National Park Service
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Natural Resource Program Center

Bluestone National Scenic River, Gauley River National Recreation Area, and New River Gorge National River

Weather of 2009

Natural Resource Data Series NPS/ERMN/NRDS—2010/082

ON THE COVER
Mist over insignificant rapid, Gauley River, Gauley River National Recreation Area.
Photograph by: Jim Vanderhorst.

Bluestone National Scenic River, Gauley River National Recreation Area, and New River Gorge National River

Weather of 2009

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September 2010

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

The National Park Service, Natural Resource Program Center 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 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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Please cite this publication as:

Knight, P., T. Wisniewski, C. Bahrmann, and S. Miller. 2010. Bluestone National Scenic River , Gauley River National Recreation Area, and New River Gorge National River: Weather of 2009. Natural Resource Data Series NPS/ERMN/NRDS—2010/082. National Park Service, Fort Collins, Colorado.

NPS 619/105523, 600/105523, 637/105523, September 2010

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List of Key Acronyms

BLUE	Bluestone National Scenic River
COOP	National Weather Service Cooperative Observer Program
CWOP	Citizen Weather Observer Program
ERMN	Eastern Rivers and Mountains Network
FAA	Federal Aviation Administration
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
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 the 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, 2009, and to place current patterns and trends in an appropriate historical and regional context (Knight et al., in preparation). It is our intention that this report will satisfy an inherent interest in meteorological phenomena and meets a portion of the Eastern Rivers and Mountains Network (ERMN) Weather and Climate Monitoring objectives:

- Document long-term trends in weather and climate through seasonal and annual summaries of selected parameters (e.g., multiple forms of precipitation, temperature).
- Identify and document extremes and averages of climatic conditions for common parameters (e.g., precipitation, air temperature) and other parameters where sufficient data are available (e.g., wind speed and direction, solar radiation).
- Provide information on near real-time weather parameters, historical climate patterns, and climate station metadata from a single, easy-to-use Internet portal.

To accomplish these objectives, 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 (Knight et al., in preparation). 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 climatological 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 (Knight et al., in preparation) 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 and is frequently used for compiling climate statistics (http://www.esrl.noaa.gov/psd/data/usclimate/map.html). WV is divided into six 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 reaches 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 27 weather observing stations comprising five 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 (Knight et al., in preparation). A subset of these observing networks (NADP and CWOP; three total stations) are not yet utilized for these reports due to limited data availability and/or lack of data quality assurance (Bureau of Land Management 1997). Moreover, the percentage of time a station reports particular parameters (e.g., temperature) can influence data inclusion. Thirteen stations were excluded in 2009 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.

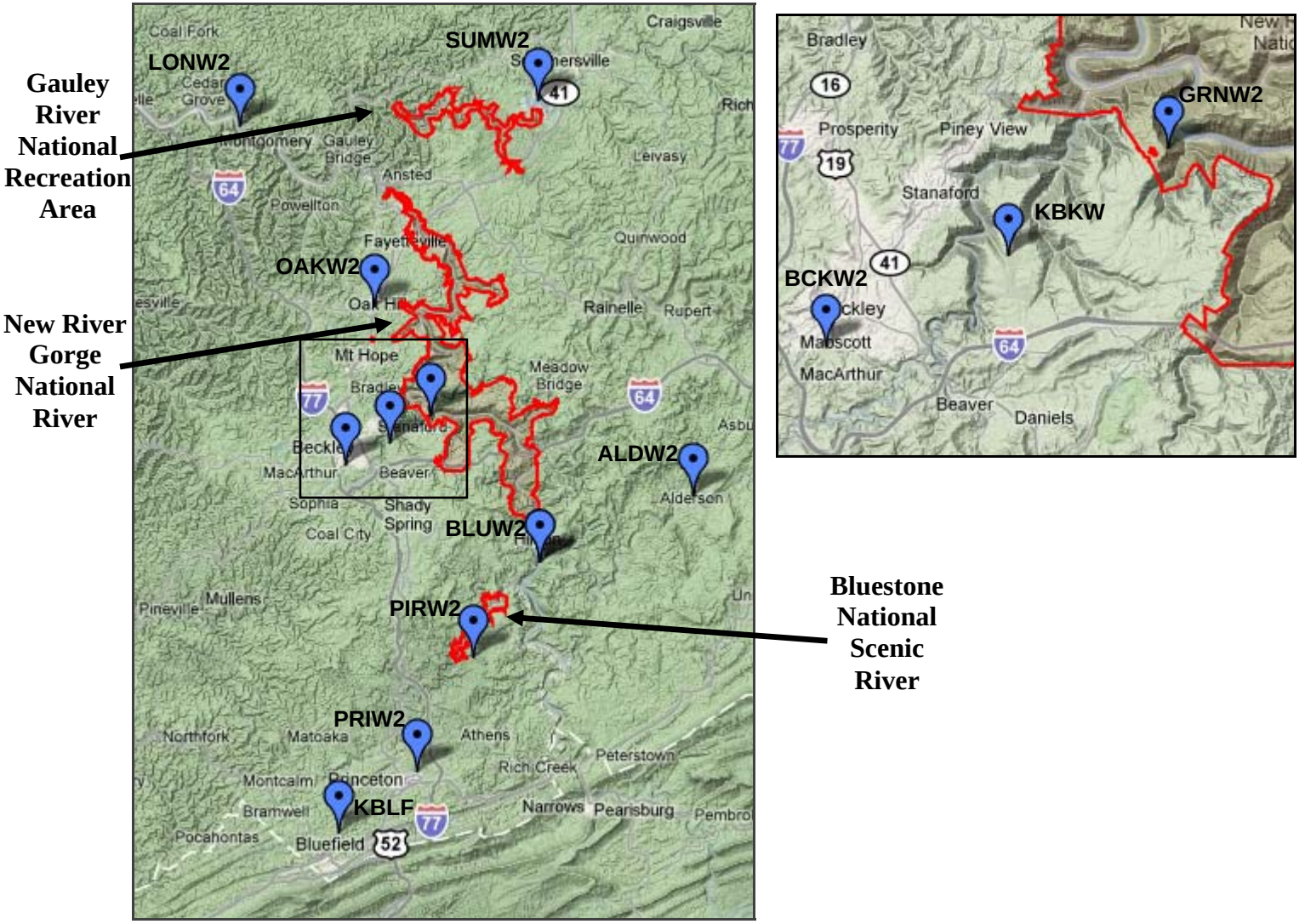

Figure 1. Location of weather observing stations around Bluestone National Scenic River, Gauley River National Recreation Area, and New River Gorge National River.

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 2009.

