Issued: October 26, 2004

CLIMAS
Southwest Climate Outlook

October 2004 Climate Summary

Hydrological Drought – Hydrological drought continues for much of the Southwest.

- Short-term drought status has decreased in southeastern and west-central New Mexico and north-central Arizona.
- Far eastern New Mexico remains free of all drought categories.
- Storage in many reservoirs in the Southwest continues to decrease.

Precipitation – Eastern New Mexico and the western third of Arizona have experienced much wetter-than-average conditions at the beginning of the new water year, while precipitation in central and southern Arizona and along the states' border is below average.

Temperature – Over the last 30 days, most of the Southwest has experienced somewhat cooler-than-average temperatures, with much cooler-than-average conditions in eastern New Mexico and warmer-than-average conditions around Lake Mead.

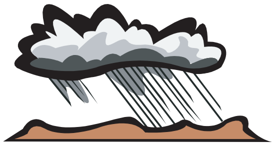
Climate Forecasts – Seasonal forecasts indicate increased chances of above-average temperatures for Arizona and western New Mexico through April. Precipitation forecasts call for increased chances of wetter-than-average conditions in late winter and early spring.

El Niño – A weak El Niño continues in the tropical Pacific Ocean. Experts believe that the strongest effects may not occur in the Southwest until late winter or early spring.

The Bottom Line – Short-term drought status is expected to improve in the Southwest through January.

The climate products in this packet are available on the web:
http://www.ispe.arizona.edu/climas/forecasts/swoutlook.html

Monsoon Season Summary



The monsoon provided little relief from the dry conditions that have dominated the Southwest, except in eastern New Mexico, the only portion of the region that has been removed from drought classification. The above-average precipitation received there has helped increase the state-wide averaged precipitation to a rank of 25th wettest year. In Tucson, the monsoon officially lasted from July 8–September 30. Tucson received a mere 2.43 inches of rain, which is 3.63 inches below average. This total ranks as the driest monsoon since 1989 and the 4th driest since records have been kept.

For more on monsoon visit our online archives...

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Plan to thin trees in Apache-Sitgreaves forest could increase streamflow in short term

By Melanie Lenart

As the Apache-Sitgreaves National Forest launches its stewardship project to thin about 15,000 acres of Ponderosa pine forest a year over the next decade, the question arises: Will the reduction of trees in these forests mean an increase in streamflow for the communities that border them?

The consensus of researchers who have tackled this issue is a qualified “yes.” Thinning some of the trees in these admittedly dense stands of pines should lead to an increase in runoff for the streams that flow through the thinned areas—but only for a few years, and perhaps only noticeably so during years of high precipitation.

“I can’t see any reason why it wouldn’t have the benefit of providing additional water,” University of Arizona Natural Resources Professor Peter Ffolliott said of the planned Apache-Sitgreaves thinning project. “The question is does that (benefit) persist, and of course it doesn’t because the site recovers after awhile.”

Typically, the increase in streamflow, a.k.a. water yield, that a thinning project promotes drops off after about five years, he noted. But if the thinning project stretches across 10 years, as planned for the stewardship project, the increase in water yield could continue for more than a dozen years, albeit it with the benefits turning up in different streams within the White Mountains watershed.

The forest stands targeted for thinning as part of the stewardship project drain variously into three major rivers: the Little Colorado, the Gila, and the Salt rivers, noted Robert Dyson, who handles public affairs for the Apache-Sitgreaves National Forest. Some of the local tributaries that stand to benefit in the near future include San Francisco, Mineral, Show Low, Silver, and Chevelon creeks.

A research project on the White Mountains’ Thomas Creek headed by one of Ffolliott’s then-graduate students, Gerald Gottfried, found that streamflow increased measurably in the eight years following a 1978–79 tree harvest that reduced the ground coverage of trees by about a third.

Gottfried, who now works as a research forester for the Rocky Mountain Research Station, used streamflow measurements to estimate an average increase in annual runoff of about 1 to 1½ inches based on measurements from when the logging ended in 1979 to when the study ended in 1986 (Figure 1). Runoff is the amount of water that makes it to streams after trees and soils get their fill. Like precipitation, runoff is a point measurement often reported in inches.

The water yield increase came mainly from winter precipitation (Oct. 1 through May 30 in his analysis), especially from March through May, Gottfried indicated. Apparently snow piled up in cleared openings, thus leaving less surface area susceptible to evaporative processes. However, the difference was driven mainly by wet years, he noted. Annual precipitation on the Thomas Creek watershed averaged about 30

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Salt cedar: Villain or scapegoat when it comes to water use?

By Melanie Lenart

Salt cedar’s reputation as a high water user has made it the bane of water agencies for many decades. When the drought slowed the flow of many southwestern rivers down to a trickle in 2002, its presence along New Mexican waterways even made it a target of then-gubernatorial candidate Bill Richardson.

Upon his election, Richardson followed through with his plan to eradicate salt cedar stands lining the state’s riverbeds. In 2003, the state spent $4 million to spray the herbicide Arsenal from helicopters onto stands of salt cedar, also known as tamarisk because of its scientific name *(Tamarix* species, mainly *ramosissima).* About 25,000 acres of salt cedar had been so treated by spring of this year, according to an April 1 op-ed piece in the *Albuquerque Journal* by Assistant Secretary of the Interior Rebecca Watson, who touted the eradication effort as an outstanding example of water conservation in the West.

Yet there are some who consider salt cedar to be a scapegoat. One of these skeptics is Edward Glenn, a senior research scientist with the University of Arizona’s Environmental Research Laboratory. Glenn mentored then-graduate student Pam Nagler in research estimating water use of salt cedar compared to other species based on their leaf area indices and other remotely sensed data for a roughly 200-mile stretch of the Lower Colorado River.

“Particularly, salt cedar doesn’t seem to be the big hog, the biggest water user, that people have given it credit for,” Glenn said. “For years and years, people

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Runoff, continued

inches a year between 1964 and 1986, but ranged from about 20 to 44 inches.

"In high-precipitation years, it seemed there was more water in the ground than the trees could use, but this would not work in a dry year," he explained during a recent telephone conversation. "In the middle of drought—and this is not just in Arizona but throughout the U.S.—you're not going to create more water."

David Goodrich, a hydraulic engineer with the U.S. Department of Agriculture Research Service unit, concurred. Measurable water yield increases are difficult to detect in dry years or dry areas, he said, noting that a research project he worked on that involved removing woody vegetation on 10 acres near Tombstone found no difference in water yield after the treatment. The research site receives an average of about 13.8 inches in annual precipitation.

"The conclusion was that the variability or some of the uncertainty in rainfall was enough to mask the potential change in water yield," Goodrich explained.

In the case of the Apache-Sitgreaves stewardship project, any water yield increases would be seen as a fringe benefit to the main intention: to reduce fire risk in the forest stands near communities, which foresters call the wildland-urban interface.

Another potential fringe benefit, although more speculative, might be increased resistance to bark beetle outbreaks among the remaining trees in the stand. Drought stress makes it more difficult for trees to repel these invasive insects with their sap, so the thinking goes that reducing the competition for water among trees can only help boost a stand's resistance to bark beetle.

For that matter, the millions of trees killed in recent years by beetles and by fire in southwestern forests have also stopped drawing water for sustenance (although their remains may still increase surface area and therefore evaporation rates). All living plants use water for tissue construction as they photosynthesize, and for nutrient transport as they transpire, with the latter describing the process of transporting water from their roots to their leaves for eventual evaporation.

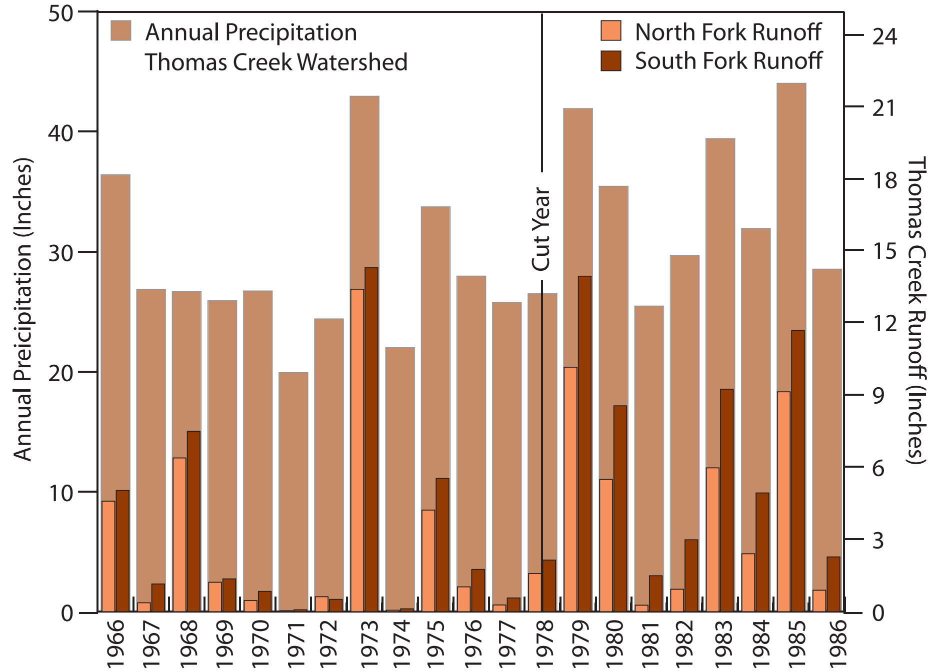

Figure 1. The South Fork of Thomas Creek in the White Mountains had a slight tendency to produce more "runoff," or water yield from overland flow, before a logging treatment that was completed on the South Fork of the watershed in 1978. After the treatment, this tendency was more pronounced, as the above graphic illustrates. However, the main difference occurred in years of high precipitation. On the graphic, the scale for precipitation for the Thomas Creek watershed is on the left, while the scale for runoff values is given on the right. Data from 1989 University of Arizona dissertation of Gerald Gottfried, School of Natural Resources.

It's comforting to know that there's a silver lining to the clouds of smoke and flying insects that have ravaged southwestern forests in recent years. But the increase in water yield from beetle kill and particularly from fire poses other problems—namely floods and erosion.

It's ironic that drought can actually increase the risk of floods, albeit indirectly, because it increases the risk of severe fires and insect attacks, commented Daniel Evans, a hydrologist with the U.S. Geological Survey's Tucson office. Severe fires in particular can increase flood risk by searing the soil, changing its structure so that it repels water. This, in turn, reduces the rate at which water can infiltrate soil and so increases the runoff rate, i.e. the rate at which water will flow over the land and reach streams. (For more details, see "Flooding after Fire" from the May 2003 packet at: http://www.ispe.arizona.edu/climas/forecasts/archive/may2003/may2003figs/19_Floods.html)

Like the White Mountain logging treatment, the 2003 Aspen fire on Tucson's Mount Lemmon caused peak streamflow increases when severely burned watersheds were exposed to monsoonal rains, reported Evans, who helped monitor streamflow within the Sabino Canyon and Canyon del Oro drainages. After making adjustments for precipitation differences, he estimated streamflow highs on some creeks draining the burn area were more than five times greater than they had been before the fire.

Unfortunately, the excessive streamflow turned into a wall of water that careened through the town of Oracle in August of

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Runoff, continued

2003, sweeping 60-year-old newspaper publisher Jim Huntington to his death.

Peak streamflow increases also occurred on watersheds draining forests affected by the Rodeo-Chediski fire. For instance, concerns over potential floods led officials to evacuate the town of Carrizo three times, Evans said. But no deaths related to fire-caused floods were reported.

The Rodeo-Chediski fire of 2002 set the Arizona record for fire severity in the past century, with about 460,000 acres burned to varying degrees. So perhaps it's not surprising that the highest measured increase in streamflow peaks occurred within that burn area, in Ffolliott's estimation.

