2012 Water Year in Review

Introduction

The 2012 Water Year in Review is a summary of the information presented in the Southwest Climate Outlook between October 1, 2011, and September 30, 2012. The water year is a standard period of measurement used in hydrology because the natural seasonal ground recharge and discharge cycles are more aligned with the October–September period than the calendar year due to precipitation and evaporation patterns. This review highlights precipitation, temperature, reservoir levels, drought, wildfire, and El Niño-Southern Oscillation (ENSO) conditions over this 12-month period.

Heat and drought defined the water year, smothering the Midwest, in particular, during the spring and early summer. Temperatures during the water year were among the top five warmest on record in 39 of the 48 contiguous states, ranking as the 19th and fifth warmest on record in Arizona and New Mexico, respectively, out of 117 years. These conditions conspired with scant precipitation to cause many of the nation's fertile farmlands to wilt.

Warmer-than-average temperatures and below-average precipitation across nearly all of Arizona and New Mexico characterized the water year (see pages 4 and 5). Consequently, moderate or more severe drought covers almost the entire Southwest and drought conditions are now more widespread, though less intense, than they were at the beginning of the water year (see page 7). The fact that drought has persisted in many parts of the Southwest during the last two years is not surprising given the occurrence of a La Niña event during back-to-back winters (see page 9); La Niña conditions often deflect winter storms north of the Southwest. It was also a relatively dry winter in the headwaters of the Colorado River and Rio Grande in Colorado, where scant rain and snow contributed to storage declines in many reservoirs on these rivers (see page 6). Dry conditions also set the stage for wildland fires in the Southwest. Although this water year's fire season did not surpass the record number of acres burned last year, New Mexico's largest wildland fire on record—the Whitewater-Baldy Complex fire—tore across 298,000 acres in the west-central part of the state in and around the Gila National Forest, nearly doubling the size of the state's previously largest fire (see page 8).

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Top 5 headlines of the water year

1 Back-to-back La Niña Events A La Niña event re-emerged in September 2011, marking the second consecutive winter in which a La Niña influenced weather in the Southwest. The statewide November 2011–April 2012 precipitation for Arizona was 66 percent of average, while New Mexico fared slightly better, recording 91 percent of average.

2 Widespread but less intense drought Moderate drought now covers nearly 100 percent of Arizona and New Mexico, an increase of about 30 and 4 percent, respectively, since the water year began on October 1. Although drought has expanded, it has become less severe. Extreme or exceptional drought covered about 6 percent of Arizona on October 2, down from about 15 percent one year ago, and less than 1 percent of New Mexico, a decrease of about 34 percent from one year ago.

3 Monsoon: A tale of two states The position of the subtropical high pressure area allowed moist air to waft into Arizona. Southern areas of the state and the Mogollon Rim benefited the most, receiving above-average rainfall totaling 6.5 to 9.5 inches between July and September. The position of the high, however, limited rain in New Mexico and nearly all of the state received below-average rainfall.

4 Elephant Butte Reservoir nearly empty Winter rain and snow in the Upper Rio Grande Basin in Colorado, from which most of the water flowing in the Rio Grande originates, was below average for the fifth time in the last 10 years. Consequently, Elephant Butte Reservoir, which provides irrigation water to New Mexico's most productive agricultural region, stood at less than 5 percent of capacity and water available to farmers is now completely exhausted.

5 Colorado River streamflows tank Combined storage in Lakes Mead and Powell stood at 54 percent of capacity as of September 1, which is 7 percent lower than it was one year ago. Based on preliminary data, flow into Lake Powell for October 2011 to September 2012 was 5 million acre-feet (maf), or about 46 percent of average, making it the lowest inflow volume since 2002. Also, inflow between April and July was 2.06 maf, or 29 percent of average, which was the third smallest April to July volume since the closure of Glen Canyon Dam in 1963.

