



# **Weather of Bluestone National Scenic River, Gauley River National Recreation Area, and New River Gorge National River**

*Eastern Rivers and Mountains Network Summary Report for 2010*

Natural Resource Data Series NPS/ERMN/NRDS—2011/291



**ON THE COVER**

Mist over insignificant rapid, Gauley River, Gauley River National Recreation Area.

Photograph by: Jim Vanderhorst.

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Paul Knight, Tiffany Wisniewski, Chad Bahrmann, and Sonya Miller

Pennsylvania State Climate Office  
503 Walker Building  
Pennsylvania State University  
University Park, Pennsylvania

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The National Park Service, Natural Resource Stewardship and Science Office in Fort Collins, Colorado publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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# Table of Contents

	Page
Figures.....	v
Tables.....	vii
List of Key Acronyms.....	ix
Introduction.....	1
Climate of the Central and Southern West Virginia Region.....	3
Observing Stations.....	5
Temperature Summary.....	9
Precipitation Summary.....	15
Drought Status.....	19
References.....	23



# Figures

	Page
<b>Figure 1.</b> Location of weather observing stations around Bluestone National Scenic River, Gauley River National Recreation Area, and New River Gorge National River. See Table 1 for station names. ....	6
<b>Figure 2.</b> Maps showing departure from average monthly maximum temperature compared to the 30-year normal (1971–2000).....	11
<b>Figure 3.</b> Maps showing departure from average monthly minimum temperature compared to the 30-year normal (1971–2000).....	12
<b>Figure 4.</b> Maps showing percent of average monthly precipitation compared to the 30-year normal (1971–2000). ....	17
<b>Figure 5.</b> Monthly Palmer Drought Severity Index (PDSI) values for West Virginia Climate Division 4, 2008–2010.....	20
<b>Figure 6.</b> Monthly Palmer Drought Severity Index (PDSI) values for West Virginia Climate Division 5, 2008–2010.....	20
<b>Figure 7.</b> Mid-month values of the United States Drought Monitor (DM) – Drought Intensity Index for West Virginia in 2010.....	21
<b>Figure 8.</b> Mid-month values of the United States Drought Monitor (DM) – Drought Intensity Index for the Northeast in 2010.....	22



# Tables

	Page
<b>Table 1.</b> List of weather observing stations around Bluestone National Scenic River, Gauley River National Recreation Area, and New River Gorge National River selected as best representative of the parks in 2010.....	7
<b>Table 2.</b> Status of 2010 temperature indicators compared to the 30-year normal (1971–2000) at the London Locks (LONW2), Beckley Airport (KBKW), and Summersville Lake (SUMW2) stations.....	10
<b>Table 3.</b> Summary of monthly average temperature for 2010 for the selected stations.....	13
<b>Table 4.</b> Summary of 2010 departure from normal temperature based on 30-year normal (1971–2000) for the selected stations.....	14
<b>Table 5.</b> Seasonal temperature and precipitation rankings over 116 years (1 = warmest/wettest year and 116 = coldest/driest year) for West Virginia Climate Division 4 (top) and 5 (bottom).....	14
<b>Table 6.</b> Status of 2010 precipitation indicators compared to the 30-year normal (1971–2000) at the London Locks (LONW2), Beckley Airport (KBKW), and Summersville Lake (SUMW2) stations.....	16
<b>Table 7.</b> Top five wettest days and top five dry spells (consecutive days with a trace or less of rainfall) during 2010 from stations London Locks (LONW2), Beckley Airport (KBKW), and Summersville Lake (SUMW2).....	16
<b>Table 8.</b> Summary of 2010 monthly total precipitation for selected stations.....	18
<b>Table 9.</b> Summary of 2010 percent of normal precipitation based on 30-year normal (1971–2000) for selected stations.....	18



## List of Key Acronyms

ASOS	Automated Surface Observing System
BLUE	Bluestone National Scenic River
COOP	National Weather Service Cooperative Observer Program
CWOP	Citizen Weather Observer Program
ERMN	Eastern Rivers and Mountains Network
GARI	Gauley River National Recreational Area
GOES	Geostationary Operational Environmental Satellite
IFLOWS	Integrated Flood Observing and Warning System
NADP	National Atmospheric Deposition Program
NARR	North American Regional Reanalysis
NCDC	National Climatic Data Center
NERI	New River Gorge National River
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NR	National River
NRA	National Recreation Area
NSR	National Scenic River
NWS	National Weather Service
PDSI	Palmer Drought Severity Index
POR	Period of Record
PRISM	Parameter-elevation Regressions on Independent Slopes Model
RAWS	Remote Automated Weather Stations
USDM	United States Drought Monitor
USGS	United States Geological Survey



## Introduction

Weather and climate are widely recognized as key drivers of terrestrial and aquatic ecosystems, affecting biotic as well as abiotic ecosystem characteristics and processes. Global and regional scale climatic patterns, trends, and variations are critical to the cycling of elements, nutrients, and minerals through ecosystems and can deliver pollutants from regional and even global sources (National Assessment Synthesis Team 2001). These variations and trends influence the fundamental properties of ecologic systems such as soil-water relationships and plant-soil processes and their disturbance rates and intensity. Information obtained from meteorological monitoring will be useful to interpreting and understanding changes in species composition, community structure, water and soil chemistry, and related landscape processes (Marshall and Piekielek 2007).

The purpose of this report is to provide a concise weather and climate summary for January 1 to December 31, 2010, and to place current patterns and trends in an appropriate historical and regional context (Marshall et al., in review). It is our intention that this report will satisfy an inherent interest in meteorological phenomena and meet a portion of the Eastern Rivers and Mountains Network (ERMN) Weather and Climate Monitoring objective:

- Document current status and long-term trends in air temperature and precipitation at multiple temporal scales (e.g., daily, monthly, seasonal, annual, and decadal) and spatial scales (e.g., individual stations and aggregated stations such as climate divisions) utilizing existing weather and climate monitoring programs and datasets.

To accomplish this objective, a variety of atmospheric data streams were evaluated for their quality, longevity, and applicability to the ERMN parks. Since no single weather observing network contains all the pertinent measures of atmospheric phenomena to assess ecosystem health, an objective analysis of the data networks was developed and outlined in the Weather and Climate Monitoring Protocol for the Eastern Rivers and Mountains Network and Mid-Atlantic Network of the National Park Service (Marshall et al., in review). Through this analysis, a select number of weather/climate observing stations were chosen as representative of each park and these are the primary data sources used to profile climate summary and trends.

In addition to a suite of summary tables, graphs, and narratives, we specifically identify a series of key weather indicators to report status and trends on an annual basis and periodically in separate and more thorough reports. These key indicators are further described in the protocol (Marshall et al., in review) and summarized in the body of this report.



## Climate of the Central and Southern West Virginia Region

Bluestone National Scenic River (NSR) lies within West Virginia (WV) Climate Division 5, “Southern,” while Gauley River National Recreation Area (NRA) lies in WV Climate Division 4, “Central.” New River Gorge National River (NR) lies in both. A climate division is a region that is reasonably homogenous with respect to climatic and hydrologic characteristics (<http://www.esrl.noaa.gov/psd/data/usclimdivs/data/map.html> [NOAA 2010]) and is frequently used for compiling climate statistics. West Virginia is divided into 6 climate divisions.

The two climate divisions encompassing these parks are generally considered to have a humid, continental type of climate, but the varied physiographic features have a marked effect on the weather and climate of the various parts of this region. The prevailing westerly winds carry most of the weather disturbances that affect the region from the interior of the continent, with the Atlantic Ocean having only an occasional influence on the climate of the area (Davey et al. 2006). Coastal storms do, at times, affect the day-to-day weather, especially in the winter. Infrequently, storms of tropical origin can have a significant effect, causing severe floods in some instances.

Temperatures are moderately continental with the tempering effects of the Great Lakes contributing to cloud production in the winter and mountain-valley circulation clouds reducing the heat at times during the summer. The lowest readings in the winter occur with polar air masses of Canadian origin settling over the region after a fresh snowfall. The highest readings of the summer happen when the sub-tropical fair weather system, the Bermuda high, pushes westward into the Carolinas; its clockwise circulation will direct hot, humid air from the Gulf region into the Ohio Valley and West Virginia. The humid southwest winds ascending the crest of the Appalachians can produce widespread afternoon thunderstorms. On average, Gauley River National Recreational Area tends to have a greater number of hot days (temperatures above or equal to 90.0°F/32.0°C) than New River Gorge National River and Bluestone National Scenic River. The last freeze typically occurs in mid-May and the first frosts appear in October.

