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

Eastern Rivers and Mountains Network Summary Report for 2010

Natural Resource Data Series NPS/ERMN/NRDS—2011/290

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

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Natural Resource Data Series NPS/ERMN/NRDS—2011/290

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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.

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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, 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 meets 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;jk 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.

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 2010]). 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

A total of 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., in review). Moreover, the percentage of time a station reports particular parameters (e.g., temperature) can influence its data inclusion. No stations were excluded in 2010 based on this criterion; therefore, a total of five 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.

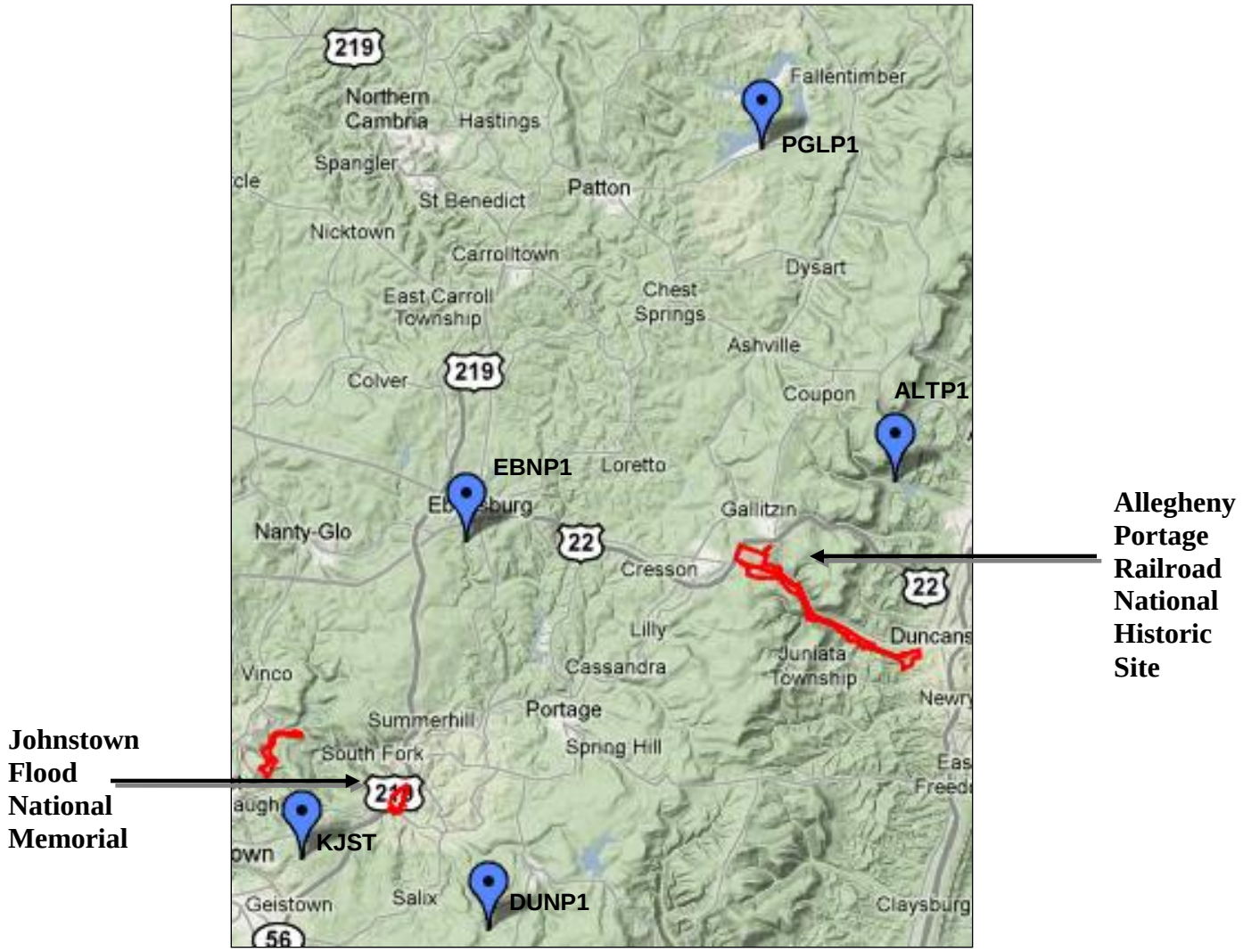

Figure 1. Location of weather observing stations around Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial. See Table 1 for station names.

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 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
KJST	ASOS	John Murtha Johnstown-Cambria County Airport	01/01/1973	Present	100.0	100.0	99.7	38.0
ALTP1	COOP	Altoona 3 W	10/01/1967	Present	100.0	100.0	96.0	96.0
EBNP1	COOP	Ebensburg Sewage Plant	02/01/1964	Present	100.0	99.7	99.4	99.4
PGLP1	COOP	Prince Gallitzin State Park	09/01/1982	Present	100.0	99.7	94.8	95.8
DUNP1	COOP	Dunlo	02/01/1992	Present	-	100.0	-	99.3

Temperature Summary

Calendar year 2010 was only slightly warmer than average for the Allegheny Portage Railroad National Historic Site and Johnstown Flood National Memorial region, with maximum temperatures averaging very close to normal between +0.3 to -0.4 degrees Fahrenheit (°F) (+0.1 to -0.2 degrees Celsius [°C]) from normal, though minimums were milder, ranging from +1.7°F (+1.0°C) to -0.4°F (-0.2°C) from normal (Figures 2 and 3, Table 2)[1].

