

Climate and Water Monitoring at Montezuma Castle and Tuzigoot National Monuments, 2018

Montezuma Castle National Monument (/moca/), Tuzigoot National Monument (/tuzi/)



Climate, groundwater, and surface water are closely related. At Montezuma Castle and Tuzigoot national monuments, the Sonoran Desert Network monitors all three to track broad-scale change and provide early warning of potential problems.

Background

Many National Park Service units in the U.S. Southwest were established to protect precious cultural resources. In most cases, however, the surrounding natural environment is an equally significant part of the story. At Montezuma Castle and Tuzigoot national monuments, in central Arizona, the remains of the precontact built environment reflect the importance of reliable water sources.

At Montezuma Castle National Monument, the cliff dwellings of the Castle unit overlook the perennial waters of Beaver Creek. The Sinagua people inhabited this riparian oasis for over 400 years. At the nearby Well unit, cliff dwellings nestled just below the rim of the well—a huge limestone sinkhole—are testament to the value of the site, still considered sacred by many local tribes. Wet Beaver Creek flows through the Well unit, joining Beaver Creek a

few miles downstream. Both are tributaries of the Verde River, which passes through nearby Tuzigoot National Monument. The stream segment within Tuzigoot lies below an agricultural dam that diverts all but about 14% of the river's flow. At both parks, springs also contribute to perennial surface waters.

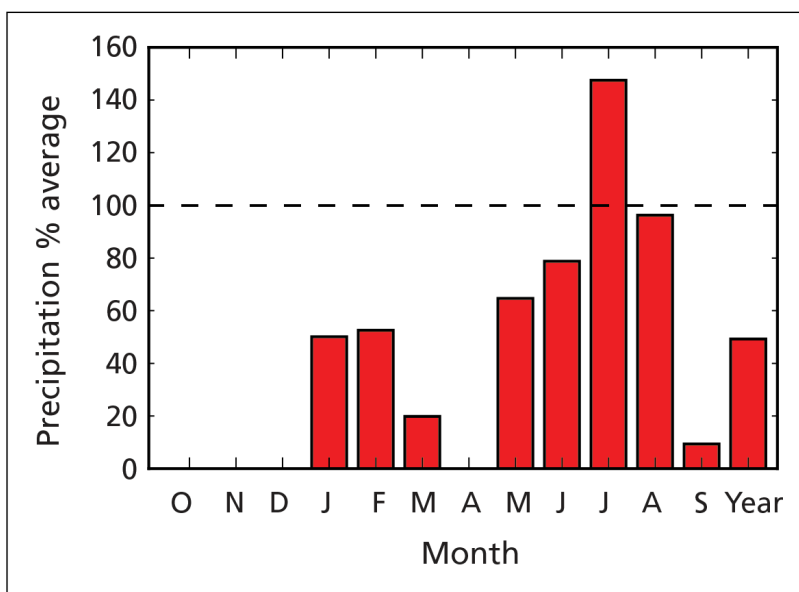
The **Sonoran Desert Network** (<https://www.nps.gov/im/sodn/index.htm>) monitors **groundwater** (<https://www.nps.gov/im/sodn/groundwater.htm>), **springs** (<https://www.nps.gov/im/sodn/springs.htm>), and **streams** (<https://www.nps.gov/im/sodn/streams.htm>) at Montezuma Castle and Tuzigoot national monuments. The goal of the program is to detect broad-scale changes in ecological condition by observing certain parameters over time—and to give park managers early warning of any issues they may need to address.

Hydrologic conditions are closely related to **climate** (<https://www.nps.gov/im/sodn/climate.htm>) conditions. Because the two are better understood together, the Sonoran Desert Network reports on climate in conjunction with water resources. Reporting is done by water year (WY), which begins in October and ends the following September.

Recent Findings

Climate

Water year 2018 was hotter and drier than normal. Overall annual precipitation was 49% of normal for Montezuma Castle National Monument (NM) and 76% of normal for Tuzigoot NM. Rainfall in fall and winter was extremely low. Mean monthly maximum temperatures at both parks were above normal for all months except one at Montezuma Castle. Tuzigoot NM showed a return to drought conditions following recent wetter years. Additional information can be found at **The Climate Analyzer** (http://www.climateanalyzer.us/sonoran_desert/tuzma).