Ffolliott was watching the televised account of the fire in action when he noticed that it was spreading to an area that he and others had worked on in the 1970s. Although they had finished the project in 1977, they had left the flume and some other measuring devices in place—and were able to relocate them within a week after the Rodeo-Chediski's devastating passage through the area.

"It was a tragic event, but it was a unique research opportunity," Ffolliott said of the fire. He and U.S. Forest Service project leader Daniel Neary used a high water mark to estimate that, at one point during monsoonal rains a few weeks after the fire, streamflow through the plume peaked at 232 feet per second —about 2,300 greater than the peak of 0.1 feet per second they measured during the 1972–77 experiment on the same creek.

The arrival of the monsoon season near the tail end of the southwestern fire season contributes to peak streamflow and erosion extremes that—along with drought—help define the semi-arid lands of the Southwest. Particularly in the case of severe fire, higher erosion rates tend to accompany the dramatic increase in streamflow peaks, with soil often seared and formerly protective vegetation shriveled or dying.

On the severely burned watershed of the Rodeo-Chediski fire, Ffolliott and Neary measured post-fire sediment yield rates of about 25 tons per acre. This is about five times higher than the baseline rates of 4 to 5 tons per acre they calculated for the 1972–77 time frame.

Similarly, Evans noted that the July Nuttall Complex wildfire on Mount Graham led to erosion that dumped at least 30 feet of sediment into the Frye Mesa Reservoir. But, as in the case of streamflow and water yield, he estimated that it generally takes about five years or less for a mountainside to stop shedding topsoil at unusually high rates.

Streamflow peaks on the creeks Ffolliott is monitoring at the Rodeo-Chediski site are already coming back to normal, at least at the larger scale of the watershed, he indicated.

"Actually, peak flow declined quite rapidly down to pre-fire conditions. I think we still have some elevated flows coming through, but it's nothing like in that first year," he said. "During our first trip out there, it was during the monsoon and thunderstorms started. You felt a little uneasy. Literally, we were the only living things out there. Now it's getting green again, which is kind of nice."

Nature has a track record of rebounding from disturbance, whether it's from fire, insect invasion or tree cutting. Assuming topsoil remains, vegetation will find a way to respond with a fresh flush of growth to the inherent productivity of a site—which is based on the input of sunshine, snow and rain. As it does, the transient benefit of increased water yield will fade away—like a far-away cloud drifting across the horizon.

Salt Cedar, continued

would quote these figures that they were using 3 to 4 meters of water a year, but they didn't have good methods for measuring it."

More recent techniques using sophisticated technology have found that salt cedar trees were using comparable amounts of water as the native cottonwood and willow trees they are seen as replacing.

"They (researchers) found that it actually uses less water than Bermuda grass. So your back lawn is actually using more water than salt cedar," Glenn said. Nagler, Glenn and others reported in a 2004 paper in *Agricultural and Forest Meteorology* that salt cedar actually appeared to consume less water than cottonwood, based on leaf area indices.

A year-long study conducted by Steve Hansen, an assistant area manager for the Albuquerque office of the U.S. Bureau of Reclamation (USBR), and colleagues found that salt cedar at the site they measured in the late 1990s used about 4 feet of water a year. This is about one third of the 4 meters it had been accused of consuming, although values would vary somewhat by site. Salt cedar used about the same amount of water as alfalfa, and roughly 20 percent more water than cottonwood, Hansen's research indicated.

Glenn credited Juliet Stromberg, an associate professor at Arizona State University, with launching the effort to examine the salt cedar issue objectively.

Stromberg explained by telephone that she falls into the camp of researchers who suspect salt cedar has proliferated because of changes in streamflow patterns, livestock grazing, water availability, and water quality. Given sufficiently high water tables and natural flood regimes (which reduce soil salinity) and protection from grazing, cottonwood

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Salt Cedar, continued

and willow will grow taller than salt cedar and therefore maintain dominance in stands, her research indicates.

"There is an assumption that salt cedar has contributed to changes in stream hydrology and geomorphology that has, in turn, reduced the ability of cottonwood and willow to survive," she explained.

However, seeds from both native species are distributed and nourished by a natural flood regime, which typically is lacking in the dam-regulated environment of western rivers. In addition to salt cedar, houses tend to line the rivers, and it's doubtful many residents would welcome annual floods. Also, the ongoing water use by the growing population of people and by long-time farmers may be lowering the water table beyond the tolerance of cottonwood and willow.

"If salt cedar is not the cause—if it's just sort of a symptom—then if you clear the salt cedar you haven't addressed the root cause of vegetation change," she added. Rather than native vegetation, salt cedar is likely to return, unless changes occur in the management of rivers and floodplain lands.

New Mexico planners have not yet moved fully into the stage of re-establishing native vegetation to replace the Arsenal-killed salt cedar stands. Although thousands of salt cedars lining the Middle Rio Grande River are "deader than a hammer," many of them remain standing on the landscape while officials confirm their demise, Hansen said. State officials are trying to figure out what to do with all the dead wood, which can act as a fuel source in case of fire, or transform into dangerous woody debris in case of floods. Until then, little can be done to re-establish native species, he indicated.

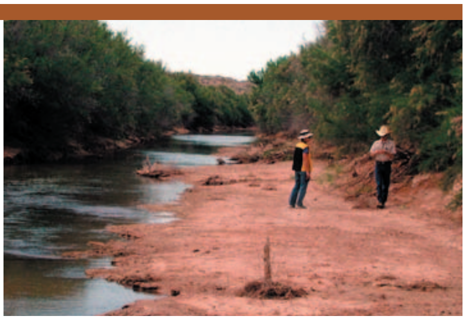
Streamflow in river stretches in which salt cedar was killed are not showing clear signs of an increase in water yield since eradication, said Hansen, who attributed this to an inability to measure water levels accurately enough to detect a difference. He compared the concept of measuring a difference to trying to detect how much water a person has consumed based on a change in their weight. Instead, he suggested it is more accurate to measure the actual amount of water the person consumed, as with studies like his that document how much water a salt cedar tree consumes.

Given the relatively small portion of the water allotment consumed by "phreatophytes" like salt cedar, cottonwood, and willow—which the USBR estimates at about 7 percent of its total water budget along the lower Colorado River from Hoover Dam to Mexico—it's even more understandable that a difference would be difficult to detect. Based on the 7 percent proportion, even if salt cedar represented all the phreatophytes and was completely replaced with cottonwood stands that used 20 percent less water, the best the Bureau could hope for would be about a 1.4 percent increase in total available water along this stretch.

Still, in the Middle Rio Grande, the savings estimated from the approximately 60,000 acres covered by salt cedar in 2002 potentially would amount to about 40,000 acre-feet of water, Hansen noted. However, if riverside trees follow water use patterns similar to mountaintop trees, the water yield increase may be more obvious during wet years than dry ones. (See related story in this issue.)

Also, it's a bit more complicated than a one-to-one replacement of salt cedar with native vegetation because cottonwood and willow trees won't necessarily be able to survive in the same places occupied by salt cedar, noted Fred Nibling, a research botanist for the USBR's Denver office.

"The difference is the footprint on the terrain that salt cedar is capable of occupying is much greater than that of cottonwood and willow," he elaborated. So the eradication program could help the USBR in its mission to deliver the allotted water to its clientele, which includes farmers near New Mexico's Elephant Butte Reservoir who have not received their full allotment for several years.



U.S. Bureau of Reclamation scientists work on methods for revegetation that can be used once they eradicate the salt cedar lining the banks of Pecos River near Carlsbad, New Mexico. Although most salt cedar eradication efforts in New Mexico involve using chemical control, the area above is about five miles from a Pecos River site where scientists are trying biological control by introducing a beetle that kills salt cedar. Photo by Fred Nibling.

Salt cedar is considered an invasive species by most ecologists. It was introduced to the West from Asia, in part to help control erosion. Its ability to live along relatively dry channels that do not support other riparian species does help prevent erosion, but salt cedar is also accused of making the soil more saline via leaffall, and of contributing to flood risk by narrowing channels.

Nibling acknowledged that the situation posed an environmental challenge, with the goal of controlling invasive plants (salt cedar) competing with the goal to protect endangered species (including the willow flycatcher, which does well in salt cedar stands).

"It's an interesting quandary," Nibling said. "It's really a challenge to our scientific skills to make it work for both groups."

Melanie Lenart is a postdoctoral research associate with the Climate Assessment for the Southwest.

Temperature (through 10/24/04)

Sources: Western Regional Climate Center, High Plains Regional Climate Center

A new water year started at the beginning of October, so the temperatures and departure from average temperatures reflect only the first three weeks of the month (Figures 1a and 1b). Temperatures over the past 30 days were cooler than average over most of the region, except in a few areas (Figures 1c and 1d). Some stations in the central and northern parts of Arizona and New Mexico registered temperatures 4 degrees F cooler than average for this time of year. Much of western Arizona had warmer-than-average conditions, especially near Lake Mead, where temperatures were up to 2 degrees F above average. Similarly, scattered locations throughout Arizona and New Mexico also had slightly above-average temperatures.

The Albuquerque National Weather Service (NWS) reports that September was the fourth consecutive month in which Duke City experienced below-average maximum temperatures. In addition, the average temperature for the month was cooler than the 1971–2000 average by 0.5 degrees. October seems to be another cooler-than-average month in Albuquerque and throughout the state. According to the NWS offices in Arizona, the September trends for each city are continuing in October: average temperatures in Tucson, warmer-than-average in Phoenix, and cooler-than-average in Flagstaff.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. Water year is more commonly used in association with precipitation; water year temperature can be used to measure the temperatures associated with the hydrological activity during the water year.

Average refers to the arithmetic mean of annual data from 1971–2000. Departure from average temperature is calculated by subtracting current data from the average. The result can be positive or negative.

The continuous color maps (Figures 1a, 1b, 1c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. The dots in Figure 1d show data values for individual stations. Interpolation procedures can cause aberrant values in data-sparse regions.

Figures 1c and 1d are experimental products from the High Plains Regional Climate Center.

On the Web:

For these and other temperature maps, visit:
http://www.wrcc.dri.edu/recent_climate.html and
http://www.hprcc.unl.edu/products/current.html

For information on temperature and precipitation trends, visit:
http://www.cpc.ncep.noaa.gov/trndtext.htm

Figure 1a. Water year '03–'04 (through October 21, 2004) departure from average temperature.

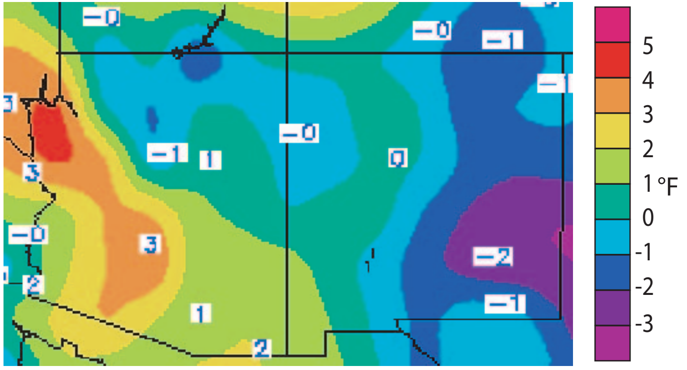


Figure 1b. Water year '03–'04 (through October 21, 2004) average temperature.

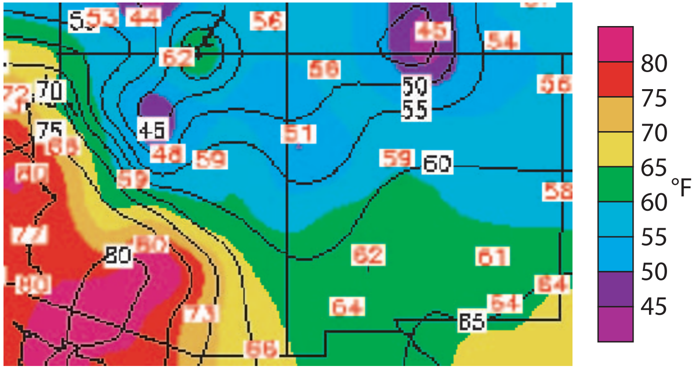


Figure 1c. Previous 30 days (September 25–October 24, 2004) departure from average temperature (interpolated).