Negative temperature departures in 2010 were bookends, with the first and last two months of the year averaging below normal and the eight months in between averaging above the long-term mean. January was cold, with readings more than 3.5°F (2.0°C) below average at Johnstown, PA (Tables 3 and 4). The lowest readings of the year occurred in February (7th) as temperatures dropped to -9°F (-22.8°C) in the Laurel Highlands (Table 2). Mean temperatures in February were even colder, with departures as large as -6.3°F (3.5°C) at Johnstown (Table 4). Positive temperature anomalies returned in March as readings averaged as much as 5.5°F (3.1°C) above normal (Table 4). The winter months of January–February–March were the 34th warmest in the South Central Mountain Climate Division of Pennsylvania since records began in 1895 (58 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 52.2F (11.2°C); 5.4°F (3.0°C) above average (Tables 3 and 4). An early warm spell had daytime maxima above 75°F (24°C) from April 1st-9th. The last 32°F (0°C) reading of the spring occurred on May 11 (Table 2). The positive anomalies during May were lower, but very warm nights in June led to monthly departure of 3.6°F (2.0°C) in Ebensburg, PA. In its entirety, temperatures in the spring were the 3rd warmest in 116 years of record-keeping (Table 5).

Warmer-than-average conditions continued through the summer months, which were the 30th warmest since records began in 1895, in part due to a very warm July, ranking the 18th warmest (Table 5). Warmer-than-normal readings lingered into August (Tables 3 and 4), but temperatures were very near average by September (Figures 2 and 3). The average temperature in July was 73.9°F (23.3°C) in Altoona, PA; 2.8°F (1.6°C) above average (Tables 3 and 4). More seasonal temperatures returned in September, with an average +0.4°F (0.2°C) temperature anomaly for the four stations. The highest temperature of the year occurred on July 8th in Ebensburg, PA, with a reading of 91.0°F (32.8°C) (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
2010 vs. 1971–2000

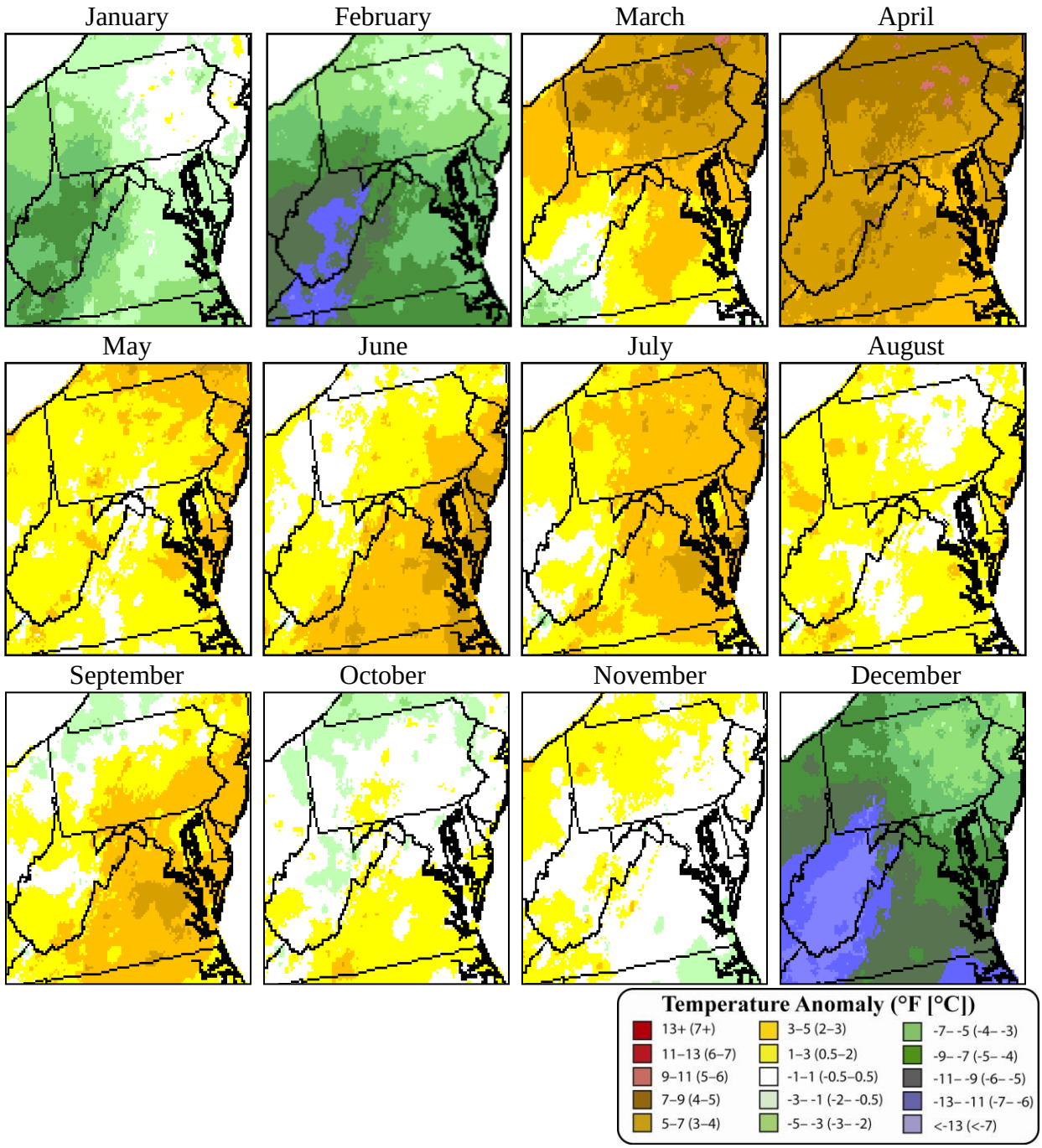

Figure 2. Maps showing departure from average monthly maximum temperature compared to the 30-year normal (1971–2000).

