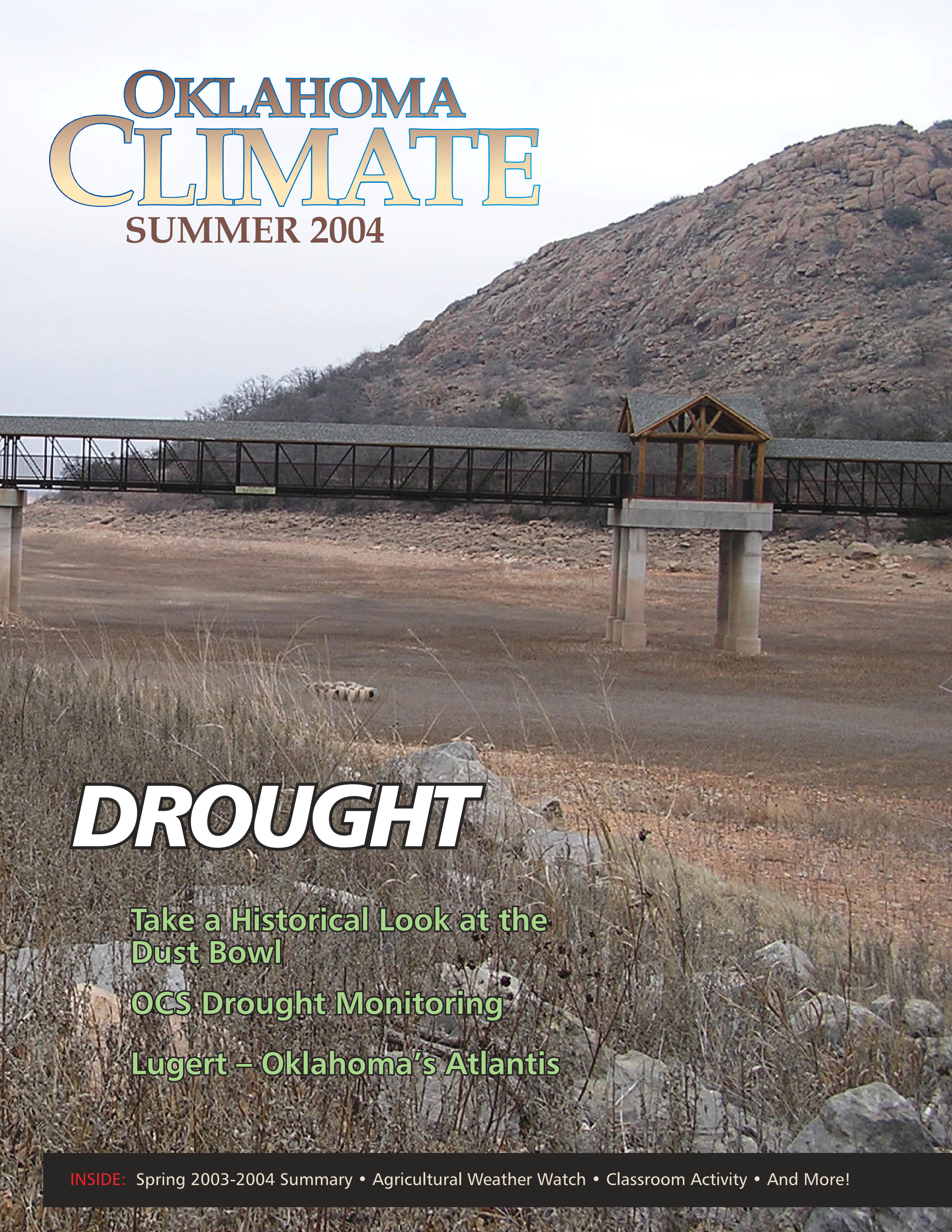

OKLAHOMA CLIMATE

SUMMER 2004

DROUGHT

Take a Historical Look at the Dust Bowl

OCS Drought Monitoring

Lugert – Oklahoma's Atlantis

INSIDE: Spring 2003-2004 Summary • Agricultural Weather Watch • Classroom Activity • And More!

MESSAGE FROM THE EDITOR

Oklahoma is a tornado-obsessed state. Being in the center of Tornado Alley, where the wind can come sweeping down the plain at 300 mph, it's somewhat understandable. That doesn't change drought's standing as Oklahoma's most important weather event, however. That statement might shock some, considering the emphasis placed by our society upon severe weather, such as tornadoes and thunderstorms. Admittedly, those dangers pose greater risks to human life than drought. Nonetheless, for our agricultural-based economy, drought is the clear winner.

In this issue of "Oklahoma Climate," we cover the gamut of drought's impacts on Oklahoma. History buffs will be delighted by our historical perspective on the Dust Bowl, one of the worst ecological disasters in the history of the world. The misconceptions about this cataclysmic event are numerous, but we try to separate fact from fiction. "What is drought?" Sometimes even the climatological community has a tough time with that one. Our drought experts will try and paint a clearer picture. We also cover the use of the Oklahoma Mesonet to quantify drought conditions in Oklahoma, and how OCS leads the nation in real-time drought monitoring. "Oklahoma's Atlantis" is a fascinating photo essay of the lost town of Lugert, which was buried under Lake Altus until drought uncovered its concrete remains. Want to keep your plants and lawns alive over the summer, even if drought occurs? Read the expert's advice in our urban farmer article. Summer means heat, so we provide you with a list of hot weather health tips. Oklahoma educators will appreciate the classroom exercise provided by our education outreach group, so students can better understand how heat affects the body. And, last but not least, a recap of Oklahoma's spring weather.

We certainly hope you enjoy this issue, and remember, please feel free to contact us with any questions or comments you might have. Just drop me a line at gmcmanus@mesonet.org.

Gary McManus - Editor

Oklahoma Climate Summer 2004

Cover Photo: The walkway to the Quartz Mountain Lodge on Lake Altus-Lugert is designed to carry pedestrians over the lake's waters. It has been quite some time since the lake lapped at the pillars of the walkway. Photo by Derek Arndt. If you have a photo that you would like to be considered for the cover of Oklahoma Climate, please contact Gary McManus at gmcmanus@ou.edu.

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DUST BOWL

By Gary McManus
Climatologist
Oklahoma Climatological Survey

A boiling cloud of dust approaches Stratford, Texas. Photo courtesy of NOAA Photo Library, George E. Marsh album.

"I saw when he opened the sixth seal…and the sun became black as sackcloth." – Revelations 6:12.

Deep in the throes of The Great Depression, the nation paid little attention to reports of massive clouds of dust enveloping the High Plains. Ironically, the Dust Bowl farmers had not been greatly affected by the early days of the depression. The Oklahoma Panhandle was a place of economic boom in the beginning of the 1930s, and had been named the country's most prosperous region. Already tempered to a tough mettle by life on the great American prairie, the farmers of the High Plains learned how to survive bouts of drought and economic hardship by living off the land. The Dust Bowl would soon take that away, however, bringing the harsh realities of the depression to those that thought themselves immune. In time, the country would come to realize that the two events were connected at their very core, each adding strength to the severity of the other. By the time the rains returned in 1940, along with the economic recovery associated with WW II, the High Plains had lost one-quarter of its farmers, and America had experienced the greatest mass-migration of people in its history. Much of the credit for that great exodus to the west would be given to the Dust Bowl. History would prove, however, that the depression was the primary culprit.

Times of Plenty

Although the Dust Bowl occurred during the 1930s, its underlying causes actually date back to the turn of the century. It was then that farmers first flocked in great numbers to the High Plains, an area labeled by early European explorers as the "Great Desert." At that time, the region's climate was uncharacteristically wet, which allowed crops to flourish in the rich soil. Railroads exploited this good fortune to entice even more settlers to the area with promises of lush green fields stretching from horizon to horizon. As the nation grew, the food demands of the burgeoning population followed suit. This need drove the price of wheat even higher, which the farmers took advantage of by planting more acres of wheat. The start of World War I in Europe brought further demands on the farmers, as the federal government became desperate in their need of food for troops and refugees. As wheat prices skyrocketed, the farmers on the High Plains realized their dreams of feeding the world. Droughts still occurred from time to time, but the rains always returned. With the end of WWI, however, the bountiful harvests soon turned to surpluses, and the wheat prices crashed.

When the prices fell, the farmers reacted by planting more wheat to compensate. This became easier with the advances in agricultural technology, such as tractors and disc plows. Vast areas of grasslands, some of which could barely even support wheat during moist periods, were plowed and sown. The new plows cut the sod shallowly, breaking up the hard dirt into fine powder and smaller clods. Tales of the region's natural history of severe decade-long droughts and extreme temperatures went unheeded in a frenzy of greed and false security. In less than two decades, millions of acres of native grasslands were plowed under and laid open to the fury of the wind.

Winds of Change

Contrary to popular belief, the Dust Bowl was not a singular, long-term drought, but a series of shorter droughts. When the rains did arrive, the baked earth was often so impenetrable that the moisture would almost totally be lost to runoff. Even during the driest periods of the Dust Bowl, terrible floods still occurred. On April 3-4, 1934, 14 inches of rain fell in just six hours near Cheyenne, Oklahoma. The resulting runoff flooded the nearby community of Hammon, killing 17.

The first of the series of droughts struck the region in 1931, after a bumper wheat crop that spring. The harvest was bountiful, but prices were not. Farmers poured their wheat upon the ground to await better prices, but to no avail. The wheat deteriorated, and farmers were paid even less due to its substandard quality. Hopes then rested on the following year's harvest, and that prices would rebound. Unfortunately, the prices would be irrelevant, as hope became as scarce as the rains.

The dust started in earnest in 1932 with 14 massive storms. That total would soon be looked upon with envy, as the dust storms multiplied with each successive year. The storms struck 38 times in 1933; in 1934, when there was wind, there was dust. Cimarron County in Oklahoma saw its wheat production diminish from nearly 6 million bushels in 1931 to 11,100 in 1933. The crop failed outright during 1935, 1937, and 1938.

Living With Dust

Life in the High Plains was difficult even in prosperous times. Extreme temperatures, violent weather, and periodic droughts were well known to the region before the Dust Bowl, and dust storms were a known hazard. But nothing could prepare the area for the horror of the wind-borne dust of the 1930s. The fine, powdery dust would permeate any crack, making it virtually impossible to keep houses protected. Residents were forced to wear dust masks during storms. Despite that meager protection, dust pneumonia resulted in many deaths. During the 1935 storms, one-third of the deaths in Ford County, Kansas, were from dust pneumonia. People were coughing up pencil-shaped dirt clods, and animals were found dead in fields with two inches of dust lining their stomachs. The area residents would try anything to keep the dust from their homes. Hanging wet sheets caught some of the offending particulate, yet it would still reach the beds at night, leaving a head-shaped apparition on pillows as people arose from slumber. Women kneaded bread in drawers to keep out unwanted grit, and children were sent to school in dust masks to protect their developing lungs. And leaving the house after each storm usually meant shoveling the newly drifted sand dune blocking the front door.

(below) A modern-day dust storm strikes near Colby, Kansas. Photo courtesy of Loucinda Smith.

A Civilian Conservation Corps enrollee planting trees for a windbreak to stop erosion. Photo courtesy of the NOAA Photo Library, Historic NWS Collection.

A dust storm turns day into night, as the street lights of Garden City try and penetrate the darkness. Photo courtesy of the NOAA Photo Library, Historic NWS Collection.

This farmstead lost the battle versus the encroaching dust. Photo courtesy of the NOAA Photo Library, Historic NWS Collection.