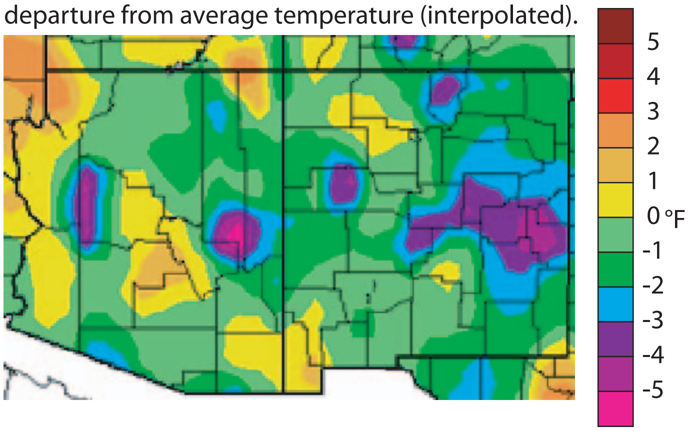
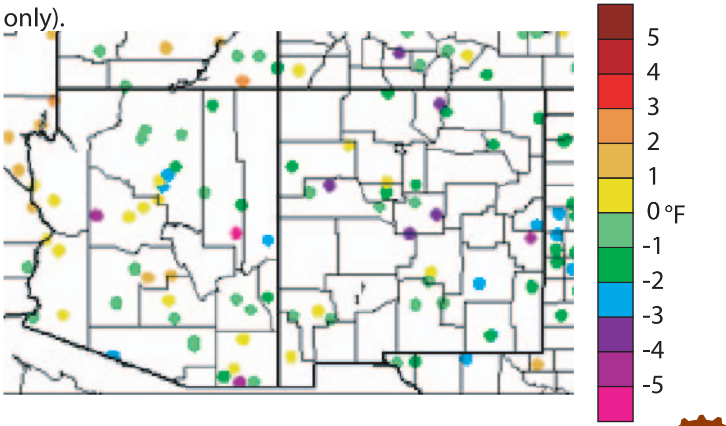


Figure 1d. Previous 30 days (September 25–October 24, 2004) departure from average temperature (data collection locations only).



Precipitation (through 10/21//04)

Source: High Plains Regional Climate Center

The onset of a new water year in the Southwest shows Arizona wetter than average in the western third of the state and drier than average elsewhere (Figure 2a). The northeastern and extreme southeastern portions of New Mexico have experienced much above-average precipitation, while the northwestern corner of the state is below average; other locations are near average. Over the past 30 days, eastern New Mexico, western Arizona, and the White Mountains received much above-average precipitation (Figure 2c). Most of the remainder of the Southwest received less than 75 percent of average rainfall for the period, with several areas at less than 5 percent of average.

September and October have been slightly drier than average in Flagstaff according to the National Weather Service (NWS), despite the city receiving nearly an inch of precipitation recently. Phoenix is approximately one inch below average over the past two months, with a large portion of that deficit (0.6 inch) coming in September. The NWS reports that Tucson is even worse off since the beginning of September: 1.30 inches below average. The annual statewide averaged precipitation for New Mexico ranks as the 25th wettest year on record. While this fact, along with drought classification being eliminated in eastern New Mexico, seems encouraging, some areas have received less than 50 percent of average precipitation for the year (Albuquerque NWS).

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2003 we are in the 2004 water year. The water year is a more hydrologically sound measure of climate and hydrological activity than is the standard calendar year.

Average refers to the arithmetic mean of annual data from 1971–2000. Percent of average precipitation is calculated by taking the ratio of current to average precipitation and multiplying by 100.

The continuous color maps (Figures 2a, 2c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. Interpolation procedures can cause aberrant values in data-sparse regions.

The dots in Figures 2b and 2d show data values for individual meteorological stations.

On the Web:

For these and other precipitation maps, visit:
http://www.hprcc.unl.edu/products/current.html

For National Climatic Data Center monthly precipitation and drought reports for Arizona, New Mexico, and the Southwest region, visit: http://lwf.ncdc.noaa.gov/oa/climate/research/2003/perspectives.html#monthly

Figure 2a. Water year '03–'04 through October 21, 2004 percent of average precipitation (interpolated).

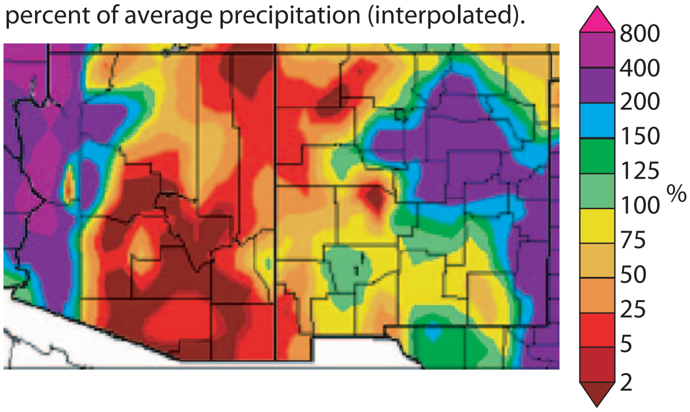


Figure 2b. Water year '03–'04 through October 21, 2004 percent of average precipitation (data collection locations only).

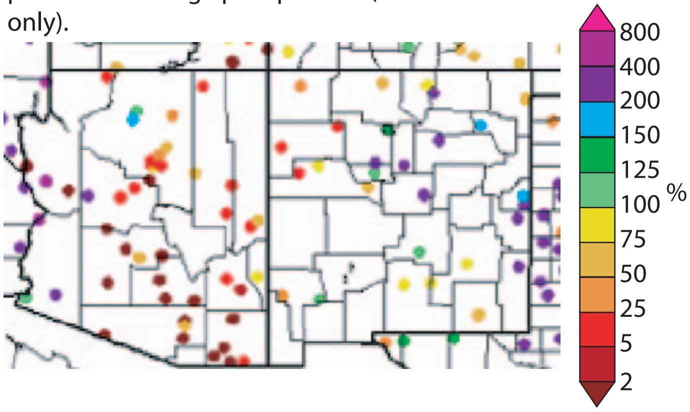


Figure 2c. Previous 30 days (September 22–October 21, 2004) percent of average precipitation (interpolated).

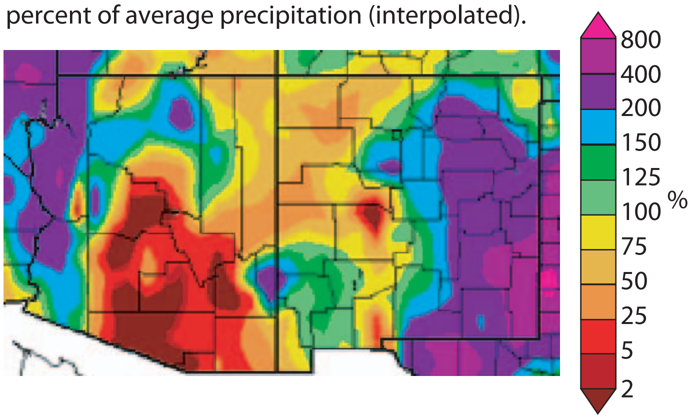
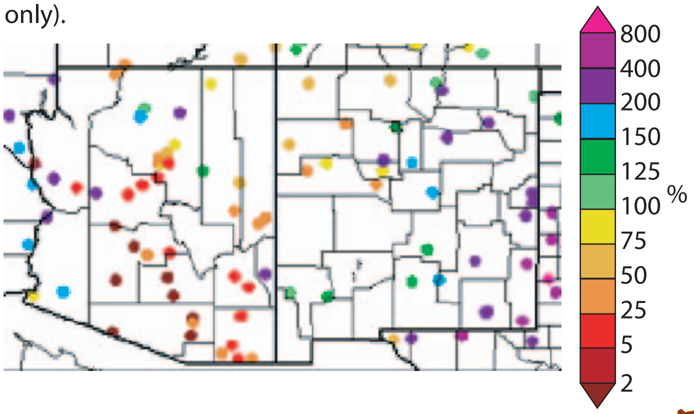


Figure 2d. Previous 30 days (September 22–October 21, 2004) percent of average precipitation (data collection locations only).



U.S. Drought Monitor

(released 10/21/04)

Sources: U.S. Department of Agriculture, National Drought Mitigation Center, National Oceanic and Atmospheric Administration

Drought intensity continued to decrease in some areas of the West, but conditions are still far from suitable in many states (Figure 3). Central and north-central Arizona show decreased drought status since mid-September, due in part to the remnants of Hurricane Javier passing through the region. Although these areas are classified in severe drought, this marks the first time in several months that the drought intensity has dropped below extreme. New Mexico maintained its drive toward improved conditions. This is apparent in the removal of the abnormally dry category from more of the southeastern portion of the state and changes from severe to moderate drought in the west-central areas. The northwestern corner of New Mexico is now classified in extreme drought.

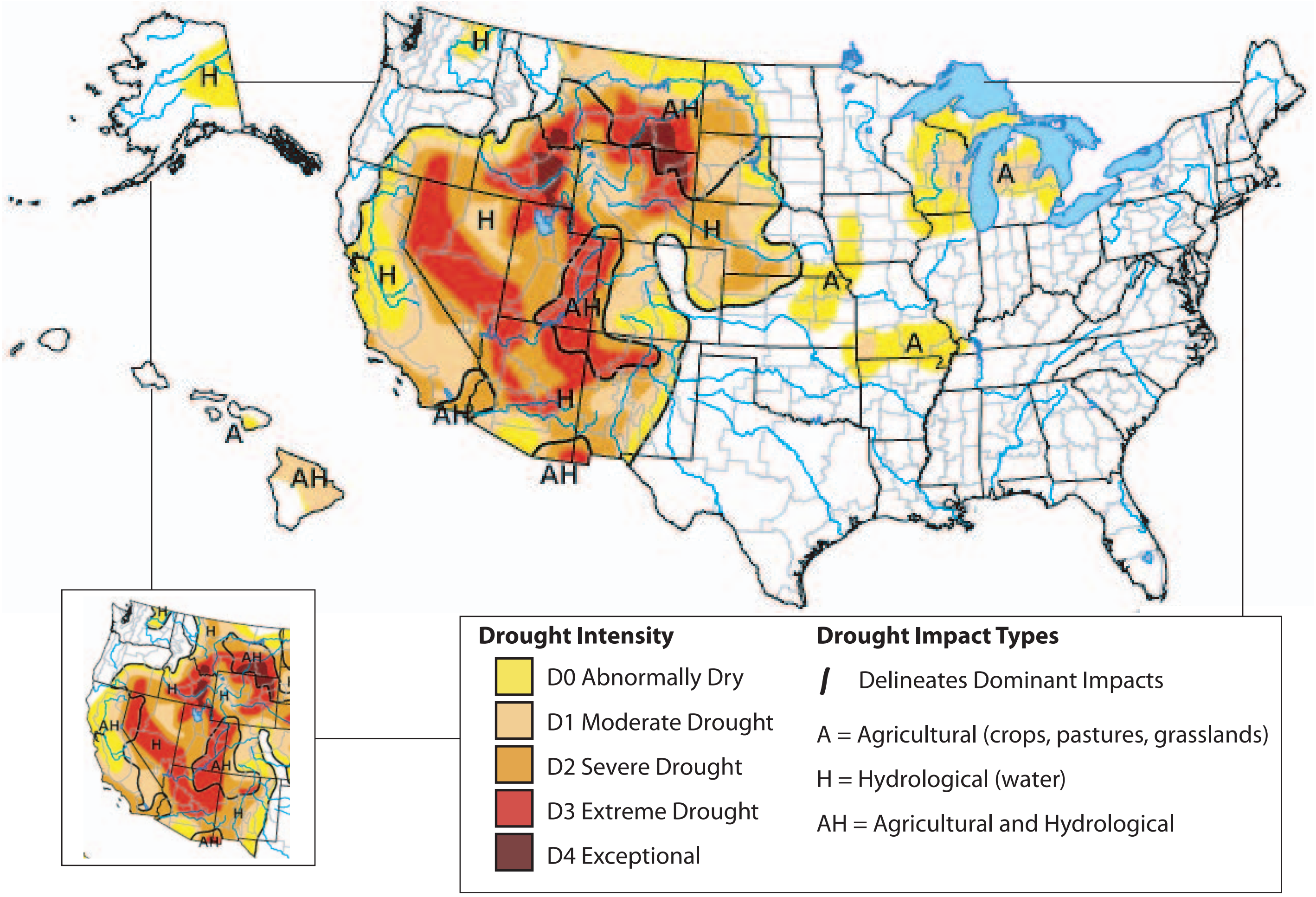
The town manager of Gilbert, Arizona decided to continue the city's water alert due to continuing dry conditions in the state (*Arizona Republic*, September 29). The alert has now been in effect for over a year. Elsewhere in the western United States, the secretary of the Department of Agriculture declared Nevada a disaster area, due to conditions that farmers and ranchers must confront due to the drought (*Reno Gazette-Journal*, October 19). Some areas have lost 100 percent of certain crops due to the drought or Mormon grasshoppers.