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Temperature

Temperatures during the 2012 water year were 1 to 3 degrees Fahrenheit warmer than average across large swaths of both Arizona and New Mexico, with temperatures in Arizona generally slightly cooler than in New Mexico (*Figure 1a*). The warmest regions were northeastern New Mexico and Gila County in Arizona, where temperatures were 2 to 4 degrees F warmer than average (*Figure 1b*). The La Niña event, which prevailed during the winter, kept most of the cold winter storms north of both states. Those storms that crossed the region tended to waft over northern Arizona, bypassing southern regions and New Mexico. This helped cause temperatures to be well above average in New Mexico. In Arizona, most areas also experienced above-average temperatures, although they were slightly cooler than New Mexico. The one exception, where temperatures were below average, was in south-central Arizona. In this area, several cold winter storm and strong summer thunderstorm activity delivered significant rainfall and lowered temperatures. In the Southwest, a strong positive correlation exists between the amount of precipitation and temperature.

The dry winter and spring weather gave way to an active monsoon season in Arizona. Summer storm activity was more frequent in the western part of the state, bringing copious rain to the lower Colorado River valley and across central Arizona and cooling air temperatures there. The general position of the tropical high pressure area, however, prevented moist air from rolling into New Mexico; consequently the state was dry and warmer than average during the monsoon.

A view of the average temperatures for the water year reveals the impact topography has on temperature, with higher elevations cooler than lower areas (*Figure 1a*). Average temperatures on the Colorado Plateau, for example, were between 50 and 60 degrees F, with the highest mountains averaging between 40 and 50 degrees F. Southeastern New Mexico recorded average temperatures of 55 to 65 degrees F, while the southwestern deserts of Arizona were warmest, at 65 to 75 degrees F.

Figure 1a. Water year 2012 (October 1, 2011 through September 30, 2012) average temperature.*

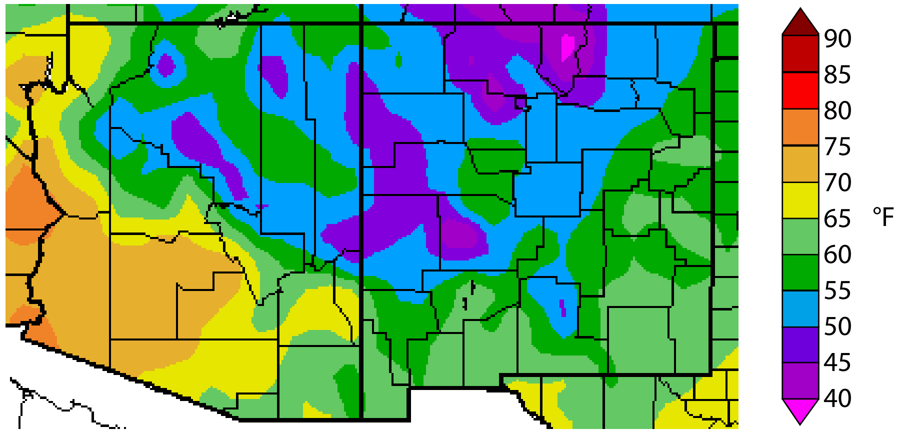
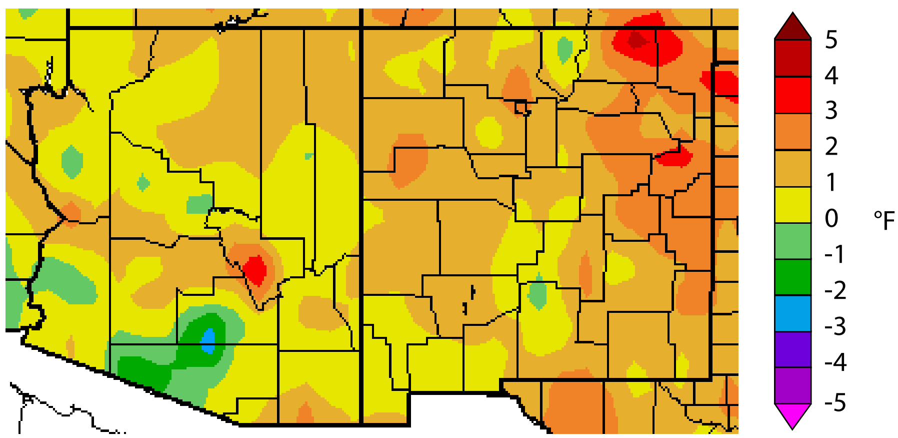


Figure 1b. Water year 2012 (October 1, 2011 through September 30, 2012) departure from average temperature*



