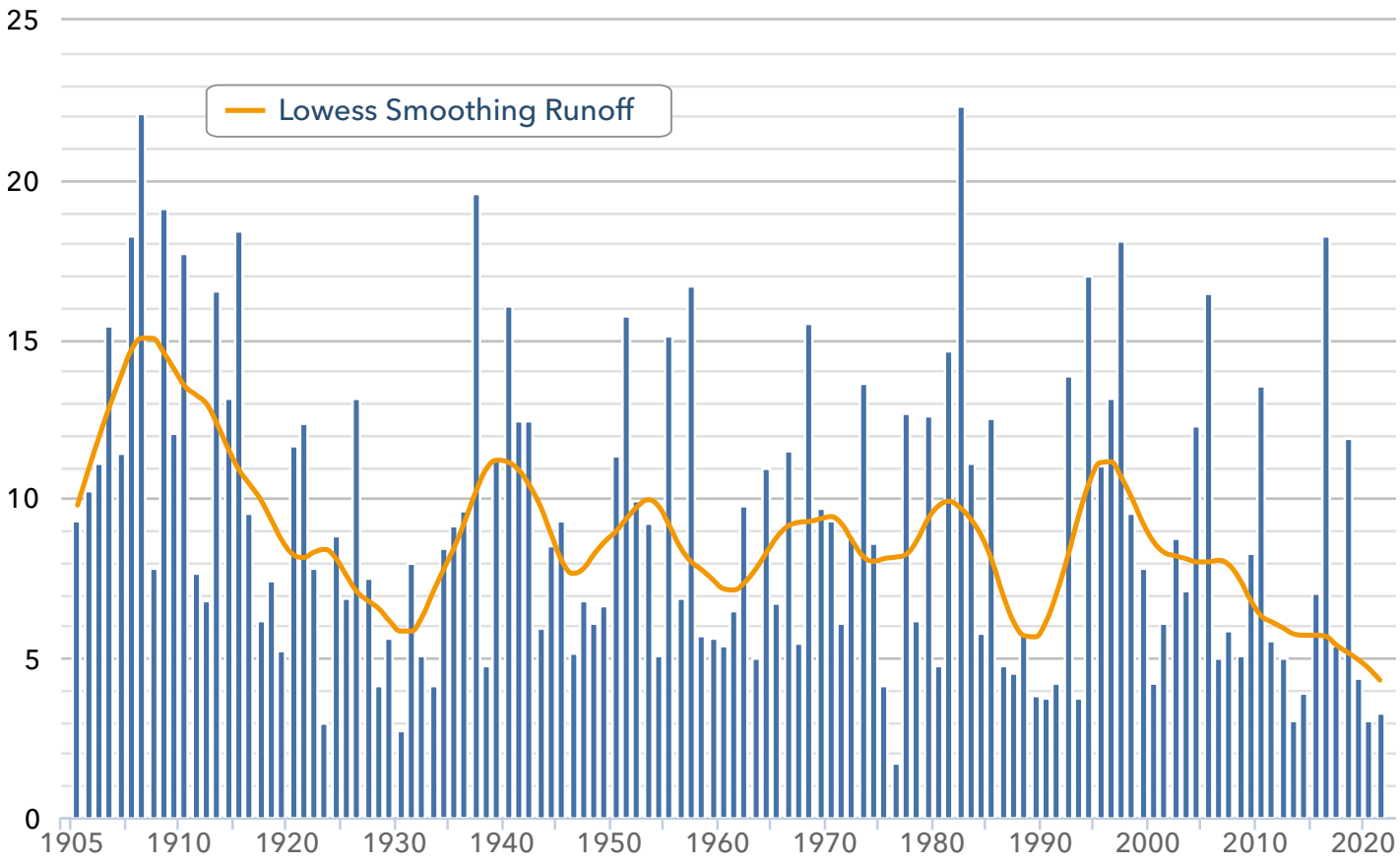


Figure credit: USGS

in terms of statewide precipitation. However, Water Year 2018 reverted to dry conditions that were only briefly relieved by a modestly above normal Water Year 2019. California's hydrologic conditions are increasingly resembling those that have been experienced in the Colorado River Basin this century, where predominantly dry conditions are interspersed with an occasional wet year.