Notes:

The U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The inset (lower left) shows the western United States from the previous month's map.

The U.S. Drought Monitor maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of the several agencies; the author of this monitor is Rich Tinker CPC/NCEP/NWS/NOAA.

Figure 3. Drought Monitor released October 21, 2004 (full size) and September 16, 2004 (inset, lower left).



On the Web:

The best way to monitor drought trends is to pay a weekly visit to the U.S. Drought Monitor website: http://www.drought.unl.edu/dm/monitor.html

New Mexico Drought Status

(through 8/13/04)

Source: New Mexico Natural Resources Conservation Service

The U.S. Drought Monitor (page 8) shows that drought conditions in eastern and west-central New Mexico have decreased, while in other portions of the state they worsened. At the end of September, New Mexico held their second annual drought summit. The conference focused on the impacts of the current drought, (i.e. wildfire and wildlife issues to the responses of ranchers and farmers), drought management, and issues of economic development (*Albuquerque Tribune*, September 22 and *Albuquerque Journal*, September 28). At the conference, the president of the Arizona Center for Public Policy, reported that the Federal Emergency Management Agency places the economic cost of the drought at $6–8 billion per year (*Alamogordo News*, September 28). An example of this effect is the loss of 18 businesses in Elephant Butte, New Mexico (*Alamogordo News*, September 28). The Ute Water Project also continues to be a major issue in New Mexico. As part of the plan to show that all 12 groups involved are committed to the project, Clovis and Portales city councils have held discussions (*Portales News-Tribune*, September 24), and the mayors of both cities traveled to Washington, D.C., to relay the importance of federal funding (*Portales News-Tribune*, September 28). Elsewhere, the Santa Fe City Council and the Santa Fe County Commission agreed on a regional water compact that defines a 50-50 cost-sharing of a Rio Grande diversion project, which will be in place by 2008 (*Santa Fe New Mexican*, October 8).

Notes:

The New Mexico drought status maps are produced monthly by the New Mexico Drought Monitoring Workgroup. When near-normal conditions exist, they are updated quarterly. The maps are based on expert assessment of variables including, but not limited to, precipitation, drought indices, reservoir levels, and streamflow. They have not been updated since last month's Southwest Climate Outlook.

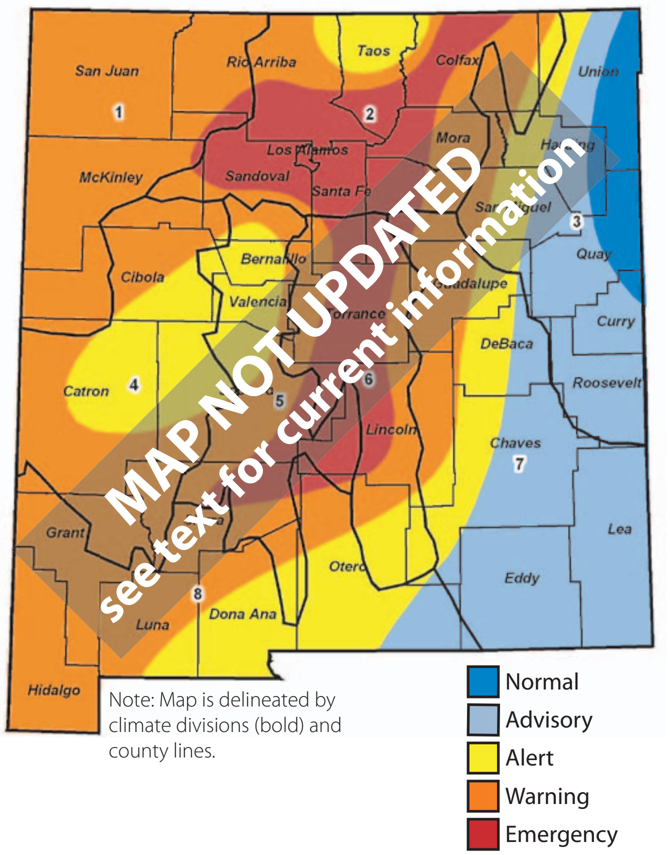
Figure 4a shows short-term or *meteorological* drought conditions. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) over a relatively short duration (e.g., months). Figure 4b refers to long-term drought, sometimes known as *hydrological* drought. Hydrological drought is associated with the effects of relatively long periods of precipitation shortfalls (e.g., many months to years) on water supplies (i.e., streamflow, reservoir, and lake levels, groundwater). This map is organized by river basins—the white regions are areas where no major river system is found.

On the Web:

For the most current New Mexico drought status map, visit:
http://www.nm.nrcs.usda.gov/snow/drought/drought.html

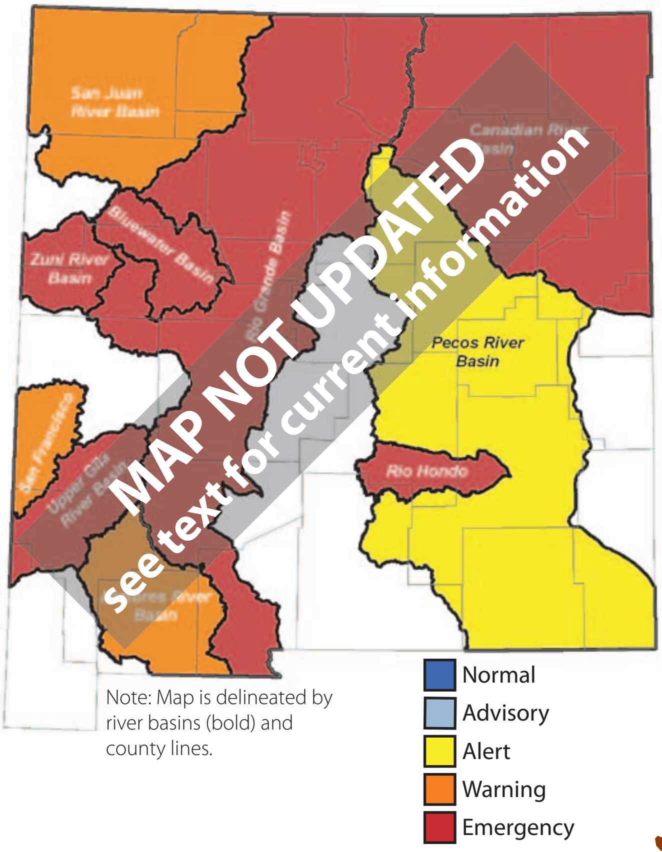
Information on Arizona drought can be found at:
http://www.water.az.gov/gdtf/

Figure 4a. Short-term drought map based on meteorological conditions as of August 13, 2004.



Note: Map is delineated by climate divisions (bold) and county lines.

Figure 4b. Long-term drought map based on hydrological conditions as of August 13, 2004.



Note: Map is delineated by river basins (bold) and county lines.

Arizona Reservoir Levels

(through 9/30/04)

Source: National Water and Climate Center

Storage in Arizona reservoirs changed only slightly in September. Storage decreased at Lake Mead and Lyman Reservoir (Figure 5). Notably, storage increased in the Verde River System by 5 percent to 139,800 acre-feet. After a brief rise at Lake Mead in August, storage has once again dipped below 14 million acre-feet. In late September the Southern Nevada Water Authority began considering the possibility of drilling for the placement of a third intake at Lake Mead to help supply water to Las Vegas (*Las Vegas Sun*, September 28). The deepest intake allows water to be drawn provided that the lake does not drop below 1,000 feet above sea level, or about 125 feet below the current level. Geologists have measured weak earthquakes (below 3.0 on the Richter Scale) at Lake Mead, which they attribute to the decreasing water levels (*Las Vegas Sun*, October 7). These "temblors" are due to pressure changes in pores of rocks that are along faults. The scientists measured six earthquakes from September 20–29 and more than 20 since the beginning of 2004. Bob Walsh of the U.S. Bureau of Reclamation assured the public that Hoover Dam has not been stressed by the temblors, as it was constructed to hold up to a 9.0 level earthquake (*Las Vegas Sun*, October 7). The low storage in the western U.S. reservoirs is making international news as well. *The Guardian* (UK) reports that since the current drought began, the water levels in Lake Powell have decreased by more than 130 feet (October 11). A statistic from the *Los Angeles Times* (October 12) further drives home the message that when full, Lake Powell extends 186 miles up the Colorado River; currently, the river is only 145 miles long.

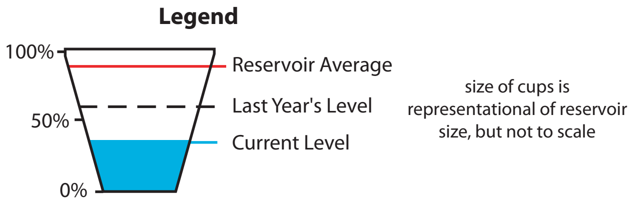
Notes:

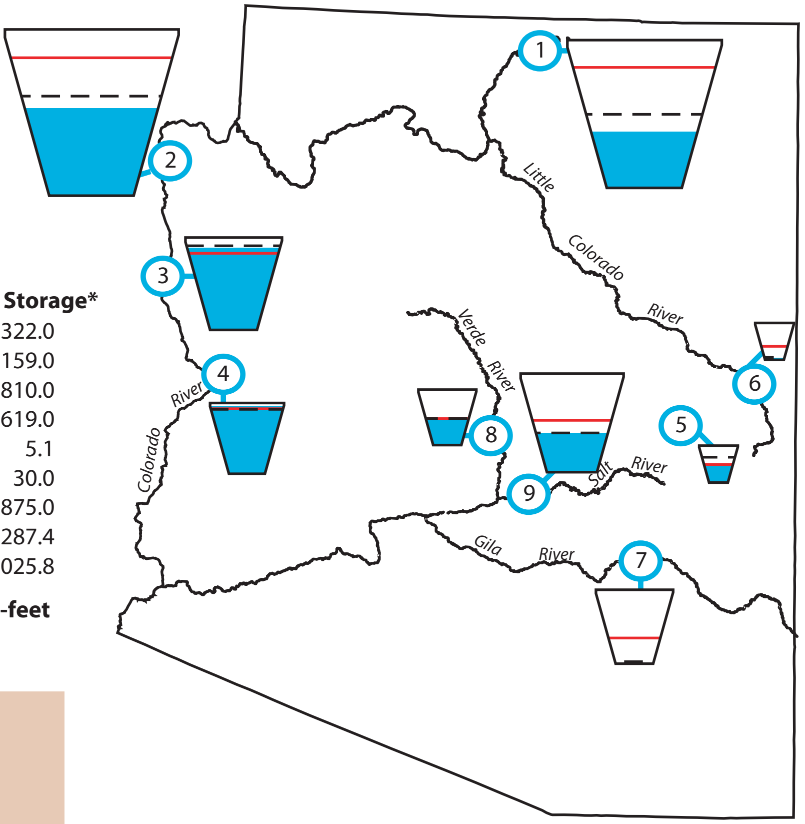
The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total capacity. Note that while the size of each cup varies with the size of the reservoir, these are representational and not to scale. Each cup also represents last year's storage level (red line) and the 1971–2000 reservoir average (dotted line).

