Report to Governor Roy Cooper and the North Carolina General Assembly Environmental Review Commission

North Carolina Drought Management Advisory Council

Annual Report

October 1, 2024

Division of Water Resources

NORTH CAROLINA DEPARTMENT

OF ENVIRONMENTAL QUALITY

Pursuant to G.S. 143-355.1

North Carolina Department of Environmental Quality
Division of Water Resources

N.C. Drought Management Advisory Council Annual Report
July 1, 2023 – June 30, 2024

Introduction

The North Carolina Drought Management Advisory Council (DMAC) was created as required by North Carolina General Statute 143-355.1 to coordinate 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 Oct. 1 of each year.

Drought Overview 2023 - 2024

Climate Summary - State Climate Office (Corey Davis)

Overall Summary

The 12-month period from July 2023 until June 2024 ranked as North Carolina's seventh warmest (2.4°F above average) and 44th-driest (1.97 inches below average) out of the past 129 years based on data from the National Centers for Environmental Information.

This period included two notable fast-emerging flash drought events that occurred in the fall of 2023 and the early summer of 2024. Pockets of Extreme Drought (D3) were present in North Carolina during both events, representing a degree of dryness and impacts that we had not seen in several years.

While these droughts occurred in different seasons and had varying sectoral impacts, both were brought on by several weeks of dry weather following otherwise normal or wet patterns, and they also ended with the sudden return of heavy rainfall.

Summer 2023

By mid-summer in 2023, North Carolina was drought-free with only a few pockets of Abnormally Dry (D0) conditions in the northeastern corner of the state. Despite periods of pronounced heat in the 28th-warmest July on record, frequent showers and thunderstorms – at times severe, even spawning a rare summertime EF3 tornado near Rocky Mount on July 19 – prevented any drought development before the end of the month.

August arrived with more heat, including the hottest temperature recorded in Asheville (94°F) in more than 11 years, but it also began with limited rainfall. During an 18-day stretch beginning in late July, Kinston had only one day with measurable rainfall, and just 0.03 inches on that date. As a result, Moderate Drought (D1) had emerged in parts of the southern Piedmont and central Coastal Plain by Aug. 22, with noted impacts including crops wilting in Pitt County and a 264-acre wildfire burning in Pamlico County.

The end of summer saw welcome rains in these areas from Tropical Storm Idalia as it tracked to the south. Rainfall totaled up to 8.59 inches in Whiteville, which caused flooding within the town. That rain also helped reduce the coverage of Moderate Drought to less than 2% of the state by early September.

Fall 2023

September 2023 began with a few final hot days, but regular cold frontal passages later in the month made for a timely arrival of fall-like weather. However, winds and weather primarily moving in from the northwest meant limited moisture and dry conditions for much of the state, including the ninth driest September on record in Shelby. Eastern areas did pick up some heavier rainfall later in the month from Tropical Storm Ophelia, but that rain missed the western counties, and by the end of the month, Abnormally Dry conditions had reemerged in the southern mountains.

That dryness ramped up in October, which was the 11th-driest on record statewide with less than an inch of rain observed across much of the state. Even for a relatively wet site such as Raleigh, which had 2.16 inches, there were only four days all month with measurable rainfall, and only one with at least a half-inch of rain.

That persistent dryness led to Moderate Drought emerging across the western half of the state in late October, with Severe Drought (D2) in the southern mountain counties. In response to the rapid onset of drought conditions, municipalities such as Hendersonville and Tryon implemented water conservation measures, and some

farmers delayed harvesting soybeans because of concerns about pods shattering due to low moisture content.

Drought further intensified in early November, including the return of Extreme Drought in North Carolina for the first time since March 2017. In the driest areas in the southwestern counties, wildfire activity was on the increase, with notable events including the 5,505-acre Collett Ridge fire in Cherokee County and 434-acre Poplar Drive fire in Henderson County.

A cold frontal passage just before Thanksgiving brought widespread rainfall that helped contain those fires, but did little to make a dent in the entrenched drought conditions. By the end of November, drought covered almost 58 percent of the state following the 16th-driest fall on record statewide.

Winter 2023-24

Entering the winter, an El Niño pattern had taken shape and its typical impacts – namely, wet weather in North Carolina from more frequent storm systems tracking to the south and east – arrived in December. It was the seventh wettest December on record in North Carolina, with local monthly totals as high as 15.69 inches at Lake Toxaway and 11.26 inches in Marion.

That wet pattern continued in January, which was the 17th-wettest on record statewide. Week-on-week improvements on the US Drought Monitor meant the entire state was drought-free by Jan. 30. Parts of far western North Carolina picked up a bit of snow as part of their January precipitation, with 37.2 inches on Beech Mountain and 6.7 inches in Boone during the month.

February saw decidedly less wintry weather, with a number of 70-degree days across the state thanks to the warm southerly circulation around offshore high pressure. That pattern also made for a dry end to winter in the state's 16th-driest February on record. Parts of northeastern North Carolina began drying out even sooner by mid-January, and they ended the season with Moderate Drought, reflecting recent precipitation deficits and a corresponding drop in streamflows.

Spring 2024

March brought a wetter pattern with the final vestiges of the fading El Niño. Multiple heavy rain events affected the state, especially along the coastline, with the wettest March on record in both Hatteras (13.86 inches) and Elizabeth City (9.25 inches) That rain helped pare back drought in eastern North Carolina, but a small pocket of dry and drought conditions remained in the central Coastal Plain heading into April.

In a big change from the March pattern, April was dry – the 13th-driest on record statewide. By the end of the month, Abnormally Dry conditions had spread across the Piedmont and more of the Coastal Plain. A key impact was a reduction in topsoil moisture, which caused some farmers to delay planting later in the month.

May flipped back to a wetter pattern across much of the state, including the second wettest May on record in Hickory, Marion, and North Wilkesboro. That rain helped to remove almost all of the Abnormally Dry conditions from April, leaving only 1.1% of the state – in the far northeast, where some groundwater levels remained slightly below normal – classified as dry entering the summer.

June 2024

Following the heavy rain in May, drier weather in early June was initially a welcome sight, including for farmers who were able to complete the first cutting of hay and resume their fieldwork. As the month went along, the dryness continued, with a 17-day rain-free streak for much of the northern Mountains and western Piedmont, a 19-day rain-free streak in Fayetteville and 23 days in a row with no measurable rainfall in Greenville, the longest such streak since the fall of 2000. Statewide, it finished as the second driest June on record.

In addition, extreme heat set in by the middle of the month, with 100-degree temperatures observed across parts of the Sandhills and eastern Piedmont. That led to increased evaporation rates and a rapidly emerging drought as much of the state saw categorical degradations from week to week. By late June, Moderate Drought covered 56% of the state, and early July saw the return of Severe and Extreme Drought.