Calendar Year 2022 saw a first-ever Lower Colorado River Basin shortage pursuant to the provisions of the U.S. Bureau of Reclamation's (USBR's) Interim Guidelines for Lower Basin Shortages and Coordinated Operations of Lake Mead and Lake Powell adopted in 2007, as the prolonged drought conditions that began in 2000 continued to deplete reservoir storage. Supplies to Arizona, Nevada, and Mexico were reduced, but California's apportionment was not affected because Lake Mead's projected elevation did not drop to the California shortage trigger level. A more active than usual Southwest summer monsoon season helped sustain Lake Mead elevations with inflows from tributaries downstream of Lake Powell. The September 1st preliminary forecast of unregulated inflow into Lake Powell for the water year, the key metric for Colorado River conditions, was 63 percent of average, despite watershed precipitation for the year being almost exactly average, continuing the observed pattern of a decline in runoff efficiency as temperatures warm throughout the basin.

Reservoir and Groundwater Storage

California ended Water Year 2022 with greater statewide reservoir storage than it had in Water Year 2021, reflecting this year's higher precipitation. There have been notable changes in reservoir management during dry years over the long-term in response to lessons learned in prior droughts, especially in comparison to 1977. Water

agencies have operated reservoirs more conservatively to preserve storage against possible multi-year droughts and environmental regulatory requirements for some reservoirs have required greater carry-over storage to protect fisheries. This water year two of the state's largest northern reservoirs, Shasta and Trinity, lagged other large reservoirs for much of the year because winter storm tracks favored more southerly reservoirs including the small local reservoirs in Marin County and Folsom Lake.

As it did in Water Year 2021, the Department of Water Resources (DWR) again constructed a temporary emergency drought barrier at West False River in the Delta to help with salinity management and to preserve storage in Lake Oroville. Reservoir releases from Shasta, Oroville, Folsom, and New Melones are used to meet Delta outflow and salinity requirements when natural flows are insufficient. As it did in Water Year 2021, the State Water Resources Control Board (SWRCB) again curtailed diversions on the mainstem Sacramento and San Joaquin rivers, helping ensure that reservoir releases from the large Central Valley Project (CVP) and State Water Project (SWP) reservoirs would not be diverted by others.

Looking at only a single-year change in groundwater levels shows that many of the measured sites had no significant changes. (Fall 2022 groundwater level data will not be available until later in the year.) Groundwater levels in the Tulare Lake hydrologic region, however, were predominantly in decline.

Lone Rock Beach at Lake Powell, note people at the base of the rock formation for scale. Lake Powell's historical elevation can be seen from the color contrast on the formation. This portion of the reservoir is now dry. Photo credit: Getty Images.

Since groundwater basin storage conditions (represented by changes in groundwater levels) change relatively slowly in comparison to reservoir storage, readers are encouraged to review DWR's online data to view longer-term trends in conditions and to view the 2022 Groundwater Conditions Update for a full overview of groundwater conditions. Land subsidence, mapped from interferometric synthetic radar data, also has the greatest aerial extent and highest rates in the Tulare Lake hydrologic region. Information on land subsidence over longer timeframes is available on DWR's website.

DWR's California Water Watch website allows viewers to see current and historical conditions at many reservoirs and wells with reported data. The website also provides precipitation, streamflow, and temperature data for selected gauges or areas.