The disaster led to the bizarre as well. Jack rabbits, driven mad with hunger, came down out of the hills in droves to eat everything in sight. In an attempt to save what they could, great roundups of the rabbits would occur, and the day would ring out with their cries as they were slaughtered. Drastic measures were used to get cattle to eat what they would normally find unpalatable. Farmers would pour sorghum molasses on tumbleweeds to entice their livestock to consume the prickly bushes. As legend would have it, birds began making nests of barbed wire due to the lack of vegetation. While more fiction than fact, it is no less believable than determining where the dust was coming from by its color: Oklahoma and Texas – red, Kansas – black, and Colorado and New Mexico – gray.

Black Sunday: A Turning Point

The dust storm that hit far northwestern Oklahoma on April 14, 1935, came to epitomize the Dust Bowl's black blizzards, and helped change the face of the nation's soil conservation effort. Unlike the sand blows that occurred with the sirocco-like winds from the southwest, Black Sunday was one of the less frequent but more dramatic storms borne south on polar air originating in Canada. Rising some 8000 feet into the air, these churning walls of dirt generated massive amounts of static electricity, complete with their own thunder and lightning. Reports of the storm indicate that the cold air from the "Norther" struck first, with the wall of dust following soon thereafter. Temperatures plunged 40 degrees along the storm front before the dust hit. Mr. Ralph H. Guy, National Weather Service cooperative observer in Kenton, Oklahoma, noted about the storm: "Severe dust storm hit at 4:20 p.m., turning afternoon brightness immediately into midnight darkness, and absolutely zero visibility. It was totally dark and impossible to see without searchlight, for at least 15 minutes…the storm came from the north and northeast and traveled at a very great speed." The Black Sunday storm seemed to mark the peak of the dust storms across the region, although the dust would not stop with that most violent of storms. Several stations in the Oklahoma panhandle reported moderate to heavy dust on 20 days during the month, and light dust on other days. Other areas of Oklahoma were not immune to the dust. The Oklahoma City Airport station noted dust on 18 days during the month.

Black Sunday marked the turning point in the Federal Government's recognition of the soil erosion occurring in the Dust Bowl region, labeling it a "national menace." Hugh Bennett, considered the father of the soil conservation movement, had long tried to draw attention to the farmer's plight. Up to that point, he had been largely ignored, and the Dust Bowl was seen in the nation's capitol as just another facet of the depression. Already scheduled to deliver an address to Congress concerning the matter, he heard tales of the massive Black Sunday storm, spreading its dust towards the east. He stalled his report until the dust settled over Washington D.C. Upon its arrival, many of the Congressmen were horrified at the fine, powdery sand choking their throats and scratching their eyes. On April 27th, 1935, the Soil Conservation Service (SCS) was created, and placed under the control of Bennett.

Seeds of Hope

With the SCS came action, although most farmers were resistant to federal intervention. It took cash payments to entice many rural residents to try and reclaim the land. By 1937, soil conservation plans were in full swing. By the end of 1938, topsoil losses were reduced by 65 percent, despite the continuing drought. The Dust Bowl consumed an estimated 50 million acres of land from 1932-38, with Oklahoma farmers losing 30-50 tons of soil per acre each year (approximately 3-5 inches of topsoil). The first shelter belt, a row of trees designed to slow the wind's effects outward up to 20 times the height of the trees, was planted near Granite in Greer County, Oklahoma, on March 18, 1935. When its success was determined, shelter belts soon dotted the countryside. When the farmers witnessed the effectiveness of the shelter belts, they soon adopted the other conservation practices being taught by the SCS. Terraces were built on wind-blown fields to help collect what rain did fall, and crops were rotated to reduce the stress on the soil. Acre upon acre was allowed to return to its natural state, and the native vegetation soon anchored the soil once again.

Okies

John Steinbeck's seminal Depression-era work "The Grapes of Wrath" was intended to dramatize the plight of Oklahoma farmers displaced by greed due to the increasing use of farm machinery. Unfortunately, his book did more to perpetuate the myth that the Dust Bowl area farmers made up the bulk of the great "Okie" migration westward. He placed his protagonists, the Joad family, in Salisaw, Oklahoma. Situated in far eastern Oklahoma, Salisaw rests far from the center of the Dust Bowl in the Oklahoma Panhandle. Yet he opens his book with the description of a classic Dust Bowl storm, scouring the land and destroying crops. In truth, the bulk of the mass migration of refugees to California came not from the Dust Bowl region, but from points east of there. Three out of four Dust Bowl farmers stayed on their land, displaying the indomitable spirit required to live in the region's harsh climate. The term "Okie," first thought of as an epithet, has since become a source of pride for Oklahomans.

Lessons Learned

Drought, extreme temperatures, and dust storms are as much a part of life on the High Plains as the unpredictable weather that produce them. Long had the region survived the periods of drought, and the occasional black blizzard. Not until man and his machinery found their way to the prairie did the widespread devastation occur. The greed and lack of foresight that drove this calamity forestalled the common sense normally found in the hardy souls of the region. Money guided their actions, instead of their connection with the land. This truth was borne out during the next great drought of the 1950s, which in many ways was more severe than the Dust Bowl droughts. Indeed, during that catastrophic drought, crops withered, animals died, but the earth did not blow upon the wind. The conservation practices had saved the soil from the same fate it had suffered during the "Dirty Thirties." It was a harsh lesson to have thrust into not only this country's consciousness, but that of the world's as well.

What is DROUGHT?

By Brad Illston
Research Associate
Oklahoma Climatological Survey

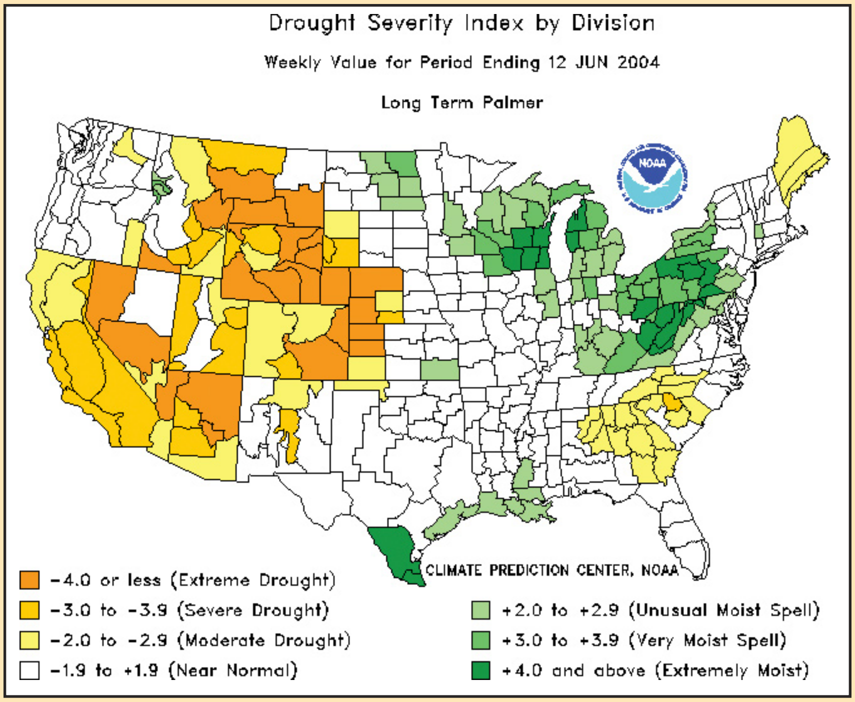
The impacts of drought are an unavoidable worldwide threat and are felt in many ways, but mainly in the form of depleted water resources, reduced agricultural yields, and increased livestock fatality rates. Agricultural communities such as Oklahoma, for which agriculture is a $2-billion component of the state economy, are especially susceptible to short-term drought (less than 6 months) impacts due to their reliance on rainfall and soil moisture reserves in the production of non-irrigated crops. As a result, short-term droughts can be responsible for financial disasters to agricultural-based economies. Long-term droughts (lasting 6 months or longer) impact regions by further depleting surface and ground water levels. These droughts can take longer from which to recover than it takes to deplete water levels.

The term “drought” is frequently used without adequate clarification. There are many types of droughts and they impact various aspects of our climate and hydrology. These different droughts are usually interrelated, but still have their distinct qualities. The primary classifications of drought are:

Meteorological – an extended period of time with no or very little precipitation. These droughts are the easiest for people to understand. Precipitation is the driving force to add and maintain levels of water in the ground and thus its absence is perceived physically.

Hydrological – an extended period of time in which the river stream flow, reservoir, or ground-water levels are below normal. This type of a drought may take longer to develop in some areas that water demands less than that of others. These droughts can bee seen around lakes when the shoreline drops gradually over time.

Agricultural – an extended period of time where the levels of moisture in the soils are below normal. These droughts can be the most difficult to observe but are also the costliest. When soil moisture levels drop below dangerous levels for a long period of time, plants and crops begin to perish without external support (i.e. irrigation). In agricultural and ranching communities, these types of droughts have severe consequences.



The Palmer Drought Severity Index for the week ending June 12th. Map courtesy of the Climate Prediction Center.

Many of the drought classifications can either start or enhance another type of drought. For example, a meteorological drought can enhance an agricultural drought by not adding moisture back to the soil. In turn, an agricultural drought could cause farmers to irrigate their crops by using water from a reservoir thus causing a hydrological drought. To help aid in not making matters worse, drought plans and policies have been created in most states to deal with such issues.

It is possible to be impacted by one type of drought and not be impacted by another type of drought. For example, you may live on a lake that is fed into by a river. At your house you may not have had rain for a long period of time, but upstream there has been plenty of rain which is flowing down to keep the lake level from dropping. So, while you are in the midst of a meteorological drought, you feel no impacts of the existing hydrological drought. However, it is typical during droughts to be impacted by all three of these types of droughts at the same time.

Measuring a drought is a difficult task to undertake. A drought in one area of the country may not be a drought in another. Additionally, many physical factors must be taken into consideration when determining drought severity. Typically, indexes are used in an attempt to assign a number designation to regions to demonstrate their drought conditions. These indexes can then be compared in different areas to determine which areas are experiencing or have experienced the worst drought conditions.

Some of the most commonly used drought indices are the Palmer Drought Severity Index (PDSI), the Standard Precipitation Index (SPI), and the Keetch-Byram Drought Index (KBDI). Each index has its own method of determining drought severity.

The PDSI is a meteorological drought index, and it responds to weather conditions that have been abnormally dry or abnormally wet. The PDSI is calculated based on precipitation and temperature data, as well as the available water from the soil. This index was originally developed in 1965 to provide measurements of moisture conditions that were standardized so that comparisons using the index could be made between locations and between months. The PDSI is the main drought index used by the U.S. government; however, it is slow to detect fast-emerging droughts.

The SPI was designed in 1993 to determine the precipitation deficit over many different time periods. These different time periods reflect the impact of drought on the water that is available to be utilized. The SPI can provide early warning of drought and help assess drought severity, and is less complex to calculate than the PDSI.

The KBDI was designed in 1968 to determine fire potential in various regions over a very short time period. It uses temperature, evapotranspiration, and rainfall data to estimate the flammability of organic material in the region. The KBDI is based on a scale of 0 to 800, which corresponds to the amount of rainfall (0 to 8 inches) needed to return the soil moisture back to full capacity and remove a fire threat.

