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Natural Resource Stewardship and Science

Weather of Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial

Eastern Rivers and Mountains Network Summary Report for 2011

Natural Resource Data Series NPS/ERMN/NRDS—2012/383

ON THE COVER
Photo description. Summer sky at Allegheny Portage Railroad National Historic Site 2009.
Photograph by: Kathy Penrod.

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Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial

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Paul Knight, Kyle Imhoff, 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. These reports are 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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List of Key Acronyms

ALPO	Allegheny Portage Railroad National Historic Site
ASOS	Automated Surface Observing System
COOP	National Weather Service Cooperative Observer Program
CWOP	Citizen Weather Observer Program
ERMN	Eastern Rivers and Mountains Network
FAA	Federal Aviation Administration
GOES	Geostationary Operational Environmental Satellite
NHS	National Historic Site
IFLOWS	Integrated Flood Observing and Warning System
JOFL	Johnstown Flood National Memorial
NADP	National Atmospheric Deposition Program
NARR	North American Regional Reanalysis
NCDC	National Climatic Data Center
NOAA	National Oceanic and Atmospheric Administration
NMem	National Memorial
NPS	National Park Service
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 the period from January 1 through December 31, 2011, and to place current patterns and trends in an appropriate historical and regional context (Marshall et al. 2012). 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. 2012). 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. 2012) and summarized in the body of this report.

The Climate of the South Central Mountains

Allegheny Portage Railroad National Historic Site (NHS) and Johnstown Flood National Memorial (NMem) are located in Pennsylvania Climate Division 8, also known as the South Central Mountains. 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/usclimdivs/data/map.html [NOAA 2011]). Pennsylvania is divided into 10 climate divisions.

The South Central Mountain region is generally considered to have a humid continental type of climate, but the elevated terrain and rolling mountains keep temperatures lower than surrounding areas. 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, though the air circulating southeastward from the Great Lakes dominates in the winter. Seldom do storms of tropical origin have an effect in this part of Pennsylvania, but the rough terrain has led to memorable severe floods in the warm half of the year (Gelber 2002).

Temperatures are moderately continental, with the tempering effects of the Great Lakes contributing to cloud production in the winter and mountain-valley circulation-induced clouds reducing the heat during the summer. The lowest readings in the winter occur with polar air masses of Canadian origin settling over the Northeast 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 Laurel Highlands. Allegheny Portage Railroad National Historic Site tends to have greater daytime temperatures than Johnstown Flood National Memorial; however, Johnstown Flood National Memorial tends to have fewer sub-freezing nights than the Allegheny Portage Railroad National Historic Site. The last freeze for the region typically occurs in May and the first frosts appear in late September or October.

Precipitation is fairly evenly distributed throughout the year. Annual amounts generally range between 36–54 in (914–1,371 mm), while the majority of places receive 40–46 in (1,016–1,168 mm). Greatest amounts usually occur in the spring and summer months, while February is the driest month, having about 2 in (51 mm) less than the wettest months. Precipitation tends to be somewhat greater in the higher terrain due to uplift and additional moisture from the Great Lakes. Based upon long-term averages, annual precipitation amounts tend to be greater at Allegheny Portage Railroad National Historic Site than at Johnstown Flood National Memorial.

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 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 two years. 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

Five weather observing stations, comprised of two observing networks, were selected around Allegheny Portage Railroad NHS and Johnstown Flood NMem. Representative stations within a 100-km range of each park were chosen based on several criteria, including proximity to the park, representativeness of the station to the park elevation profile, type and frequency of observations, the period of record of the data, and data availability (Marshall et al. 2012). Moreover, the percentage of time a station reports particular parameters (e.g., temperature) can influence its data inclusion. No stations were excluded in 2011 based on this criterion; therefore, all five stations were used for this report (Figure 1, Table 1).

The average value of a climate element over 30 years is defined as a climatological normal, which is calculated and established by NOAA's National Climatic Data Center (NCDC). Every ten years, NCDC computes new thirty-year climate normals for selected temperature and precipitation elements for a large number of U.S. climate and weather stations. The current (as of 2011) normals cover the period 1981–2010. In this report, the 30-year normals established by NCDC are used as the baseline for comparisons (e.g., departures from normal). In cases where data for the 30-year normal period are not available, we use alternative comparisons such as the new pseudo-normal from NCDC or a recent 10-year period. In some cases, sufficient data may simply not be available to calculate normals. For metrics that NCDC may not routinely calculate a normal, such as the number of days with more than 2 in (55 mm) of rain or liquid equivalent, normals will be calculated using the same time period (e.g., 1981−2010) as the current NCDC standard. Throughout the report, descriptions of a station's values as compared to the normals are described as a difference from the "average", "mean", "typical", "long-term value", as well as "normal", to improve the readability of the document. However, all of these terms are comparing a value from one year at that station to that station's normal, whether it be the 30-year normal or the pseudo-normal calculated on a shorter time frame.

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.