** See "Notes" section on page 10 for more information on interpreting these figures.*

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Precipitation

Precipitation across most of Arizona and New Mexico during the 2012 water year was below average (*Figures 2a–b*). Precipitation deficits ranged from 0 to 8 inches in most regions of both states and up to 12 inches in a few locations in northern New Mexico. Deficits in Flagstaff were more than 6 inches (*Table 1*). There were a few exceptions in western Arizona. Above-average precipitation fell in central Mohave County, for example, bolstered by a few wet monsoon storms, and western Pima County also benefited from a few strong monsoon storms as well as a large winter storm. Departures from average precipitation can be misleading. Small departures may not seem significant, but in arid environments like the desert Southwest, a 2-inch rainfall deficit may equate to a 25- to 50-percent decrease in rainfall.

The La Niña event, which began in September 2011 and persisted through April 2012, helped push most storms north of Arizona and New Mexico. The winter was followed by an active monsoon that tended to favor the western half of Arizona, leaving eastern Arizona and most of New Mexico very dry. Southwestern Maricopa County and the Four Corners area have been the two driest locations in Arizona, as both winter and summer storm activity bypassed them. In New Mexico, precipitation in eastern regions has been less than 70 percent of average in the last 12 months. In the southwestern corner of the state, scant monsoon rainfall contributed to precipitation amounts of less than 50 percent of average. Overall, the below-average rain and snow in Arizona and New Mexico helped sustain drought conditions, which are both widespread and intense across the region. All of the Southwest is currently experiencing at least moderate drought, with severe and extreme conditions covering the areas that have experienced the driest conditions in the last year (see page 7).

Figure 2a. Water year 2012 (October 1, 2011 through September 30, 2012) departure from normal precipitation.*

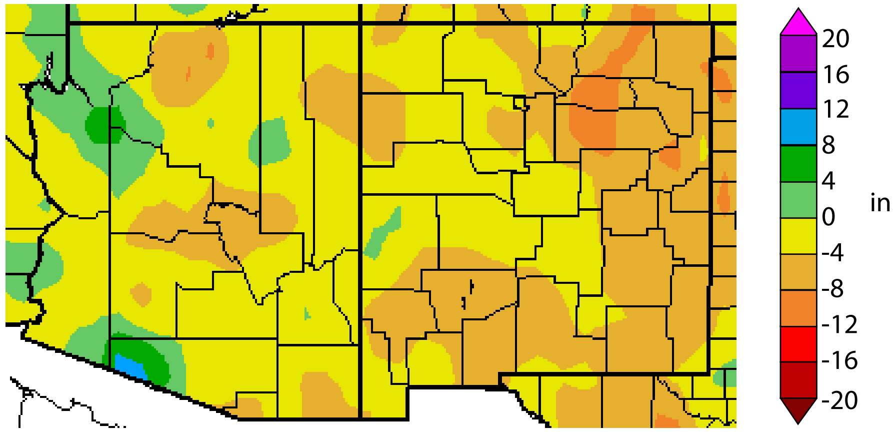
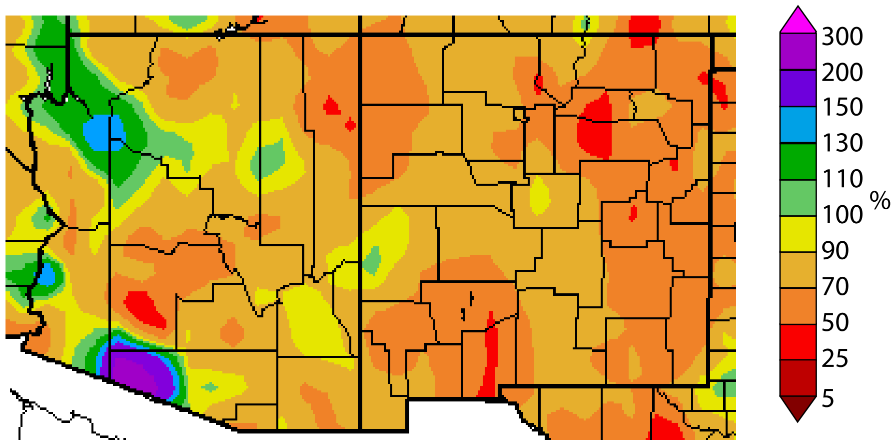


Figure 2b. Water year 2012 (October 1, 2011 through September 30, 2012) percent of average precipitation.*



** See "Notes" section on page 11 for more information on interpreting these figures.*

Table 1. Water year 2012 precipitation values (in inches) for select cities.