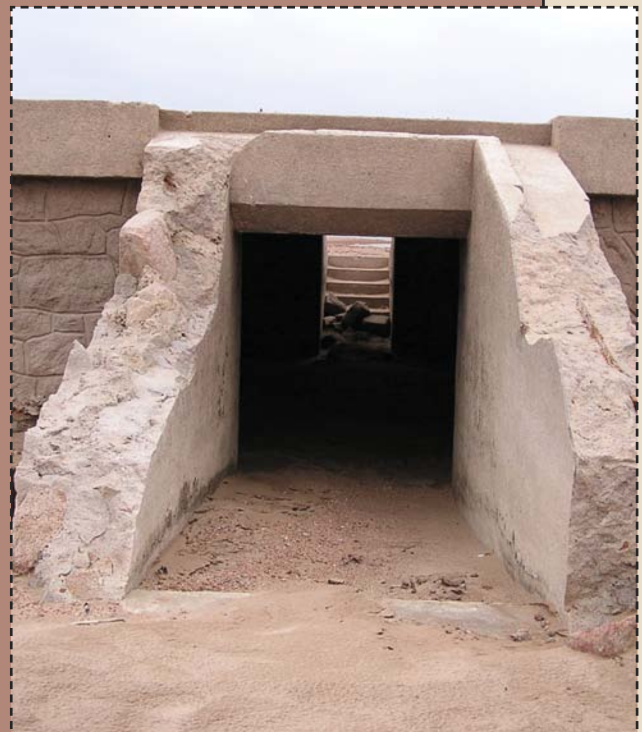
Each drought index has both benefits and drawbacks. Some indices have a short term focus, while others focus more on the long term trend. Some indices use types of data that others do not take into consideration. Thus, a comprehensive analysis of each index is performed when determining drought impacts in various regions and situations.

Droughts are climatic events which impact almost every part of the globe. While droughts are unavoidable, their impact can be minimized with better understanding and proper preparation and planning. For information on how Oklahoma monitors drought conditions, visit the Oklahoma Climate Survey's Climate website at http://climate.ocs.ou.edu/.

PHOTOS FROM THE FIELD

Panning back, the magnitude of the lake's decline is evident as its dike dwarfs the school's foundation.

The cellar of the school building is cluttered with sixty years of sand and debris.



The remains of Lugert's one-story schoolhouse on the northwest end of the former townsite. Built in 1939, this structure held Lugert's future on its shoulders for just a few years before slipping under the waters.

The lake's retreat has exposed a number of wells in the townsite and what used to be the surrounding countryside. These wells are very hazardous, and walking in the lake bed is discouraged.

Lugert
Oklahoma's Atlantis

One of several large walkways and foundations that belie the ruins of a once-prosperous town. Lugert was born in 1901 upon the opening of the Kiowa-Comanche-Apache reservation. Like many early-century Oklahoma towns, its promise was fleeting and the hard realities of life on the plains subdued its founders' ambitions. A tornado, several droughts, changing economic conditions, improved transportation and consolidation of farms dealt severe blows to its future. The final blow came with the construction of the Altus-Lugert Dam, which is visible beyond the school cellar. The present-day dock (featured elsewhere on this page) can be seen across the lake on the right edge of the photo.

Seasonal drawdown is a normal cycle in Lake Altus-Lugert. Nevertheless, this year's lows were highly unusual, as witnessed by this dock, long since abandoned by the shoreline. The conservation capacity can be seen against the hill in the background.

All photos courtesy of Derek Arndt

DROUGHT MONITORING
AT THE OKLAHOMA CLIMATOLOGICAL SURVEY

Oklahoma is known for its spectacular and sometimes violent weather, but its history is sewn with the hardships, lessons, defeats and victories associated with drought. Drought is a recurring and natural part of Oklahoma's climate cycle, just like severe weather. It may ebb and flow with the seasons and years, but – also like severe weather – drought won't go away for good any time soon.

As a creeping hazard, drought doesn't produce compelling images and dramatic descriptions like those of violent weather. Much to the contrary, drought goes about its destructive business hour by hour, day by day, until the gradual accumulation of its consequences becomes severe. For this reason, drought often receives little attention until it is too late for decisive mitigating action. Despite the relative inattention paid to developing drought episodes (versus more immediate severe weather threats), drought's larger coverage and longer timescales make it Oklahoma's costliest natural hazard, capable of hundreds of millions of dollars in damages across several economic sectors.

The numbers associated with drought damage are staggering. On a national scale, drought and associated heat waves represent ten of the 58 natural disasters that caused billion-dollar-plus damages since 1980. However, those ten disasters account for almost half of the group's total economic damage.

In recent years, OCS has aggressively pursued the task of improving drought monitoring in Oklahoma. OCS's drought-monitoring philosophy recognizes that careful monitoring is one of the most effective and realizable mitigation strategies. The Oklahoma Mesonet's real-time, high-quality, and highly-reliable data makes possible a comprehensive web-based product to decision-makers and the public. Today, OCS's product is used as a prototype for a national drought-monitoring infrastructure.

Before sunrise each day, real-time precipitation and soil moisture data from the Mesonet are assimilated into summary information, modeled fire danger conditions, smoke dispersion indices and other drought-related products. For products and indices that require a long-term perspective, Mesonet data are compared to records from the NWS Cooperative Observer (COOP) network.

The OCS drought report is automatically updated and immediately available via the world-wide-web. This allows drought decision-makers instant access to the latest information when they arrive at their desk, 24 hours per day, seven days per week. The information is available on the web at: http://climate.ocs.ou.edu/rainfall_update.html

By Derek Arndt
Assistant State Climatologist
Oklahoma Climatological Survey

Features of the OCS Drought-Monitoring Package:

Ten "Seasons" to Study: Which period is most relevant to me?

Drought affects different people and economic interests on different timescales. A wheat farmer may be very concerned with short-term (very recent) conditions in autumn, while a reservoir operator will be more concerned with fluctuations over many months. To meet the widely-varying needs of the public, OCS prepares summary information over ten "seasons" for each of Oklahoma's nine climate divisions.

Basic Statistics: How do we stand versus normal?

Rainfall statistics are the beginning of the report for each climate division and drought "season". Simple statistics such as total rainfall, departure from normal, and percentage of normal help provide a first-glance assessment of precipitation versus historical normals.

Season	Dates
Current Season to Date	Since Mar. 1, Jun. 1, Sep. 1 or Dec 1.
Current Growing Season	Cool: since Mar.1; warm: since Sep. 1
Year to Date	Since Jan. 1
Water Year to Date	Since Oct. 1
Last 30 Days	Moving window
Last 60 Days	Moving window
Last 90 Days	Moving window
Last 120 Days	Moving window
Last 180 Days	Moving window
Last 365 Days	Moving window

The ten "seasons" over which OCS monitors drought.

Last 90 Days: Feb 9, 2003 through May 9, 2003

Climate Division	Total Rainfall	Departure from Normal	Pct of Normal	Driest since	Wettest since	Rank since 1921 (83 periods)
Panhandle	2.73"	-2.19"	55%	2002 (1.11")	2001 (5.87")	28th driest
N. Central	5.98"	-1.91"	76%	2002 (4.13")	2001 (6.73")	38th driest
Northeast	8.00"	-2.68"	75%	2001 (6.88")	2002 (8.59")	28th driest
W. Central	3.87"	-3.36"	54%	2002 (3.80")	2001 (8.27")	16th driest
Central	5.55"	-4.19"	57%	1996 (3.91")	2002 (6.99")	11th driest
E. Central	7.62"	-4.24"	64%	1982 (5.33")	2002 (11.78")	9th driest
Southwest	3.65"	-3.67"	50%	1996 (2.25")	2002 (6.77")	8th driest
S. Central	4.37"	-6.15"	42%	1980 (3.88")	2002 (11.89")	2nd driest
Southeast	7.47"	-5.59"	57%	1980 (6.80")	2002 (17.93")	4th driest
Statewide	5.49"	-3.75"	59%	1996 (4.15")	2002 (7.97")	6th driest

Rainfall statistics for the 90-day period ending May 9, 2003. The percentage of normal precipitation for the period was nearly identical for three climate divisions. However, their historical significance was strikingly different because the climate history of each division is unique.

Statistical Maps: Where are the largest deficits?

Sometimes, numbers aren't enough to tell a complete story. Statewide maps of rainfall and basic statistical information allow a quick assessment of which regions of the state are suffering the most, and where conditions are nearer to normal.

Historical Context: Where does this fit in history? When was the last time it was this dry? How bad can it get?

Basic statistics mean little unless put into historical context. When considering the societal impact of a drought event, "two inches below normal" doesn't mean nearly as much as "fourth driest of the century" or "driest since 1992". For example, last May, three of Oklahoma's climate divisions stood at about 55% of normal precipitation. To be sure, each division was dry, but the severity of the drought was vastly different when viewed through the lens of history.

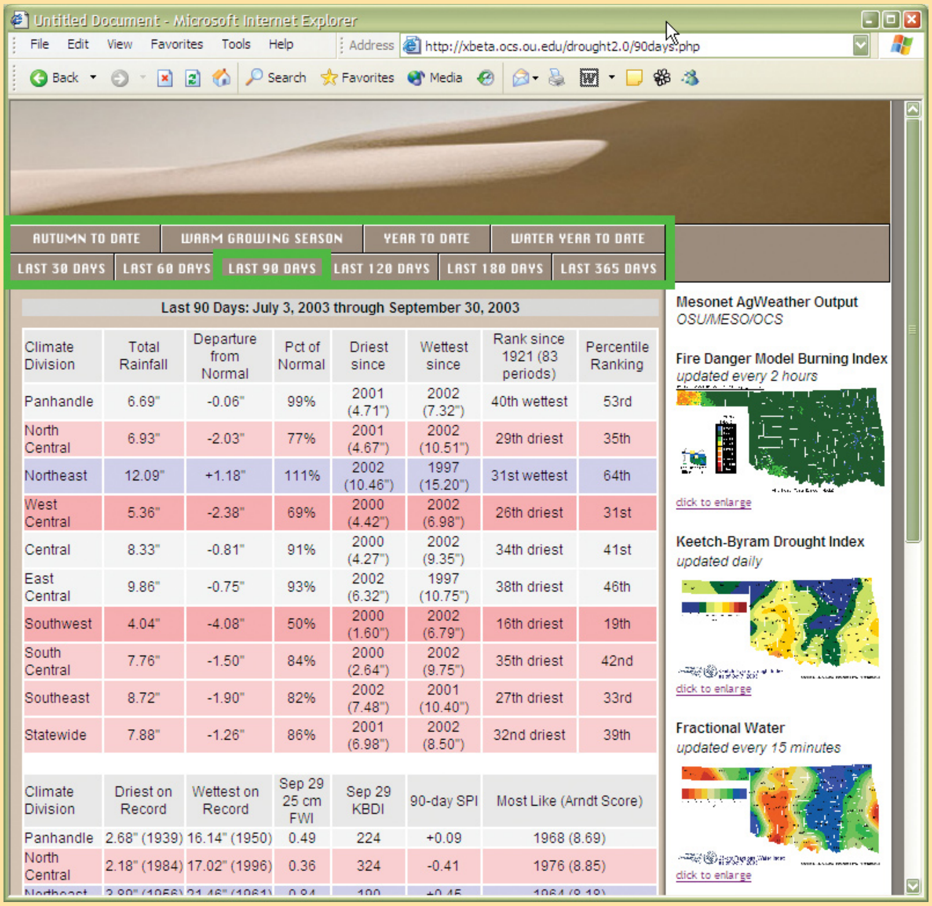
Likewise, the period's historical extremes are provided to provide a "bracket" on how wet or dry it can be over the period. While this doesn't exactly answer the question of how extreme can get, it does address how extreme the period has been.