Station	Observing Network	Station Name	Period of Record (POR)		Percentage of Time Reporting Temperature for 2009	Percentage of Time Reporting Precipitation for 2009	Percentage of Time Reporting Temperature for entire POR	Percentage of Time Reporting Precipitation for entire POR
BLUW2	COOP	Bluestone Lake	08/01/1948	Present	-	100.0	95.0	99.6
OAKW2	COOP	Oak Hill	08/01/1948	Present	94.0	95.1	98.5	98.5
LONW2	COOP	London Locks	08/01/1948	Present	97.5	99.5	97.5	97.8
SUMW2	COOP	Summersville Lake	07/01/1966	Present	94.8	95.3	97.5	99.0
PRIW2	COOP	Princeton	08/01/1948	Present	-	99.7	-	99.1
ALDW2	COOP	Alderson	08/01/1948	Present	100.0	100.0	23.7	97.2
BCKW2	COOP	Beckley VA Hospital	08/01/1948	Present	100.0	99.5	94.5	95.1
KBKW	FAA	Beckley	05/15/1963	Present	100.0	100.0	99.9	99.8
KBLF	FAA	Bluefield	01/01/1972	Present	100.0	100.0	99.9	99.8
GRNW2	RAWS	Grandview	01/01/2005	Present	100.0	99.5	99.4	99.1
PIRW2	RAWS	Pipestem	06/09/2005	Present	100.0	99.5	99.2	99.2

Temperature Summary

The 2009 calendar year averaged virtually normal compared with the long-term mean for temperature (Table 2), though not as warm as earlier years in this decade. After a rather cold January, the next two months were progressively milder than usual, with March exhibiting the largest positive departures (Figures 2 and 3). 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/.

Several cold episodes brought morning readings near or just below 0 degrees Fahrenheit (°F) (-17.8 degrees Celsius [°C]) during January and February, and the lowest values in many sections were measured around January 16–17, 2009. The lowest reading for the year near the parks, which occurred in Beckley, WV, on January 16 was -4.0°F (-20.0°C) (Table 2). The number of sub-freezing nights was below the long-term mean, though the number of cold days was slightly above the average (Table 2).

The spring had milder-than-average nighttime temperatures, but cooler-than-normal daytime readings during the period April–May–June (Figures 2 and 3; Table 3); however, nocturnal warmth dominated so that spring temperatures were above the long-term mean values (Tables 4 and 5). An outbreak of unseasonably cold weather in the middle of May brought most sections a late freeze and frost (on May 18–19), so the growing season in parts of each park began later than in recent years (Table 2). The highest readings of the year came very early when temperatures rose well into the 80s to near 90°F (32°C) between April 26–27 (Table 2). Most of this spring's warmth can be attributed to mild nights (Figure 3).

The summer months of July–August–September were much cooler than average due to lower-than-normal maximum readings (Figure 2). No record maximums were recorded during the period and the summer ranked as the 14th–20th coolest in 115 years of records (Table 5).

Overall, autumn ranked near the mid-point of the last 115 years for temperature (Table 5). Frosts and freezes occurred earlier than in recent years, with most sections noticing sub-freezing readings (<32°F [<0°C]) on October 20. As a result, the length of the growing season was shorter (by about two–three weeks) (Table 2) than in other years this decade. November was the odd month, averaging well above normal and having the largest positive departures of the year (Figures 2 and 3). For example, the monthly average temperature in Beckley, WV, for November was 45.9°F (7.7°C), which was 2.5°F (1.4°C) above normal (Tables 3 and 4). December brought seasonably cold weather. The average annual temperature ranged from 0.3°F (0.1°C) to -0.3°F (-0.1°C), making 2009 virtually normal.

Bluestone National Scenic River,
Gauley River National Recreation Area,
and New River Gorge National River
Departure from Average Monthly Maximum Temperature
2009 vs. 1971–2000

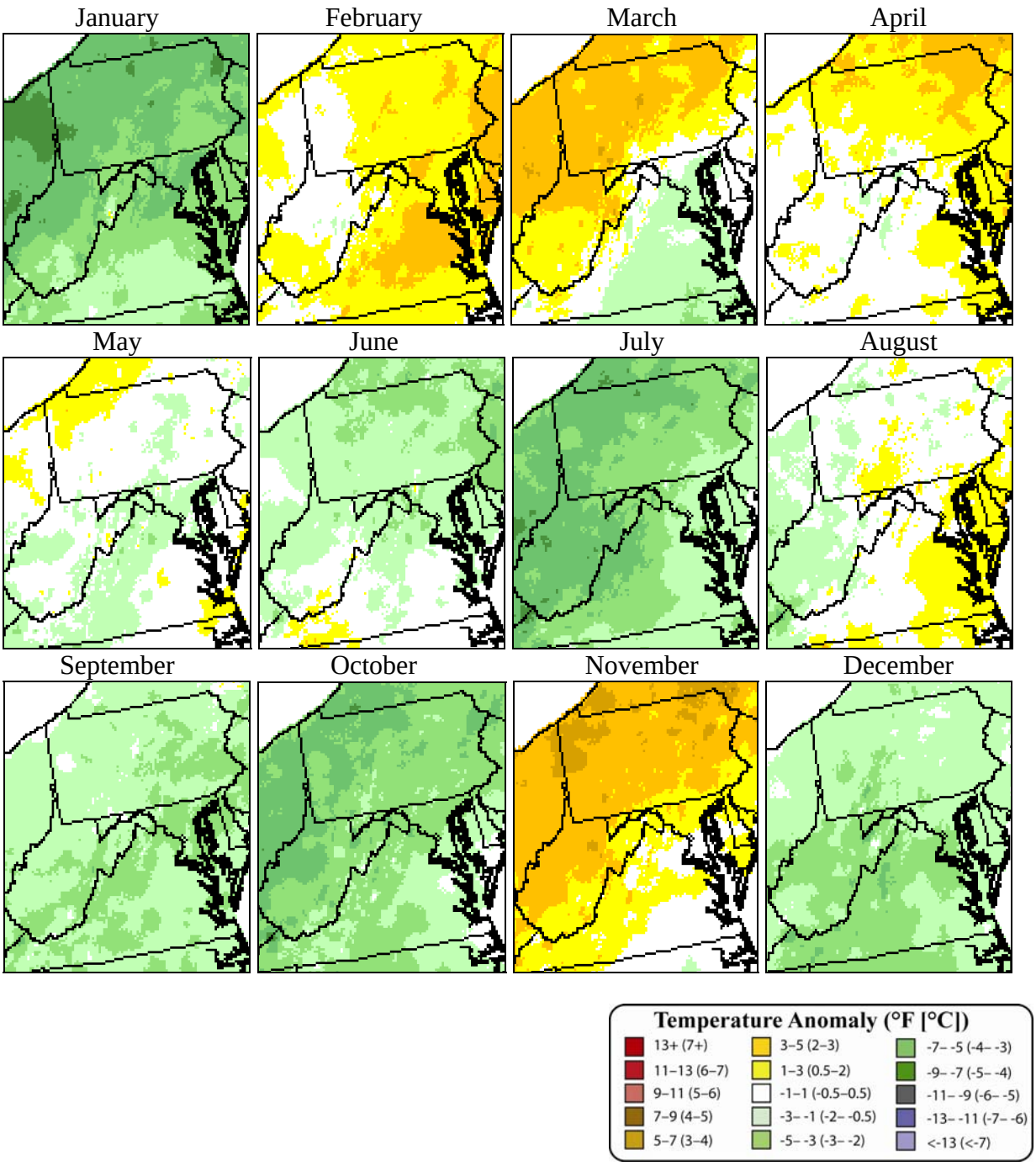

Figure 2. Maps showing departure from average monthly maximum temperature compared to the 30-year normal (1971–2000).