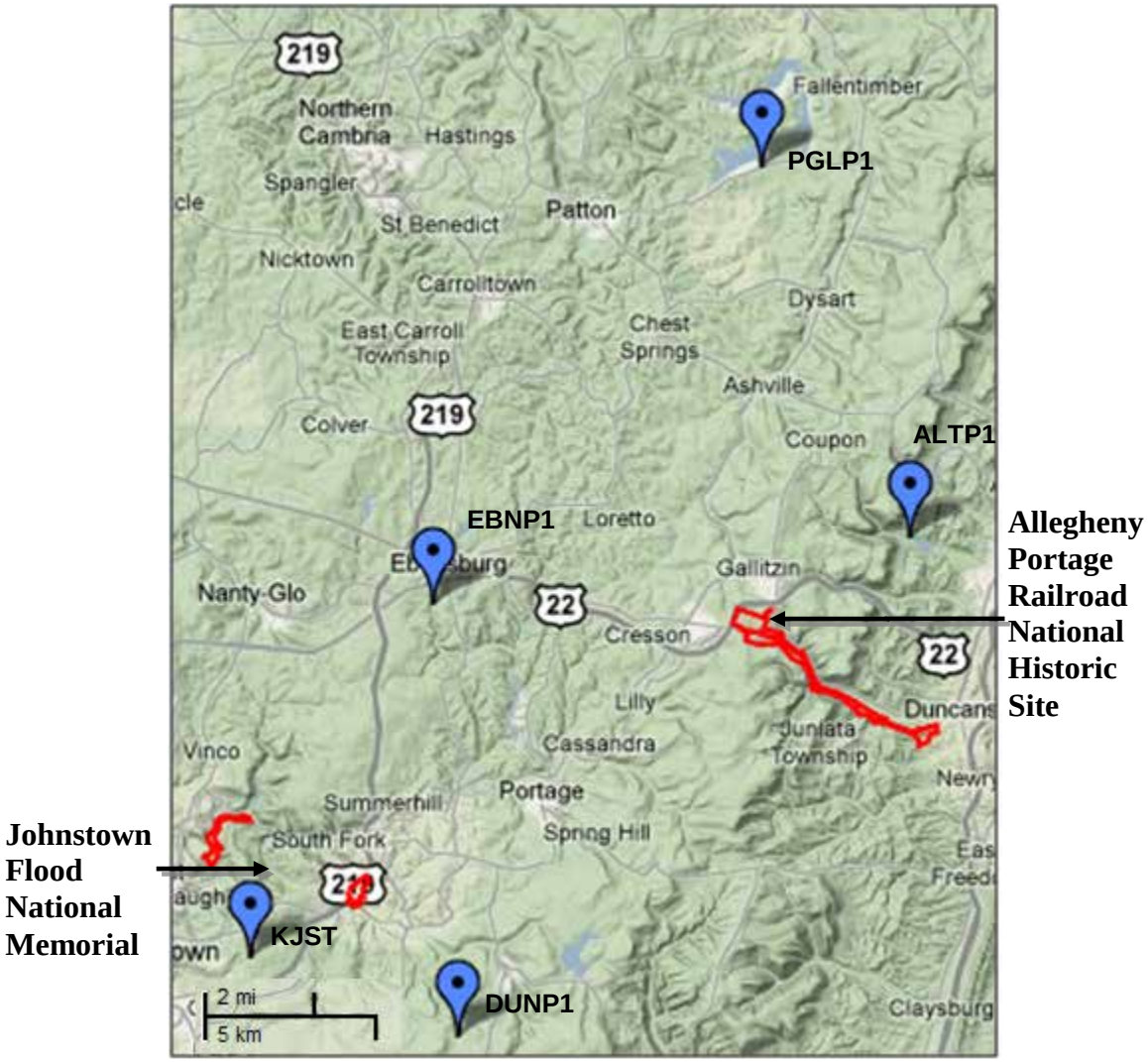

Figure 1. Location of weather observing stations around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial. See Table 1 for station names.

Table 1. List of weather observing stations around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial selected as best representative of the parks in 2011.

Station	Observing Network	Station Name	Period of Record (POR)		Percentage of Time Reporting Temperature for 2011	Percentage of Time Reporting Precipitation for 2011	Percentage of Time Reporting Temperature for entire POR	Percentage of Time Reporting Precipitation for entire POR
KJST	ASOS	John Murtha Johnstown-Cambria County Airport	01/01/1973	Present	97.5	97.5	99.6	39.5
ALTP1	COOP	Altoona 3 W	10/01/1967	Present	100.0	100.0	96.1	96.2
EBNP1	COOP	Ebensburg Sewage Plant	02/01/1964	Present	100.0	100.0	99.5	99.6
PGLP1	COOP	Prince Gallitzin State Park	09/01/1982	Present	100.0	100.0	95.7	97.4
DUNP1	COOP	Dunlo	02/01/1992	Present	-	98.6	-	99.2

Temperature Summary

Calendar year 2011 was noticeably warmer than average for the Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial region, with maximum temperatures averaging consistently normal between +0.6 to +0.8 degrees Fahrenheit (°F) (+0.4 to +0.5 degrees Celsius [°C]) from normal and minimums were even milder, ranging from +0.6°F (+0.3°C) to +1.1°F (+0.8°C) from normal (Figures 2 and 3, Table 2)[1].

Negative temperature departures in 2011 were quite limited, with the first and tenth months of the year averaging below normal and the other ten months averaging near to above the long-term mean. January was cold, with readings more than 5.4°F (3.0°C) below average at Johnstown, PA (Tables 3 and 4). The lowest readings of the year occurred in January (24th) as temperatures dropped to -16°F (-26.7°C) in the Laurel Highlands (Table 2). Mean temperatures in February were milder, with departures of +2.5°F (1.3°C) at Prince Gallitzin State Park (Table 4). Positive temperature anomalies continued in March as readings averaged 0.4°F (0.2°C) above normal (Table 4). The winter months of January–February–March were the 45th coolest in the South Central Mountain Climate Division of Pennsylvania since records began in 1895 (59 is the mid-point; Table 5).

Spring was noted by above-normal temperatures at all stations in each month (Table 4). The average temperature in Ebensburg, PA, during April was 49.4F (9.7°C); 2.2°F (1.2°C) above average (Tables 3 and 4). The first hot spell had daytime maxima above 85°F (29.6°C) from May 29-June 1. The last 32°F (0°C) reading of the spring occurred between April 6-22 (Table 2). The positive anomalies during May were higher and very mild nights in June led to a monthly departure of 2.2°F (1.2°C) in Altoona, PA. In its entirety, temperatures in the spring were the 11th warmest in 117 years of record keeping (Table 5).

Warmer-than-average conditions continued through the summer months, which were the 18th warmest since records began in 1895, in part due to a very warm July, ranking the 6th warmest (Table 5). More seasonable readings returned during August (Tables 3 and 4), but temperatures turned warmer than normal by September (Figures 2 and 3). The average temperature in July was 75.9°F (24.4°C) in Altoona, PA; 5.2°F (2.9°C) above average (Tables 3 and 4). The state experienced below seasonable readings for only the second time during October with an average -0.7°F (-0.4°C) temperature anomaly for the four stations. The highest temperature of the year occurred on July 22nd in Ebensburg, PA, with a reading of 99.0°F (37.2°C) (Table 2). The first freeze of the autumn occurred on October 23rd. Both November and December averaged well above normal temperatures and the fall of 2011 ranked the 15th warmest for the South Central Mountain Climate Division. Calendar year 2011 featured nearly normal frequency of cold days and below normal number of hot days (Table 2). The total growing season length (days between last spring freeze and first fall freeze) ranged from 170–178 days or about 10 to 40 days longer than average (Table 2).

[1] 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/.

