



Weather of Delaware Water Gap National Recreation Area and Upper Delaware Scenic and Recreational River

Eastern Rivers and Mountains Network Summary Report for 2013

Natural Resource Data Series NPS/ERMN/NRDS—2014/694



ON THE COVER

Sunset over West Branch of the Delaware River near Shehawken Creek.
Photograph by: Caleb Tzilkowski.

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Natural Resource Data Series NPS/ERMN/NRDS—2014/694

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August 2014

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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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Please cite this publication as:

Knight, P., K. Imhoff, A. Person, and S. Miller. 2014. Weather of Delaware Water Gap National Recreation Area and Upper Delaware Scenic and Recreational River: Eastern Rivers and Mountains Network summary report for 2013. Natural Resource Data Series NPS/ERMN/NRDS—2014/694. National Park Service, Fort Collins, Colorado.

Contents

| | Page |
|---|------|
| Figures..... | v |
| Tables..... | v |
| List of Key Acronyms..... | vii |
| Introduction..... | 1 |
| Climate of the Pocono Mountains and Eastern Plateau | 3 |
| Observing Stations | 5 |
| Temperature Summary..... | 9 |
| Precipitation Summary..... | 17 |
| Drought Status | 23 |
| References..... | 27 |

Figures

| | Page |
|---|------|
| Figure 1. Location of weather observing stations around Upper Delaware Scenic and Recreational River and Delaware Water Gap National Recreation Area. See Table 1 for station names..... | 6 |
| Figure 2. Maps showing departure from average monthly maximum temperature compared to the 30-year normal (1981–2010)..... | 14 |
| Figure 3. Maps showing departure from average monthly minimum temperature compared to the 30-year normal (1981–2010)..... | 15 |
| Figure 4. Maps showing percent of average monthly precipitation compared to the 30-year normal (1981–2010)..... | 20 |
| Figure 5. Monthly Palmer Drought Severity Index (PDSI) values for Pennsylvania Climate Division 1, 2011–2013. | 24 |
| Figure 6. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for Pennsylvania in 2013. | 25 |
| Figure 7. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for the Northeast in 2013. | 26 |

Tables

| | Page |
|---|------|
| Table 1. List of weather observing stations around the Upper Delaware Scenic and Recreational River and Delaware Water Gap National Recreation Area selected as most representative of the parks in 2013. | 7 |
| Table 2. Status of 2013 temperature indicators compared to the 30-year normal (1981–2010) at the Matamoras (MATP1), Hawley 1 E (HAWP1), and Pleasant Mount 1 W (PLEP1) stations. * - only a partial record due to missing data..... | 11 |
| Table 3. Summary of monthly average temperatures for 2013 for the selected stations. | 12 |
| Table 4. Summary of 2013 departure from normal temperature based on 30-year normal (1981–2010) for the selected stations. | 13 |
| Table 5. Seasonal and annual temperature and precipitation rankings for 2013 over 119 years (1 = warmest/wettest year and 119 = coldest/driest year) for Pennsylvania Climate Division 1 (top), New Jersey Climate Division 1 (middle), and New York Climate Division 2 (bottom). T = Tie..... | 16 |
| Table 6. Status of 2013 precipitation indicators compared to the 30-year normal (1981–2010) at the Matamoras (MATP1), Hawley 1 E (HAWP1), and Pleasant Mount 1 W (PLEP1) stations. * missing data, summaries are only partial..... | 18 |

Tables (continued)

| | Page |
|---|------|
| Table 7. Top five wettest days and top five dry spells (consecutive days with a trace or less of liquid precipitation) during 2013 from the Hawley and Pleasant Mount stations. | 18 |
| Table 8. Summary of 2013 monthly total precipitation for selected stations. | 19 |
| Table 9. Summary of 2013 percent of normal precipitation based on 30-year normal (1981–2010) for selected stations. | 21 |

List of Key Acronyms

| | |
|--------|---|
| ASOS | Automated Surface Observing System |
| COOP | National Weather Service Cooperative Observer Program |
| CWOP | Citizen Weather Observer Program |
| DEWA | Delaware Water Gap National Recreational Area |
| ERMN | Eastern Rivers and Mountains Network |
| FAA | Federal Aviation Administration |
| 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 |
| NOAA | National Oceanic and Atmospheric Administration |
| NPS | National Park Service |
| NRA | National Recreation Area |
| 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 |
| SRR | Scenic and Recreational River |
| UPDE | Upper Delaware Scenic and Recreational River |
| 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, 2013, 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 the 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; these are the primary data sources used to profile climate summary and trends.

The NCDC also calculates and provides climatological ranks for selected temperature and precipitation elements (<http://www.ncdc.noaa.gov/temp-and-precip/ranks.php>). Data and statistics are as of January 1895 providing a substantial period of record to place the current year in historical context.

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 this report.

Climate of the Pocono Mountains and Eastern Plateau

Delaware Water Gap National Recreation Area (NRA) lies in Pennsylvania Climate Division 1 “Pocono Mountains” and New Jersey Climate Division 1 “Northern NJ,” while Upper Delaware Scenic and Recreational River (SRR) lies within Pennsylvania Climate Division 1 and New York Climate Division 2 “Eastern Plateau.” 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 2013]). Pennsylvania and New York are each divided into 10 climate divisions; New Jersey has three divisions.

The three climate divisions encompassing Delaware Water Gap NRA and Upper Delaware SRR 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 the Delaware River valley. The prevailing westerly winds carry most of the weather disturbances that affect the region from the interior of the continent, so that the Atlantic Ocean has limited 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. Also, storms of tropical origin can have the greatest effect within this portion of the Pennsylvania–New Jersey–New York region, causing severe floods in some instances (Gelber 2002).

Temperatures are moderately continental, with the tempering effects of the Great Lakes contributing to cloud production in the winter and onshore winds 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 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 Delaware River valley. The southwest winds gain additional warmth when descending the crest of the Appalachians.

Precipitation is fairly evenly distributed throughout the year. Annual amounts generally range between 34–52 in (864–1,320 mm), while the majority of places receive 38–46 in (965–1,168 mm). Greatest amounts usually occur in the late-spring and summer months; while February is the driest month, having about 2.0 in (51 mm) less than the wettest months. Precipitation tends to be somewhat greater in the mountains, due primarily to coastal storms which occasionally frequent the area. During the warm season these storms can bring heavy rain, while in winter, heavy snow or a mixture of rain, ice, and snow may be produced.

Surface winds blow from the west and northwest in the cold season and from the southwest during the warm half of the year. Thunderstorms follow a frequency that matches the solar cycle, occurring between the equinoxes and reaching a peak near the summer solstice. Hail is relatively infrequent, but flash floods and damaging thunderstorm winds affect parts of the river valley 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

Twelve weather observing stations, comprised of three observing networks, were selected around Delaware Water Gap NRA and Upper Delaware SRR. 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 parks' elevation profile, the 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 2013 based upon this criterion. Therefore, all 12 stations were used for this report despite the station at Matamoras reporting for low percentage of time (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 2013) 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 are 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.

The NCDC also calculates and provides climatological ranks for selected temperature and precipitation elements (<http://www.ncdc.noaa.gov/temp-and-precip/ranks.php>). Data and statistics are as of January 1895 providing a substantial period of record to place the current year in historical context.

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/NPS/interface.php>.



Figure 1. Location of weather observing stations around Upper Delaware Scenic and Recreational River and Delaware Water Gap National Recreation Area. See Table 1 for station names.