Drought Indices: What does it mean to specific interests?

Because drought affects different communities differently, a multitude of drought indices have evolved to meet the specific needs of each group. For example, the fire protection community is very sensitive to changes in the Keetch-Byram drought index, and climatologists rely heavily on the information contained in the Standardized Precipitation Index. The Fractional Water Index, based on Mesonet soil moisture observations, shows promise in several sectors.

Analog Years: What year was most like this one?

Analog years are those periods in history that most resemble the current period. OCS uses a handful of statistical techniques to score historical periods versus today. The strongest match is listed, along with a score indicating the strength of the match. This may help recall the decisions that were made during the analog year, and these can be referenced or adjusted based on their effectiveness.



Last 90 Days: July 3, 2003 through September 30, 2003

Climate Division	Total Rainfall	Departure from Normal	Pct of Normal	Driest since	Wettest since	Rank since 1921 (83 periods)	Percentile Ranking
Panhandle	6.69"	-0.06"	99%	2001 (4.71")	2002 (7.32")	40th wettest	53rd
North Central	6.93"	-2.03"	77%	2001 (4.67")	2002 (10.51")	29th driest	35th
Northeast	12.09"	+1.18"	111%	2002 (10.46")	1997 (15.20")	31st wettest	64th
West Central	5.36"	-2.38"	69%	2000 (4.42")	2002 (6.98")	26th driest	31st
Central	8.33"	-0.81"	91%	2000 (4.27")	2002 (9.35")	34th driest	41st
East Central	9.86"	-0.75"	93%	2002 (6.32")	1997 (10.75")	38th driest	46th
Southwest	4.04"	-4.08"	50%	2000 (1.60")	2002 (6.79")	16th driest	19th
South Central	7.76"	-1.50"	84%	2000 (2.64")	2002 (9.75")	35th driest	42nd
Southeast	8.72"	-1.90"	82%	2002 (7.48")	2001 (10.40")	27th driest	33rd
Statewide	7.88"	-1.26"	86%	2001 (6.98")	2002 (8.50")	32nd driest	39th

Climate Division	Driest on Record	Wettest on Record	Sep 29 25 cm FWI	Sep 29 KBDI	90-day SPI	Most Like (Arndt Score)
Panhandle	2.68" (1939)	16.14" (1950)	0.49	224	+0.09	1968 (8.69)
North Central	2.18" (1984)	17.02" (1996)	0.36	324	-0.41	1976 (8.85)

The tabular portion of the Oklahoma Drought Update. The statistics for each column are updated daily. Colors indicate relative surplus or deficit versus normal precipitation.

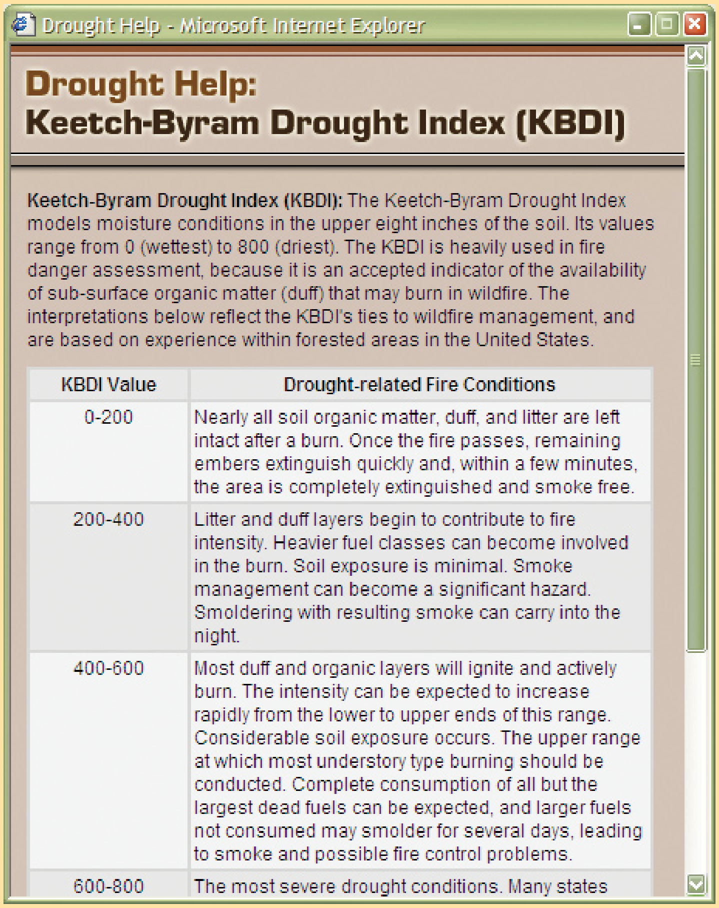
Related Maps: So, what's the impact today?

Four maps display statewide conditions associated with drought. The Oklahoma Fire Danger Model's Burning Index provides information on wildfire danger and potential severity. It is updated every hour during the day. Smoke dispersion conditions modeled from Oklahoma Mesonet data are updated every 15 minutes. Statewide maps of FWI and KBDI values are also updated daily.

Additional Information: What are some other resources?

Many agencies provide additional expertise in monitoring drought conditions in the region, including information beyond the scope of OCS drought monitoring efforts. Forecast information, burn restrictions and economic assessments are all part of the drought management process. Therefore, the OCS drought monitoring presence includes links to a comprehensive set of additional information, and the agencies that supply it.

As always, the Oklahoma Climatological Survey encourages feedback from users of its products. If you know a way to improve the drought product, or if you have needs that aren't being met, please contact OCS!


Drought Help - Microsoft Internet Explorer

Drought Help:
Keetch-Byram Drought Index (KBDI)

Keetch-Byram Drought Index (KBDI): The Keetch-Byram Drought Index models moisture conditions in the upper eight inches of the soil. Its values range from 0 (wettest) to 800 (driest). The KBDI is heavily used in fire danger assessment, because it is an accepted indicator of the availability of sub-surface organic matter (duff) that may burn in wildfire. The interpretations below reflect the KBDI's ties to wildfire management, and are based on experience within forested areas in the United States.

KBDI Value	Drought-related Fire Conditions
0-200	Nearly all soil organic matter, duff, and litter are left intact after a burn. Once the fire passes, remaining embers extinguish quickly and, within a few minutes, the area is completely extinguished and smoke free.
200-400	Litter and duff layers begin to contribute to fire intensity. Heavier fuel classes can become involved in the burn. Soil exposure is minimal. Smoke management can become a significant hazard. Smoldering with resulting smoke can carry into the night.
400-600	Most duff and organic layers will ignite and actively burn. The intensity can be expected to increase rapidly from the lower to upper ends of this range. Considerable soil exposure occurs. The upper range at which most understory type burning should be conducted. Complete consumption of all but the largest dead fuels can be expected, and larger fuels not consumed may smolder for several days, leading to smoke and possible fire control problems.
600-800	The most severe drought conditions. Many states

Online help is available for each element of the OCS drought monitoring package.

SPRING 2004 SUMMARY

Until May, the state looked as if it would finish with a relatively wet spring. Unfortunately, much of that hope fell by the wayside as the season's final stanza finished as the driest on record. That unfortunate occurrence helped the season finish as the 25th driest spring on record for the state of Oklahoma. The temperature took a different tack, warming up early in the season and generally staying that way. Particularly warm during March and May, the statewide-averaged temperature for the season ranked as the 7th warmest on record. Severe weather was not overly abundant throughout the spring, although April did see several major outbreaks of turbulent weather. According to preliminary statistics from the National Weather Service, 34 tornadoes touched down in the state during the spring, which is right in line with the 35 spring tornadoes Oklahoma has averaged since 1950. Only one of those tornadoes was found to be a significant tornado, however, rated at least an F2 on the Fujita Scale. The state's longest period without a tornado ended at 292 days during March, and a streak of 381 days without a significant tornado ended in May. Accurate tornado statistics date back to 1950.

Precipitation

Most of the state suffered significant spring precipitation deficits following the record-setting dry weather of May, which dropped the season's statewide-averaged deficit to over three inches. The only areas not significantly dry during the season were portions of north central and northeastern Oklahoma. The northeast's average precipitation finished less than a tenth of an inch below normal, while north central's total was just over one and one-half inches below normal. The southern half of the state, however, was decidedly dry. An area from Cleveland and McClain counties eastward to Latimer and Pushmataha counties was over six inches below normal, and much of the southern half of the state had a four inch deficit.

Temperature

As with the season's precipitation pattern, much of the state was significantly above normal temperature-wise during spring, with the exception of portions of north central and northeastern Oklahoma. Otherwise, the statewide-averaged temperature finished 2.6 degrees above normal. The Panhandle and west central Oklahoma were both greater than 3 degrees above normal to rank as the 4th and 3rd warmest springs on record for those two sections of the state. Isolated areas across the state were greater than 4 degrees above normal, including a larger area in the northwest and west central regions.

Spring Daily Highlights

March 1-4: A warm front on the 2nd and 3rd pushed northwards through the state, generating showers and thunderstorms which dumped close to 4 inches of rain in northeastern Oklahoma. That was merely a prelude to a more severe scenario that played out on the 4th, culminating with an end to the state's longest recorded tornado drought in history. A large complex of storms moved from southwestern up through central and finally north central Oklahoma in the early morning hours, accompanied by flooding rainfall and high winds. Another bout of severe weather moved into southwestern and southern sections of the state later that afternoon. Flooding was common in west central Oklahoma. Rainfall amounts of greater than 4 inches were common across the area. Flash flooding was reported in Logan, Garfield, Kay, Noble, and Kingfisher counties. At 5:27 p.m., Oklahoma's longest recorded tornado drought ended at 292 days when a small F0 twister touched down 2 miles north of Muldrow, lifting a minute later.

March 5-12: The intervening eight days were a study in tranquil weather. Highs were often found lazily drifting into the 70s as high pressure dominated. The pleasant weather was interrupted every so often by cool fronts and a brief cool-down, but temperatures seemed to recover quite nicely after each intrusion of cold air.

March 13-16: The state saw a bit more in the way of precipitation the next four days, although amounts were generally less than an inch. An upper level storm system over the Texas panhandle on the 13th furnished the southern sections with a few showers. Idabel saw nearly one-half of an inch. High temperatures throughout this period ranged from the 50s under cloudy skies, to the 70s in more sunny environs.

March 17-22: The month's second major bout with severe weather struck on the 17th, this time confined to the northeast. Widespread reports of damage and hail up to golfball size occurred with these storms. Temperatures that day warmed into the 80s before the intrusion of cool air. The temperatures rebounded quite nicely on the 18th, however, once again rising into the 70s and 80s. The month's high temperature of 88 degrees was recorded at the Hollis Mesonet site on the 19th. The first day of spring was very mild and humid. Southerly winds ferried moisture northward to clash with a cold front which had rapidly traversed the state from the north. The result was a few strong thunderstorms.

