

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

---

***Drought Management Advisory Council Report***

July 1, 2019 – June 30, 2020

**Division of Water Resources**



**NORTH CAROLINA  
DEPARTMENT OF ENVIRONMENTAL QUALITY**

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

**N.C. Drought Management Advisory Council Annual Report  
July 1, 2019 – June 30, 2020**

**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 2019 - 2020**

**Climate Summary – State Climate Office (Corey Davis, Rebecca Ward, Darrian Bertrand)**

***Overall Summary***

The period from July 1, 2019 through June 30, 2020 was an overall warm and wet year in North Carolina. Average statewide temperatures ranked as the 4<sup>th</sup> warmest since modern record-keeping began in 1895, while the average precipitation of 57.9 inches was 8.6 inches above the long-term average, or the 9<sup>th</sup> wettest July-through-June on record. The main exception to the wet weather was a fast-emerging drought in the western part of the state during an unusually hot and dry September 2019. The return of a tropical, moisture-rich air mass from the south by mid-October brought above-normal precipitation in North Carolina and drought recovery throughout the fall. This generally wet pattern remained through the winter and spring of 2020.

## ***Seasonal Breakdown***

### *Summer 2019*

June, July, and August 2019 were mostly characterized by typical summertime scattered showers and thunderstorms, and the average seasonal precipitation was 0.2 inches above normal. Average temperatures ranked as the 17<sup>th</sup> warmest out of the past 125 years. However, there was relatively little extreme heat, aside from one week in mid-July when a stagnant high-pressure system moved over the Southeast U.S. Throughout the summer, Moderate Drought conditions remained in place across the southern Coastal Plain. This drought was part of a longer-term dry pattern that began after Hurricane Florence hit in September 2018, but the near-normal summer precipitation did not cause drought conditions to substantially expand or contract. In New Bern, the summertime precipitation was 1.1 inches below normal, although the year-to-date precipitation by August 31 was 8.2 inches below normal, or the 5<sup>th</sup>-driest start to a year there since 1949.

### *Fall 2019*

On September 6, the Category-1 Hurricane Dorian tracked parallel to the southern coastline before briefly making landfall on Hatteras Island. The storm produced gusty winds and a 7-foot storm surge that inundated Ocracoke Island, along with 6 to 12 inches of rain in the previously noted drought-affected areas, effectively canceling out any rainfall deficits for the year to that point. The western two-thirds of the state received no rain from the storm, though, and saw drought quickly develop during the following weeks.

With high pressure directly over the Carolinas, the weather pattern after Dorian provided little moisture or rising air to support cloud cover, showers, or thunderstorms. Asheville recorded 10 days with temperatures in the 90s – the most of any September there since 1946. Most of the Mountains and Piedmont received less than an inch of rainfall during the entire month, including no measurable precipitation in Lincolnton and Salisbury. The unseasonably warm and dry weather continued into early October, with temperatures at or above 100°F on October 3 in Raleigh and October 4 in Roanoke Rapids – the latest recorded instances in the calendar year of such extreme heat at those sites. By mid-October, the large-scale pattern had shifted. High pressure moved offshore, allowing more moisture from the south to fuel rains across western North Carolina. The result was the state's 19<sup>th</sup>-wettest October on record, including the 4<sup>th</sup>-wettest in Boone and the 5<sup>th</sup>-wettest in Asheville. The heavy rains in the Mountains offered a quick recovery from the drought, while Moderate Drought and Abnormally Dry conditions remained in parts of the Piedmont entering November. That month brought further relief in the form of near-normal precipitation and cooler temperatures.

Overall, the three-month period of September, October, and November 2019 ranked as the state's 11<sup>th</sup> warmest and 51<sup>st</sup> wettest fall on record. However, those statistics alone do not capture the extreme variability both geographically – with flooding in one part of the state after Dorian and emerging dryness in another – and over time, as drought developed, intensified, and recovered between mid-September and mid-November.

### *Winter 2019-20*

The wet pattern from the late fall persisted through the winter, which saw storm systems from the south and west bring above-normal seasonal precipitation across almost all of North Carolina. The three months from December 2019 through February 2020 ranked as the state's 11<sup>th</sup> wettest winter on record. The only dry areas were across the central Coastal Plain, and a few weeks with limited rainfall early in the year saw Abnormal Dryness re-emerge from Jacksonville through Elizabeth City in mid-January. This dryness disappeared during the state's 3<sup>rd</sup> wettest February since 1895.