Table 1. List of weather observing stations around the Upper Delaware Scenic and Recreational River and Delaware Water Gap National Recreation Area selected as most representative of the parks in 2013.

| Station | Observing Network | Station Name | Period of Record (POR) | | Percentage of Time Reporting Temperature for 2013 | Percentage of Time Reporting Precipitation for 2013 | Percentage of Time Reporting Temperature for entire POR | Percentage of Time Reporting Precipitation for entire POR |
|---------|-------------------|--------------------------|------------------------|---------|---|---|---|---|
| MATP1 | COOP | Matamoras | 10/01/1904 | Present | - | - | 88.2 ¹ | 92.8 |
| EQNP1 | COOP | Equinunk 2 NW | 03/01/1957 | Present | - | 100.0 | - | 99.2 |
| HAWP1 | COOP | Hawley 1 E | 11/01/1897 | Present | 99.7 | 100.0 | 76.4 ² | 81.0 |
| DEPN6 | COOP | Deposit | 05/01/1953 | Present | - | - | 96.8 | 96.9 |
| SDBP1 | COOP | Stroudsburg | 12/01/1910 | Present | 99.7 | 100.0 | 90.8 | 91.5 |
| KFWN | ASOS | Sussex Airport | 12/27/2000 | Present | 98.6 | 98.4 | 98.6 | 98.6 |
| K12N | ASOS | Aeroflex-Andover Airport | 10/25/2000 | Present | 92.3 | 93.2 | 84.8 | 79.1 |
| RKHN6 | COOP | Rock Hill 3 SW | 05/01/1953 | Present | 76.7 | 76.4 | 98.6 ³ | 98.7 |
| PLEP1 | COOP | Pleasant Mount 1W | 10/01/1924 | Present | 98.6 | 97.5 | 98.7 ⁴ | 98.0 |
| MLAP1 | COOP | Milanville | 08/01/1945 | Present | 100.0 | 98.6 | 33.7 ⁵ | 42.9 |
| TS717 | RAWS | Blue Mountain Lakes | 12/11/2007 | Present | 9.3 | - | 83.5 | 74.1 |
| LOLP1 | RAWS | Loch Lomond | 01/01/2005 | Present | 28.5 | 28.5 | 87.7 | 87.7 |

¹ Matamoras did not start reporting temperature until 07/01/1963. The percentage time of reporting temperature is based upon this por.

² Hawley 1 E did not start reporting temperature until 08/02/1962. The percentage time of reporting temperature is based upon this por.

³ Rock Hill 3 SW did not start reporting temperature until 07/01/1962. The percentage of time reporting temperature is based upon this por.

⁴ Pleasant Mount 1 W did not start reporting temperature until 12/01/1951. The percentage of time reporting temperature is based upon this por.

⁵ Milanville did not start reporting temperature until 06/20/1963. The percentage of time reporting temperature is based upon this por.

Temperature Summary

Calendar year 2013 averaged virtually at the long-term mean temperature (Tables 2 -4). Maximum temperatures departed -0.3 degrees Fahrenheit (°F) -0.2 degrees Celsius [°C]) for the year (Table 2) and minimum temperature readings averaged +0.2 degrees Fahrenheit (°F) +0.1 degrees Celsius [°C]) (Table 2). All of the 2013 seasons were near or slightly warmer than normal with February, March, August, September and November had below-average temperature departures at nearly all sites (Table 4). 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/>. For the entire contiguous United States, 2013 was the 35th warmest in the past 119 years. Recall that the station departures are based on the most recent 30 years (1981-2010).

Only January 2013 averaged above normal maximum temperatures and far above normal minimum temperatures (Figures 2 and 3), but by far, March brought the largest monthly negative departures for the winter and this allowed the winter months to rank between 29-40th warmest in 119 years (Table 5). The mean temperature departures in January ranged from 2.7°F (1.5°C) at Hawley, PA to 4.0°F (2.3°C) in Pleasant Mount, PA (Table 4). A cold episode brought morning readings below 0°F (-17.8°C) during January, with the lowest values in many sections occurring on January 23 with minima near -9°F (-22.8°C) (Table 2). The number of sub-zero days at Pleasant Mount tallied nine compared with the normal of twelve (Table 2).

The spring was near normal in the region, with climate division rankings of 15th warmest to the 47th coolest in the past 119 years (Table 5). The first significant heat spell occurred from May 31st to June 2nd when readings rose above 86°F (+30°C). Most sections had their last freeze and frost around May 15th, though some spots noted frost on May 22nd which contributed to a growing season length which was a week longer than average at Pleasant Mount, PA (Table 2). Temperatures during June averaged above normal at all sites, with departures ranging between +0.6 to +1.8°F (+0.4 to +1.0°C) above the 1981–2010 long-term mean (Table 4).

The summer period started with very warm conditions, with virtually all stations averaging above normal in June (Table 4). With the exception of Milanville during August, +2.0°F; +1.1°C), all stations averaged below normal during the last two months of summer. July tallied the highest positive anomalies, with July average temperatures ranging from +1.6 to +4.3°F (+0.9 to +2.4°C) (Figure 2). Despite this season being the 25th to 68th warmest in 119 years (Table 5), the annual maxima were set on July 18-19.

Autumn temperatures started above average (Tables 3 and 4; Figures 2 and 3). Frosts and freezes occurred a noticeably earlier than the long-term average date, with most sections noticing sub-freezing readings (<0°C) on September 17. November was the only autumn month with all stations averaging below seasonal levels. Temperatures during December were slightly below seasonal levels,

with readings as much as 2.6°F (1.4°C) below normal (Table 4). Overall, the annual average temperature for 2013 averaged exactly normal (Table 2) with values of +/-0.1°F (0.0°C).

Table 2. Status of 2013 temperature indicators compared to the 30-year normal (1981–2010) at the Matamoras (MATP1), Hawley 1 E (HAWP1), and Pleasant Mount 1 W (PLEP1) stations. * - only a partial record due to missing data.

| Temperature Indicator | Matamoras, PA 2013 | Matamoras, PA 1981-2010 | Hawley 1 E, PA 2013 | Hawley 1 E, PA 1981-2010 | Pleasant Mount 1 W, PA 2013 | Pleasant Mount 1 W, PA 1981-2010 |
|---|--------------------------|-------------------------------|---------------------------|--------------------------------|--------------------------------------|---|
| Average Annual Temperature | M°F M°C | 48.4°F 9.1°C | 46.4°F 8.0°C | 46.5°F 8.1°C | 44.0°F 6.7°C | 43.9°F 6.6°C |
| Average Annual Maximum Temperature | M°F M°C | 59.6°F 15.3°C | 57.4°F M°C | 57.7°F 14.3°C | 53.6°F 12.0°C | 53.6°F 12.0°C |
| Maximum Temperature | M°F M°C | 93.8°F 34.3°C | 94.0°F 34.4°C | 92.1°F 33.4°C | 88.0°F 31.2°C | 88.3°F 31.3°C |
| Hot Days (days with Tmax≥90°F/32°C) | M | 7 | 6 | 4 | 0 | 0 |
| Average Annual Minimum Temperature | M°F M°C | 37.1°F 2.8°C | 35.3°F 1.8°C | 35.3°F 1.8°C | 34.3°F 1.3°C | 34.1°F 1.2°C |
| Minimum Temperature | M°F M°C | -3.5°F -19.7°C | -9.0°F -22.8°C | -9.5°F -23.1°C | -9.0°F -22.8°C | -12.0°F -24.4°C |
| Cold Days (days with Tmax≤32°F/0°F) | M | 31 | 45 | 40 | 73 | 61 |
| Sub-freezing Days (days with Tmin≤32°F/0°C) | M | 152 | 165 | 162 | 177 | 169 |
| Sub-zero Days (days with Tmin≤0°F/-17.8°C) | M | 5 | 5 | 10 | 9 | 12 |
| Growing Season Length (days between last spring Tmin 32°F/0°C and first fall Tmin 32°F/0°C) | M | 166 | 158 | 145 | 156 | 136 |