Impacts became widespread by the end of June, including early-planted corn suffering severe setbacks during a moisture-critical point in its development. In addition, local water systems - particularly in eastern North Carolina- requested water conservation, and there were occurrences of rare summertime fire activity as vegetation dried out.

That early summer flash drought was one of the fastest-emerging droughts the state has seen since the US Drought Monitor began its weekly assessments in 2000. The month of June 2024 featured North Carolina’s second-largest week-to-week increase in Abnormally Dry conditions from June 11 to June 18, and the second-largest increase in Moderate Drought the following week.

Streamflow and Groundwater – USGS (Curtis Weaver)

Streamflow conditions during the annual period (July 1, 2023, through June 30, 2024) were characterized by four periods during which below-normal conditions (less than the 25th percentile) were observed across much of the state. These below-normal periods were noted from late October through early December 2023, during the end of February 2024, late April through early May 2024 and the latter half of June 2024.

Figure 1 shown below indicates the percentage of USGS stream gages 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 U.S. Geological Survey (USGS) stream gages across North Carolina having 7-day flow percentiles below the 25th and 10th percentiles reached maximum values of 89 percent (November 17-18, 2023) and 57 percent (Nov. 20, 2023), respectively. By comparison, the maximum percentages observed during the previous annual period (2022–2023) were 68 and 28 percent, respectively, for these two streamflow indicators.

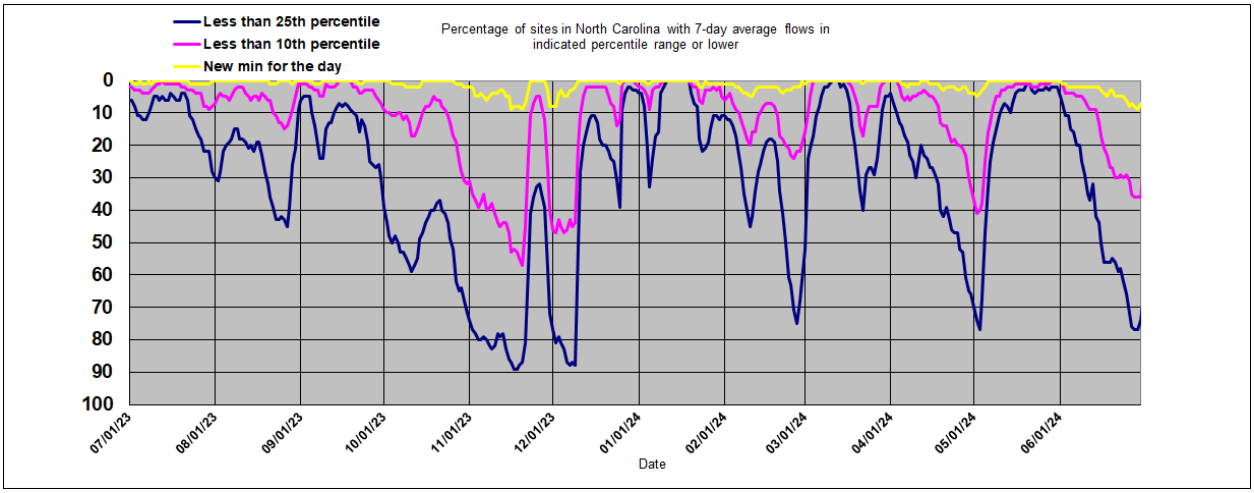

Figure 1. *7-day Flow Percentiles for USGS Streamgages in North Carolina*

The extent of below-normal streamflows across North Carolina during the middle of the 2023 fall (or autumn) season was further echoed with 92 percent of the stream gages across the state having 28-day average streamflows (or 28-day flows) less than the 25th percentile on November 19, 2023 (Figure 2, similarly structured as Figure 1 but for 28-day flows). Correspondingly, the maximum percentage of stream gages with 28-day flows less than the 10th percentile reached 59 percent on Nov. 19-20, 2023.

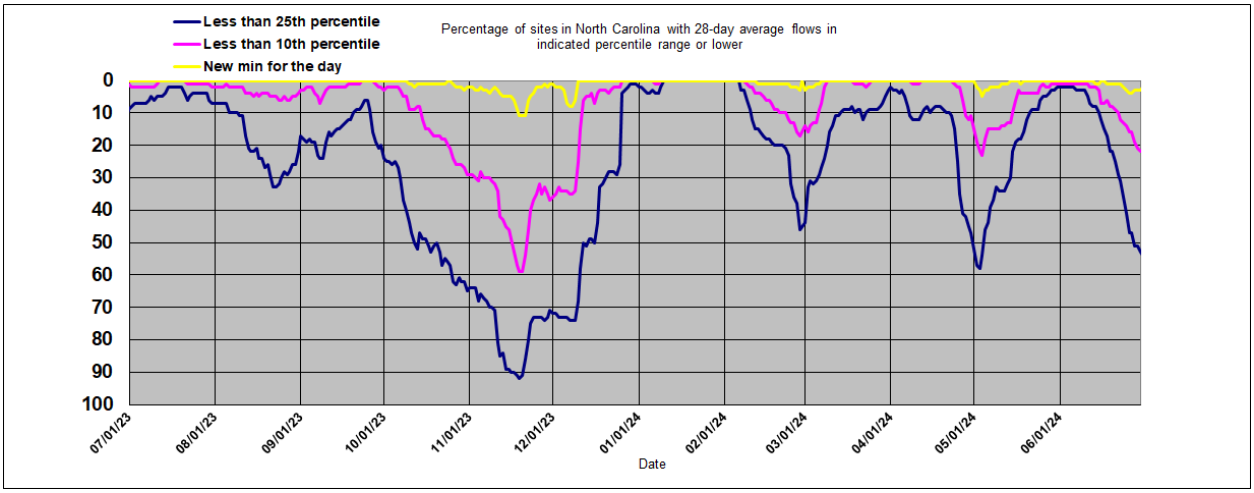

Figure 2. *28-day Flow Percentiles for USGS Streamgages in North Carolina*

Examination of approved (2023 water year) and provisional (2024 water year) daily discharge data indicate no period of record minimum daily mean discharges were set at any USGS stream gages in North Carolina during the annual period. However, varying numbers of zero-flow occurrences were observed at five stream gages during the period, meeting the previous record "zero flow" daily discharges set at these stream gages:

(1) USGS 02077200 – Hyco Creek near Leasburg in Caswell County (14 days during the period between Aug. 24 and Sept. 22, 2022),
(2) USGS 0208111310 - Cashie River at SR 1257 near Windsor in Bertie County (six days during June 25-30, 2024),
(3) USGS 02084557 – Van Swamp near Hoke in Washington County (11 days during June 16-26, 2024),
(4) USGS 0208524090 – Mountain Creek at Secondary Road 1617 near Bahama in Durham County (two days during Sept. 7-8, 2023), and
(5) USGS 02101800 – Tick Creek near Mount Vernon Springs in Chatham County (98 days during the period between Aug. 23 and Dec. 09, 2023).