Temperatures were generally warmer than normal due to ridging, or large-scale high pressure, in the jet stream over the eastern U.S. The winter was the 5<sup>th</sup> warmest on record in North Carolina, and with few cold air outbreaks, most areas saw limited snow totals. The only widespread snow event across the state was on February 20 and 21, when parts of the northern Coastal Plain received 4 to 6 inches while the southern Piedmont had only a trace of measurable snow. Charlotte recorded only 0.3 inches of snow all season, despite having its 14<sup>th</sup> wettest winter on record.

### *Spring 2020*

Spring-like weather arrived by February and lasted through March, which ended with high temperatures reaching 90°F in parts of the Sandhills and Coastal Plain – one of the earliest recorded occurrences of such warmth in those locations. Under persistent ridging in the jet stream and without as many storm systems arriving from the west, the state was also drier in March, with the average precipitation 1.06 inches below normal. That pattern reversed in early April, with jet stream troughing, or large-scale low pressure, in place across the eastern US. This resulted in cooler temperatures and more active and wetter weather. Our 17<sup>th</sup>-wettest April on record included a tornado outbreak on April 13, with 16 tornadoes confirmed by the National Weather Service, mostly across the southern Piedmont and Coastal Plain. May remained cool and wet, as precipitation from tropical storms Arthur and Bertha contributed to the state's 3<sup>rd</sup> wettest May, with the average precipitation 3.3 inches above the long-term average. The spring, as a whole, was the 10<sup>th</sup> wettest on record, while average temperatures ranked as the 36<sup>th</sup> warmest, 1.1°F above normal.

### **Streamflow and Groundwater – USGS (Curtis Weaver)**

Streamflow conditions during much of the annual period (July 1, 2019 through June 30, 2020) were commonly characterized by normal and above-normal conditions. However, below normal streamflows were noted during varying lengths of “short-term” dryness that would occur in almost seemingly random patterns throughout the annual period.

During July and August 2019, [USGS WaterWatch](#) streamflow maps indicated two relatively small areas of below-normal conditions (flows less than 25th and 10th percentiles) in North Carolina. The first was across the north central part of the State near the border with Virginia, and the second was focused in the southern and central Coastal Plain. Beneficial rainfalls in latter August as well as from Hurricane Dorian in early September 2019 brought improved streamflow conditions across the Coastal Plain. However, the below normal streamflows continued and intensified across the north central Piedmont region such that “less than 10<sup>th</sup> percentile” conditions were widespread near the State border by end of September. These very low streamflow conditions continued into the first half of October for the north central Piedmont and began to expand elsewhere across the State. However, rainfalls in latter October through November resulted in streamflow increases into the mostly normal ranges during this time, with the exception of the north central part of the State where below-normal streamflow conditions continued to persist through November. Additional rainfalls during mid-December resulted in a large area of much-above normal streamflow (greater than 90<sup>th</sup> percentile) across most of the State. However, by the end of the 2020 calendar year, below normal streamflows had begun to return across parts of the northern Piedmont and northern Coastal Plain regions.

This pattern of below normal streamflows temporarily persisted into January 2020 until rainfalls during the mid and latter parts of the month began to increase streamflows across much of the State. Streamflows during February were characterized by much-above normal and record high levels for the calendar date. Short-term dryness during the month of March into the first half of April resulted in a return decline of streamflows into the “less than 10<sup>th</sup> percentile” range, once again across the north central part of the State. However, climatic conditions in latter April shifted into a very wet period of frequent and abundant rainfalls that lasted through most of the remaining annual period (ending on June 30). During these last few months, streamflows were commonly in the normal ranges but also frequently paired with above-normal (greater than 76<sup>th</sup> percentile) to record high (calendar date) conditions across the State.

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 57 and 22 percent during early fall 2019 and again early spring 2020, respectively. By comparison, the maximum percentages observed during the previous annual period (2018–2019) were 45 and 22 percent, respectively, for these two streamflow indicators. Outside of the early fall 2019 and early spring 2020 seasons, all indicators for the 7-day flows were less than 20 percent, with very low percentages less than 5 percent from mid-May through the end of the annual period (ending on June 30). Highlighting the extent of normal and above-normal 7-day flows during May and June 2020, there were no observed occurrences of below-normal 7-day flows on 34 of the 61 days during this period, with 27 of these 34 days on or after May 22.

