

**Annual Report to the
North Carolina General Assembly**

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(July 1, 2020 to June 30, 2021)

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**NORTH CAROLINA
DEPARTMENT OF ENVIRONMENTAL QUALITY**

<https://deq.nc.gov/>

**N.C. Department of Environmental Quality
Division of Water Resources**

**N.C. Drought Management Advisory Council Annual Report
July 1, 2020 – June 30, 2021**

Introduction

The N.C. Drought Management Advisory Council (DMAC), created as required by North Carolina General Statute 143-355.1, coordinates drought monitoring, assessment, and response activities between State and Federal agencies, public water systems, and water users. The objective of the DMAC is to provide consistent and accurate information on drought conditions to these entities, the U.S. Drought Monitor, the Environmental Management Commission, the Secretary of the N.C. Department of Environmental Quality, the N.C. Environmental Review Commission, and the public in order to manage and mitigate the harmful effects of drought. In accordance with statutory requirements, the council must submit an annual report to the Secretary of the N.C. Department of Environmental Quality, the Governor and the N.C. Environmental Review Commission by October 1 of each year.

Drought Overview 2020 - 2021

Climate Summary – State Climate Office (Corey Davis)

Overall Summary

The past year in North Carolina has been mostly wet and characterized by rainfall from tropical systems or their remnants reaching all corners of the state. Between these periods of heavy rainfall, some localized dryness emerged, most notably during the drought in spring 2021.

Overall, the 12-month period from July 1, 2020, through June 30, 2021, tied for the 13th warmest July-through-June on record since 1895, based on data from the National Centers for Environmental Information. It was also the sixth wettest such period, with a statewide average precipitation of 59.67 inches, or 10.35 inches greater than the 1900 to 2000 average.

Seasonal Breakdown

Summer 2020

Last July and August experienced the arrival of high pressure over the Southeast U.S. that produced persistent hot, humid weather across North Carolina. Statewide, July was the 6th-warmest and August was the 18th-warmest on record. In late July, hundred-degree heat hit the northern Coastal Plain, which was also enduring an extremely dry month with less than an inch of rainfall observed at sites such as Jackson (0.59 inches) in Northampton County. As a result, Abnormally Dry (D0) conditions briefly emerged across a dozen counties, with impacts including declining streamflows and crop stress.

That dryness was short-lived, as Hurricane Isaias made landfall at the southern coast on August 3 and brought 2 to 4 inches of rain across much of the Coastal Plain, including more than three inches in the driest areas to the north. August ended with more tropical rainfall, this time in the western part of the state from the remnants of Hurricane Laura. Overall, August 2020 ranked as our 13th-wettest on record.

Fall 2020

Following Laura's lead, a series of tropical storms that originally made landfall along the Gulf Coast reached North Carolina during the fall. With tropical air and tropical moisture prevalent, the three-month period from September through November ranked as our eighth warmest and ninth wettest fall on record.

Notable events included the remnants of Hurricane Sally bringing a widespread two or more inches of rain on September 16-18; Tropical Storm Beta producing heavy rain and large hail in the Sandhills on September 25-26; and the remnants of hurricanes Delta and Zeta each dropping more than four inches of rain in the Mountains during October. The most significant rainfall event of the season was during November 10-12. A cold front crossing the mountains pulled in moisture from Tropical Storm Eta to our south. Local rainfall totals exceeded eight inches in Alexander County, where heavy flooding at the Hiddenite campground caused three deaths, and along the Tar River, which reached its fifth-highest crest on record in Greenville.

Winter 2020-21

Despite the La Niña pattern that is often associated with drier winters in North Carolina, the prevailing pattern this winter defied those predictions and saw a continuation of our wet fall weather, with moisture-rich storm systems tracking from the Gulf of Mexico across the Carolinas. The three-month period from December 2020 through February 2021 ranked as our 12th-wettest winter on record in North Carolina and tied for the 51st-warmest in the past 126 years.

December featured slightly cooler-than-normal temperatures in the mountains and up to six inches of Christmas snow at Beech Mountain, Marshall, and Oconaluftee. The heaviest precipitation totals came across the eastern half of the state, including the fifth-wettest December in Louisburg (6.43 inches) and the fourth wettest in Elizabeth City (6.25 inches).

January saw the cooler temperatures and snowfall shift eastward. On January 28, more than three inches of snow fell in the northern Coastal Plain, including 3.7 inches in Plymouth. Areas farther south had little to no snow, but multiple rain events that added up to 8.71 inches for the month in Kinston. That pattern continued through February, which ranked as the second wettest on record in Kinston and Raleigh, along with the wettest February in Williamston with 10.36 inches of precipitation observed. Mid-February included two ice storms within a week that affected the northern Piedmont.

The lone exception to the wet winter weather was in the far western corner of the state. By late January, sites such as Murphy had accrued a seasonal precipitation deficit of more than five inches, and Abnormally Dry conditions emerged across parts of Cherokee, Clay, Graham, Macon, and Swain counties. Above-normal precipitation during February curbed that dry pattern and left the state with no outstanding dryness entering the spring.

Spring 2021

The beginning of March brought a sudden reversal in the overall pattern that lasted through the season. March through May ranked as our 12th-driest and tied for our 31st-warmest spring on record. The frequent precipitation events from the winter were replaced by stretches of warm and dry weather, especially in the south and east. Cold fronts crossing the Appalachians tended to soak the mountains and dry out afterwards, although the moisture surplus from the winter meant dry weather impacts were slow to emerge.