City	WY 2012 Precipitation	Average WY Precipitation	2012 Departure from Average	2011 Departure from Average
Phoenix, AZ	5.38	8.03	-2.65	-3.65
Tucson, AZ	9.76	12.17	-2.41	-2.08
Douglas, AZ	9.17	13.76	-4.59	-6.64
Albuqu.,NM	8.04	9.47	-1.43	-6.21
Winslow, NM	6.95	8.03	-1.08	-1.99
Flagstaff, AZ	16.73	22.91	-6.18	-0.09
Yuma, AZ	3.92	3.05	+0.87	-1.38
El Paso, TX	6.81	9.43	-2.62	-4.80

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Reservoirs

Arizona. Storage in most reservoirs across the Southwest declined in the last 12 months as a result of lower-than-average precipitation and above-average temperatures. In Arizona, total reservoir storage in San Carlos Reservoir on the Gila River and in the Salt and Verde river reservoir systems decreased by about 305,700 acre-feet during the 2012 water year (*Table 2*). The La Niña event, which began in September 2011 and persisted through April 2012, robbed Arizona watersheds of much-needed winter snow. That event also affected the Colorado River, where combined storage in Lakes Powell and Mead decreased by 3.65 million acre-feet (maf; *Figure 3*). The 2012 water year inflow to Lake Powell was 4.91 maf, or about 46 percent of average, placing 2012 as the third driest water year on record—only 2002 and 1977 registered lower inflows.

New Mexico. In New Mexico, total reservoir storage was about 431,700 acre-feet less than it was one year ago, not including changes in storage for El Vado and Heron reservoirs, which did not report storage values in October 2011. Like in Arizona, back-to-back La Niña events in the 2011 and 2012 winters helped steer storms north of the state, starving headwaters of snow and contributing to substantially lower reservoir levels than those recorded in 2010 prior to the onset of La Niña conditions. In New Mexico's largest reservoir, Elephant Butte, storage decreased by 95,000 acre-feet, halving the amount of water that was stored in the reservoir at the beginning of the water year. As a result of low reservoir levels, irrigators in the lower Rio Grande Valley received only 10 inches of surface water—a full allotment is 36 inches. It was the ninth time in the last 10 years irrigation allotments were low. In the Navajo Reservoir in the San Juan River Basin, the state's second-largest reservoir, storage declined by more than 293,000 acre-feet, or about 17 percent (*Table 3*). Reservoir storage on the Pecos River also fell by more than one-third during the water year, dropping by 6,800 acre-feet.

Figure 3. Combined storage in Lakes Mead and Powell

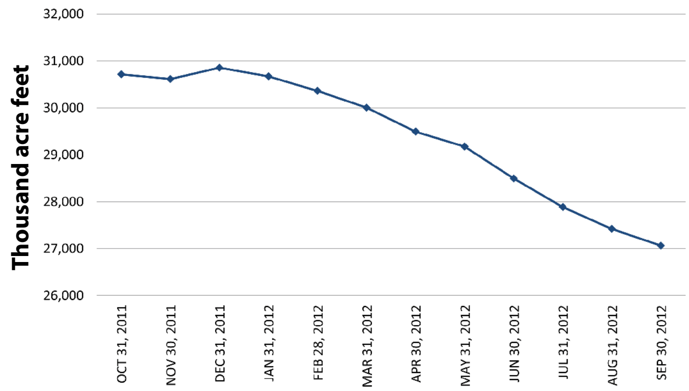

Table 2. Selected Arizona reservoirs' water year statistics.

Reservoir	Oct. 11 Percent full	Sept. 12 Percent full	WY Peak Percent	Peak Month
Powell	71	57	71	October
Mead	51	50	57	February
Gila	1	1	3	March
Verde	30	31	31	September
Salt	71	55	72	March

Table 3. Selected New Mexico reservoirs' water year statistics.

