Inventory & Monitoring Program
National Park Service
US Department of the Interior

SONORAN DESERT NETWORK
Inventory and Monitoring Program

CASA GRANDE RUINS ✷ CHIRICAHUA ✷ CORONADO ✷ FORT BOWIE ✷ GILA CLIFF DWELLINGS ✷
MONTEZUMA CASTLE ✷ ORGAN PIPE CACTUS ✷ SAGUARO ✷ TONTO ✷ TUMACÁCORI ✷ TUZIGOOT

The Heliograph

Official Newsletter of the Sonoran Desert Network and Desert Research Learning Center

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Springs Monitoring Begins

Anyone who's spent time in the Sonoran Desert knows that water is its most precious resource—so it shouldn't come as a surprise that some of the most exciting work happening at the Sonoran Desert Network (SODN) this year is taking place at springs and tinajas. Starting at Organ Pipe Cactus National Monument in March, our springs crew has begun to implement the network's springs protocol, slated to eventually be done at nine of the 11 SODN parks.

Why get excited about springs monitoring? Two main reasons. One, because what we learn, and how we learn it, will be new. The spring and tinaja systems of southeast Arizona are more diverse and variable than most systems addressed in traditional scientific literature about springs and streams monitoring. As a result, we are developing our own methods for measuring tank (e.g., tinaja) systems, with help from Saguaro NP staff. Two, this work provides an unusual opportunity for us to collect data that will be directly used by interpreters and park visitors, in addition to resource managers.

The Challenge

For the most part, SODN springs monitoring (see box, p. 4) follows a protocol based on work done in the Mojave, Sonoran, and Chihuahuan deserts and on the Colorado Plateau. Other NPS Inventory & Monitoring (I&M) networks primarily survey rheocrene springs (flowing springs that emerge into stream channels) and hanging gardens. But in southeast Arizona, particularly at Saguaro NP and Organ Pipe Cactus NM, perennial surface water often takes the form of tinajas—pools situated in bedrock. These structural differences make it difficult to measure the wetted extent and depth of a tinaja using traditional methods.

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Sonoran Desert Network Project Updates

Air Quality

Due to vast improvements in the content and usability of the National Park Service Air Resources Division website, SODN no longer plans to do regular reporting on air quality. For details, see our new air quality monitoring brief.

Climate

With support from park staff and a U.S. Forest Service fire crew, we replaced the weather station on Repeater Ridge at Tonto NM this spring. Also, several enhancements have been added to the Sonoran Desert page of The Climate Analyzer, including data feeds from research-grade climate stations (formerly operated by NOAA) at Casa Grande Ruins NM, Chiricahua NM, Organ Pipe Cactus NM, and Montezuma Castle NM.

Data Management

Collection of field data for the landbirds and springs protocols is underway. Assistance with iNaturalist guides was provided to Saguaro NP. The park will use the guides for their yearlong Schoolyard Bioblitz. Data management staff are also providing support for the wildlife camera project and preparing for the next season of uplands monitoring.

Groundwater

In March, the regional hydrologist worked with a University of Arizona PhD student to collect groundwater samples at seven wells in Organ Pipe Cactus NM. These samples will be analyzed for isotopes and basic water quality. She also met with Arizona Department of Water Resources (ADWR) staff and surveyed wells at Coronado NMem. In April, the hydrologist met with staff from the Chihuahuan Desert Network and Guadalupe Mountains NP for training in groundwater field methods, data processing, and database operations. With staff from the ADWR and Chiricahua NM, she is currently working toward the installation (by ADWR) of a real-time, automated water-level monitoring station at Faraway Ranch. This station would be similar to the installation already in place near Santa Gertrudis Lane at Tumacácori NHP. A previously unknown well at Saguaro NP's Rincon Mountain District was discovered by park archeologist Ron Beckwith, not far from the SODN offices. This well, and several wells at properties recently added to the park, will be investigated in the coming weeks.

Springs

SODN springs monitoring was initiated at Tonto NM in April (see cover article). Subsequent monitoring was completed at Organ Pipe Cactus NM, Chiricahua NM, Coronado NMem, and Fort Bowie NHS. The crew will monitor springs and tinajas at Saguaro NP in May/June, and at Montezuma Castle (both units), Tuzigoot NM, and Gila Cliff Dwellings NM in July.