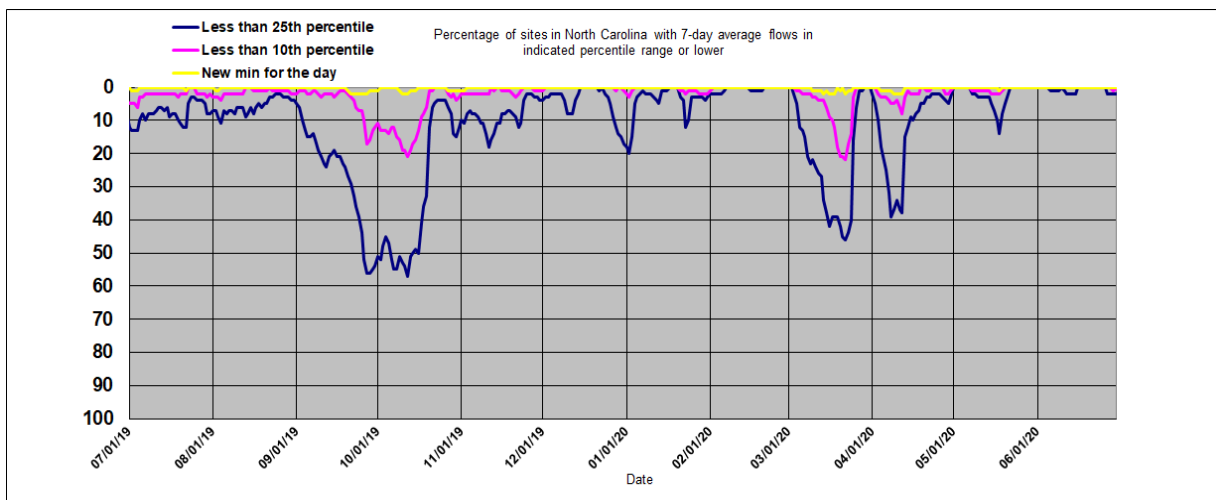


Figure 1. 7-day Flow Percentiles for USGS Streamgages in North Carolina

Examination of approved (2019 water year) and provisional (2020 water year) daily discharge data indicates no new period of record minimum daily mean discharges were set at any USGS streamgage in North Carolina during the annual period. However, two occurrences of zero flow were observed at USGS Station 02077200 - Hyco Creek near Leasburg in Caswell County (46 consecutive days September 4 through October 19, 2019) and USGS Station 02081500 - Tar River near Tar River in Granville County (October 12-13, 2019), meeting the previous record “zero flow” daily discharges set at these two streamgages. Consecutive “daily” new record minimum 7-day flows were set May 23-30, 2019, at USGS Station 02092500 - Trent River at Trenton in Jones County. The first record minimum 7-day flow of 4.03 ft<sup>3</sup>/s occurring on May 23 fell below the

previous record minimum of 4.14 ft<sup>3</sup>/s set in May 1986. However, by May 30, the new record minimum 7-day flow was set at 1.29 ft<sup>3</sup>/s. No new minimum monthly average streamflows were observed at any USGS streamgages in North Carolina.

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, 2019, through June 30, 2020. 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. With very brief exception at the Marble well in Cherokee County at the beginning of February 2020, there were no instances of below-normal water levels observed in these Blue Ridge observations wells during the annual period. A provisional period of record high water level was set during February 2020 at the Pisgah Forest well in Transylvania County. Provisional monthly record high water levels were also set at the Marble well (5 months), the Champion well in Haywood County (1 month), and at both the Pisgah Forest well (2 months) and Blantyre well (1 month) in Transylvania County.

Water levels at the five Piedmont wells in this network were also sustained in the normal and above-normal ranges throughout the annual period. No instances of below-normal water levels were observed in these Piedmont observation wells during the annual period. Provisional period of record high water levels were set at the Langtree well in Iredell County (June 2020), the Piedmont Research Station well in Rowan County (May 2020), and the Oak Ridge well in Guilford County (June 2020). Provisional monthly record high water levels were also noted for a varying number of months during the annual period at the Langtree well in Iredell County (4 months), the Piedmont Research Station (RS) well in Rowan County (5 months), the Mocksville well in Davie County (2 months), the Oak Ridge well in Guilford County (6 months), and the Duke Forest well in Orange County (7 months).

