SONORAN DESERT NETWORK
Inventory and Monitoring Program

Inventory & Monitoring Program
National Park Service
U.S. Department of the Interior

Casa Grande Ruins NM ✷ Chiricahua NM ✷ Coronado NMem ✷ Fort Bowie NHS ✷ Gila Cliff Dwellings NM ✷
Montezuma Castle NM ✷ Organ Pipe Cactus NM ✷ Saguaro NP ✷ Tonto NM ✷ Tumacácori NHP ✷ Tuzigoot NM

The Heliograph

Official Newsletter of the Sonoran Desert Network

Volume 4, Issue 1
Spring 2014

Water Loss on the Santa Cruz River

The Value of Effluent Inputs in a Desert Landscape

With a breeze shaking the cottonwood leaves and birds singing all around, taking a walk in the cool shade along the Santa Cruz River at Tumacácori National Historical Park (NHP) can be a rare treat in the beating heat of the Sonoran Desert. If the park's riparian gallery forest seems anomalous, it is. In modern times, the river has only been capable of supporting this lush environment since 1951, when regular effluent inputs from the Nogales International Wastewater Treatment Plant (NIWTP), 10 miles upstream of the park, began to bolster its flow. But now, reductions to those inputs, coupled with more than 10 years of Southwest drought, are bringing changes to the river that may eventually alter the forest, as well.

From its headwaters in the U.S., the Santa Cruz River heads south into Mexico before curving back around to the north and re-entering the U.S., where it flows through Tumacácori NHP (see map). That flow is diminishing. According to monitoring by the U.S. Geological Survey (USGS) and Sonoran Desert Network, the Santa Cruz River is currently receiving about 2.4 mgd (million gallons per day) less aquatic input than in recent years. At Tumacácori NHP, the Santa Cruz stopped flowing in mid-April 2013 and remained dry into August (see photos below).

So where did all that water go? More than half of the decrease in flow is attributed to a Mexican water treatment plant that came online in 2012. In the past, water used by the municipal water supply in Nogales, Sonora, was piped to the NIWTP and, ultimately, into the Santa Cruz watershed. Now, the Mexican plant treats approximately 1.5 mgd and sends it back into Sonora for agriculture and aquifer recharge (Prichard and Scott 2013), preventing it from ever reaching the Santa Cruz River. The effluent stream has also been reduced by continued leakage in the pipes and infrastructure that carries the untreated

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Santa Cruz River, 2012.

Santa Cruz River, July 2013.

Project Updates

Flora Project

Plants of Fort Bowie National Historic Site, a companion volume to the recently published vegetation mapping report for that park, will soon be available on the Flora Project page of the SODN website, where field guides to plants of Casa Grande Ruins NM and Tumacácori NHP are already available. Keep an eye on our Facebook page to find out when the Fort Bowie report is released. The guide for Tonto NM should be released later this spring.

Through the Southwest Network Collaboration, the Flora Project has also drafted the first field guide for the U.S. Fish and Wildlife Service's Sonoran and Chihuahuan Deserts Zone. The 668-page Plants of Buenos Aires National Wildlife Refuge will be the first of six field guides for the national wildlife refuges in southern Arizona and southern New Mexico. This guide is under internal review and is expected to be publicly available in mid-2014.

National Park Service
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The Sonoran Desert Network is one of 32 National Park Service inventory and monitoring networks nationwide that are implementing vital signs monitoring in order to assess the condition of park ecosystems and develop a stronger scientific basis for stewardship and management of natural resources across the National Park System.

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The National Park Service cares for the special places saved by the American people so that all may experience our heritage.

The Flora Project and the Desert Research Learning Center are collaborating with the Bureau of Land Management's Safford District office and the Coronado National Forest to develop online floras through the Southwest Environmental Information Network (SEINet). The intent is to increase the capacity for managing floristic information for those agencies and gain access to the vast wealth of data found in SEINet. Visit SEINet for more information.

Groundwater

Groundwater monitoring has been conducted at Coronado NMem, Fort Bowie NHS, and Saguaro NP. Park staff continued monitoring of water levels at three wells in Chiricahua NM and nine wells in Organ Pipe Cactus NM. A new water-level sensor was installed at Saguaro NP (West) to replace the malfunctioning sensor that was retrieved in July. The groundwater protocol is on track for completion in the near future. Quarterly monitoring is planned for Coronado NMem, Fort Bowie NHS, and Saguaro NP in February.

At Coronado NMem, initiation of monitoring at Border Well, a 758-foot-deep well that was last monitored in 1975, is planned. This well is located in a section of the groundwater system at the park that is not sampled by any of the existing monitoring wells. It was not monitored previously due to inability to access the casing. A survey of well measuring-point elevations at the park's Montezuma Ranch is planned for March. A summary report of groundwater activities at network parks to date will be initiated this spring.