By April, dry conditions became more widespread, and it was the 13th-driest April on record statewide. Spurred on by 80-degree temperatures early in the month, topsoil moisture levels declined across the southern Coastal Plain, which was first classified as Abnormally Dry on April 20. Less than an inch of rain fell all month in parts of the Sandhills.

Continuing April's trend, May ranked as the 15th-driest on record. Despite slightly cooler-than-normal temperatures, the dry spring by then had taken its toll, and on May 18, Moderate Drought (D1) re-emerged in North Carolina for the first time since November 19, 2019. By the end of the month, more than half of the state was classified

in drought, including Raleigh, which recorded its driest spring on record, and both Wilmington and Lumberton, which had their second-driest springs and reached Severe Drought (D2) status.

June 2021

The season change again brought an abrupt shift in our weather pattern. The driest areas exiting the spring received heavy rainfall from multiple events in June, including a stalled frontal boundary across the Coastal Plain on June 2-3 and Tropical Storm Claudette on June 20-21. These events combined to produce the wettest June on record at sites such as Greenville (15.05 inches), Washington (16.13 inches), and Ocracoke (12.36 inches).

By the end of the month, only patchy areas of Moderate Drought remained along the Waccamaw River at the southern coast and along the Virginia border in the northern Piedmont. Roughly half of the state remained classified as Abnormally Dry, including the southwestern Piedmont, which missed the heaviest rains during the month.

Streamflow and Groundwater – USGS (Curtis Weaver)

Streamflow conditions during much of the annual period (July 1, 2020 through June 30, 2021) were commonly characterized by above-normal (>75th percentile) and much above-normal (>90th percentile) conditions across the State. However, several periods of short-term below normal streamflows were noted, the longest being about three months towards the end of the report period.

Figure 1 shown below indicates the percentage of USGS streamgages in North Carolina with 7-day average streamflows (or 7-day flows) less than the 25th, 10th, and 1st percentiles (or record-low for the calendar date) during the annual period. The percentages of USGS streamgages across North Carolina having 7-day flow percentiles below the 25th and 10th percentiles reached maximum values of 36 and 15 percent, respectively, on May 27, 2021. By comparison, the maximum percentages observed during the previous annual period (2019–2020) were 57 and 22 percent, respectively, for these two streamflow indicators. From early August through mid-January, most of February, then mid-March through mid-April, all indicators for the 7-day flows were commonly less than two percent, highlighting the extent of normal and above-normal streamflow conditions that persisted throughout much of this annual period. A total of 130 days occurred in which no below-normal 7-day flows were noted among any of the streamgages across North Carolina. The longest number of *consecutive* days of no below-normal 7-day flows was 28 days from December 14, 2020, through January 10, 2021. This is the fifth longest stretch of consecutive days since January 2001 when [USGS WaterWatch](#) began compiling 7-day flow data at selected streamgages across the Nation.

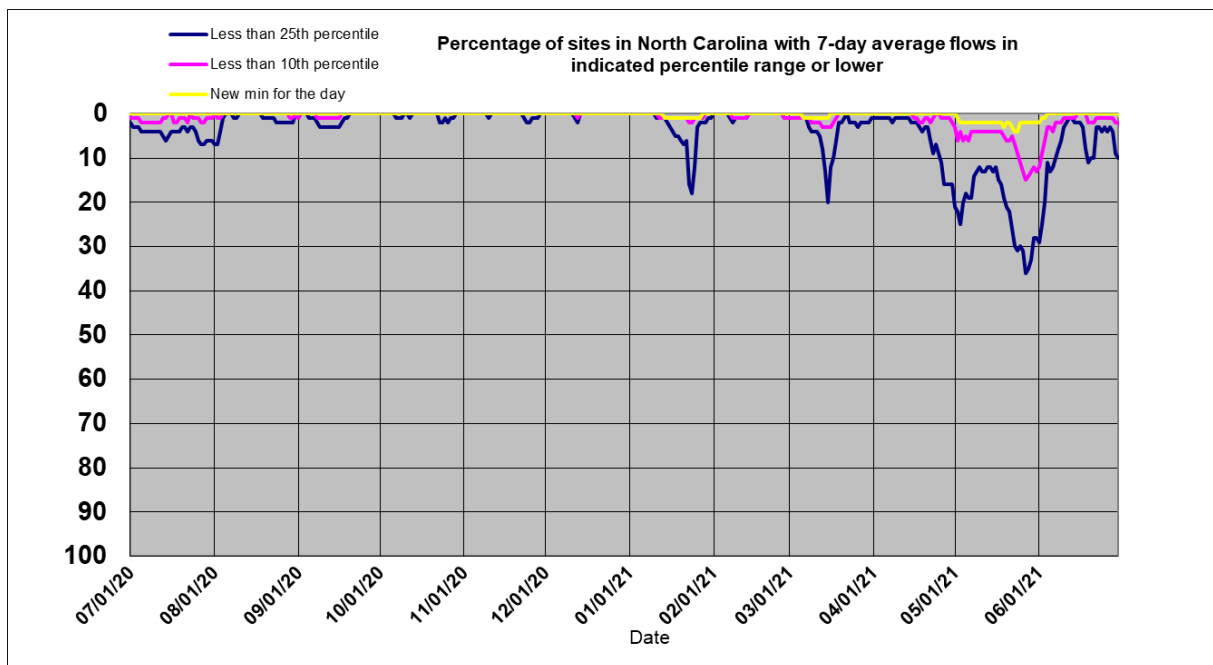


Figure 1. 7-day Flow Percentiles for USGS Streamgages in North Carolina

The persistence of above-normal streamflow conditions can also be seen in Figure 2 showing the percentage of USGS streamgages in North Carolina with 28-day average streamflows (or 28-day flows) less than the 25th, 10th, and 1st percentiles. Further emphasizing the very wet conditions during this annual period is the record 126 days of no observed below-normal 28-day flows noted among the streamgages across North Carolina, running from September 18, 2020, through January 21, 2021. This is longest stretch of consecutive days since July 2004 when [USGS WaterWatch](#) began compiling 28-day flow data at selected streamgages across the Nation.