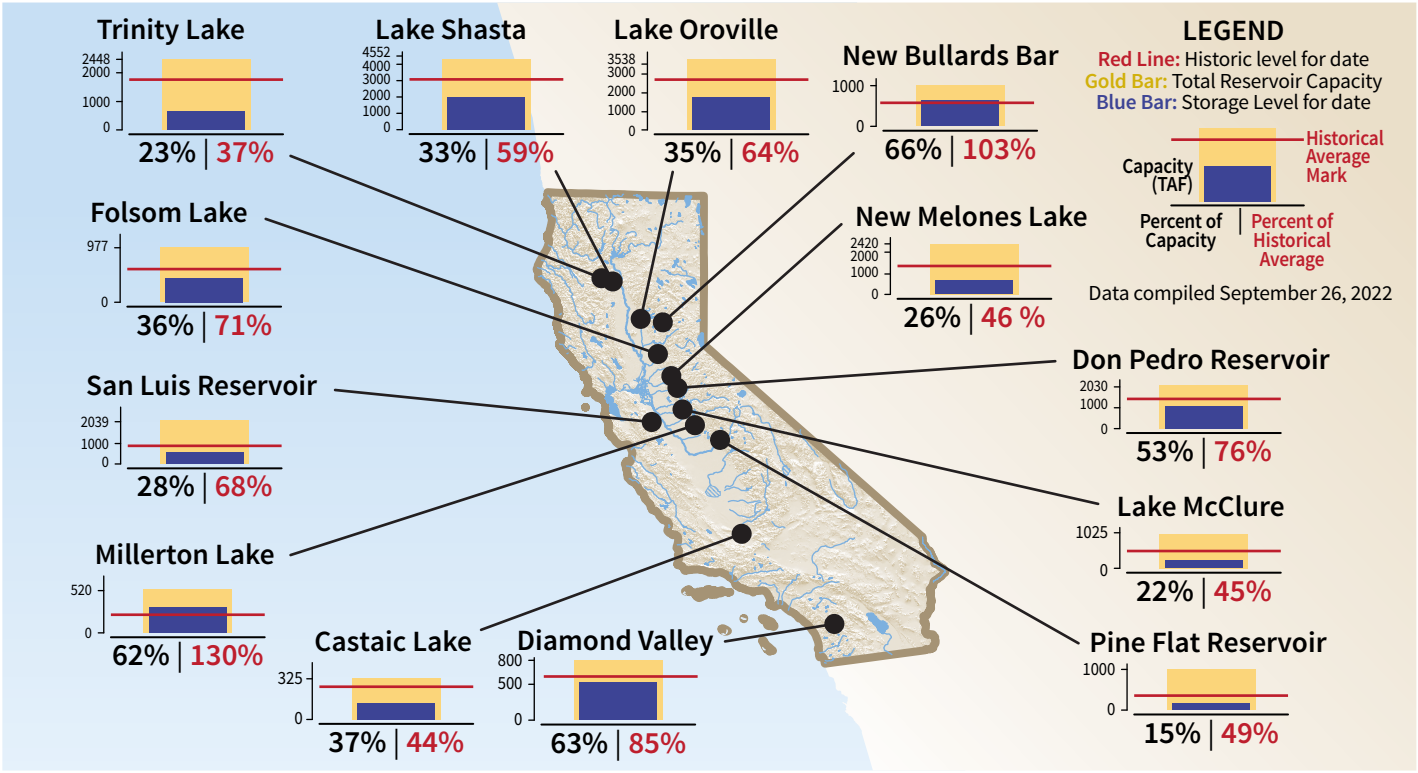
End of Water Year Statewide Reservoir Storage

September 2022

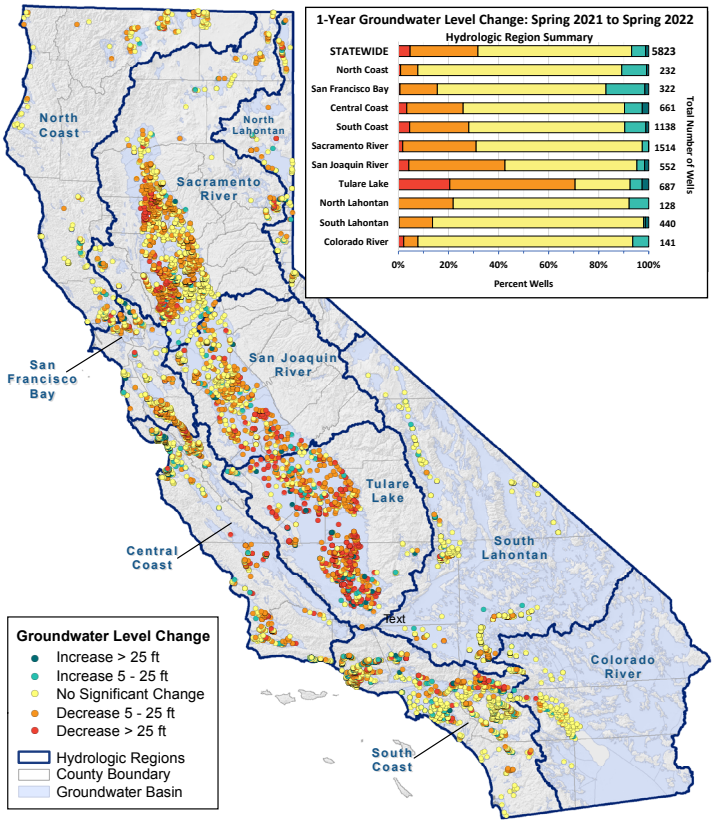
Water Year	Statewide Reservoir Storage end of August (MAF)	Percent of Historic Average
2022	14.7	69*
2021	12.5	58
2020	20.2	93
2019	26.9	124
2018	21.5	99
2017	25.9	120
2016	17.8	82
2015	11.9	55
1977	7.8	36

