Issued: May 25, 2004

CLIMAS
Southwest Climate Outlook

May 2004 Climate Summary

Hydrological Drought – Hydrological drought continues in the Southwest.

- Interior Arizona and New Mexico reservoirs are still at well below-average levels.
- The levels of Lake Powell and Lake Mead are well below average. Colorado River Basin states' water resource managers are discussing plans of action for possible future shortages.

Precipitation – Following copious early April precipitation across southern Arizona and most of New Mexico, the region has been seasonally dry. Snowmelt has been early across our region, and low snowpack in the Upper Colorado River Basin is driving forecasts for below-average inflow to Lake Powell.

Temperature – Temperatures have been well above average across the Southwest since around the third week of April.

Climate Forecasts – Seasonal forecasts indicate considerably increased probabilities of above-average temperatures across Arizona and most of New Mexico through the summer months.

El Niño – Conditions in the tropical Pacific Ocean remain neutral. Forecasts do not indicate a strong likelihood for the development of either El Niño (wet Southwest winter) or La Niña (dry Southwest winter).

The Bottom Line – Hydrological drought is expected to persist in most of the Southwest through the summer. There is no drought-ending "silver-bullet" on the horizon.

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

We want your feedback!

Send your comments and questions to Kristen Nelson, knelson7@email.arizona.edu

We've built a better packet...

At least we hope you will think so.

For this month's edition we literally went back to the drawing board to come up with a new design that we hope you will find more reader-friendly. In the process we also overhauled a few graphics, such as the Arizona and New Mexico reservoir levels, while tweaking several others.

In the coming months look for additional changes as we add and revise more content to better serve you.

In this issue:

The Southwest Climate Outlook is published monthly by the Climate Assessment for the Southwest Project at the University of Arizona.

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Beetles devastate forests in response to drought

by Melanie Lenart

If termites were devouring homes at the rate that beetles are killing southwestern trees, cities the size of Phoenix and Albuquerque would be crumbling under the attack.

More than 20 million Ponderosa pines died in Arizona and New Mexico following bug attacks between fall of 2002 and summer of 2003, noted Bobbe Fitzgibbon, an entomologist with the U.S. Forest Service's Forest Health Protection office in Flagstaff. Another 50 million piñon trees died in 2003, she added during a presentation to tribal land foresters.

Fitzgibbon makes her assessments based on extensive aerial surveys, where dry red needles serve as a telltale sign of mortality within the past year at the one-acre scale. A variety of bugs, mostly bark beetle species, are converting large tracts of southwestern forests from evergreen into ominous red.

The epidemic started in 2002 and worsened in 2003 throughout the West, with virtually every state west of the Rockies except Nevada suffering from the onslaught. And there's no sign that the pest outbreak will subside anytime soon—especially if the entrenched drought marches on and temperatures continue to climb.

The drought connection

Drought has a close association to an increase in bark beetle attacks, for a known physical reason. Trees typically defend themselves against beetles by "pitching them out" with their sap. Drier conditions mean less sap flow, however, so beetles find it easier to penetrate beneath the outer layer of bark during times of drought.

Bark beetle species include numerous species of ips, Douglas-fir beetle, spruce beetle, true fir beetles, round-headed pine beetle, mountain pine beetle, and western pine beetle. Together these beetles damaged about 87,000 acres in 2001, 627,000 acres in 2002, and 1.9 million acres in 2003 in Arizona (Figure A). Overall, the wave of peak insect kill appears to be moving north in time, according to Arizona data provided by Fitzgibbon.

"The ips beetles have been the most important in precipitating this latest outbreak," Fitzgibbon said. Ips beetles traditionally target smaller trees, but in this latest outbreak they are often striking at the tops of relatively large trees, where the bole tapers down.

Ips in Ponderosa forests accounted for 75 and 80 percent, respectively, of the acres damaged in 2001 and 2002. But the ratio dropped to about 37 percent in 2003, when piñon ips took over and attacked 1.1 million acres of Arizona piñon-juniper forest.

Another quarter of a million acres of spruce and aspen trees were defoliated in 2003 in the state by other bugs, such as the western spruce budworm and the spruce aphid. The damage continues to spiral upward in time (Figure A). In addition, drought alone appears to have killed trees on more than 65,000 acres in 2002 and 2003, the data show.

These figures showing millions of acres damaged compare to a previous high for Arizona of 490,000 acres damaged by bark beetles in 1957, Fitzgibbon said. The outbreak followed a devastatingly dry period for Arizona—to this day, 1955–56 retains the statewide record for driest water year.

Climate change impacts

In the Pinaleño Mountains of southern Arizona, similarly, the current insect outbreak among Ponderosa and piñon pines is "an order of magnitude larger and more severe" than the outbreak that occurred during the 1950s drought, noted entomologist Ann Lynch of the U.S. Forest Service's Research office in Flagstaff.

A half dozen different insect species are converging on Mount Graham and other peaks in the Pinaleños. Other southwestern high-elevation forests are succumbing to outbreaks of insect species that were previously innocuous or unknown to the region, such as the spruce aphid, formerly considered a maritime pest.

Why is more forest area being affected in this drought than during the 1950s drought? Lynch suspects the climbing temperatures of the past few decades help explain the difference.

"It's too hot, it's too dry, and there are too many bugs," as Lynch summed it up succinctly to the couple of hundred people attending her plenary session at a Sky Island biodiversity conference in Tucson in mid-May. "The drought is not sufficient to explain the extent of the devastation."

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Six-spine Ips Engraver, *Ips calligraphus*—not actual size.

Beetles, continued

As one example of climate change in action, Lynch focused on the McNary station at 7,000 feet in elevation in northern Arizona's White Mountains. Since 1940, the number of frost days has declined, with the year's frost-free period increasing from an average of 102 days to 147 days. Meanwhile, both minimum and midpoint temperatures for the year increased during this period.

"Much of the Rim country in Arizona was presumed to be beetle-proof," Lynch said. Not anymore. Bark beetles attacked more than half a million acres of Mogollon Rim forest managed by the White Mountain Apache and by Sitgreaves National Forest staff in 2002 and 2003, up from a total of 14,000 acres infested in 2001.

Temperatures from the 1990s on have established new highs for the 100-year plus instrumental record of temperature in the northern hemisphere, with 2002, 2003, and 1998 down as the three hottest years on record. The extra warmth increases the length of the growing—and beetle-breeding—season, while the drop in frost days decreases opportunities to kill off over-wintering broods.

A tendency toward earlier springs and longer growing seasons are among the predicted results of climate changes that are already occurring in the Southwest. Many tree species will face a change in their suitable range as a result of these and other impacts of climate change, including precipitation changes. The higher evaporation rates that accompany higher temperatures also are likely to increase drought frequency.

Ponderosa pine populations could decline in Arizona yet increase in New Mexico, suggested a 1997 study led by Robert S. Thompson of the U.S. Geological Survey. The study also predicted spruce, piñon pine, lodgepole- and Douglas-fir, and gambel oak would decline in the Southwest. Beetles, and the insects attacking higher elevation spruce and fir forests, may be among the agents of change for this predicted conversion, along with fire.

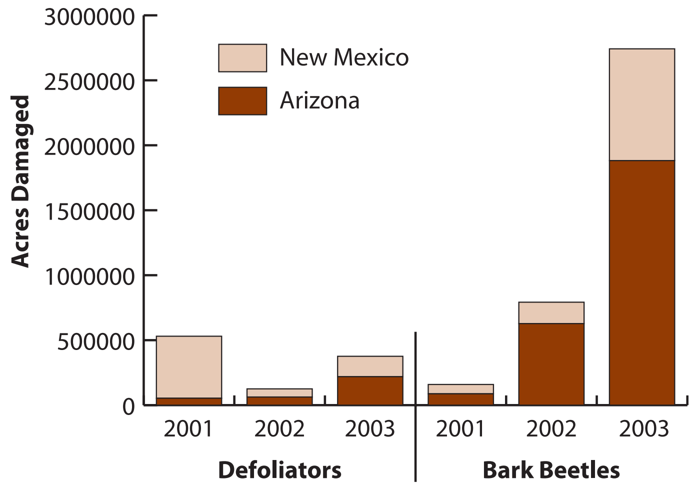


Figure A. Bark beetle attacks have been increasing in the Southwest, especially in Arizona. Bark beetles kill trees by attacking the cambium under the bark, girdling them so that they can no longer transport water to their needles. Defoliators eat the leaves and needles of trees—their attacks are not always fatal.

Management issues

Along with climbing temperatures and drought, Lynch blamed the "overgrown" state of southwestern forests for the ongoing insect attacks. She and other entomologists agreed that reducing the density of the trees in a stand, known as thinning, can help prevent outbreaks.

"I am a big proponent of thinning, thinning, and thinning. I don't care how you do it," Lynch proclaimed, indicating she supported the use of prescribed fires and cutting of some trees to reduce stand densities.

"You have to thin, and then it has to rain or snow," she added. If climate remains dry in the weeks or months following a thinning effort, the remaining trees in a thinned stand may be more vulnerable because of their increased exposure.

Victoria Wesley, a supervisory forester and entomologist for the San Carlos Apache Reservation, agreed that thinning out some of the trees potentially could save the rest. The 400,000 beetle-killed trees within the reservation's 111,000 acres of Ponderosa pine forest were mostly in "inoperable areas," where steep or rocky slopes prevent much management, she told University of Arizona CLIMAS researchers earlier this year.

"I think since we're not thinning those areas, the bark beetles are doing our jobs and going in and thinning," she said.

During an April outing at the reservation, she pointed to a section of green in an area that was otherwise reddened or left barren by bug kill: "That's an area where we thinned."

Jim Youtz, a supervisory forester and silviculturist working for the Bureau of Indian Affairs Fort Apache Agency in the White Mountains of northern Arizona, reported a similar observation.

"All of those big pockets of bark beetle outbreak were in unmanaged stands," he noted after observing a mortality map for the White Mountains shown in a presentation by Fitzgibbon. "Any area that had thinning in the last 10 years didn't have any significant mortality."