Allegheny Portage Railroad National Historic Site
and Johnstown Flood National Memorial
Departure from Average Monthly Maximum Temperature
2011 vs. 1981–2010

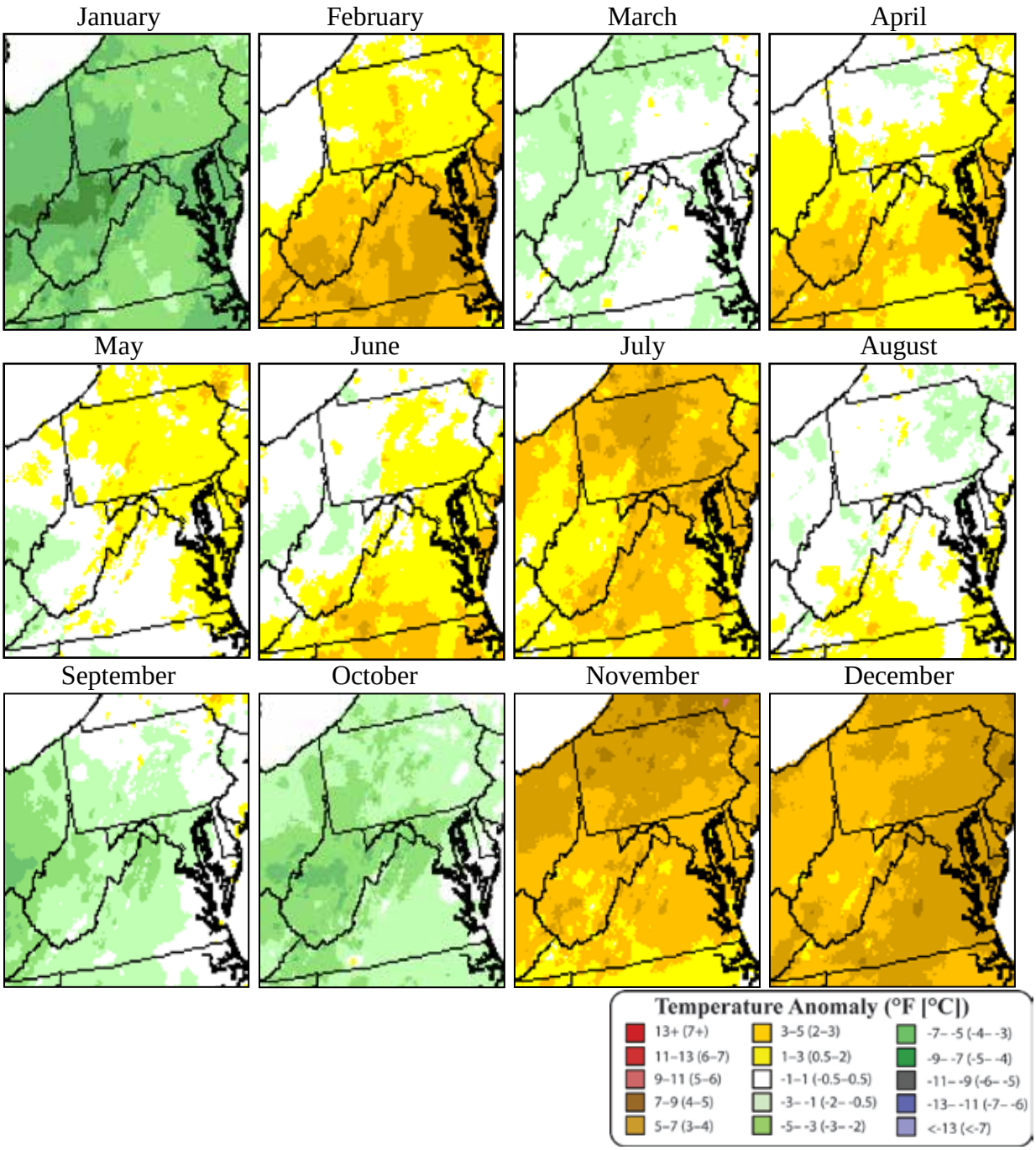

Figure 2. Maps showing departure from average monthly maximum temperature compared to the 30-year normal (1981–2010).

Allegheny Portage Railroad National Historic Site
and Johnstown Flood National Memorial
Departure from Average Monthly Minimum Temperature
2011 vs. 1981–2010