During July 2020, [USGS WaterWatch](#) streamflow maps indicated a very small number of streamgages (generally less than five) widely scattered across the northern Piedmont region where below-normal conditions were depicted. However, towards the end of July, additional streamgages within the northern Coastal Plain towards the northeast corner of the State were beginning to depict below-normal conditions.

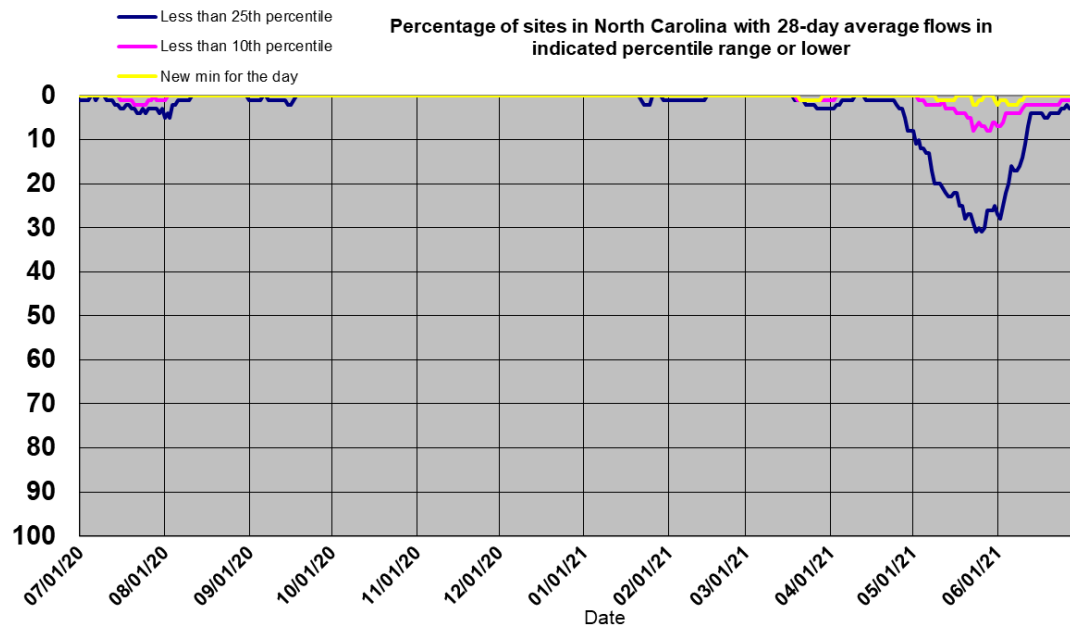


Figure 2. 28-day Flow Percentiles for USGS Streamgages in North Carolina

However, from early August 2020 through early January 2021, rainfalls from a combination of tropical systems as well as frontal passages ushered a long-sustained period of above-normal and much-above normal streamflow conditions. In mid-January, below-normal streamflow conditions began to appear with two small clusters appearing by about the 25th of the month across parts of the southern Blue Ridge and across parts of the northeast Coastal Plain. The end of January brought another round of above-normal rainfalls that quickly returned streamflow conditions to above-normal and much above-normal conditions across much of the State.

In early March, below-normal streamflow conditions began to reappear across the State such that by March 15, about 20 percent of the USGS streamgages in North Carolina had 7-day average streamflows below the 25th percentile (see Figure 1). The spatial distribution of below-normal streamgages was focused in two general areas: (1) parts of the northern Coastal Plain and northern Piedmont across the Triad and Triangle regions, and (2) along and near the Eastern Continental Divide in the Blue Ridge. From the end of March to early April, beneficial rainfalls again returned overall streamflows across the State into the above-normal and much above normal ranges.

In mid and late April, below-normal conditions again began to reappear across parts of the Coastal Plain, further expanding into the parts of the northern Piedmont as well as across the southern and central Blue Ridge. While early May rainfalls erased the below-normal streamflows in the Blue Ridge, an increasing number of USGS streamgages across the Coastal Plain, northeast Piedmont, and Sand Hills began to depict below-

normal streamflows on a more sustained basis. By May 27, up to 36 percent of streamgages across the state had 7-day average streamflows below the 25th percentile, and 15 percent had 7-day average streamflows in the “less than 10th percentile” range (see Figure 1). Early June brought more beneficial rainfalls – initially across the Coastal Plain then across the remainder of the State by mid-June – such that by the end of the month, the percentage of sites with 7-day flows below the 25th percentile declined to less than 10 percent.