The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir.

These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tpagano@wcc.nrcs.usda.gov; 503-414-3010) or Larry Martinez, Natural Resource Conservation Service, 3003 N. Central Ave, Suite 800, Phoenix, Arizona 85012-2945; 602-280-8841; Larry.Martinez@az.usda.gov).

Figure 5. Arizona reservoir levels for September 2004 as a percent of capacity, the map also depicts the average level and last year's storage for each reservoir, while the table also lists current and maximum storage levels.





Reservoir Name	Capacity Level	Current Storage*	Max Storage*
1. Lake Powell	38%	9,169.0	24,322.0
2. Lake Mead	53%	13,937.0	26,159.0
3. Lake Mohave	89%	1,605.2	1,810.0
4. Lake Havasu	95%	589.1	619.0
5. Show Low Lake	47%	2.4	5.1
6. Lyman Reservoir	6%	1.8	30.0
7. San Carlos	2%	16.3	875.0
8. Verde River System	49%	139.8	287.4
9. Salt River System	40%	806.9	2,025.8

*** thousands of acre-feet**

On the Web:

Portions of the information provided in this figure can be accessed at the NRCS website:
http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html

New Mexico Reservoir Levels

(through 9/30/04)

Source: National Water and Climate Center

Albuquerque hosted the second annual New Mexico Drought Summit in late September to discuss the impacts of the ongoing drought in the state (*Alamogordo News*, September 28). At the summit Kay Dunlap, superintendent of Elephant Butte State Park, reported that the lake, which can hold over 2 million acre-feet of water, was at approximately 95,000 acre-feet just before the meeting. This represents 4.6 percent of capacity. Also attending the summit was Kirk Bemis, the water program manager for the Zuni Pueblo in New Mexico (*Albuquerque Tribune*, September 29). According to the Tribune, Bemis has developed a water agenda that is based on what the tribe has learned from past experience and that is founded on restoring streams, and protecting water rights in an effort to reduce risks that the Zuni Indian Tribe might experience with the drought, while respecting the beliefs of the tribe.

On October 10 the U.S. Senate passed the Arizona Water Settlement Act, which has a three-fold impact on New Mexico. It settles water disputes between Arizona and New Mexico and for the next 10 years, it helps New Mexico in its effort to attain 14,000 acre-feet a year of water in the Gila and San Francisco Rivers to which it possesses water rights. It also provides from $66–128 million in federal money for water projects in the state (*New Mexico Business Weekly*, October 11). The Act will go to the House of Representatives later this year. A panel of water officials and University of New Mexico delegates recently met to discuss alternative uses for the water that the state will received if the act passes in the House (*Daily Press*, October 19). One of the representatives encouraged the residents work together to reach an agreement of how best to use the water and the money.

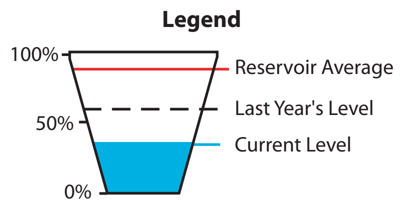
Notes:

The map gives a representation of current storage levels for reservoirs in New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total capacity. Note that while the size of each cup varies with the size of the reservoir, these are representational and not to scale. Each cup also represents last year's storage level (red line) and the 1971–2000 reservoir average (dotted line).

The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir.

These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tpagano@wcc.nrcs.usda.gov; 503-414-3010) or Dan Murray, NRCS, USDA, 6200 Jefferson NE, Albuquerque, NM 87109; 505-761-4436; Dan.Murray@nm.usda.gov).

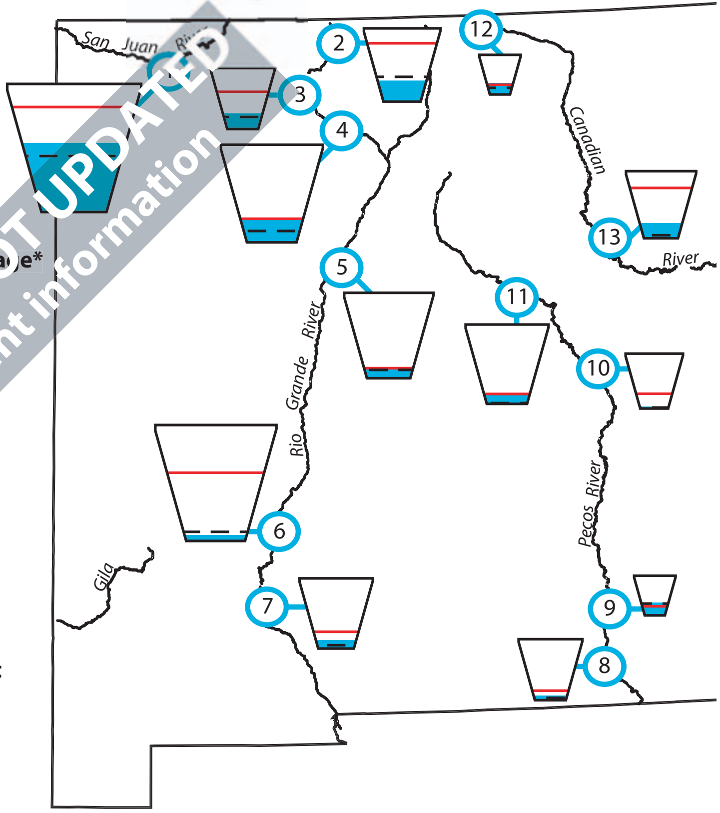
Figure 6. New Mexico reservoir levels for August 2004 as a percent of capacity, the map also depicts the average level and last year's storage for each reservoir, while the table also lists current and maximum storage levels.



size of cups is representational of reservoir size, but not to scale

Reservoir Name	Capacity Level	Current Storage*	Max Storage*
1. Navajo	54%	919.0	[illegible]
2. Heron	29%	115.4	400.0
3. El Vado	26%	47.8	[illegible]
4. Abiquiu	23%	126.5	[illegible]
5. Cochiti	10%	[illegible]	[illegible]
6. Elephant Butte	5%	[illegible]	2,065.0
7. Caballo	12%	[illegible]	331.5
8. Brantley	8%	11.8	147.5
9. Lake Avalon	33%	[illegible]	6.0
10. Sumner	4%	3.8	102.0
11. Santa Rosa	13%	56.7	447.0
12. Costilla	28%	4.4	16.0
13. Conchas	23%	57.4	254.0

*** thousands of acre-feet**



On the Web:

Portions of the information provided in this figure can be accessed at the NRCS website:
http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html

Temperature Outlook

(November 2004–April 2005)

Source: NOAA Climate Prediction Center

The NOAA-Climate Prediction Center (CPC) and International Research Institute for Climate Prediction (IRI) forecasts show increased chances for above-average temperatures across nearly the entire West from November 2004–April 2005 (Figures 7a-d; IRI data not shown). This category gradually moves eastward until it extends from south-central New Mexico into Minnesota (Figures 7c-d). The highest probabilities for above-average temperatures are in the Lower Colorado River Valley during early 2005 (Figures 7c-d). Increased chances of cooler-than-average conditions are predicted from central Texas into the lower Mississippi River Valley for November 2004–January 2005 (Figure 7a). Increased chances of below-average temperatures are predicted to linger in the Gulf Coast states and the Southeast (Figures 7c-d). These forecasts are based mainly on long-term temperature trends and indications from statistical forecast tools.

Notes:

These outlooks predict the likelihood (chance) of above-average, average, and below-average temperature, but not the magnitude of such variation. The numbers on the maps do not refer to degrees of temperature.

The NOAA-CPC outlooks are a 3-category forecast. As a starting point, the 1971–2000 climate record is divided into 3 categories, each with a 33.3 percent chance of occurring (i.e., equal chances, EC). The forecast indicates the likelihood of one of the extremes—above-average (A) or below-average (B)—with a corresponding adjustment to the other extreme category; the "average" category is preserved at 33.3 likelihood, unless the forecast is very strong.

Thus, using the NOAA-CPC temperature outlook, areas with light brown shading display a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average temperature. A shade darker brown indicates a 40.0–50.0 percent chance of above-average, a 33.3 percent chance of average, and a 16.7–26.6 percent chance of below-average temperature, and so on.

Equal Chances (EC) indicates areas where the reliability (i.e., 'skill') of the forecast is poor; areas labeled EC suggest an equal likelihood of above-average, average, and below-average conditions, as a "default option" when forecast skill is poor.

Figure 7a. Long-lead national temperature forecast for November 2004–January 2005.

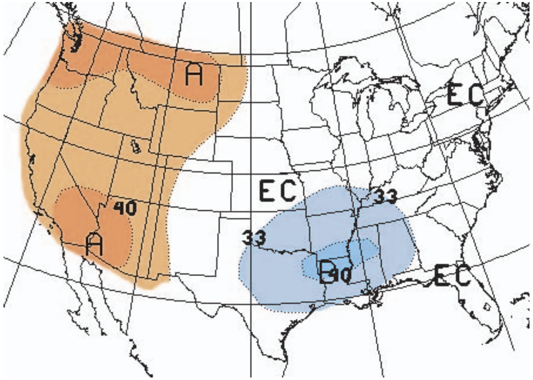


Figure 7b. Long-lead national temperature forecast for December 2004–February 2005.

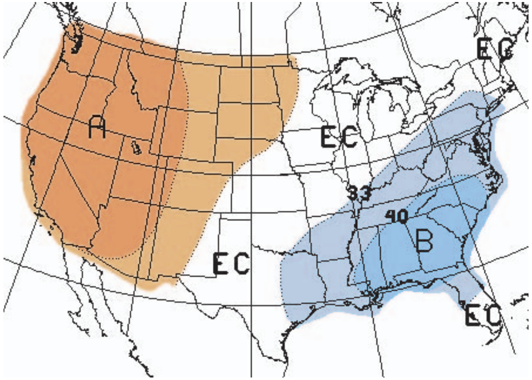


Figure 7c. Long-lead national temperature forecast for January–March 2005.

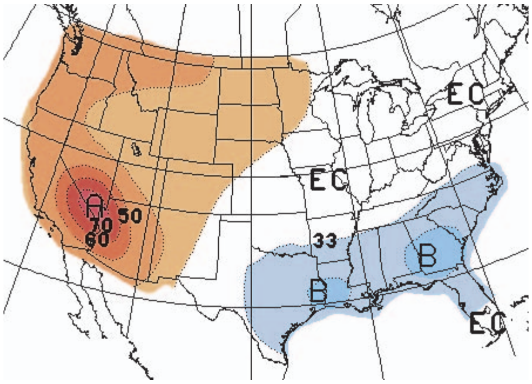
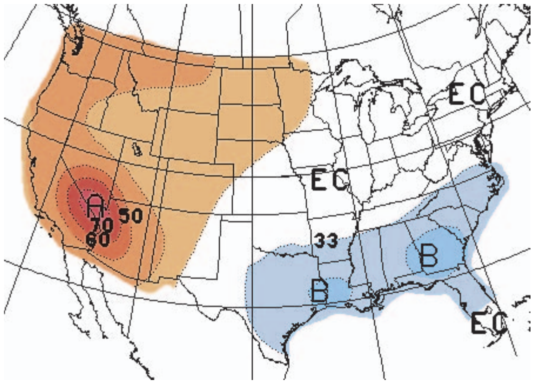


Figure 7d. Long-lead national temperature forecast for February–April 2005.