Precipitation is fairly evenly distributed throughout the year. Annual amounts generally range between 36–52 in (914–1,321 mm), while the majority of places receive 38–44 in (965–1,118 mm). Greatest amounts usually occur in the late spring and summer months, while February is the driest month, having about 2 in (51 mm) less than the wettest months. During the warm season, the uneven heating over the irregular terrain leads to numerous thunderstorms which typically form over the mountains.

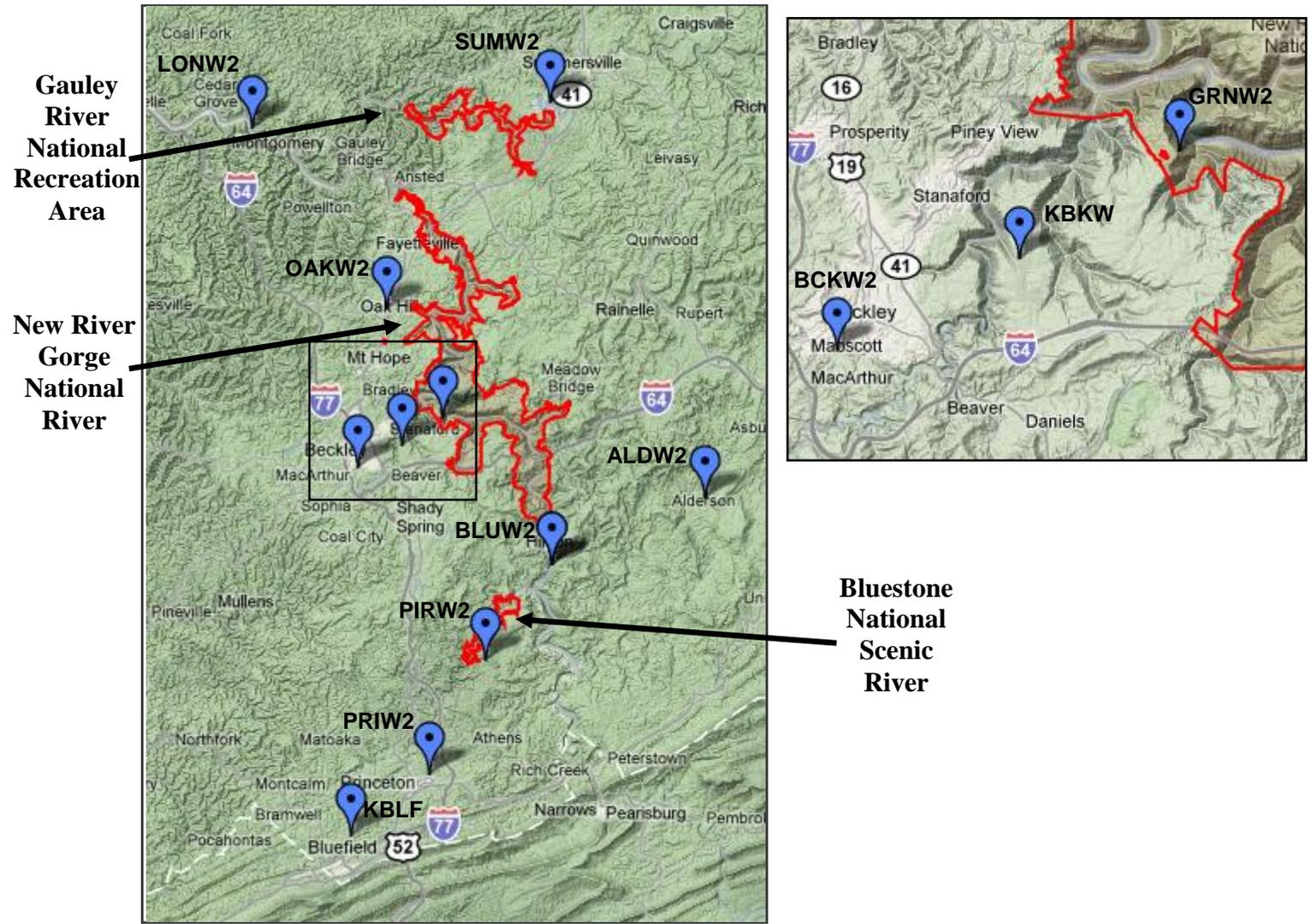
Surface winds blow from the west and northwest in the cold season and from the southwest during the warm half of the year. Thunderstorms follow a frequency that matches the solar cycle, occurring between the equinoxes and reaching a peak near the summer solstice. Hail is relatively infrequent, but flash floods and damaging thunderstorm winds affect parts of the region each summer. On average, tornadoes pass through the area about once every three years. The direct effects of an Atlantic hurricane are uncommon, though remnant rains from hurricanes and tropical storms have contributed to the region’s worst floods. Ice storms, which can cause significant disruption, occur at irregular intervals and are primarily confined to the months between December and March (Kocin and Uccellini 2004).



## Observing Stations

A total of 11 weather observing stations comprising three observing networks were selected around Bluestone NSR, Gauley River NRA, and New River Gorge NR. Representative stations within a 100-km range of each park were chosen based on several criteria, which include proximity to the park, the representativeness of the station to the park elevation profile, the type and frequency of observations, the period of record of the data, and data availability (Marshall et al., in review). Moreover, the percentage of time a station reports particular parameters (e.g., temperature) can influence data inclusion. No stations were excluded in 2010 due to this criterion; therefore, a total of 11 stations were used for this report (Figure 1, Table 1).

In addition to the summary information available in this report, a near real-time data stream has been made available to the ERMN through a Web interface for the selected stations along with monthly, seasonal, and annual summaries. The Web interface is accessible through the following link: [http://climate.met.psu.edu/gmaps/NPS\\_DEVELOPMENT/interface.php](http://climate.met.psu.edu/gmaps/NPS_DEVELOPMENT/interface.php).



9

**Figure 1.** Location of weather observing stations around Bluestone National Scenic River, Gauley River National Recreation Area, and New River Gorge National River. See Table 1 for station names.

**Table 1.** List of weather observing stations around Bluestone National Scenic River, Gauley River National Recreation Area, and New River Gorge National River selected as best representative of the parks in 2010.

Station	Observing Network	Station Name	Period of Record (POR)		Percentage of Time Reporting Temperature for 2010	Percentage of Time Reporting Precipitation for 2010	Percentage of Time Reporting Temperature for entire POR	Percentage of Time Reporting Precipitation for entire POR
BLUW2	COOP	Bluestone Lake	03/01/1943	Present	-	99.7	98.4*	99.6
OAKW2	COOP	Oak Hill	10/01/1941	Present	97.0	97.3	97.7	97.8
LONW2	COOP	London Locks	07/01/1934	Present	100.0	99.7	90.0*	88.9
SUMW2	COOP	Summersville Lake	02/01/1967	Present	100.0	98.4	98.1	99.0
PRIW2	COOP	Princeton	07/01/1940	Present	-	97.5	-	98.7
ALDW2	COOP	Alderson	03/01/1944	Present	100.0	100.0	85.1*	95.1
BCKW2	COOP	Beckley VA Hospital	12/01/1893	Present	97.0	97.0	78.5	76.3
KBKW	ASOS	(Beckley) Raleigh County Memorial Airport	05/15/1963	Present	100.0	100.0	99.9	99.9
KBLF	ASOS	(Bluefield) Mercer County Airport	01/01/1972	Present	100.0	100.0	99.2	99.2
GRNW2	RAWS	Grandview	01/01/2005	Present	93.1	93.1	98.6	98.3
PIRW2	RAWS	Pipestem	06/09/2005	Present	80.9	80.9	96.4	96.4

\*BLUW2 stopped reporting temperature in 2007.

\*LONW2 began reporting temperature on 8/4/1936.

\*ALDW2 stopped reporting temperature on 9/30/1959, but restarted on 2/1/2005.

\*BCKW2 began reporting temperature on 4/1/1896.



## Temperature Summary

The 2010 calendar year averaged slightly below normal compared with the long-term mean for temperature (Tables 2, 3, and 4) and had departures that were rather similar to 2009. After a chilly January, February was quite cold, but March saw a return to seasonal temperatures.(Figures 2 and 3).<sup>1</sup>

The lowest readings, which were near 0 degrees Fahrenheit (°F) (-17.8 degrees Celsius [°C]), during the winter, were measured on January 11, 2010. The lowest value for the year near the parks occurred in Summerville Lake, WV, and was -1.0°F (-18.3°C) (Table 2). The number of sub-freezing days was slightly above the long-term mean, but the number of cold days was far above the average (Table 2), with most stations tallying double the normal number of cold days. The winter ranked as the 16<sup>th</sup> and 17<sup>th</sup> coldest in 116 years for the climate divisions encompassing the parks (58 is the mid-point; Table 5).