Allegheny Portage Railroad National Historic Site
and Johnstown Flood National Memorial
Departure from Average Monthly Minimum Temperature
2010 vs. 1971–2000

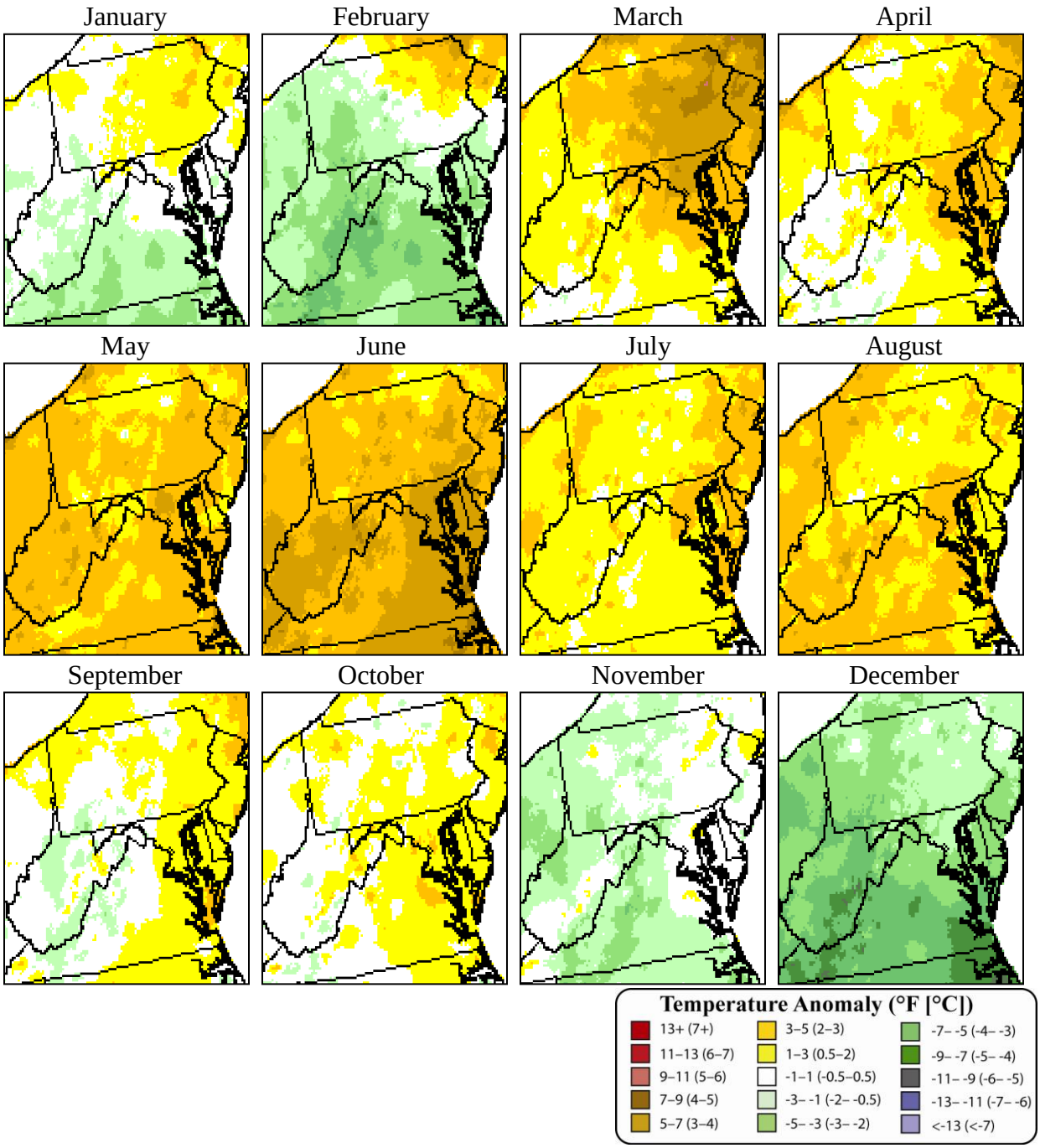

Figure 3. Maps showing departure from average monthly minimum temperature compared to the 30-year normal (1971–2000).

Table 2. Status of 2010 temperature indicators compared to the 30-year normal (1971–2000) at the Ebensburg Sewage Plant (EBNP1) and Johnstown Airport (KJST) stations.

Temperature Indicator	Ebensburg Sewage Plant, PA 2010	Ebensburg Sewage Plant, PA 1971–2000	Johnstown Airport, PA 2010	Johnstown Airport, PA 1971–2000
Average Annual Temperature	48.4°F 9.1°C	47.8°F 8.8°C	48.1°F 8.9°C	48.1°F 8.9°C
Average Annual Maximum Temperature	59.3°F 15.2°C	59.7°F 15.4°C	55.6°F 13.1°C	55.3°F 12.9°C
Maximum Temperature	91.0°F 32.8°C	90.1°F 32.3°C	88.0°F 31.1°C	91.1°F 32.8°C
Hot Days (days with Tmax≥90°F/32°C)	2	3	0	3
Average Annual Minimum Temperature	37.5°F 3.1°C	35.8°F 2.1°C	40.5°F 4.7°C	40.9°F 4.9°C
Minimum Temperature	-9.0°F -22.8°C	-13.7°F -25.4°C	2.0°F -16.7°C	-5.4°F -20.8°C
Cold Days (days with Tmax≤32°F/0°F)	59	35	75	53
Sub-freezing Days (days with Tmin≤32°F/0°C)	152	161	127	125
Sub-zero Days (days with Tmin≤0°F/-17.8°C)	4	10	0	4
Growing Season Length (days between last spring Tmin 32°F/0°C and first fall Tmin 32°F/0°C)	155	123	173	164

