



## Streams Monitoring at Montezuma Castle and Tuzigoot National Monuments

2013

### Importance

Riparian habitats constitute less than 2% of the land area in the American Southwest, but support the highest density and abundance of plants and animals of any habitat type, making streams and associated riparian areas critical to the ecological integrity of the region. Riparian areas supply food, cover, and water, and serve as migration routes and habitat connectors, for a variety of wildlife. They also help control water pollution, reduce erosion, mitigate floods, and increase groundwater recharge. Riparian systems perform numerous ecosystem functions important to human populations, yet are one of the most endangered forest types in the United States.

### Monitoring Objectives

The overall goal of the Sonoran Desert Network (SODN) streams monitoring program is to detect broad-scale changes in aquatic and riparian ecological condition by observing selected ecological drivers, stressors, and processes. Specific, measurable objectives for streams monitoring at Montezuma Castle National Monument (Castle unit, MOCC; Well unit, MOWE) and Tuzigoot National Monument (TUZI), are to determine the status of and detect long-term trends in:

- **Water quality** for daily, seasonal, and annual core water quality parameters (temperature, pH, dissolved oxygen, specific conductivity, turbidity), and seasonal nutrients, metals, inorganics, and bacteria.
- **Aquatic macroinvertebrates** for relative abundance of selected taxa and community structure and selected multimetric indicators of biotic integrity.
- **Surface water quantity** for seasonal and annual base flow conditions; frequency, magnitude, and duration of low-flow and flood events; and extent of wet and dry areas.
- **Channel morphology** for cross-sectional area, sinuosity, channel slope, and sediment size distribution.
- **Riparian vegetation cover** for dominant and common (>10%) perennial species.
- **Fish** for communities on local and regional scales.

### Status of the Effort

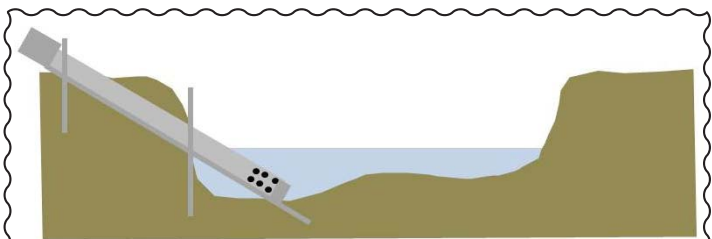
During 2012, SODN staff completed quarterly site visits to Beaver Creek (MOCC), Wet Beaver Creek (MOWE), and the Verde River (TUZI). Water quality and water quantity parameters were measured during each site visit. Aquatic macroinvertebrate samples were collected in May and sent to the University of Utah's BugLab for analysis. SODN also augmented routine streams monitoring in two ways. First, through a col-



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Beaver Creek, Montezuma Castle National Monument.

laboration with the U.S. Environmental Protection Agency, we began to collect and analyze water samples for contaminants of emerging concern—those that have not traditionally been tested for during water quality sampling and may not be adequately cleansed by current wastewater treatment methods—such as pesticides, personal care products, and pharmaceuticals. Second, SODN began to deploy a logging water quality probe at various sites for two weeks every quarter to investigate fine-scale temporal variability. The probe records core water quality parameters every 15 minutes. These two new data sets will provide useful baseline data and information on potential pollutants.



### Probing the Depths of Water Quality

Over the past year, the SODN staff has been installing mounts for water quality monitoring equipment in all network parks where streams are monitored. The mounts provide “quasi-permanent” (so-called because some flow events do have the potential to render the mounts impermanent!) housing for stream probes that should prove stable and secure under most flow regimes.

This instrumentation will enable SODN staff to detect trends in important water quality parameters, such as temperature, pH, and dissolved oxygen, by examining variation across days, months, seasons, and years. The network's long-term goal is to install telemetry systems at these sites, enabling real-time streaming of water quality data.

## Management Concerns

### *E. coli*

Preliminary *E. coli* sampling results from the fall quarterly sampling period showed exceedances of the Arizona designated use standard for partial body contact on Beaver Creek and the Verde River. *E. coli* exceedances have been known to occur in all three streams following rain events, especially in Beaver Creek. The unknown source of *E. coli* contamination could be from wildlife, domestic animals, humans, or a combination thereof.

During high-discharge events, runoff from the watershed contributes large amounts of sediment and organic material to streams. Fecal matter and its microbial components, such as *E. coli*, are carried into streams, along with the silts and sands being eroded during overland flow events. *E. coli* readily binds to benthic and suspended sediment in surface water bodies, and is able to survive for prolonged periods of time when attached to sediments (Sampson et al. 2006). In addition, *E. coli* concentrations have been shown to be positively correlated with turbidity levels (Smith et al. 2008). Therefore, elevated *E. coli* concentrations are more likely to occur during high-turbidity discharge events, such as those that typically occur after a large thunderstorm. However, if elevated concentrations also occur in clear water conditions, then a persistent source may exist (Van Grinsven et al. 2010).

In water year 2013, SODN will examine the connection between precipitation events in the watershed, flow events, and *E. coli*, as well as the correlation between *E. coli* and other parameters, such as turbidity. After rain events, staff and visitors should use caution when wading in park streams.

### Low flow and low dissolved oxygen

Dissolved oxygen levels at Beaver Creek and the Verde River did not meet state's minimum standard of 6 mg/L for aquatic and wildlife (warm water). Low flows can cause water temperature to increase and dissolved oxygen to decrease, negatively affecting sensitive aquatic organisms. Low flows are common on all three streams, especially during springtime sampling.

### Beavers

Beavers are a native part of the riparian ecosystem on Beaver Creek. They are also nature's engineers and architects, modifying their habitat to maximize shelter and feeding opportunities. Beaver-dam construction removes riparian trees and creates pool-dominated habitat in place of a more active flowing stream, all of which affects water quality—and SODN's ability to accurately monitor a variety of parameters, especially water quantity and quality. SODN will continue to work with park resource staff to maximize monitoring data quality while allowing beavers to continue their normal activities.

### Invasive Species

Crayfish have been frequently observed during spring and summer at the Beaver Creek stream segment, and less frequently at the Verde River and Wet Beaver Creek stream segments.



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To test for *E. coli* in Sonoran Desert Network streams, water samples are inoculated with a growth medium that produces a color (magenta in this case) and also fluoresces under a black light. By comparing the number of positive large to positive small cells, the concentration of *E. coli* can be estimated.

Northern crayfish (*Orconectes virilis*), which have no natural local predators, feed on larval fish, plants, and insects, which can severely harm the aquatic environment. SODN has not quantified the abundance and effect of crayfish in the streams.

## Conclusions

The three monitored stream segments at Montezuma Castle and Tuzigoot NMs are very small sections of larger stream systems. Parameters monitored by SODN are highly influenced by land-use activities upstream and in the stream watersheds. Runoff from urban areas, improvised septic systems, agricultural uses, climate, and other influences beyond the control of park managers can all have significant impacts on park resources. Continued monitoring and analysis of park resources will be necessary for park managers to make informed decisions about management, planning, and mitigation.

## Citations

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- Smith, R. P., G. A. Paiba, and J. Ellis-Iversen. 2008. Short communication: Turbidity as an indicator of *Escherichia coli* presence in water troughs on cattle farms. *Journal of Dairy Science* 91:2082–2085.
- Van Grinsven, M., D. Thoma, M. Malick, and M. Moran. 2010. Water quality in the Northern Colorado Plateau Network, 2006–2009. Natural Resource Technical Report NPS/NCPN/NRTR—2010/358. National Park Service, Fort Collins, Colorado.

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