Water levels in the Marston well in Scotland County (Sand Hills region) were sustained in the normal and above-normal ranges throughout the annual period. No instances of below-normal water levels were observed in this observation well during the annual period. However, no period of record or monthly maximum record water levels were likewise observed at this well during the annual period.

Among the six wells in the Coastal Plain, water levels varied widely during the annual period. Conditions were commonly in the normal and above-normal ranges throughout the annual period. The wide variations reflect the quick response of water levels to climatic conditions in shallow wells common in the Coastal Plain. These variations included some months during the annual period where water levels gradually descended into the below-normal ranges for varying number of months during the latter half of the period. Provisional new period of record high water levels were noted during the annual period at 5 of the 6 Coastal Plain wells (the exception being the Hoke well in Washington County. New provisional record monthly minimum water levels were also observed at all six wells: Grantham well in Wayne County (4 month), Southport well in Brunswick County (1 month), Comfort well in Jones County (5 months), Simpson well in Pitt County (5 months), Hoke well in Washington County (1 month), and the Elizabeth City in Pasquotank County (6 months).

### **Forest Resources – NC Forest Service (Cabe Speary)**

From July 1, 2019 to June 30, 2020, the N.C. Forest Service responded to 3,246 wildfires across the state that burned approximately 9,641 acres on state and private lands. The number of fires increased by approximately 14 percent, while the number of acres increased by approximately 38 percent over the previous year. The number of fires was approximately 10 percent less than the 10-year average. The total number of acres burned was 24 percent lower than the 10-year average. There were 54,619 acres on state and private lands which were treated with prescribed fire during the past fiscal year, a 30 percent decrease from the previous year. This reduction in acres can be attributed primarily to COVID-19 restrictions during the prime burning season, not necessarily on weather conditions.

Weather impacts had some effect on wildfire operations across the state during the past year. Hurricane Dorian brought some moderate flooding to the coastal plain in September. However, the western piedmont and mountains developed a “flash drought” at about that same time. Plans were developed to bring additional firefighting resources to these areas if necessary. By mid-October, conditions eased with the return of normal rainfall. Regular winter and spring precipitation kept fire occurrence in check through June. 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)**

In late August 2019, southeastern North Carolina was experiencing mild to moderate dryness that had minimal impact on agricultural production. With good warning, farmers east of the I-95 corridor were harvesting corn grain and silage, as well as other crops, and moved large numbers of livestock to markets, ahead of hurricane Dorian. After making landfall on September 6, Dorian dumped up to 10 inches of rain on eastern North Carolina, temporarily slowing harvest, while providing needed rain to crops that were still maturing.

Three weeks later, dry conditions were contributing to early leaf loss in soybeans, decreased forage production and delayed maturity of sweet potatoes, from the eastern piedmont to the mountains. By mid- to late-October, dryness through the eastern piedmont had improved slightly but D1 and D2 were inconsistently entrenched across the mountains. At the same time, eastern North Carolina received enough rain to temporarily slow cotton and peanut harvest. These conditions continued through the remainder of harvest, the end of November. Most fall harvested commodities realized normal harvests.

January of 2020 started out warm and wet in the central piedmont through our south central and eastern counties, giving wheat and forages a great start. Spring saw generally normal planting conditions with cooler weather and excess rain slowing field work in May, through some of our east-central counties, requiring some soybeans across the eastern, north-central and south-central counties to be replanted. By mid-June, wet conditions continued to hamper field work and wheat harvest and required additional fertilization to replace nutrients flushed from sandy soils.

While a small number of our north-central and east-central counties experienced dryness through July and early August of 2020, much of the state experienced adequate to excessive rainfall, delaying field work and harvest. Excess rainfall brought with it, higher than normal levels of pests and made weed control more difficult. With few exceptions, crop production throughout the year and across commodities was normal, relative to the State's five-year average.