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

Station name	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Altoona 3 W , PA	ALTP1	25.0°F	25.0°F	43.0°F	53.9°F	60.7°F	69.6°F	73.9°F	71.0°F	63.4°F	52.2°F	41.3°F	24.1°F	50.2°F
		-3.9°C	-3.9°C	6.1°C	12.1°C	16.0°C	20.9°C	23.3°C	21.7°C	17.4°C	11.2°C	5.1°C	-4.4°C	10.1°C
Ebensburg Sewage Plant, PA	EBNP1	23.4°F	22.8°F	40.2°F	52.2°F	59.1°F	68.0°F	70.2°F	68.3°F	62.6°F	50.5°F	40.0°F	22.2°F	48.3°F
		-4.8°C	-5.1°C	4.6°C	11.2°C	15.1°C	20.0°C	21.2°C	20.2°C	17.0°C	10.3°C	4.4°C	-5.5°C	9.0°C
Prince Gallitzin State Park, PA	PGLP1	22.6°F	21.9°F	38.4°F	50.2°F	58.0°F	67.1°F	71.0°F	68.2°F	60.8°F	50.5°F	40.4°F	22.5°F	47.6°F
		-5.2°C	-5.6°C	3.6°C	10.1°C	14.5°C	19.5°C	21.6°C	20.1°C	16.0°C	10.3°C	4.7°C	-5.3°C	8.7°C
Johnstown Airport, PA	KJST	21.7°F	21.7°F	39.8°F	52.1°F	59.3°F	67.2°F	71.2°F	68.5°F	61.8°F	50.3°F	39.8°F	21.6°F	47.9°F
		-5.7°C	-5.7°C	4.3°C	11.2°C	15.2°C	19.6°C	21.8°C	20.3°C	16.6°C	10.2°C	4.3°C	-5.8°C	8.8°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
Altoona 3 W, PA	ALTP1	-1.5°F	-4.1°F	5.5°F	5.0°F	1.7°F	2.4°F	2.8°F	1.2°F	0.1°F	0.3°F	-0.8°F	-7.4°F	0.4°F
		-0.8°C	-2.3°C	3.1°C	2.8°C	0.9°C	1.3°C	1.6°C	0.7°C	0.1°C	0.2°C	-0.4°C	-4.1°C	0.2°C
Ebensburg Sewage Plant, PA	EBNP1	-1.9°F	-4.9°F	3.6°F	5.4°F	2.6°F	3.6°F	1.8°F	1.1°F	1.7°F	0.5°F	0.1°F	-7.7°F	0.5°F
		-1.1°C	-2.7°C	2.0°C	3.0°C	1.4°C	2.0°C	1.0°C	0.6°C	0.9°C	0.3°C	0.1°C	-4.3°C	0.3°C
Prince Gallitzin State Park, PA	PGLP1	-1.8°F	-5.2°F	2.7°F	3.3°F	0.7°F	1.5°F	1.1°F	0.1°F	-0.1°F	0.9°F	0.4°F	-7.5°F	-0.3°F
		-1.0°C	-2.9°C	1.5°C	1.8°C	0.4°C	0.8°C	0.6°C	0.1°C	-0.1°C	0.5°C	0.2°C	-4.2°C	-0.2°C
Johnstown Airport, PA	KJST	-3.7°F	-6.3°F	3.2°F	3.9°F	1.3°F	1.2°F	1.5°F	-0.1°F	0.6°F	0.2°F	-0.5°F	-7.9°F	-0.6°F
		-2.1°C	-3.5°C	1.8°C	2.2°C	0.7°C	0.6°C	0.8°C	-0.1°C	0.3°C	0.1°C	-0.3°C	-4.4°C	-0.3°C

Table 5. Seasonal temperature and precipitation rankings over 116 years (1 = warmest/wettest year and 116 = 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
Temperature-2010	34	3	30	93
Precipitation-2010	36	61	60	19

The autumn turned progressively colder with respect to normal temperatures, though October had slightly above-average readings (Table 4). The first 32°F (0°C) reading occurred on October 13, which is a bit later than average. November brought the onset of colder conditions; Altoona averaged 41.3°F (5.1°C), which is 0.8°F (0.4°C) below normal (Tables 3 and 4). Well below-average temperatures occurred in December, which was -7.9°F (-4.4°C) below normal in Johnstown, PA (Table 4). Calendar year 2010 featured above normal frequency 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 155–173 days or about 10 to 30 days longer than average (Table 2).

Precipitation Summary

Liquid precipitation (rain and melted snow, ice, sleet, etc.; hereafter precipitation) was slightly above normal in 2010 around Johnstown Flood National Memorial and Allegheny Portage Railroad National Historic Site (Table 6) with several notable dry spells (Table 7). The cold seasons were rather moist and the warmer half of the year was dry; this allowed the year to rank as the 29th wettest in the South Central Mountain Climate Division (8) of Pennsylvania since records began in 1895.

The beginning of the year featured above-normal precipitation from January through March (Figure 4). In fact, the first three months of 2010 were the 36th wettest such period in 116 years of record keeping (Table 5). Between 9.4 and 11.4 in (239–290 mm) was tallied by the end of March (Tables 8 and 9); about 110 percent of normal. The start-of-the-year surplus began to be erased in April when only 2.58 in (66 mm) of precipitation fell in the climate division. This was the 37th driest April since records began in 1895. Snowfall was almost double the normal amount (Table 6) and was especially abundant during February. At Dunlo, more than 67 in (170 cm) fell from February 1-28, 2010.