"In a way, we're losing trees where we need to lose them," Fitzgibbon agreed, alluding to attacks on dense stands of trees that have turned many Ponderosa forests into fire hazards and sites where drought and bugs are killing off trees that expanded into marginal areas during the wet period of the 1970s and 1980s.

continued on page 4

Beetles, continued

But Lynch worried that the beetles' approach to "thinning" tends to take out the large trees, such as old-growth Ponderosa, whereas forest managers and surface fires tend to thin out the smaller trees in a stand.

Even thinning by foresters can backfire if slash from the cut trees remains in the forest as a potential lure for beetles. For instance, the abandoned slash from thinning operations attracted the round-headed pine beetle to Tucson's Mount Lemmon in the fall of 2001, before the catastrophic wildfires of 2002 and 2003 struck, Fitzgibbon noted.

Similarly, using prescribed burns to thin stands can be risky in the unusually dense forests of this century, as New Mexico forest managers learned the hard way. A prescribed burn morphed into a wildfire and consumed about 47,000 acres of forest around Los Alamos in the summer of 2000.

Meanwhile, the wildfire risk is growing with the number of insect-infested trees on the landscape. The large patches of "red trees," along with the newly attacked trees trying to fend off bark beetle attacks with volatile compounds, feed the fires that can rage through the Southwest during dry months like May and June. Also, some of the dead trees that remain standing on the landscape could stoke fires decades from now, when they finally fall over to act as fuel on the forest floor.

As with catastrophic wildfires, there is little humans can do once beetles decide to consume a tree. Homeowners can water urban trees to prevent attacks, and even use pesticides to protect favorite trees, but these techniques remain too expensive to apply to large tracts of forests, Fitzgibbon said. Even thinning operations carry a price tag of many hundreds of dollars an acre.

That points to one big way forest wood differs from the wood found in and around homes. If bark beetles were devouring homes in Phoenix or Albuquerque, residents would be finding ways to resist the destruction. But the trees in the forest have to rely on their own chemicals to fight for their lives—and they're continuing to lose the battle on a large scale. There's no expectation for an end to the mortality anytime soon.

Melanie Lenart is a postdoctoral research associate with CLIMAS.

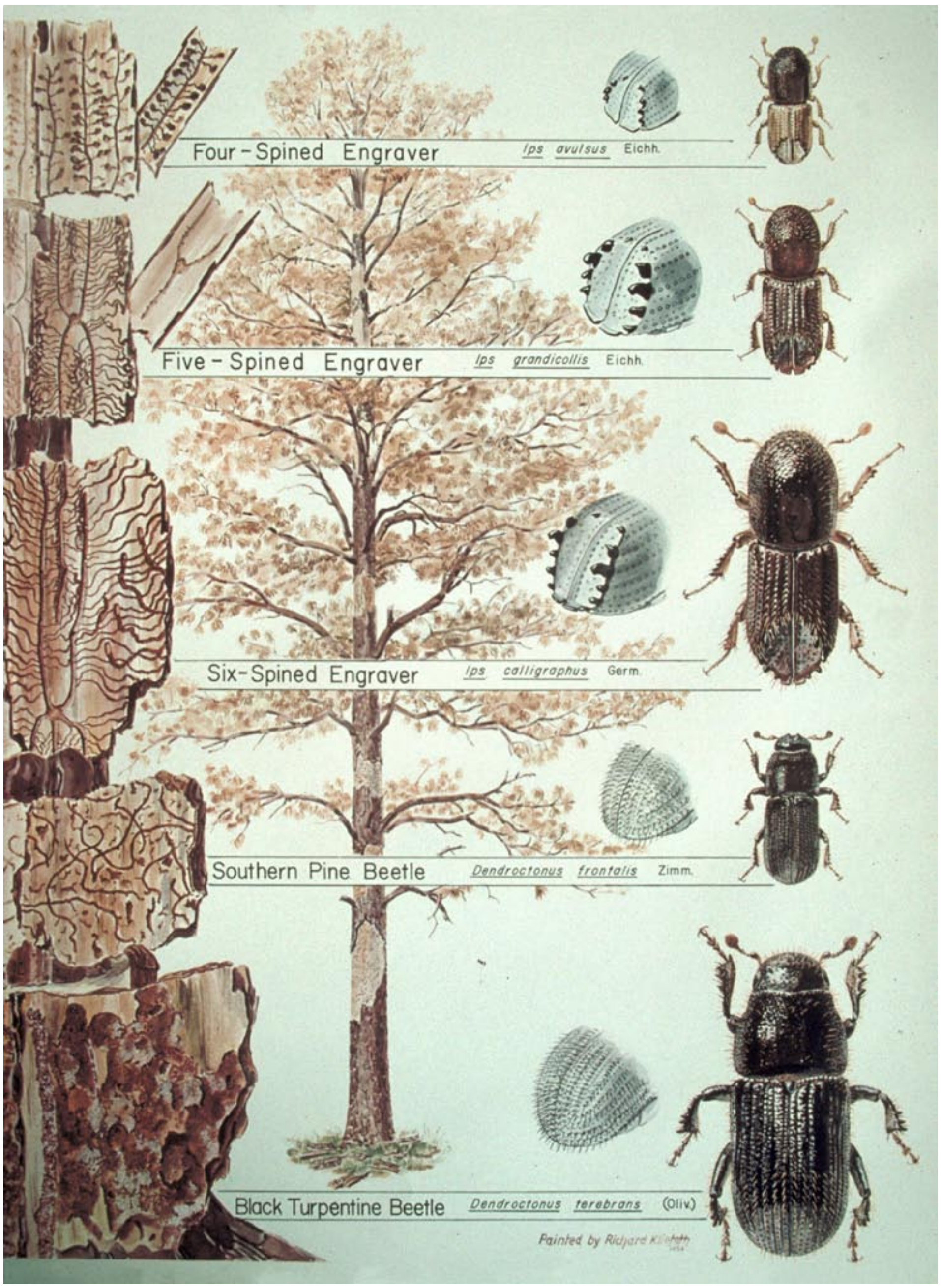


Figure B. Diagram of adults, gallery patterns, and attack sites of 5 bark beetle species (*Ips avulsus, Ips grandicollis, Ips calligraphus, Dendroctonus frontalis,* and *Dendroctonus terebrans*) The Ips beetles, typically about the size of a grain of rice, are the ones causing the most trouble in the Southwest in the recent onslaught on Ponderosa and piñon pines. Damage by *Dendoctonus* species, illustrated here by southern pine beetles and black turpentine beetles, are occurring at a much smaller scale. The images at left show the typical reproductive "galleries" created by the different beetle species under the bark. Image provided by Ronald F. Billings, Texas Forest Service, http://www.forestryimages.org.

Temperature (through 5/20/04)

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

Southwest regional temperatures have been chiefly above average since October 1, 2003 (Figures 1a and 1b). Central and southwestern Arizona have been key regions for above-average temperatures, which is consistent with long-term temperature trends in our region (Figure 1a). During the past 30 days, temperatures have also been well above average over most of our region, especially western Arizona (Figures 1c and 1d). It should be noted that seasonal temperature predictions issued during the past year have indicated a high likelihood of above-average temperatures for western Arizona (see page 12); surprisingly low early April temperatures were a rare exception to this long-term trend. Since the third week of April, minimum and maximum temperatures for Tucson, Arizona have been well above average, according to the National Weather Service. Similarly warm minimum temperatures (not pictured) have been observed in both rural and urban locations across virtually all of Arizona, as well as southern and central New Mexico. Increases in minimum temperatures are a key feature associated with climate change.

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 blue numbers in Figure 1a, the red and black numbers in Figure 1b, and 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 May 20, 2004) departure from average temperature.

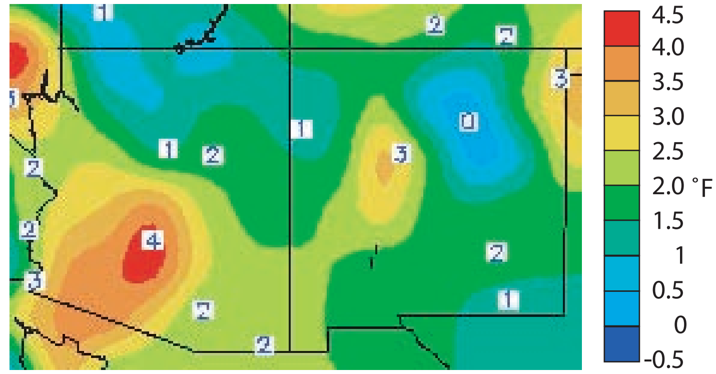


Figure 1b. Water year '03–'04 (through May 20, 2004) average temperature.

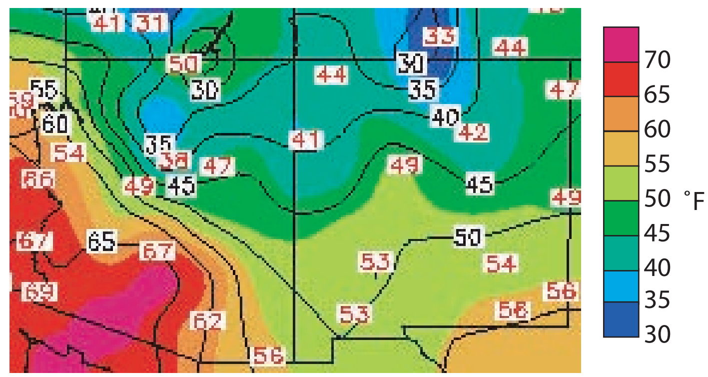


Figure 1c. Previous 30 days (April 21–May 20, 2004) departure from average (interpolated).