Examination of approved (2020 water year) and provisional (2021 water year) daily discharge data indicates no period of record minimum daily mean discharges or 7-day flows were set at any USGS stream gage in North Carolina during the annual period. However, provisional minimum 7-day flows for the *month of May* were set May 29-31, 2021, at USGS Station 02109500 – Waccamaw River at Freeland in Brunswick County. The first record minimum 7-day flow of 7.53 ft³/s occurring on May 29 fell below the previous record minimum of 7.79 ft³/s set in May 2002. However, by May 31, the record minimum 7-day flow was set at 6.49 ft³/s. No minimum monthly average streamflows were observed at any USGS streamgages in North Carolina during the annual period, although *maximum* monthly average streamflows were observed at 40 USGS streamgages across the State.

Groundwater levels at the 16 USGS observation wells within the [USGS North Carolina Climate Response Network](#) commonly were in the normal and above-normal ranges during the annual period from July 1, 2020, through June 30, 2021. Water levels in the wells reflect the climate conditions (occurrence of precipitation), but temporal changes are also affected by individual well characteristics (e.g., well depth, surrounding material through which the water moves).

Water levels at the four Blue Ridge observation wells in this network were generally sustained in the normal and above-normal ranges throughout much of the annual period. While there were no instances of period of record or monthly low water levels noted among these four wells, the water levels at the Marble well in Cherokee County intermittently declined into the below-normal ranges from December 2020 through April 2021. Water levels at the Champion well in Haywood County were also very briefly depicted in the below-normal ranges at the ends of May and June 2021 each. At the remaining two Blue Ridge observation wells, there were no instances of below-normal water levels observed during the annual period. A provisional period of record high water level was set near the end of March 2021 at the Pisgah Forest well in Transylvania County. Provisional monthly record high water levels were also set at the Marble well (2 months) as well as both the Pisgah Forest well (4 months) and Blantyre well (1 month) in Transylvania County.

Water levels at the five Piedmont observation wells in this network were sustained solely within the above-normal ranges throughout the annual period. No instances of below-normal water levels were observed in these wells during the annual period. Provisional period of record high water levels was set at all wells: The Langtree well in Iredell County (March 2021), the Piedmont Research Station (RS) well in Rowan County (February 2021), the Mocksville well in Davie County (March 2021), the Oak Ridge well in Guilford County (April 2021), and the Duke Forest well in Orange County (June 2021). Provisional monthly record high water levels were also noted for a varying number of months during the annual period at the Langtree well (7 months), the Piedmont RS well (8 months), the Mocksville well (8 months), the Oak Ridge well (6 months), and the Duke Forest well (6 months).

Water levels in the Marston observation well in Scotland County (Sand Hills region) were sustained solely within the above-normal ranges throughout the annual period. A provisional period of record high water level was set in mid-March 2021 at this well, and provisional monthly record high water levels were also set at this well during of two months within this annual period.

Among the six observation wells in the Coastal Plain, water levels varied widely during the annual period. Conditions commonly ranged in the normal and above-normal ranges from July 2020 through February 2021, then ranged from above normal down to below normal during varying numbers of months from March to June 2021. The wide variations reflect the quick response of water levels to climatic conditions commonly observed in shallow wells within the Coastal Plain. No provisional period of record low water levels was noted during the annual period at any of the six Coastal Plain wells, but provisional record monthly low water levels were observed at four of the six wells: Grantham well (1 month), Comfort RS well in Jones County (2 months), Hoke well in Washington County (2 months), and the Elizabeth City in Pasquotank County (1 month). Provisional period of record high water levels was noted during the annual period at all 6 Coastal Plain wells: Grantham well (February 2021), Southport well in Brunswick County (February 2021), Comfort RS well (February 2021), Simpson well in Pitt County (June 2021), Hoke well (February 2021), and the Elizabeth City well (February 2021). Provisional record monthly high-water levels were also observed at all six wells: Grantham well (5 months), Southport well (1 month), Comfort RS well (4 months), Simpson well (6 months), Hoke well (2 months), and the Elizabeth City well (7 months).

Forest Resources – NC Forest Service (Cabe Speary)

From July 1, 2020 to June 30, 2021, the N.C. Forest Service responded to 3,444 wildfires across the state that burned approximately 9,583 acres on state and private

lands. The number of fires increased by approximately 6 percent, while the number of acres decreased by less than one percent over the previous year. The number of fires was 7.5 percent less than the 10-year average. The total number of acres burned was 27 percent lower than the 10-year average. There were 68,245 acres on state and private lands which were treated with prescribed fire during the past fiscal year, a 25 percent increase from the previous year. This increase in acres can be attributed primarily to easing of COVID-19 restrictions during the prime burning season, better weather, and an effort by agencies that burn to reduce the backlog of burning that did not get accomplished the previous year due to COVID.

Weather impacts had some effect on wildfire operations across the state during the past year. Lack of rain in May in the SE Coastal and Sandhills areas resulted in a “flash drought.” Fire danger reached a point that triggered a severity need. A burn ban was put in place for these areas from May 24 through June 2. A NC Type 2 Incident Management Team was mobilized to Lumberton. Other personnel and equipment were brought from other parts of the state to reinforce local resources. No large fires occurred, but fires that did occur burned deeply into the duff or organic soil as can happen during droughts. By June 2nd, wet frontal passages and typical summer humidity, showers and thunderstorms had moderated wildfire conditions. Although precipitation was higher than normal for much of the state, forest health was generally not significantly impacted.