Bluestone National Scenic River,
Gauley River National Recreation Area,
and New River Gorge National River
Departure from Average Monthly Minimum Temperature
2009 vs. 1971–2000

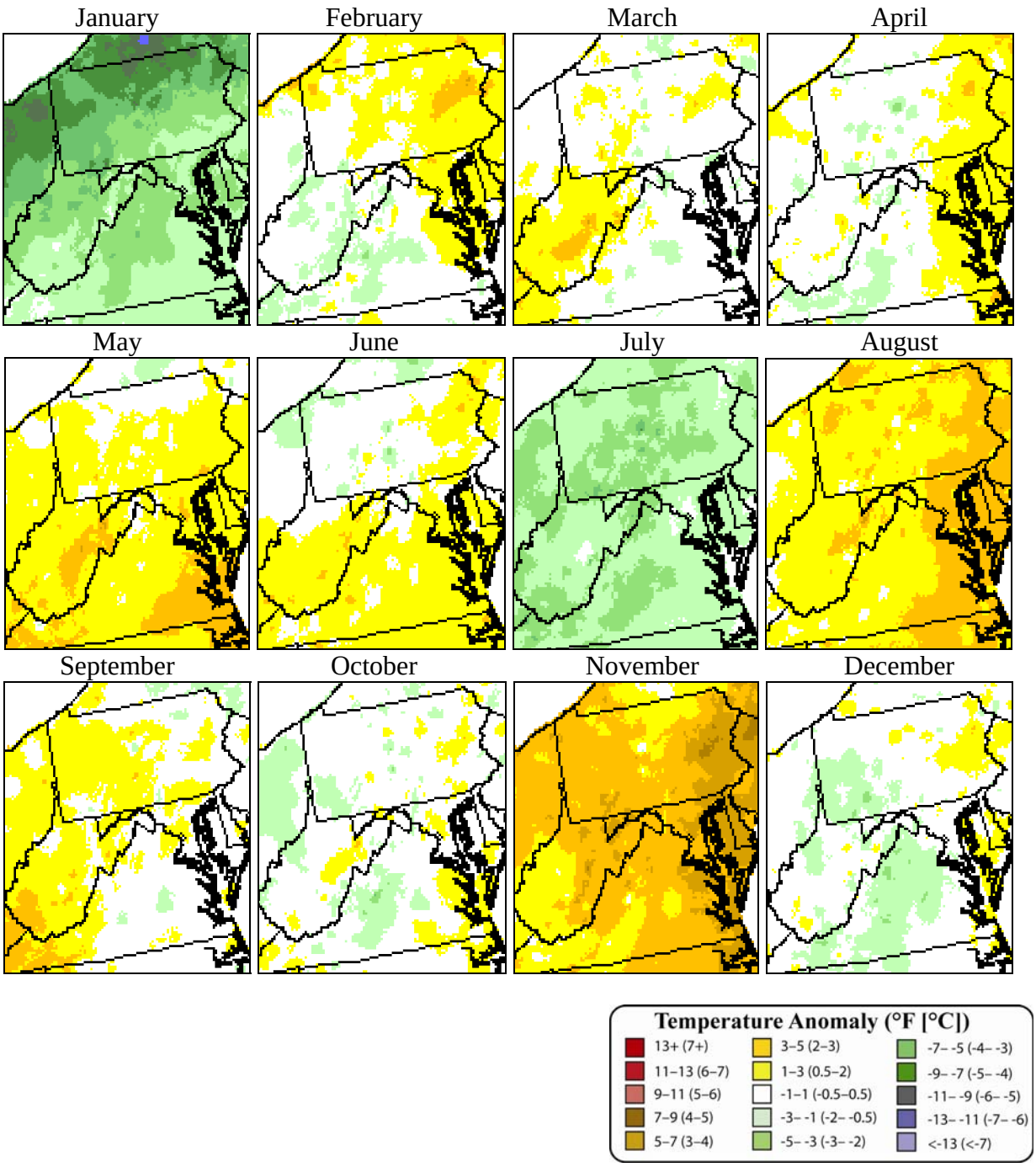

Figure 3. Maps showing departure from average monthly minimum temperature compared to the 30-year normal (1971–2000).

Table 2. Status of 2009 temperature indicators compared to the 30-year normal (1971–2000) at the London Locks (LONW2), Beckley (KBKW), and Summersville Lake (SUMW2) stations.

Temperature Indicator	London Locks, WV 2009	London Locks, WV 1971–2000	Beckley, WV 2009	Beckley, WV 1971–2000	Summersville Lake, WV 2009	Summersville Lake, WV 1971–2000
Average Annual Temperature	55.6°F 13.1°C	55.5°F 13.1°C	51.4°F 10.8°C	51.7°F 10.9°C	51.7°F 10.9°C	51.4°F 10.8°C
Average Annual Maximum Temperature	65.9°F 18.8°C	65.9°F 18.8°C	60.4°F 15.8°C	61.3°F 16.3°C	61.8°F 16.6°C	62.3°F 16.8°C
Summer Maximum (highest temperature)	91.0°F 32.8°C	94.3°F 34.6°C	85.0°F 29.4°C	88.0°F 31.1°C	87.0°F 30.6°C	90.0°F 32.2°C
Hot Days (days with Tmax≥90°F/32°C)	6	19	0	1	0	4
Average Annual Minimum Temperature	45.4°F 7.4°C	45.0°F 7.2°C	42.3°F 5.7°C	42.1°F 5.6°C	41.5°F 5.3°C	40.4°F 4.7°C
Winter Minimum (lowest temperature)	2.0°F -16.7°C	1.2°F -17.1°C	-4.0°F -20.0°C	-5.5°F -20.8°C	-3.0°F -19.4°C	-6.6°F -21.4°C
Cold Days (days with Tmax≤32°F/0°F)	16	14	30	28	28	28
Sub-freezing Nights (days with Tmin≤32°F/0°C)	88	94	108	111	110	127
Cold Winter Nights (days with Tmin≤0°F/-17.8°C)	0	1	2	3	1	5
Growing Season Length (days between last spring 32°F/0°C and first fall 32°F/0°C)	170	200	153	159	154	165