March 23-28: Low pressure in the lee of the Rockies the next several days provided the conditions needed for another outbreak of severe weather. With abundant moisture in place, and an approaching cold front, storms finally popped up on the 26th in both northern and southern sections of the state. Amounts were generally less than an inch, but the state's most violent weather since May 2003 appeared on the 27th. Hail greater than 2 inches in size was reported in Beckham and Custer County. The big story of the day, however, was an outbreak of weak tornadoes, which occurred in northwestern sections. Seven tornadoes touched down that day, with the largest, an F1, occurring near Sharon in Woodward County. Fortunately, the 250 yard wide tornado lasted only a few minutes, striking mostly rural areas. The other tornadoes that day were even weaker, touching down for a few moments only, in general.

March 29-31: The month did not live up to its billing, exiting as more lamb than lion. Mostly clear skies and highs in the 70s greeted Oklahoma in the month's final 3 days. Winds died down as well as high pressure furnished a tranquil curtain-call for the month.

April 1-5: High pressure provided fair weather for most of the state throughout this period. High temperatures were generally in the 60s and 70s, with just a smattering of 80s thrown in as a reminder of the season. A few intermittent rain showers did manage to pop up, but amounts were generally light.

April 6-10: An upper-level disturbance approached the state from the west, setting off a few thunderstorms in the west that afternoon. A brief, pencil-like tornado was reported to have touched down for approximately two minutes in Tillman County. Widespread showers and thunderstorms formed in southern Oklahoma the next morning as the upper-level storm entered the state from the southwest. After a pleasant intermission to the severe weather on the 8th, a stalled cold front set off another round of showers and storms on the 9th. These storms quickly went severe, dropping large hail in the eastern half of the state. A brief tornado was reported by a sheriff's deputy on the ground near Whitesboro. The storms basically continued into the 10th as the weather-producing upper-level storm moved overhead. A cold front eventually moved through the state, dropping temperatures into the upper 40s and low 50s, to go along with pea-sized hail and rainfall totals over an inch in several locales.

April 11-18: Low temperatures on the 11th were 10-15 degrees below normal, with wind chills below-freezing in the north. A secondary blast of cold air on the 12th produced a late-season snowfall in northwestern Oklahoma. Nearly an inch of snow was reported on grassy surfaces in Gage before quickly melting. By the 18th, temperatures in the 70s and 80s were the norm, accompanied by strong southerly winds.

April 19-25: This turbulent period will be remembered for the less-glamorous (but more damaging) aspects of severe weather: hail and flooding. The excitement started on the 19th as a cold front dropped into northwestern Oklahoma. A large complex of storms moved into Harper County, complete with 69 mph winds and large hail. A tornado warning was issued for the area, although an actual sighting was never confirmed. The storms continued early into the morning of the 20th. Severe storms formed over northwestern and north central sections along a dryline later that day, with the main culprits again being large hail and high winds. A tornado was reported by a trained spotter near Sapulpa in Creek County, as well as hailstones the size of softballs; a punctuation mark on that storm's violent updraft. A weak tornado was confirmed by NWS personnel to have touched down near Mannford in Creek County on the 21st, and large hail was widespread throughout the state. A hailstorm pummeled central Oklahoma, associated with a supercell that rumbled through Yukon and Oklahoma City, with estimated damages near $100 million. The slow-moving storm buried parts of the city in ice until it resembled a winter landscape. The severe weather was once again widespread on the 22nd. Tornadoes were confirmed in Ellis, Mayes, Muskogee, Tulsa, and Wagoner counties. With the front stalled through south central Oklahoma, the threat shifted to flash flooding. A large supercell camped over Stephens County for several hours, bringing flash flooding and baseball-sized hail. Fourteen separate instances of flash flooding were reported by the NWS. The flooding turned fatal in Sequoyah County, one mile west of Short. A camper trailer with three occupants was carried away by flood waters along Lee Creek early on the 24th. An 85 year old male and 54 year old female were swept away by the flood waters.

April 26-28: Calm weather took hold on the 25th as the upper-level storm which caused so much excitement moved off to the east. Skies were sunny through this entire period, and temperatures were fitting for the season in the 70s and 80s.

April 29-30: Another cold front entered the state from the northwest, dropping temperatures into the 40s in the panhandle, with winds from the north gusting to 40 mph. Severe storms rumbled through southwestern Oklahoma on the 29th before spreading over the eastern two-thirds of the state the following day.

May 1-7: High temperatures struggled to rise above 60 degrees on the 1st, but temperatures rebounded into the 70s the following day, continuing to climb throughout the period. Gage reached a very unseasonable 33 degrees low temperature on the 2nd, and Oklahoma City set a record low of 38 degrees on the same day, which broke the old record of 39 degrees, set in 1961. Fair skies and southerly winds were the rule through the 7th, with temperatures reaching the 80s and 90s by the end of the period.

May 8-13: A small upper-level disturbance on the 11th and 12th produced a modicum of rainfall for central and southern Oklahoma, but a cold front on the 13th was the real weather-maker. Temperatures fell behind the front from the 80s to the 50s and 60s, with gusty northerly winds up to 40 mph. There were severe thunderstorms in southwest and central Oklahoma, with small hail being the largest threat from those storms. The northeast received the most severe weather, with large hail, high winds, and heavy rainfall. The state's first confirmed tornado during May touched down northwest of Coweta in Wagoner County that afternoon. The twister was rated an F1, and traveled a total of 2.6 miles before dissipating.

May 14-22: The rain disappeared and the temperatures soared during this period. Near-freezing temperatures greeted the Panhandle on the 14th, but very pleasant weather followed. Warm and windy weather was the norm, and the state's first triple-digit temperatures since August 28th, 2003, were reported on the 19th. Buffalo reached 105 degrees, the state's highest reported temperature during spring.

May 23-29: Severe storms erupted in central Oklahoma on the 23rd, bringing a few reports of small hail. Stronger storms struck the western half of the state on the 24th, with very large hail being reported with the storms, and a couple of F1 tornadoes spotted in Caddo County near Alfalfa and Eakly. Grapefruit-sized hail was reported in Manitou in Tillman County. After a few isolated storms in southern Oklahoma on the 25th, more widespread severe weather struck on the 26th associated with a surface low in the northwest. A weak tornado touched down in Noble County and traveled into Pawnee County before dissipating. Another tornado touched down later in Osage County. The most severe weather of the month occurred on the 29th, as a large tornadic supercell formed in Custer County and traveled to the east-northeast before exiting the state into Arkansas. The storm produced damaging winds, up-to softball-sized hail, and 10 tornadoes. A 19 year old man died when his vehicle struck horses which had roamed onto the road after the fence enclosing them was destroyed by a tornado near Piedmont. Baseball-sized hail shattered the windshields of the Okarche police department's vehicles, and 100 mph non-tornadic winds were estimated by National Weather Service employees along the storm's path.
May 30-31: The final two days of the month were relatively calm after the previous bouts of severe weather. Temperatures in the 80s and 90s returned to the state, and skies were mostly sunny.

Spring 2004 Statewide Extremes

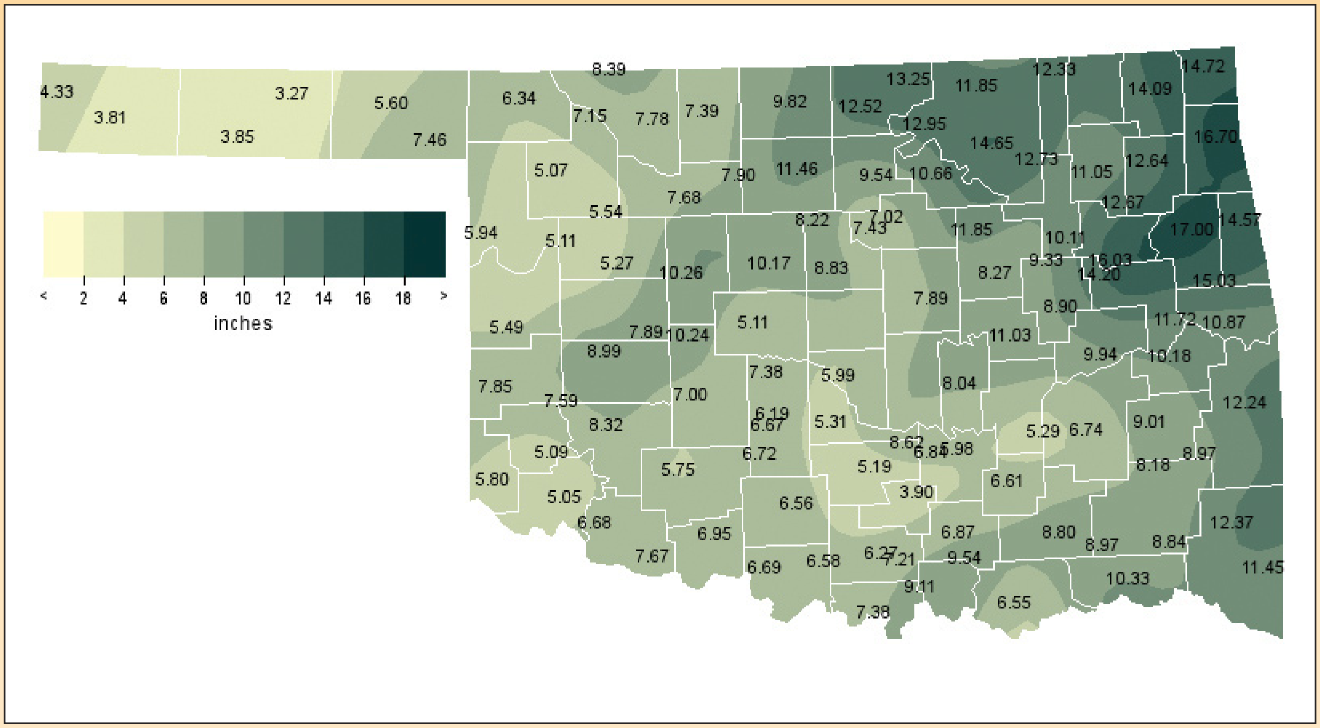
Description	Extreme	Station	Date
High Temperature	105ºF	Buffalo	May 19th
Low Temperature	19ºF	Boise City	March 2nd
High Precipitation	8.99 in.	Porter	
Low Precipitation	3.27 in.	Hooker	