Reservoir	Oct. 11 Percent full	Sept. 12 Percent full	WY Peak Percent	Peak Month
Navajo	78	61	79	April
Heron	57*	48	66	June
Elephant Butte	9	5	18	March
Conchas	7	2	7	December
Santa Rosa	2	1	4	April
Brantley	1	0	3	April

* based on estimated value

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Drought

The moderate-to-strong La Niña event that persisted during the 2010–2011 winter led to record low precipitation across the Southwest. This led to rapidly intensifying and expanding drought conditions across much of Arizona and New Mexico that the ensuing mediocre monsoon did not alleviate. By the beginning of the 2012 water year, the drought was widespread and intense in the Southwest, with extreme or exceptional drought covering more than 30 and 63 percent of Arizona and New Mexico, respectively. Dry conditions persisted through October and November, further helping to entrench drought conditions that covered most of Arizona and New Mexico (*Figure 4a*). In December an unusually wet weather pattern delivered above-average precipitation in Arizona, despite the formation of a second consecutive La Niña event. New Mexico, however, received less moisture. Drought conditions improved to moderate levels across Arizona by mid-February, but severe to exceptional drought continued to cling to much of New Mexico (*Figure 4b*).

The 2011–12 La Niña, albeit a weaker event than the one in the preceding winter, brought the return of dry weather to the Southwest between January and April. Very little precipitation fell during this period, leading to the reemergence of severe drought conditions in many parts of Arizona and western New Mexico. By mid-May, some level of drought blanketed all of Arizona and New Mexico, with most areas classified with at least severe drought (*Figure 4c*). Monsoon precipitation hit the region in late June and early July, slightly earlier than average. By the end of the summer, monsoon precipitation was close to normal for much of Arizona but below average for most of New Mexico. The monsoon helped improve short-term drought conditions in Arizona, but led to the intensification of drought in some parts of New Mexico (*Figure 4d*). The water year ended with at least moderate drought covering all of Arizona and New Mexico.

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Figure 4a. Drought Monitor released November 22, 2011.*

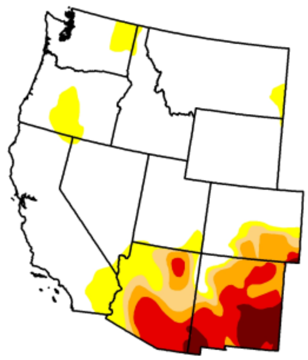


Figure 4b. Drought Monitor released February 21, 2012.*

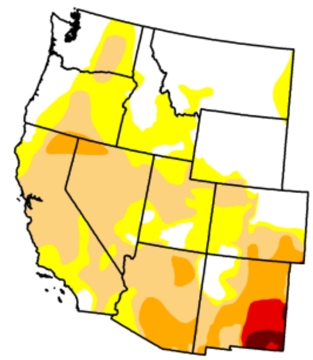


Figure 4c. Drought Monitor released May 22, 2012.*

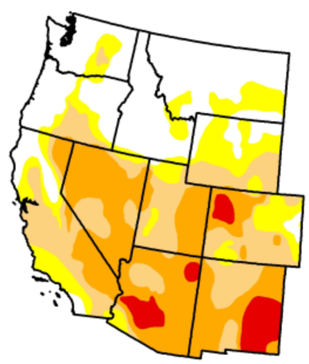
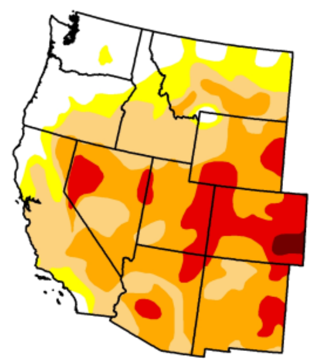
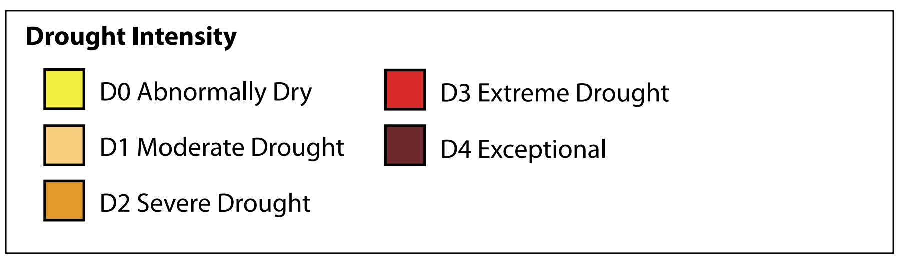