No period of record minimum 7-day flows was observed at any of the USGS stream gages in North Carolina, with exception of four of the five stream gages identified above (02077200, 0208111310, 02084557, and 02101800), where the previous record "zero flow" 7-day average streamflows were again observed within parts of the above-indicated periods.

Minimum monthly average streamflows were observed during the annual period at 12 USGS stream gages widely scattered across central and eastern North Carolina. However, only one of the new provisional monthly minimum averages was low enough

to surpass the previous period of record minimum monthly average flow at USGS 02097314 New Hope Creek near Blands in Durham County. The provisional period of record minimum monthly average flow for June 2024 occurred on the 30th of the month, superseding the previous record of 10.84 on Sept. 30, 1984 (1984 water year).

Groundwater levels at the 14 observation wells within the USGS Climate Response Network (Figure 3) varied widely during the annual period from July 1, 2023, through June 30, 2024. The water levels in these 14 wells reflect the climate conditions (occurrence of precipitation), but changes in water levels are also affected by individual well characteristics (e.g., well depth, surrounding material through which the water moves). It should be noted the number of observation wells within this network declined from 16 at this time in 2023 to 14, following the discontinuation of two observation wells (Southport well in Brunswick County and Oak Ridge well in Guilford County). These two wells were discontinued due to the loss of funding support for continued data collection at these sites.

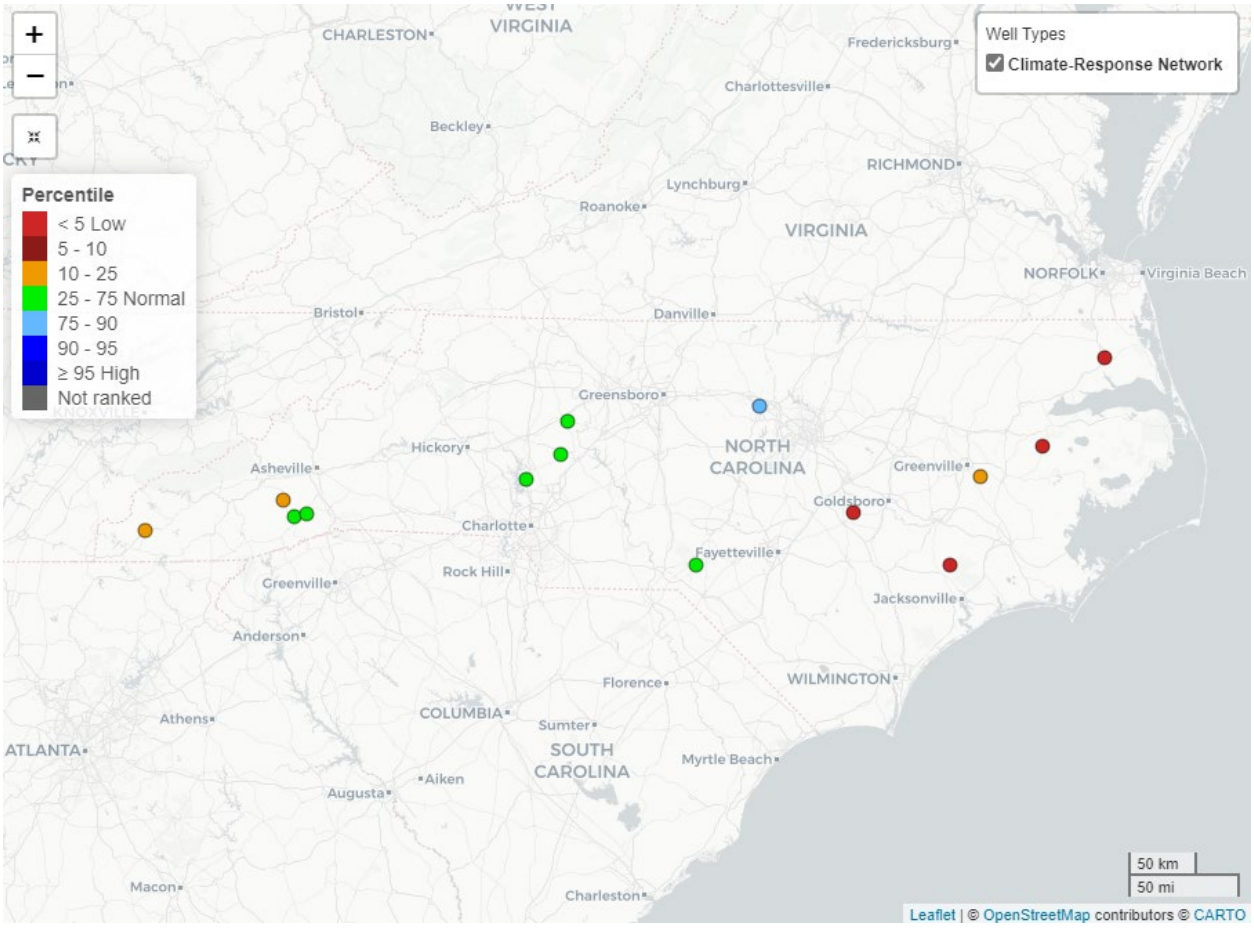

Figure 3. *14 Observation Wells across North Carolina within the USGS Climate Response Network as of June 27, 2024*

At the beginning of the annual period in July 2023, observed water levels at the four Blue Ridge observation wells in this network began a general decline from mostly normal conditions to below normal by mid-December 2023. Even the slow-changing water levels at the deeper Blantyre well in Transylvania County dropped into the below-normal ranges from November 2023 through January 2024. Multiple beneficial precipitation events beginning in late December 2023 reversed the water-level trends in these four wells to an upward pattern that lasted through the February-April 2024 timeframe. An extended dry period began to settle across much of the Blue Ridge region during spring 2024 and lasted through the remainder of the annual period ending June 2024. While overall water-level declines were noted during the last four months of the report period (March–June), rainfalls from passing storm systems were sufficient to maintain the water-level fluctuations within the normal ranges over the course of the decline. No period of record minimum water levels was noted among any of these four Blue Ridge wells during the annual period. However, it can be noted that provisional monthly record minimum and maximum water levels were observed during December 2023 and January 2024, respectively, for the Pisgah Forest well in Transylvania County.

Water levels at the four Piedmont observation wells in this network generally were in the normal ranges throughout the annual period, although occasional fluctuations into the above-normal ranges were observed between mid-December 2023 and late May 2024. No period of record or monthly record minimum water levels were noted among any of these four Piedmont wells during the period. Analogous to water levels in the Blantyre well in the Blue Ridge region, water level changes in the Duke Forest well in Orange County have been observed to be from extremely slow to seemingly almost nonresponsive to the occurrence of precipitation events.