The spring brought a dramatic turnaround as warmth returned quickly, such that the period from April to June, 2011 ranked as the 2<sup>nd</sup> warmest in 116 years (Figures 2 and 3; Table 5). Record early warmth was noted during the first week of April as readings rose above 86°F (30°C) in some locations. An outbreak of cold weather in the early part of May brought most sections their last frost (on May 10–11), so the growing season in parts of each park began near the average date (Table 2). Most of this spring's warmth can be attributed to warm April days and sultry June nights (Figures 2 and 3).

The summer months of July–August–September were quite warm due to hot July days (Figure 2) and warm August nights (Figure 3). No record maximums were recorded during the period and the summer ranked as the 7<sup>th</sup>–15<sup>th</sup> warmest in 116 years of records (Table 5). The highest readings of the year, above 90°F (32.2°C) occurred from July 7–10 (Table 2).

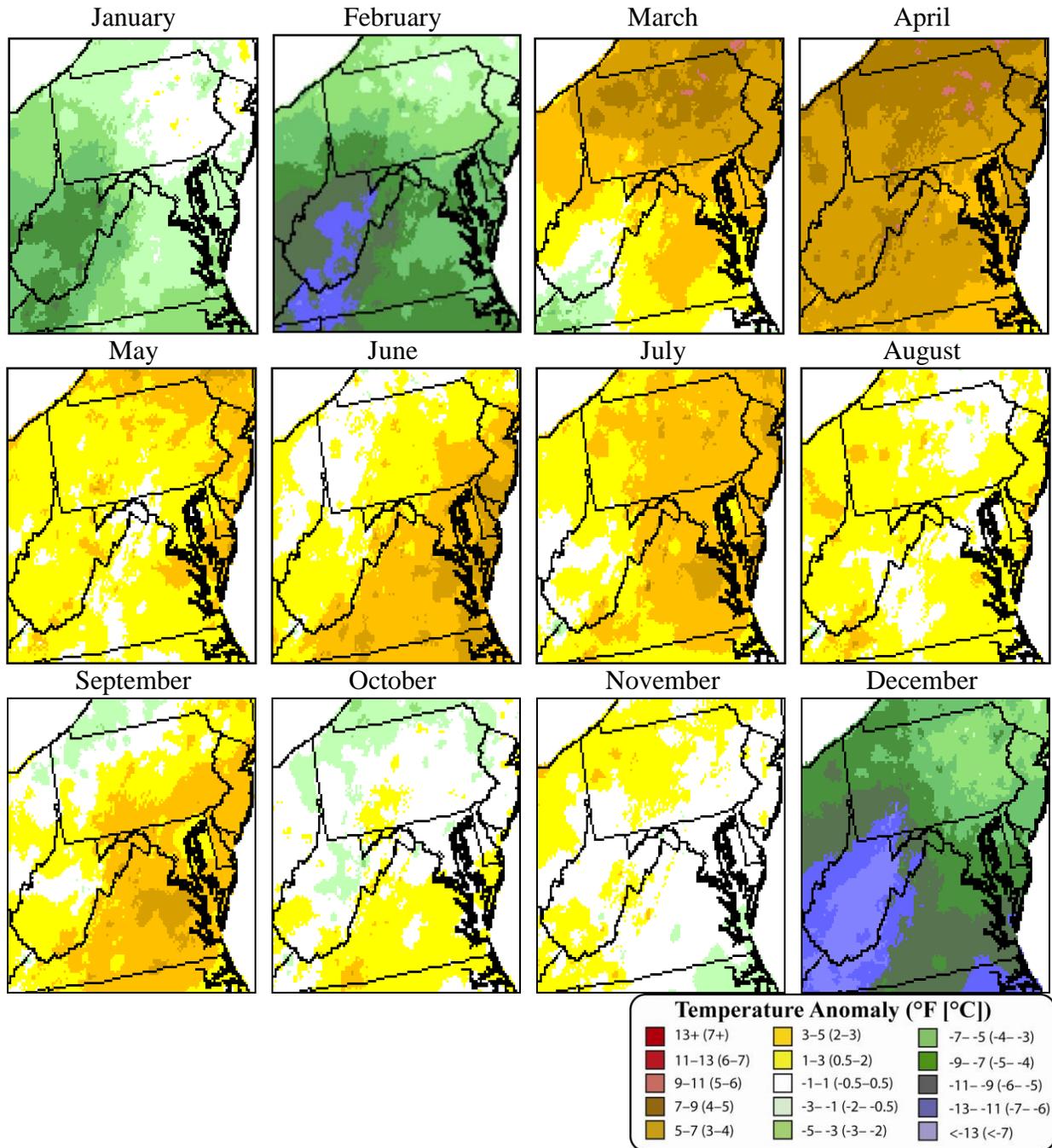
Overall, autumn ranked as one of the ten coldest of the last 116 years for temperature (Table 5). Frosts and freezes occurred later than in recent years, with most sections noticing sub-freezing readings (<32°F [<0°C]) on October 30. As a result, the length of the growing season was longer (by about two–three weeks) (Table 2) than in 2009. While October and November averaged near to slightly below normal (Figures 2 and 3), it was December, which had departures of -10°F (-5.6°C) that made this season so cold (Table 4). The average annual temperature ranged from 0.0°F (0.0°C) to -1.3°F (-0.7°C), making 2010 colder than the previous 11 years.

<sup>1</sup> The maps in Figures 2 and 3 were created using estimates from the Parameter-elevation Regressions on Independent Slopes Model (PRISM). PRISM uses an interpolation scheme for temperature between actual observations and corrects these estimates for changes in topography across the region (Daly et al. 2002). More information can be found at <http://www.prism.oregonstate.edu/>.

**Table 2.** Status of 2010 temperature indicators compared to the 30-year normal (1971–2000) at the London Locks (LONW2), Beckley Airport (KBKW), and Summersville Lake (SUMW2) stations.