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

The July 1, 2019 to June 30, 2020 period began with approximately 20 percent of the state in abnormally dry (D0) and another 10 percent in drought (D1 to D4) conditions (see Figure 2). The highest levels of dryness were seen in early October.

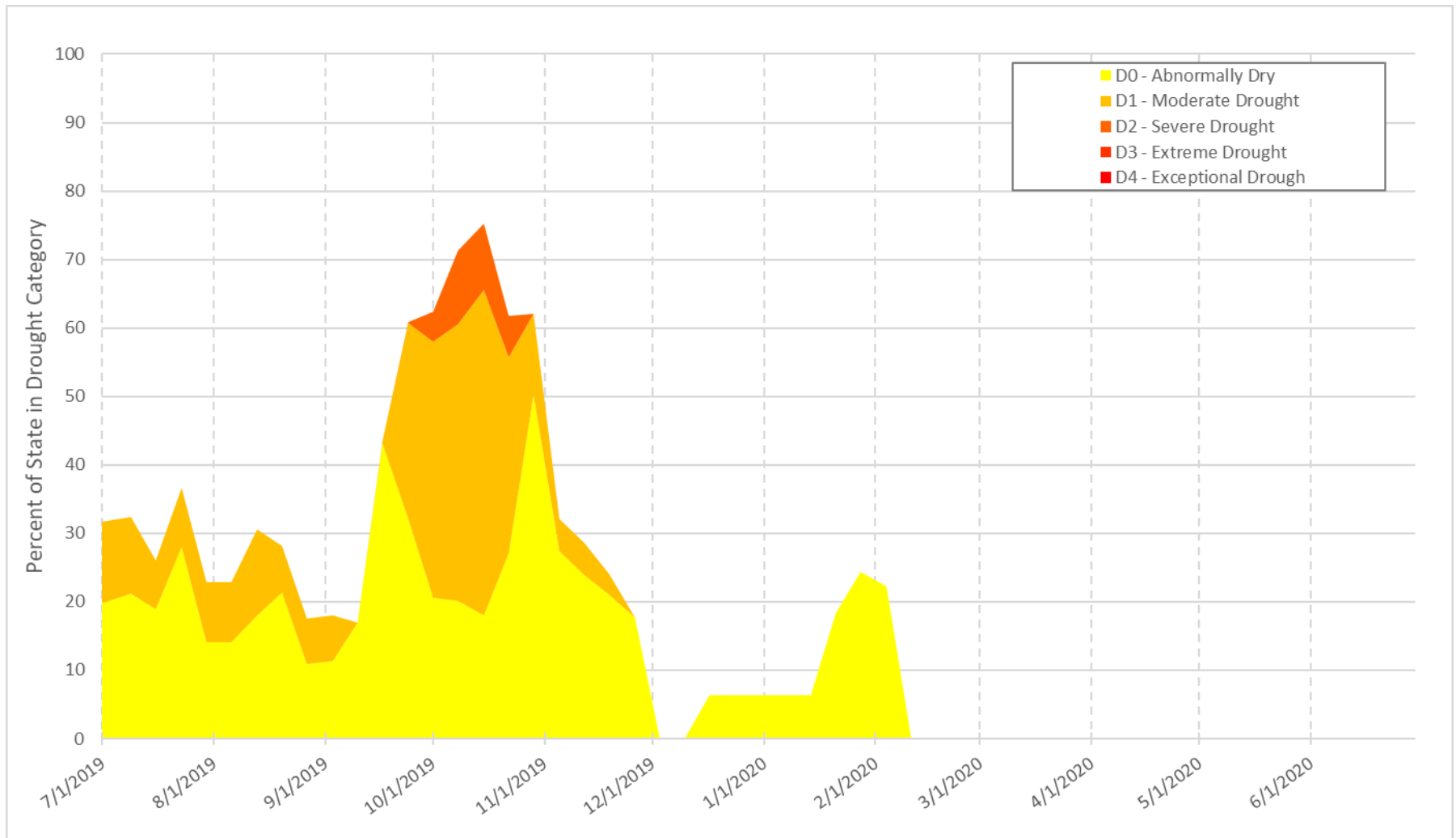


Figure 2. Drought Levels from July 1, 2019 through June 30, 2020

The dry conditions that were seen in July 2019 were focused on the coastal plain with abnormally dry conditions stretching from the Virginia border south to the South Carolina border. An area from Pamlico County to Columbus County was categorized as being in moderate drought. A small area in Stanly and Montgomery Counties was also classified as being abnormally dry (D0) (see Figure 3).