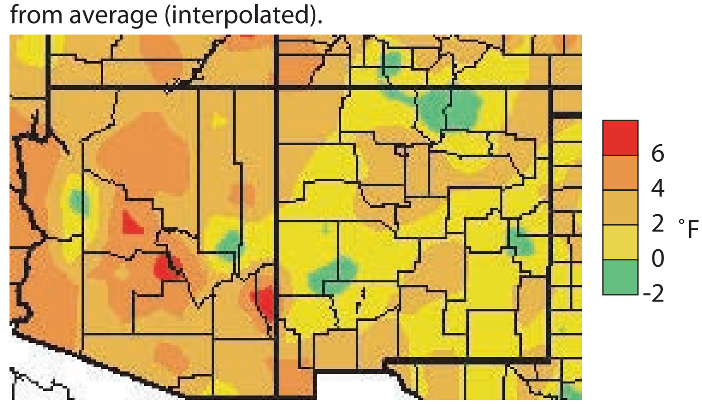
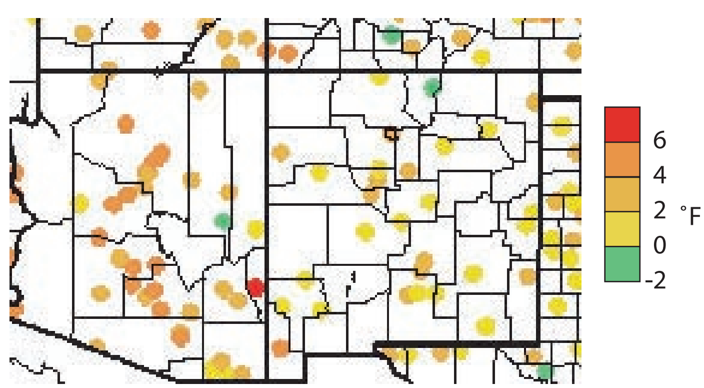


Figure 1d. Previous 30 days (April 21–May 20, 2004) departure from average temperature (data collection locations only).



Precipitation (through 5/16/04)

Source: High Plains Regional Climate Center

Since October 1, 2003, precipitation has been below average across most of Arizona (Figures 2a and 2b), with the exception of the southeastern part of the state. Central and, especially, southeastern New Mexico, buoyed by early April precipitation, have received above-average water year precipitation. The National Weather Service Albuquerque forecast office reported that New Mexico statewide precipitation for April 2004 ranked as the fourth wettest on record; more than a dozen locations in the state reported new record precipitation totals for April. The past 30 days, however, have been dry, as one would expect during the late spring in the Southwest. However, the past 30 days have been drier than expected based on the 1971–2000 average (Figures 2c and 2d). Despite above-average water year precipitation across much of New Mexico, long-term drought still prevails. Farmers in the Elephant Butte irrigation district are still experiencing water shortages and below-average irrigation allotments (Associated Press, May 16, 2004). Hanover, New Mexico is in an emergency water situation, as one of their wells has run dry and the other has very little water (*The Daily Press,* May 18, 2004). The Hanover Water Association anticipates water delivery restrictions between 8 a.m. and 5 p.m.

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 May 16, 2004 percent of average precipitaion (interpolated).

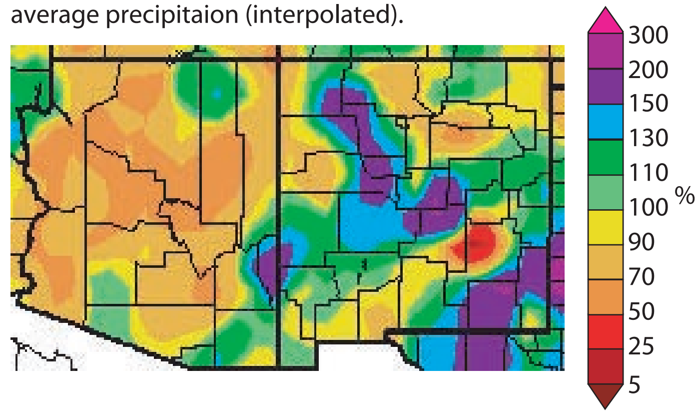


Figure 2b. Water year '03–'04 through May 16, 2004 percent of average precipitation (data collection locations only).

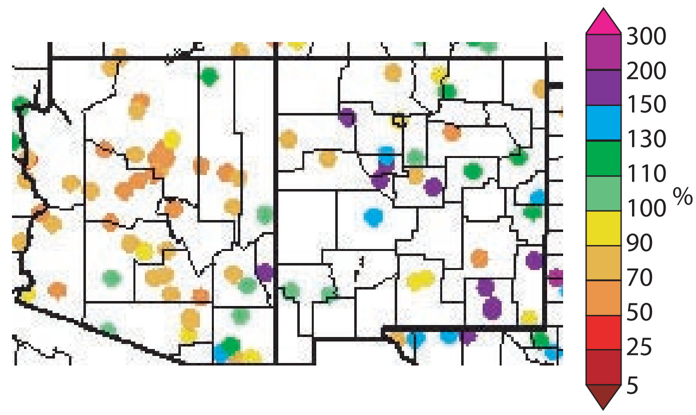


Figure 2c. Previous 30 days (April 17–May 16, 2004) percent of average precipitation (interpolated).

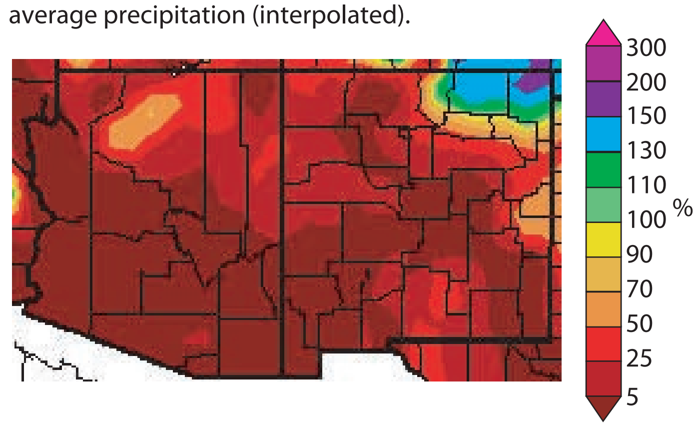
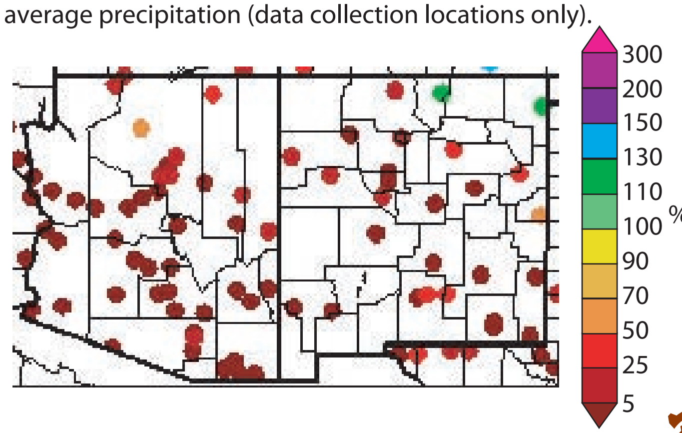


Figure 2d. Previous 30 days (April 17–May 16, 2004) percent of average precipitation (data collection locations only).



U.S. Drought Monitor

(released 5/20/04)

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

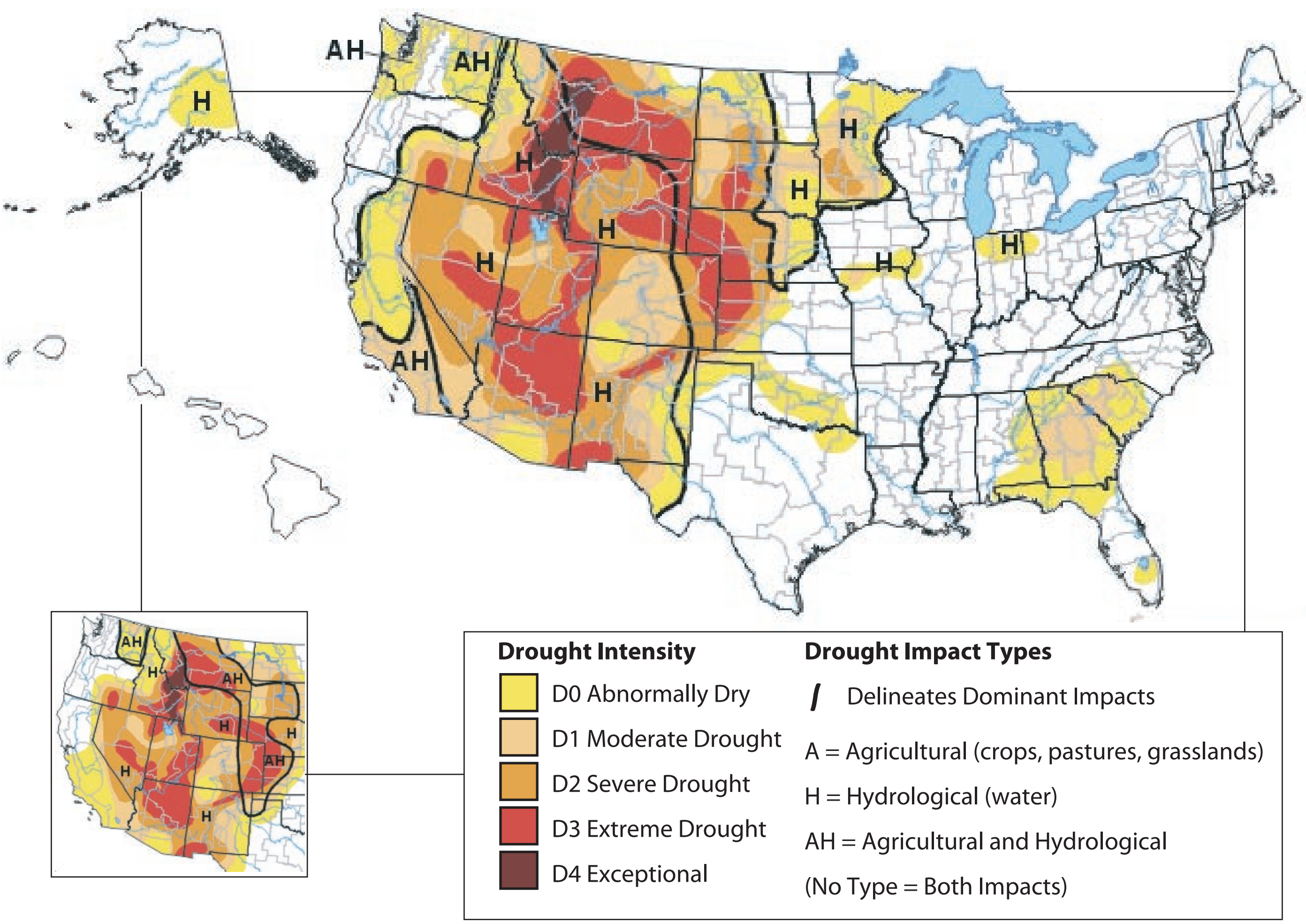
The drought pattern for the Southwest remains much the same as last month. At this time of year, we receive very little precipitation, and little is expected until the monsoon season begins. As a result, changes in drought status are difficult to justify without additional criteria beyond precipitation. As of May 17, Arizona and New Mexico had 43 and 47 percentrespectively of their range and pasture land classified in "poor or very poor" condition. The drought conditions depicted in Figure 3 are a combination of expert opinion to reflect both short-term and long-term drought. The reservoir system provides an excellent measure for long-term drought conditions, and reservoirs along the Colorado River system are in trouble. Lake Powell and Lake Mead, which account for 92 percent of the Colorado River storage, lost 19.7 million acre feet in the past four years. Storage in these reservoirs is down 44 percent from April 2000. The *San Diego Times* (April 25, 2004) suggests that water planners have been reluctant to risk public backlash until water supplies are truly scarce, quoting Central Arizona Project general manager Sid Wilson who said, "We don't worry about drought until it's dry. We don't worry about floods until it rains." According to the current drought status in the West, it's time to start worrying.