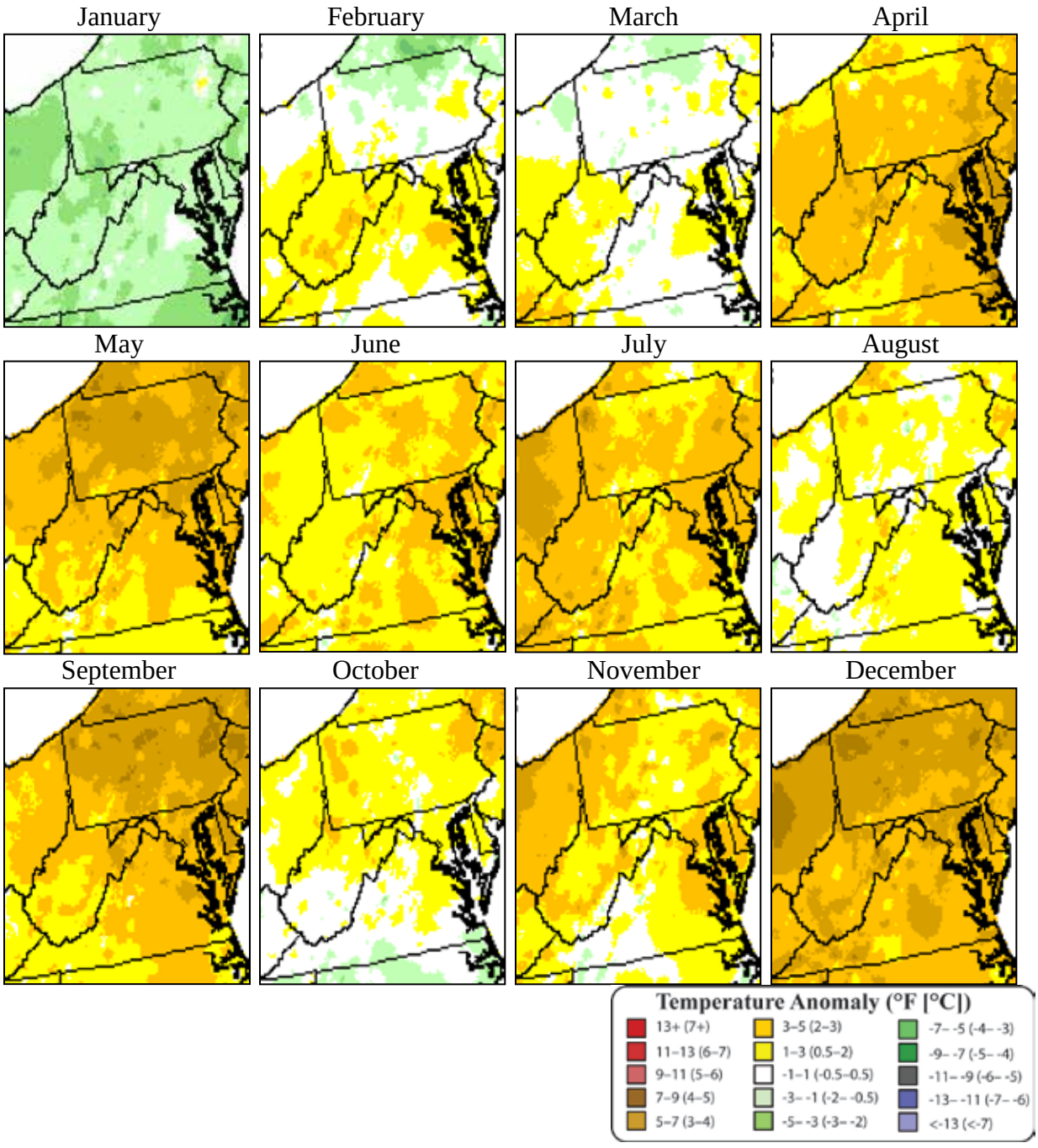

Figure 3. Maps showing departure from average monthly minimum temperature compared to the 30-year normal (1981–2010).

Table 2. Status of 2011 temperature indicators compared to the 30-year normal (1981–2010) at the Ebensburg Sewage Plant (EBNP1) and Johnstown Airport (KJST) stations.

Temperature Indicator	Ebensburg Sewage Plant, PA 2011	Ebensburg Sewage Plant, PA 1981–2010	Johnstown Airport, PA 2011	Johnstown Airport, PA 1981–2010
Average Annual Temperature	49.2°F 9.6°C	47.7°F 8.7°C	48.6°F 9.2°C	47.7°F 8.7°C
Average Annual Maximum Temperature	59.7°F 15.4°C	58.9°F 14.9°C	56.4°F 13.6°C	55.8°F 13.2°C
Maximum Temperature	94.0°F 34.4°C	90.6°F 32.6°C	94.0°F 34.4°C	86.9°F 30.5°C
Hot Days (days with Tmax≥90°F/32°C)	4	1	2	3
Average Annual Minimum Temperature	38.7°F 3.7°C	36.6°F 2.6°C	40.8°F 4.9°C	39.7°F 4.3°C
Minimum Temperature	-16.0°F -26.7°C	-11.7°F -24.3°C	-4.0°F -20.0°C	-1.3°F -18.5°C
Cold Days (days with Tmax≤32°F/0°F)	33	38	47	50
Sub-freezing Days (days with Tmin≤32°F/0°C)	144	151	123	127
Sub-zero Days (days with Tmin≤0°F/-17.8°C)	6	7	2	1
Growing Season Length (days between last spring Tmin 32°F/0°C and first fall Tmin 32°F/0°C)	170	129	178	166

Table 3. Summary of monthly average temperatures for 2011 for the selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Altoona 3 W	ALTP1	21.9°F	29.8°F	36.7°F	50.2°F	62.1°F	68.5°F	75.9°F	69.8°F	63.9°F	50.4°F	45.1°F	35.1°F	50.8°F
		-5.6°C	-1.2°C	2.6°C	10.1°C	16.7°C	20.3°C	24.4°C	21.0°C	17.7°C	10.2°C	7.3°C	1.7°C	10.4°C
Ebensburg Sewage Plant	EBNP1	21.0°F	27.8°F	36.3°F	49.4°F	60.4°F	66.0°F	71.5°F	67.3°F	63.0°F	49.1°F	43.9°F	34.0°F	49.1°F
		-6.1°C	-2.3°C	2.4°C	9.7°C	15.8°C	18.9°C	21.9°C	19.6°C	17.2°C	9.5°C	6.6°C	1.1°C	9.5°C
Prince Gallitzin State Park	PGLP1	20.0°F	28.8°F	35.0°F	48.1°F	60.1°F	66.9°F	73.7°F	68.9°F	63.5°F	48.8°F	44.5°F	34.5°F	49.4°F
		-6.7°C	-1.8°C	1.7°C	8.9°C	15.6°C	19.4°C	23.2°C	20.5°C	17.5°C	9.3°C	6.9°C	1.4°C	9.7°C
Johnstown Airport	KJST	19.8°F	27.5°F	34.3°F	48.7°F	60.0°F	65.0°F	72.8°F	66.8°F	61.3°F	48.3°F	44.0°F	34.2°F	48.6°F
		-6.8°C	-2.5°C	1.3°C	9.3°C	15.6°C	18.3°C	22.7°C	19.3°C	16.3°C	9.1°C	6.7°C	1.2°C	9.2°C

Table 4. Summary of 2011 departure from normal temperature based on 30-year normal (1981–2010) for the selected stations.

Station Name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Altoona 3 W	ALTP1	-3.5°F	1.6°F	0.3°F	1.9°F	4.1°F	1.9°F	5.2°F	0.4°F	1.9°F	-0.5°F	4.2°F	5.4°F	1.9°F
		-1.9°C	0.9°C	0.2°C	1.1°C	2.3°C	1.1°C	2.9°C	0.2°C	1.1°C	-0.3°C	2.3°C	3.0°C	1.1°C
Ebensburg Sewage Plant	EBNP1	-4.4°F	0.0°F	0.4°F	2.2°F	4.2°F	1.5°F	3.2°F	0.2°F	2.6°F	-0.6°F	3.9°F	4.5°F	1.5°F
		-2.4°C	0.0°C	0.2°C	1.2°C	2.3°C	0.8°C	1.8°C	0.1°C	1.4°C	-0.3°C	2.2°C	2.5°C	0.8°C
Prince Gallitzin State Park	PGLP1	-4.3°F	2.3°F	0.4°F	1.9°F	4.2°F	2.2°F	5.1°F	1.8°F	3.8°F	0.4°F	5.3°F	6.0°F	2.4°F
		-2.4°C	1.3°C	0.2°C	1.1°C	2.3°C	1.2°C	2.8°C	1.0°C	2.1°C	0.2°C	2.9°C	3.3°C	1.3°C
Johnstown Airport	KJST	-5.4°F	0.4°F	-1.2°F	1.4°F	3.3°F	0.2°F	3.5°F	-1.0°F	1.5°F	-1.4°F	4.5°F	5.5°F	0.9°F
		-3.0°C	0.2°C	-0.7°C	0.8°C	1.8°C	0.1°C	1.9°C	-0.6°C	0.8°C	-0.8°C	2.5°C	3.1°C	0.5°C

Table 5. Seasonal and annual temperature and precipitation rankings for 2011 over 117 years (1 = warmest/wettest year and 117 = coldest/driest year) for Pennsylvania Climate Division 8.