Invasive Exotic Plants

This winter's work has focused on database development and reporting. Our goal is to better integrate our efforts with those of the southwest region Exotic Plant Management Team, including developing ways to track treatment efforts. No field work is planned for this year.

Landbirds

Bird monitoring is planned for Chiricahua NM, Coronado NMem, Gila Cliff Dwellings NM, and Saguaro NP (East) in FY14. With those surveys complete, we will have obtained at least five years of data for those parks, which is the amount required for trend analysis. For the other units, efforts in 2014 will focus on detailed trends analysis (via SODN staff time, collaboration with the Southern Plains Network, and assistance from researchers at New Mexico State University and the University of Wyoming) before continuing annual data collection. Our objectives are to validate the sampling design and determine any potential changes to the design going forward.

Springs

Springs monitoring was curtailed during the last quarter of 2013 and first quarter of 2014 due to the impacts of federal budget sequestration. Work that was planned for last fall has been rescheduled for spring/early summer 2014. Building off the work of botanist John Spence and others, SODN's international intern, Jesper Devantier, will complete the vegetation-monitoring section of the protocol during spring and early summer 2014. With assistance from the Chihuahuan Desert Network (CHDN)'s springs monitoring field crew, springs monitoring will begin in SODN parks this spring. The CHDN staff will also assist Chickasaw National Recreation Area (of the Southern Plains Network) with a springs inventory.

Streams

Streams monitoring has been completed for the first quarter of Water Year 2014, including deployment of logging water quality instruments at Southwest Network Collaboration (SWNC) stream segments and sample collection for water quality and macroinvertebrates. Sampling of stream channel morphology at Bent's Old Fort NHS was postponed

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Under Pressure

Measuring Water Stress in Riparian Plants

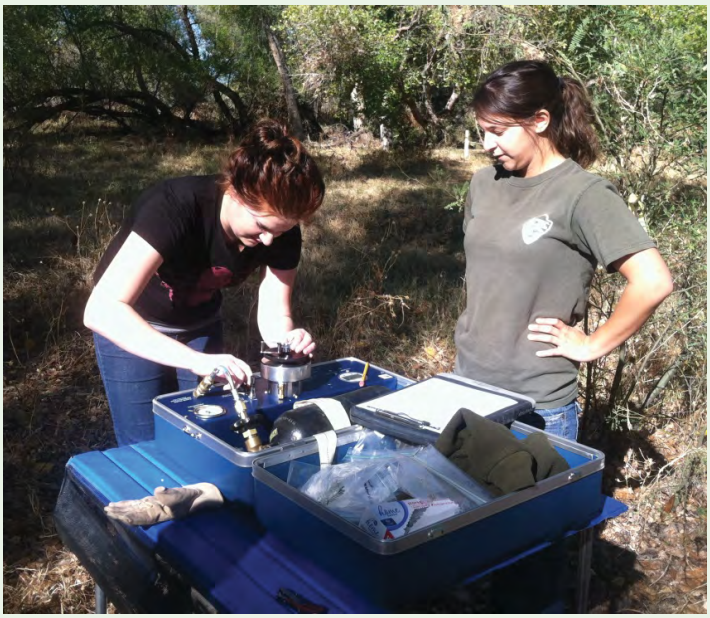
The Sonoran Desert Network is using a Scholander "pressure bomb" to track the effects of water loss on the riparian area at Tumacácori NHP. To operate the device, a crew member places a single tree leaf inside a chamber (see photo at right) and then increases the pressure of nitrogen gas inside the chamber until water from the xylem (the plant tissue that transports water) is pressed out of the petiole (the transition point between the stem and leaf). The amount of pressure needed to extract water from the petiole is positively correlated with how water-stressed the tree is. As water stress increases in the plant, the amount of pressure it takes to force water out of the leaves also increases. By measuring the water stress of multiple trees and species along a moisture gradient from the river, we can better understand the direct effects of the decreasing amount of water flowing through the ecosystem.

Scholander pressure bomb.

At Tumacácori, common trees include Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), and mesquite species (*Prosopis* spp.). The responses of these species to available moisture vary widely, and each has a previously documented, specific water-stress level that it can tolerate before the stress becomes detrimental to the plant. During the growing season, we will measure all three species directly next to the river, as well as mesquites in the bosque, further from the water source. The bosque mesquites are assumed to be using groundwater, rather than river water, and we expect them to be less affected by the changing river system. The three riparian species groups are expected to be more drastically affected by the reduced streamflow and should show immediate signs of stress as flow decreases.