Table 3. Summary of monthly average temperature for 2009 for the selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Oak Hill, WV	OAKW2	27.8°F	34.2°F	43.7°F	52.5°F	58.8°F	67.5°F	66.7°F	70.2°F	64.2°F	48.7°F	47.1°F	32.4°F	51.2°F
		-2.3°C	1.2°C	6.5°C	11.4°C	14.9°C	19.7°C	19.3°C	21.2°C	17.9°C	9.3°C	8.4°C	0.2°C	10.6°C
London Locks, WV	LONW2	30.5°F	37.8°F	46.6°F	55.5°F	63.3°F	72.2°F	71.1°F	74.3°F	68.6°F	54.7°F	50.2°F	36.8°F	55.6°F
		-0.8°C	3.2°C	8.1°C	13.1°C	17.4°C	22.3°C	21.7°C	23.5°C	20.3°C	12.6°C	10.1°C	2.7°C	12.9°C
Summersville Lake, WV	SUMW2	28.1°F	32.6°F	43.3°F	50.9°F	61.0°F	67.4°F	66.3°F	69.4°F	62.9°F	50.1°F	45.4°F	31.4°F	51.7°F
		-2.2°C	0.3°C	6.3°C	10.5°C	16.1°C	19.7°C	19.1°C	20.8°C	17.2°C	10.1°C	7.4°C	-0.3°C	10.5°C
Alderson, WV	ALDW2	29.9°F	35.2°F	44.4°F	52.7°F	63.0°F	70.8°F	69.4°F	73.5°F	66.5°F	53.0°F	47.4°F	33.8°F	53.3°F
		-1.2°C	1.8°C	6.9°C	11.5°C	17.2°C	21.6°C	20.8°C	23.1°C	19.2°C	11.7°C	8.6°C	1.0°C	11.9°C
Beckley VA Hospital, WV	BCKW2	25.6°F	30.5°F	41.1°F	49.3°F	58.5°F	65.1°F	63.2°F	67.0°F	60.7°F	48.5°F	43.3°F	30.3°F	48.6°F
		-3.6°C	-0.8°C	5.1°C	9.6°C	14.7°C	18.4°C	17.3°C	19.4°C	15.9°C	9.2°C	6.3°C	-0.9°C	9.2°C
Beckley, WV	KBKW	28.7°F	34.7°F	43.6°F	52.6°F	60.3°F	67.4°F	66.1°F	68.6°F	62.2°F	51.1°F	45.9°F	32.2°F	51.3°F
		-1.8°C	1.5°C	6.4°C	11°C	15.7°C	19.7°C	18.9°C	20.3°C	16.8°C	10.6°C	7.7°C	0.1°C	10.6°C
Bluefield, WV	KBLF	31.6°F	37.4°F	46.3°F	55.5°F	63.4°F	70.8°F	69.3°F	72.3°F	65.3°F	54.9°F	49.0°F	34.3°F	54.2°F
		-0.2°C	3.0°C	7.9°C	13.1°C	17.4°C	21.6°C	20.7°C	22.4°C	18.5	12.7°C	9.4°C	1.3°C	12.3°C
Grandview, WV	GRNW2	27.3°F	34.2°F	43.1°F	52.6°F	60.0°F	67.0°F	65.1°F	68.0°F	61.5°F	50.0°F	45.2°F	31.6°F	50.5°F
		-2.6°C	1.2°C	6.2°C	11.4°C	15.6°C	19.4°C	18.4°C	20.0°C	16.4°C	10.0°C	7.3°C	-0.2°C	10.3°C
Pipestem, WV	PRRW2	30.4°F	37.2°F	44.5°F	52.7°F	60.5°F	67.5°F	65.9°F	68.8°F	62.1°F	51.6°F	46°F	33.1°F	51.7°F
		-0.9°C	2.9°C	6.9°C	11.5°C	15.8°C	19.7°C	18.8°C	20.4°C	16.7°C	10.9°C	7.8°C	0.6°C	10.9°C

Table 4. Summary of 2009 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	-2.8°F	0.4°F	1.8°F	1.2°F	-0.8°F	0.3°F	-4.4°F	0.2°F	0.5°F	-4.1°F	3.4°F	-2.2°F	-0.5°F
		-1.5°C	0.2°C	1.0°C	0.7°C	-0.4°C	0.1°C	-2.4°C	0.1°C	0.3°C	-2.3°C	1.9°C	-1.2°C	-0.3°C
London Locks, WV	LONW2	-2.4°F	1.3°F	2.0°F	1.5°F	0.4°F	1.4°F	-4.6°F	0.4°F	0.5°F	-2.4°F	3.4°F	-1.3°F	0.1°F
		-1.3°C	0.7°C	1.1°C	0.9°C	0.2°C	0.8°C	-2.6°C	0.2°C	0.3°C	-1.3°C	1.9°C	-0.7°C	0.0°C
Summersville Lake, WV	SUMW2	-0.7°F	1.1°F	3.6°F	1.5°F	2.3°F	0.9°F	-4.2°F	0.4°F	-0.2°F	-1.7°F	3.1°F	-2.0°F	0.3°F
		-0.4°C	0.6°C	2.0°C	0.8°C	1.3°C	0.5°C	-2.3°C	0.2°C	-0.1°C	-0.9°C	1.7°C	-1.1°C	0.2°C
Alderson, WV	ALDW2	-1.1°F	0.4°F	1.3°F	0.4°F	2.0°F	1.7°F	-3.9°F	1.2°F	0.5°F	-1.3°F	3.4°F	-0.9°F	0.3°F
		-0.6°C	0.2°C	0.7°C	0.2°C	1.1°C	0.9°C	-2.2°C	0.7°C	0.3°C	-0.7°C	1.9°C	-0.5°C	0.2°C
Beckley VA Hospital, WV	BCKW2	-2.9°F	-1.0°F	1.6°F	0.7°F	0.8°F	0.7°F	-4.9°F	0.2°F	0.1°F	-1.4°F	2.5°F	-2.4°F	-0.5°F
		-1.7°C	-0.5°C	0.9°C	0.4°C	0.4°C	0.4°C	-2.8°C	0.1°C	0.0°C	-0.7°C	1.4°C	-1.3°C	-0.3°C
Beckley, WV	KBKW	-1.5°F	1.0°F	1.2°F	1.1°F	0.7°F	0.7°F	-4.4°F	-0.1°F	-0.3°F	-1.7°F	2.5°F	-3.0°F	-0.3°F
		-0.8°C	0.6°C	0.7°C	0.6°C	0.4°C	0.4°C	-2.4°C	0.0°C	-0.1°C	-1.0°C	1.4°C	-1.7°C	-0.2°C
Bluefield, WV	KBLF	-1.1°F	1.3°F	1.7°F	2.1°F	2.8°F	-2.3°F	1.5°F	0.5°F	-0.1°F	3.8°F	-2.3°F	-2.3°F	0.8°F
		-0.6°C	0.7°C	0.9°C	1.0°C	1.1°C	1.6°C	-1.3°C	0.8°C	0.3°C	0.0°C	2.1°C	-1.3°C	0.4°C

* Stations with a period of record of less than 5 years (Grandview and Pipestem) were not included in this table.