Agriculture - North Carolina Cooperative Extension (Mike Yoder)

The first quarter of the 2020-2021 season, was a story of too much rain and too little, inconsistent rain coverage and a hurricane that dropped from 2 to 4 inches of rain over eastern North Carolina. Early in the spring, too much rain from the south to north-east counties resulted in soybeans and some cotton having to be replanted. Wheat often sat in the fields too long for optimum production but overall was close to normal for the year.

By July, dryness was starting to set into several north-central counties, as well as some of the far eastern counties. Late in the month, farmers worked diligently to get tobacco and corn out of the field before hurricane Isaias made landfall. Rainfall from Isaias helped limit the impact of the previous week’s dry conditions in the east. North-central counties like Person, Franklin, Halifax saw harvest deficits due to dryness. From Forsyth to Union counties, producers experienced dry conditions with corn being impacted the greatest in the southern counties. North-eastern NC experienced some dryness in September with limited impact on agriculture. The remainder of 2020 saw more rain in the mountains, north-central and eastern parts of the state, delaying soybean harvest in some cases.

January through March saw wetter than normal conditions for much of the state. Cereal grains got a slow start due to the excess moisture and leaching of soil nutrients was seen in some counties. April saw adequate soil moisture across most of the state with field work starting slowly. By early May, dry conditions were widespread across the western piedmont, eastward with spotty rains helping some, while others waited for more moisture. The north-central counties from Forsyth, eastward to Halifax, were especially dry. Above average dryness also affected counties across the coastal plain, especially down into the southeast counties.

June saw substantial rain fall across much of the state, slowing field operations and setting sweet potatoes back a couple of weeks. Most of the other row crops were progressing at a higher rate than the previous year but very much in-line with North Carolina's 5-year averages.

Drought Condition Summary – Division of Water Resources (Klaus Albertin)

The July 1, 2020 to June 30, 2021 period began with no areas of the state in abnormally dry (D0) or in drought (D1 to D4) conditions and saw little dryness throughout the annual report period (see Figure 3).