Spring was drier across the region, ranking as 58th driest in the South Central Mountain Climate Division with 116 years of records (Table 5). Only May provided the region with above-average rainfall at all reporting stations (Table 9). The wettest location was Johnstown during May when 5.7 in (145 mm) was measured (Table 8). Prince Gallitzin and Dunlo averaged slightly above-normal rainfall during the spring (Table 9).

The summer of 2010 had virtually normal rainfall and ranked 60th in 116 years (Table 5). August saw negative precipitation anomalies at all stations ranging from 98 to 65 percent of normal precipitation (Table 9). Two of the five longest dry spells in 2010 occurred during the summer months (Table 7). July brought the wettest month of the year as 7.8 in (198 mm) fell at Dunlo (Table 8). There were no direct influences from tropical storms during this year, but the remnants of Tropical Storm Nicole produced excessive rainfall from September 30 – October 1. Total rainfall at Ebensburg, PA was 3.2 in (80 mm), the wettest days of 2010 (Table 7).

Precipitation anomalies in the fall varied dramatically. November and December were both above normal; October brought the lowest rainfall of the year (Figure 4). Johnstown tallied only 0.80 in (20 mm) during October (Table 8). Despite the dry weather in October, the season concluded as the 19th wettest (Table 5). Two of the wettest days of the year occurred from late November into early December (Table 7). As a whole, 2010 had more than the average number of excessive rain days and well above normal number of snowy days (Table 6).

Table 6. Status of 2010 precipitation indicators compared to the 30-year normal (1971–2000) at the Ebensburg Sewage Plant (EBNP1) and Johnstown Airport (KJST) stations.

Precipitation Indicator	Ebensburg Sewage Plant, PA 2010	Ebensburg Sewage Plant, PA 1971-2000	Johnstown Airport, PA 2010	Johnstown Airport, PA 1971-2000
Annual Precipitation	48.0 in 1,219 mm	49.7 in 1,262 mm	43.4 in 1,102 mm	38.6 in 980 mm
Autumn (Oct, Nov, Dec) Precipitation	13.6 in 345 mm	11.1 in 282 mm	6.8 in 173 mm	8.8 in 224 mm
Heavy Precipitation Days (days with ≥1.0 in [25 mm] rain)	12	9	9	7
Extreme Precipitation Days (days with ≥2.0 in [51 mm] rain)	2	1	1	1
Micro-drought (strings of 7+ days without rain)	6	5	9	5
Annual Snowfall	155.3 in 3,94.5 cm	96.8 in 245.9 cm	130.1 in* 330.5 cm*	73.8 in 187.5 cm
Measurable Snow Days (days with ≥0.1 in [0.3 cm] snow)	52	45	48*	38
Moderate Snow Days(days with ≥2.0 in [5.0 cm] snow)	27	21	22*	14
Heavy Snow Days(days with ≥5.0 in [12.7 cm] snow)	10	3	9*	3

*Snowfall totals 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 rainfall) during 2010 from stations Ebensburg Sewage Plant (EBNP1) and Johnstown Airport (KJST).

Wettest Days in 2010	Dry Spells in 2010
Oct. 1: 2.82 in (72 mm)	Jun. 30–Jul. 9
Dec. 1: 2.15 in (55 mm)	Aug 25–Sep. 3
Nov. 26: 1.53 in (39 mm)	Dec. 15–24
May. 12: 1.43 in (36 mm)	Mar. 4–11
Aug. 12: 1.32 in (34 mm)	Oct. 27–Nov. 3