By monitoring the water stress in Tumacácori-area trees, we may be able to more fully understand the extent of the changes that the drying river may cause to the surrounding vegetation—and provide park managers with information they can use to help preserve this dynamic ecosystem.

—Laura Palacios, Student Conservation Association intern



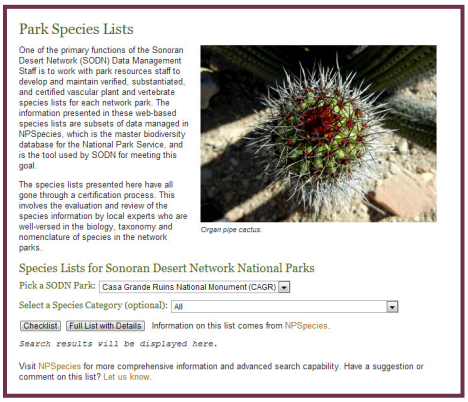
One person generally operates the device while another collects leaves and records data.

Staff profile: Laura Palacios

When she left the Los Angeles area for Tucson to attend the University of Arizona, Laura Palacios didn't know she was going to stay in the desert. But she decided to stick around after graduating with a double-major in Animal Science and Renewable Natural Resources last May, and we at SODN are really glad she did. Laura started with us about three years ago as a student clerk, working mostly on data management duties. (If your park has received a SODN bird checklist, then you're familiar with her ability to pull data together). Now, she's a Student Conservation Association intern and part of our Aquatic Ecology and Physical Sciences team (known as the "Streams Team" on our Facebook page). Data management is still part of her job, but now she's getting out in the field to collect the data, too—traveling to different network parks to help with quarterly sampling of core water quality parameters and monitoring discharge, macroinvertebrates, and contaminants of emerging concern. She especially enjoys their trips to Gila Cliff Dwellings National Monument, but just generally has come to love the desert—and be fascinated by its complex hydrology. Outside work, Laura is a hiker and—*fun fact!*—tap dancer.

—Alice Wondrak Biel, Writer-Editor

See What You're Missing Online!



At our Facebook page, you can find out where we are on the map, track our progress on various tasks and projects, and see pretty pictures like this!

Breaking news on our weather-station project

Need to know what lives where? If you're one of the 650 people following our Facebook page, then you may already know that you can now generate species lists for all SODN parks right from our webpage. It's fast, easy, and even kind of fun (if you're into that sort of thing, like we are)! Give it a try at http://go.nps.gov/SODNspecies.

NEW DOCUMENTS AVAILABLE AT OUR WEBSITE

Bird Checklists
- Chiricahua NM
- Coronado NMem
- Fort Bowie NHS
- Montezuma Castle NM
- Tonto NM

Briefs
- Streams monitoring: Gila Cliff Dwellings NM, Montezuma Castle & Tuzigoot NMs, Tumacácori NHP
- The Vanishing Santa Cruz River
- Uplands monitoring at Tonto NM

Report
- Uplands monitoring at Tonto NM, 2009–2010

Water Loss

Continued from page 1

effluent to the plant. In addition, 10 years of drought have reduced the amount of surface flow in regional rivers, along with groundwater levels. Increased temperatures also put more stress on plants and increase the rate of evaporation.

A no-flow period of the length seen in 2013 has not previously occurred during the record for the USGS stream gage at Tubac, Arizona; it marked a change in system hydrodynamics and ecology. Groundwater levels are dropping as a result of the overall reduction in flow, which has put stress on riparian trees and plants. Fremont cottonwoods (*Populus fremontii*), the dominant trees in the park's riparian forest, need groundwater to remain at a level around two meters below the surface (Stromberg et al. 1996). If groundwater falls below that level, then the plants begin to get stressed and drop their leaves to conserve water. If the plants continue to have limited access to groundwater, extensive vegetation mortality can result.

See what we're doing to monitor plant stress

The amount of water discharged by the NIWTP will likely be further reduced in the near future. This reduction, combined with the ongoing drought and changes to the stream water/groundwater interaction, will mean further changes in the ecology of the aquatic and riparian systems of Tumacácori NHP. Ecologists can't predict exactly what those changes will look like, but with a continued reduction in river flow, the system may eventually resemble the pre-1951 river, with new animal and plant communities responding to the less-reliable availability of surface and groundwater. Intermittent flow, dependent on precipitation events, may create microhabitats for a number of fish and other taxa. The cottonwood gallery forest may become interspersed with mesquite woodland or vegetation communities more typical of the drier adjoining uplands. What does seem certain is that the natural systems of Tumacácori NHP are about to enter a new phase of anthropogenic change.