Table 5. Seasonal temperature and precipitation rankings over 115 years (1 = warmest/wettest year and 115 = 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-2009	65	48	101	63
Precipitation-2009	84	25	50	46

WV Climate Division 5 Rankings "Southern"	Jan–Feb–Mar WINTER	Apr–May–Jun SPRING	Jul–Aug–Sep SUMMER	Oct–Nov–Dec AUTUMN
Temperature-2009	66	40	94	57
Precipitation-2009	79	6	5	14

Precipitation Summary

For the seventh time in the last eight years, annual liquid precipitation (rain and melted snow, ice, sleet, etc.; hereafter precipitation) for the region averaged above the long-term mean (Table 6). The wettest days occurred during the warmer half of the year, which is a change from recent years (Table 7). An unusual dry period was noted from August 30 until October 9 when there were three long spells without any measurable rain (Table 7). Snowfall was far above normal with more than 200% of average snowfall at most locations (Table 6). The number of days with excessive rainfall (>1.0 in [25 mm]) was generally above the long-term average for south-central West Virginia (Table 6).

The winter began quite moist (Figure 4) as January averaged approximately 142% of normal precipitation in Beckley, WV, and 151% in Bluestone Lake, WV (Tables 8 and 9). February was much drier (Figure 4), with between 31% and 74% of average precipitation (Tables 8 and 9) plus a long, dry spell from February 13–21 (Table 7). Monthly precipitation in March continued to be below normal, with 2.5–3.7 in (64–93 mm) accumulating across the central and southern districts of West Virginia (Table 8). Winter precipitation, including rain and snow (liquid equivalent), ranked as 31st–33rd driest in 115 years of recordkeeping (Table 5).

Spring 2009 was much wetter with all of months (Figure 4) averaging above normal rainfall at some stations (Tables 8 and 9). By far, May was the wettest month, as 130–212% of normal rain was reported (Table 9); this is remarkable since the period from May 12–25 had no measurable rain (Table 7). The season ranked as the 6th wettest in climate division 5, which is located in southern West Virginia (Table 5).

Wet weather continued during the summer months of July, August, and September. The central valleys averaged near normal rainfall, but the eastern and southern mountains were quite wet (Figure 4). The wettest day of 2009 occurred on July 5 as an average of 2.3 in (58 mm) was tallied in the region (Table 7). The summer ranked the 5th wettest in the southern West Virginia climate division, yet it was the 50th wettest in the central division (Table 5).

The autumn was not quite as wet, due to a dry November (Figure 4). October was wet with most sections averaging from 96–164% of the normal rainfall (Table 9). However, November brought below-average precipitation to virtually all sites. For example, Summersville Lake, WV, had 44% of normal rainfall with a monthly rainfall total of 1.4 in (36 mm) (Tables 8 and 9). December turned quite wet with more than 200% of normal rain and snow tallied at Bluestone Lake and Alderson, WV (Table 9). Overall, 2009 ranked in the top ten (6 of 115) of wet years for the southern climate division.

Bluestone National Scenic River,
Gauley River National Recreation Area,
and New River Gorge National River
Percent of Average Monthly Precipitation
2009 vs. 1971–2000

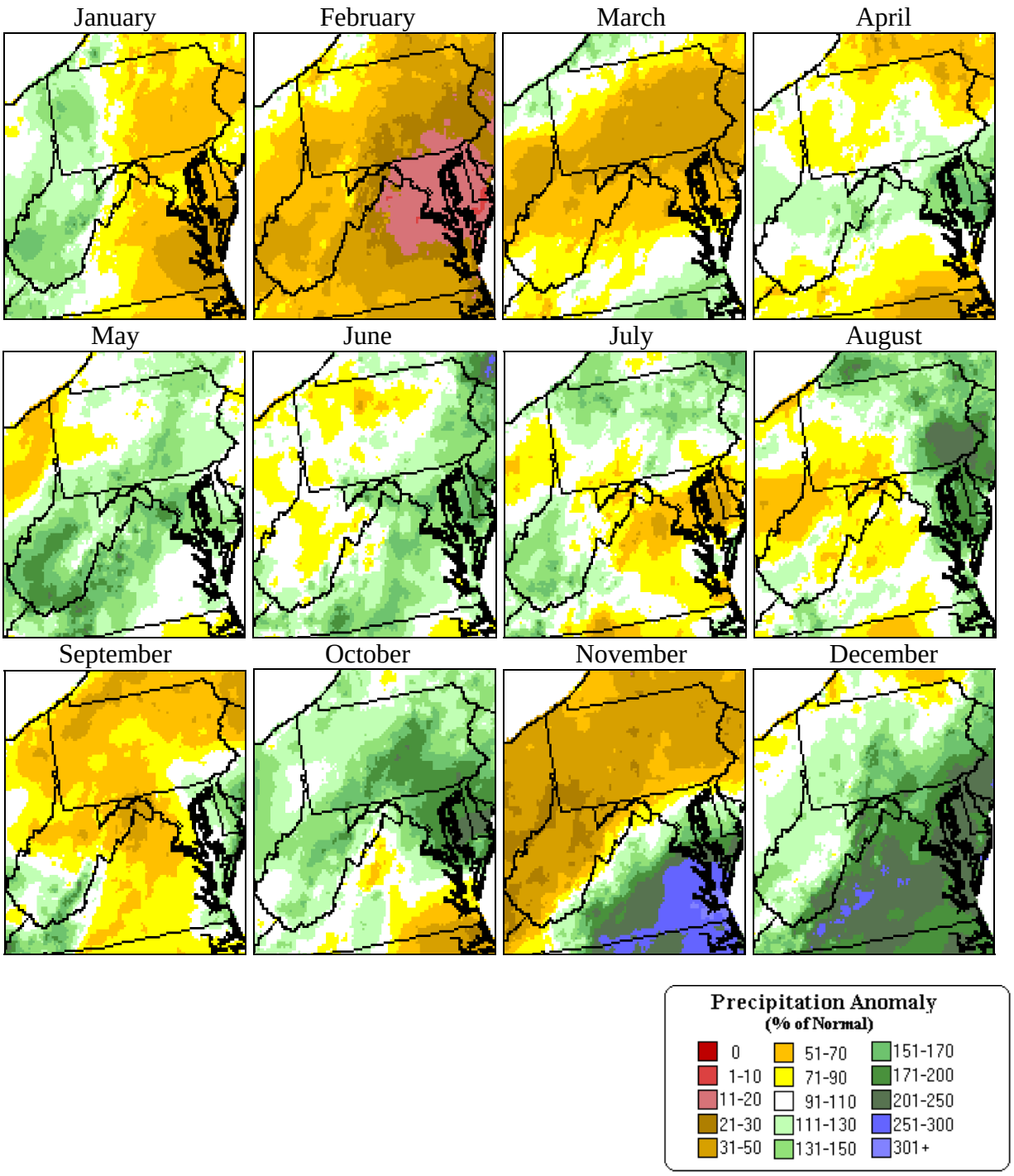

Figure 4. Maps showing percent of average monthly precipitation compared to the 30-year normal (1971–2000).