PA Climate Division 8 Rankings "South Central Mountains"	Jan–Feb–Mar WINTER	Apr–May–Jun SPRING	Jul–Aug–Sep SUMMER	Oct–Nov–Dec AUTUMN	Jan-Dec ANNUAL
Temperature-2011	72	11	18	15	16
Precipitation-2011	27	7	3	13	2

Precipitation Summary

Liquid precipitation (rain and melted snow, ice, sleet, etc.; hereafter precipitation) was far above normal in 2011 around Johnstown Flood National Memorial and Allegheny Portage Railroad National Historic Site (Table 6) with a series of very wet days during September (Table 7). The transition seasons were very moist and the early to mid summer was dry; this allowed the year to rank as the 2nd wettest in the South Central Mountain Climate Division (8) of Pennsylvania since records began in 1895.

The beginning of the year featured below-normal precipitation from January through early February (Figure 4). However, the next four months of 2011 were the wettest such period in 117 years of record keeping (Table 5). Between 17.6 and 23.0 in (447–584 mm) was tallied by the end of May (Tables 8 and 9); about 150 percent of normal. The start-of-the-year deficit began to be erased in February when an average of 4.18 in (106 mm) of precipitation fell in the climate division. This was the 27th wettest February since records began in 1895. Snowfall was very close to the normal amount (Table 6) and was average during February. At Dunlo, 12.4 in (31 cm) fell from February 1-28, 2011.

Spring was one of the wettest on record across the region, with April ranking as 2nd wettest in the South Central Mountain Climate Division with 117 years of records (Table 5). May provided the region with near average rainfall at all reporting stations and June had the least rainfall in the warm season (Table 9). The driest location was Johnstown during June when 1.3 in (32 mm) was measured (Table 8). Overall, June ranked as the 12th driest for the South Central Mountain Climate Division (Table 9).

The summer of 2011 had two faces, as it was quite dry in July, which ranked 14th driest in 117 years (Table 5). The other face became evident in mid-August as heavy showers continued through mid-September (Table 9). Only one notable dry spell occurred during the summer months (Table 7). September brought the wettest month of the year as 11.5 in (292 mm) fell at Altoona (Table 8). There were two direct influences from tropical storms during this year with the area being influenced by outer rain bands of Hurricane Irene on August 28th and receiving very heavy rain from the remnants of Tropical Storm Lee from September 6-9. Total rainfall at Ebensburg, PA was 2.68 in (68 mm) on September 7th, the wettest day of 2011 (Table 7).

Precipitation anomalies in the fall continued to be largely positive. October and December were both above normal; November brought the closest to normal precipitation (Figure 4). Dunlo tallied only 3.6 in (90 mm) which was 98% of normal (Table 8). Despite the seasonable weather in November, the season concluded as the 13th wettest (Table 5). Three of the dry spells of 2011 occurred during this season (Table 7). As a whole, 2011 had more than the average number of excessive rain days and near normal number of snowy days (Table 6).

Table 6. Status of 2011 precipitation indicators compared to the 30-year normal (1981–2010) at the Ebensburg Sewage Plant (EBNP1) and Johnstown Airport (KJST) stations.

Precipitation Indicator	Ebensburg Sewage Plant, PA 2011	Ebensburg Sewage Plant, PA 1981-2010	Johnstown Airport, PA 2011	Johnstown Airport, PA 1981-2010
Annual Precipitation	60.7 in 1,542 mm	47.7 in 1,212 mm	52.0 in 1,321 mm	41.1 in 1,044 mm
Autumn (Oct, Nov, Dec) Precipitation	14.7 in 373 mm	11.2 in 284 mm	11.7 in 297 mm	9.3 in 236 mm
Heavy Precipitation Days (days with ≥1.0 in [25 mm] rain)	14	9	9	7
Extreme Precipitation Days (days with ≥2.0 in [51 mm] rain)	1	1	0	0
Micro-drought (strings of 7+ days without rain)	2	5	1	5
Annual Snowfall	76.9 in 195.3 cm	87.5 in 222.3 cm	77.6 in* 197.1 cm*	75.6 in* 192.0 cm*
Measurable Snow Days (days with ≥0.1 in [0.3 cm] snow)	37	40	32*	39*
Moderate Snow Days(days with ≥3.0 in [7.6 cm] snow)	8	11	12*	10*
Heavy Snow Days(days with ≥5.0 in [12.7 cm] snow)	5	4	5*	3*

*Annual Snowfall totals and snowfall normal values were taken from Dunlo, PA (DUNP1) due to the lack of reporting snowfall at Johnstown Airport (KJST).

Table 7. Top five wettest days and top five dry spells (consecutive days with a trace or less of liquid precipitation) during 2011 from stations Ebensburg Sewage Plant (EBNP1) and Johnstown Airport (KJST).