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

Table 3. Summary of monthly average temperatures for 2013 for the selected stations.

| Station name | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|--------------------------|---------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Matamoras | MATP1 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Hawley 1 E | HAWP1 | 24.9°F | 24.9°F | 31.5°F | 45.1°F | 55.8°F | 65.2°F | 71.9°F | 65.4°F | 58.6°F | 50.8°F | 34.9°F | 27.2°F | 46.4°F |
| | | -3.9°C | -3.9°C | -0.3°C | 7.3°C | 13.2°C | 18.4°C | 22.2°C | 18.6°C | 14.8°C | 10.4°C | 1.6°C | -2.7°C | 8.0°C |
| Deposit | DEPN6 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Pleasant Mount 1 W | PLEP1 | 22.3°F | 21.0°F | 27.6°F | 41.9°F | 54.2°F | 63.6°F | 70.4°F | 63.1°F | 56.2°F | 49.8°F | 31.6°F | 25.7°F | 44.0°F |
| | | -5.4°C | -6.1°C | -2.4°C | 5.5°C | 12.3°C | 17.6°C | 21.3°C | 17.3°C | 13.4°C | 9.9°C | -1.1°C | -3.5°C | 6.7°C |
| Milanville | MLAP1 | 25.1°F | 25.9°F | 32.9°F | 46.2°F | 57.6°F | 66.2°F | 73.5°F | 66.7°F | 59.7°F | 52.7°F | 36.4°F | 27.3°F | 47.5°F |
| | | -3.8°C | -3.4°C | 0.5°C | 7.9°C | 14.2°C | 19.0°C | 23.1°C | 19.3°C | 15.4°C | 11.5°C | 2.4°C | -2.6°C | 8.6°C |
| Stroudsburg | SDBP1 | 29.8°F | 27.9°F | 36.0°F | 49.2°F | 59.8°F | 68.4°F | 75.0°F | 68.5°F | 61.3°F | 53.7°F | 38.3°F | 29.4°F | 49.8°F |
| | | -1.2°C | -2.3°C | 2.2°C | 9.6°C | 15.4°C | 20.2°C | 23.9°C | 20.3°C | 16.3°C | 12.1°C | 3.5°C | -1.4°C | 9.9°C |
| Rock Hill 3 SW | RKHN6 | M | M | M | 44.9°F | 54.4°F | 64.0°F | 70.7°F | 64.7°F | 57.2°F | 50.3°F | 34.4°F | 26.1°F | 49.5°F |
| | | M | M | M | 7.2°C | 12.4°C | 17.8°C | 21.5°C | 18.2°C | 14.0°C | 10.2°C | 1.3°C | -3.3°C | 9.7°C |
| Sussex Airport, | KFWN | 29.2°F | 29.2°F | 36.0°F | 49.3°F | 59.0°F | 67.4°F | 74.6°F | 68.3°F | 60.3°F | 52.8°F | 37.6°F | 29.5°F | 49.4°F |
| | | -1.6°C | -1.6°C | 2.2°C | 9.6°C | 15.0°C | 19.7°C | 23.7°C | 20.2°C | 15.7°C | 11.6°C | 3.1°C | -1.4°C | 9.7°C |
| Aeroflex-Andover Airport | K12N | 30.2°F | 29.5°F | 36.7°F | 49.6°F | 59.2°F | 69.5°F | 76.6°F | 69.8°F | 62.1°F | 54.5°F | M | M | 50.8°F |
| | | -1.0°C | -1.4°C | 2.6°C | 9.8°C | 15.1°C | 20.8°C | 24.8°C | 21.0°C | 16.7°C | 12.5°C | M | M | 10.4°C |
| Blue Mountain Lakes | TS717 | 24.8°F | M | M | 48.2°F | M | M | M | M | M | M | M | M | M |
| | | -4.0°C | M | M | 9.0°C | M | M | M | M | M | M | M | M | M |
| Loch Lomond | LOLP1 | 21.9°F | 25.0°F | 31.1°F | 48.6°F | M | M | M | M | M | M | M | M | M |
| | | -5.6°C | -3.9°C | -0.5°C | 9.2°C | M | M | M | M | M | M | M | M | M |

Table 4. Summary of 2013 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 |
|--------------------------|--------------------|-------|--------|--------|--------|--------|--------|-------|--------|--------|-------|--------|--------|--------|
| Matamoras | MATP1 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Hawley 1 E | HAWP1 | 2.7°F | -0.2°F | -2.5°F | -0.1°F | 0.2°F | 0.8°F | 3.4°F | -1.7°F | -1.0°F | 2.5°F | -3.8°F | -2.6°F | -0.1°F |
| | | 1.5°C | -0.1°C | -1.4 | -0.1°C | 0.1°C | 0.4°C | 1.9°C | -0.9°C | -0.6°C | 1.4°C | -2.1°C | -1.5°C | -0.1°C |
| Deposit | DEPN6 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Pleasant Mount 1 W | PLEP1 | 4.0°F | -0.6°F | -1.0°F | 0.4°F | 1.1°F | 0.7°F | 3.1°F | -1.7°F | -1.1°F | 3.1°F | -2.1°F | 0.4°F | 0.1°F |
| | | 2.2°C | -0.3°C | -0.6°C | 0.2°C | 0.6°C | 0.4°C | 1.7°C | -0.9°C | -0.6°C | 1.7°C | -1.2°C | 0.2°C | 0.1°C |
| Milanville | MLAP1 ¹ | 3.0°F | 0.3°F | -1.2°F | 0.7°F | 0.6°F | 0.6°F | 3.7°F | 2.0°F | -1.1°F | 2.2°F | -3.4°F | M | M |
| | | 1.7°C | 0.2°C | -0.7°C | 0.4°C | 0.3°C | 0.3°C | 2.0°C | 1.1°C | -0.6°C | 1.2°C | -1.9°C | M | M |
| Stroudsburg | SDBP1 | 3.9°F | 0.3°F | -1.2°F | -0.1°F | 0.0°F | 1.8°F | 4.3°F | -1.9°F | -0.9°F | 2.7°F | -0.9°F | -1.1°F | 0.4°F |
| | | 2.1°C | 0.2°C | -0.7°C | -0.1°C | 0.0°C | 1.0°C | 2.4°C | -1.0°C | -0.5°C | 1.5°C | -0.5°C | -0.6°C | 0.2°C |
| Rock Hill 3 SW | RKHN6 | M | M | M | 1.8°F | -2.5°F | -1.4°F | 1.6°F | -3.5°F | -2.9°F | 1.8°F | -3.8°F | -1.8°F | 3.2°F |
| | | M | M | M | 1.0°C | -1.4°C | -0.8°C | 0.9°C | -1.9°C | -1.6°C | 1.0°C | -2.1°C | -1.0°C | 1.8°C |
| Sussex Airport | KFWN ¹ | 4.0°F | 0.3°F | -1.5°F | 0.7°F | 0.6°F | 0.6°F | 3.7°F | -1.7°F | -1.1°F | 2.2°F | -3.5°F | -1.4°F | 0.1°F |
| | | 1.6°C | 0.1°C | -0.9°C | 0.4°C | 0.4°C | 0.4°C | 2.1°C | -0.9°C | -0.6°C | 1.3°C | -2.0°C | -0.8°C | 0.1°C |
| Aeroflex-Andover Airport | K12N ¹ | 3.9°F | 0.3°F | -1.2°F | -0.1°F | 0.0°F | 1.8°F | 4.3°F | -0.9°F | -0.9°F | 2.7°F | M | M | 0.7°F |
| | | 2.2°C | 0.1°C | -0.7°C | -0.1°C | 0.0°C | 1.0°C | 2.4°C | -0.5°C | -0.5°C | 1.5°C | M | M | 0.3°C |

¹Indicates 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. Stations with a Period of Record of less than 10 years were not included in this table.