Table 6. Status of 2009 precipitation indicators compared to the 30-year normal (1971–2000) at the London Locks (LONW2), Beckley (KBKW), and Summersville Lake (SUMW2) stations.

Precipitation Indicators	London Locks, WV 2009	London Locks, WV 1971–2000	Beckley, WV 2009	Beckley, WV 1971–2000	Summersville Lake, WV 2009	Summersville Lake, WV 1971–2000
Annual Precipitation	45.1 in 1,146 mm	44.9 in 1,141 mm	44.4 in 1,128 mm	41.6 in 1,057 mm	49.0 in 1,245 mm	47.5 in 1,207 mm
Autumn (Oct, Nov, Dec) Precipitation	6.8 in 173 mm	9.0 in 229 mm	10.9 in 277 mm	8.6 in 218 mm	9.3 in 236 mm	10.1 in 257 mm
Heavy Rain (days with ≥1.0 in [25 mm] rain)	12	9	7	7	12	9
Extreme Rain (days with ≥2.0 in [51 mm] rain)	0	1	1	1	0	1
Micro-drought (strings of 7+ days without rain)	10	7	3	4	3	4
Annual Snowfall	42.9 in 1,090 mm	16.0 in 406 mm	77.3 in 1,963 mm	37.1 in 942 mm	59.0 in 1,499 mm	43.5 in 1,105 mm
Snow (days with ≥0.1 in [0.3 cm] snow)	31	11	30	18	24	20
Moderate Snow (days with ≥2.0 in [5.0 cm] snow)	9	3	10	8	10	11
Heavy Snow (days with ≥5.0 in [12.7 cm] snow)	1	1	4	2	2	1

Table 7. Top five wettest days and top five dry spells (consecutive days with a trace or less of rainfall) during 2009 from stations London Locks (LONW2), Beckley (KBKW), and Summersville Lake (SUMW2).

Wettest Days in 2009	Dry Spells in 2009
Jul. 5: 2.3 in (58 mm)	May 12–25
Apr. 11: 1.9 in (48 mm)	Sep. 11–23
Aug. 2: 1.8 in (46 mm)	Sep. 30–Oct. 9
Sep. 27: 1.7 in (43 mm)	Feb. 13–Feb. 21
Jul. 26: 1.7 in (43 mm)	Aug. 30–Sep. 6

Table 8. Summary of 2009 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	4.6 in	0.8 in	3.3 in	2.9 in	6.5 in	5.4 in	4.2 in	3.5 in	5.3 in	2.7 in	3.0 in	5.7 in	48.0 in
		116 mm	21 mm	84 mm	74 mm	166 mm	138 mm	107 mm	88 mm	134 mm	69 mm	75 mm	146 mm	1,219 mm
Oak Hill, WV	OAKW2	5.0 in	1.6 in	3.5 in	3.5 in	7.5 in	4.2 in	7.2 in	5.3 in	5.5 in	3.8 in	2.5 in	5.9 in	55.4 in
		128 mm	39 mm	88 mm	88 mm	190 mm	106 mm	182 mm	135 mm	140 mm	97 mm	64 mm	150 mm	1,407 mm
London Locks, WV	LONW2	4.8 in	1.1 in	3.1 in	4.3 in	3.6 in	4.5 in	7.0 in	6.0 in	3.9 in	2.7 in	1.3 in	2.8 in	45.1 in
		122 mm	27 mm	78 mm	110 mm	92 mm	115 mm	178 mm	152 mm	99 mm	69 mm	33 mm	71 mm	1,146 mm
Summersville Lake, WV	SUMW2	5.0 in	1.1 in	3.7 in	4.0 in	5.9 in	3.7 in	8.0 in	4.6 in	3.8 in	3.7 in	1.4 in	4.3 in	49.0 in
		128 mm	29 mm	93 mm	101 mm	149 mm	93 mm	204 mm	116 mm	96 mm	93 mm	36 mm	108 mm	1,245 mm
Princeton, WV	PRIW2	4.8 in	2.0 in	2.7 in	3.6 in	8.3 in	2.8 in	5.6 in	3.3 in	5.7 in	2.8 in	2.8 in	4.9 in	49.2 in
		121 mm	51 mm	67 mm	90 mm	212 mm	71 mm	143 mm	83 mm	146 mm	70 mm	71 mm	126 mm	1,250 mm
Alderson, WV	ALDW2	4.5 in	0.9 in	3.4 in	3.0 in	7.4 in	3.2 in	7.6 in	2.4 in	6.8 in	2.7 in	2.9 in	6.5 in	51.1 in
		114 mm	23 mm	86 mm	75 mm	189 mm	81 mm	192 mm	61 mm	174 mm	68 mm	73 mm	165 mm	1,298 mm
Beckley VA Hospital, WV	BCKW2	3.9 in	1.0 in	3.0 in	2.3 in	8.0 in	3.5 in	8.0 in	3.4 in	3.2 in	3.2 in	2.6 in	3.7 in	45.8 in
		98 mm	26 mm	77 mm	57 mm	204 mm	89 mm	203 mm	85 mm	81 mm	82 mm	67 mm	94 mm	1,163 mm
Beckley, WV	KBKW	4.5 in	1.4 in	2.8 in	2.3 in	7.2 in	3.0 in	7.3 in	2.4 in	2.5 in	4.3 in	1.9 in	4.7 in	44.4 in
		115 mm	36 mm	71 mm	57 mm	183 mm	76 mm	186 mm	62 mm	64 mm	110 mm	48 mm	118 mm	1,128 mm
Bluefield, WV	KBLF	3.6 in	2.0 in	2.5 in	3.1 in	6.7 in	2.7 in	3.8 in	5.9 in	5.0 in	2.5 in	2.8 in	3.9 in	44.4 in
		91 mm	50 mm	64 mm	78 mm	170 mm	68 mm	97 mm	150 mm	128 mm	64 mm	70 mm	99 mm	1,128 mm
Grandview, WV	GRNW2	4.3 in	2.3 in	4.0 in	2.8 in	7.0 in	1.3 in	8.7 in	3.9 in	3.7 in	4.4 in	3.4 in	4.9 in	50.7 in
		110 mm	57 mm	102 mm	70 mm	178 mm	34 mm	220 mm	98 mm	94 mm	113 mm	87 mm	124 mm	1,288 mm
Pipestem, WV	PIRW2	4.4 in	2.5 in	3.4 in	3.1 in	7.7 in	3.9 in	4.1 in	2.1 in	3.0 in	2.5 in	3.0 in	4.1 in	43.7 in
		112 mm	62 mm	87 mm	80 mm	195 mm	99 mm	104 mm	54 mm	75 mm	63 mm	76 mm	104 mm	1,111 mm