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 David Miskus from the U.S. Department of Agriculture.

Figure 3. Drought Monitor released May 20, 2004 (full size) and April 15, 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 4/21/04)

Source: New Mexico Natural Resources Conservation Service

What a difference a month can make! In April, the eastern half of the state was in emergency-level drought with the rest in warning or alert drought status. The situation has changed for short-term meteorological drought (Figure 4a) in most areas due to well-above-normal April precipitation. Albuquerque had the second wettest first four months of the year, second only to 1905 (Albuquerque National Weather Service). While no location in the state is in "normal" long-term drought status (Figure 4b), the conditions have improved significantly. For example, the Pecos River basin has improved, yet the rest of the state remains in the same long-term drought category as last month.

The long-term drought is stressing urban and agricultural water systems. In Santa Fe, which gets only 40 percent of its water from surface sources, city officials recently received permission to drill four new wells to support current and future water demands (*New Mexico Business Weekly,* May 3, 2004). Groundwater sources, however, are sometimes subject to withdrawals from distant sources. For example the *Desert-Mountain Times* (May 13, 2004), an independent weekly newspaper in western Texas, reports that El Paso water extraction has lowered the local water table by up to 150 feet, and has impacted aquifer flows as far away as New Mexico. The region is likely to experience continued pressure from growing urban regions regarding water to support expanded populations (*New Mexico Business Weekly,* April 30, 2004).

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.

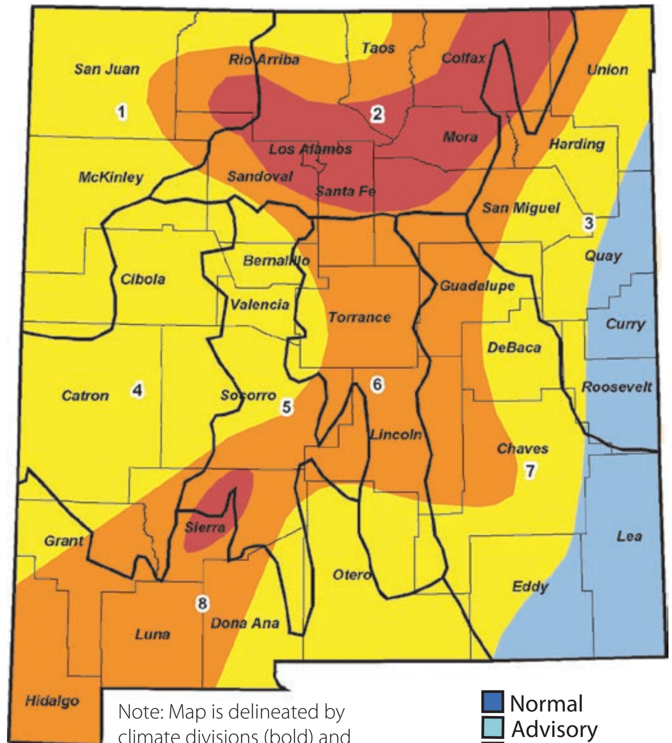
Figure 4a shows short-term or *meteorological* drought conditions. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) over a relatively short duration (e.g., months). Figure 4b refers to long-term drought, sometimes known 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/

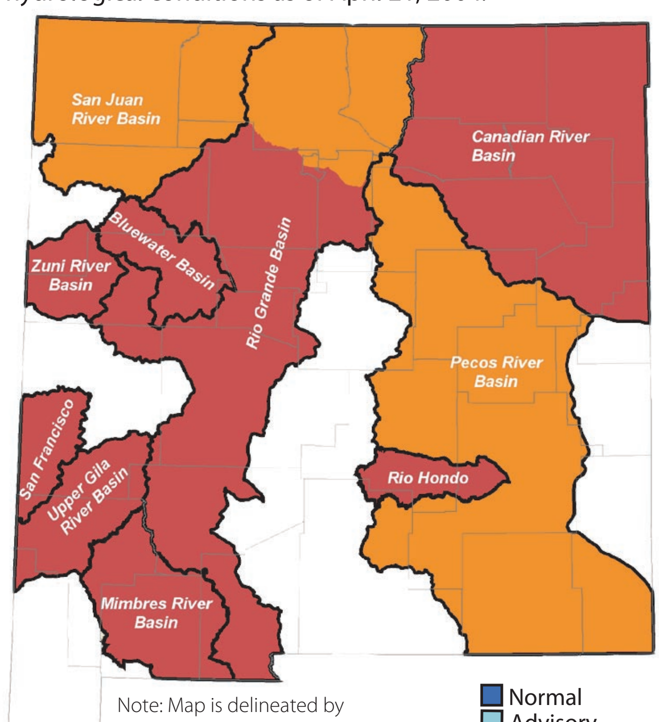
Figure 4a. Short-term drought map based on meteorological conditions as of April 21, 2004.



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

Normal
Advisory
Alert
Warning
Emergency

Figure 4b. Long-term drought map based on hydrological conditions as of April 21, 2004.



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

Normal
Advisory
Alert
Warning
Emergency

Arizona Reservoir Levels
(through 4/30/04)
Source: National Water and Climate Center

This month, we debut a new graphic to show Arizona reservoir levels (Figure 5) that we hope is a better representation of the state of the water storage system. All the same information is contained in our new "cup" diagrams that replace the bar graphs from previous packets—see the notes for details and feel free to send us your comments and suggestions.

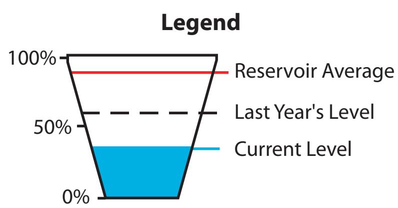
The continuing story for Arizona reservoirs is the lack of water for Lake Powell and Lake Mead. In general, Arizona reservoirs stayed near the same level as last month with Lake Mead showing a slight loss. The state of the Colorado River system has gained nationwide prominence in the news. The *New York Times* (May 2, 2004) reports that the U.S. Geological Survey has declared the period since 1999 officially to be the driest in the 98 years of recorded monitoring on the Colorado River. With the system now in a multiple-year drought, less than half of the normal inflow to Lake Powell is projected to occur. As a result, Lake Powell is at its lowest levels since being filled in 1970, which suggests significant water shortage may be in our future. W. Bennett Raley, the Bush administration's top water official, is quoted in the *Tucson Citizen* (May 3, 2004) as saying, "If current trends continue…the secretary [of the Interior] would be forced to take action certainly within three years and potentially within two." Raley continued, stating that the Bush administration's preference is for the states who use the Colorado River water to work out solutions that are acceptable to the government. According to the *Arizona Republic* (April 30, 2004), the Colorado River provides water to more than 25 million people in seven states. Stay tuned—this story will continue to develop.

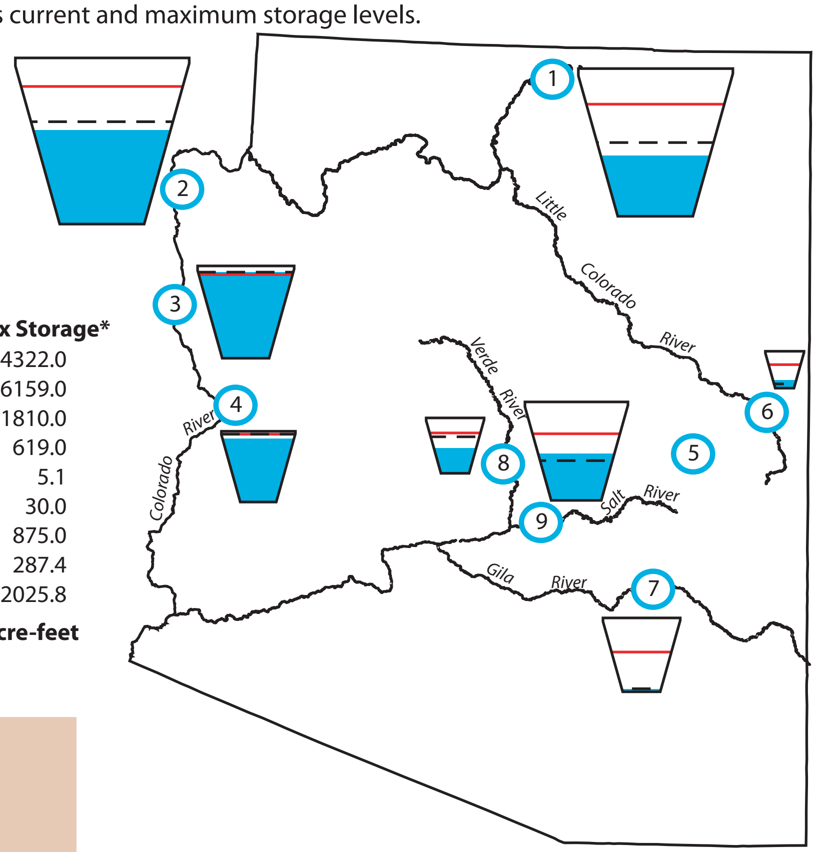
Notes:
The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent 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 April 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	42%	10193.0	24322.0
2. Lake Mead	57%	14866.0	26159.0
3. Lake Mohave	93%	1680.3	1810.0
4. Lake Havasu	90%	558.2	619.0
5. Show Low Lake	65%	3.3	5.1
6. Lyman Reservoir	23%	6.9	30.0
7. San Carlos	4%	32.3	875.0
8. Verde River System	46%	133.0	287.4
9. Salt River System	48%	980.1	2025.8

*** 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 4/30/04)

Source: National Water and Climate Center

This month, we debut a new graphic to show New Mexico reservoir levels (Figure 6) that we hope is a better representation of the state of the water storage system. All the same information is contained in our new "cup" diagrams that replace the bar graphs from previous packets—see the notes for details and feel free to send us your comments and suggestions.