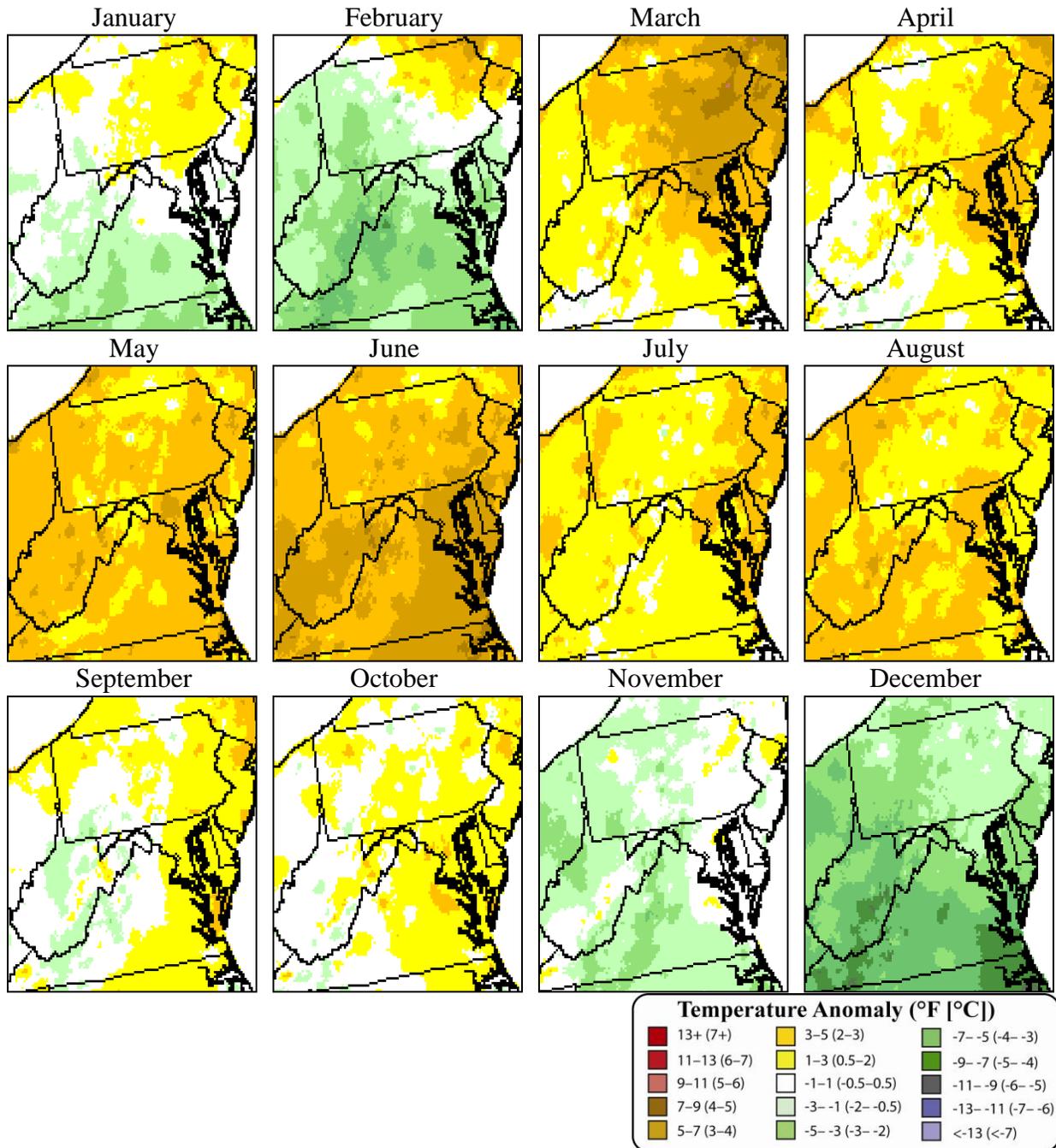
<b>Temperature Indicator</b>	<b>London Locks, WV 2010</b>	<b>London Locks, WV 1971-2000</b>	<b>Beckley Airport, WV 2010</b>	<b>Beckley Airport, WV 1971-2000</b>	<b>Summersville Lake, WV 2010</b>	<b>Summersville Lake, WV 1971-2000</b>
Average Annual Temperature	55.5°F 13.1°C	55.5°F 13.1°C	51.8°F 11.0°C	51.7°F 10.9°C	50.1°F 10.1°C	51.4°F 10.8°C
Average Annual Maximum Temperature	65.7°F 18.7°C	65.9°F 18.8°C	60.7°F 15.9°C	61.3°F 16.3°C	60.2°F 15.7°C	62.3°F 16.8°C
Maximum Temperature	94.0°F 34.4°C	94.3°F 34.6°C	89.1°F 31.7°C	88.0°F 31.1°C	92.0°F 33.3°C	90.0°F 32.2°C
Hot Days (days with T <sub>max</sub> ≥90°F/32°C)	40	19	0	1	4	4
Average Annual Minimum Temperature	45.2°F 7.3°C	45.0°F 7.2°C	42.9°F 6.1°C	42.1°F 5.6°C	40.0°F 4.4°C	40.4°F 4.7°C
Minimum Temperature	7.0°F -13.9°C	1.2°F -17.1°C	3.9°F -15.6°C	-5.5°F -20.8°C	-1.0°F -18.3°C	-6.6°F -21.4°C
Cold Days (days with T <sub>max</sub> ≤32°F/0°F)	37	14	56	28	57	28
Sub-freezing Days (days with T <sub>min</sub> ≤32°F/0°C)	100	94	113	111	138	127
Sub-zero Days (days with T <sub>min</sub> ≤0°F/-17.8°C)	0	1	0	3	1	5
Growing Season Length (days between last spring T <sub>min</sub> 32°F/0°C and first fall T <sub>min</sub> 32°F/0°C)	224	200	172	159	165	165

Bluestone National Scenic River,  
 Gauley River National Recreation Area,  
 and New River Gorge National River  
 Departure from Average Monthly Maximum Temperature  
 2010 vs. 1971–2000



**Figure 2.** Maps showing departure from average monthly maximum temperature compared to the 30-year normal (1971–2000).

Bluestone National Scenic River,  
Gauley River National Recreation Area,  
and New River Gorge National River  
Departure from Average Monthly Minimum Temperature  
2010 vs. 1971–2000



**Figure 3.** Maps showing departure from average monthly minimum temperature compared to the 30-year normal (1971–2000).

**Table 3.** Summary of monthly average temperature for 2010 for the selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Oak Hill, WV	OAKW2	27.2°F	26.5°F	41.7°F	55.4°F	63.3°F	71.9°F	72.6°F	73.0°F	65.8°F	54.3°F	44.7°F	23.9°F	51.7°F
		-2.7°C	-3.1°C	5.4°C	13.0°C	17.4°C	22.2°C	22.6°C	22.8°C	18.8°C	12.4°C	7.0°C	-4.5°C	10.9°C
London Locks, WV	LONW2	30.2°F	30.2°F	44.6°F	58.7°F	66.6°F	76.3°F	77.3°F	77.2°F	70.0°F	57.7°F	46.9°F	28.8°F	55.4°F
		-1.0°C	-1.0°C	7.0°C	14.8°C	19.2°C	24.6°C	25.2°C	25.1°C	21.1°C	14.3°C	8.3°C	-1.8°C	13.0°C
Summersville Lake, WV	SUMW2	25.6°F	25.0°F	40.2°F	54.1°F	61.6°F	70.4°F	72.1°F	71.1°F	63.5°F	52.0°F	42.0°F	22.5°F	50.0°F
		-3.6°C	-3.9°C	4.5°C	12.3°C	16.4°C	21.3°C	22.3°C	21.7°C	17.5°C	11.1°C	5.6°C	-5.3°C	10.0°C
Alderson, WV	ALDW2	28.2°F	28.0°F	43.7°F	56.1°F	65.4°F	73.7°F	75.6°F	75.4°F	66.6°F	54.5°F	43.5°F	26.0°F	53.1°F
		-2.1°C	-2.2°C	6.5°C	13.4°C	18.5°C	23.1°C	24.2°C	24.1°C	19.2°C	12.5°C	6.4°C	-3.3°C	11.7°C
Beckley VA Hospital, WV	BCKW2	24.8°F	24.1°F	38.1°F	51.7°F	60.5°F	67.9°F	69.3°F	69.4°F	61.9°F	51.1°F	41.1°F	21.8°F	48.5°F
		-4.0°C	-4.4°C	3.4°C	11.0°C	15.8°C	20.0°C	20.7°C	20.8°C	16.6°C	10.6°C	5.0°C	-5.6°C	9.2°C
Beckley Airport, WV	KBKW	26.0°F	26.0°F	41.5°F	56.4°F	63.5°F	70.5°F	72.7°F	72.8°F	65.8°F	55.0°F	45.4°F	24.4°F	51.7°F
		-3.3°C	-3.3°C	5.3°C	13.6°C	17.5°C	21.4°C	22.6°C	22.7°C	18.8°C	12.8°C	7.5°C	-4.2°C	10.9°C
Bluefield Airport, WV	KBLF	28.6°F	28.3°F	44.1°F	59.6°F	66.0°F	73.3°F	75.2°F	74.8°F	68.2°F	57.3°F	47.8°F	25.7°F	54.1°F
		-1.9°C	-2.1°C	6.7°C	15.3°C	18.9°C	23.0°C	24.0°C	23.8°C	20.1	14.1°C	8.8°C	-3.5°C	12.3°C
Grandview, WV	GRNW2	27.3°F	26.0°F	41.8°F	57.0°F	63.1°F	70.3°F	71.6°F	70.7°F	64.5°F	53.3°F	43.3°F	23.1°F	51.0°F
		-2.6°C	-3.3°C	5.5°C	13.9°C	17.3°C	21.3°C	22.0°C	21.5°C	18.0°C	11.8°C	6.3°C	-5.0°C	10.6°C
Pipestem, WV	PIRW2	32.4°F	28.6°F	43.1°F	57.6°F	63.2°F	70.6°F	71.9°F	75.0°F	65.5°F	54.9°F	44.0°F	23.4°F	52.5°F
		0.2°C	-1.9°C	6.2°C	14.2°C	17.3°C	21.4°C	22.2°C	23.9°C	18.6°C	12.7°C	6.6°C	-4.8°C	11.4°C