Spring 2004 Statewide Statistic

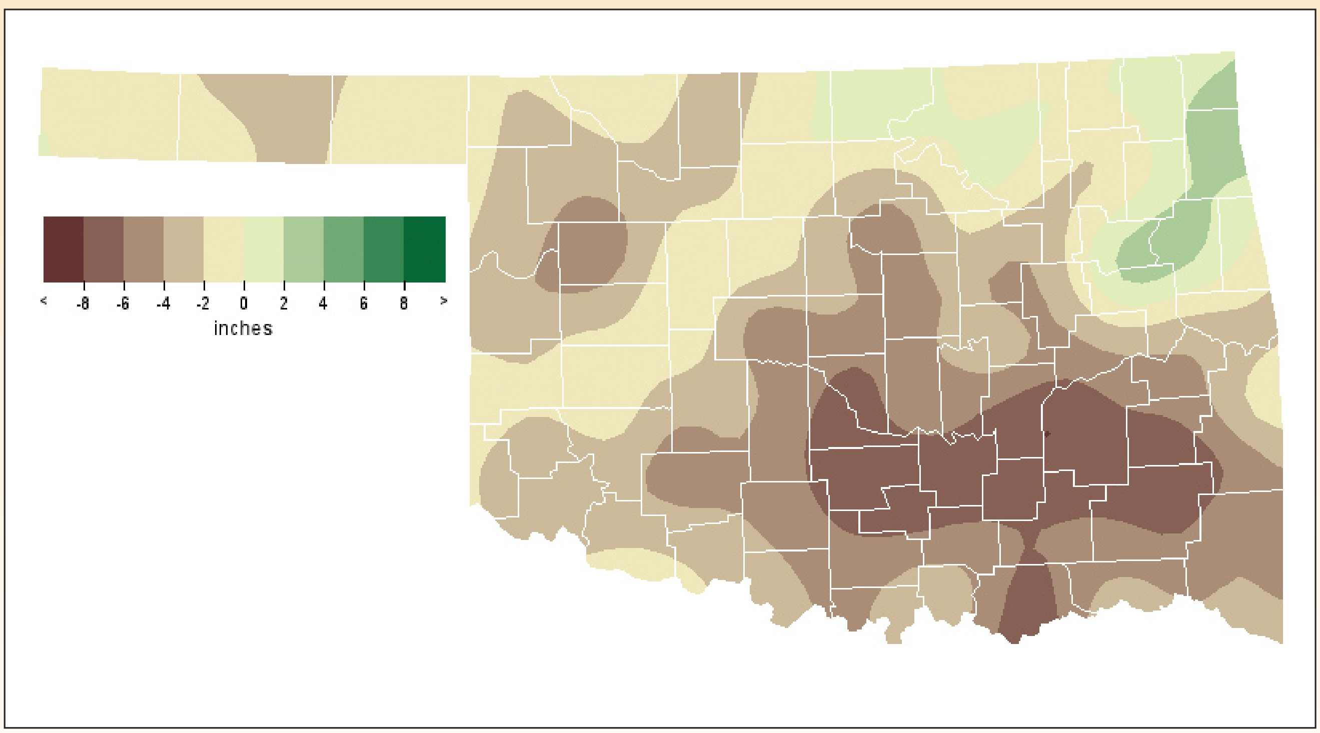
	Average	Depart.	Rank (1892-2004)
Temperature	61.7ºF	2.6ºF	7th Warmest
	Total	**Depart.**	**Rank (1892-2004)**
Precipitation	8.54 in.	-3.14 in.	25th Driest

SPRING 2004 SUMMARY

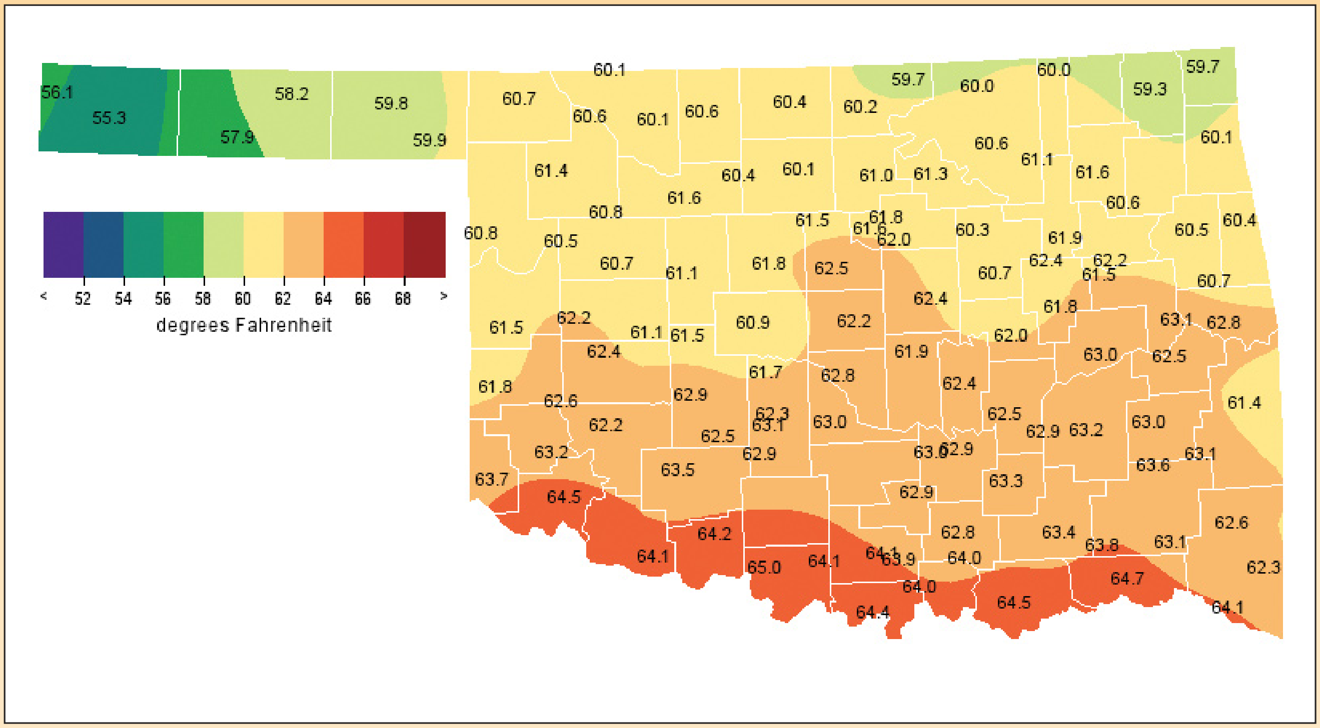
Observed Rainfall



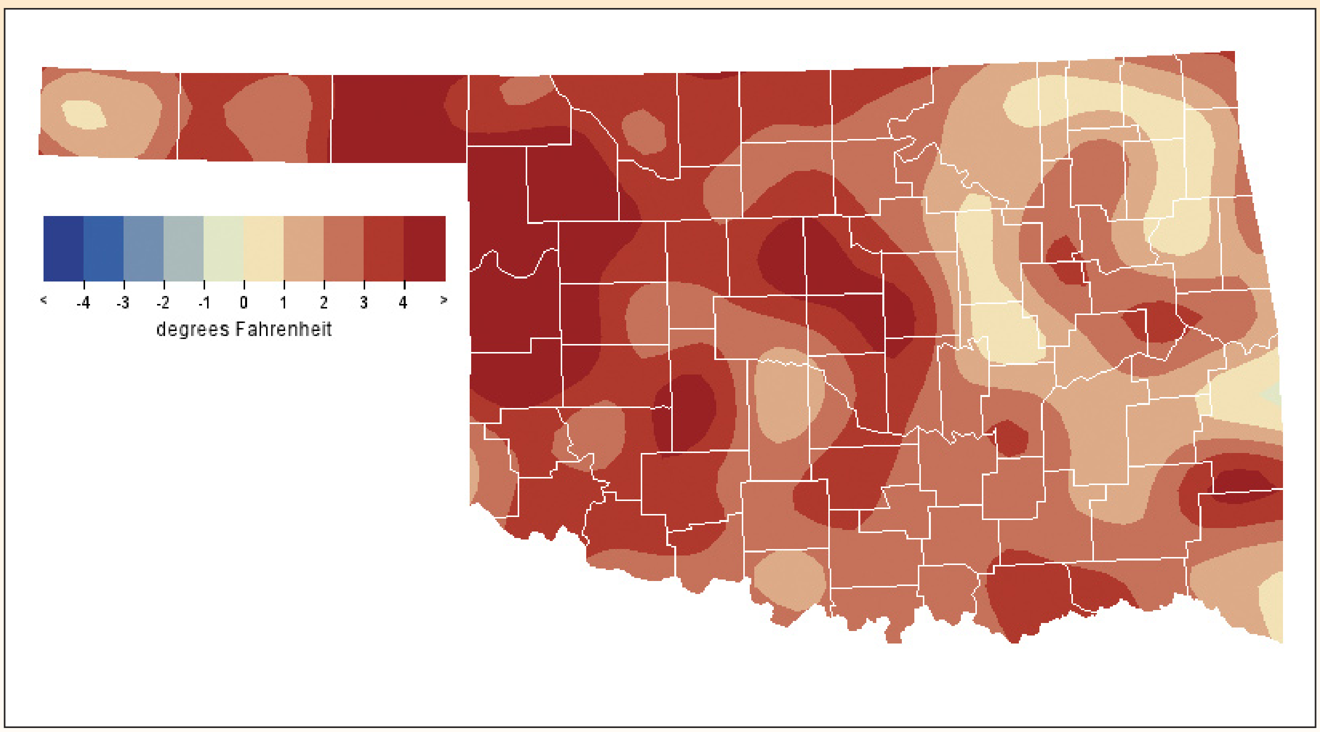
Rainfall Departure from Normal



Average Temperature



Temperature Departure from Normal



Spring 2004 Mesonet Precipitation Comparison

Climate Division	Precipitation (inches)	Departure from Normal (inches)	Rank since 1895	Wettest on Record (Year)	Driest on Record (Year)	2003
Panhandle	5.08	-1.77	49th Driest	13.27 (1957)	1.15 (1966)	4.14
North Central	8.73	-1.63	50th Wettest	21.31 (1957)	1.77 (1895)	8.60
Northeast	13.08	-0.07	39th Wettest	25.15 (1957)	3.12 (1895)	12.21
West Central	7.31	-2.59	50th Driest	19.30 (1957)	1.86 (1971)	5.89
Central	7.77	-4.63	19th Driest	22.89 (1957)	3.74 (1932)	7.72
East Central	11.15	-3.16	30th Driest	30.36 (1990)	4.49 (1936)	9.73
Southwest	6.86	-3.04	26th Driest	20.48 (1957)	3.28 (1971)	5.61
South Central	6.98	-5.93	6th Driest	27.30 (1957)	5.07 (1896)	7.47
Southeast	10.04	-5.29	14th Driest	30.18 (1990)	7.12 (1936)	8.35
Statewide	8.54	-3.14	25th Driest	22.74 (1957)	4.89 (1895)	7.82

Spring 2004 Mesonet Temperature Comparison

Climate Division	Average Temp (F)	Departure from Normal (F)	Rank since 1895	Hottest on Record (Year)	Coldest on Record (Year)	2003
Panhandle	58.6	3.3	4th Warmest	59.5 (1963)	49.4 (1915)	56.8
North Central	60.5	2.9	11th Warmest	61.6 (1963)	52.8 (1924)	59.1
Northeast	60.7	2.1	12th Warmest	61.7 (1977)	53.5 (1924)	60.2
West Central	61.5	3.5	3rd Warmest	61.9 (1963)	52.9 (1915)	61.5
Central	62.0	2.5	9th Warmest	63.1 (1974)	54.5 (1924)	60.9
East Central	62.1	2.1	13th Warmest	63.7 (1974)	55.1 (1931)	62.4
Southwest	63.2	2.7	7th Warmest	64.4 (1963)	55.1 (1915)	63.9
South Central	63.8	2.4	10th Warmest	65.0 (1974)	56.5 (1931)	64.1
Southeast	63.2	2.5	11th Warmest	64.3 (1938)	56.8 (1924)	63.8
Statewide	61.7	2.6	7th Warmest	62.5 (1974)	54.3 (1924)	61.3

Spring 2004 Mesonet Extremes

Climate Division	High Temp	Day	Station	Low Temp	Day	Station	High Monthly Rainfall	Station	High Daily Rainfall	Day	Station
Panhandle	105	May 19th	Buffalo	19	Mar 2nd	Boise City	4.44	Slapout	2.67	Apr 19th	Slapout
North Central	102	May 19th	Freedom	26	Apr 13th	Freedom	7.65	Breckenridge	4.51	Mar 4th	Breckenridge
Northeast	90	May 23rd	Bixby	26	Mar 16th	Foraker	8.99	Porter	4.44	Apr 22nd	Porter
West Central	100	May 24th	Erick	28	Mar 2nd	Butler	7.10	Bessie	4.39	Mar 4th	Bessie
Central	97	May 23rd	Ninnekah	28	Mar 22nd	Oilton	7.07	Kingfisher	5.31	Mar 4th	Kingfisher
East Central	91	May 30th	McAlester	28	Mar 10th	Okmulgee	8.44	Westville	3.66	Mar 3rd	Tahlequah
Southwest	101	May 24th	Altus	30	Mar 6th	Mangum	7.47	Hinton	5.21	Mar 4th	Hinton
South Central	94	May 23rd	Waurika	28	Apr 14th	Burneyville	6.47	Bee	2.97	Apr 23rd	Bee
Southeast	90	May 30th	Wilburton	26	Mar 10th	Wister	7.71	Wister	3.38	Apr 24th	Wister
Statewide	105	May 19th	Buffalo	19	Mar 2nd	Boise City	8.99	Porter	5.31	Mar 4th	Kingfisher

Agriculture Weather Watch

By Albert Sutherland, CPH, CCA
Mesonet Assistant Extension Specialist
Oklahoma State University

Low rainfall and lots of wind have been the agricultural weather topics of note this spring. High wind days act like a straw, sucking the water out of plants. With low soil moisture and rainfall, drought symptoms develop even sooner when the winds blow hard.