The above-average rains in the past month have helped the reservoirs. With only a few exceptions, the reservoirs are in better shape; however, most reservoirs remain well below their average storage for this time of year. According to the Albuquerque National Weather Service office, the Rio Grande basin is at 94 percent of last year's storage but only 35 percent of the 1971–2000 normal storage as of May 6. In the San Juan basin, Navajo Reservoir storage is at 68 percent of the 1971–2000 average for this time of year. While short-term meteorological drought (see page 8) has eased, the reservoir system deficit confirms that New Mexico remains in a hydrological drought situation. Only three years ago, the Rio Grande basin storage was at 113 percent of average and Navajo Reservoir storage was 109 percent of average. Despite a wet spring, New Mexico reservoirs have not caught up from the long-term deficit. It must be noted that the situation has improved over last month, with almost 89,000 acre-feet of additional water in storage in the last month, according to Natural Resources Conservation Service's Richard Armijo (*Albuquerque Tribune,* May 7, 2003). Last month we reported that irrigation supplies might be limited, according to an NRCS water resource specialist. This month, they report that the irrigation season might extend into September.

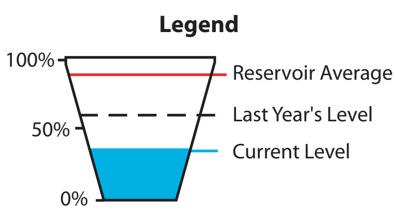
Notes:

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.

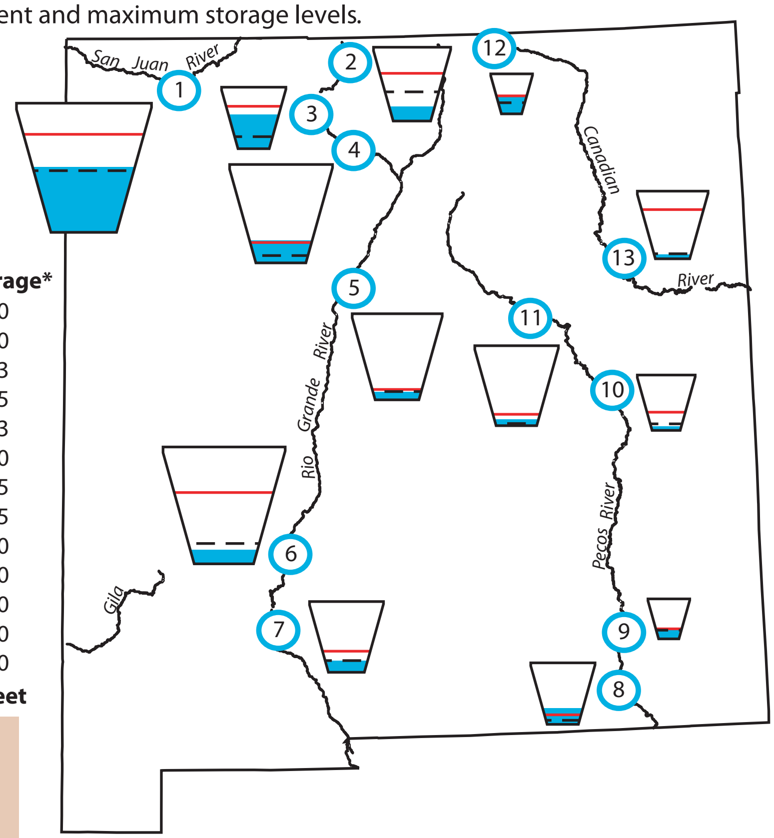
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service. For additional information, contact Tom Pagano at the National Water Climate Center (tpagano@wcc.nrcs.usda.gov; 503-414-3010) 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 April 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. Navajo	51%	869.1	1696.0
2. Heron	20%	81.8	400.0
3. El Vado	56%	104.8	186.3
4. Abiquiu	23%	126.1	554.5
5. Cochiti	10%	52.0	502.3
6. Elephant Butte	12%	254.5	2065.0
7. Caballo	17%	56.1	331.5
8. Brantley	26%	38.1	147.5
9. Lake Avalon	23%	1.4	6.0
10. Sumner	7%	7.5	102.0
11. Santa Rosa	8%	35.1	447.0
12. Costilla	44%	7.0	16.0
13. Conchas	7%	17.5	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

Southwest Snowpack
(updated 5/18/04)

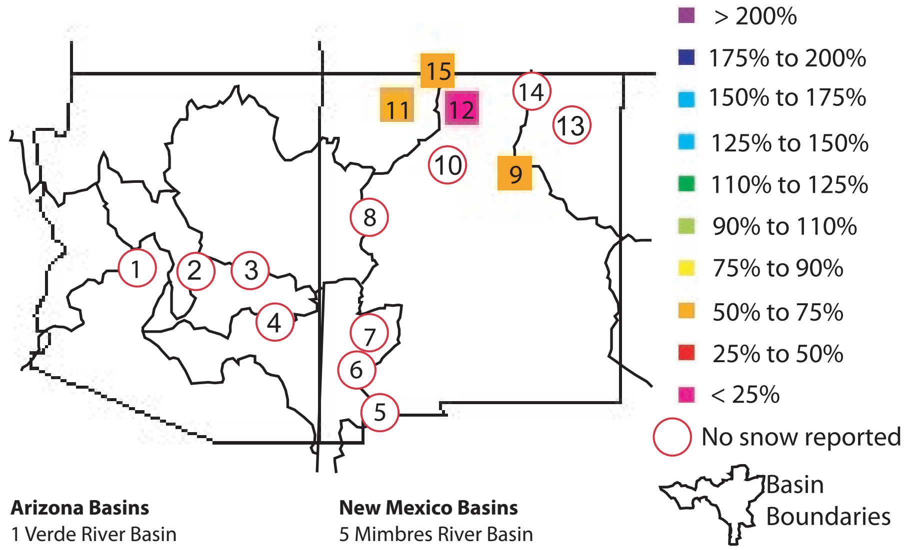
Source: National Water and Climate Center, Western Regional Climate Center

The 2003-2004 winter snowpack has melted from all of Arizona and most of New Mexico (Figure 7). According to the National Weather Service Albuquerque forecast office, the southern Sangre de Cristo Mountains received significant snowpack during April, which improved snowmelt runoff in the upper Canadian River basin and the upper Pecos River basin. Warmer than average temperatures have enhanced snowmelt. In fact, during 2004 the western United States never recovered from extremely high mid-March temperatures which melted off what had been a decent snowpack. As of May 18, the upper Colorado River Basin and Upper Rio Grande River Basin were both showing below-average snow water content. Larry Martinez of the USDA-Natural Resources Conservation Service reported that Arizona snowpack was below average for its sixth consecutive year.

The below-average snowpack in our region has had important implications for streamflow and reservoir levels in virtually all regional river basins. Evaporation of snow and incorporation of snow melts into thirsty soils has sent water officials in Colorado River Basin states into negotiations regarding potential Colorado River shortages. Further inland, communities in Central Arizona's Mogollon Rim, such as Payson, which normally receive significant winter snow, have had to implement water conservation programs. This summer Payson residents will be under Stage 3 water restrictions, according to a report from *The Payson Roundup* (May 18, 2004).

This is the last month until fall 2004 that we will provide Southwest snowpack data.

Figure 7. Average snow water content (SWC) in percent of average for available monitoring sites as of May 18, 2004.



Arizona Basins
1 Verde River Basin
2 Central Mogollon Rim
3 Little Colorado - Southern Headwaters
4 Salt River Basin

New Mexico Basins
5 Mimbres River Basin
6 San Francisco River Basin
7 Gila River Basin
8 Zuni/Bluewater River Basin
9 Pecos River
10 Jemez River Basin
11 San Miguel, Dolores, Animas, and San Juan River Basins
12 Rio Chama River Basin
13 Cimarron River Basin
14 Sangre de Cristo Mountain Range Basin
15 San Juan River Headwaters

Notes:

The data shown on this page are from snowpack telemetry (SNOTEL) stations grouped according to river basin. These remote stations sample snow, temperature, precipitation, and other parameters at individual sites.

Figure 7 shows the snow water content found at selected SNOTEL sites in or near each basin compared to the average value for those sites on this day. *Average* refers to the arithmetic mean of annual data from 1971–2000. Snow water content (also known as snow water equivalent) is the amount of water currently in snow. It depends on the density and consistency of the snow. Wet, heavy snow will produce greater snow water content than light, powdery snow.

Each box on the map represents a river basin for which data from individual SNOTEL sites have been averaged. Arizona and New Mexico river basins that have SNOTEL data available are numbered on the map. The colors of the boxes correspond to the percent of average snow water content in the river basins. The dark lines within state boundaries delineate large river basins in the Southwest.

These data are provisional and subject to revision. They have not been processed for quality assurance. However, they provide the best available land-based estimates during the snow measurement season.