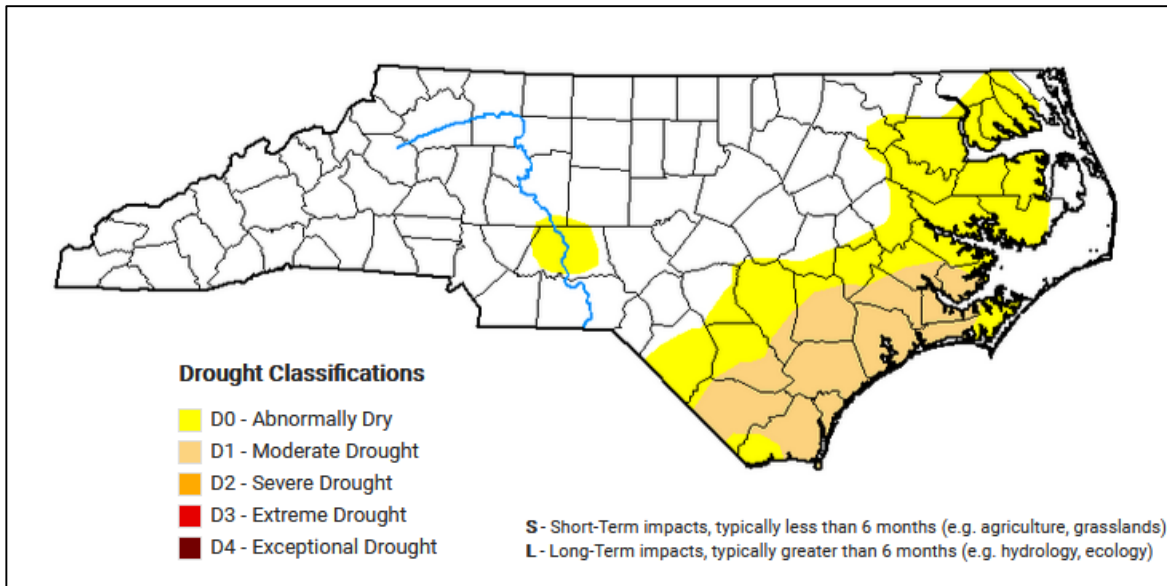


Figure 3. North Carolina Drought Classification (early July 2019)

The abnormally dry and moderate drought classifications in the eastern part of the state were erased with the occurrence of Hurricane Dorian on September 6. Dryness had started to creep in in the western part of the state which did not see any rainfall from Hurricane Dorian. The entire state saw little rainfall in September and western NC experienced a flash drought hitting its peak around October 8 (See Figure 4).