A= Above
🟥 60.0–69.9%
🟥 50.0–59.9%
🟧 40.0–49.9%
🟧 33.3–39.9%

B= Below
🟦 33.3–39.9%
🟦 40.0–49.9%

EC= Equal chances. No forecasted anomalies.

On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
(note that this website has many graphics and may load slowly on your computer)

For IRI forecasts, visit:
http://iri.columbia.edu/climate/forecast/net_asmt/

Precipitation Outlook

(November 2004–April 2005)

Source: NOAA Climate Prediction Center

The multi-season precipitation forecasts from NOAA-CPC predict similar conditions from November 2004–February 2005 (Figures 8a-b). Figure 8c and 8d are also comparable showing increased chances of below-average precipitation in the Midwest and Northwest and increased chances of above-average precipitation along the southern tier of the country for January–April 2005. Arizona is predicted to have increased chances of wetter-than-average conditions during this time period, while CPC withholds judgment in New Mexico until February–April 2005 (Figure 8d). Forecasts from IRI (not shown) are nearly identical to Figures 8a-d, except from February–April 2005 when IRI does not predict increased chances for above-average precipitation in northeastern New Mexico. These forecasts are based chiefly on the output of statistical and dynamic models of precipitation impacts associated with weak El Niño episodes.

Notes:

These outlooks predict the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation.

The NOAA-CPC outlooks are a 3-category forecast. As a starting point, the 1971–2000 climate record is divided into 3 categories, each with a 33.3 percent chance of occurring (i.e., equal chances, EC). The forecast indicates the likelihood of one of the extremes—above-average (A) or below-average (B)—with a corresponding adjustment to the other extreme category; the "average" category is preserved at 33.3 likelihood, unless the forecast is very strong.

Thus, using the NOAA-CPC precipitation outlook, areas with light green shading display a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. A shade darker green indicates a 40.0–50.0 percent chance of above-average, a 33.3 percent chance of average, and a 16.7–26.6 percent chance of below-average precipitation, and so on.

Equal Chances (EC) indicates areas where the reliability (i.e., 'skill') of the forecast is poor; areas labeled EC suggest an equal likelihood of above-average, average, and below-average conditions, as a "default option" when forecast skill is poor.

Figure 8a. Long-lead national precipitation forecast for November 2004–January 2005.

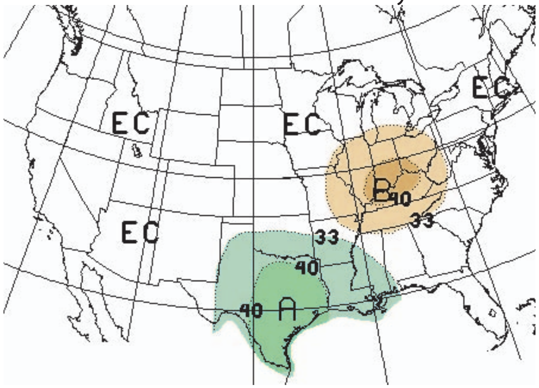


Figure 8b. Long-lead national precipitation forecast for December 2004–February 2005.

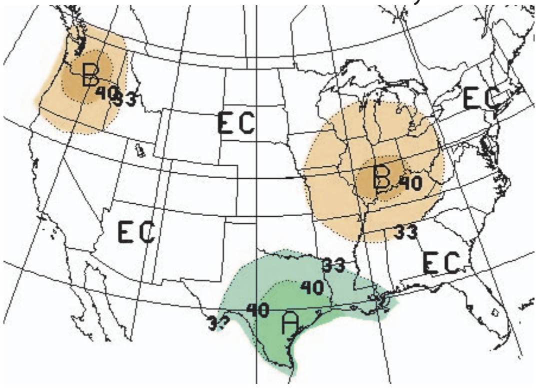


Figure 8c. Long-lead national precipitation forecast for January–March 2005.

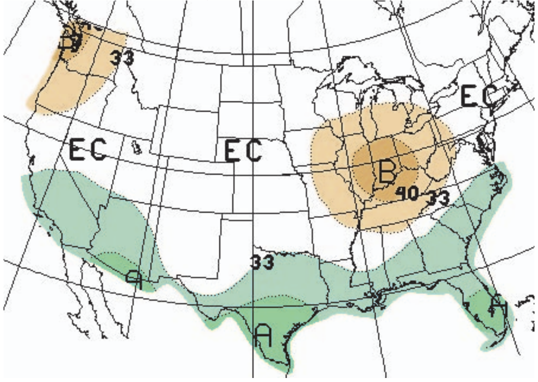
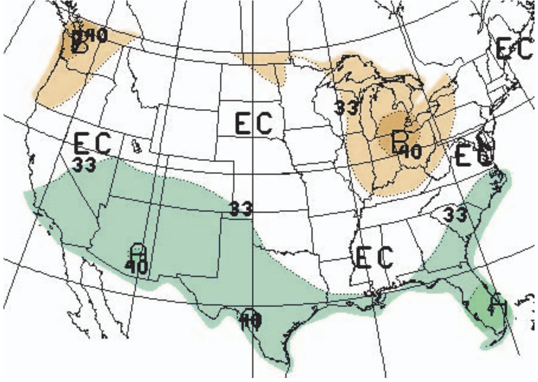


Figure 8d. Long-lead national precipitation forecast for February–April 2005.



A= Above 🟩 40.0–49.9%
🟩 33.3–39.9%

B= Below 🟧 33.3–39.9%
🟧 40.0–49.9%

EC= Equal chances. No forecasted anomalies.

On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
(note that this website has many graphics and may load slowly on your computer)

For IRI forecasts, visit:
http://iri.columbia.edu/climate/forecast/net_asmt/

Seasonal Drought Outlook

(through January 2005)

Sources: NOAA Climate Prediction Center

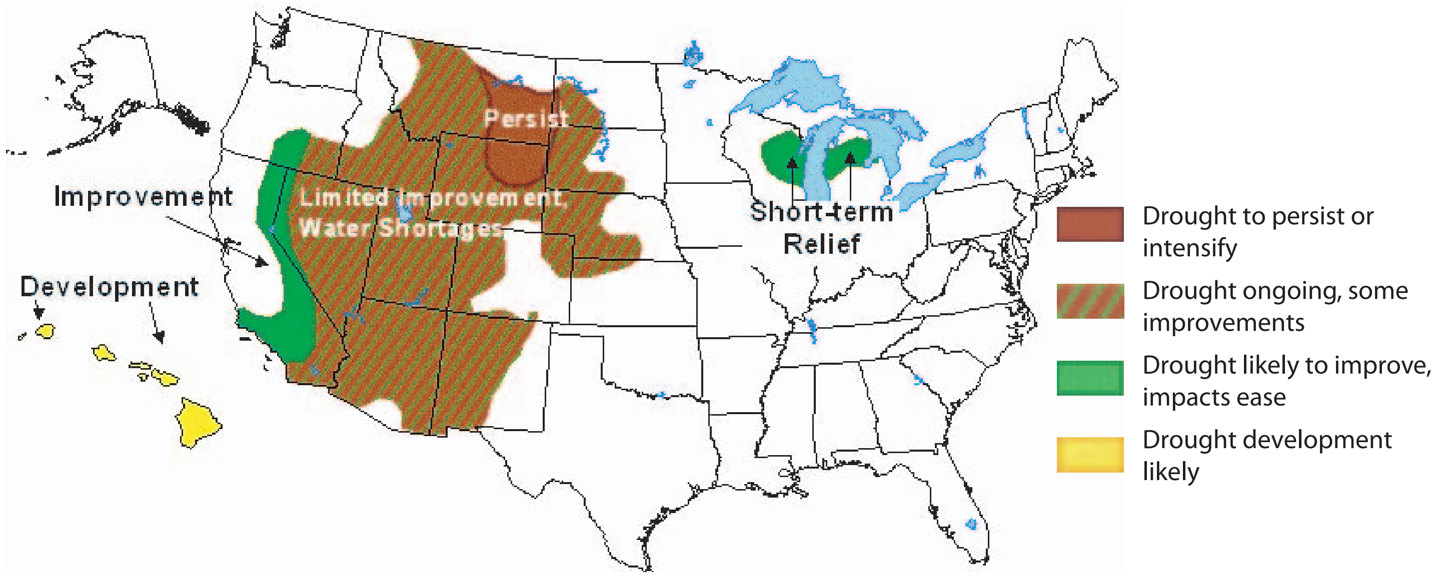
Other than southeastern Montana and northeastern Wyoming, the western United States is expected to see at least limited improvement in the drought conditions through January 2005 according to the NOAA-CPC (Figure 9). The areas of limited improvement are still expected to experience some water shortages, because several months of potentially wetter-than-average conditions will not compensate for more than five years of drought. The impacts are most likely to ease in the Sierra Nevadas and much of southern California. The likelihood of improvement is due in part to the onset of the winter, which is typically the wet season for much of the West. The continuing weak El Niño in the tropical Pacific Ocean also holds the possibility of contributing to above-average precipitation in Arizona and New Mexico. The CPC continues to consider February–April 2005 as the favored period for increased chances of wetter-than-average conditions, with special emphasis on early spring.

Longer-term concerns of water shortages have led several regions to consider the impacts of increasing populations on water supply. The National Science Foundation awarded a $6.9 million grant to five programs, including the Decision Center for a Desert City (DCDC) at the Arizona State University, to research methods that may help metropolitan areas in the Desert Southwest balance limited water resources with population growth (*Arizona Republic*, September 29). Charles Redman, the co-director of the DCDC, expects that the findings will be applicable to other cities in arid regions around the world and that the center will work with the Governor's Drought Task Force. The problem of increasing population is also a concern in smaller cities, like Flagstaff and Williams, Arizona, as well as in rural areas (*Arizona Daily Star*, September 23, and *Arizona Republic*, September 23). Elsewhere, a water symposium was recently held in Indian Wells, California, to discuss the maintenance of water supply in the Coachella Valley of southeastern California (*Desert Sun*, October 20).

Notes:

The delineated areas in the Seasonal Drought Outlook (Figure 9) are defined subjectively and are based on expert assessment of numerous indicators, including outputs of short- and long-term forecasting models.

Figure 9. Seasonal drought outlook through January 2005 (release date October 21, 2004).



On the Web:

For more information, visit:
http://www.drought.noaa.gov/

Wildland Fire Outlook

Sources: National Interagency Coordination Center, Southwest Coordination Center

Several areas scattered around the United States have an above-average potential for large fires (greater than 100 acres), but the Southwest continues to be exempt from this category. Much of the United States from the lower Mississippi and Ohio River valleys and the Great Lakes to the East Coast remain under below-average large fire potential following the numerous hurricanes and tropical storms that moved through the region earlier in the year. While the potential for large fires is near normal in the Southwest, fire danger levels are average to above average in Arizona, especially in the western portion of the state according to the National Interagency Coordination Center. A greater probability of drier conditions existing in Arizona has led to an increase in the prescribed fire activity in October.

Figure 10a. National wildland fire potential for fires greater than 100 acres (valid October 1–31, 2004).

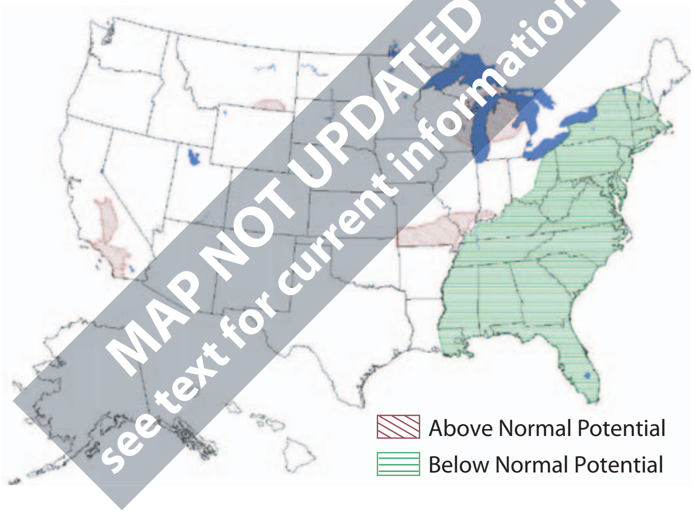


Figure 10b. Current fine fuel condition and live fuel moisture status in the Southwest.