* indicates estimated value based on less than 12 months of data (usually 11)

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

**Delaware Water Gap National Recreation Area
and Upper Delaware Scenic and Recreational River
Departure from Average Monthly Maximum Temperature
2013 vs. 1981–2010**

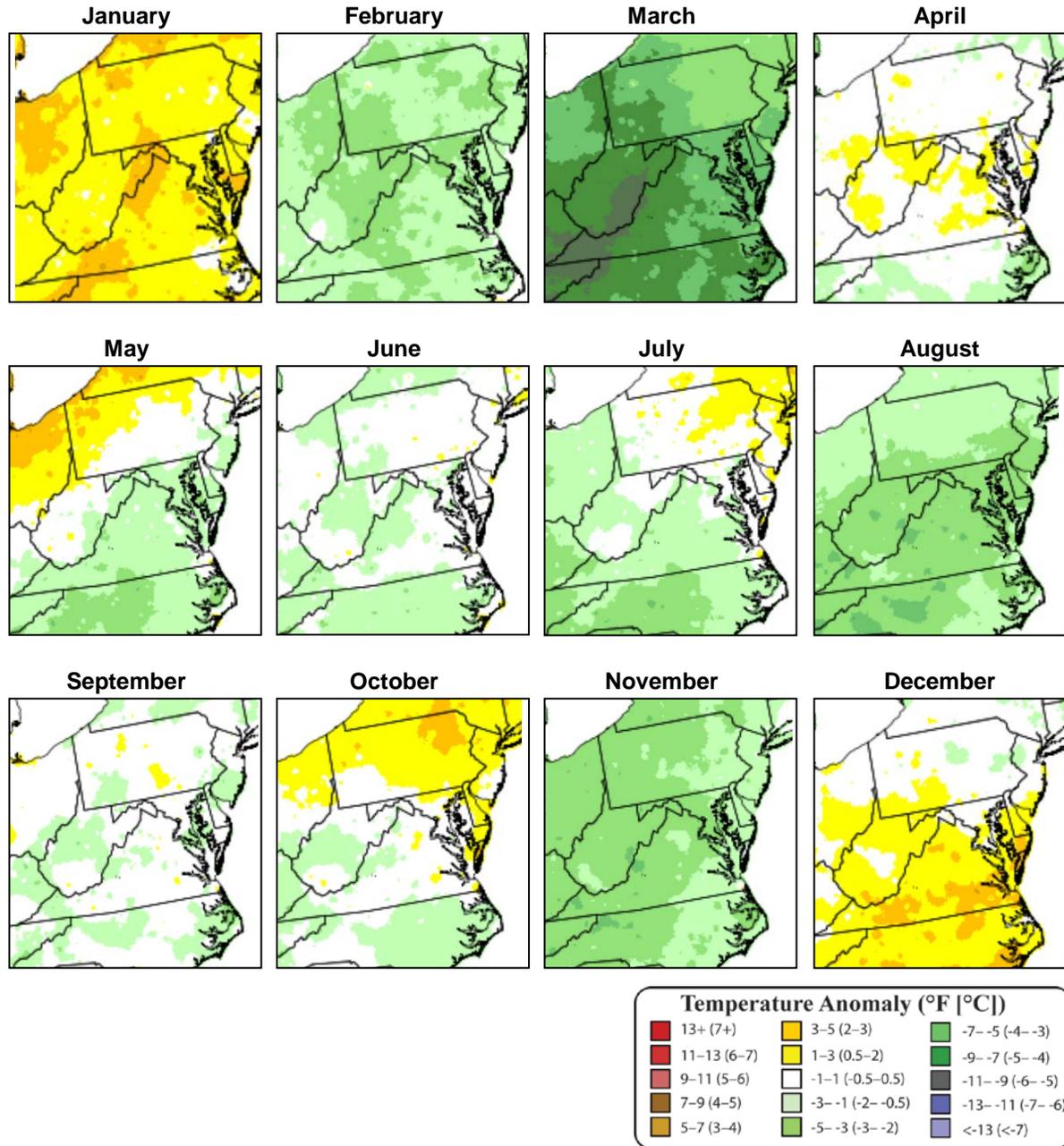


Figure 2. Maps showing departure from average monthly maximum temperature compared to the 30-year normal (1981–2010).

**Delaware Water Gap National Recreation Area
and Upper Delaware Scenic and Recreational River
Departure from Average Monthly Minimum Temperature
2013 vs. 1981–2010**