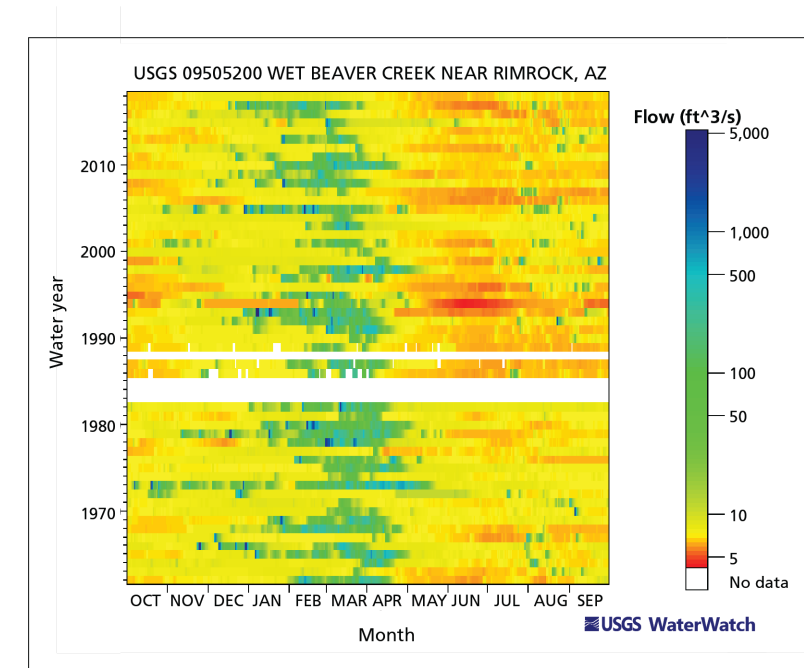
Precipitation in water year 2018 was lower than normal in all months except July at Montezuma Castle National Monument.

Groundwater

Groundwater levels at the water-supply wells for both units of Montezuma Castle National Monument declined from WY2017, by 24.20 (Castle unit) and 8.10 (Well unit) feet, respectively. However, both wells had been recently pumped, so those values may not represent actual conditions. Over the monitoring record, water levels at the Castle unit have been variable, while water levels at the Well unit have generally declined. Groundwater levels in the three monitoring wells near Tuzigoot National Monument showed variable changes from water year 2017. All three wells have shown relatively stable groundwater levels since 1999.

Springs

Expansion Spring (Montezuma Castle NM Castle unit) and Shea Spring (Tuzigoot NM) were both classified as “undisturbed,” despite some evidence of beaver activity at Shea Spring. Sensors indicated that both springs were likely wetted throughout the sampling period.



Raster hydrograph for Wet Beaver Creek. The very top line of pixels represents water year 2018, in which no snowmelt pulse (shown in green) was detected.

Water Quality

There were 10 exceedances of water-quality standards during WY2018: seven on Beaver Creek (one *E. coli*, three dissolved oxygen, and three total arsenic), one on Wet Beaver Creek (total arsenic), and two on the Verde River (one *E. coli* and one total lead). This resulted in a 94% compliance rate across the three units.

Exceedances of water-quality standards in WY2018

Water body	Park	Standard exceeded
Beaver Creek	Montezuma Castle NM (Castle unit)	<i>E. coli</i> (1) Dissolved oxygen (3) Total arsenic (3)
Wet Beaver Creek	Montezuma Castle NM (Well unit)	Total arsenic (1)
Verde River	Tuzigoot NM	<i>E. coli</i> (1) Total lead (1)

Streams

Streamflow

The lack of precipitation was reflected in the parks’ low streamflow in WY2018. Mean daily discharge from the Beaver Creek station was 7.13 cubic feet per second (cfs)—approximately one-tenth of the mean value from WY2005 to 2008. At Wet Beaver Creek, mean daily discharge was 7.05 cfs, well below the gage record mean of 30.2 cfs. Recorded flow at the Verde River gage was either at or below the 25th percentile for most of the year. There was a striking lack of flow events at all sites. There was no snowmelt pulse observed in the hydrographs for Wet Beaver Creek and the Verde River this year.

Macroinvertebrates and Fish

Macroinvertebrate index values for warmwater streams were likely attaining at all sample sites. The values for Beaver and Wet Beaver Creek were the highest recorded by SODN. This was good news after several years of either not attaining or scoring in the inconclusive category.

Information was summarized from E. L. Gwilliam, L. Palacios, and K. Raymond. 2019. Status of climate and water resources at Montezuma Castle and Tuzigoot national monuments: Water year 2018 (<https://irma.nps.gov/DataStore/Reference/Profile/2266004>).

WARNING

Contact with the natural waters found at Montezuma Castle and Tuzigoot national monuments be avoided, or minimized when contact is required. There has been a reoccurring exceedance of the Arizona state water quality standard (partial and full body contact) for **arsenic** due to mineral arsenic in the rocks and other materials that compose the geology of the region.

This includes Beaver Creek, Wet Beaver Creek, the Verde River, Tavaschi Marsh, and Montezuma Well, including the ditch that carries water from the Well to Wet Beaver Creek. Additionally, exceedances for ***E. coli*** have occurred in these streams, typically associated with precipitation runoff carrying material bearing the bacterium from the ground surface into the stream. **These waters should not be ingested under any circumstances.**

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