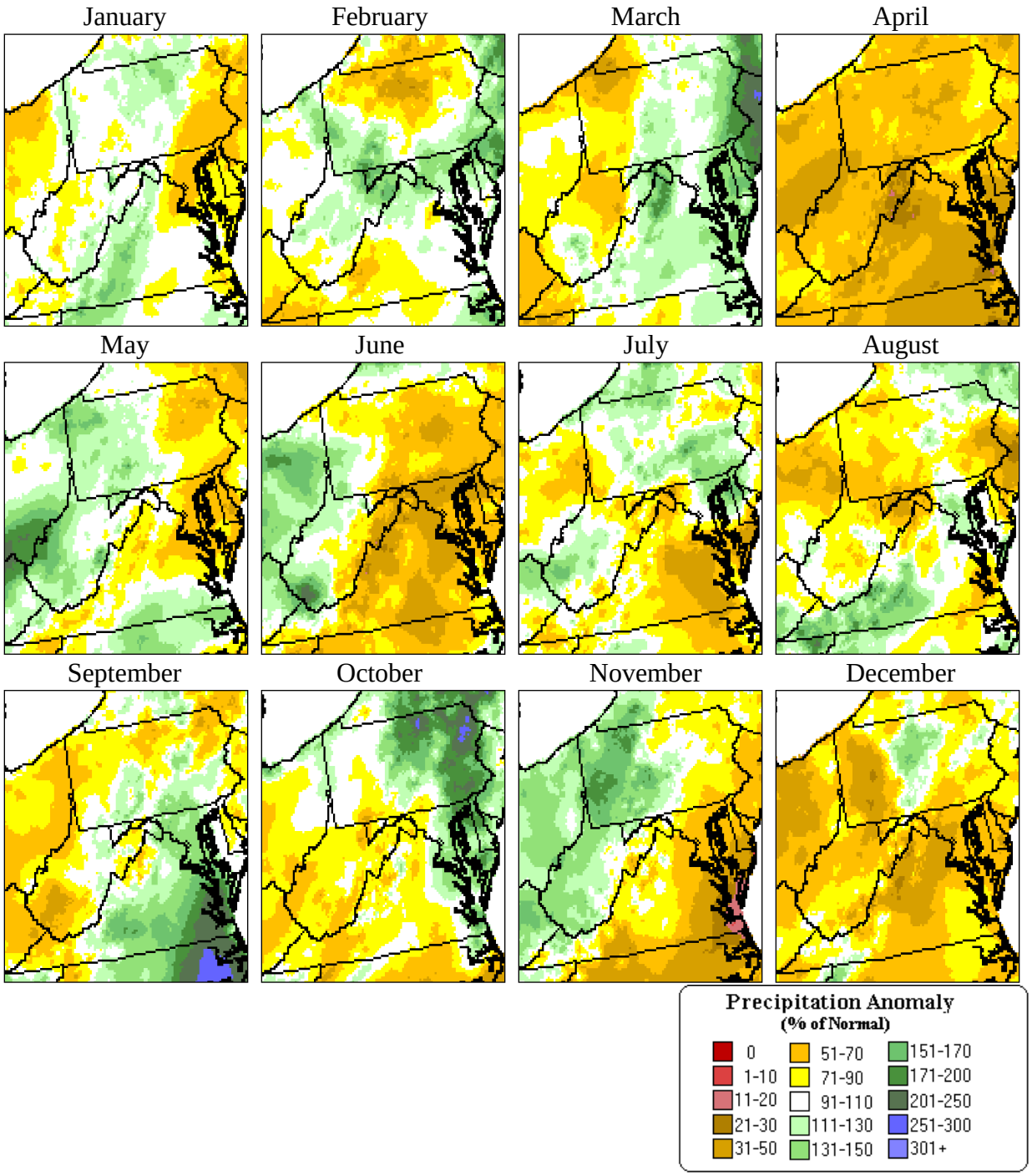

Figure 4. Maps showing percent of average monthly precipitation compared to the 30-year normal (1971–2000).

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
Johnstown Airport, PA	KJST	2.2 in	3.9 in	3.3 in	2.9 in	5.7 in	4.3 in	5.8 in	3.6 in	5.1 in	0.8 in	4.7 in	1.3 in	43.4 in
		56 mm	99 mm	84 mm	74 mm	145 mm	109 mm	147 mm	91 mm	130 mm	20 mm	119 mm	33 mm	1,102 mm
Altoona 3 W, PA	ALTP1	3.1 in	3.8 in	3.9 in	2.7 in	5.3 in	3.0 in	4.4 in	3.2 in	5.5 in	1.9 in	6.2 in	2.3 in	45.3 in
		79 mm	97 mm	99 mm	69 mm	135 mm	76 mm	107 mm	81 mm	140 mm	48 mm	157 mm	58 mm	1,151 mm
Ebensburg Sewage Plant, PA	EBNP1	3.6 in	4.3 in	3.5 in	3.4 in	5.1 in	4.9 in	4.1 in	2.5 in	3.1 in	4.9 in	4.9 in	3.8 in	48.0 in
		91 mm	109 mm	89 mm	86 mm	130 mm	124 mm	104 mm	64 mm	79 mm	124 mm	124 mm	97 mm	1,219 mm
Prince Gallitzin State Park, PA	PGLP1	2.9 in	3.1 in	3.7 in	3.0 in	4.5 in	4.4 in	5.0 in	2.4 in	3.0 in	5.4 in	3.6 in	2.5 in	43.4 in
		74 mm	79 mm	94 mm	76 mm	114 mm	112 mm	127 mm	61 mm	76 mm	137 mm	91 mm	64 mm	1,102 mm
Dunlo, PA	DUNP1	3.1 in	3.4 in	3.9 in	2.8 in	5.6 in	5.3 in	7.8 in	3.1 in	2.9 in	5.4 in	3.1 in	3.7 in	50.1 in
		79 mm	86 mm	99 mm	71 mm	142 mm	135 mm	198 mm	79 mm	74 mm	137 mm	79 mm	94 mm	1,273 mm

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
Johnstown Airport, PA	KJST	56	114	85	76	133	88	114	88	123	24	129	39	89
Altoona 3 W, PA	ALTP1	111	146	108	73	120	70	109	98	136	56	169	78	106
Ebensburg Sewage Plant, PA	EBNP1	92	134	80	78	107	109	82	63	71	145	118	101	98
Prince Gallitzin State Park, PA	PGLP1	122	129	107	90	119	122	130	65	78	207	108	105	115
Dunlo, PA*	DUNP1	92	136	105	73	137	127	199	76	68	175	90	123	117

*Indicates a station's period of record is 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 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 Pennsylvania Climate Division 8 in 2010 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 Pennsylvania (Figure 6) and the Northeast (Figure 7) are shown for 2010.

According to the PDSI, the value of this index in Climate Division 8 was a mirror image of the monthly temperature anomalies during 2010. A cold and moist winter saw values just above the normal range, but warmer-than-normal readings from March through September resulted in an overall decline to abnormally dry conditions by late September. While the markedly colder weather did not return until November, in the transition period, very moist conditions returned, raising the PDSI to normally moist levels in the autumn. There was no widespread drought noted in the Allegheny Highlands during 2010 (Figure 5). When comparing 2010 with previous years, the values of the PDSI during the peak of the growing season (June–September) have remained within the normal range for all three years. It is interesting to note that December, during the past three years, has been wetter than average. The DM – Drought Severity Index for Pennsylvania (Figure 6) and the Northeast (Figure 7) shows a similar pattern for the growing season (May through October); abnormally dry (D0) only during the late summer and early autumn.