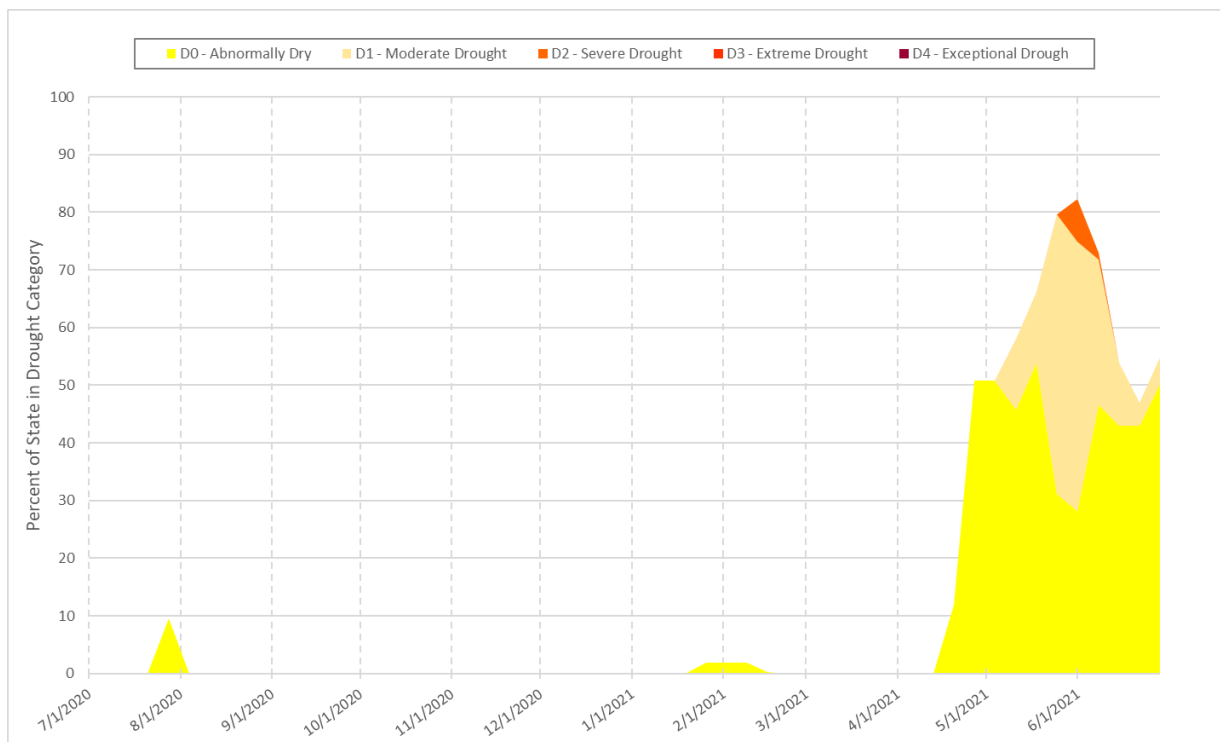
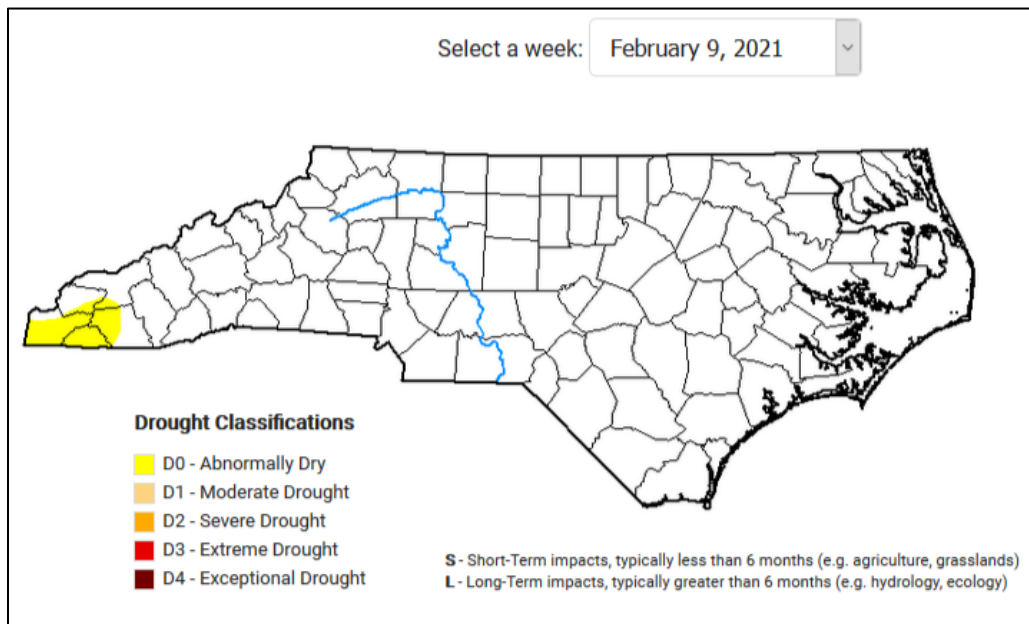
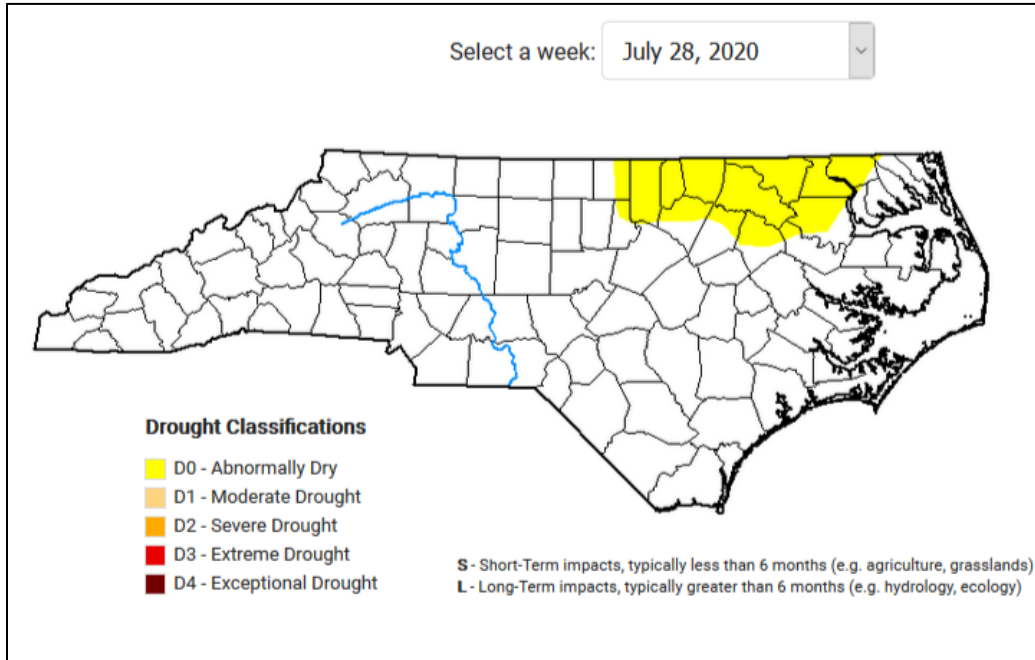
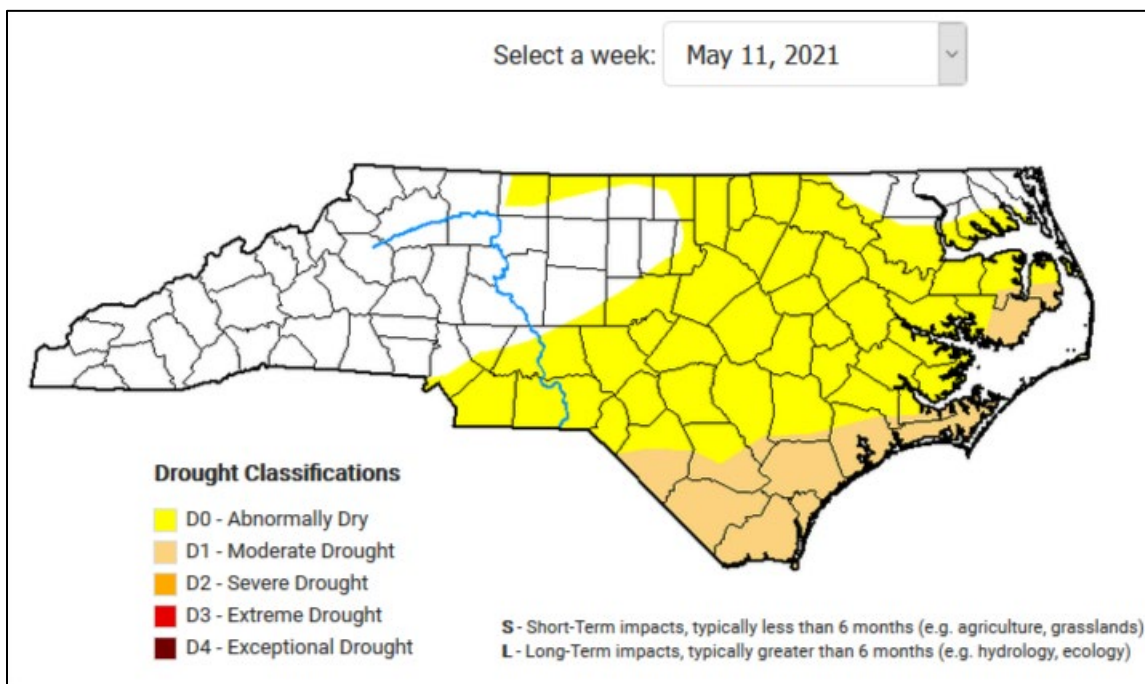