** Projected*

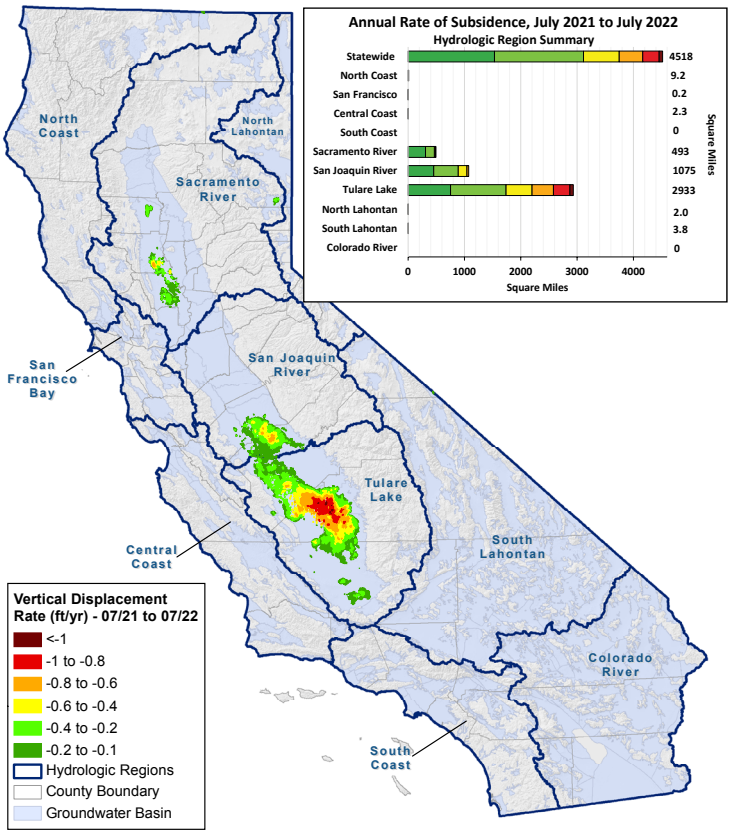
Storage in Selected Major Reservoirs



One-Year Groundwater Level Change



Subsidence Annual Rate



Water Supply Conditions

California's full Colorado River supply was the bright spot in the state's water supply picture for Water Year 2022. Historically the Colorado River has been the most reliable of California's major surface water supplies during droughts thanks to its substantial reservoir storage. However, this circumstance is now changing. In 2022 USBR took the unprecedented step of holding back 500,000 acre-feet of water in Lake Powell that was scheduled to be released into Lake Mead, and moved an additional 500,000 acre-feet from Flaming Gorge into Lake Powell to preserve reservoir elevations in Powell. In 2021 USBR had begun implementing provisions of the Upper Basin Drought Contingency Plan's Drought Response Operations Agreement, releasing water from Colorado River Storage Project reservoirs above Lake Powell to bolster Powell levels. USBR seeks to keep Lake Powell from falling below the power generation elevation because it is concerned that Glen Canyon Dam's low-level outlets may not be able to support sustained long-term operations. Although USBR's August 24-month study used to establish the operating conditions for calendar year 2023 did not project a Lake Mead elevation that would trigger a shortage for California, discussions are ongoing regarding conservation actions that would result in reduced 2023 supplies for California in order to slow the rapid decline in lake levels

California's large water projects continued to experience shortages in response to ongoing dry conditions.

Top: *Hoover Dam on Lake Mead, showing the effect of prolonged drought in the Colorado River Basin. Photo credit: Alamy*