—Evan Gwilliam, Aquatic Ecologist
—Alice Wondrak Biel, Writer-Editor

Read more at http://go.nps.gov/DrySC

Works Cited

Prichard, H. A., and C. A. Scott. 2013. Interbasin water transfers at the U.S.–Mexico border city of Nogales, Sonora: Implications for aquifers and water security. International Journal of Water Resources Development, February 20. http://www.tandfonline.com/doi/abs/10.1080/07900627.2012.755597.

Stromberg, J. C., R. Tiller, and B. Richter. 1996. Effects of groundwater decline on riparian vegetation of semiarid regions: The San Pedro, Arizona. Ecological Applications 6(1):113–131.

Project Updates

Continued from page 2

due to the impacts of federal budget sequestration. Fish sampling was completed at Tumacácori and Pecos NHPs. Repairs to the stream gages at Gila Cliff Dwellings and Montezuma Castle NMs have proven challenging. Work to fine-tune the results will continue. Streams monitoring briefs have been published for for Gila Cliff Dwellings, Montezuma Castle, and Tuzigoot NMs and Tumacácori NHP.

In the next few months, we will complete scheduled monitoring in SWNC parks, as well as channel morphology sampling at Montezuma Castle NM (Beaver Creek). As the first revisit for the Streams Protocol, this trip will provide an opportunity for us to assess methods and results.

Uplands

Data entry, quality-checking, and reporting have been the focus since December. We conducted the first year of re-sampling at four park units in 2013, which has been followed by changes to data analysis methods (e.g., toward trends) and database structure.

Vegetation Mapping

The Fort Bowie NHS vegetation inventory report has been published. Spatial products are under review, soon to be available online. Several other inventory efforts are in the final stages, with accuracy assessment, the final field-based phase, scheduled for Coronado NMem and Montezuma Castle NM during this calendar year. Accuracy assessment for Gila Cliff Dwellings NM was finalized in November. We have moved into the final phase of reporting and product development for that park. Field work was initiated at Saguaro NP (East) this past spring, and classification data were collected at over 160 sites throughout the park. These data have been analyzed, giving us our first drafts of community types. Work will continue at both units of Saguaro NP this year.

Washes

A cooperative study of indirect stream gaging methods and modeling effforts with U.S. Geological Survey research hydrologist Dr. Laura Norman has been completed. In the next few months, we plan to expand our work with Dr. Norman to include watershed modeling in Chiricahua NM—as part of a study looking at the impact of fire on ephemeral streams—and at Saguaro NP (with park biologist Don Swann), modeling watershed dynamics in the Rincon Mountains.

Where Are We?

Here's what we have planned for February–May 2014 (subject to change).

Park	February	March	April	May
BIBE[1]		**Uplands:** Mar 12–19, Mar 26–Apr 2		
CAVE[1]			**Uplands:** Apr 9–16	
CORO		**Vegetation Mapping:** Mar 26–Apr 2, Apr 9–16, Apr 23–30		
SAGE	**Vegetation Mapping:** Feb 26–Mar 5			
TUMA	**Streams:** Quarterly sampling, Feb 13			**Streams:** Quarterly sampling and macroinvertebrates, May 20
MOCC	**Streams:** Quarterly sampling, gage work, Feb 18–20			**Streams:** Quarterly sampling and macroinvertebrates, May 25–29
MOWE		**Streams:** Sonde retrieval, Mar 5		
TUZI				
GICL	**Streams:** Quarterly sampling, Feb 3–6	**Streams:** Gage repair	**Streams:** Possible channel survey, sonde deployment, and & training, Apr 14–23	**Streams:** Quarterly sampling and macros, May 4–8
BEOL[2]				
PECO[2]				

[1] Chihuahuan Desert Network parks: BIBE=Big Bend National Park, CAVE=Carlsbad Caverns National Park

[2] Southern Plains Network parks: PECO=Pecos National Historical Park, BEOL=Bent's Old Fort National Historic Site

Acronyms for SODN parks are shown in the box below.

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The Heliograph is a publication of the Sonoran Desert Inventory & Monitoring Network.

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Sonoran Desert Network Park Units

Casa Grande Ruins NM (CAGR)
Chiricahua NM (CHIR)
Coronado NMem (CORO)
Fort Bowie NHS (FOBO)
Gila Cliff Dwellings NM (GICL)
Montezuma Castle NM (MOCA)
Castle unit (MOCC)
Well unit (MOWE)
Organ Pipe Cactus NM (ORPI)
Saguaro NP (SAGU)
East (SAGE)
West (SAGW)
Tonto NM (TONT)
Tumacácori NHP (TUMA)
Tuzigoot NM (TUZI)

NM = National Monument
NMem = National Memorial
NHS = National Historic Site
NHP = National Historical Park