Wettest Days in 2011			
Sep. 7:	2.68 in (68 mm)	Oct. 31–Nov. 9	
Sep. 6:	1.94 in (49 mm)	Dec. 8–Dec.14	
Sep. 9:	1.90 in (48 mm)	May 29–Jun. 4	
Jul. 29:	1.90 in (48 mm)	Oct. 5–Oct. 11	
Nov. 23:	1.42 in (39 mm)	Jul. 13–Jul. 18	

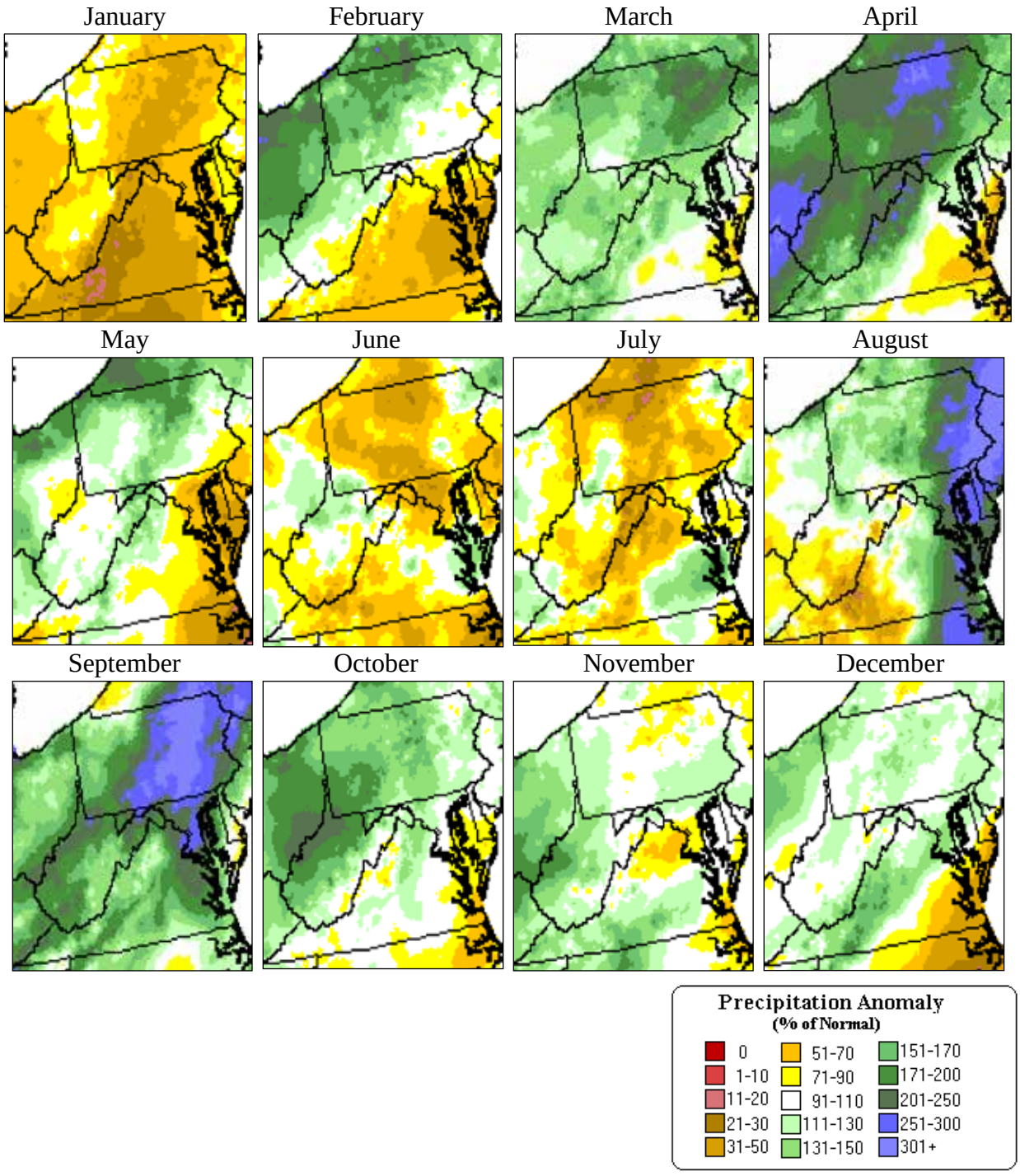

Figure 4. Maps showing percent of average monthly precipitation compared to the 30-year normal (1981–2010).

Table 8. Summary of 2011 monthly total precipitation for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Johnstown Airport	KJST	1.3 in	3.9 in	3.8 in	6.8 in	4.1 in	1.3 in	2.3 in	5.7 in	11.3 in	5.2 in	3.3 in	3.2 in	52.0 in
		33 mm	100 mm	97 mm	172 mm	103 mm	32 mm	59 mm	144 mm	286 mm	132 mm	83 mm	82 mm	1,322 mm
Altoona 3 W	ALTP1	1.1 in	4.2 in	5.3 in	8.5 in	5.0 in	1.3 in	2.6 in	5.0 in	11.5 in	7.4 in	3.7 in	3.8 in	59.3 in
		29 mm	105 mm	134 mm	216 mm	126 mm	34 mm	66 mm	128 mm	292 mm	188 mm	93 mm	97 mm	1,507 mm
Ebensburg Sewage Plant	EBNP1	2.2 in	5.1 in	5.3 in	8.5 in	4.4 in	2.6 in	4.0 in	4.5 in	9.3 in	6.0 in	3.4 in	5.3 in	60.7 in
		56 mm	130 mm	135 mm	216 mm	113 mm	66 mm	101 mm	115 mm	237 mm	152 mm	86 mm	136 mm	1,542 mm
Prince Gallitzin State Park	PGLP1	1.2 in	4.3 in	4.1 in	7.5 in	4.0 in	2.3 in	1.4 in	6.1 in	10.8 in	4.9 in	3.3 in	3.4 in	53.0 in
		29 mm	108 mm	103 mm	190 mm	101 mm	57 mm	35 mm	156 mm	274 mm	124 mm	83 mm	86 mm	1,347 mm
Dunlo	DUNP1	2 in	3.4 in	5.6 in	7 in	5.5 in	2.3 in	2.4 in	7.5 in	8.9 in	6.2 in	3.6 in	M	54.4 in
		50 mm	87 mm	143 mm	179 mm	140 mm	58 mm	60 mm	191 mm	227 mm	156 mm	90 mm	M	1,381 mm

Table 9. Summary of 2011 percent-of-normal precipitation based on 30-year normal (1981–2010) for selected stations.

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Johnstown Airport	KJST	45	167	116	189	89	31	61	149	329	170	88	126	127
Altoona 3 W	ALTP1	41	162	149	239	112	34	67	140	294	214	94	128	140
Ebensburg Sewage Plant	EBNP1	60	174	129	196	97	61	84	113	239	183	81	142	127
Prince Gallitzin State Park	PGLP1	43	178	122	220	108	59	37	165	295	162	97	138	135
Dunlo[1]	DUNP1	59	139	162	199	128	55	57	192	229	201	96	M	127

[1]Indicates a station's Period of Record is ten or more years but less than 30 years. In these cases, the departure from normal values were calculated with normals derived from data spanning the length of the station's Period of Record.