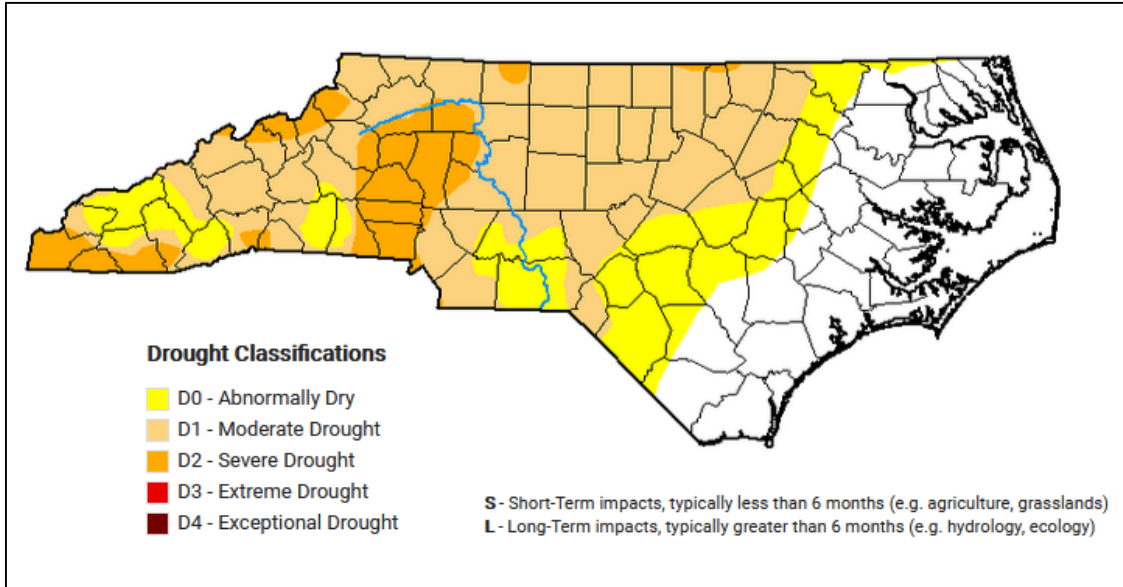


Figure 4. North Carolina Drought Classification (October 2020)

Conditions gradually improved throughout the early winter with all drought and abnormally dry classifications in the Piedmont and mountains having been removed by December 3. The northern coastal plain had been slowly falling behind with regards to average rainfall, however. The dry fall may also have depleted groundwater storages. As a result, an area from Currituck to Lenoir Counties was classified as abnormally dry by December 17. This dryness spread gradually until extending all the way to the South Carolina border by February 4 (Figure 5).

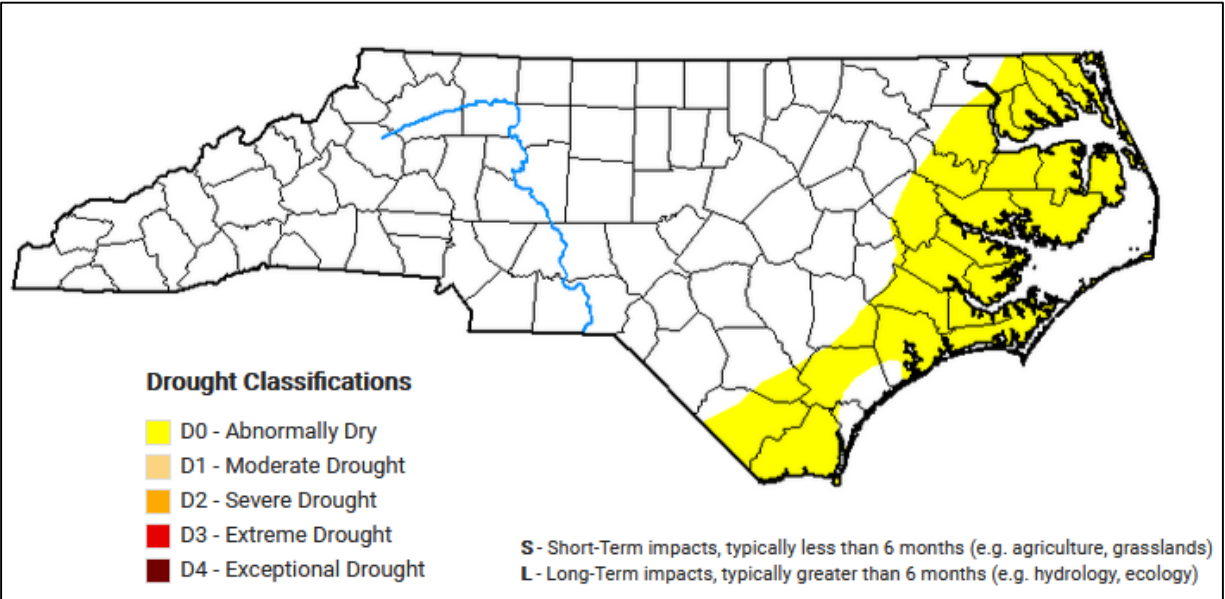


Figure 5. North Carolina Drought Classification (early June 2020)

Heavy rains over the following week were sufficient to remove the dryness along the coast. Slightly dry conditions were seen in isolated areas across the state at times after February 11, but none were of sufficient duration or extent to require classification as abnormally dry or as drought. The drought map remained clear through June 2000.

The most significant impact to water supply was seen during the dry fall when a few systems initiated voluntary water restrictions. The USACE, TVA, Cube Hydro, and Duke Energy reservoirs were all able to maintain water storage during the annual report period.