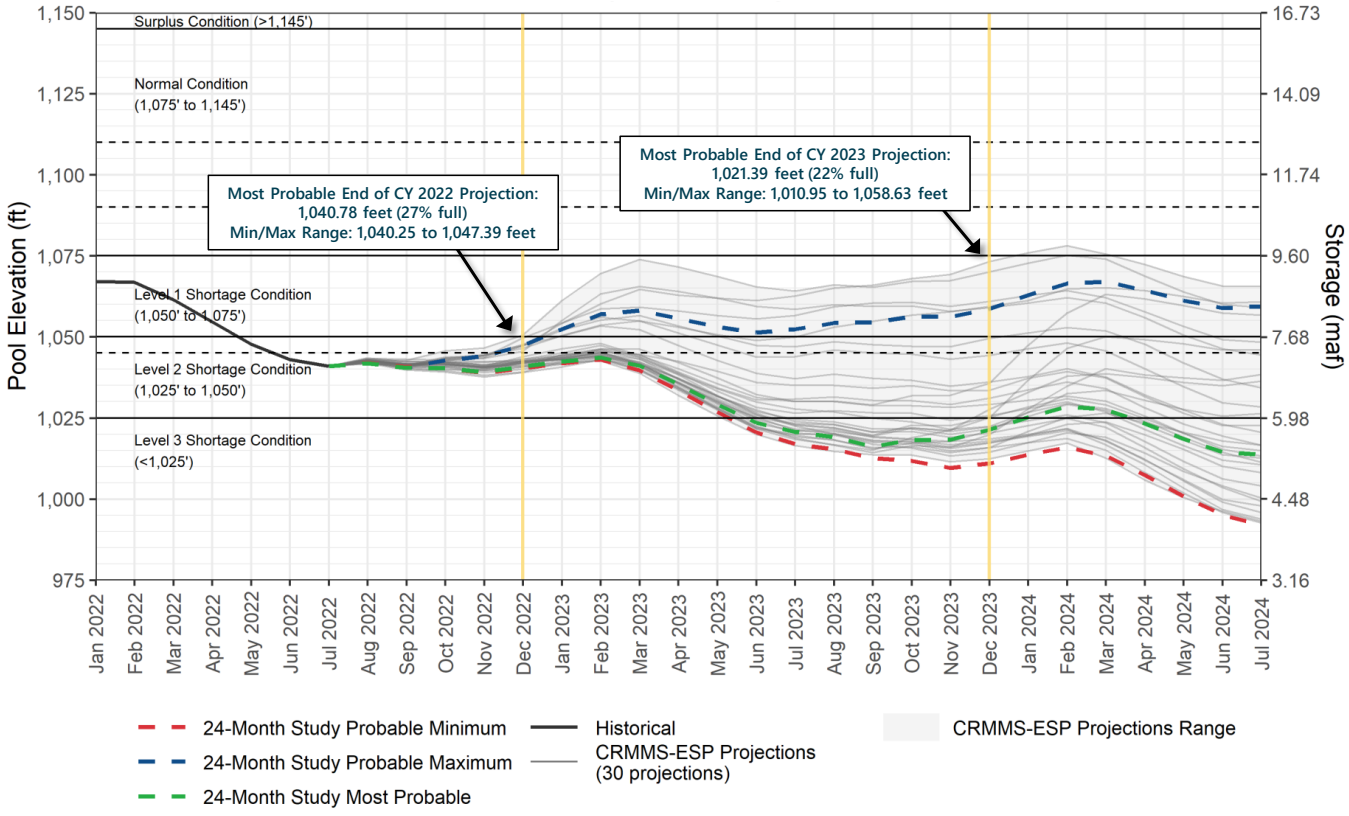
Below: *Drone view of an algal bloom at O'Neill Forebay in May 2022. The forebay is a popular destination for windsurfing, an activity that can put people in contact with harmful algal blooms. Photo credit: DWR*

USBR had a zero allocation for its CVP agricultural contractors north and south of the Delta; Friant Division contractors received a 30 percent allocation. Municipal and agricultural (M & I) contractors in these areas had a public health and safety allocation, as did M & I contractors on the American River and the Contra Costa Canal. Wildlife refuges and settlement contractors north of Delta received 18 percent supplies, and those south of Delta received Shasta Critical supplies. The SWP provided a five percent allocation plus additional residential health and safety water to a few contractors who had no source of supply other than the SWP. The SWP's Feather River settlement contractors received a 50 percent allocation. Much of the additional SWP residential health and safety water (which is calculated at 55 gallons per person per day) went to Metropolitan Water District for member agencies in the western part of its service area where it is unable to deliver Colorado River water

Minimal CVP and SWP supplies have cascading impacts. Reduced supplies to CVP and SWP water rights settlement contractors lessen water available for voluntary annual water transfers, as these contractors often participate in market-based sales to urban areas. This year to date DWR has received less than 70,000 acre-feet of requests for conveyance of temporary transfers in SWP facilities. Sacramento Valley rice acreage, much of which is irrigated with water provided through CVP and SWP project contracts and water rights settlement contracts, was noticeably affected; the California Rice Commission has estimated that this year's harvested acreage will be about half of normal levels, which also affects migratory waterfowl that

Lake Mead End-of-Month Elevations

Projections from August 2022



[1] Projected Lake Mead end-of-month physical elevations from the latest CRMMS-ESP and 24-Month Study inflow scenarios.