Current Fine Fuels						
Grass Stage	Green		Cured	x		
New Growth	Sparse		Normal	x	Above Normal	

Live Fuel Moisture	**Percent of Average**
Ponderosa Pine	110–138
Douglas Fir	119–190
Piñon	80–130
Juniper	80–112
Sagebrush	90–110
1000-hour dead fuel moisture	**12–22**
Average 1000-hour fuel moisture for this time of year	**12–18**

Notes:

The National Interagency Coordination Center at the National Interagency Fire Center produces monthly wildland fire outlooks. The forecasts (Figure 10a) consider climate forecasts and surface-fuels conditions in order to assess fire potential for fires greater than 100 acres. They are subjective assessments, based on synthesis of regional fire danger outlooks.

The Southwest Area Wildland Fire Operations produces monthly fuel conditions and outlooks. Fuels are any live or dead vegetation that are capable of burning during a fire. Fuels are assigned rates for the length of time necessary to dry. Small, thin vegetation, such as grasses and weeds, are 1-hour and 10-hour fuels , while 1000-hour fuels are large-diameter trees. The top portion of Figure 10b indicates the current condition and amount of growth of fine (small) fuels. The lower section of the figure shows the moisture level of various live fuels as percent of average conditions.

On the Web:

National Wildland Fire Outlook web page:
http://www.nifc.gov/news/nicc.html

Southwest Area Wildland Fire Operations (SWCC) web page:
http://www.fs.fed.us/r3/fire/

El Niño Status and Forecast

Sources: NOAA Climate Prediction Center, International Research Institute for Climate Prediction

The Southern Oscillation Index (SOI), which is an indication of the atmospheric response to changing sea surface temperatures in the tropical Pacific Ocean, has increased slightly in recent months, but it is still indicative of weak El Niño conditions (Figure 11b). Probabilistic ENSO forecasts from the International Research Institute for Climate Prediction for the El Niño 3.4 monitoring region show a 70 percent chance that El Niño will persist through February–April 2005 (Figure 11a). The probabilities decrease thereafter until neutral conditions become more likely by late spring and early summer. The models predict very low chances for La Niña to develop in the next 12 months.

The NOAA-Climate Prediction Center (CPC) reports that the warmer sea surface temperatures in the tropical Pacific expanded eastward through the end of September. The CPC does caution, however, that this occurrence does not necessarily represent a "basin-wide" El Niño, which refers to the spread of warmer tropical sea surface temperatures to the western coast of South America. Weaker-than-average easterly winds and an increase in the depth of the warm water in the tropical Pacific lead experts to believe that El Niño conditions will persist. These conditions tend to result in above-average precipitation in the southwestern United States. By comparing the present conditions with similar past El Niño events, forecasters also believe that warmer-than-average conditions will occur in the West (Figure 7 on page 12). Forecasters with the National Weather Service offices in Arizona warn that these predictions are tendencies and not hard facts (*Arizona Daily Star*, October 20).

Notes:

Figure 11a shows the International Research Institute for Climate Prediction (IRI) probabilistic El Niño-Southern Oscillation (ENSO) forecast for overlapping three month seasons. The forecast expresses the probabilities (chances) of the occurrence of three ocean conditions in the ENSO-sensitive Niño 3.4 region, as follows: El Niño, defined as the warmest 25 percent of Niño 3.4 sea-surface temperatures (SSTs) during the three month period in question; La Niña conditions, the coolest 25 percent of Niño 3.4 SSTs; and neutral conditions where SSTs fall within the remaining 50 percent of observations. The IRI probabilistic ENSO forecast is a subjective assessment of current model forecasts of Niño 3.4 SSTs that are made monthly. The forecast takes into account the indications of the individual forecast models (including expert knowledge of model skill), an average of the models, and other factors.

Figure 11b shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through September 2004. The SOI measures the atmospheric response to SST changes across the Pacific Ocean Basin. The SOI is strongly associated with climate effects in the Southwest. Values greater than 0.5 represent La Niña conditions, which are frequently associated with dry winters and sometimes with wet summers. Values less than -0.5 represent El Niño conditions, which are often associated with wet winters.

On the Web:

For a technical discussion of current El Niño conditions, visit:
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/

For more information about El Niño and to access graphics similar to the figures on this page, visit:
http://iri.columbia.edu/climate/ENSO/

Figure 11a. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released October 21, 2004). Colored lines represent average historical probability of El Niño, La Niña, and neutral.

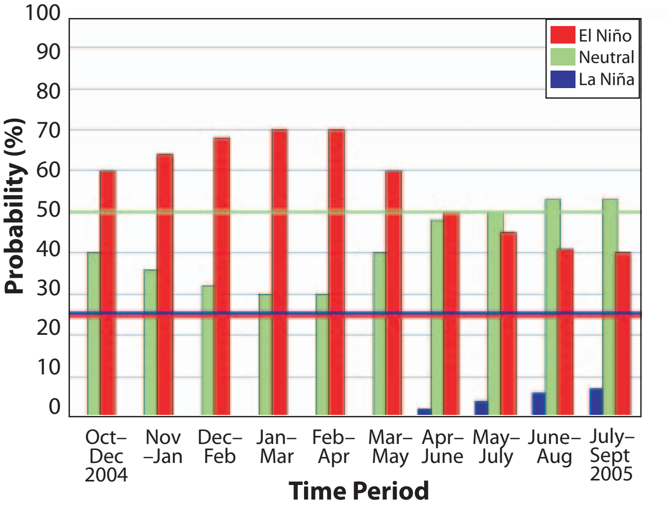
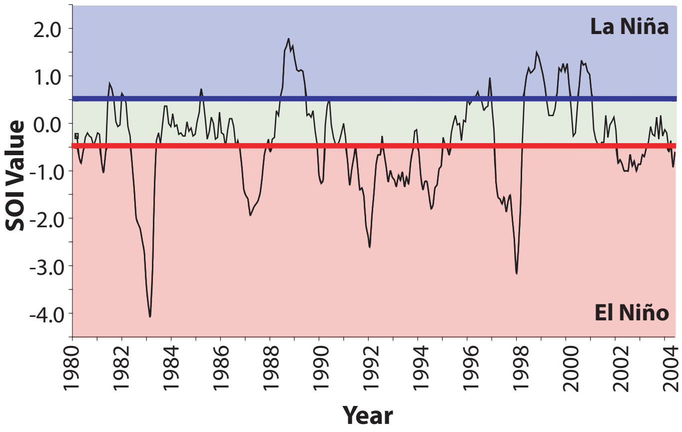


Figure 11b. The standardized values of the Southern Oscillation Index from January 1980–September 2004. La Niña/El Niño occurs when values are greater than 0.5 (blue) or less than -0.5 (red) respectively. Values between these thresholds are relatively neutral (green).



Temperature Verification

(July–September 2004)

Source: NOAA Climate Prediction Center

The NOAA-CPC temperature forecast for July through September predicted increased chances of above-average temperatures across much of the western United States and from northern Alabama and Georgia into New England (Figure 12a). The highest probabilities were in Arizona and extreme southern Nevada. Increased chances of cooler-than-average conditions were forecast the Gulf Coasts of Texas and Louisiana and the western Great Lakes. Judgment was withheld elsewhere. Much of the nation experienced below-average temperatures, with the largest departures in the mid-Mississippi River Valley, central and southern Great Plains, and portions of North Dakota (Figure 12b). Of significance in the western United States are the much warmer-than-average temperatures in Washington and much cooler-than-average conditions in west-central Arizona (up to 4–5 degrees F). Otherwise, the Southwest was generally within 1–2 degrees F of the average temperatures for the period. Except for the mid-Mississippi River Valley and lower Ohio River Valley, the NOAA-CPC predictions captured the temperature departures well.

Figure 12a. Long-lead U.S. temperature forecast for July–September 2004 (issued June 2004).

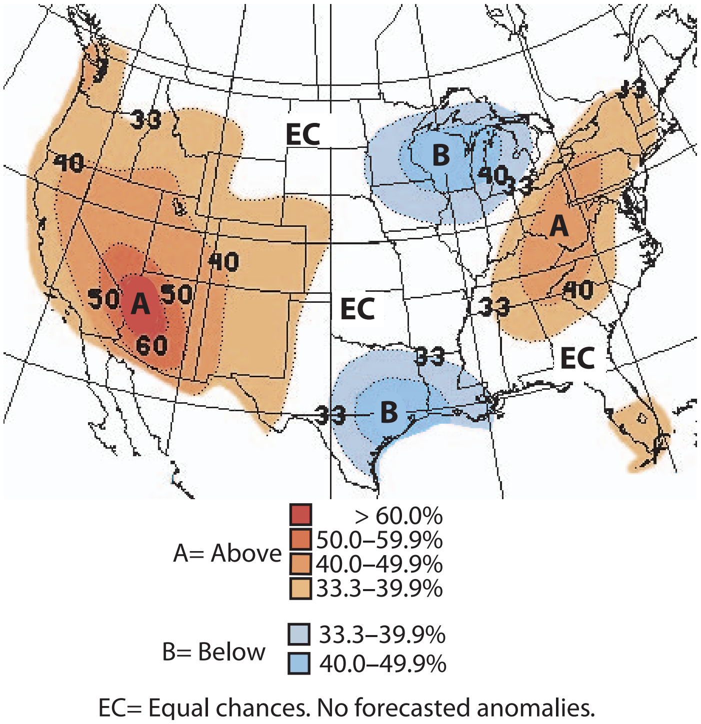
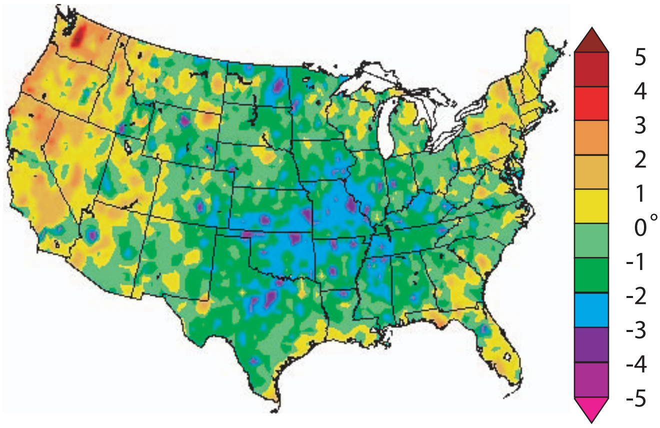


Figure 12b. Average temperature departure (in degrees F) for July–September 2004.



Notes:

Figure 12a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months July–September 2004. This forecast was made in June 2004.

The July–September 2004 NOAA CPC outlook predicts the likelihood (chance) of above-average, average, and below-average temperature, but not the magnitude of such variation. The numbers on the maps do not refer to degrees of temperature. Care should be exercised when comparing the forecast (probability) map with the observed temperature maps described below.

Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average temperature. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 12b shows the observed departure of temperature (°F) from the average for July–September 2004.