On the Web:

For color maps of SNOTEL basin snow water content, visit: http://www.wrcc.dri.edu/snotelanom/basinswe.html

For a numeric version of the map, visit: http://www.wrcc.dri.edu/snotelanom/basinswen.html

For a list of river basin snow water content and precipitation, visit: http://www.wrcc.dri.edu/snotelanom/snotelbasin

Temperature Outlook
(June–November 2004)
Source: NOAA Climate Prediction Center

The NOAA-CPC temperature outlooks for June-November 2004 (Figures 8a-8d) show increased probabilities of above-average temperatures for the Southwest. These forecasts, based chiefly on long-term trends, show high probabilities of above-average temperatures for the summer and into the fall, with maximum probabilities of above-average temperatures over western Arizona. Forecasts for New Mexico are not as strong, tapering off to equal chances in northeastern New Mexico during the September–November season (Figure 8d). The International Research Institute for Climate Prediction (IRI) temperature forecasts (not pictured) show a similar pattern of increased probabilities of above-average temperatures for the Southwest, although IRI maximum probabilities are lower than those indicated by the CPC. It is important to remember that 1971–2000 (i.e., average) was a very warm period in the climate record.

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 8a. Long-lead national temperature forecast for June–August 2004.

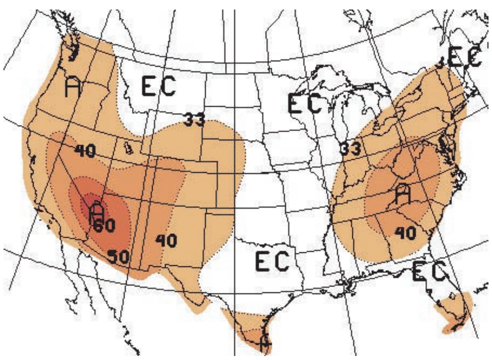


Figure 8b. Long-lead national temperature forecast for July–September 2004.

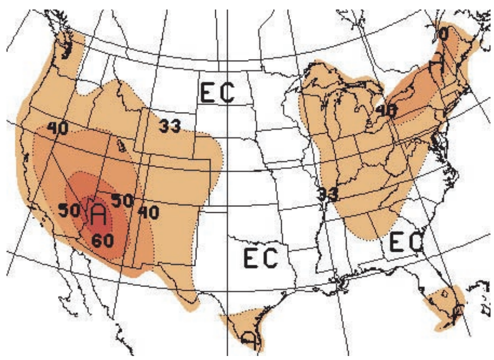


Figure 8c. Long-lead national temperature forecast for August–October 2004.

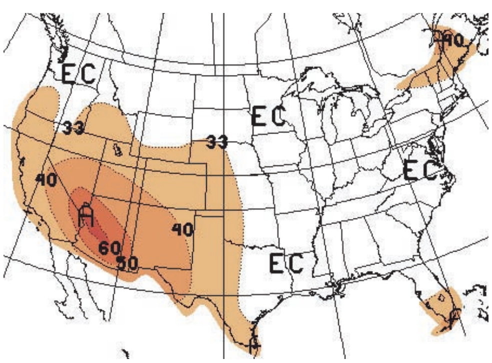
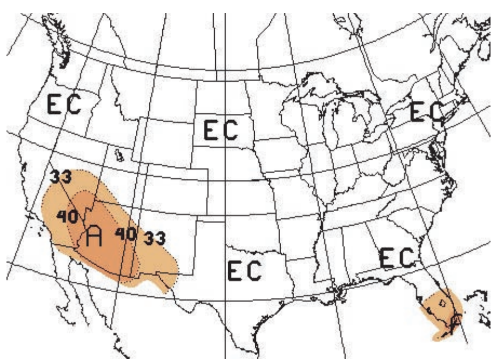


Figure 8d. Long-lead national temperature forecast for September–November 2004.



A= Above
- >60.0%
- 50.0–59.9%
- 40.0–49.9%
- 33.3–39.9%

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
(June–November 2004)
Source: NOAA Climate Prediction Center

The NOAA-CPC precipitation outlooks withhold judgment (EC) for the Southwest for June–November 2004 (Figures 9a-d). The International Research Institute for Climate Prediction (IRI) precipitation forecasts for this time period (not pictured) also withhold judgment for the June–November 2004 forecast period. Summer precipitation in the Southwest is characterized by great spatial variability and little seasonal forecast skill. During neutral ENSO conditions (see page 17), there is even less skill. This summer, NOAA and the National Center for Atmospheric Research are leading an intensive effort to learn more about the behavior of the summer monsoon. CLIMAS will keep you informed about the progress of the 2004 North American Monsoon Experiment (NAME).

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 9a. Long-lead national precipitation forecast for June–August 2004.

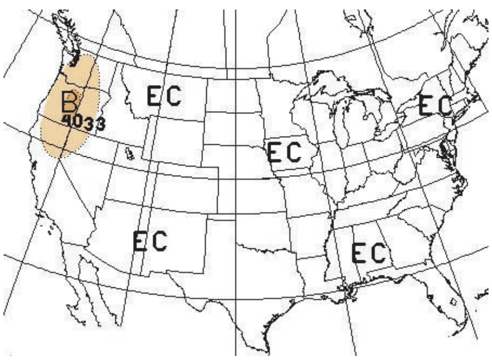


Figure 9b. Long-lead national precipitation forecast for July–September 2004.

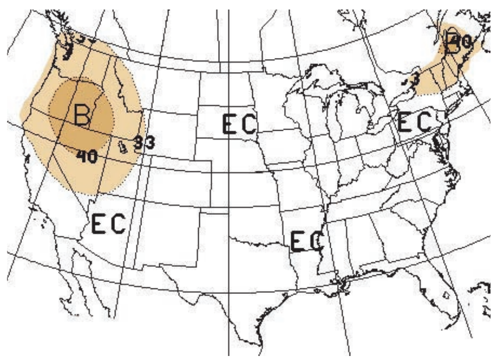


Figure 9c. Long-lead national precipitation forecast for August–October 2004.

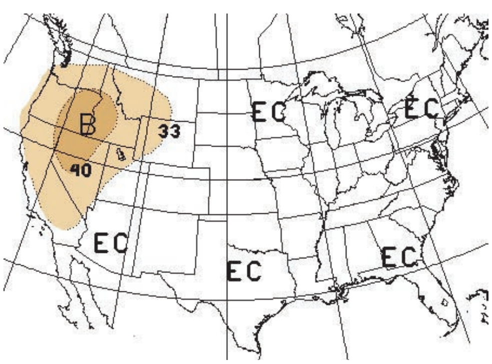
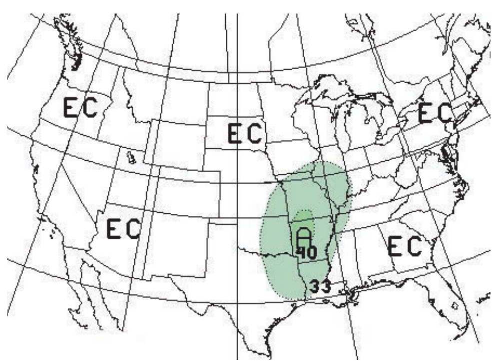


Figure 9d. Long-lead national precipitation forecast for September–November 2004.



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)

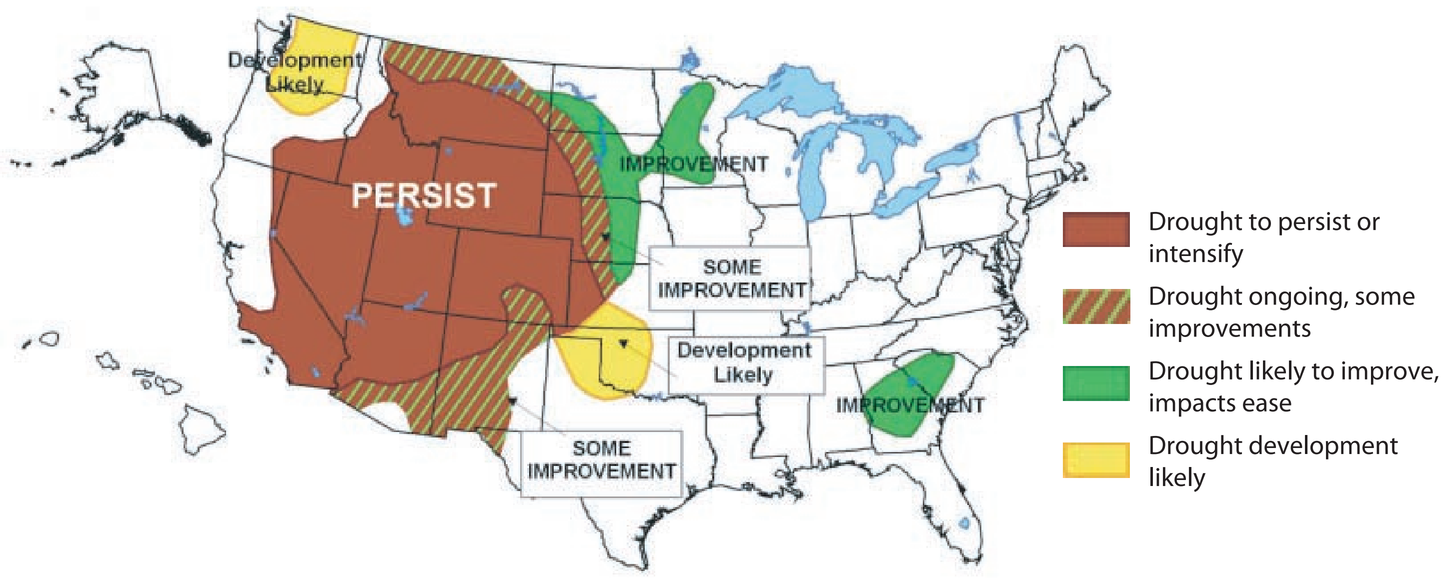
For IRI forecasts, visit:
http://iri.columbia.edu/climate/forecast/net_asmt/

Seasonal Drought Outlook
(through August 2004)
Sources: NOAA Climate Prediction Center

The U.S. seasonal drought outlook (Figure 10) forecasts continuing drought conditions for northern Arizona and northwestern New Mexico, with the possibility of some improvement across southern Arizona and central and southern New Mexico. Areas of possible improvement shown in Figure 10 are probably related to record early April precipitation across most of New Mexico. Drought outlook authors expect that the summer thunderstorm season will bring some short-term relief; however, the long-term hydrological drought will persist at least until next winter's snow season. One of the most interesting and frustrating aspects of drought as a natural hazard is that it operates on many timescales. It is possible for current conditions to simultaneously register short-term relief, such as improvements in range and pasture conditions and/or delay of severe fire conditions, as well as continued severe long-term hydrological drought, such as reduced surface water supplies and ongoing depletion of groundwater supplies. Drought conditions take many months or years to develop; similarly it takes many months or years of average to above-average precipitation for soil moisture and reservoir levels to be replenished. In a recent guest commentary in the *Albuquerque Journal* north edition (May 16, 2004), Santa Fe mayor Larry Delgado advises "Water conservation is a permanent requirement for all New Mexicans. Drought conditions require increased emphasis on limiting our water demand." Given the inherent lag time in the hydrological system's response to precipitation following drought, we should expect delays in improvements to water supplies even following above-average precipitation.