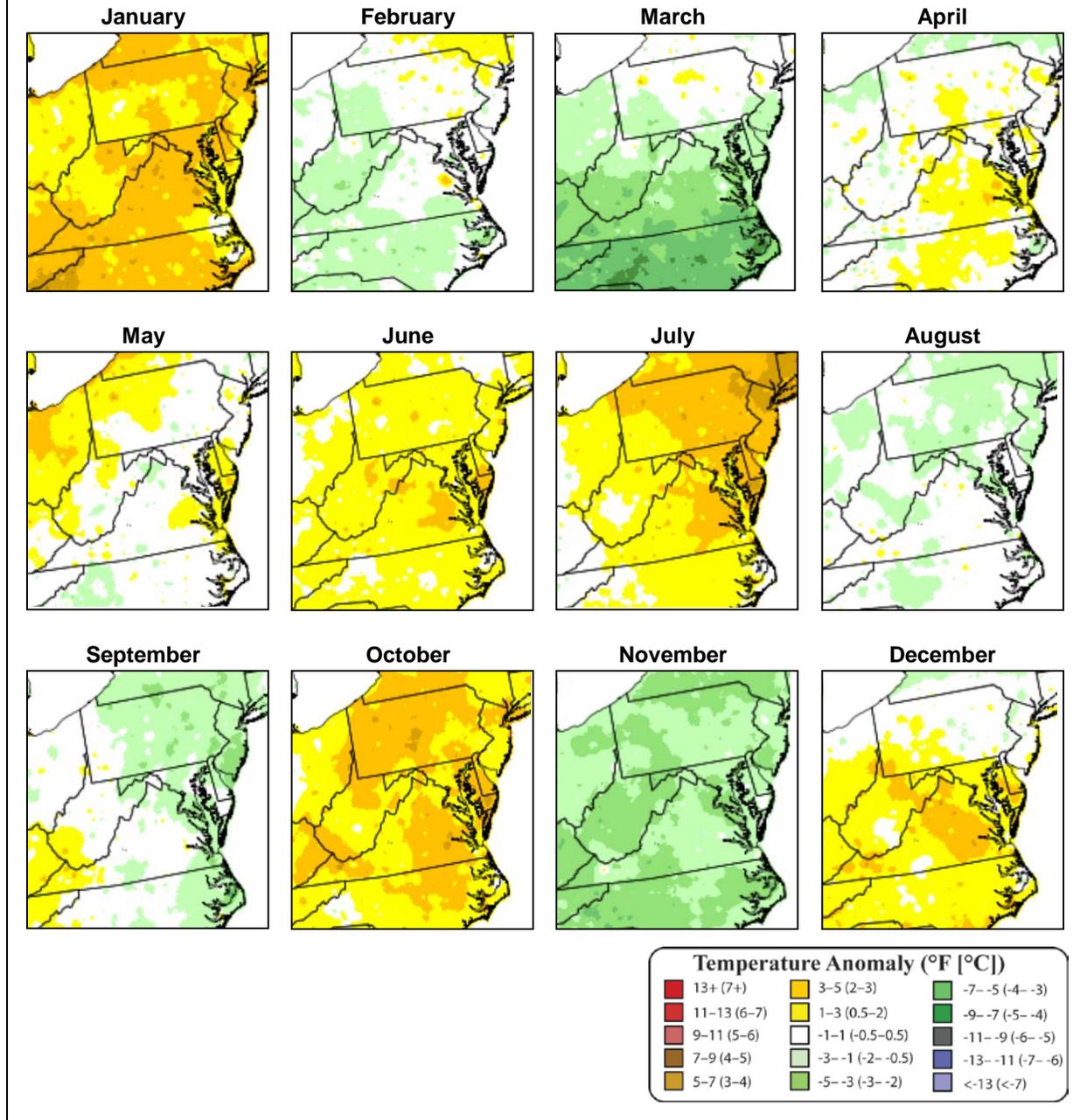


Figure 3. Maps showing departure from average monthly minimum temperature compared to the 30-year normal (1981–2010).

Table 5. Seasonal and annual temperature and precipitation rankings for 2013 over 119 years (1 = warmest/wettest year and 119 = coldest/driest year) for Pennsylvania Climate Division 1 (top), New Jersey Climate Division 1 (middle), and New York Climate Division 2 (bottom). T = Tie.

| PA Climate Division 1 Rankings "Pocono Mountains" | Jan–Feb–Mar WINTER | Apr–May–Jun SPRING | Jul–Aug–Sep SUMMER | Oct–Nov–Dec AUTUMN | Jan–Dec ANNUAL |
|--|-------------------------------|-------------------------------|-------------------------------|-------------------------------|---------------------------|
| Temperature-2013 | 40 | T15 | T25 | T35 | T15 |
| Precipitation-2013 | T109 | 25 | 80 | 77 | 82 |
| NJ Climate Division 1 Rankings "Northern NJ" | | | | | |
| Jan–Feb–Mar WINTER | Apr–May–Jun SPRING | Jul–Aug–Sep SUMMER | Oct–Nov–Dec AUTUMN | Jan – Dec ANNUAL | |
| Temperature-2013 | T29 | T31 | T42 | T40 | T25 |
| Precipitation-2013 | 101 | 9 | 49 | 72 | 44 |
| NY Climate Division 2 Rankings "Eastern Plateau" | | | | | |
| Jan–Feb–Mar WINTER | Apr–May–Jun SPRING | Jul–Aug–Sep SUMMER | Oct–Nov–Dec AUTUMN | Jan – Dec ANNUAL | |
| Temperature-2013 | 40 | T72 | T68 | T64 | T52 |
| Precipitation-2013 | 107 | 6 | 6 | 37 | 13 |

Precipitation Summary

For the first time in 12 years, annual precipitation (rain and melted snow, ice, sleet, etc.; hereafter precipitation) for calendar year 2013 averaged below the long-term mean (Table 6) in part due to having one of the driest winters of record (Table 5). Contrary to the trend of some past years, all five of the wettest days occurred within an eight week period in the summer (Table 7). The highest accumulated liquid occurred in late June (Table 8). Only the months of May, June and July averaged above-normal precipitation throughout the region (Figure 4; Table 9). Dry spells were noted in January (once), March (once), July (once) and November (twice), which is typical for an average year (Table 7). Snowfall was below normal, due, in large part, to a very mild early winter. The number of days with excessive rainfall (>1.0 in [25 mm]) was near to the long-term average for northeastern Pennsylvania (Table 6).

The year began with below-normal precipitation during much of January, February and March (Figure 4). The first three months of 2013 were ranked as the 9th to 18th driest in 119 years of record keeping (Table 5). Essentially, all stations reported below-average precipitation (rain and snow) during the months of January, February and March, with the only near normal (93 percent) tallied at Stroudsburg, PA, in January and February (Table 9).

Spring 2013 (April–May–June) became progressively wetter, but only one month (June) had all station with 100 percent of normal rainfall (Table 9). This three month period ranked from the 6th to 25th wettest in 119 years for the three climate divisions encompassing the parks (Table 5). Two of the wettest days (June 11 and 28), but none of the longer dry spells occurred during this season (Table 7).

The summer has sporadic rainfall with generally well-above-average precipitation in July and August, but by September, the stations tallied only about 42 percent of normal (Table 9). September was particularly dry with two long dry spells (Sept 4-11 and Sept 23-Oct 4) (Table 7). There were no direct effects of any hurricanes or tropical storms during this period.

Bucking the trend for much of the last decade, the autumn was generally drier than normal, with total precipitation ranging from 7.9–10.8 in (199–274 mm) (Table 6). December was the wettest of the fall months, as stations tallied 73-136 percent of normal rainfall (Table 9). Rock Hill, NY, measured 5.35 in (136 mm), for the maximum accumulation (Table 8). October was very dry, with the majority of the stations averaging less than 50 percent of the normal rainfall and this was almost as dry as September (Table 9). Precipitation during the last three months of 2013 ranked between 37th wettest and 42nd driest for the climate divisions surrounding the parks. Snowfall during the year only tallied 35.9-43.7 in (91-112 cm) which was below average.

Overall, 2013 had between 83-101 percent of the normal precipitation (Tables 6 and 9) and this was very similar to the previous year.

Table 6. Status of 2013 precipitation indicators compared to the 30-year normal (1981–2010) at the Matamoras (MATP1), Hawley 1 E (HAWP1), and Pleasant Mount 1 W (PLEP1) stations. * missing data, summaries are only partial.

| Precipitation Indicator | Matamoras, PA 2013 | Matamoras, PA 1981-2010 | Hawley 1 E, PA 2013 | Hawley 1 E, PA 1981-2010 | Pleasant Mount 1 W, PA 2013 | Pleasant Mount 1 W, PA 1981-2010 |
|---|---------------------|-------------------------|---------------------|--------------------------|-----------------------------|----------------------------------|
| Annual Precipitation | M in M mm | 46.0 in 1,168 mm | 41.2 in 1,046 mm | 42.9 in 1,090 mm | 44.7 in 1,136 mm | 49.5 in 1,257 mm |
| Autumn (Oct, Nov, Dec) Precipitation | M in M mm | 11.5 in 292 mm | 7.85 in 199 mm | 10.6 in 269 mm | 10.8 in 274 mm | 12.7 in 323 mm |
| Heavy Precipitation Days (days with ≥ 1.0 in [25 mm] rain) | M | 11 | 10 | 10 | 9 | 11 |
| Extreme Precipitation Days (days with ≥ 2.0 in [51 mm] rain) | M | 1 | 3 | 1 | 3 | 2 |
| Micro-drought (strings of 7+ days without rain) | 6 | 4 | 6 | 5 | 6 | 5 |
| Annual Snowfall | 9.3 in* 23.6 cm* | 37.8 in 96.0 cm | 35.9 in 91.2 cm | 44.2 in 112.3 cm | 43.7 in 111.0 cm | 68.5 in 174.0 cm |
| Measurable Snow Days (days with ≥ 0.1 in [0.3 cm] snow) | 12* | 22 | 23 | 20 | 22 | 28 |
| Moderate Snow Days (days with ≥ 3.0 in [7.6 cm] snow) | 1* | 4 | 4 | 5 | 8 | 8 |
| Heavy Snow Days (days with ≥ 5.0 in [12.7 cm] snow) | 0* | 2 | 2 | 3 | 2 | 4 |