Table 9. Summary of 2009 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	151	31	96	89	165	163	101	106	186	105	118	222	128
Oak Hill, WV	OAKW2	139	49	87	88	166	97	136	131	157	125	77	170	118
London Locks, WV	LONW2	139	36	81	118	74	107	138	143	111	103	47	91	100
Summersville Lake, WV	SUMW2	138	40	94	105	130	90	145	97	106	110	44	130	103
Princeton, WV	PRIW2	150	74	78	106	212	77	145	102	193	110	104	191	129
Alderson, WV	ALDW2	143	31	92	92	179	89	182	75	220	97	103	216	127
Beckley VA Hospital, WV	BCKW2	112	39	95	67	192	101	176	95	100	128	93	127	110
Beckley, WV	KBKW	142	47	80	71	164	80	153	75	78	164	70	155	107
Bluefield, WV	KBLF	117	67	69	90	155	69	95	184	156	96	104	139	112

* Stations with a period of record of less than 5 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 2009 are shown in Figure 5.

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 (Figure 6) and the Northeast (Figure 7) are shown for 2009.

According to the PDSI for WV Climate Division 4, most of 2009 was "moist" (PDSI > 0; Figure 5) in the West Virginia parks. While the calendar year began quite moist, dry conditions set in by mid-January and continued until the end of March. As a result, PDSI values plummeted from near 2 in early January to near -1.5 (approaching "moderate drought" but still in the "normal" range) by the end of March. Regular rains returned during April and continued until November keeping PDSI values > 0 (Figure 5). When comparing the PDSI values with recent years, 2009 had the fewest months with a deficit. The DM – Drought Severity Index for West Virginia (Figure 6) and the Northeast (Figure 7) indicated a sufficiently wet year with no drought conditions near the parks during the growing season (May through October) in 2009.

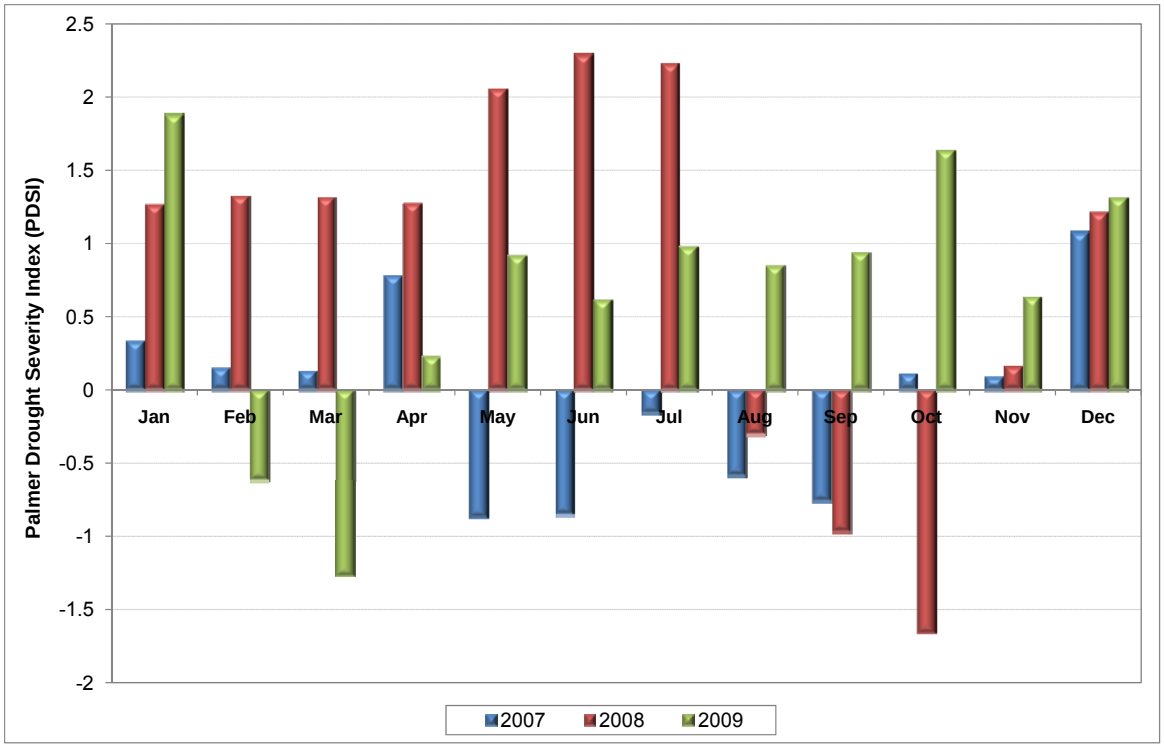

Figure 5. Monthly Palmer Drought Severity Index (PDSI) values for West Virginia Climate Division 4, 2007–2009.