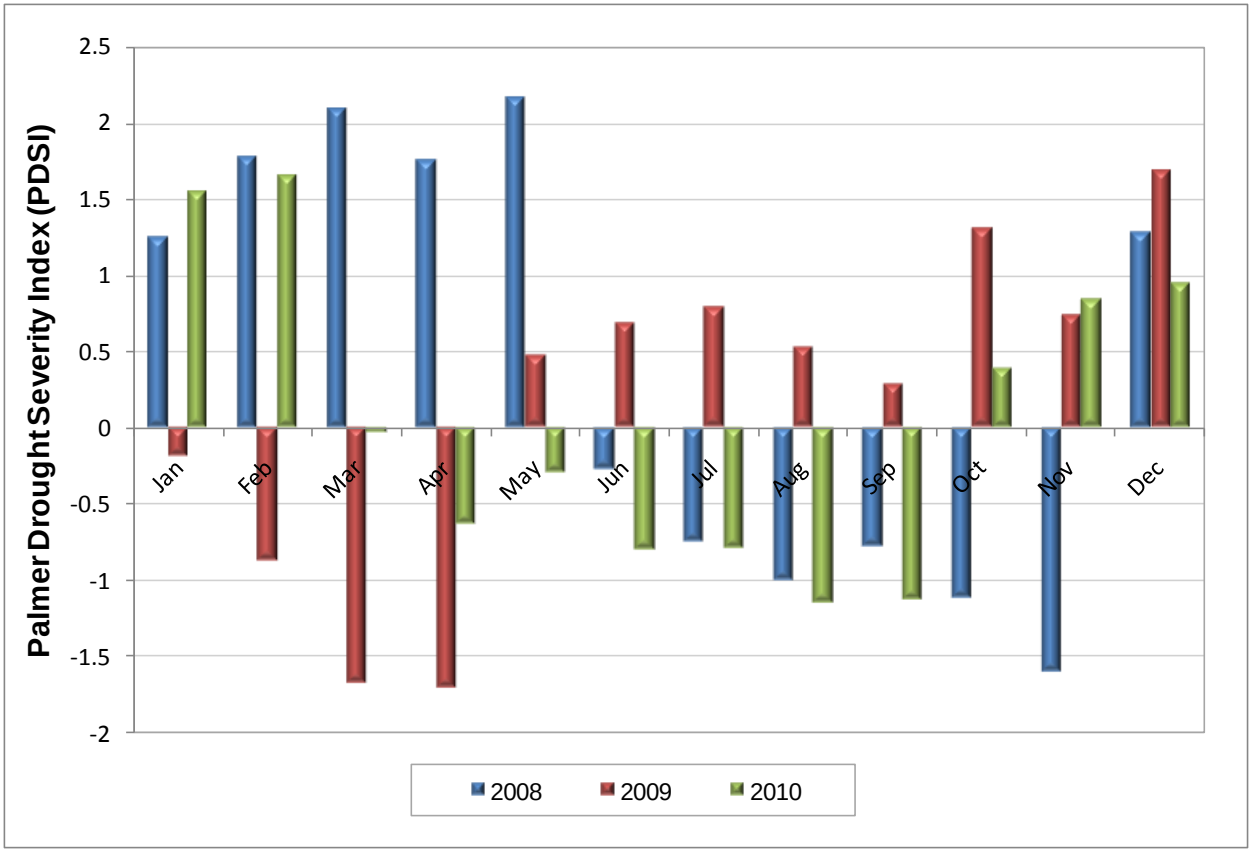

Figure 5. Monthly Palmer Drought Severity Index (PDSI) values for Pennsylvania Climate Division 8, 2008–2010.