Water levels in the Marston observation well in Scotland County (Sandhills region) were sustained solely within the normal ranges throughout the annual period. No period of record or monthly record minimum water levels were noted for this well. Similar to water levels in the Blantyre well in the Blue Ridge region and the Duke Forest well in the Piedmont region, water levels in the Marston well are characterized by slow responses to the occurrence of precipitation events.

Among the five observation wells in the Coastal Plain, water levels varied widely during the annual period. Given the shallow depths of the Coastal Plain wells, water levels are typically quick to respond to the occurrence of precipitation. Hence a wide range of conditions can be in effect at a given point in time, as was noted for this annual period. Inspection of the hydrograph for the annual period at the Comfort Research Station (RS) well in Jones County indicated water levels generally remaining in the normal

ranges throughout much of the 12-month period until late May, when water levels fell into the below-normal ranges through the end of June 2024. Inspections of the hydrographs for the past year at three of the five wells (Grantham well in Wayne County, Simpson well in Pitt County, Hoke well in Washington County) indicate water levels mostly in the normal ranges during July–November 2023 (or the first four months of the annual period). During the remainder of the annual period (December 2023 – June 2024), water levels fluctuated between the normal and below-normal ranges at 2 of these three wells (Grantham well, Comfort well). But water levels at the Hoke well were more commonly in the below-normal ranges during most of the remaining annual period. Below-normal water levels were more present throughout the annual period at the Elizabeth City in Pasquotank County, reflective of the persistent dry conditions that remained in effect during eight of the 12 months (December, January, March, and April being the exception where normal conditions were in effect). In short, the above three characterizations suggest water levels in the northern Coastal Plain were more commonly in the below-normal ranges during the annual period. Conversely, the water levels in the southern Coastal Plain exhibited a wide range of fluctuations across both normal and below-normal ranges. No period of record water levels was noted for any of the five Coastal Plain wells. However, provisional monthly record minimum water levels were observed during April 2024 at the Grantham well, as well as during April and May 2024 at both the Hoke well and the Elizabeth City well.

Forestry – NC Forest Service (Jamie Dunbar)

From July 1, 2023, to June 30, 2024, the N.C. Forest Service responded to 5,692 wildfires across the state that, all together, burned approximately 28,145 acres on both public and private lands. The number of wildfires increased by approximately 22 percent, while the number of acres decreased by 60 percent over the previous fiscal year. The number of wildfires was 29 percent more than the 10-year average. The total number of acres burned was 4 percent above the 10-year average. Figure 4 presents the wildfire activity by month for the fiscal year 2024.

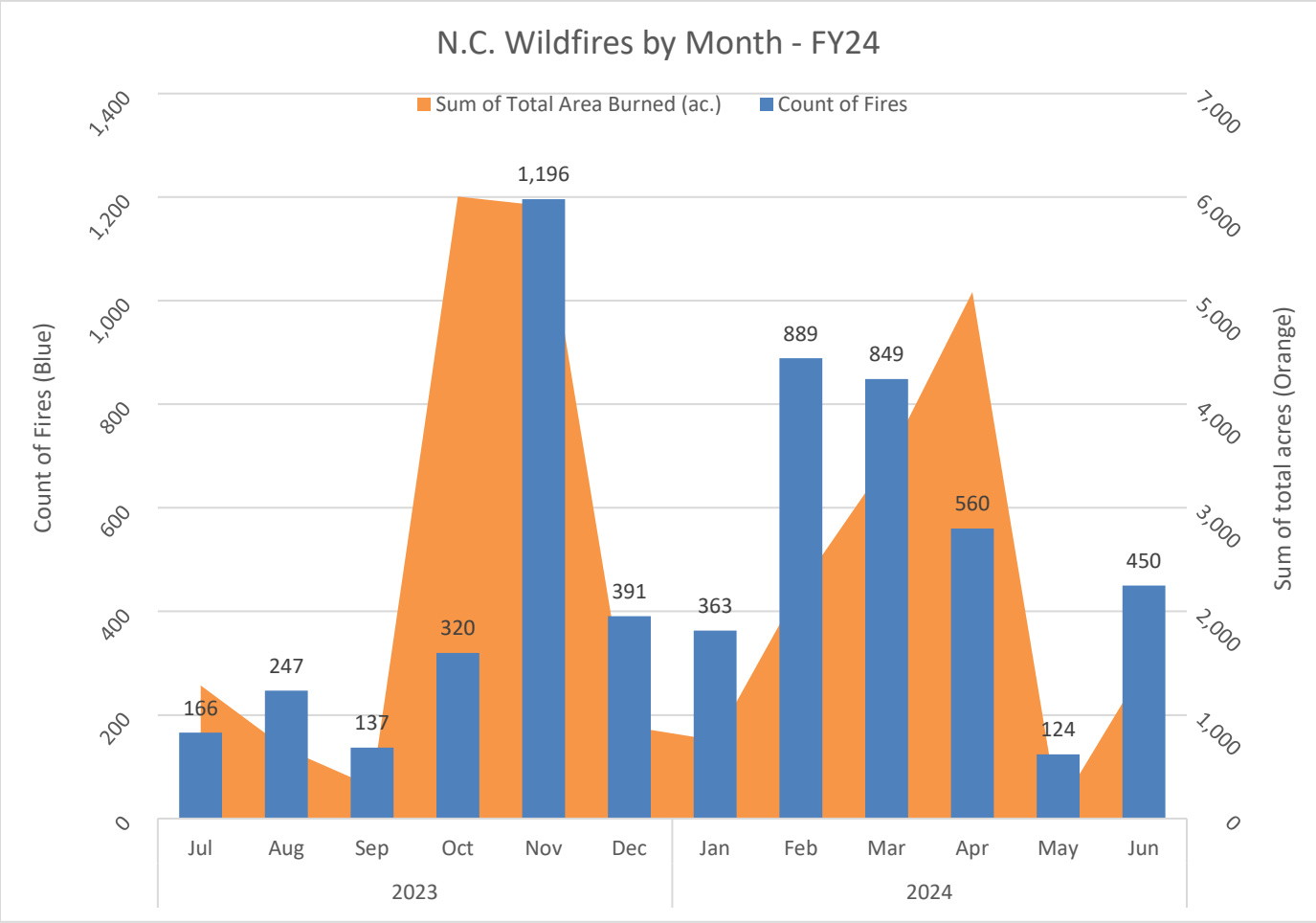

Figure 4. *Wildfire Activity by Month for Fiscal Year 2024*

Abnormally hot, dry periods aligned with seasonal influences on forest fuels, causing an increase in overall wildfire activity across the state for much of the fiscal year. This challenging fire environment led to multiple Incident Management Team deployments, out-of-area resource requests and significantly enhanced difficulty of control, especially fires with deeper organic surface horizons.