### Historical Perspective

Due to the natural variability of climate, drought may occur at any location in the state. In recent history, 2003 was the only year where no drought occurred in any part of the state. More typically, we expect to see many parts of the state with brief abnormally dry conditions and a much more limited area in moderate drought from time to time. 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 2019 – 2020 period was comparably minimal 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 6). 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.

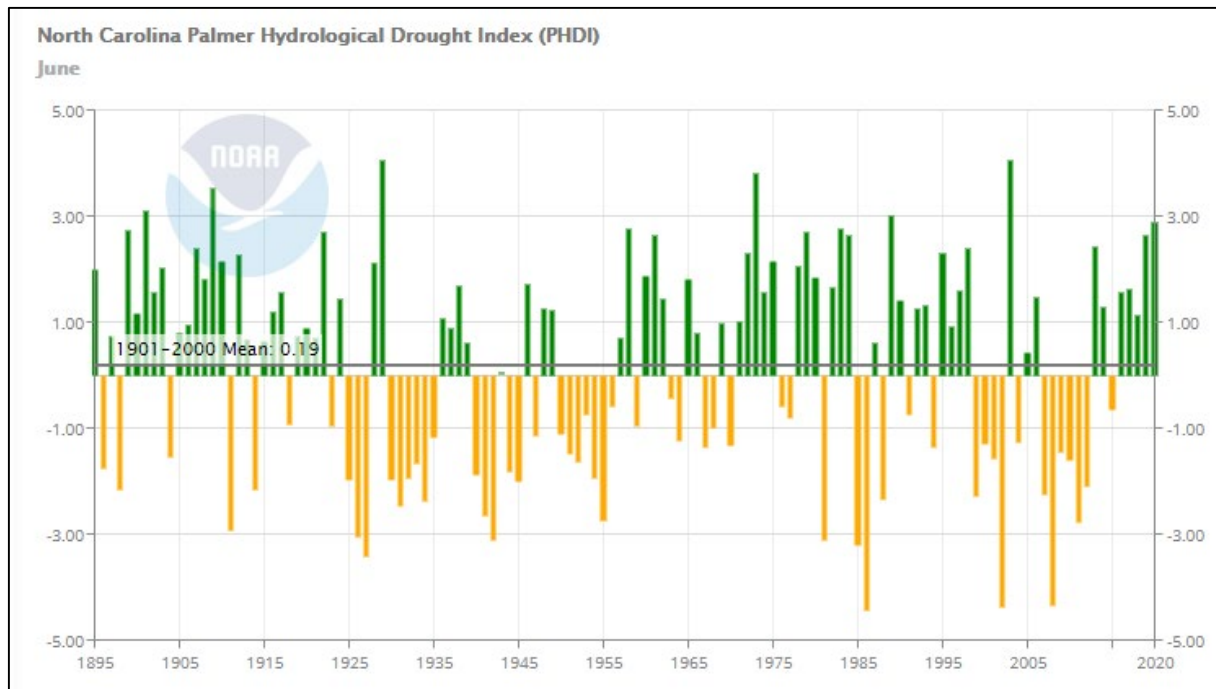


Figure 6. Annual Palmer Hydrologic Drought Index since 1895. Source: NOAA, 2020

North Carolina experienced extreme drought conditions from 1925 through 1927 with monthly 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 annual 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.

### **DMAC Meetings**

Drought conditions in North Carolina are updated weekly through an audio-video teleconference 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 each Thursday. To see or download a copy of the current drought map, go to the state's official drought website at: [www.ncdrought.org](http://www.ncdrought.org).

The DMAC is required by law to meet in person at least once each calendar year. This meeting is normally done in April of each year. It had been scheduled for April 2, 2020 but was cancelled due to the Covid-19 outbreak. The annual council meeting has been rescheduled as a virtual meeting since face-to-face meetings are still discouraged as of August 1, 2020. The virtual annual meeting will be held on September 8, 2020 from 2pm to 4pm. Items to be discussed at the meeting included historic conditions for stream flow and ground water levels, lake and reservoir levels, agriculture, forestry, and public water systems. Current conditions will also be reviewed, and recommendations will be provided to the US Drought Monitor.

### **References:**

NOAA. 2020. Climate at a Glance. National Oceanographic and Atmospheric Administration. Website: <https://www.ncdc.noaa.gov/cag/>. Accessed August 3, 2020.