Rainfall in Oklahoma has been so low that it is starting to impact the record books. May 2004 has taken the No. 1 spot as the driest May recorded since 1892, when Oklahoma rainfall record keeping began.

If we look at the last 90 days of precipitation, central Oklahoma has seen the driest 90 days since 1921, while west central had the 3rd driest period. During these 90 days, it has been the 4th driest for the southwest and the 5th driest for south central region. Statewide, this 90-day time has been the 4th driest, since 1921.

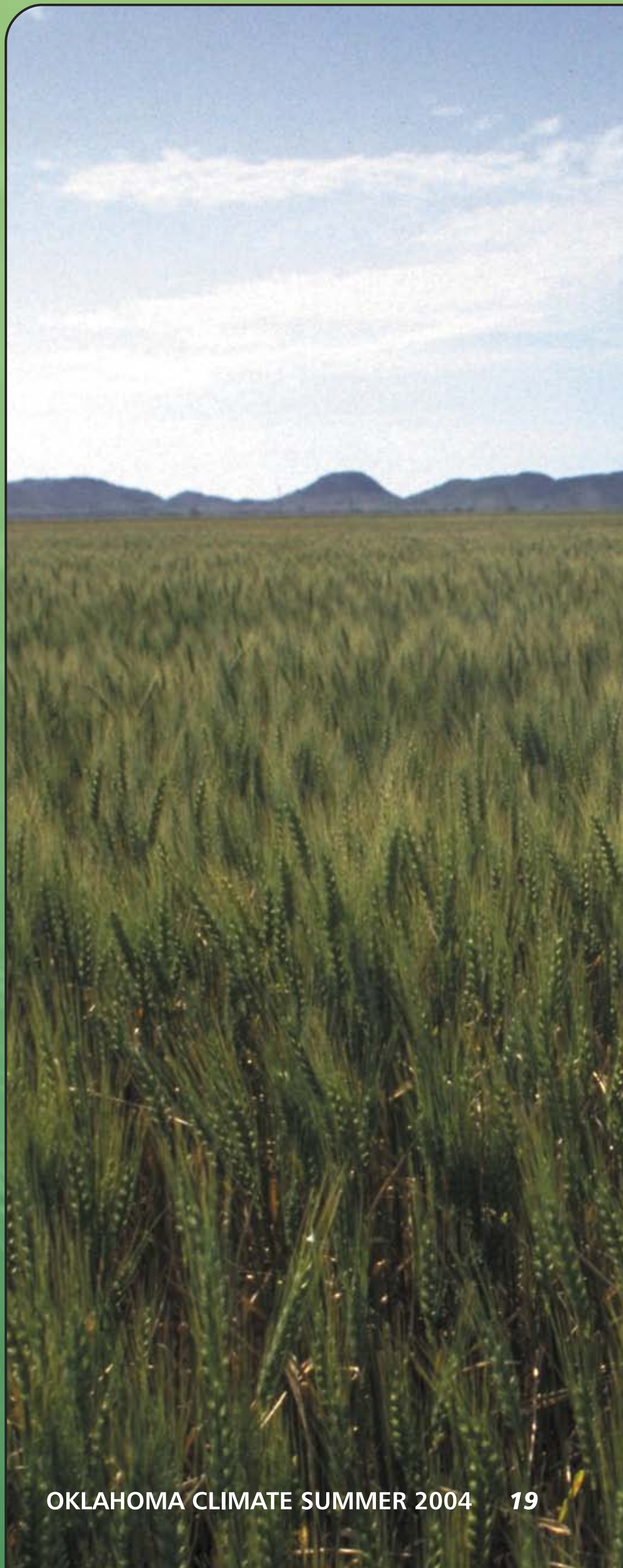
While this lack of rain is hurting hay production and pasture, the wheat crop has showed great resilience. Farmers say that like a cat, wheat seems to have "nine lives." Fortunately for Oklahoma farmers, the wheat has survived heat, high winds, low rainfall, and a late spring frost to still produce a decent crop for most growers. Wheat harvest, as well as other small grain harvesting, came early to Oklahoma this year. The bulk of the crop has produced near average grain yields with high test weights. High test weights come from good quality, well-filled wheat kernels.

Much of eastern Oklahoma has received rainfall at just the "right times," even though a dry May has increased crop risk. Dryland corn was just beginning to tassel in late May and received rain at this critical plant stage. April planted soybeans were progressing well as of late May. Rain in early May would not only benefit the April planted soybeans, but provide important moisture for the later June planted soybeans.

So what agricultural producers need soon is rain and lots of it. Without rain, producers will not only have to start feeding livestock forage earlier, but will not produce the amount of forage they need to feed this winter. Low moisture conditions will force livestock producers to spend more for livestock feed and/or reduce herd size. Either management practice will likely increase the cost of beef that typically leads to higher meat prices.

As of late May, the soil moisture at the 10-inch depth was low at many Oklahoma Mesonet sites, most notably in the Northwest portion of the state. But even in the majority of locations in eastern Oklahoma it had dropped below ideal levels. At the 24-inch depth more areas of eastern Oklahoma had adequate soil moisture, except for a broad band from Oklahoma City to McAlester. Out in western Oklahoma, the deep soil levels were very dry.

Let's hope the rain comes soon and provides some meaningful amounts of water.



AGRICULTURE – LAWN AND GARDEN

June

- Mulch ornamentals, vegetables, and annuals to lower soil temperatures, reduce weeds, and conserve soil moisture. Use natural mulches, such as compost products or tree bark, because they can lower the soil temperatures by as much as 20ºF.
- Keep a grass-free zone around trees and shrubs by using a product with one of the systemic grass herbicides, sethoxydim (Poast® or Grass and Weed Killer®) or fluazipop-p-butyl (Grass-B-Gon®).
- Water wisely! Water as needed by using the new crop and horticultural evapotranspiration models on Oklahoma AgWeather. Avoid watering driveways or over-watering and running water into the street. Use weeping soaker hoses and run sprinklers in the morning to reduce water lost to evaporation.
- Fertilize bermuda grass turf areas with one pound of actual nitrogen per 1,000 square feet of lawn area. For zoysia grass, cut this rate in half.
- Avoid fertilizer on tall fescue lawn areas. Tall fescue won't need fertilizer until September.
- Check lawn for weeds and apply herbicides as needed. Avoid applications when the daytime temperature will be above 90∞F. Applications made closer to sunset, speeds plant chemical uptake and helps reduce problems with herbicide volatilization.
- Seed new bermuda grass areas before the end of June.
- Apply fungicide for brown patch disease of tall fescue when warm, humid conditions are present. Avoid watering tall fescue grass in the evening.
- Apply a fungicide for control of early blight and septoria leaf spot on tomatoes.
- Check for bagworms on evergreens and spider mites on ornamentals and vegetables.

July

- Hunker down to avoid the heat. Schedule garden work for early mornings and avoid afternoon heat. Use the Oklahoma Mesonet heat index to determine times when extra heat caution is necessary.
- Perform mid-season lawn mower maintenance by changing oil, cleaning or replacing air filter, cleaning spark plug, and most importantly, sharpening the blade. Keeping the mower blade sharp is key to a healthier, better looking grass.
- Treat for white grubs with products containing the insect growth regulator insecticide, halofenozide (Mach II®) or those with imidacloprid (Merit®). Pre-water, apply the grub control, and follow with another watering to move the active ingredient into the soil.
- For irrigated bermudagrass turf areas, fertilize with one pound of actual nitrogen per 1,000 square feet of lawn area.
- July is a good month when summer tree pruning is needed. Trees that commonly "bleed" sap when pruned (maple, elm and pine), will have less sap flow when pruned in July or January.
- Divide and replant hybrid iris (bearded iris).

August

- Water, water, water!!! Continue to use the evapotranspiration models to help you water wisely.
- Schedule garden work to avoid intense afternoon heat.
- For white grub control, select a quick kill material, like 24-Hour Grub Control® with dylox, and apply it in the third week of August. Pre-water, apply the grub control, and follow with another watering to move the active ingredient into the soil.
- Shear shrubs and trim trees as needed to maintain good traffic visibility. The kids will be back in school after mid-August.
- Towards the end of August, divide and replant spring flowering perennials.

By Andrea Melvin
Program Manager for K-12 Outreach
Oklahoma Climatologcial Survey

In the Oklahoma Climate Fall 2003 summary, the standard station model plot was described. This issue will use a modified station model plot consisting of air temperature in red, relative humidity in green, and Heat Index in blue. The maps also contain a color contour of each variable to help identify patterns easier. Map 1 contains the modified station plot and a color contour of air temperature. A red contour line of 95°F temperature is used to highlight the area of highest air temperatures. Map 2 contains the modified station plot and a color contour of relative humidity. The blue line contour represents relative humidities of 20%. The red line contour represents relative humidities of 55%. Map 3 contains the modified station plot and a color contour of Heat Index. A line contour of the 100°F Heat Index is used to highlight the area of highest Heat Index values. Brief descriptions of relative humidity and Heat Index follow.

Relative Humidity

Relative humidity is the ratio of the amount of water vapor actually in the air compared to the maximum amount that can be mixed in air at that particular temperature. Hence, when the temperature changes, so does the relative humidity, even without changing the amount of water vapor in the air.

Relative humidity is expressed as a percentage. If the relative humidity were 0% (unrealistic near Earth's surface), there would be no water vapor in the air. When the relative humidity is 100%, the air is saturated and the air temperature and dewpoint temperature are equal.

Relative humidity is a good indicator of the potential for evaporation to occur. When the relative humidity is high, little evaporation occurs. When the relative humidity is low, evaporation likely will occur, especially with moderate to strong winds and warm temperatures.

