

Monitoring Climate and Water at Montezuma Castle and Tuzigoot National Monuments

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

Overview and Importance

Many National Park Service units in the U.S. Southwest were established to protect precious cultural resources, such as cliff dwellings. 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 extant 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, a sight

both beautiful and vital to the Sinagua people who 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.



Cliff dwelling overlooking Beaver Creek, Montezuma Castle National Monument. NPS/AW Biel



Wet Beaver Creek, Montezuma Castle National Monument. NPS/AW Biel

These streams, and their associated riparian areas, are critical to the ecological integrity of the region. Riparian areas supply food, cover, and water, and serve as wildlife migration routes. They also help control water pollution, reduce erosion, mitigate floods, and increase groundwater recharge. Riparian systems perform numerous ecosystem functions important to humans, yet are one of the most endangered forest types in the United States.

At Montezuma Castle and Tuzigoot national monuments and two other National Park Service units, the **Sonoran Desert Network**

(<https://science.nature.nps.gov/im/units/sodn/>) monitors stream health. 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. The network measures water quality, water quantity (streamflow), channel morphology (the shape and composition of the streambed), riparian vegetation, and macroinvertebrate communities.

Stream conditions are closely related to climate 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

In WY2016, overall annual precipitation was 92% of normal for Montezuma Castle National Monument (13.2" vs. 14.4") and 107% of normal for Tuzigoot NM (13.58" vs. 12.71"). Precipitation at both parks was below normal for the fall and winter of WY2016 (75% or -1.8" at Montezuma Castle, 63% or -2.35" at Tuzigoot), while for the spring and summer it was close to average at Montezuma Castle (109%, +0.65") and greater than normal at Tuzigoot (150%, +3.22"). The reconnaissance drought index

for both parks reflected the extended regional drought that began in 2000 and has continued through WY2016. Both parks experienced higher numbers of extremely cold days than normal in WY2016 (24 vs. 22.3 ± 1.4 days for Montezuma Castle, 23 days vs. 14.6 ± 1.1 days for Tuzigoot). Extremely warm days were also more plentiful at Tuzigoot NM (36 days vs. $16.6 \text{ days} \pm 1.6$). Additional information can be found at climateanalyzer.org



Climate monitoring station, Montezuma Castle National Monument.

(http://www.climateanalyzer.org/sonoran_desert/tuzma).



Streams monitoring on the Verde River, Tuzigoot National Monument.

NPS/L. Palacios

Water Resources

Streamflow

At Wet Beaver Creek, mean daily discharge (flow) during WY2016 was 12.2 cubic feet per second (cfs)—well below the gauge record mean of 30.3 cfs. During the latter half of the spring snowmelt period (mid-January to mid-May), mean daily discharge was below or approaching the lower 5th percentile. In addition, peak runoff occurred about one month earlier than average based on the 55-year gauge record. Earlier peak runoff can

impact plants and animals that depend on the timing of the spring melt for successful recruitment.

Recorded flow at the Verde River gauge at Tuzigoot NM was either at or below historic lows in WY2016—well below the 5th percentile for a majority of the year. Eight months during WY2016 measured record lows for mean daily flow. Flow data for Beaver Creek were provisional (results indicated that the Beaver Creek gauge accurately captures the occurrence and duration of flow events, but not their magnitude).

Water Quality and Macroinvertebrates

Across the three units, there were four exceedances of state water quality standards for *E. coli* and arsenic during WY2016, resulting in an average of 98.4% overall compliance with standards. Macroinvertebrate values from the Beaver Creek and Verde River index sites both attained state standards for the Arizona Index of Biological Integrity (an index used to measure wetland health) for warmwater streams. Data from the Wet Beaver Creek index reach fell in the “inconclusive” range, though there was no obvious observed decrease in water quality at the Wet Beaver Creek site.

For more detailed information, see the most recent **full report** (<https://irma.nps.gov/DataStore/DownloadFile/588154>).

☒ Please Note

There has been a reoccurring exceedance of the arsenic standard due to mineral arsenic in the rocks and other materials that compose the regional geology at Montezuma Castle and Tuzigoot national monuments. Exceedances for *E. coli* have also occurred in these streams. To limit exposure, care should be taking when handling water from Beaver Creek, Wet Beaver Creek, and the Verde River in Tuzigoot National Monument.