**Table 4.** Summary of 2010 departure from normal temperature based on 30-year normal (1971–2000) for the selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Oak Hill, WV	OAKW2	-3.4°F	-7.3°F	-0.2°F	4.1°F	3.7°F	4.7°F	1.5°F	3.0°F	2.1°F	1.5°F	1.0°F	-10.7°F	0.0°F
		-1.9°C	-4.1°C	-0.1°C	2.3°C	2.1°C	2.6°C	0.8°C	1.7°C	1.2°C	0.8°C	0.5°C	-5.9°C	0.0°C
London Locks, WV	LONW2	-3.7°F	-6.6°F	-0.4°F	4.7°F	3.7°F	5.0°F	1.6°F	2.5°F	1.5°F	0.6°F	-0.1°F	-9.3°F	-0.04°F
		-2.1°C	-3.7°C	-0.2°C	2.6°C	2.1°C	2.8°C	0.9°C	1.4C	0.8°C	0.3°C	-0.1°C	-5.2°C	-0.02°C
Summersville Lake, WV	SUMW2	-3.2°F	-6.5°F	0.5°F	4.7°F	2.9°F	3.9°F	1.6°F	2.1°F	0.4°F	0.2°F	-0.3°F	-10.9°F	-0.4°F
		-1.8°C	-3.6°C	0.3°C	2.6°C	1.6°C	2.2°C	0.9°C	1.2°C	0.2°C	0.1°C	-0.2°C	-6.0°C	-0.2°C
Beckley VA Hospital, WV	BCKW2	-3.7°F	-7.4°F	-1.4°F	-3.1°F	2.8°F	3.6°F	1.2°F	2.6°F	1.3°F	1.2°F	0.3°F	-10.9°F	-0.6°F
		-2.0°C	-4.1°C	-0.8°C	1.7°C	1.6°C	2.0°C	0.7°C	1.4°C	0.7°C	0.6°C	0.1°C	-6.0°C	-0.3°C
Alderson, WV	ALDW2	-4.6°F	-8.1°F	-0.9°F	2.3°F	4.1°F	5.7°F	4.0°F	4.6°F	1.8°F	-0.3°F	-1.7°F	-10.6°F	-0.3°F
		-2.5°C	-4.5°C	-0.5°C	1.3°C	2.3°C	3.2°C	2.2°C	2.6°C	1.0°C	-0.2°C	-0.9°C	-5.9°C	-0.1°C
Beckley Airport, WV	KBKW	-4.4°F	-7.9°F	-0.6°F	4.9°F	3.6°F	3.5°F	2.0°F	3.5°F	2.7°F	2.2°F	2.0°F	-10.4°F	0.1°F
		-2.5°C	-4.4°C	-0.3°C	2.7°C	2.0°C	1.9°C	1.1°C	1.9°C	1.5°C	1.2°C	1.1°C	5.8°C	0.1°C
Bluefield Airport, WV	KBLF	-4.2°F	-7.8°F	-0.5°F	5.8°F	4.7°F	5.3°F	3.6°F	4.0°F	3.4°F	2.5°F	2.6°F	-10.9°F	0.7°F
		-2.3°C	-4.3°C	-0.3°C	3.2°C	2.6°C	2.9°C	2.0°C	2.2°C	1.9°C	1.4°C	1.4°C	-6.1°C	0.4°C

\* Stations with a period of record of less than 8 years (Grandview and Pipestem) were not included in this table.

**Table 5.** Seasonal temperature and precipitation rankings over 116 years (1 = warmest/wettest year and 116 = coldest/driest year) for West Virginia Climate Division 4 (top) and 5 (bottom).

WV Climate Division 4 Rankings "Central"	Jan–Feb–Mar WINTER	Apr–May–Jun SPRING	Jul–Aug–Sep SUMMER	Oct–Nov–Dec AUTUMN
Temperature-2010	101	2	15	109
Precipitation-2010	75	73	82	68

WV Climate Division 5 Rankings "Southern"	Jan–Feb–Mar WINTER	Apr–May–Jun SPRING	Jul–Aug–Sep SUMMER	Oct–Nov–Dec AUTUMN
Temperature-2010	100	2	7	105
Precipitation-2010	58	30	72	55

## Precipitation Summary

Liquid precipitation (rain and melted snow, ice, sleet, etc.; hereafter, precipitation) for the region averaged very near the long-term mean (Table 6). The majority of the wettest days occurred during the warmer half of the year with only two excessively damp days in the winter (Table 7). An unusually dry period was noted from August 26 until September 26 when there were two long spells without any measurable rain (Table 7). Snowfall was far above normal with record snow totals at most locations (Table 6). The number of days with excessive rainfall (>1.0 in [25 mm]) was above the long-term average for south-central West Virginia (Table 6).

The winter was a bit wetter than normal (Figure 4), as January averaged approximately 93 percent of normal precipitation in Beckley, WV, and 125 percent in Bluestone Lake, WV (Tables 8 and 9). February was drier (Figure 4), with between 68 percent and 115 percent of average precipitation (Tables 8 and 9), though virtually all that fell did so in the form of snow. Monthly precipitation in March was above normal, with 2.6–7.0 in (66–178 mm) accumulating across the central and southern districts of West Virginia (Table 8). Winter precipitation, including rain and snow (liquid equivalent), was ranked as 36–48<sup>th</sup> driest in 116 years of record keeping (Table 5).

Spring 2010 brought dry conditions to the more northern parks and rather wet conditions to the southern sections (Figure 4), averaging the 45<sup>th</sup> driest in climate division 4 and 30<sup>th</sup> wettest in climate division 5 (Table 5). By far, May was the wettest month of this season, as 103–171 percent of normal rain was reported (Table 9) and one of the year's wettest days occurred on May 13<sup>th</sup>, when over 2 in (>55mm) of rain fell (Table 7). June brought more sporadic rainfall. Alderson tallied only 45 percent of average rainfall, while Beckley's VA Hospital measured 184 percent of normal rainfall, and these stations are only about 25 miles apart.

The summer months of July, August, and September were a bit drier than average. The southern valleys averaged near-normal rainfall, but the eastern and central mountains were dry (Figure 4). The wettest day of 2010 occurred on July 14, as an average of 3.0 in (76.2 mm) was tallied in the region (Table 7). The summer ranked the 35<sup>th</sup> driest in the central West Virginia climate division, and the 45<sup>th</sup> driest in the southern division (Table 5).

The autumn brought virtually normal precipitation (Figure 4). October was dry with most sections averaging from 53–100 percent of the normal rainfall (Table 9); however, November brought above-average precipitation to southern sites. For example, Summersville Lake, WV, had 64 percent of normal rainfall, but Bluefield, WV, tallied 150 percent with 4.3 inches (86 mm) (Tables 8 and 9). December turned rather wet, with more than 150 percent of normal rain and snow tallied at Princeton, WV (Table 9). Overall, 2010 brought between 76–110 percent of average annual precipitation, which ranged from -3 in (-76 mm) to +3 in (76 mm). It was a virtually normal year with regards to precipitation.

**Table 6.** Status of 2010 precipitation indicators compared to the 30-year normal (1971–2000) at the London Locks (LONW2), Beckley Airport (KBKW), and Summersville Lake (SUMW2) stations.