Notes:
The delineated areas in the Seasonal Drought Outlook (Figure 10) are defined subjectively and are based on expert assessment of numerous indicators, including outputs of short- and long-term forecasting models.

Figure 10. Seasonal drought outlook through August 2004 (release date May 20, 2004).



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

and, http://www.ncdc.noaa.gov/oa/climate/research/drought/drought.html

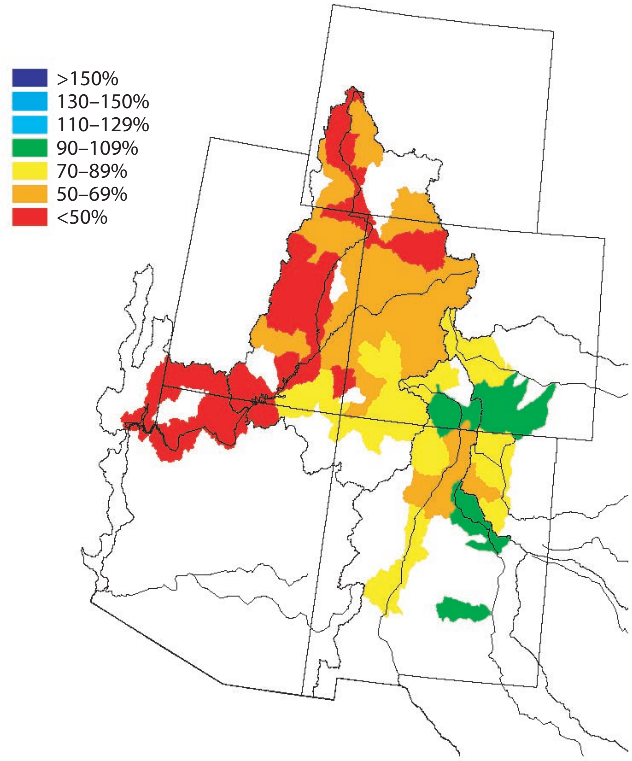
Streamflow Forecast
(for spring and summer)
Source: National Water and Climate Center

The general picture for western streamflow remains below average, although above-average precipitation in New Mexico has improved streamflow in several basins (the best streamflow is on the Animas, Gila, Vermejo, and Mora Rivers). But, the snowpack is melting ahead of schedule, thus reducing the projected streamflow in many areas. Snowmelt provides the basis for these streamflow forecasts and approximately 70 percent of the West's water flow begins as snow. Throughout the West, increasing temperatures have caused peak snowmelt to occur two to three weeks earlier than it did 50 years ago, resulting in peak runoff happening five to ten days earlier (*LA Times,* May 9, 2004). These trends have prompted studies to determine potential impacts if this trend continues. A University of Washington study recently suggested a further 30 percent reduction in snowfall over the Rocky Mountains with snowmelt occurring a month earlier in the next 50 years (*LA Times,* May 9, 2004). Warming temperatures and reduced snowpack pose problems for western water use. Martin Hoerling, a research meteorologist with NOAA said, "The West has become habituated because of the ability to store and have a reliable water supply. Simply, the temperature effect is going to put a much greater strain on water availability (Associated Press, May 5, 2004)."

As the western U.S. drought continues, greater stress will be placed on the hydrologic system. It is projected that Colorado River waters may reach some stage of shortage levels that could promote new efforts at conservation and different allocation plans. For example, Las Vegas area golf courses are now limited to 6.5 acre-feet of water annually by the Southern Nevada Water Authority (*Las Vegas Business Press,* May 11, 2004). In addition, Clarke County, Nevada is limiting new golf course construction to only 45 acres of turf—the rest cannot be watered. Efforts such as these help conserve our precious water resources.

This will be the last month in 2004 that we provide the streamflow forecast in this packet. NRCS resumes streamflow forecasts in January 2005.

Figure 11. Spring and summer streamflow forecast as of May 1, 2004 (percent of average).



Notes:
The forecast information provided in Figure 11 is updated monthly by the National Water and Climate Center, part of the U.S. Department of Agriculture's National Resources Conservation Center. Unless otherwise specified, all streamflow forecasts are for streamflow volumes that would occur naturally without any upstream influences, such as reservoirs and diversions. The USDA-NRCS only produces streamflow forecasts for Arizona between January and April, and for New Mexico between January and May.

The NWCC provides a range of forecasts expressed in terms of percent of average streamflow for various statistical exceedance levels. The streamflow forecast presented here is for the 50 percent exceedance level, and is referred to as the most probable streamflow.

There is at least a 50 percent chance that streamflow will occur at the percent of average shown in Figure 11 or lower.

On the Web:
For state river basin streamflow probability charts, visit:
http://www.wcc.nrcs.usda.gov/cgibin/strm_cht.pl

For information on interpreting streamflow forecasts, visit:
http://www.wcc.nrcs.usda.gov/factpub/intrpret.html

For western U.S. water supply outlooks, visit:
http://www.wcc.nrcs.usda.gov/water/quantity/westwide.html

Wildland Fire Outlook

Sources: National Interagency Coordination Center, Southwestern Coordination Center

While fire risk in New Mexico has been reduced because of good precipitation in the past month, portions of Arizona have remained dry and are now in the above-normal risk category (Figure 12b). Early drying of forest fuels and grasses is expected in the area north of the Grand Canyon into southern Utah. Conditions are expected to become critical in the northern part of our region with an increased risk for large fires. Fortunately, the forecast is for an approximately normal numbers of fires. These conditions result from the ongoing drought, lower than average annual snowfall, and early snowmelt in higher elevations. Fire danger is expected to rise during the latter half of May as grassy fuels cure and dead fuels continue to dry. According to the Southwest Coordination Center, the potential for large fires (greater than 100 acres) is above normal for all of Arizona and parts of northwestern New Mexico (not pictured). This month, we have seen two large fires in Arizona—the Diamond fire near Phoenix (Tonto National Forest) and the KP fire (Apache-Sitgreaves National Forest) on the Arizona-New Mexico border. As a result of severe conditions, the Tonto National Forest implemented fire restrictions on May 13.

Notes:

The National Interagency Coordination Center at the National Interagency Fire Center produces monthly (Figure 12a) wildland fire outlooks. These forecasts 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 Coordination Center produces more detailed monthly subjective assessments of fire danger for Arizona, New Mexico, and west Texas (Figure 12b).

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/

For an array of climate and fire assessment tools, visit the Desert Research Institute program for Climate, Ecosystem, and Fire Applications (CEFA) web page:
http://cefa.dri.edu/Assessment_Products/assess_index.htm

Figure12a. National wildland fire potential for fires greater than 100 acres (valid May 1–31, 2004).

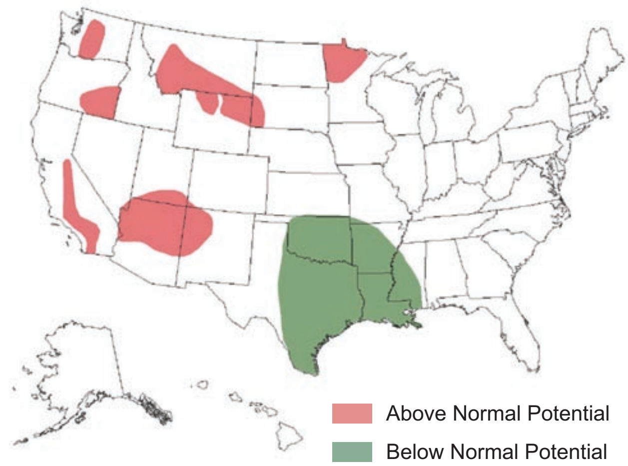
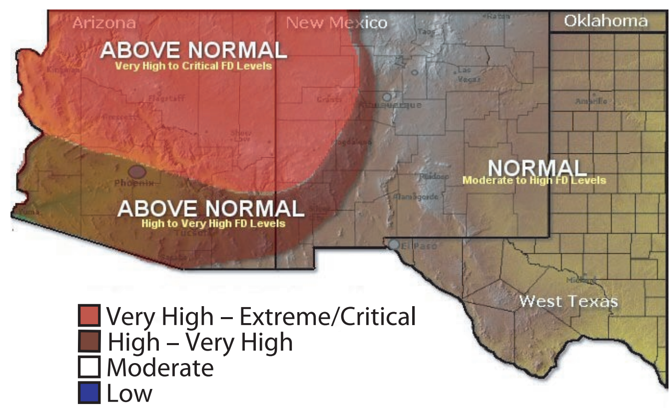


Figure 12b. Southwest monthly fire danger outlook (valid May 1–31, 2004).