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 provide 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 Pennsylvania Climate Division 8 in 2011 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 (NIDIS 2011). 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 Pennsylvania (Figure 6) and the Northeast (Figure 7) are shown for 2011.

According to the PDSI, the value of this index in Climate Division 8 reflected the excessive rainfall that occurred during 2011. While values were in the "near normal" range during January and February, the effects of well above normal precipitation during the spring months raised the PDSI to "very moist" conditions. However, it turned much drier during the first two-thirds of the summer, allowing the PDSI to approach "moderate drought" levels by late July. However, the rain returned during mid-August and even some flooding accompanied the remnants of Tropical Storm Lee in early September. The very moist soil remained through the autumn. There was no widespread drought noted in the Allegheny Highlands during 2011 (Figure 5). When comparing 2011 with previous years, values of PDSI during the peak of the growing season (June–September) remained near the normal range for all three years. It is interesting to note that October–December, during the past three years, have been wetter than average.

The DM – Drought Severity Index for Pennsylvania (Figure 6) and the Northeast (Figure 7) show a similar pattern for the growing season (May through October); abnormally dry (D0) only during the mid-summer period.

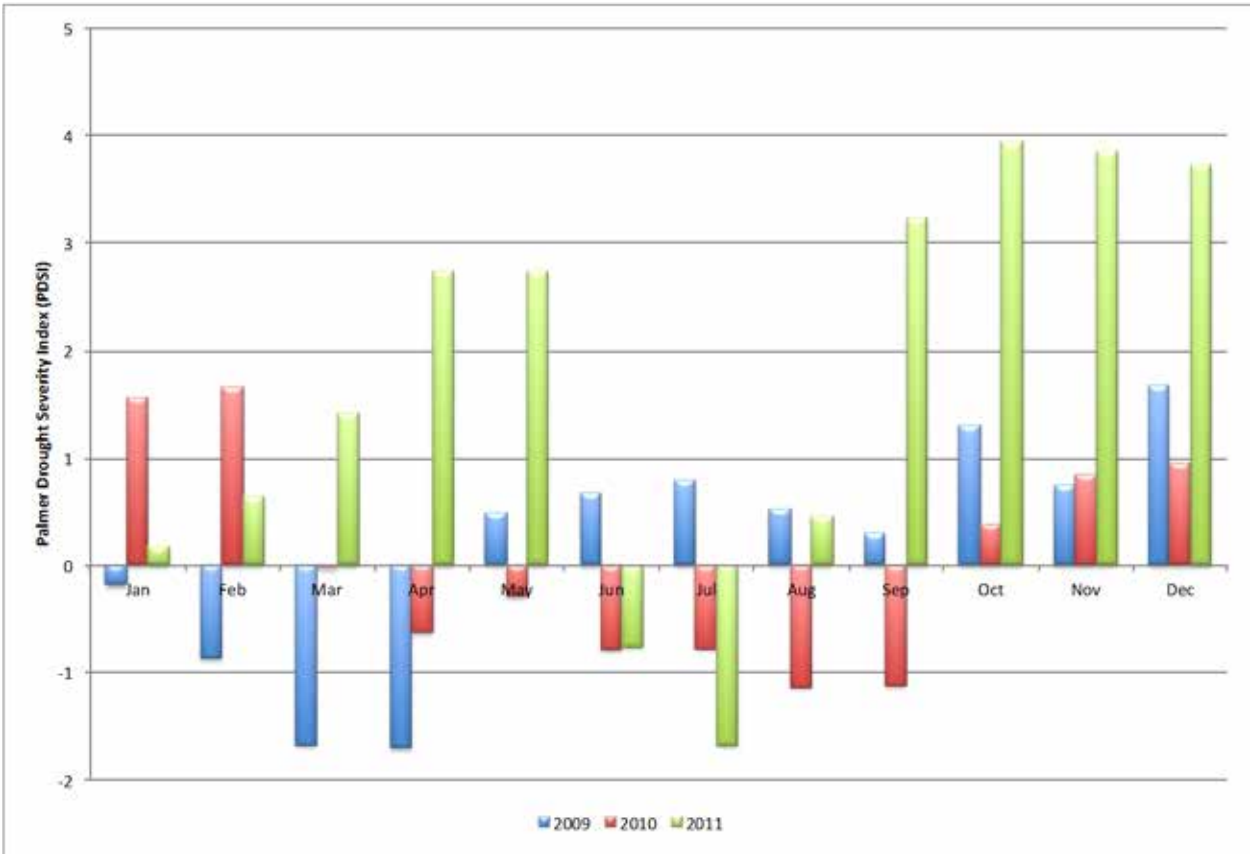

Figure 5. Monthly Palmer Drought Severity Index (PDSI) values for Pennsylvania Climate Division 8, 2009–2011.