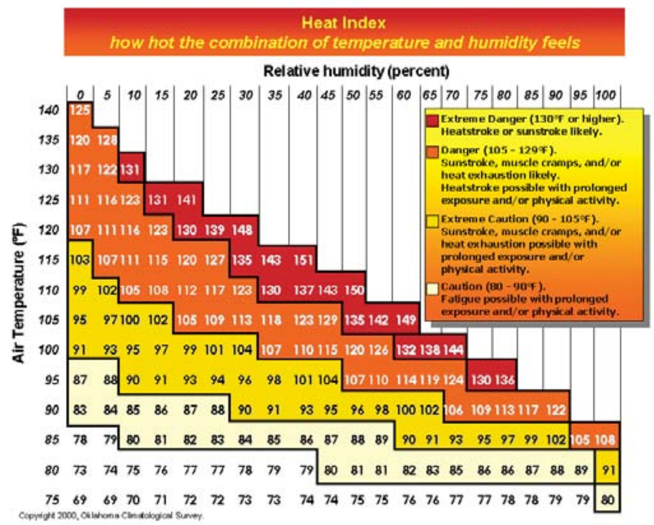
Evaporation

Evaporation is the process by which a liquid is transformed into a gas. Conversely, condensation is the physical process by which a gas becomes a liquid. Energy is exchanged during both of these processes.

When liquid water evaporates, energy is required to separate the molecular bonds which hold the water molecules close together in liquid form. This energy is removed from the nearby environment, whether that be the air or an object onto which the liquid water is attached. For example, when you step out of the shower into a drier environment, your skin suddenly feels cooler. This physical sensation is a result of the evaporation of the water on your skin into the air. Heat is taken from your body to change the water from liquid to gas. Hence, evaporation is a cooling process.

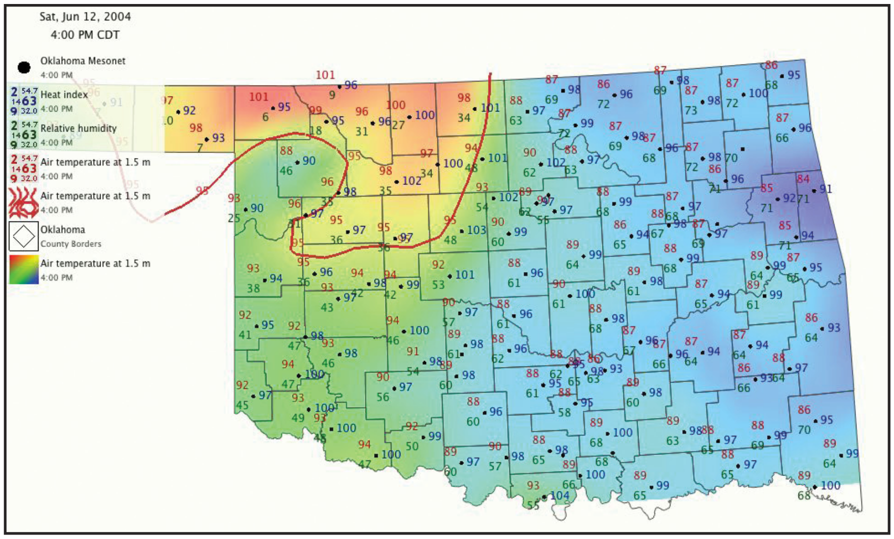
Heat Index (HI)

Heat Index is a calculated value used to represent how the body reacts to the combination of relative humidity and high temperature. When the human body gets too warm, it forms perspiration on the skin. As the perspiration evaporates, the skin feels cooler. In a high relative humidity atmosphere, the rate of evaporation slows and the perspiration falls off the skin. The body continues to produce perspiration without the benefit of evaporational cooling. This scenario leads to heat exhaustion and heat stroke as described in the Heat Index Table (Figure 1). The following classroom activity demonstrates the relationship between air temperature and relative humidity and their affect on Heat Index.

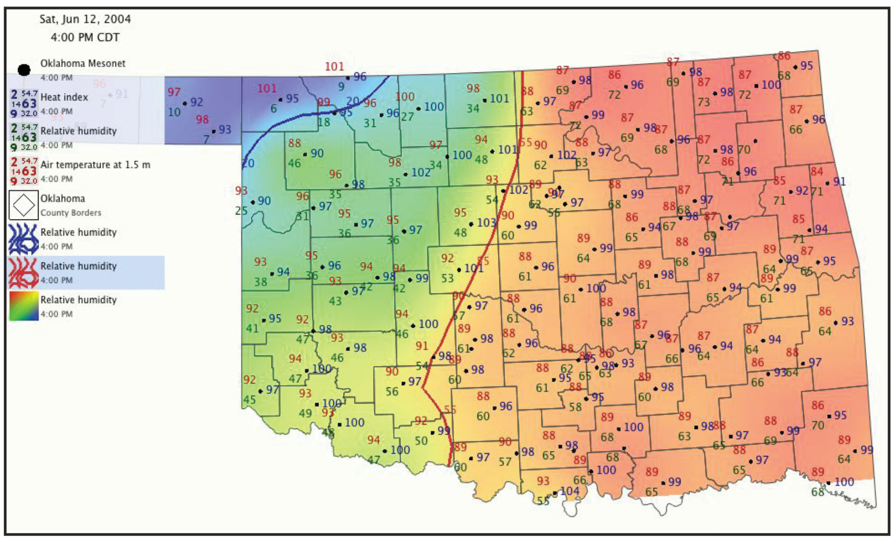


Air Temperature (°F) \ Relative humidity (percent)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
140	125																				
135	120	128																			
130	117	122	131																		
125	111	116	123	131	141																
120	107	111	116	123	130	139	148														
115	103	107	111	115	120	127	135	143	151												
110	99	102	105	108	112	117	123	130	137	143	150										
105	95	97	100	102	105	109	113	118	123	129	135	142	149								
100	91	93	95	97	99	101	104	107	110	115	120	126	132	138	144						
95	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136				
90	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113	117	122		
85	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97	99	102	105	108
80	73	74	75	76	77	77	78	79	79	80	81	81	82	83	85	86	86	87	88	89	91
75	69	69	70	71	72	72	73	73	74	74	75	75	76	76	77	77	78	78	79	79	80

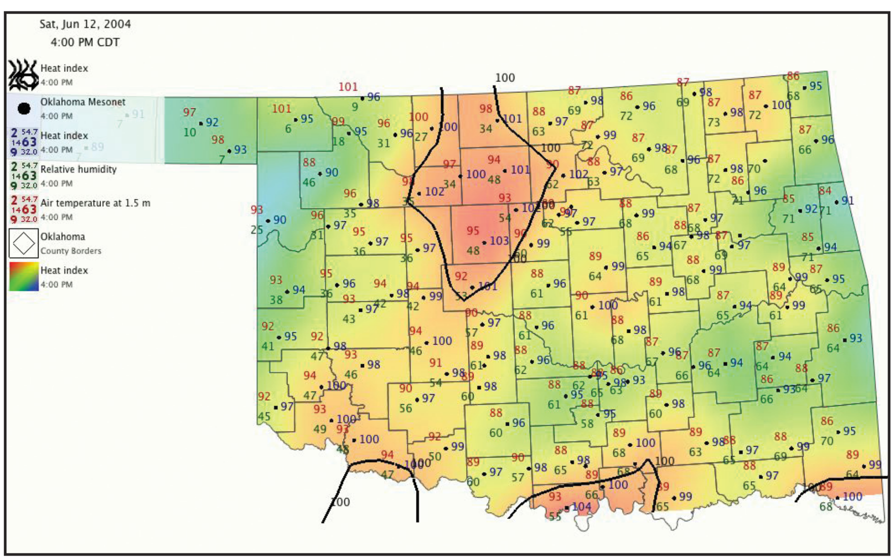
Figure 1 - Heat Index Table. Air temperature (°F) is on the vertical axis and relative humidity (%) is on the horizontal axis. Use these values to determine the Heat Index.



Map 1 – Air Temperature (°F)



Map 2 – Relative Humidity (%)



Map 3 – Heat Index (°F)

1. On Map 1, what is the range of relative humidity values in the area with the highest air temperatures?

2. On Map 2, what is the range of air temperature values in the area with the highest relative humidity?

3. Describe the area of highest Heat Index values in terms of air temperature and relative humidity. Are the highest Heat Index values located in the same location as the highest air temperatures or highest relative humidity values?

4. Calculate the difference between the Heat Index and the air temperature for each of the stations below. (Remember that air temperature is in red, relative humidity is in green and Heat Index is in blue.) Based on your calculations, would you rather spend the day in Harper, Love, or Nowata County?

101 95 6	87 98 73	93 104 55
Highest Temperature Station located in Harper County, Northwest OK	Highest Relative Humidity Station located in Nowata County, Northeast OK	Highest Heat Index Station located in Love County, South central OK

5. Explain how your body would react if you spent several hours outside at any of the three locations. Use the color-coded Heat Index table for reference.

6. Of the three stations above, explain why the Harper County station with the highest temperature and the Nowata County station with the highest relative humidity did not produce the highest Heat Index.

7. If you took the 101°F temperature from Harper County and combined it with the 73% relative humidity of Nowata County, what would be your approximate Heat Index value? How would your body react in these conditions?

HEAT SAFETY...

If a Heat Wave Is Predicted or Happening...

- Avoid strenuous activity. If you must do strenuous activity, do it during the coolest part of the day, which is usually in the morning between 4:00 a.m. and 7:00 a.m.
- Stay indoors as much as possible. If air conditioning is not available, stay on the lowest floor. Try to go to a public building with air conditioning each day for several hours.
- Wear lightweight, light-colored clothing. Light colors will reflect away some of the sun's energy.
- Drink plenty of water regularly and often, even if you do not feel thirsty. Your body needs water to keep cool.
- Avoid drinks with alcohol or caffeine in them. They can make you feel good briefly, but make the heat's effects on your body worse.
- Eat small meals and eat more often. Avoid foods that are high in protein, which increase metabolic heat.
- Avoid using salt tablets unless directed to do so by a physician.

Signals of Heat Emergencies...

- Heat exhaustion: Cool, moist, pale, or flushed skin; heavy sweating; headache; nausea or vomiting; dizziness; and exhaustion. Body temperature will be near normal.
- Heat stroke: Hot, red skin; changes in consciousness; rapid, weak pulse; and rapid, shallow breathing. If the person was sweating from heavy work or exercise, skin may be wet; otherwise, it will feel dry.

Treatment of Heat Emergencies...

- Heat cramps: Get the person to a cooler place and have him or her rest in a comfortable position. Lightly stretch the affected muscle and replenish fluids. Give a half glass of cool water every 15 minutes. Do not give liquids with alcohol or caffeine in them, as they can make conditions worse.
- Heat exhaustion: Get the person out of the heat and into a cooler place. Remove or loosen tight clothing and apply cool, wet cloths, such as towels or sheets. If the person is conscious, give cool water to drink. Make sure the person drinks slowly. Give a half glass of cool water every 15 minutes. Do not give liquids that contain alcohol or caffeine. Let the victim rest in a comfortable position, and watch carefully for changes in his or her condition.
- Heat stroke: Heat stroke is a life-threatening situation. Help is needed fast. Call 9-1-1 or your local emergency number. Move the person to a cooler place. Quickly cool the body. Immerse victim in a cool bath, or wrap wet sheets around the body and fan it. Watch for signals of breathing problems. Keep the person lying down and continue to cool the body any way you can. If the victim refuses water or is vomiting or there are changes in the level of consciousness, do not give anything to eat or drink.

Sources: National Weather Service, FEMA, American Red Cross

The Dangers of Heat and Humidity
The National Weather Service – Norman
http://www.srh.noaa.gov/oun/wxsafety/summer/heathumidity.php

Summer Safety Rules
The National Weather Service – Norman
http://www.srh.noaa.gov/oun/wxsafety/summer/summersafety.php

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