Several larger wildfires occurred going into late summer of 2023, including the Bear Swamp Fire (148 acres, Chowan County), which took several months to fully control due to organic smoldering and lack of water. October saw the Collett Ridge Fire (5,419 acres on both state and federally protected lands) in Clay and Cherokee counties. Fall leaf drop further enhanced activity, with additional large fires in November, including the Poplar Drive Fire (434 acres, Henderson County) and Sauratown Mountain Fire (805 acres, Stokes County). Activity increased again moving through the spring and early summer of 2024, coinciding with abnormally low live and dead fuel dryness. Some of

these fires included the Huckleberry Mountain Fire (472 acres, Rutherford County), Horseshoe Lake Fire (569 acres, Bladen County), Highway 12 Fire (3,671 acres, Carteret County), and Morris Marina Road Fire (547 acres, Carteret County).

Agriculture - North Carolina Cooperative Extension (Mike Yoder)

Fiscal year 2023-2024 will be a year not favorably remembered by North Carolina farmers. August of 2023 was dry across much of the state, and while the dryness may have slowed the maturity of some crops, corn and tobacco, having received very timely rains, finished the year in good shape. September, with spotty rains across the state, saw a moderation of the drought status. However, by November, moderate dryness had returned to counties from Clay to Currituck. Counties like Gaston, Surry, Yadkin and Craven were closer to severe drought by the completion of harvest.

Rains through the early to mid-winter timeframe helped prepare soil for 2024 spring planting, with most of the county reports indicating adequate or better soil moisture. A few counties in the northeast were still experiencing abnormal to moderate dryness in late February, when most of the state had adequate soil moisture for planting. March into April saw much of the state in an excellent position for planting and early growth of row crops and forages. Only small areas of abnormal dryness were noted, moving around portions of the Piedmont.

The end of April saw much of the Piedmont and Coastal Plain realizing abnormal to moderate dryness. While this subsided slightly through early to mid-May, by early June, abnormal dryness began to settle into pockets across the state. By mid-June, this dryness increased in severity, with Moderate to Severe dryness consuming most of the Eastern Mountains, Piedmont, and Coastal counties. Iredell, Robeson, Johnston, and Washington Counties reported Severe Drought conditions during this time. By the next week, Moderate Drought had moved into the mountains, with more reports of Severe to Extreme Drought reported in the Piedmont and Coastal Plain counties. This dryness continued through July of 2024.

All indications are that the drought of 2024 will drastically decrease the year’s corn and possibly soybean production, since corn and late-planted soybeans were hit hard by the dryness (Figure 5). Some farmers appear to be in line to lose a majority of their most lucrative crops long before harvest. Producers who relied heavily on these crops in 2024 may find it difficult to balance the books at year’s end.

Figure 5. *Crop Impacts from the 2024 Drought*

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

The July 1, 2023, to June 30, 2024, period began with only a small part of the state in Abnormally Dry (D0) and no areas in drought. Conditions were highly variable throughout the time period, with mid-winter and early summer being the driest (see Figure 6).

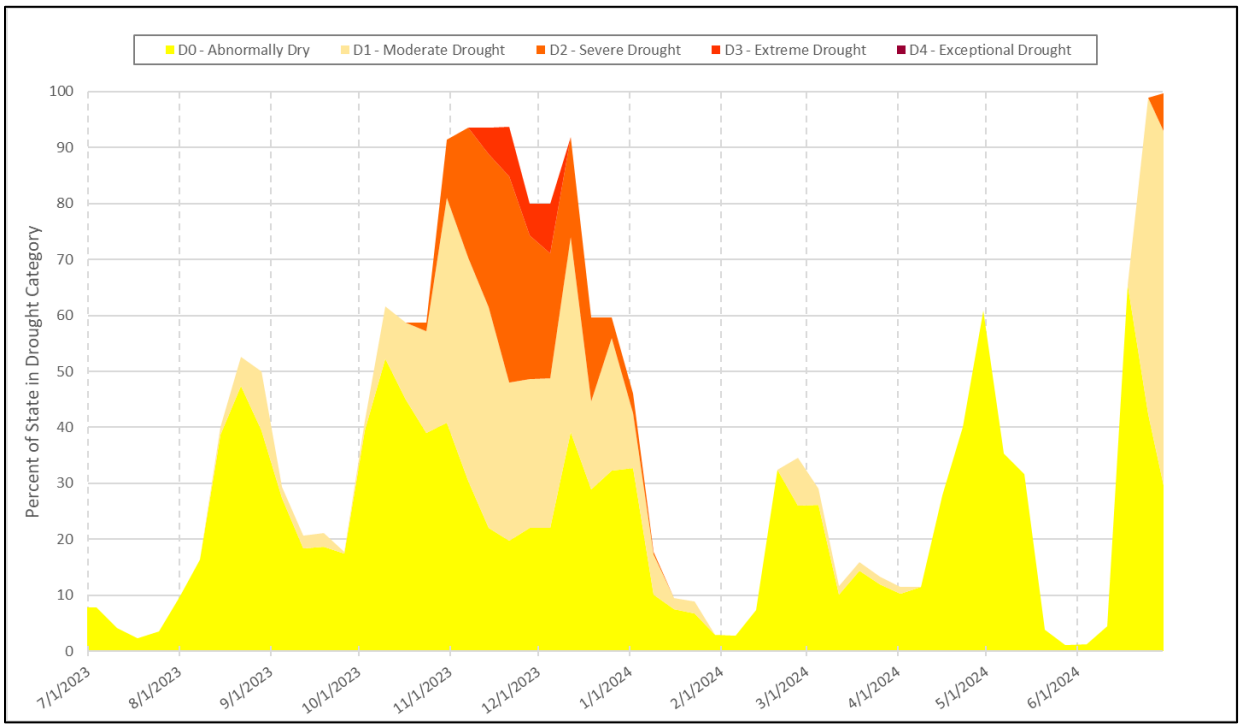

Figure 6. *Drought Levels from July 1, 2023 through June 30, 2024*

Summer 2023

Following a normal spring in 2023, dryness expanded only slowly in the summer (see Figure 7). Regular rains kept conditions from getting significantly worse through September 2023 (Figure 8).