Streams

The SODN streams crew continued to collect quarterly water quality data over the last few months. Through our SWNC partnerships, we have been training the new biologist at Pecos NHP to deploy water quality monitoring equipment and collect water samples at that park and at Bent's Old Fort NHS in the future. This will reduce the amount of travel required of SODN staff and increase the capacity of Pecos and Bent's Old Fort to achieve park goals. Through an Inventory & Monitoring (I&M) staff-exchange initiative, SODN sent aquatic technician Laura Palacios to Glen Canyon National Recreation Area, where she collected water quality samples in remote backcountry canyons. This first exchange was a success and we look forward to working with our I&M partners. The first revisit of the riparian vegetation monitoring module of the streams protocol is occurring in June and July. This vitally important dataset will not only detect change in the riparian plant community at Pecos NHP, but also allow staff to fine-tune riparian vegetation monitoring across the SWNC parks.

Uplands

The most recent field season for uplands monitoring has ended. Status reports for Organ Pipe Cactus NM and Tumacácori NHP are being drafted.

Vegetation Mapping

Accuracy assessment is underway at Coronado NMem; completion is expected by the end of May. Other work is focused on finalizing the map for Saguaro NP (TMD), and on remote-sensing and classification processes and reporting for Saguaro NP (RMD).

National Park Service
US Department of the Interior

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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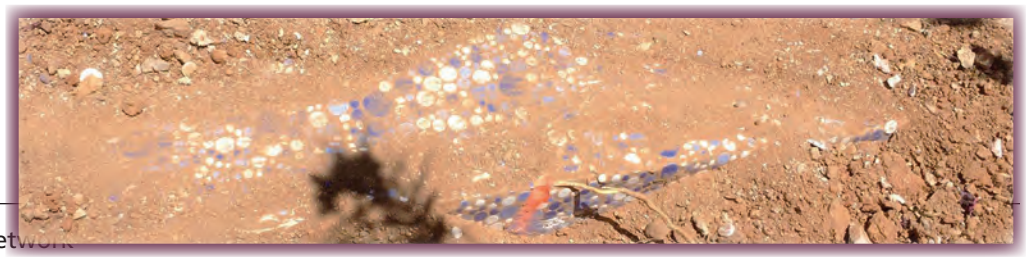
What's been unearthed in the DRLC courtyard? Look for the matching pattern on page 7.



At the Desert Research Learning Center

Loop Trail

In February, volunteers from the University of Arizona Environmental Awareness Society finished formalizing a 1.5-km loop trail on the Desert Research Learning Center (DRLC) grounds. The project was started by 60 students from Salpointe Catholic High School, with supervision by SODN staff and assistance from the Ironwood Tree Experience. The trail provides access to the entire 40-acre property, including saguaro monitoring sites and plots where SODN staff are trained in monitoring procedures. The goal of the project is to concentrate foot traffic on the trail when large groups head out for activities, minimizing impacts to plants and soils. Guided by Leave No Trace principles, project volunteers used wheelbarrows and the strength of their arms and legs to outline the trail with 12 tons of local Catalina rock.

Environmental Movie Night

In April, the DRLC hosted a movie night and potluck for the University of Arizona Environmental Awareness Society (ENVAS), which has regularly volunteered at the DRLC during the past fall and spring. We watched the documentary "Climate Refugees," then had a group discussion about climate change, ways to reduce individual carbon footprints, and how to remain hopeful when confronted with the realities of climate change and mass extinction. Based on the success of this event, the DRLC and ENVAS hope to start a film series this coming fall. It would be open to the public.

Notch Neighborhood Lecture Series

Throughout the spring, the DRLC hosted a lecture series in which local professionals were brought in to discuss various topics pertaining to their experiences and the natural history of the Sonoran Desert. Presenters included biologists Don Swann and Nic Perkins (Saguaro National Park), fire and vegetation ecologists Perry Grissom and Sarah Studd (Saguaro National Park/Sonoran Desert Network), resource chief Roger Dorr (Tonto National Monument), and designer/contractor Dennis Caldwell. The "Notch Neighborhood" is the area of Tucson where the DRLC is located. This lecture series was open to the public. We expect to repeat the series again with new speakers and topics next winter, and will increase the scope and audience.

EMC students install wildlife cameras at Organ Pipe Cactus NM.

Wildlife Camera Project

Issue 5(1) of the Heliograph detailed our plans to deploy wildlife cameras at several SODN parks. This pilot project will help us to collect baseline data on mammals ranging in size from squirrels to bears, with the ultimate goal of tracking biologically significant changes at the community and population levels over time.