Figure 3. Drought Levels from July 1, 2020 through June 30, 2021

The state only experienced limited dry conditions from July 2020 through April 2021. A small area (less than 10 percent of the state) was classified as being abnormally dry on July 28 (see Figure 4). A second limited period of abnormally dry conditions occurred in late January through early February, this time in the western tip of the state as shown in Figure 5.



The only significant period of dryness began in mid-April and continued through the end of the reporting period of this document, June 2021, as shown in Figure 1. The dryness was initially centered east of Charlotte and through the Sandhills. The abnormally dry classification for this area was first assigned on April 20, 2021. The dryness continued to spread quickly with half the state being considered abnormally dry by April 27th. The first level of drought, moderate, was specified on May 11, 2021 for the central and southern coast as shown in Figure 6.



By June 1, 2021, conditions had worsened with approximately 82 percent of the state being considered abnormally dry or in some level of drought (see Figure 7). Severe drought (D2) stage was also specified for the southern coast at this time. Fortunately, unexpectedly heavy rainfall occurred along the coast in early June, quickly removing almost all of the severe drought and most of the moderate drought and dry conditions along the coast.

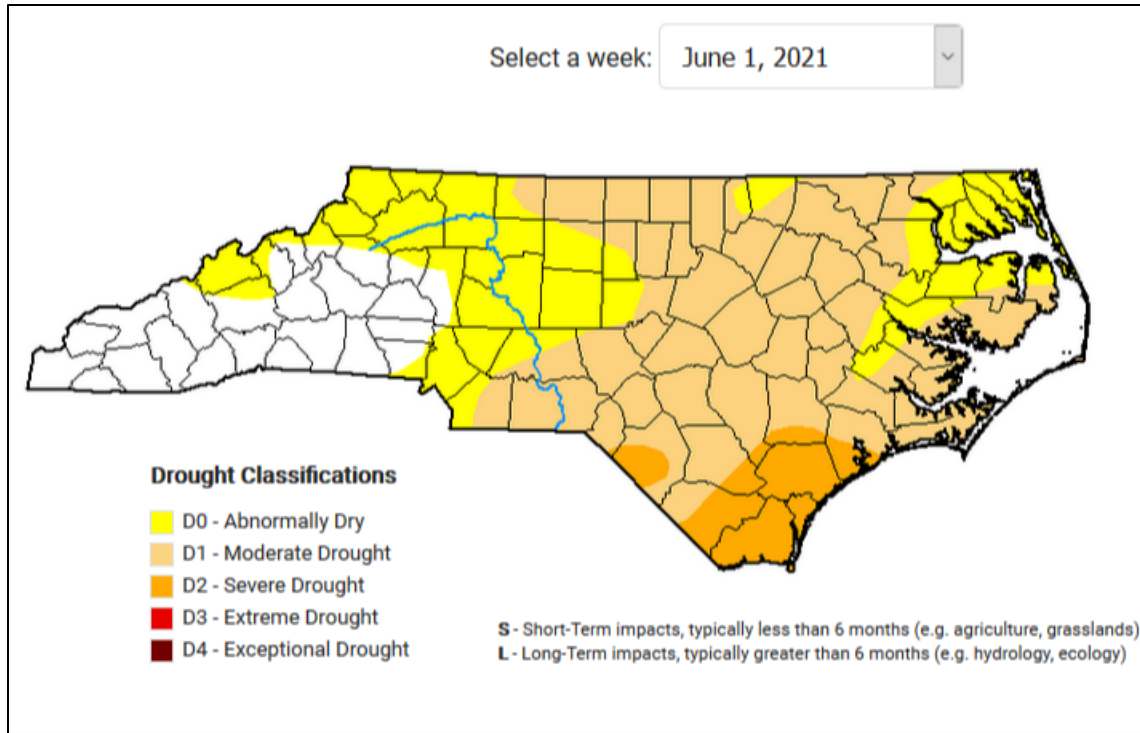


Figure 7. North Carolina Drought Classification (early June 2021)

While the dry conditions were widespread by the end of May, limited impacts were reported. The most significant impact to water supply was seen the first week of June when several coastal water systems initiated voluntary water restrictions due to classification of being in severe drought. Agriculture in the eastern North Carolina was negatively affected by drought in some cases.

Historical Perspective

In recent history, 2003 was the only year where no drought occurred in any part of the state. More typically, we see a moderate part of the state with abnormally dry conditions and a much smaller area in moderate drought. Severe drought or worse conditions do occur in many years, but the extent is often limited. The areas that are affected also shift throughout the year as localized rainfall either hits or misses locations. In this context, the 2020 – 2021 period was a fairly normal year for drought conditions.