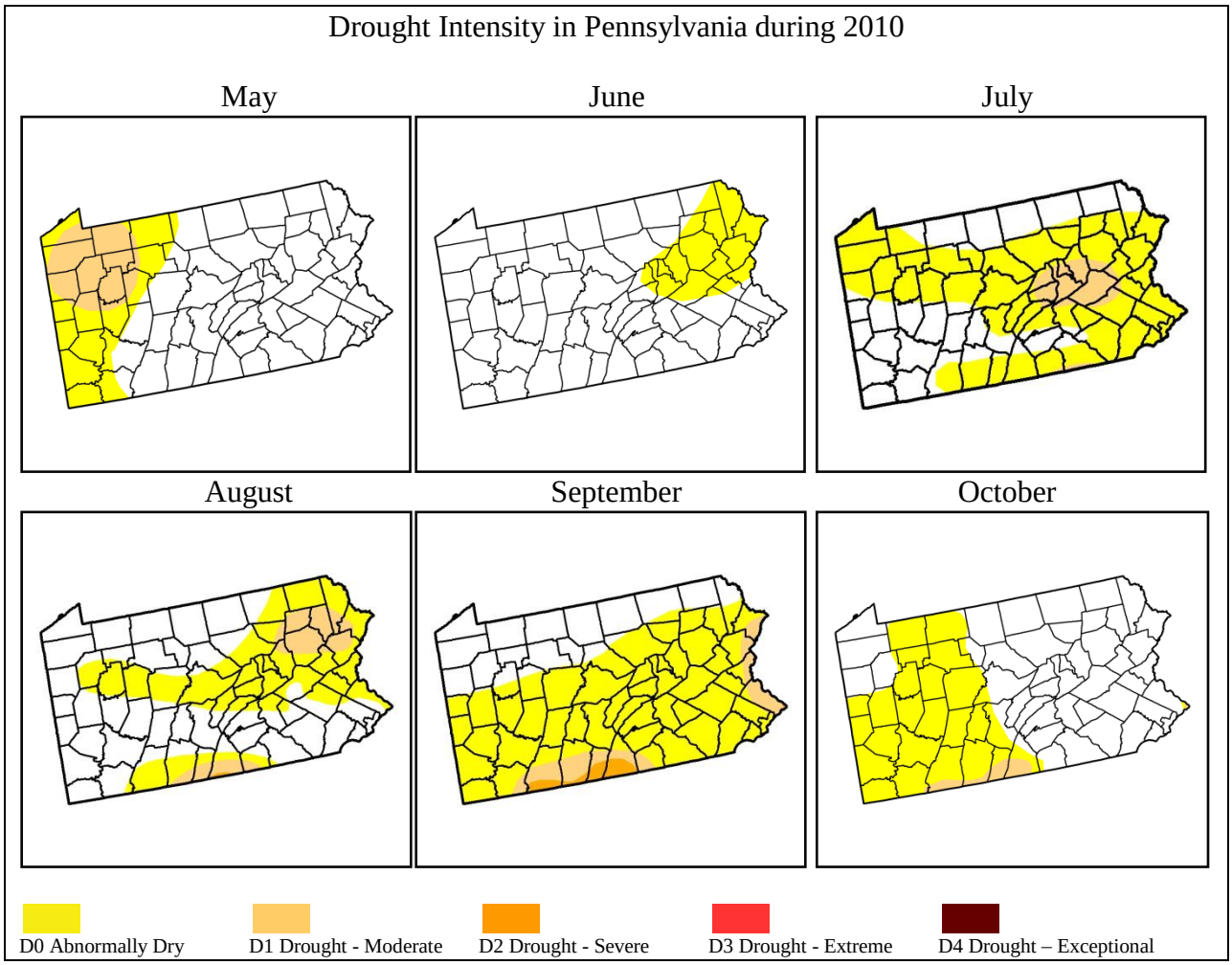

Figure 6. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for Pennsylvania in 2010.

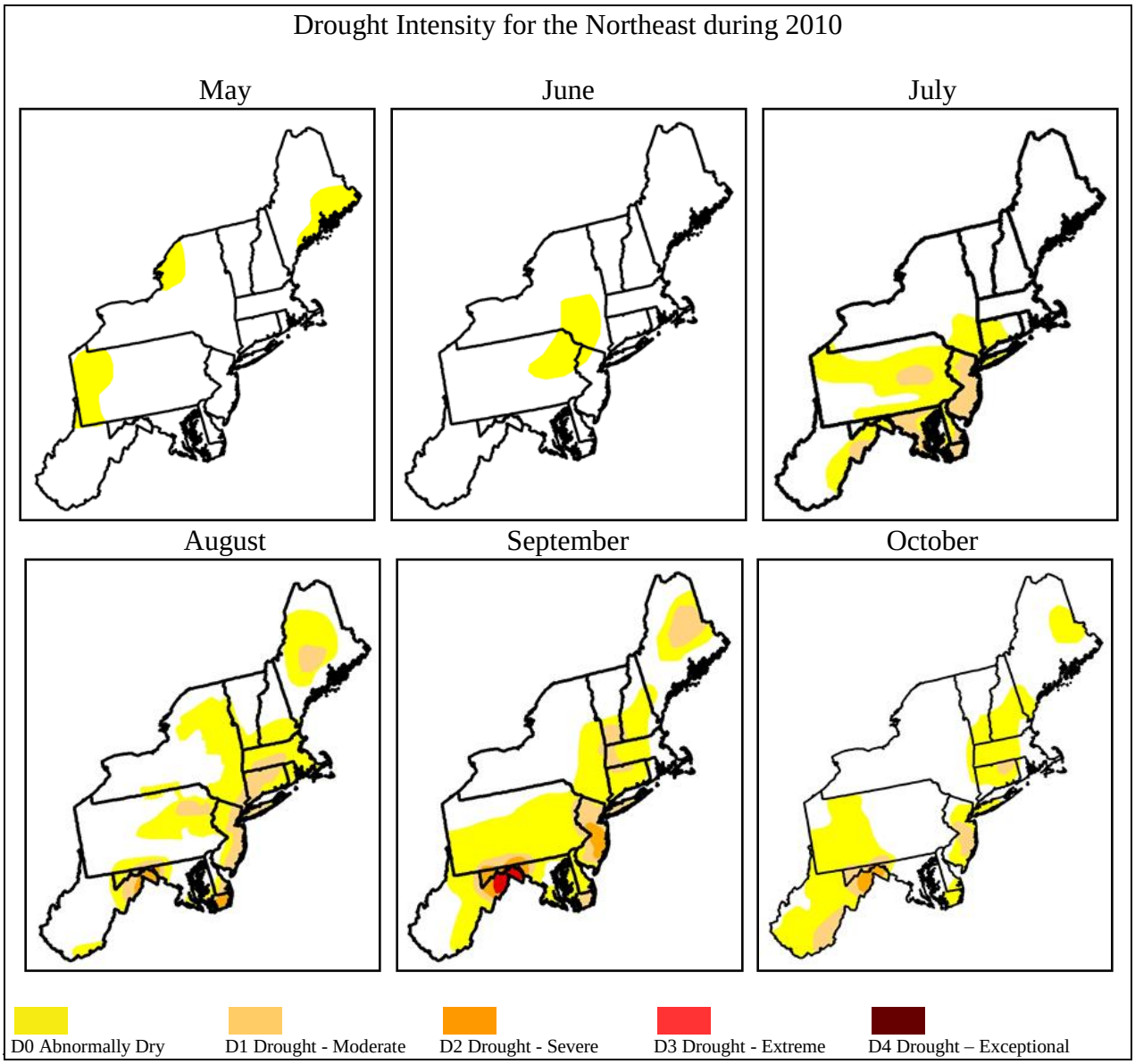

Figure 7. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for the Northeast in 2010.

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