In March and April, the first 60 cameras were successfully deployed at Organ Pipe Cactus National Monument. Eighteen of them were emplaced by four high school students participating in a citizen science program sponsored by the DRLC and the Ironwood Tree Experience.

As part of the Eco-monitoring Corps (EMC), high school students from urban Tucson will place wildlife cameras in multiple southern Arizona park units, and data from the cameras will be analyzed. At Organ Pipe, the students also learned how to operate the cameras, navigate using GPS devices, utilize Arcmap/Arcpad software, and record field data. They will learn to identify mammals and reptiles from the photos, and each will complete an independent project.

This summer, EMC participants will retrieve the cameras from Organ Pipe Cactus NM, then work to deploy cameras at Saguaro NP and Chiricahua NM. They will also pilot-test similar camera traps at Tonto NM, where they will be targeted at reptiles instead of mammals. The students will be presented with awards at the Arizona Founder's Day celebration in Flagstaff on August 20–21.

—Elise Dillingham and Alice Wondrak Biel

Continued from Page 1

To measure the wetted extent of a rheocrene spring, one digs a series of small divots out from the water's edge. If water pools in a divot, then that divot is still within the wetted extent. When no water pools in a divot, then the edge of the wetted extent has been reached, because at that point there is no permeable groundwater at the surface.

Of course, you can't dig divots into bedrock. More importantly, pools can change in length, width, and also depth—a metric that's not currently included in the protocol. So one objective of this year's monitoring is to test different methods for measuring the wetted extent and depth (and, ideally, sediment depth) of tinajas. The ultimate goal will be to implement a systematic way to account for all of these metrics, resulting in a rough (but accurate) water-volume calculation that can track changes to pool systems and be comparable over time.

The SODN crew is taking a complementary approach to monitoring water persistence (i.e., how long there is water in a spring or tinaja). A temperature logger is attached to two cables, each with a sensor at the end. One cable is suspended from a piece of hanging vegetation; this sensor measures air temperature. The other cable is submerged in the water. Crews have been deploying the water sensors in the deepest section of a pool for tinajas, and as near the orifice as possible in rheocrene systems. The loggers record temperature every two hours.

Water persistence is determined by comparing the range of variability in the two datasets. Air temperature in SODN parks tends to vary by about 40°F each day, while water temperature varies only 10–20°F. When the range of variability shown by the water sensor approaches or matches that of the air sensor, then the water is shown to no longer persist; the spring is dry.

The Opportunity

Knowing how long surface water is available at a site—or if water is present at all—can help park interpreters to give sound advice to visitors planning trips into the backcountry. Due in part to limited resources, SODN decided not to employ a randomized approach to springs sampling. Instead, we worked with park staff to identify sites of high management priority. At Saguaro NP, this meant including springs near three campgrounds (Happy Valley, Juniper Basin, and Douglas Springs). Information we collect about the state of these springs will be passed on to park interpreters so visitors can know what to expect when they arrive. In monitoring completed at four other parks this spring (Organ Pipe Cactus NM, Chiricahua NM, Coronado NMem, and Fort Bowie NHS), the crew found several springs that were dry. The crew plans to monitor springs and tinajas at Saguaro NP in May/June, and at Montezuma Castle (both units), Tuzigoot NM, and Gila Cliff Dwellings NM in July. Cave Dweller Spring, at Tonto NM, was sampled in April.

—Greg Goodrum, Alice Wondrak Biel, and Cheryl McIntyre

Measuring wetted extent at Apache Spring, Fort Bowie NHS.

Hanging the air-temperature sensor.

How do you monitor a spring?

SODN springs monitoring measures four primary metrics: site characterization, site condition, water quality, and water quantity. These metrics tell park managers about the quality of the water and how much (and for how long) surface water is at a site.

Site characterization: Observers draw a site diagram, document sampling locations with GPS points and photographs, and describe the spring system.

Site condition: The crew assigns a numerical value to the level of disturbance found and describes the vegetation community and wildlife.

Water quality: A multiparameter probe is placed in the water to record temperature, specific conductivity, dissolved oxygen, and pH. Sample bottles are also collected. These are taken back to a laboratory area and examined with a photospectrometer to determine levels of calcium hardness, alkalinity, chloride, sulfate, and magnesium content.

Water quantity: In addition to deploying temperature sensors to estimate persistence, the crew measures discharge, attempts to determine the wetted extent (see main article) and the depth of the spring's surface detritus, and measures substrate.