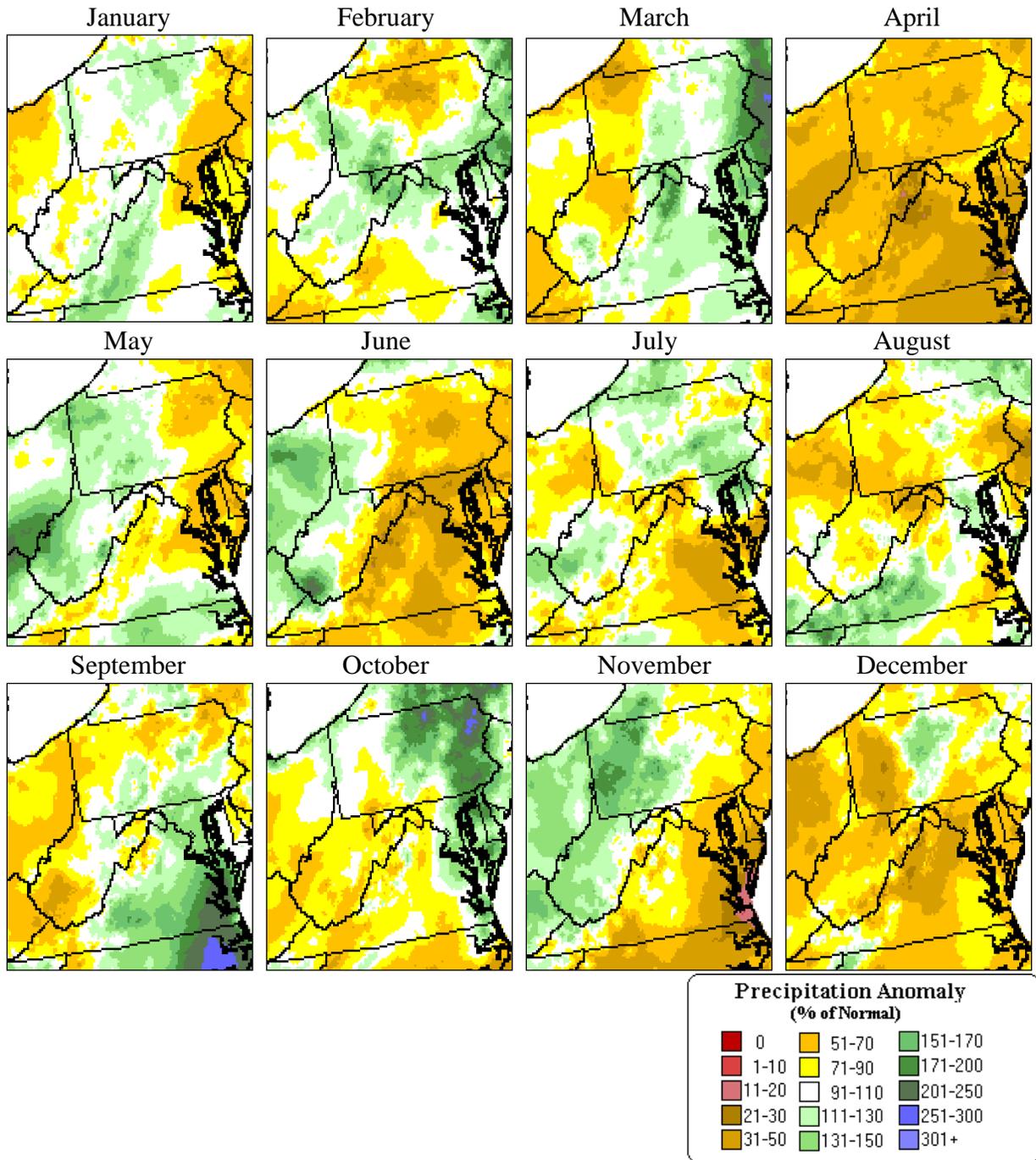
Precipitation Indicators	London Locks, WV 2010	London Locks, WV 1971-2000	Beckley Airport, WV 2010	Beckley Airport, WV 1971-2000	Summersville Lake, WV 2010	Summersville Lake, WV 1971-2000
Annual Precipitation	41.9 in 1,064 mm	44.9 in 1,140 mm	44.4 in 1,128 mm	41.6 in 1,057 mm	45.5 in 1,156 mm	47.5 in 1,207 mm
Autumn Precipitation (Oct, Nov, Dec) Precipitation	7.5 in 191 mm	9.0 in 229 mm	8.1 in 206 mm	8.6 in 218 mm	7.9 in 201 mm	10.1 in 257 mm
Heavy Precipitation Days (days with $\geq 1.0$ in (25 mm) rain)	13	9	8	7	5	9
Extreme Precipitation Days (days with $\geq 2.0$ in (51 mm) rain)	2	1	1	1	3	1
Micro-drought (strings of 7+ days without rain)	11	7	8	4	8	4
Annual Snowfall (inches)	M*	16.0 in 40.6 cm	142.7 in 362.5 cm	37.1 in 94.2 cm	88.8 in 225.6 cm	43.5 in 110.5 cm
Measurable Snow Days (days with $\geq 0.1$ in (0.3 cm) snow)	M*	11	55	18	38	20
Moderate Snow Days (days with $\geq 2.0$ in (5.0 cm) snow)	M*	3	28	8	19	11
Heavy Snow Days (days with $\geq 5.0$ in (12.7 cm) snow)	M*	1	11	2	5	1

\*Snowfall data for London Locks (LONW2) is denoted with an M (missing) because this station did not report snowfall during January and February 2010

**Table 7.** Top five wettest days and top five dry spells (consecutive days with a trace or less of rainfall) during 2010 from stations London Locks (LONW2), Beckley Airport (KBKW), and Summersville Lake (SUMW2).

Wettest Days in 2010	Dry Spells in 2010
Jul. 14: 3.00 in (76.2 mm)	Aug. 26–Sep. 7
Jun. 11: 2.86 in (72.6 mm)	Jun. 30–Jul. 9
May. 13: 2.28 in (57.9 mm)	Oct. 17–26
Dec. 1: 2.04 in (51.8 mm)	Sep. 18–26
Mar. 12: 1.99 in (50.5 mm)	Nov. 6–14

Bluestone National Scenic River,  
 Gauley River National Recreation Area,  
 and New River Gorge National River  
 Percent of Average Monthly Precipitation  
 2010 vs. 1971–2000



**Figure 4.** Maps showing percent of average monthly precipitation compared to the 30-year normal (1971–2000).

**Table 8.** Summary of 2010 monthly total precipitation for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Bluestone Lake, WV	BLUW2	3.8 in	2.6 in	3.0 in	1.3 in	5.2 in	2.3 in	1.9 in	2.7 in	2.4 in	1.8 in	1.9 in	3.1 in	32.1 in
		97 mm	66 mm	76 mm	33 mm	132 mm	58 mm	48 mm	69 mm	61 mm	46 mm	48 mm	79 mm	815 mm
Oak Hill, WV	OAKW2	3.8 in	3.4 in	6.2 in	2.6 in	5.3 in	6.8 in	6.2 in	5.2 in	1.8 in	1.9 in	2.3 in	4.7 in	50.2 in
		97 mm	86 mm	157 mm	66 mm	135 mm	173 mm	157 mm	132 mm	46 mm	48 mm	58 mm	119 mm	1,275 mm
London Locks, WV	LONW2	2.2 in	2.0 in	7.0 in	2.5 in	5.5 in	5.7 in	5.7 in	2.7 in	1.2 in	1.4 in	2.7 in	3.4 in	41.9 in
		56 mm	51 mm	178 mm	64 mm	140 mm	145 mm	145 mm	69 mm	30 mm	36 mm	69 mm	86 mm	1,064 mm
Summersville Lake, WV	SUMW2	3.7 in	3.5 in	3.3 in	2.3 in	6.0 in	5.0 in	8.1 in	4.3 in	1.5 in	3.3 in	2.1 in	2.6 in	45.5 in
		94 mm	89 mm	84 mm	58 mm	152 mm	127 mm	206 mm	109 mm	38 mm	84 mm	53 mm	66 mm	1,156 mm
Princeton, WV	PRIW2	4.2 in	3.1 in	4.7 in	1.9 in	5.8 in	4.9 in	4.4 in	3.5 in	2.2 in	1.4 in	1.8 in	3.9 in	41.7 in
		107 mm	78 mm	119 mm	48 mm	147 mm	125 mm	112 mm	89 mm	56 mm	36 mm	46 mm	99 mm	1,059 mm
Alderson, WV	ALDW2	3.9 in	3.0 in	2.6 in	1.7 in	4.3 in	1.6 in	1.8 in	2.9 in	1.9 in	1.8 in	1.7 in	3.0 in	30.2 in
		99 mm	76 mm	66 mm	43 mm	109 mm	41 mm	46 mm	74 mm	48 mm	46 mm	43 mm	76 mm	767 mm
Beckley VA Hospital, WV	BCKW2	3.4 in	2.7 in	4.8 in	2.1 in	5.4 in	6.4 in	5.0 in	3.0 in	1.7 in	2.0 in	2.6 in	3.4 in	38.5 in
		86 mm	69 mm	122 mm	53 mm	137 mm	163 mm	127 mm	76 mm	43 mm	51 mm	66 mm	86 mm	978 mm
Beckley Airport, WV	KBKW	3.1 in	2.0 in	5.8 in	1.9 in	7.5 in	4.3 in	5.9 in	2.7 in	2.0 in	2.0 in	3.9 in	2.3 in	43.3 in
		78 mm	52 mm	147 mm	48 mm	191 mm	109 mm	150 mm	69 mm	51 mm	51 mm	99 mm	58 mm	1,100 mm
Bluefield Airport, WV	KBLF	3.4 in	2.2 in	4.4 in	2.6 in	4.5 in	5.0 in	4.6 in	4.2 in	2.3 in	1.6 in	4.0 in	3.4 in	42.0 in
		86 mm	55 mm	112 mm	66 mm	114 mm	127 mm	117 mm	107 mm	58 mm	41 mm	102 mm	86 mm	1,067 mm
Grandview, WV	GRNW2	5.2 in	3.2 in	5.4 in	2.8 in	7.1 in	5.7 in	5.7 in	3.9 in	4.7 in	2.4 in	1.8 in	4.3 in	52.2 in
		132 mm	81 mm	137 mm	71 mm	180 mm	145 mm	145 mm	99 mm	119 mm	61 mm	46 mm	109 mm	1326 mm
Pipestem, WV	PIRW2	4.3 in	3.7 in	6.0 in	1.9 in	6.7 in	3.8 in	M	M	4.6 in	3.0 in	3.1 in	2.8 in	M
		109 mm	94 mm	152 mm	48 mm	170 mm	97 mm	M	M	117 mm	76 mm	79 mm	71 mm	M

\* M = missing data (Monthly statistics are reported as 'M' if more than 4 days of data are missing).

