



# Natural Resource Monitoring at Montezuma Castle National Monument

## The Sonoran Desert Network

The Sonoran Desert Network (SODN) covers the geologically and biologically diverse Sonoran Desert and Apache Highlands ecoregions of southern Arizona and southwestern New Mexico. The network comprises 11 national parks containing biomes ranging from low-elevation desert scrub to mixed conifer forests, as well as critical riparian systems associated with perennial rivers, ephemeral and intermittent washes, seeps, springs, and tinajas. The SODN is designing and implementing a long-term monitoring program to measure key indicators of ecological integrity, or “vital signs.” This coordinated, multi-perspective ecosystem monitoring effort will help inform managers and the public as to the condition of key park resources and provide an early warning system for potential problems. This brief describes SODN activities at Montezuma Castle National Monument (NM).



Montezuma Castle National Monument/NPS

## Resource Inventories



White-tailed deer.

Managers need reliable data to maintain resources “unimpaired for future generations,” especially as conditions outside parks rapidly change. Natural resource inventories are extensive, point-in-time surveys of plants, animals, and the physical environment (water, soils, geology, landforms, and air). From 2001 to 2002, biologists from the University of Arizona and the SODN evaluated the results of the rich research legacy of the Castle and Well units of Montezuma Castle NM. Detailed survey information has documented the occurrence and distributions of 472 plant species, 9 fish species, 34 amphibians and reptiles, 58 mammals, and an amazing 211 bird species—species richness that is unusual and impressive for such a small unit, and reflects the

critical importance of the perennial riparian corridors that traverse the park.

Since 2001, SODN staff and cooperators have completed resource inventories on vertebrates, vascular plants, air quality and air quality-related values (updated in 2009), water quality, climate, hydrography, and a natural resource bibliography. Projects underway include geologic-resource evaluation and mapping (expected completion in 2011) and vegetation classification and mapping. Soils inventories are planned for the future. Collectively, these inventories provide an important baseline for management and monitoring efforts to support effective park resource protection.

## Streams



Streams monitoring in the park.

Set aside to commemorate and protect the unique prehistoric settlement along Beaver and Wet Beaver creeks, Montezuma Castle also protects and manages the rich riparian ecosystems that attracted early peoples to the site. Perennial streams and the ecosystems they support are biological “hotspots” within the expansive, semi-arid landscapes of the Sonoran Desert ecoregion. The SODN monitors water quantity, water quality, aquatic biota, channel morphology, and riparian vegetation in an integrated fashion to provide managers,

scientists, and the public with key information on the condition of these critical park resources. Montezuma Castle NM was a focus for early research and development efforts for SODN streams monitoring, with preliminary efforts starting in 2006. Full implementation of streams monitoring at Montezuma Castle NM commenced in 2007. Status reports, field summaries, and monitoring briefs are produced annually, with a detailed synthesis and trend report to be produced in 2012, based on five years of monitoring information.

## Vegetation and Soils



Hedgehog cactus and red brome.

Vegetation comprises or interacts with all primary components of terrestrial ecosystems. Vegetation dynamics can indicate the integrity of ecological processes, productivity trends, and ecosystem interactions that can otherwise be difficult to monitor. Soils and landform characteristics mediate available water in semi-arid systems, influencing vegetation composition, distribution, and production. By monitoring soils and vegetation (includ-

ing established exotic plants) in an integrated fashion, we can gain key insights into the condition and trends of Sonoran Desert ecosystems. The SODN will begin monitoring terrestrial vegetation and dynamic soils vital signs at Montezuma Castle NM in fall 2010. A comprehensive status and trend report and resource brief will be completed in 2011, and repeated at five-year intervals.

## Landbirds



Yellow-billed cuckoo.

Birds are a conspicuous component of many ecosystems. They have high body temperatures, rapid metabolisms, and occupy high trophic levels. Because they can respond quickly to changes in resource conditions, birds are considered effective indicators of ecosystem condition. Therefore, changes in bird populations and community structure may indicate key changes in the biotic and abi-

otic components of the environments upon which they depend. The SODN initiated annual bird monitoring at Montezuma Castle NM in 2007, to provide insights into human perturbations and natural events. Status reports and resource briefs are produced annually; a detailed synthesis and trend report will be produced in 2012, based on five years of monitoring information.

## Exotic Plants



Horehound.

Invasive exotic plants are a critical threat to native species and (in many cases) ecosystem functional attributes. The Castle and Well units of Montezuma Castle NM were the focus of a prototype exotic plant inventory and mapping effort for SODN units. From 2003 to 2004, botanists with the University of Arizona, Sonoran Institute, and SODN conducted roaming exotic plant surveys that were comprehensive and amounted to a census of these

small units. The occurrence and distribution of exotic plants were mapped in the field using handheld GIS/GPS mapping units, backed by quantitative field plots. The maps and reports produced through this effort have been used to guide restoration and exotic plant control efforts at both units of Montezuma Castle NM, and provide a foundation for exotic plant monitoring.

## Climate



Climate monitoring station.

Climate is a primary driver of ecosystem structure and function in the Sonoran Desert and Apache Highlands ecoregions. Spatial and temporal variability in precipitation and temperature extremes have critical consequences for flora and fauna, and set the limits for community composition and productivity in these semi-arid environments. Additional parameters, including wind

velocity, relative humidity, photosynthetically active radiation, and total radiation, provide insights into environmental conditions. The SODN compiles and analyzes climate data from existing weather stations. Data are interpreted in annual climate monitoring reports, and are referenced in most reports for other vital signs.

## Seeps, Springs, and Tinajas



Sonoran mud turtle, found near springs.

Seeps and springs are important surface water locations in upland areas of the mountainous landscape of Montezuma Castle NM. Seeps and springs vary greatly in size, permanence, and landscape position. Working with park

staff, the SODN completed an inventory and tested potential monitoring techniques in 2009, with the goal of developing a monitoring protocol in 2010–2011.

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## For more information

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