In all of the figures on this page, the term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html

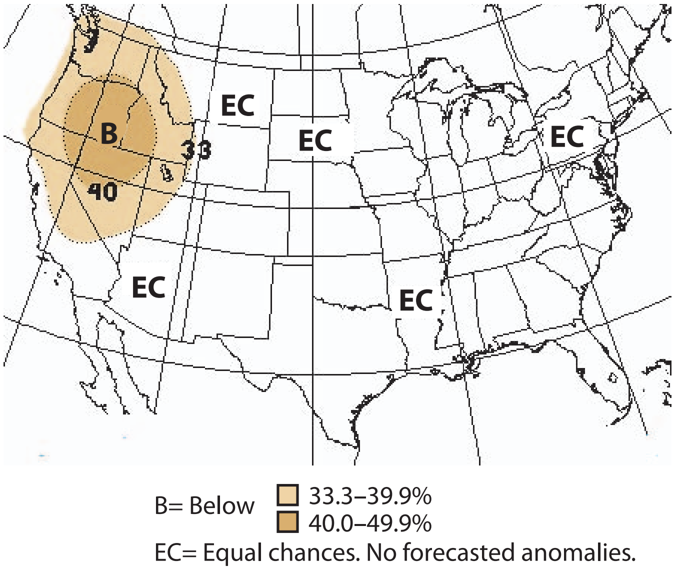
Precipitation Verification

(July–September 2004)

Source: NOAA Climate Prediction Center

According to the NOAA-CPC precipitation forecast, the only region forecast to have drier-than-average conditions for July through September extended from east-central California, Nevada, and western Utah into the Pacific Northwest (Figure 13a). There were no forecasted anomalies for the remainder of the United States. The area predicted to have below-average precipitation, in actuality was split between much wetter-than-average conditions in northeastern Nevada, northern Idaho, northern Oregon, and western Washington and much drier-than-average conditions in much of California, western Nevada, and southeastern Oregon (Figure 13b). Except for northern and part of southeastern Arizona and eastern New Mexico, the Southwest experienced below-average precipitation. Elsewhere, areas from the Texas Gulf Coast through the lower Mississippi River Valley, and into the western Great Lakes were drier-than-average, and from the Big Bend (Texas) into the north-central Great Plains, as well as the East Coast had much wetter-than-average conditions. The high precipitation amounts from Florida into New England were mainly the result of hurricanes and tropical storms.

Figure 13a. Long-lead U.S. precipitation forecast for July–September 2004 (issued June 2004).



Notes:

Figure 13a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months July–September 2004. This forecast was made in June 2004.

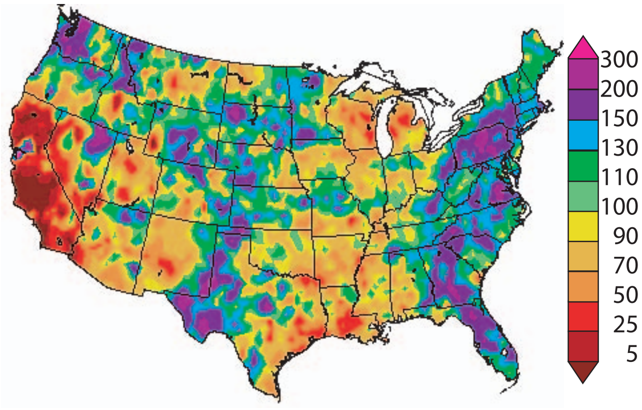
The July–September 2004 NOAA CPC outlook predicts the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation. Care should be exercised when comparing the forecast (probability) map with the observed precipitation maps described below.

Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average precipitation. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 13b shows the observed percent of average precipitation observed July–September 2004.

In all of the figures on this page, the term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

Figure 13b. Percent of average precipitation observed from July–September 2004.



On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html

Tucson NWS Southeastern Arizona Drought Monitoring

Source: Tucson National Weather Service

The Tucson National Weather Service (NWS) website (see links below) now includes a drought monitoring page, listed under the "Local News and Information" section. It focuses on precipitation in southeastern Arizona, but national information is available as well. At the top of the drought monitoring page is a graph of precipitation for the region and links for viewing the data for a portion of a county and localities in that area. Figure 16a shows Douglas, Arizona, as an example. Both the monthly and 12-month departure from average precipitation show wetter-than-average conditions in the early 1990s, a period governed by El Niño (see page 16). A dry period from 1993–1994 was followed by a wet winter in 1994–1995, again during El Niño. Since then, the Douglas record shows mainly below-average precipitation. Other wetter-than-average periods include the monsoons in 1996, 1999, and 2000 and the winters of 1997–1998 and 2000–2001. The recent drought is evident after 1996. In some cases, the 12-month departure from average precipitation is greater than 60 percent (1997, 1999, 2000, 2002, and 2003).

The site also features tables of total, average, departure from average, and percentage of average precipitation for a selection of cities (Figure 14b). Data tables for various slices of time, from the most recent month's precipitation to the total precipitation for the past 7 years are available. Maps depicting percentage of average precipitation for selected periods are available by clicking on the "Southeast Arizona percentage of normal maps" link.

In addition, a table of drought intensity by county is available (Figure 16c). The intensity classifications are the same as those indicated in the U.S. Drought Monitor map (see page 8). Drought intensity through the same time period for the past two years (through October 12 in this case) is also given to allow the user to compare the current conditions with previous years. Graphical versions of the current and past U.S. Drought Monitor are provided as well, along with the seasonal drought outlook and 1- and 3-month temperature and precipitation outlooks from the Climate Prediction Center.

On the Web:

Tucson NWS:
http://www.wrh.noaa.gov/twc/

Southeast Arizona Drought Monitoring:
http://newweb.wrh.noaa.gov/twc/climate/seazDM.php

Figure 14a. departure from average preipitation data for Douglas, Arizona, from September 2004–September 1989.

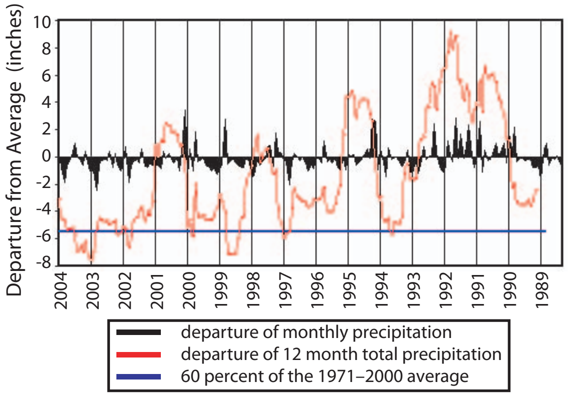


Figure 14b. Options for viewing precipitation data tables and maps for southeastern Arizona localities.

Precipitation data across southeast Arizona										
Percentage of normal precipitation tables (through September 2004)										
1 mo	2 mo	3 mo	4 mo	5 mo	6 mo	7 mo	8 mo	9 mo	10 mo	11 mo
12 mo	15 mo	18 mo	2 yr	30 mo	3 yr	4 yr	5 yr	6 yr	7 yr	

Figure 14c. Current and past drought intensity across southeastern Arizona as of October 12, 2004.

Current drought conditions versus 2003 and 2002			
Location Area (County)	2004	2003	2002
Eastern Pima	D1-Moderate	D1-Moderate	D2-Severe
Central Pima	D0-Dry	D0-Dry	D2-Severe
Western Pima	D0/D1-Dry	D0-Dry	D2/D3-Severe
Southeast Pinal	D1/D2-Severe	D1-Moderate	D2-Severe
Graham/SRN Greenlee	D2-Severe	D1/D2-Severe	D1-Moderate
Santa Cruz	D1-Moderate	D1-Moderate	D2-Severe
Northwest Cochise	D2-Severe	D2-Severe	D1-Moderate
Southwest Conchise	D2-Severe	D2-Severe	D2-Severe
Northeast Cochise	D2-Severe	D3-Extreme	D1-Moderate
Southeast Cochise	D3-Extreme	D3-Extreme	D1-Moderate

Drought Intensity Classification				
D1-Dry	D2- Moderate	D3-Severe	D4-Extreme	D5-Exceptional

Notes:

The Southeast Arizona Drought Monitoring website is experimental and under evaluation through May 22, 2005. The Tucson NWS encourages on-line user feedback about the value of the data. The data are updated between the 15th and 20th of each month.

Figure 14a is precipitation data for Douglas, Arizona. Values above the zero line are surpluses, and below are deficits. The blue line signifies 60 percent below-average precipitation. It is common for the 12-month departure from average to show a slight lag when the monthly departure from average changes unless this change is dramatic. Graphs of precipitation for subregions of southeastern Arizona can be displayed by rolling the cursor over the name of the subregion. Selecting a name gives the precipitation graph and links to cities and towns in the subregion.

Figure 16c shows the table of current drought intensity in areas of southeastern Arizona versus 2003 and 2002. The intensity classifications are identical to those in the U.S. Drought Monitor (see page 8), ranging from D0 (unusually dry) to D4 (exceptional).

USBR Upper Colorado Region

Source: U.S. Bureau of Reclamation

Graphics and data for all reservoirs and power plants in the Upper Colorado Region (UCR) are available through a U.S. Bureau of Reclamation website (see links below). This information can be attained by selecting the "Water Operations" link from the menu on the left and then clicking "Historic Data." Choices are available from a pull-down menu. For reservoirs, select the time period of interest to produce graphs of storage, inflow, release, and pool elevation. The storage at many reservoirs in the West is dependent on hydroelectric power generation releases and climatic factors, including rainfall and mountain snowpack runoff. Figure 15a shows an example of the website's reservoir data for Lake Powel. Each spike shows an increase in storage resulting from spring snowmelt runoff. The initial filling of the reservoir to planned capacity (25,000,000 acre-feet) can be seen from 1963–1980. Large drought-related decreases in storage occurred from 1988–1991 and from 1999–2004. Reservoir status reports, which summarize important events and statistics and other information, are available in the "Water and Reservoir Info" Section in the Quick Links menu on the mainpage.

From the Historic Data page, users may also select powerplant location. Figure 15b shows an example of power generation at Glen Canyon. A large increase in power generated beginning in June resulted from increased May inflow. Periodic drops in power occur on weekends when business and industrial demands are lower. Large decreases from February–April indicate an effort by the USBR to reduce trout populations that compete with native species.

Figure 15a. Storage (in acre-feet) in Lake Powell from March 14, 1963–October 18, 2004. Ticks on the x-axis correspond to March of that year.

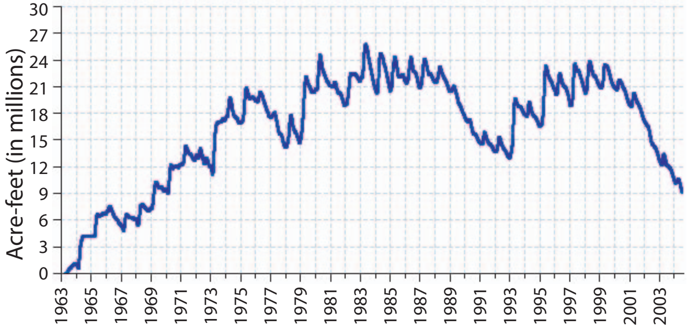
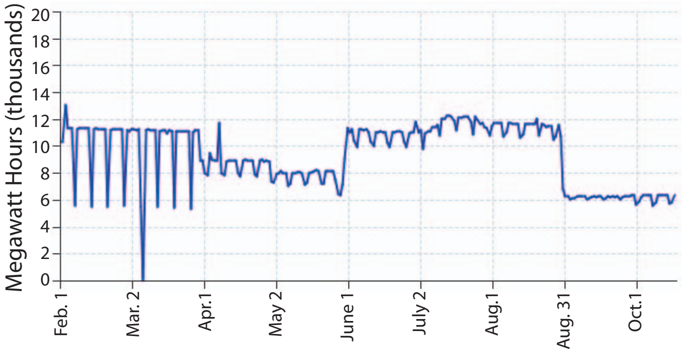


Figure 15b. Power (in Megawatt hours) generated at the Glen Canyon Dam Power Plant from February 1–October 18, 2004.



Notes:

The U.S. Bureau of Reclamation deals with water resources in the West. The Upper Colorado Region serves portions of Colorado, Idaho, Nevada, New Mexico, Texas, Utah, and Wyoming.

Reports about projects and programs can be selected from the "Quick Links" menu on the right-hand-side of the UCR home page. An important report for our region is "Water 2025."

On the Web:

Upper Colorado Region website:
http://www.usbr.gov/uc/

USBR homepage:
http://www.usbr.gov