**Table 9.** Summary of 2010 percent of normal precipitation based on 30-year normal (1971–2000) for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Bluestone Lake, WV	BLUW2	125	97	87	40	132	69	45	82	85	69	75	120	85
Oak Hill, WV	OAKW2	105	106	155	66	118	159	117	128	51	62	70	135	109
London Locks, WV	LONW2	64	68	185	68	113	135	112	65	34	53	77	98	93
Summersville Lake, WV	SUMW2	102	115	86	61	126	113	146	91	42	100	64	74	96
Princeton, WV	PRIW2	132	114	139	57	148	135	113	109	74	56	67	151	110
Alderson, WV	ALDW2	124	103	71	53	103	45	43	91	61	65	61	100	76
Beckley VA Hospital, WV	BCKW2	108	101	151	62	129	184	110	85	53	79	92	117	97
Beckley Airport, WV	KBKW	93	68	160	55	171	110	123	78	62	76	135	74	104
Bluefield Airport, WV	KBLF	108	76	121	77	104	130	115	131	72	61	150	121	106

\* Stations with a period of record of less than 8 years (Grandview and Pipestem) were not included in this table.

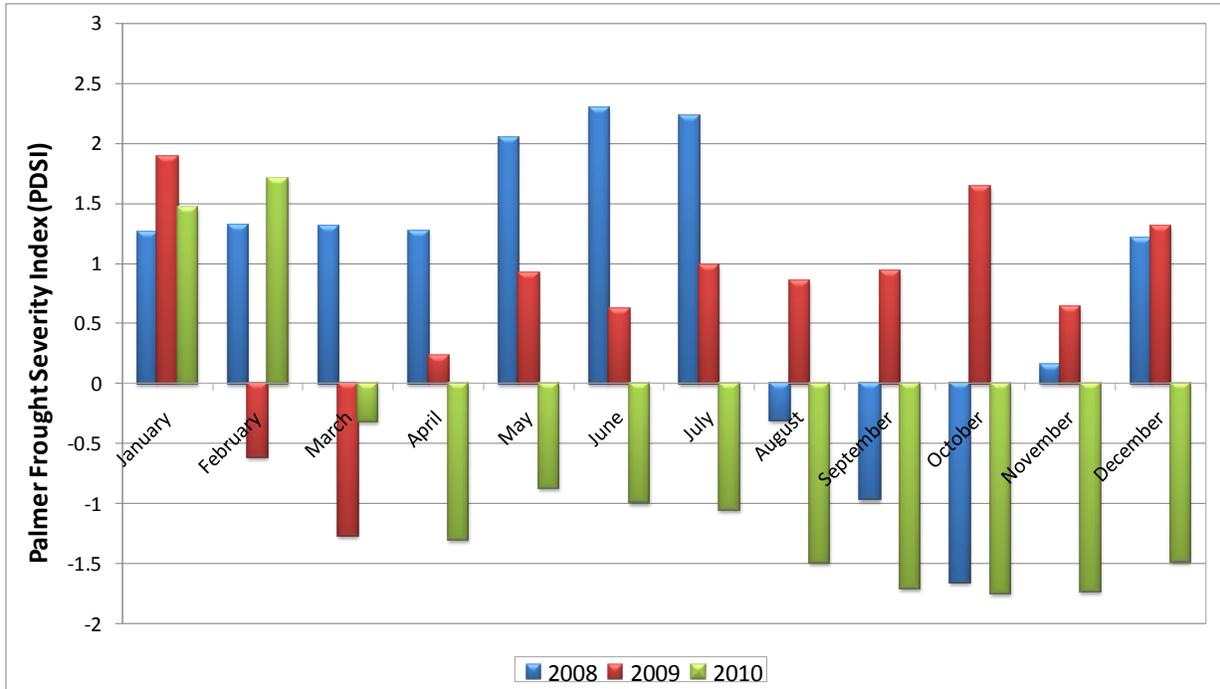
## Drought Status

There are a number of drought indices used to estimate the severity of drought in an area, using algorithms that incorporate recent temperatures, rainfall, soil moisture, and other information (<http://www.drought.gov>). The main indices we report are the Palmer Drought Severity Index (PDSI) and the United States Drought Monitor (DM) – Drought Intensity Index. While both indices provides excellent summary information on broad-scale conditions, local conditions (such as at the park scale) may vary.

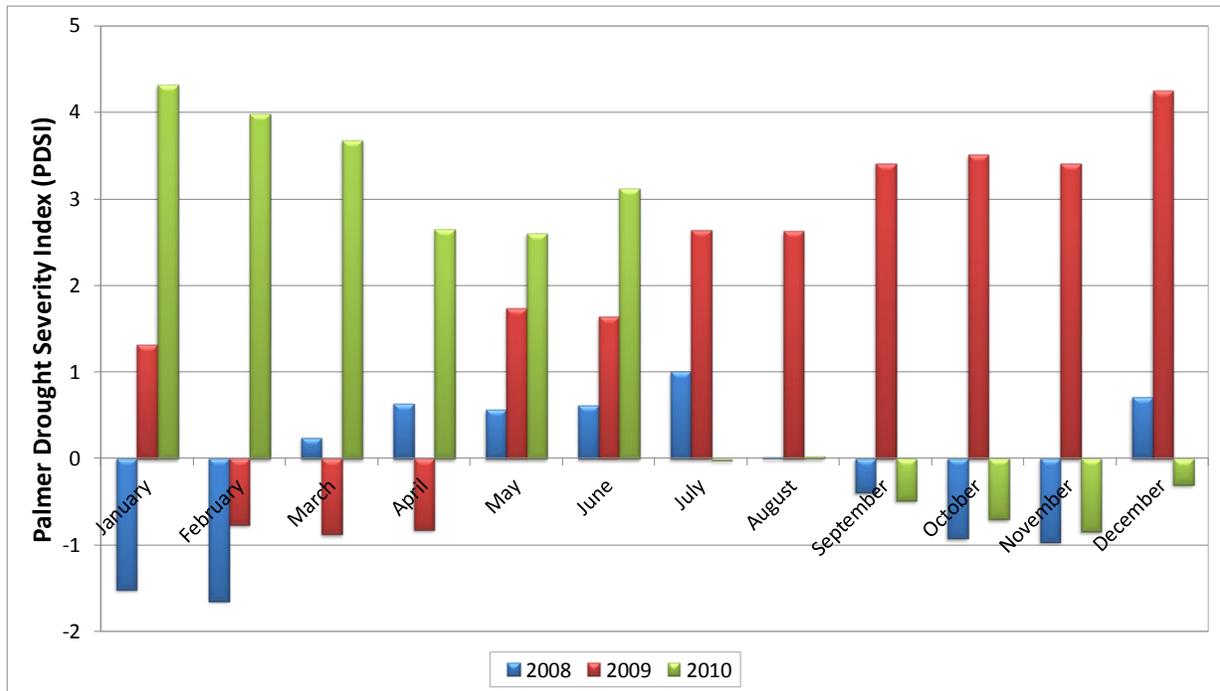
The PDSI is a soil moisture algorithm calibrated for relatively homogeneous regions and is calculated on a monthly basis using precipitation and temperature data, as well as the water content of the soil. The values vary between extremely moist ( $>4.0$ ) and extreme drought ( $<-4.0$ ) with “normal” values ranging between -1.9 and 1.9. Monthly PDSI values for West Virginia Climate Division 4 in 2010 are shown in Figure 5 and Climate Division 5 values are seen in Figure 6.

The DM – Drought Intensity Index is a synthesis of multiple indices (including the PDSI) and impacts and represents a consensus of federal and academic scientists. The DM produces a summary map of drought intensity for the nation and all states each week. It is on a scale ranging from abnormally dry (D0) to exceptional drought (D4). Mid-month (i.e., the second or third week) values for West Virginia and the Northeast are shown for 2010 in Figures 7 and 8, respectively.