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

Table 7. Top five wettest days and top five dry spells (consecutive days with a trace or less of liquid precipitation) during 2013 from the Hawley and Pleasant Mount stations.

| Wettest Days in 2013 | Dry Spells in 2013 |
|---------------------------|--------------------|
| Jun. 28: 4.68 in (119 mm) | Sep. 23–Oct. 4 |
| Jul. 1: 4.19 in (106 mm) | Mar. 22–Mar. 31 |
| Aug. 9: 2.90 in (74 mm) | Jan. 1–11 |
| Jun. 11: 2.01 in (51 mm) | Jul. 14–22 |
| Jun. 14: 1.82 in (46 mm) | Sep. 4–11 |

Table 8. Summary of 2013 monthly total precipitation for selected stations.

| Station Name | Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|--------------------------|---------|---------|--------|--------|---------|---------|---------|---------|---------|--------|--------|--------|---------|----------|
| Matamoras | MATP1 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Equinunk 2 NW | EQNP1 | 2.04in | 1.47in | 1.69in | 2.80in | 3.35in | 8.10in | 3.68in | 7.12in | 1.60in | 2.78in | 3.90in | 3.17in | 41.70in |
| | | 51.8mm | 37.3mm | 42.9mm | 71.1mm | 85.1mm | 205.7mm | 93.5mm | 180.9mm | 40.6mm | 70.6mm | 99.1mm | 80.5mm | 1059.2mm |
| Hawley 1 E | HAWP1 | 2.13in | 1.07in | 2.93in | 2.67in | 3.28in | 9.36in | 7.04in | 2.92in | 1.95in | 1.24in | 2.83in | 3.78in | 41.20in |
| | | 54.1mm | 27.2mm | 74.4mm | 67.8mm | 83.3mm | 237.7mm | 178.8mm | 74.2mm | 49.5mm | 31.5mm | 71.9mm | 96.0mm | 1046.5mm |
| Deposit | DEPN6 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Rock Hill 3 SW | RKHN6 | M | M | M | 2.76in | 3.27in | 9.35in | 8.53in | 4.04 | 2.13in | 1.97in | 3.69in | 5.35in | M |
| | | M | M | M | 70.1mm | 83.1mm | 237.5mm | 216.7mm | 102.6mm | 54.1mm | 50.0mm | 93.7mm | 135.9mm | M |
| Pleasant Mount 1 W | PLEP1 | 2.46in | 1.61in | 1.59in | 2.62in | 4.22in | 9.92in | 2.45in | 7.27in | 2.52in | 2.41in | 3.82in | 3.85in | 44.74in |
| | | 62.5mm | 40.9mm | 40.4mm | 66.6mm | 107.2mm | 252.0mm | 62.2mm | 184.7mm | 64.0mm | 61.2mm | 94.2mm | 97.8mm | 1136.4mm |
| Milanville | MLAP1 | 1.99in | 1.28in | 1.59in | 2.62in | 3.49in | 6.76in | 3.78in | 4.65in | 3.17in | 1.67in | 3.41in | 3.90in | 38.31in |
| | | 50.6mm | 32.5mm | 40.4mm | 66.6mm | 88.7mm | 171.7mm | 96.0mm | 118.1mm | 80.5mm | 42.4mm | 86.6mm | 99.1mm | 973.1mm |
| Stroudsburg | SDBP1 | 3.76in | 1.95in | 3.00in | 4.00in | 5.82in | 8.86in | 6.64in | 5.18in | 2.30in | 1.94in | 3.16in | 4.71in | 51.32in |
| | | 95.5mm | 49.5mm | 76.2mm | 101.6mm | 147.8mm | 225.0mm | 168.7mm | 131.6mm | 58.4mm | 49.3mm | 80.3mm | 119.6mm | 1303.5mm |
| Sussex Airport | KFWN | 3.05in | 1.32in | 1.97in | 1.32in | 3.33in | 7.67in | 6.47in | 4.34in | 1.67in | 1.37in | 2.27in | 2.99in | 37.77in |
| | | 77.5mm | 33.5mm | 50.0mm | 33.5mm | 84.6mm | 194.8mm | 164.3mm | 110.2mm | 42.4mm | 34.8mm | 57.7mm | 76.0mm | 959.4mm |
| Aeroflex-Andover Airport | K12N | 4.47in | 2.48in | 2.53in | 1.21in | 4.65in | 6.30in | 2.59in | 3.55in | 0.90in | 0.56in | 2.64in | 4.06in | 45.94in |
| | | 113.5mm | 63.0mm | 64.3mm | 30.7mm | 118.1mm | 160.0mm | 65.8mm | 90.2mm | 22.9mm | 14.2mm | 67.1mm | 103.1mm | 1166.9mm |
| Blue Mountain Lakes | TS717 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| | | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Loch Lomond | LOLP1 | 3.35 in | 2.75in | 2.37in | 0.98in | M | M | M | M | M | M | M | M | M |
| | | 85.1mm | 69.9mm | 60.2mm | 24.9mm | M | M | M | M | M | M | M | M | M |

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

**Delaware Water Gap National Recreation Area
and Upper Delaware Scenic and Recreational River
Percent of Average Monthly Precipitation
2013 vs. 1981–2010**