Figure 4d. Drought Monitor released August 21, 2012.*





** See "Notes" section on page 12 for more information on interpreting these figures.*

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Wildfire

The number of wildland fires between January 1 and October 4, the period that includes the bulk of the fires and acres burned in the 2012 water year, was below average in Arizona but above average in New Mexico. The fire season this year followed the typical timeline, with wildfires beginning in earnest in May and peaking in June to early July. The onset of the monsoon in early July helped extinguish fires and increased soil and fuel moisture levels, reducing the number of new fire starts thereafter. The fire season began with similar conditions as last year, as above-average temperatures and below-average precipitation during the winter and spring months elevated fire risk by reducing moisture levels in soils and live fuels such as grasses, shrubs, and trees. This year, however, was not as damaging as the 2011 fire season, when approximately one million acres—the most on record in Arizona and New Mexico—burned in each state.

In Arizona, majority of the fires burned in the Southeast corner of the state (*Figure 5a*), with fires charring about 163,250 acres—about 50,000 acres less than the 1990–2011 average. In New Mexico, nearly 372,500 acres burned, which was about 105,000 more acres than the 1990–2011 average. The majority of these acres burned in 22 fires (*Figure 5b*). New Mexico's largest wildfire this year, the Whitewater Baldy Complex fire, torched about 298,000 acres, or about 80 percent of the total acres burned in the state (*Table 4*). The blaze was caused by two lightning strikes on May 16 in the Gila National Forest near Glenwood and nearly doubled the state wildfire record set by last year's Las Conchas fire, which burned more than 150,000 acres. The second largest fire in the region was the Little Bear fire, which burned more than 44,330 acres beginning on June 4 in the Lincoln National Forest, northwest of Ruidoso, NM. The Grapevine fire, the largest in Arizona this year, tore through the Coronado National Forest near Safford on June 28. This lightning-caused fire burned 19,100 acres.

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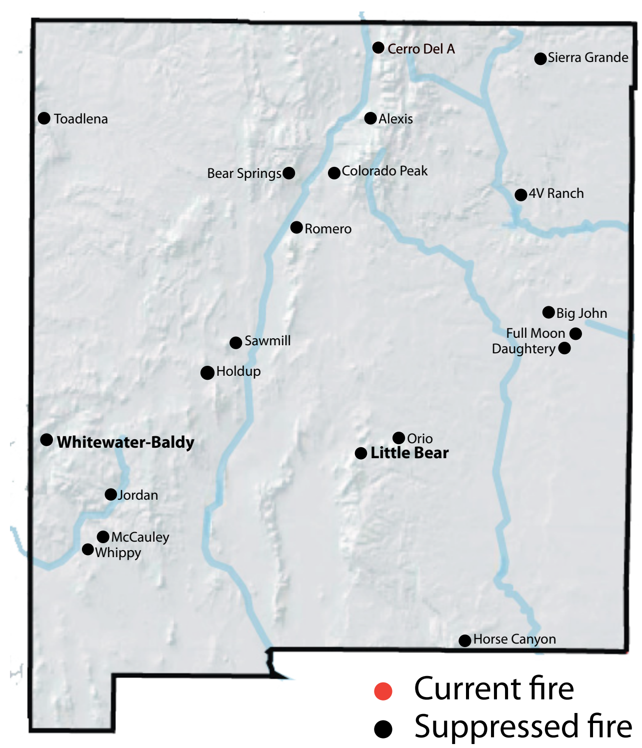
Table 4. Ten Largest Southwest fires in 2012.

Fire Name	State	Acres Burned
Whitewater-Baldy	NM	297,845
Little Bear	NM	44,330
Grapevine	AZ	19,100
Black Canyon	AZ	18,300
Sunflower	AZ	17,446
Gladiator	AZ	16,240
Poco	AZ	11,950
Canyon	AZ	8,716
Fox	AZ	7,500
Cooks Complex	AZ	7,446

Figure 5a. Arizona large fire incidents as of September 30, 2012.

Figure 5b. New Mexico large fire incidents as of September 30, 2012.



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El Niño

Sea Surface Temperatures

La Niña dominated the headlines again this water year, and the event sent shock-waves across the atmosphere that helped bring drier-than-average conditions to the Southwest. It was the second consecutive winter in which La Niña was present; back-to-back La Niña events often occur if the first one is relatively strong, like it was in the winter of 2010–2011.