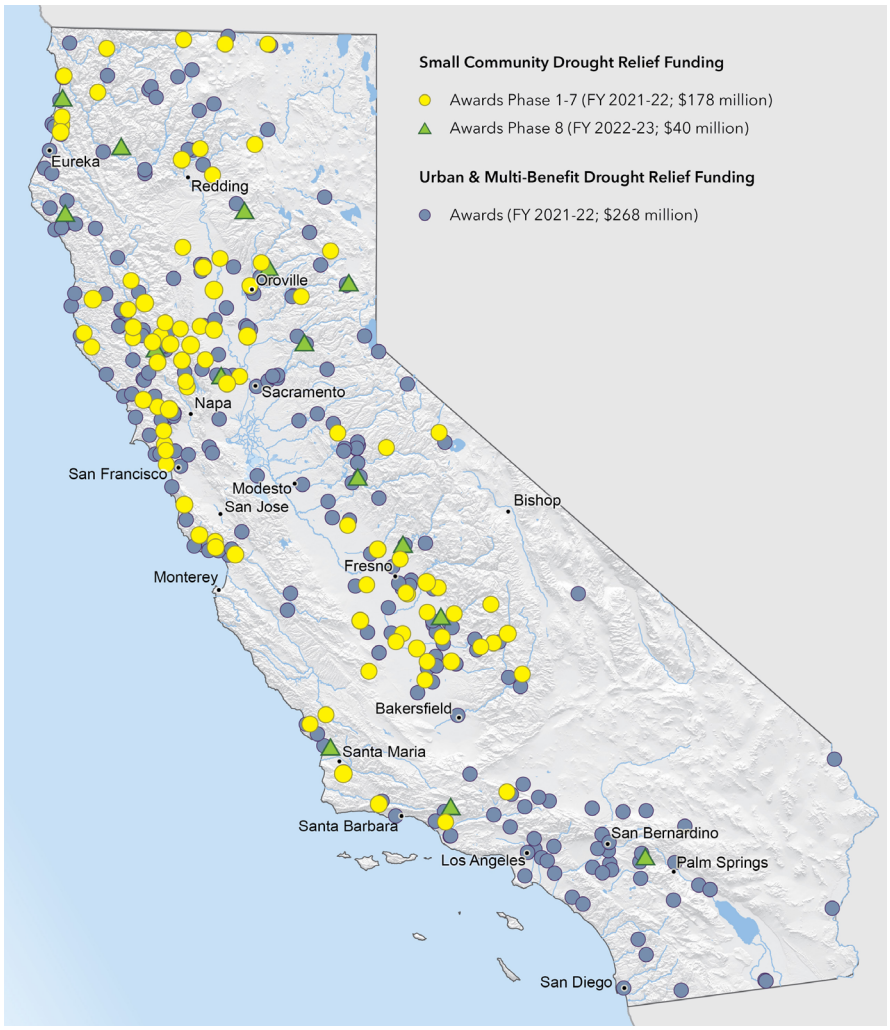
This USBR graphic show the results of the August 2022 24-month study used to establish the 2023 Lower Basin shortage condition. A significant point of the graphic is the number of model traces that are not only below the 1050 elevation at Lake Mead (the level at which Southern Nevada Water Authority's highest intake at the reservoir becomes stranded) but are even below elevation 1025 (the elevation corresponding to a Tier 3 shortage).

make use of rice acreage. With limited surface water deliveries, growers with access to groundwater will increase extractions to keep permanent plantings such as orchards and vineyards alive. The increased areal extent of land subsidence observed in the Sacramento Valley (although small in comparison to subsidence in the San Joaquin Valley) reflects impacts of two consecutive years of minimal or no CVP irrigation supplies.