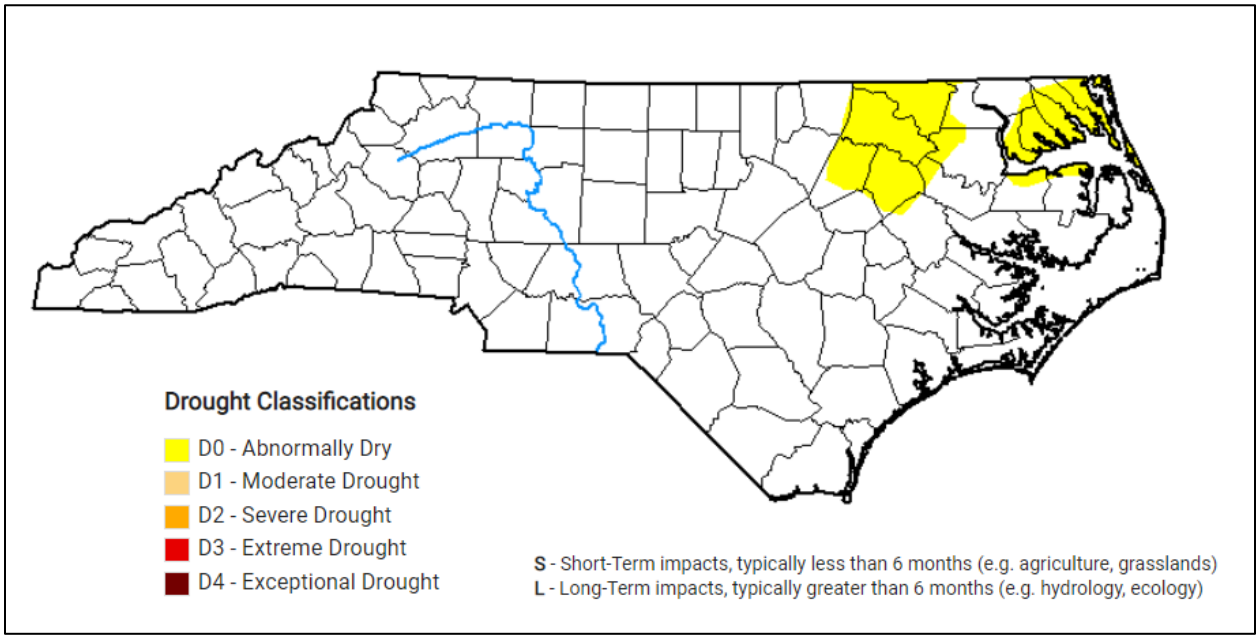

Figure 7. *North Carolina Drought Classification (late-June 2023)*

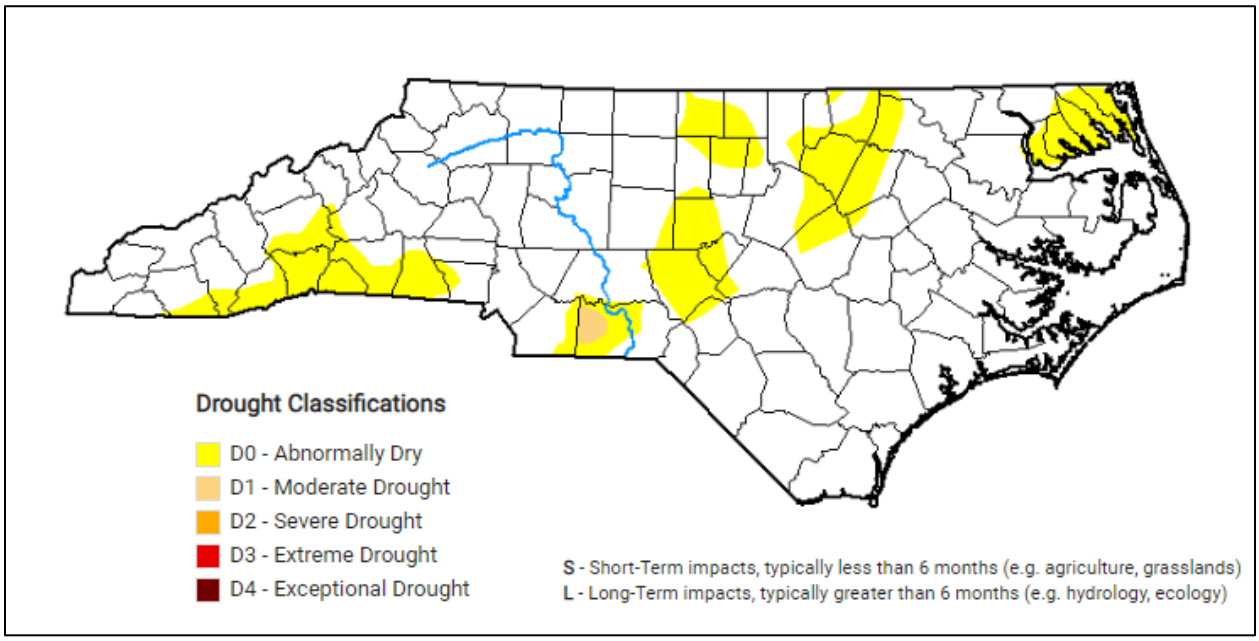

Figure 8. *North Carolina Drought Classification (late-September 2023)*

A very dry period, beginning in October and continuing through November, led to widespread degradation (Figure 9).

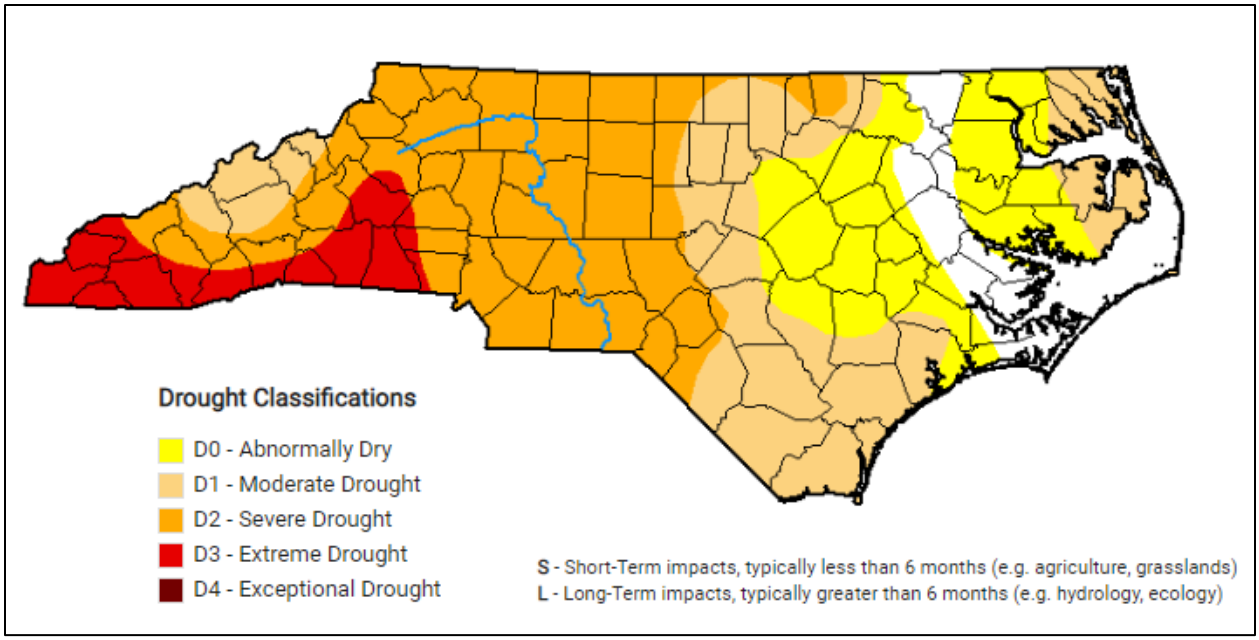

Figure 9. *North Carolina Drought Classification (November 21, 2023)*

Conditions gradually improved throughout the late winter and only limited dry areas remained by the end of January 2024 (Figure 10).