The 2012 water year began with weak La Niña conditions returning to the equatorial Pacific Ocean in September after brief hiatus between May and August (*Figures 6a–b*). During the early winter months, sea surface temperatures (SSTs) in the eastern Pacific Ocean along the equator continued to cool and the event peaked in February, reaching weak to moderate strength. The La Niña began to dissipate thereafter and officially ended in April. Even though this La Niña was relatively weak compared to the previous year's event, it had a substantial impact on weather patterns across the western U.S. throughout the winter. During the January–March period, for example, the winter storm track took on a more northerly route, dumping above-average precipitation on the Pacific Northwest but leaving much of the Southwest with below-average rain and snow, which is the typical pattern during La Niña events. This was the second winter in a row with below-average precipitation, leading to worsening drought conditions across the region.

ENSO-neutral conditions in April and May gave way to borderline El Niño conditions in June as SSTs warmed. This rapid increase in temperature gave rise to forecasts that an El Niño event would emerge during the late summer. By August, however, the eastern Pacific Ocean began to cool. The water year ended with ENSO-neutral conditions in control and the prospects of a developing El Niño event uncertain.

Figure 6a. Map of the El Niño 3.4 region. The yellow box outlines the region. Graphic credit: International Research Institute for Climate and Society.

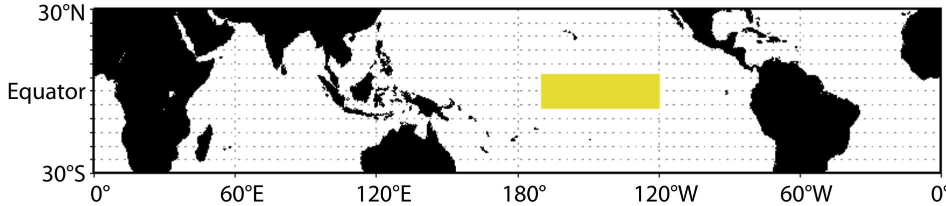
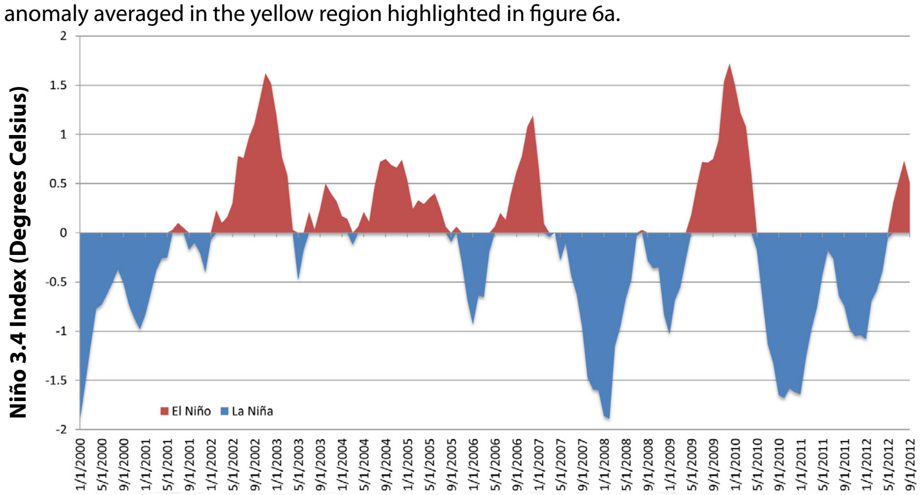


Figure 6b. Monthly values of the Niño 3.4 index, which is computed as the temperatures anomaly averaged in the yellow region highlighted in figure 6a.



Southern Oscillation Index

The Southern Oscillation Index (SOI), a measure of the atmospheric response to El Niño or La Niña conditions, showed positive values that are characteristic of La Niña events for the duration of the event. SOI values rose to moderate levels as La Niña conditions developed early in the water year, then peaked in December and quickly decreased throughout the winter and early spring as the La Niña event weakened. SOI values returned to close to zero by May and even became slightly negative in early summer, when SSTs warmed slightly in the eastern Pacific Ocean. This was the first sign that the atmosphere was being shifted by a developing El Niño event. That El Nino event never fully materialized and the water year ended with SOI values reflecting ENSO-neutral conditions.