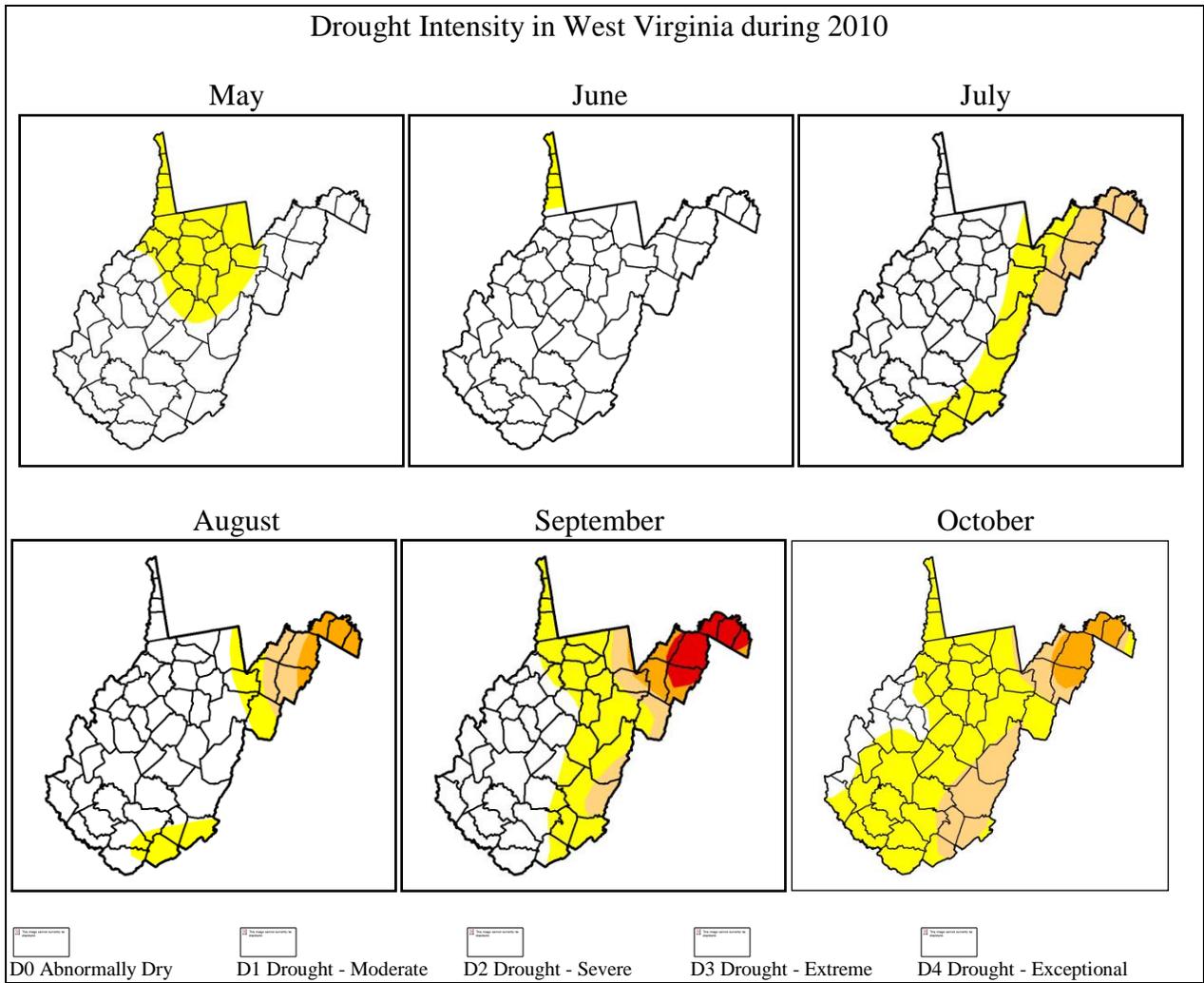
According to the PDSI for WV Climate Division 4, most of 2010 was “dry” (PDSI  $<0$ ; Figure 5) in the West Virginia parks. While the calendar year began quite moist, dry conditions set in by mid-March and continued until the end of the year. As a result, PDSI values declined from near 1.5 in early February to near -1.5 (approaching “moderate drought” but still in the “normal” range) by the end of October. Regular precipitation returned during December, raising PDSI values toward -1 (Figure 5). Remarkably, WV Climate Division 5, which includes parts of Bluestone and New River, had very moist values ( $>3$ ) of PDSI from January until June. Drier conditions during the summer led to a sharp decrease in the drought index so that by autumn the PDSI was slightly negative (drier than average). When comparing the PDSI values with recent years, 2010 had the most months with a deficit. The DM – Drought Severity Index for West Virginia (Figure 7) and the Northeast (Figure 8) indicated a near average year with no widespread drought conditions near the parks during the growing season (May through September) in 2010.



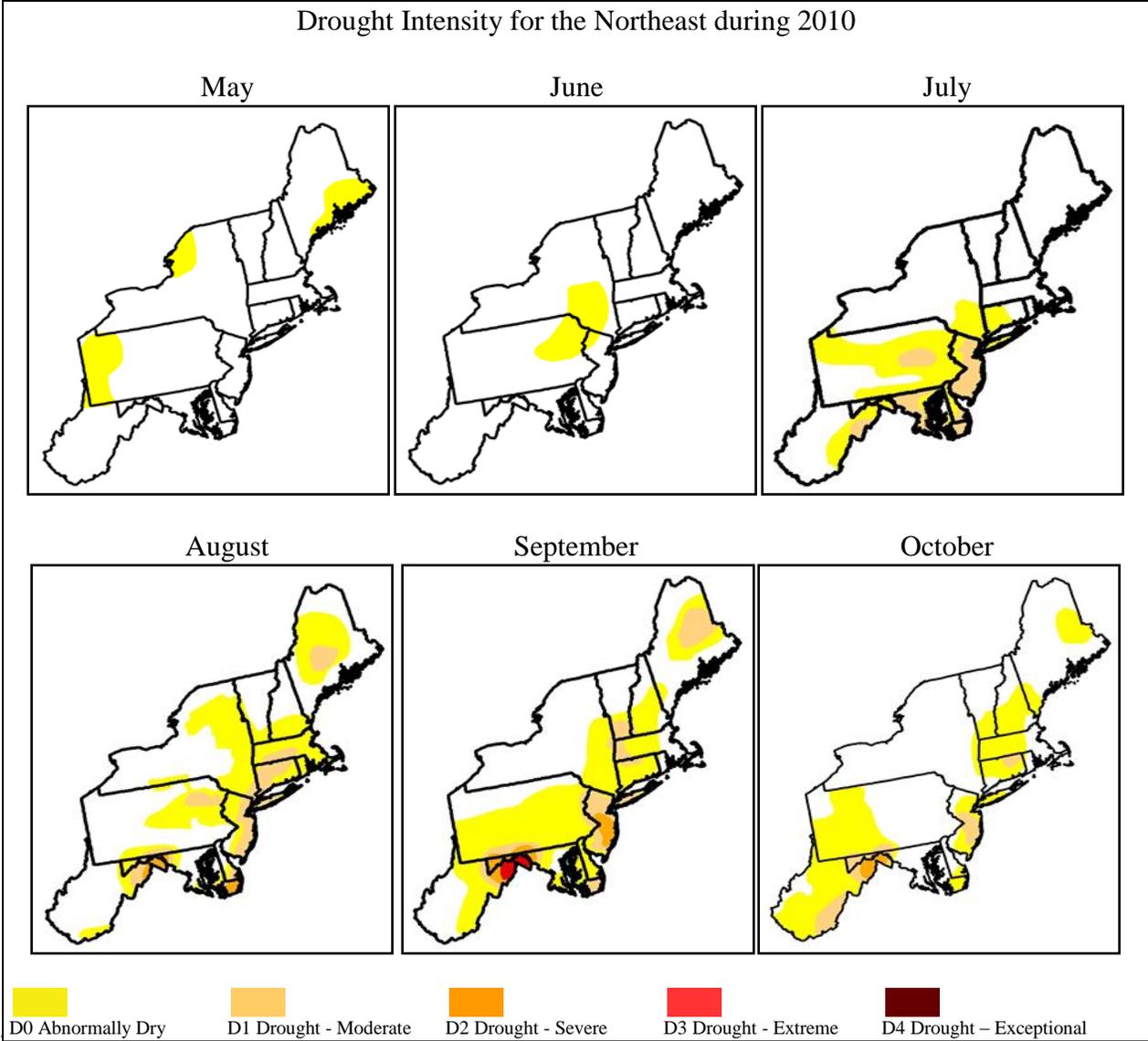
**Figure 5.** Monthly Palmer Drought Severity Index (PDSI) values for West Virginia Climate Division 4, 2008–2010.



**Figure 6.** Monthly Palmer Drought Severity Index (PDSI) values for West Virginia Climate Division 5, 2008–2010.



**Figure 7.** Mid-month values of the United States Drought Monitor (DM) – Drought Intensity Index for West Virginia in 2010.



**Figure 8.** Mid-month values of the United States Drought Monitor (DM) – Drought Intensity Index for the Northeast in 2010.

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