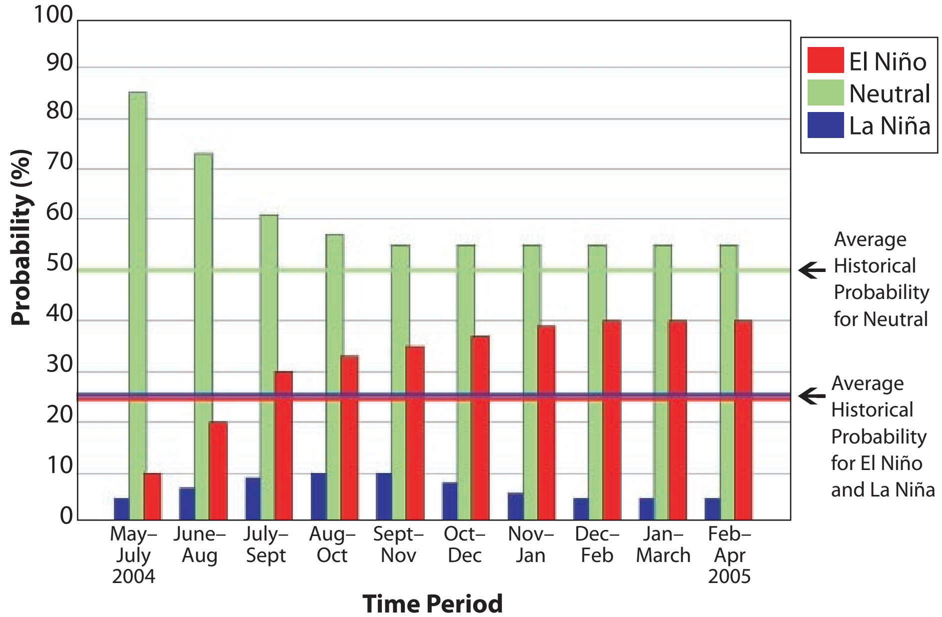


El Niño Status and Forecast

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

The El Niño-sensitive regions of the equatorial and tropical Pacific Ocean are currently exhibiting so-called neutral conditions. Over the past several weeks, conditions have given no indication of a tendency for either El Niño (usually wet Southwest winter) or La Niña (reliably dry Southwest winter) to develop. The potential for El Niño to develop during the summer is lower than its historical probability of about 25 percent. The IRI predicts a slightly higher than average chance of El Niño to develop by the end of the year, and a very low chance of La Niña developing. The NOAA-CPC suggests that there is an even lower potential for El Niño to develop by the end of the year.

Figure 13. IRI probalistic ENSO forecast for El Niño 3.4 monitoring region (released May 20, 2004).



Notes:

Figure 13 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, neutral, La Niña. El Niño conditions are defined as the warmest 25 percent of Niño 3.4 sea-surface temperatures (SSTs) during the three month period in question; La Niña conditions are the coolest 25 percent of Niño 3.4 SSTs, and neutral conditions are SSTs that 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. Only models that produce a new ENSO forecast every month are included in the assessment. The forecast takes into account the indications of the individual forecast models (including expert knowledge of model skill and how that skill varies seasonally), an average of the models, and additional factors such as the very latest observations.

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 figure above, visit:
http://iri.columbia.edu/climate/ENSO/

Temperature Verification
(February–April 2004)
Source: NOAA Climate Prediction Center

The NOAA-CPC forecast for the period February through April missed the extensive region of warmer than average temperatures (1 to 4 degrees Fahrenheit) found over much of the northern half of the United States (Figure 14b). A prediction of higher chances of cooler than average temperatures in the southeast was well captured (Figure 14a); however, the eastern New Mexico-western Texas region exhibited cooler than average temperatures as opposed to a prediction of increased chances of warmer conditions. This was likely due to the enhanced precipitation in April that brought extensive cloud cover to the area. The CPC made no February–April forecast for a region with significantly warmer than average temperatures in Montana and Wyoming.

Figure 14a. Long-lead U.S. temperature forecast for February–April 2004 (issued January 2004).

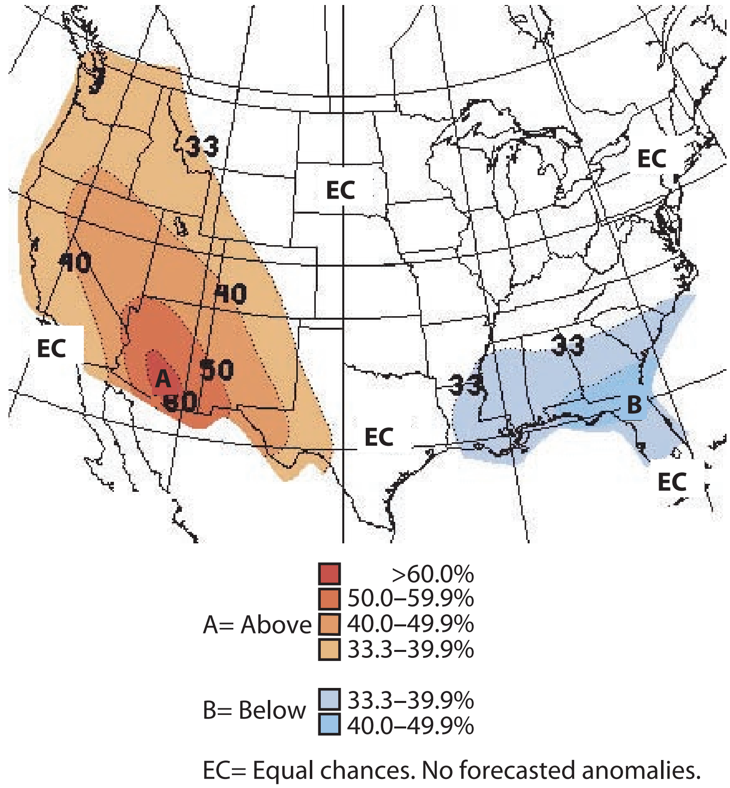
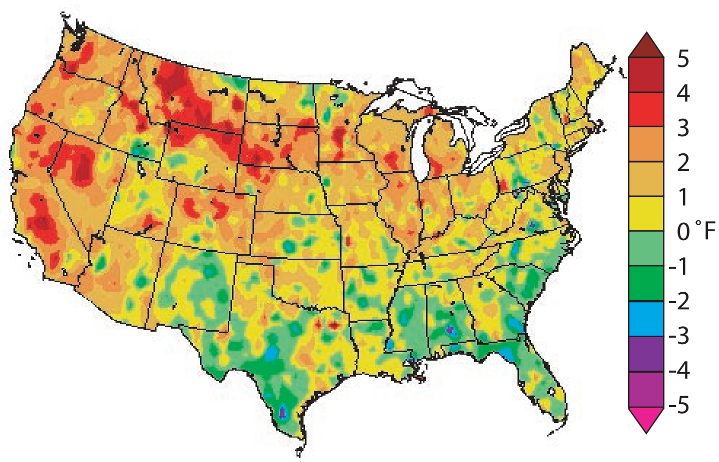


Figure 14b. Average temperature departure (in degrees F) for February through April 2004.



Notes:

Figure 14a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months February–April 2004. This forecast was made in January 2003.

The February–April 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 14b shows the observed departure of temperature (°F) from the average for February–April 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
(February–April 2004)
Source: NOAA Climate Prediction Center

When there is not a strong El Niño or La Niña event driving precipitation patterns, it is often difficult to predict wet and dry patterns well. Such was the case with the CPC precipitation predictions for February through April (Figure 15a). While the prediction of increased chances of below-average precipitation over the Arizona-New Mexico border was generally well placed, the much higher than average precipitation that fell over New Mexico and western Texas was not predicted. The forecast for higher chances of above-average precipitation for the Pacific Northwest was slightly off, with a swath of slightly above-average precipitation occurring more inland. The forecast of higher chances of below-average precipitation for the Southeast was not extensive enough to cover the entire region that fell below average. The patterns of above-average precipitation in the upper Midwest and along the Appalachian mountains were also not forecasted.

Figure 15a. Long-lead U.S. precipitation forecast for February–April 2004 (issued January 2004).

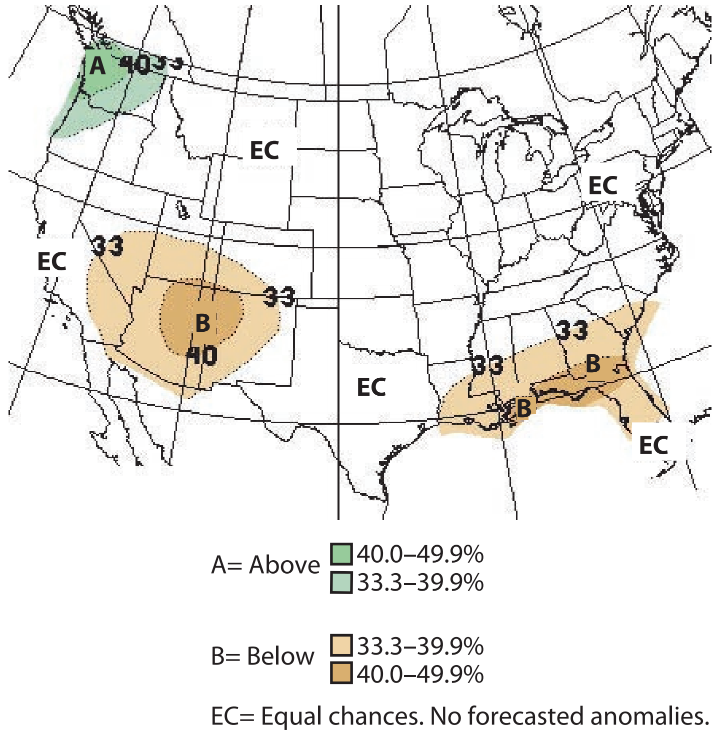
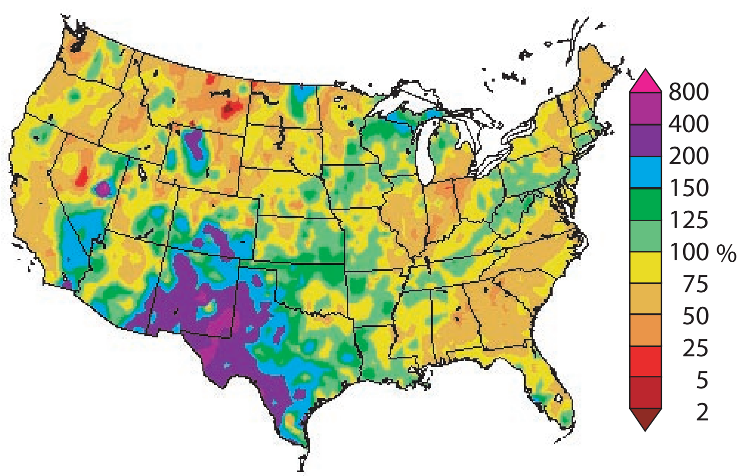


Figure 15b. Percent of average precipitation observed from February to April 2004.



Notes:
Figure 15a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months February–April 2004. This forecast was made in January 2003.

The February–April 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 15b shows the observed percent of average precipitation observed February–April 2004.

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