The CVP and SWP are entering new operational territory with the concept of limited allocations (health and safety supplies only) to municipal contractors. Calendar year 2022 marked the first instance of this for the CVP; the SWP had initially announced a health and safety only allocation for all contractors but subsequently increased that to a five percent allocation for all contractors with additional health and safety water for those urban contactors who had no other supplies. Meeting service area needs under a health and safety allocation can be challenging for some contractors who serve a high percentage of commercial, industrial, and institutional (CII) demands that are not covered under a health and safety allocation. Of the roughly 400 urban water suppliers large enough to be required to prepare Urban Water Management Plans, almost one-quarter of them have CII demands of about 25 percent or more, and many of the agencies with the highest CII demands are CVP or SWP contractors.

Small water systems (and private residential well owners) are most affected by water shortages related to groundwater conditions. Within the last year about 1,850 dry wells were reported through DWR's system for voluntary reporting of dry private residential wells, a very small percentage of the estimated two million wells in California. As shown on the map, DWR has awarded grants for urgent drought relief to numerous small communities in response to immediate drought-related shortages or threatened shortages, or needs for an interim drought solution until a longer-term solution can be developed with SWRCB assistance.
Many of these grants were for replacing failed wells and related infrastructure

Small Community and Urban and Multi-Benefit Grants

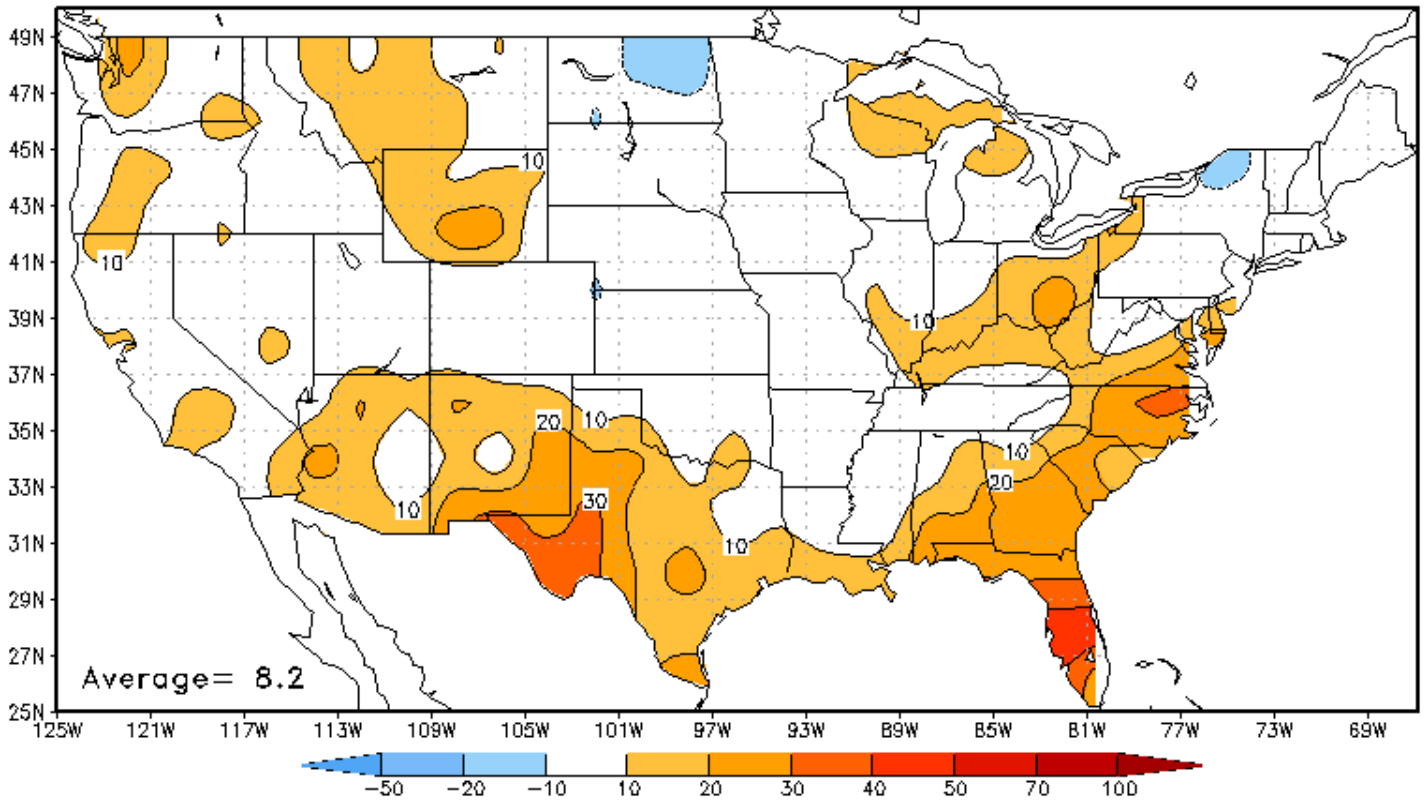


Prospects for Water Year 2023

Accurately predicting seasonal precipitation and reliably answering the question if California's coming winter will be wet or dry is not within present National Weather Service capabilities. The National Ocean and Atmospheric Administration's (NOAA's) Climate Prediction Center produces precipitation outlooks for the winter months important to California's water supply, but the historical skill of these outlooks is minimal. The high annual variability in California's annual precipitation means that any year could hold

NOAA Climate Prediction Center Verification Heidke Skill Score for Dec/Jan/Feb Precipitation Outlook

Issued Mid-Nov from 1995 to 2022