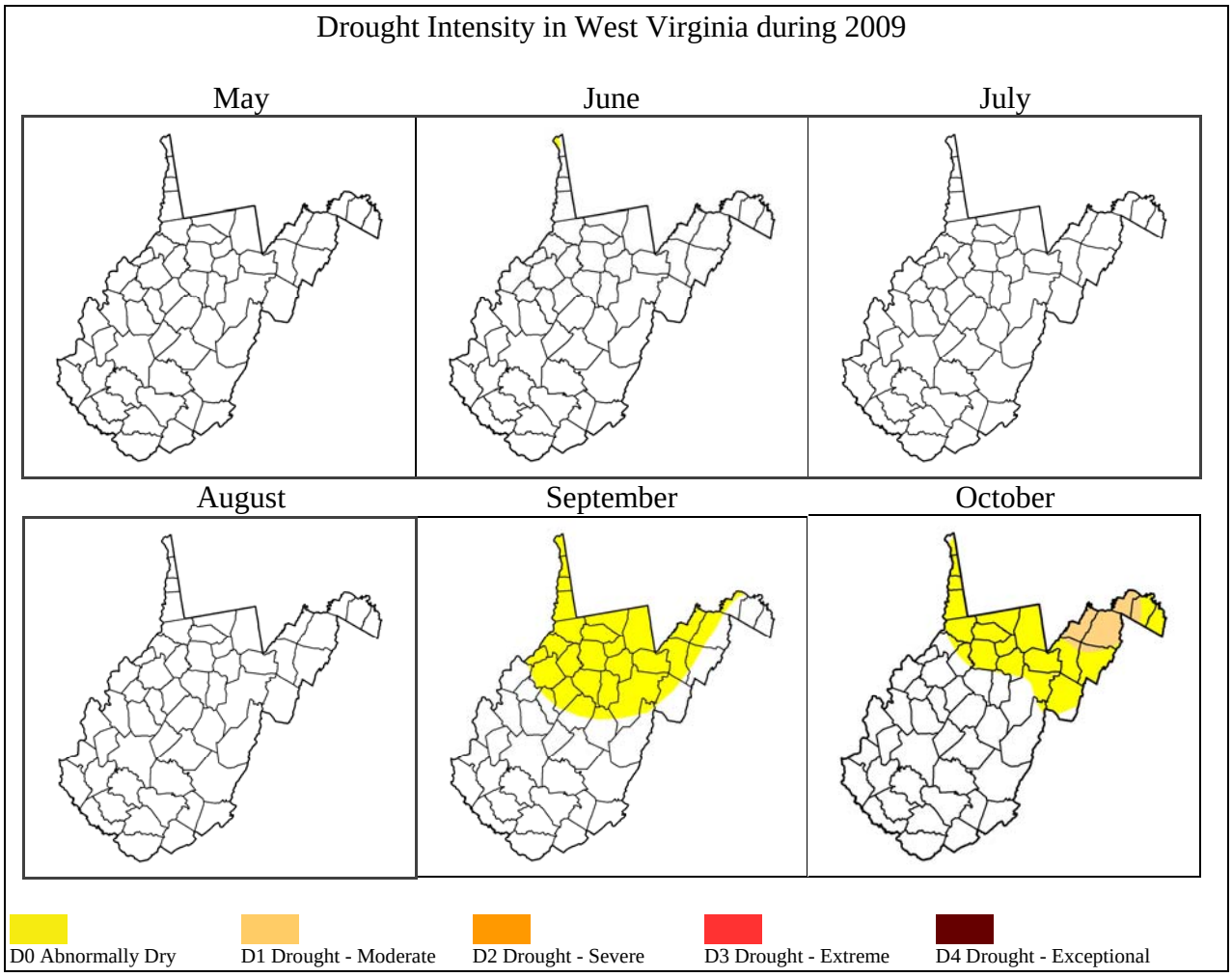

Figure 6. Mid-month values of the Drought Monitor – Drought Intensity Index for West Virginia in 2009.

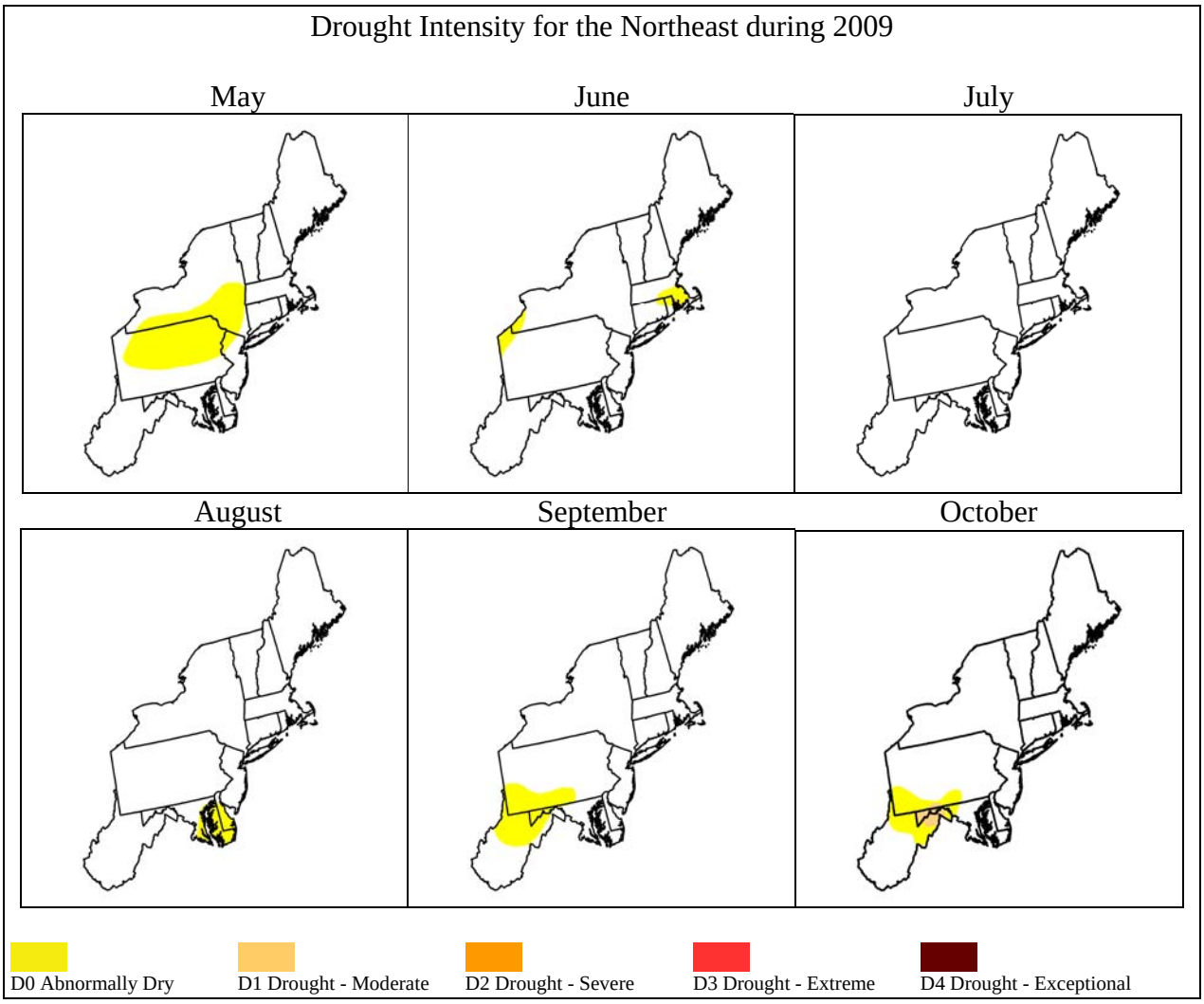

Figure 7. Mid-month values of the Drought Monitor – Drought Intensity Index for the Northeast in 2009.

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NPS 619/105523, 600/105523, 637/105523, September 2010

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