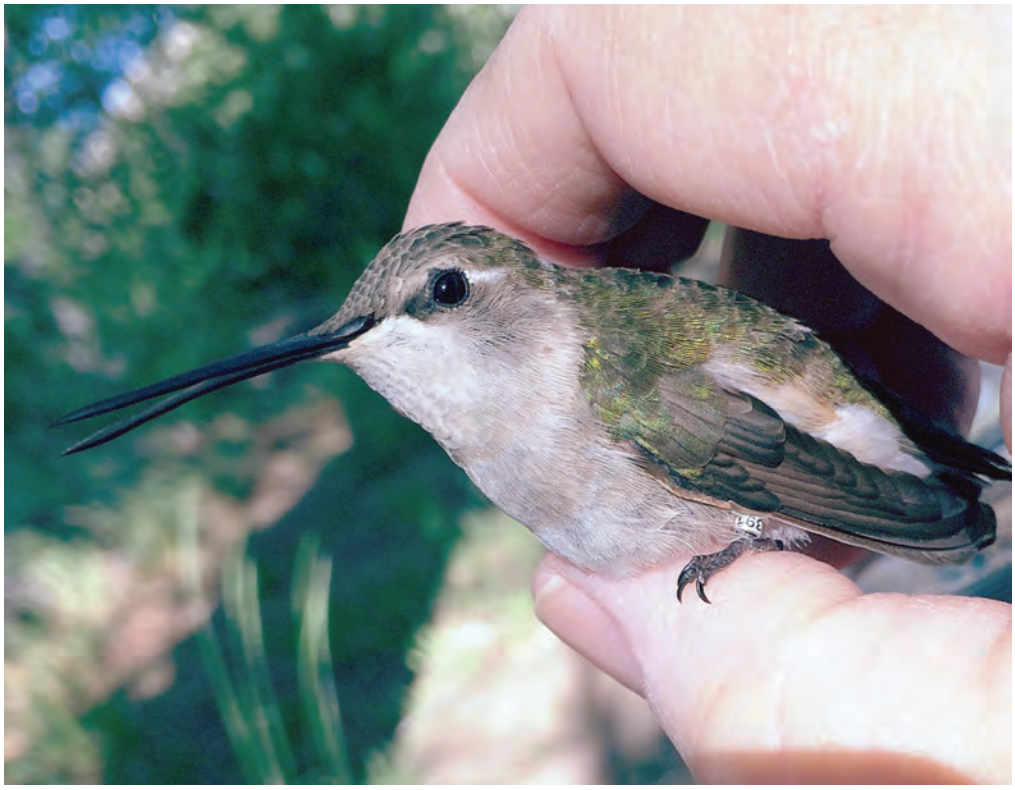
Around the Network:
Resource Management Highlights

If you'd like to be featured in Around the Network, please contact Elise Dillingham or Alice Wondrak Biel.

Montezuma Castle NM: Hummingbird Banding

National Park Service biologists use many different tools to track wildlife movement patterns. We put collars on grizzly bears, wolves, and mountain goats. We attach telemetry tags to fish. And we place bands on the legs of raptors and other birds. But can you imagine trying to band the leg of a hummingbird?

Montezuma Castle National Monument recently partnered with the Hummingbird Monitoring Network (HMN) to establish a hummingbird banding station in the park. There are about 25 banding stations in the western U.S., Canada, and Mexico affiliated with HMN. The first banding session at the park was on April 26. Banding will take place every other Tuesday through September. Of the 32 hummingbirds banded at the first session, 30 were black-chinned and 2 were Anna's hummingbirds.



Female black-chinned hummingbird with a tiny band visible on its left leg.
Photo by volunteer Ann Burkhart

In order to capture these tiny birds, we place a Hall trap, which is a drop trap made of mesh, over a hummingbird feeder, then drop it once a bird sits on the feeder. We place the bird in a small mesh bag and take it to the banding table. The bag helps to keep the birds still while they are being banded. Using a special pair of pliers, the bander carefully attaches a tiny band to the hummingbird's leg. Each band has a unique, six-digit code. The bands are generally around 6 mm in length. The bird is then removed from the bag and measurements are taken, depending on the sex and species.

For all birds, we measure culmen (bill) length and wing chord (length from the most prominent point of the wrist joint to the most prominent point of the longest primary feather). We also check for molt or feather wear, as well as pollen. If a bird is molting, we note which feathers on the wing and/or tail are molting. Pollen is recorded because it's possible to look at these data and figure out which flowers the birds are using based on what is blooming at the time. Figuring out which plant species each hummingbird species prefers could help with conservation efforts. We also check the amount of fat on each bird because hummingbirds need lots of energy for migration. It's possible to see the reservoir of stored fat by blowing on the bird's neck with a straw. We check breeding status in females and look for signs that they are about to lay an egg. All birds are then weighed, fed, and released.