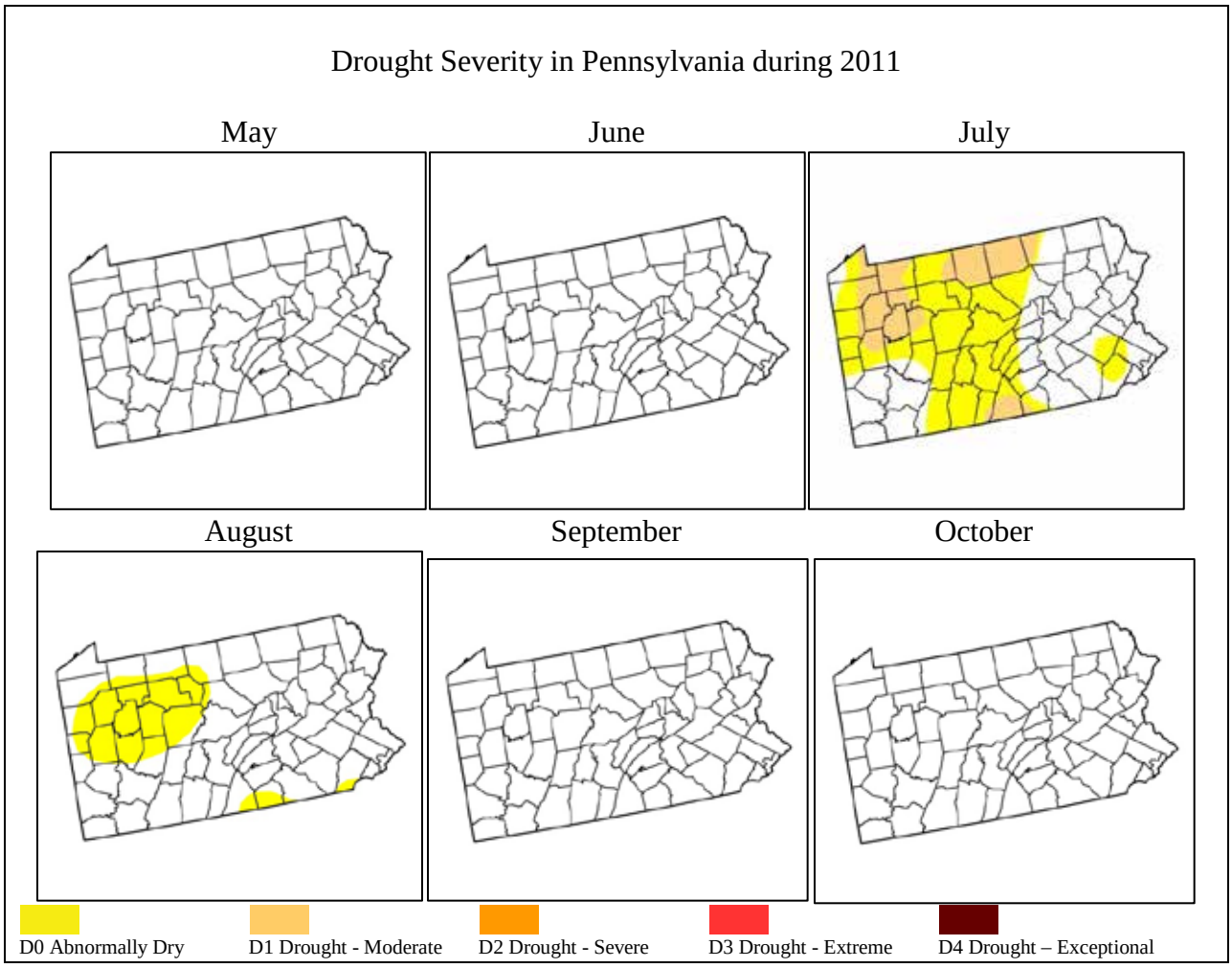

Figure 6. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for Pennsylvania in 2011.

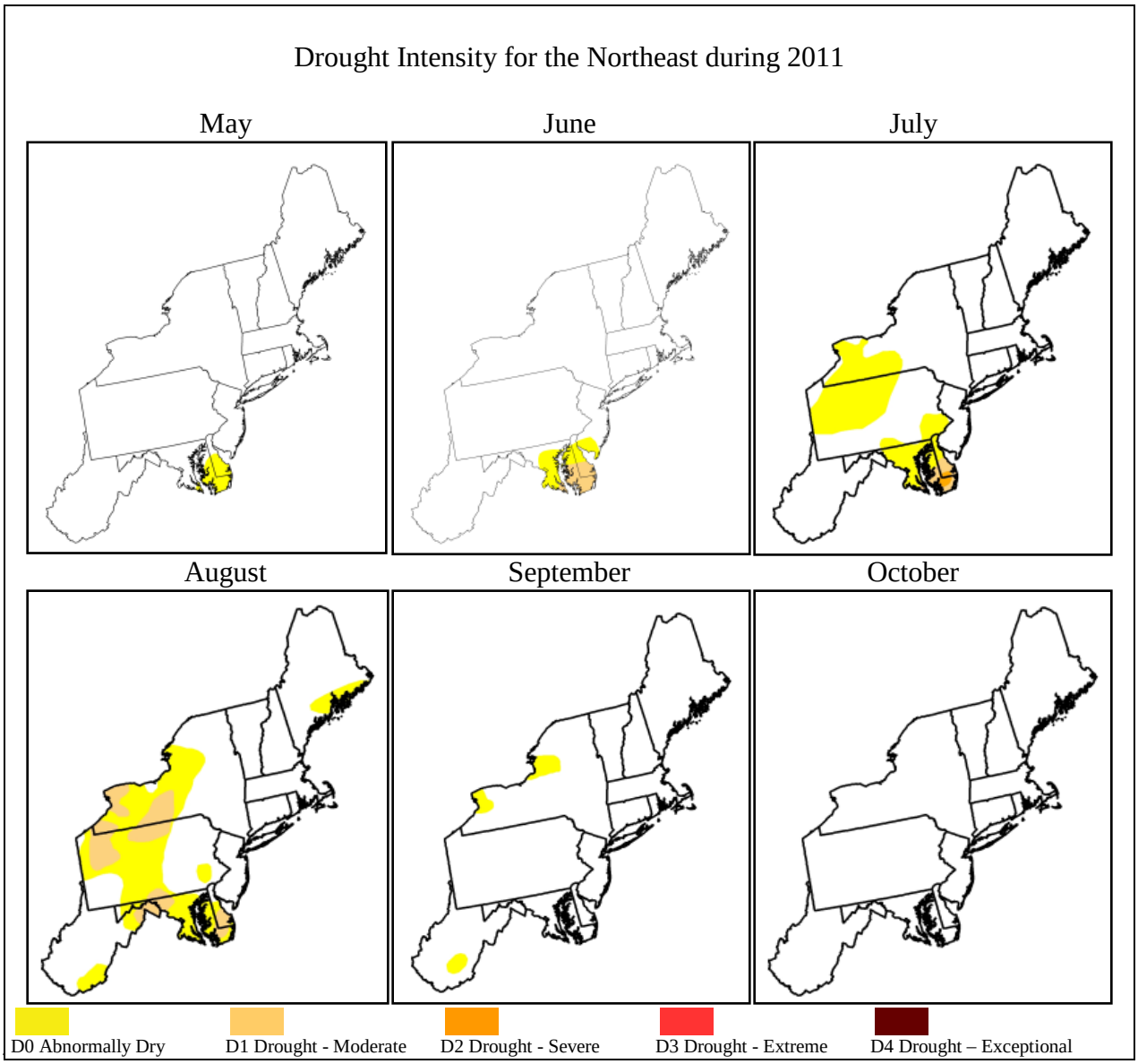

Figure 7. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for the Northeast in 2011.

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Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

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