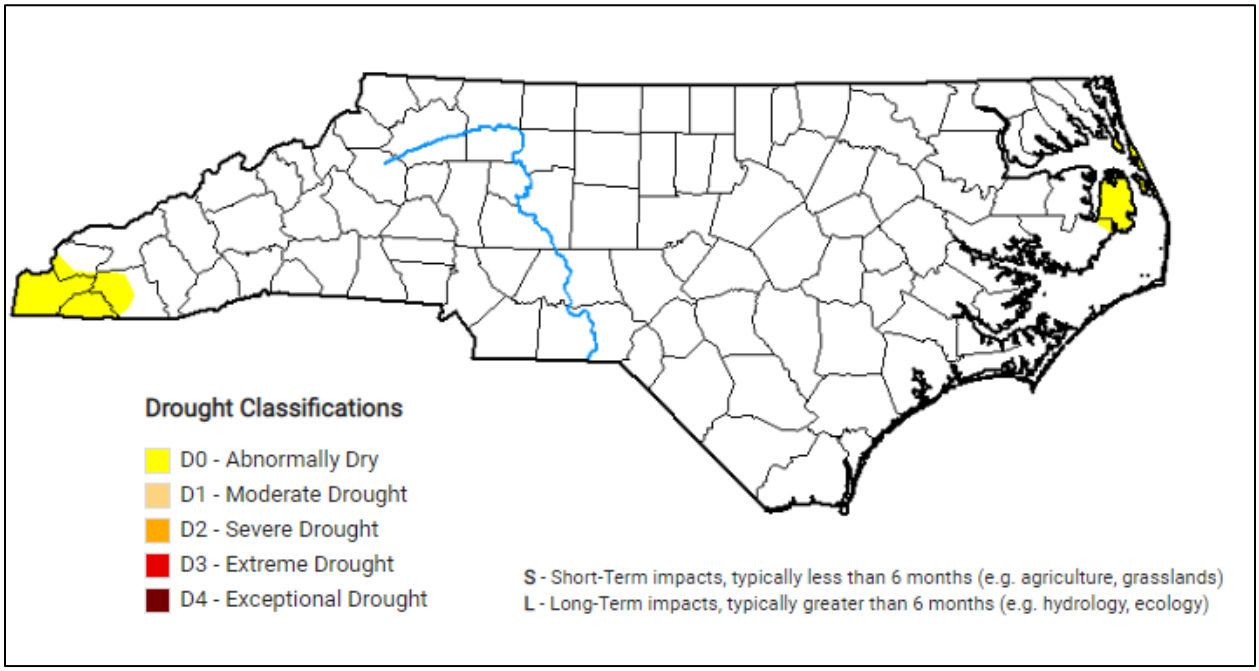

Figure 10. *North Carolina Drought Classification (January 30, 2024)*

Rainfall in early spring tended to miss the Coastal Plain, resulting in Abnormally Dry or Moderate Drought by late-March. A more widespread dry pattern formed in April, resulting in widespread abnormal dryness across the state (Figure 11).

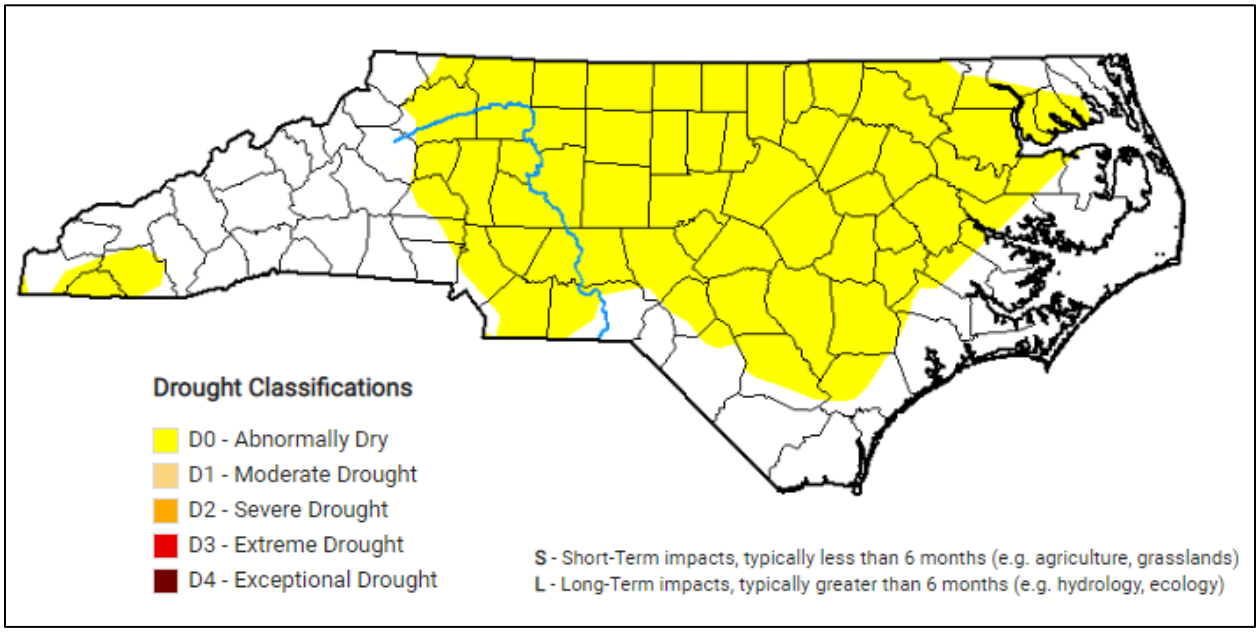

Figure 11. *North Carolina Drought Classification (April 30, 2024)*

Heavy rains in May eradicated most of the dryness in the state. Unfortunately, the entire state saw very limited rain in June and widespread dryness was seen almost statewide (Figure 12). At the end of the period for this report, 42 percent of the state was Abnormally Dry and 57 percent was in Moderate Drought.