If a bird that was banded at our site is recaptured at another site, observers there will take all the same measurements. All the information is put into a database and our banding site is notified if one of our banded birds is captured at another site. In southern Arizona, two birds that were banded eight years ago were recently recaptured. It's also possible that next year, we'll capture birds that we banded this year.

Much is being learned about migration patterns through this program. Data collected at banding stations will also help us to learn more about hummingbird survivorship, distribution, abundance, and movement patterns. There is still much we don't know about these incredible birds.

For more information, contact Tima Greenawalt at tina_greenawalt@nps.gov.

What's it like to handle a hummingbird?

"We follow a very strict protocol to prevent injury or stress to the birds. In fact, at the start of our training for handling, we practiced by placing bands on toothpicks. When I first handled a hummingbird I was very afraid of squashing it, but once you learn the proper technique it's pretty easy to handle them without harming them. The birds are held in a certain position, called the bander's grip, which allows us to take the measurements."

—Tina Greenawalt

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Tumacácori NHP: Mission Guevavi Preservation Meeting

Tumacácori National Historical Park recently hosted an interdisciplinary discussion to decide on an alternative treatment for the oldest surviving above-ground adobe walls in Arizona: the ruin of a Jesuit-era Spanish colonial mission at the park's Guevavi unit. Park staff from the divisions of interpretation, maintenance, and resource management joined Intermountain Region specialists in archaeology, historic preservation, cultural landscape, and climate change. Retired park maintenance chiefs and professors from several universities also contributed.

Existing treatments have delayed loss to the walls, but there is a need to improve our intervention efforts and to reflect multiple values of this archeologically outstanding site. Due to surface erosion and fracturing of adobes and earthen bedding mortar, the monumental earthen walls are disappearing. Unlike Tumacácori's other two units (Calabazas and Tumacácori), the Guevavi unit maintains a stunning vista of the surrounding undeveloped landscape of both the U.S. and Mexico. The remaining earthen walls serve as an anchor in that landscape.

The oldest surviving above-ground adobe walls in Arizona are at the Guevavi unit, Tumacácori NHP.

A site visit was followed by a review of alternative options for protecting the wall tops and faces. Included in the options was "no action:" total abandonment of the ruin walls except for monitoring. That option was considered and soon discarded, along with the most heavy-handed approach of total restoration to a specific era. The group reviewed the potential impacts of these and other options on four main areas: fabric (materials), form (mass, design), landscape, and maintenance. In the end, the participants agreed to protect the walls with a combination of adobe cap and sacrificial earthen coats; we will cap the wall top with adobes and apply layers of earthen plaster to the wall faces. A monitoring protocol will be established to measure the effectiveness of this approach. The group agreed that the approach is minimally invasive to the experience of the landscape and the study of buried archaeological resources. At the same time, it will provide sustainable and flexible protection for the remaining ruin walls against the environment.

The group discussion, rare in its scope and comprehensiveness (by engaging all levels of NPS operations), yielded a positive response from all participants.

For more information, contact Alex B. Lim at alex_lim@nps.gov.

Arrivals and Departures

There has been no turnover for permanent or term SODN staff. However, there has been lots of movement among our highly valued intern staff. **MATT CHRISTENSEN** has transitioned into a new position with the Tucson Audubon Society, and is working with SODN on the wildlife cameras project. **ANNIE JACOBS** has also moved to a position with Tucson Audubon, in a data management role. New NextGen Rangers are **JANELLE GAUN** (Springs and Streams), **ETHAN SANDOVAL** (Vegetation Mapping), and **NICOLE GONZALEZ** (Vegetation Mapping). DRLC interns (with Tucson Audubon) are **MELANIE JONES** and **JESSICA MCCLOSKEY** (both on wildlife cameras).

Bienvenidos to **MIKE HOLT**, new chief of resources for the NPS Southeast Arizona Group (Chiricahua NM, Fort Bowie NHS, and Coronado NMem). Michael comes to us from the Western Arctic National Parklands (Bering Land Bridge National Preserve, Cape Krusenstern NM, Kobuk Valley NP, and Noatak National Preserve), where he served as Chief of Cultural Resources/Senior Archeologist. Welcome to the Sonoran Desert, Mike!