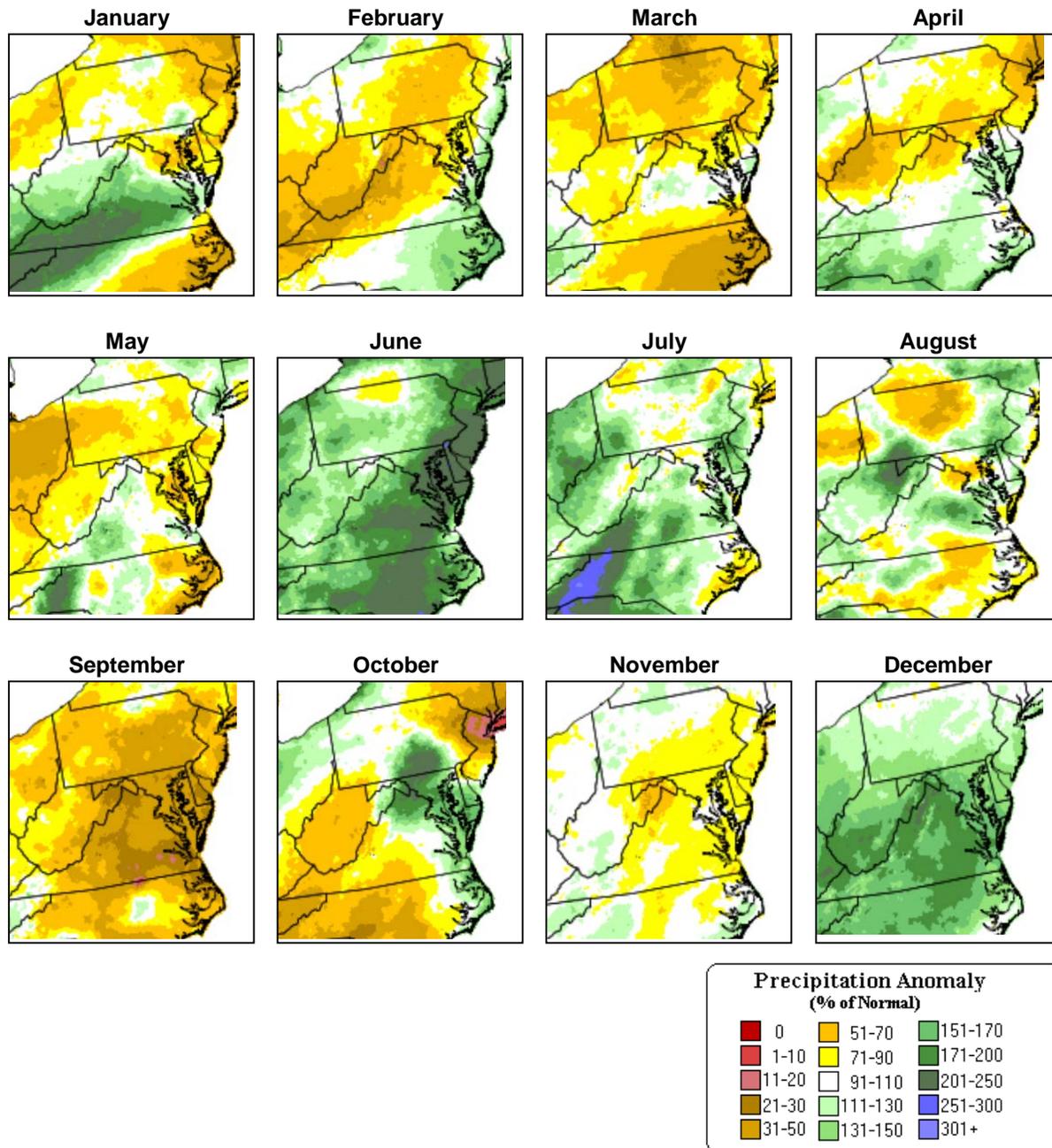


Figure 4. Maps showing percent of average monthly precipitation compared to the 30-year normal (1981–2010).

Table 9. Summary of 2013 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 |
|---------------------------------------|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|
| Matamoras | MATP1 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Equinunk 2 NW | EQNP1 | 64 | 53 | 48 | 79 | 85 | 206 | 94 | 181 | 40 | 77 | 104 | 93 | 96 |
| Hawley 1 E | HAWP1 | 73 | 40 | 91 | 76 | 84 | 236 | 181 | 76 | 52 | 36 | 85 | 87 | 96 |
| Deposit | DEPN6 | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Rock Hill 3 SW | RKHN6 | 73 | 56 | 44 | 64 | 92 | 215 | 54 | 169 | 56 | 58 | 91 | 133 | 83 |
| Pleasant Mount 1 W | PLEP1 | 89 | 67 | 78 | 100 | 143 | 208 | 145 | 116 | 52 | 49 | 82 | 104 | 90 |
| Milanville | MLAP1 ¹ | 67 | 65 | 60 | 41 | 91 | 156 | 166 | 105 | 39 | 30 | 89 | 136 | 93 |
| Stroudsburg | SDBP1 | 93 | 93 | 71 | 35 | 119 | 143 | 56 | 77 | 18 | 12 | 96 | 73 | 101 |
| Sussex Airport ¹ | KFWN | M | M | M | M | M | M | M | M | M | M | M | M | M |
| Aeroflex-Andover Airport ¹ | K12N | 64 | 53 | 48 | 79 | 85 | 206 | 94 | 181 | 40 | 77 | 104 | 105 | 96 |

¹Indicates a station's Period of Record is 10 years or more 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. Stations with a Period of Record of less than 10 years were not included in this table.

M = missing data (Monthly statistics are reported as ' M' if more than 4 days of data are missing). *pro-rated for months available

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 1 in 2013 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 2013). 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 2013.

According to the PDSI for PA Climate Division 1, every month, except June during 2013 was within the normal range, but were a bit too dry. The very moist conditions at the beginning of the summer was due to the exceptionally wet weather during the latter half of June. When compared with the past few years, 2013 was most similar to 2012 and was notably drier than 2011, one of the wettest years on record.

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); with dry weather noted in May, September and October.

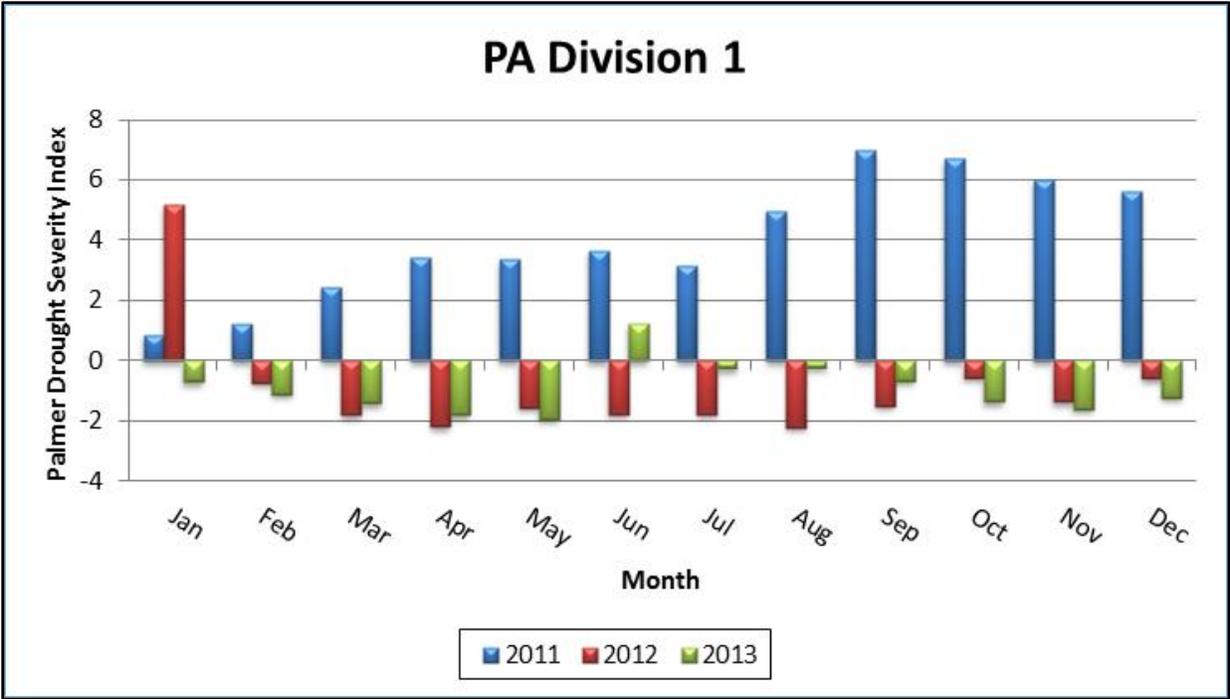


Figure 5. Monthly Palmer Drought Severity Index (PDSI) values for Pennsylvania Climate Division 1, 2011–2013.