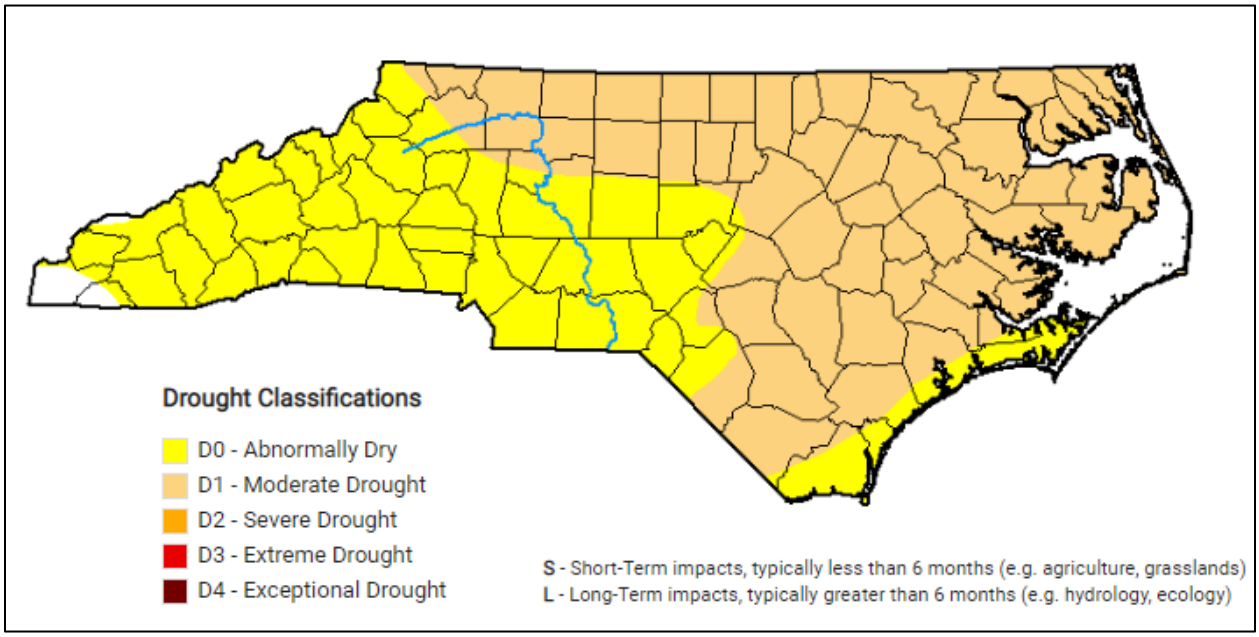

Figure 12. *North Carolina Drought Classification (June 25, 2024)*

Historical Perspective

Due to the natural variability of climate, drought may occur at any location in the state and at any time of the year. Typically, we see some part of the state with Abnormally Dry conditions and a much smaller area in Moderate Drought at some point in the year. 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 2023 – 2024 period was fairly typical, although the state did see Extreme Drought conditions for the first time since 2017. Much of the state saw Abnormally Dry or Moderate Drought at some point during the year, but the severity and impacts were very limited. The most extreme drought of the period occurred during the winter, when water demands are typically the lowest and much of the state's ecosystem is semi-dormant.

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 (Figure 13). 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.

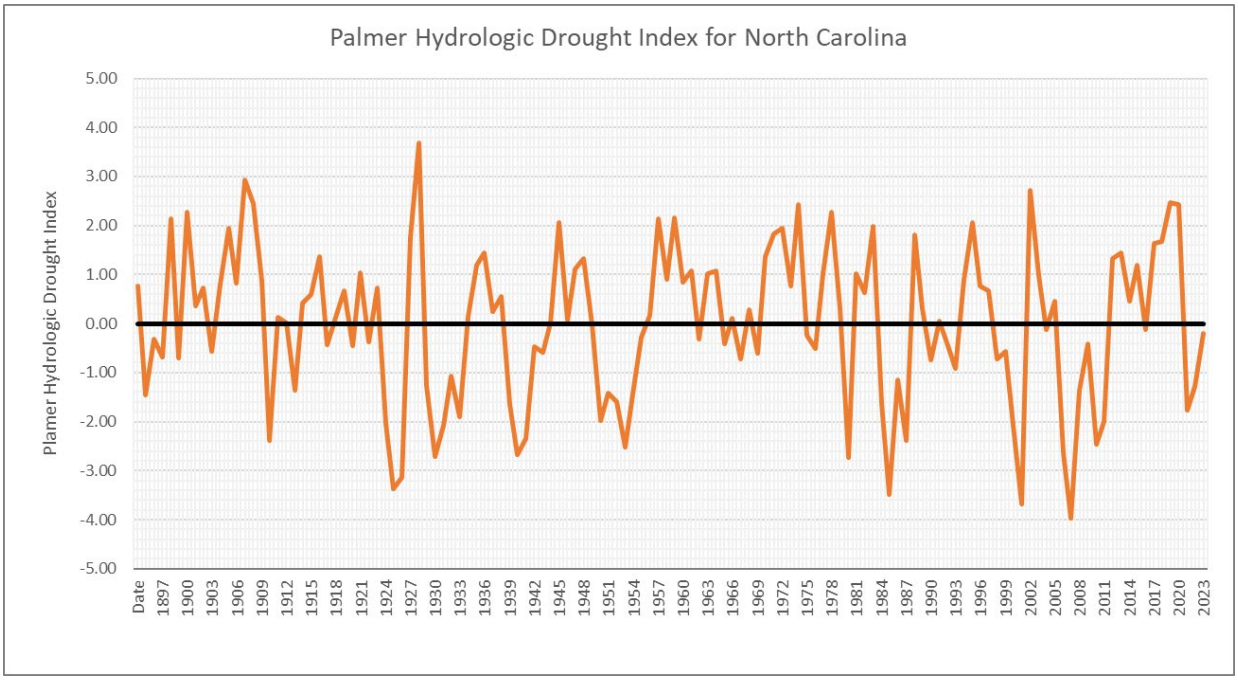

Figure 13. *Palmer Hydrologic Drought Index since 1895* Source: NOAA, 2024

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 1940s and 1950s, but it wasn't until the late 1980s that extreme drought returned. The PHDI reached a low of -4.6 in July 1986. Moderate to wet conditions returned in the 1990s, 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 -0.56 (NOAA, 2024). Since the 2007 to 2008 drought, conditions had been trending wetter than normal. However, conditions over the last two years swung back to slightly below normal.

The 2020 North Carolina Climate Science Report (Kunkel et. Al., 2020) found that based on historical observations and projected changes to temperature and rainfall, it is likely that future droughts in North Carolina will be more frequent and intense due to higher temperatures, leading to increased evaporation. The total annual precipitation is not expected to change significantly but variability is expected to increase with more frequent intense rain events and more severe dry periods.

DMAC Meetings

Drought conditions in North Carolina are updated weekly through a video call with a Technical Drought Advisory Team, which is a sub-group of the 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, visit 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. In 2024, the council's annual meeting was held on Sept. 11. Items on the agenda for discussion at the meeting included a recap of stream flow and groundwater levels, lake and reservoir levels, agriculture, forestry, and public water systems conditions over the July 2023 through June 2024 period.

References:

NOAA. 2023. Climate at a Glance. National Oceanographic and Atmospheric Administration. Website: https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/statewide/time-series/. Accessed July 29, 2024.

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