New SEAZ resource chief Mike Holt has traded Arctic snowfields for desert sands.

The Living Stream

In the Sonoran Desert, perennial streams are rare. Aquatic vertebrates in those streams are even rarer. And threatened and endangered fish populations in those waters . . . well, you get the idea. So when we looked out at the Desert Research Learning Center (DRLC)'s tinaja area and envisioned an opportunity to help conserve Sonoran Desert fish species and teach others about their importance to fragile desert ecosystems, we decided to make it happen.

Through the power of partnerships, volunteers, and a lot of hard, hot work under the desert sun, much of the DRLC grounds have already been transformed into a haven for local plants and animals. We've featured stories on our artificial tinaja, heritage orchard, and native plantings in previous issues of the Heliograph. Our latest project is a perfect complement to those.

Ground was recently broken on a living-stream habitat that will flow through the tinaja area of the DRLC. Supported by a $10,000 grant from the Arizona Game and Fish Department (AGFD), the living stream will be built within the decommisioned pool and fed by harvested rainwater. A simple pump system will provide gentle flow and ensure that the shallow "stream" is sufficiently aerated for the endangered fish. This project will provide habitat for an additional three threatened, endangered, or protected Sonoran Desert species. (The tinaja is already home to a small population of lowland leopard frogs—and at least one itinerant Gila monster who desperately wants to eat them.)

The flowing water will provide a refuge for three species of endangered fish: Gila topminnow, speckled dace, and the desert sucker. The fish from the living stream can then be used as "backup" populations and source populations for restoration efforts by the AGFD, National Park Service, and others. The stream will also add complexity to the existing habitat and create a unique educational opportunity for Tucson students, residents, and visitors. Interpretive materials and signage will tell the story of aquatic systems in the Sonoran Desert, and the impacts of water loss on fish and other threatened native species.

Designer Dennis Caldwell, who helped create the DRLC's tinaja, will oversee the stream's design and technical aspects of its installation, along with the interpretive materials. We expect to accomplish most of the project's construction with the help of students and volunteers through our existing partnerships with local schools and organizations, with guidance from National Park Service staff. Saguaro National Park wildlife biologist Don Swann will consult on aspects of habitat design and wildlife management.

Completion of this project is expected by the end of summer 2016.

—Alice Wondrak Biel and Andy Hubbard

Initial work on the stream channel, which is within an old swimming pool.
Inset: To allow streamflow, a gap had to be knocked into the wall of the decommissioned pool.

Where Are We?

Park	June	July	August
CHIR		**Wildlife cameras:** Deployment (10–15)	**Wildlife cameras:** Retrieval (14–19)
GICL	**Streams/Springs:** Sonde deployment and springs sampling (27–29)	**Streams/Springs:** Sonde retrieval and springs sampling (18–20)	**Streams:** Quarterly sampling (8–11)
MOCA/ TUZI		**Streams/Springs:** Sonde and springs sampling (4–6)	**Streams:** Quarterly sampling (23–24)
ORPI	**Wildlife cameras:** Retrieve (13–17)		
SAGE	**Springs:** Day trips (1–2), Happy Valley (7–9), Manning Camp (14–22) **Wildlife cameras:** Deploy/retrieve (TBD)	**Wildlife cameras:** Deploy/retrieve (TBD)	
	Vegetation mapping (TBD)		
SAGW	**Vegetation mapping** (TBD)		
TONT	**Wildlife cameras:** Deployment (27–30)	**Wildlife cameras:** Deployment (27–29)	**Wildlife cameras:** Retrieval (26–29)
TUMA			**Streams:** Quarterly sampling (18)
BEOL[1]			**Streams:** Quarterly sampling (8–11)
CAVO[1]			**Streams:** Quarterly sampling (8–11)
PECO[1]	**Streams/Springs:** Sonde deployment and springs (27–29)	**Streams/Springs:** Sonde retrieval (18–20)	**Streams:** Quarterly sampling (8–11)
	Riparian vegetation: June 29–July 7		

[1] Southern Plains Network park. BEOL: Bent's Old Fort NHS, CAVO: Capulin Volcano NM, PECO: Pecos NHP
Acronyms for SODN parks are shown in the box below.

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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)
Rincon Mtn District (RMD)
Tucson Mtn District (TMD)
Tonto NM (TONT)
Tumacácori NHP (TUMA)
Tuzigoot NM (TUZI)

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

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