Analysis using one of the standard drought assessment metrics, the Palmer Hydrologic Drought Index (PHDI), provides insight into long-term drought conditions for North Carolina (See Figure 8). Similar to the standard deviation of a normal distribution in statistics, PHDI values within +/- 2 reflect typical conditions. Values outside of this range show either very wet (positive) or very dry (negative) conditions. Values above +4 and below -4 reflect very extreme conditions.

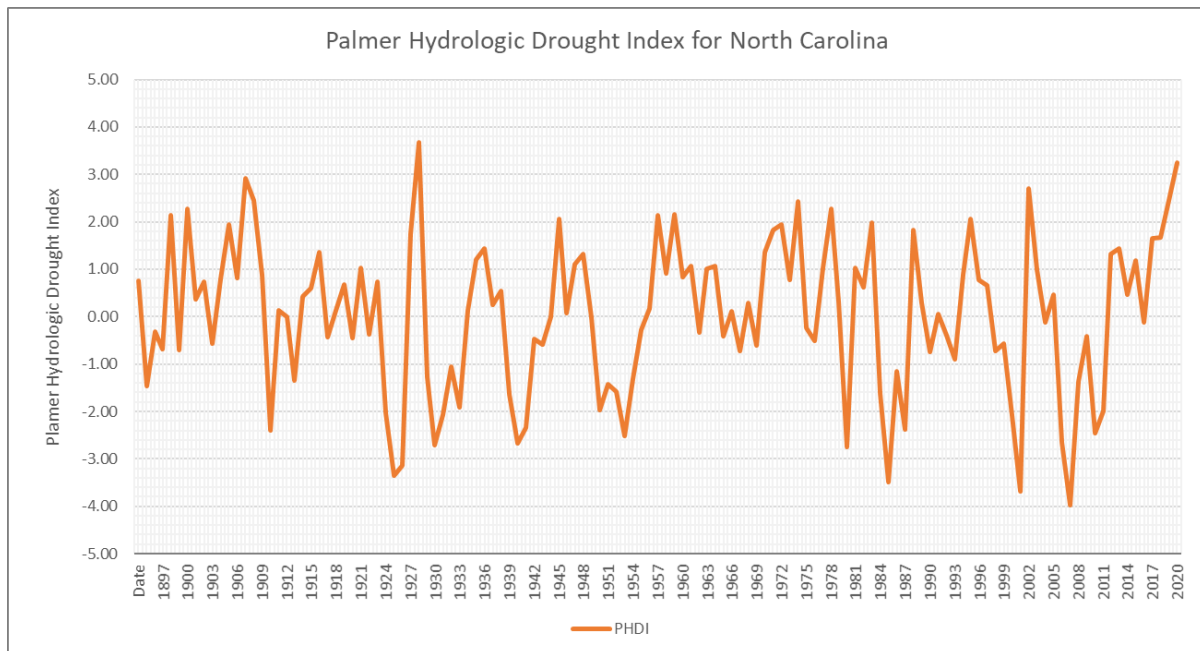


Figure 8. *Palmer Hydrologic Drought Index since 1895* Source: NOAA, 2021

North Carolina experienced extreme drought conditions from 1925 through 1927 with PHDI values reaching -4.1 at one point. A very wet period followed and then an extreme drought occurred in 1932 - 1933. This extreme drought period saw the lowest individual monthly PHDI value of -4.74. Occasional, moderate droughts occur in the 1940's and 1950's but it wasn't until the late 1980's that extreme drought returned. The PHDI reached a low of -4.6 in July 1986. Moderate to wet conditions returned in the 1990's but two of the most extreme droughts in North Carolina's recorded meteorological history occurred between 2000 and 2010. One of the wettest years also occurred during this period. Since 2010, conditions have been less extreme but highly variable swinging from moderately wet to moderately dry. No clear trend is seen but it does appear that more extreme swings in conditions are likely. The North Carolina PHDI values for the report period averaged 3.4 and peaked at 4.8 in February 2021 (NOAA, 2021). These values reflect the very wet winter period and a moderately dry spring. Since the 2007 to 2008 drought, conditions have been trending wetter than normal.

DMAC Meetings

Drought conditions in North Carolina are updated weekly through an audio-video telecom with a Technical Drought Advisory Team, which is a sub-group of the NC DMAC. The team consists of experts on climate, weather, hydrology, water supply, forestry, and agriculture that report each week on streams flows, groundwater levels,

reservoirs levels, wildfire activity, water supplies, and crop conditions. Based on this information, the team makes a recommendation to the U.S. Drought Monitor author on the state's drought conditions for that week. Those recommendations are used to draw the national drought map (<https://droughtmonitor.unl.edu/CurrentMap.aspx>) each Thursday. To see or download a copy of the current drought map for North Carolina, go to the state's official drought website at: www.ncdrought.org.

The DMAC is required by law to meet in person at least once each calendar year. The annual council meeting occurred on September 14 at 10 a.m. The meeting was held via WebEx due to rising Covid-19 concerns. Items discussed at the meeting include current conditions on stream flow and ground water levels, lake and reservoir levels, agriculture, forestry and public water systems.

References:

NOAA. 2021. Climate at a Glance. National Oceanographic and Atmospheric Administration. Website: <https://www.ncdc.noaa.gov/cag/statewide/mapping/31/phdi/202106/1/rank>. Accessed August 9, 2021.