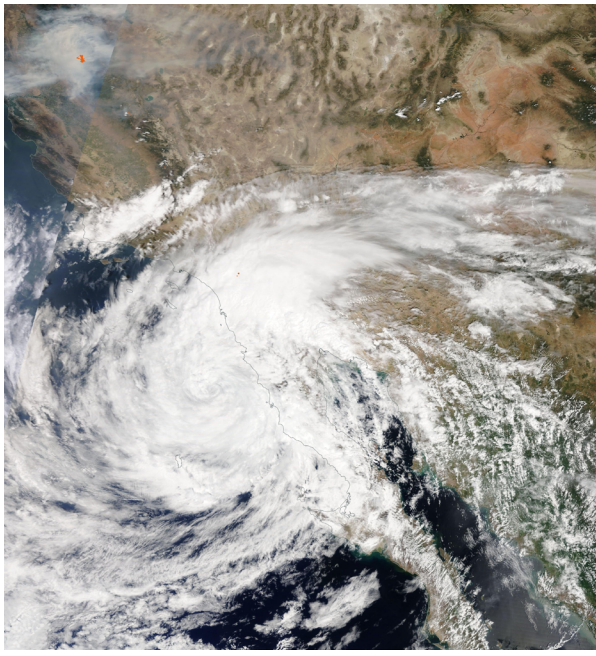


A score of zero means no more skill than predicting average climate conditions, a score of 100 is a perfect forecast. Figure credit: NOAA

the possibility for record wet conditions, such as those of Water Year 2017, or for continued dry conditions. Improving the ability to make seasonal precipitation predictions is critically needed to support drought preparedness and response.

California's observational record shows that La Niña years are often, but not always, associated with dry conditions in Southern California. Apart from this relationship, the status of the El Niño-Southern Oscillation conditions does not by itself provide an indication of potential water supply outcomes. La Niña conditions are present now in the tropical Pacific Ocean, and NOAA predicts their continuation into the coming winter, marking a rare consecutive three-year La Niña occurrence.

Present dry conditions can influence the quantity of runoff that occurs from the coming wet season. When precipitation occurs under conditions of moisture deficit in the climate system, an increased amount of that precipitation replenishes depleted soil moisture and is taken up by vegetation, reducing runoff efficiency. The warming that has occurred in California in the 21st century is visibly shifting our climate to conditions that are drier overall and additionally resulting in other impacts that affect watersheds, such as increased wildfire damage and more prevalent harmful algal blooms.



Top: *August flooding on Mud Canyon Road in Death Valley. Heavy precipitation during the very active monsoon season and from the decaying Tropical Storm Kay brought summer flash flooding to normally dry desert areas such as Death Valley, Coachella Valley, and Imperial Valley. Photo credit: National Park Service*

Bottom, left: *The Mosquito Fire in the American River watershed, California's largest fire in 2022 as of September, as seen from the Foresthill divide on September 8th. Water quality impacts from burned areas can persist for sustained periods. Photo credit: CAL FIRE*

Bottom, right: *A September image satellite of Tropical Storm Kay nearing California from the National Aeronautics and Space Administration's (NASA's) Terra satellite. Photo credit: NASA*

Back cover: *Signs were placed at the California State Capitol explaining the dead lawns. Photo credit: DWR*

OCTOBER 2022

California
Department of
Water Resources

715 P Street,
Sacramento, 95814

water.ca.gov