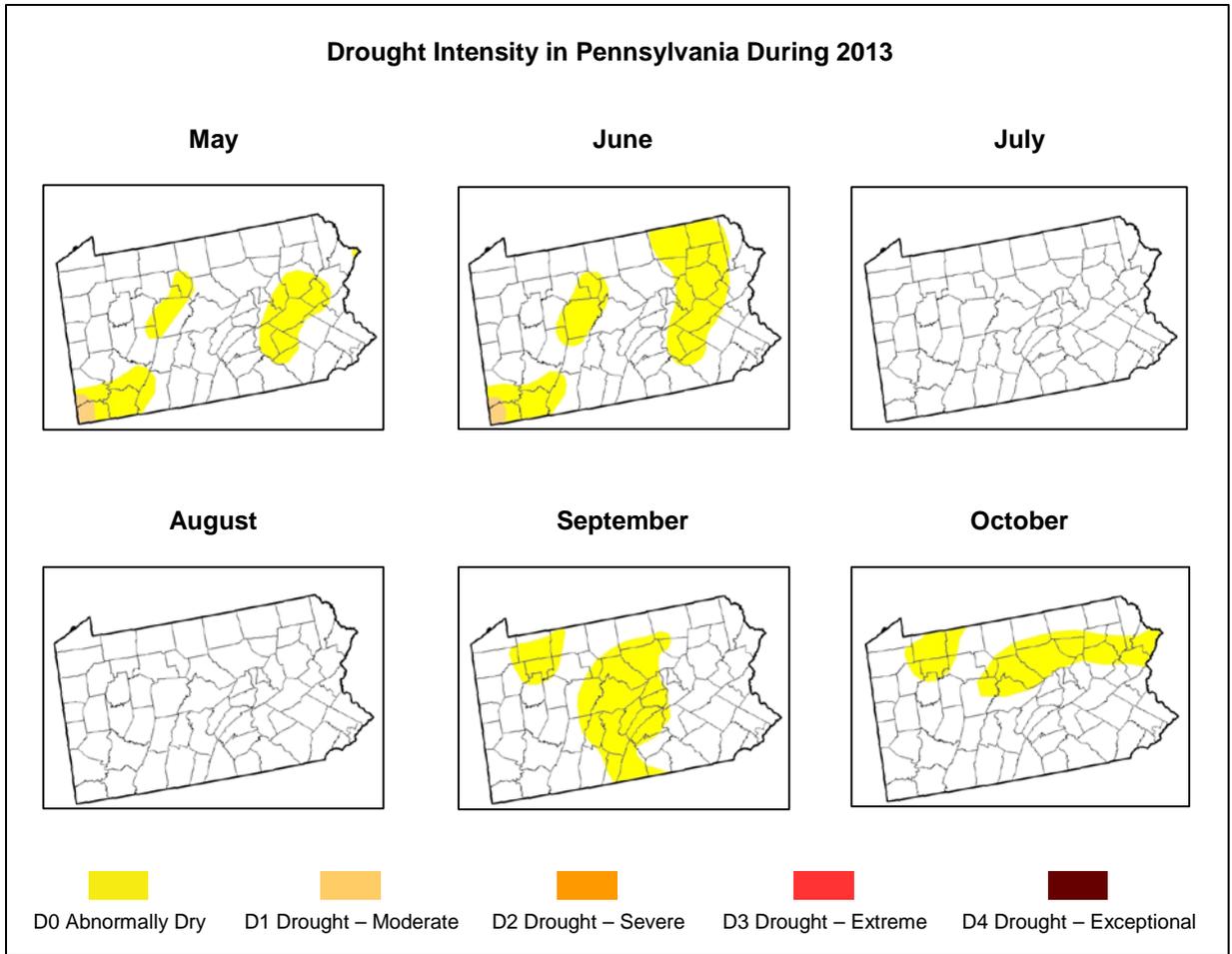


Figure 6. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for Pennsylvania in 2013.

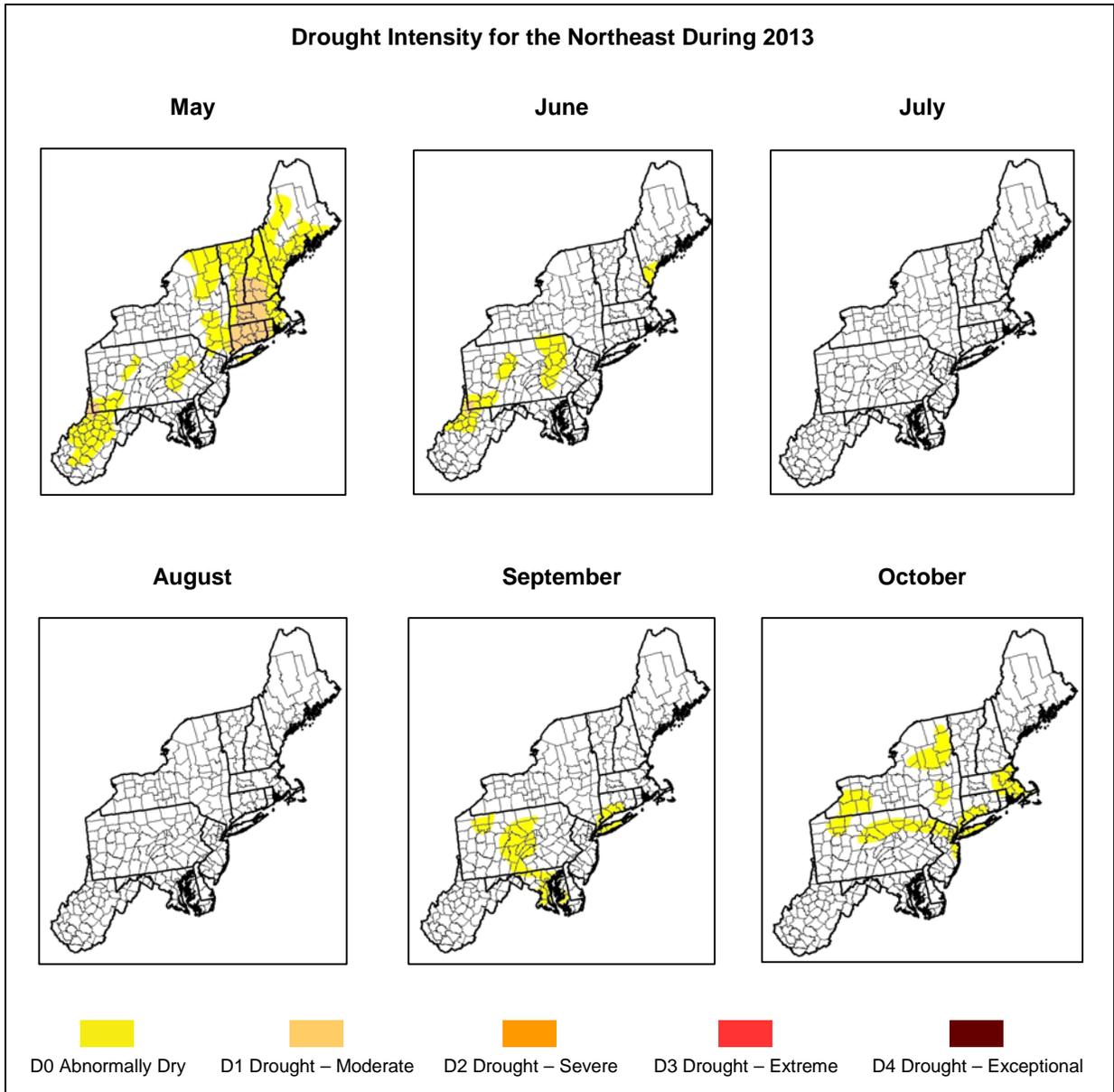


Figure 7. Mid-month values of the United States Drought Monitor (DM) - Drought Intensity Index for the Northeast in 2013.

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NPS 620/126167, 647/126167, August 2014

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