



Sonoran Desert Heliograph

Quarterly Newsletter of the Sonoran Desert Network



Rethinking Regional Floristics

Vegetation Mapping and the *Flora of the Sonoran Desert Network*

ALDO LEOPOLD famously wrote, in *A Sand County Almanac*, of not throwing away the pieces as we tinker with the planet. His sentiment rings remarkably true today, given our state of endless tinkering. But how do we know which pieces are important? The National Park Service Inventory & Monitoring Program is striving to answer this question by researching many of the pieces that make up our national parks. The 32 I&M networks across the country are the scientific eyes and ears of the NPS, collecting and analyzing data to help guide management of our natural treasures.

One piece the I&M networks are studying is the flora, or composition of plants in a given park. By definition, a flora depends on the collection of plant specimens to identify and document each plant's existence in that location. At the Sonoran Desert Network (SODN), we have embarked on a comprehensive program to identify and document park flora in order to establish baseline knowl-

edge of floristic biodiversity in network parks. This program has two components: the network's vegetation mapping program and the creation of a series of field guides, collectively titled the *Flora of the Sonoran Desert Network*.

The *Flora of the Sonoran Desert Network* project emerged from the SODN vegetation mapping program. One of the 12 basic I&M inventories, the USGS-NPS Vegetation Mapping Program is a cooperative effort by the U.S. Geological Survey/Biological Resources Discipline (USGS/BRD) and the NPS to classify, describe, and map vegetation communities in more than 270 national park units across the U.S. In the early stages of this mapping effort, SODN staff recognized that critical gaps existed in the floras of all 11 network units. Precisely knowing which plants do or do not exist in SODN parks is critical to the network's monitoring efforts, because correctly identifying plants is essential to recognizing changes in the system.

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Starting with the species lists developed in initial inventory efforts, we first verified all known collection records. Twenty years ago, this would have meant hundreds of hours of painstaking effort sifting through herbarium sheets, but the rise of digital herbarium databases over the last decade has vastly improved our ability to sort through tens of thousands of specimen records and compile complete data in a relatively short time. After we verified these records against the species lists, we had a list of species that had been observed, but not documented.

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Message from the Program Manager

After a hiatus, the Sonoran Desert Network (SODN) newsletter returns for Fall 2010—as do I, from a detail as the Greater Yellowstone Network Program Manager. While I was enjoying the brief summer of the Northern Rockies, the SODN staff was hard at work completing an inventory of seeps and springs in network parks, conducting integrated streams monitoring at several units, and continuing vegetation mapping and classification efforts at several units. In short, SODN had a great and productive summer despite—or was it because?—the boss wasn't around.

For the fall, we'll continue to implement the annual terrestrial vegetation and soils monitoring, pilot a new ecotonal vegetation effort associated with the climate change monitoring initiative, and proceed with routine streams and groundwater monitoring. Working with WASO and park staff, we're piloting a landscape dynamics protocol at Saguaro NP using the new NPScape data sets, and will be swinging into Natural Resource Condition Assessments at Montezuma Castle NM, Tuzigoot NM, Tumacácori NHP, Tonto NM, and Gila Cliff Dwellings NM. We hope you enjoy this newsletter and look forward to keeping you updated in the future!

—Andy Hubbard



Arrivals and Departures



LESLIE AILLS joined the I&M Program in March. In the classic I&M spirit of cooperation, Leslie's an administrative assistant who performs QuickTime, GovTrip, and other specific duties for SODN and four other networks (Chihuahuan Desert, Southern Plains, Rocky Mountain, and Greater Yellowstone). Leslie came to Tucson from Kenai, Alaska, where she was an office assistant for the State of Alaska, Division of Forestry, Kenai-Kodiak Area Office.

STEP Clerk and jack-of-all-trades **ALBERT CASELLA** started with SODN on a contract basis last December, and became an NPS employee in February 2010. Albert is a sophomore at the University of Arizona, majoring in sociological anthropology. For more about Albert, see http://science.nature.nps.gov/im/units/sodn/bio_albert.cfm.

KARA RAYMOND joined SODN in July 2010 as a permanent, full-time hydrologic technician for the Streams project. Prior to her arrival in Tucson, Kara was the water quality administrator for ECO (Environmental & Conservation Organization), a small non-profit in based western North Carolina.

Biological Science Technician **DANIEL WINKLER** has been with SODN since January, working primarily on vegetation mapping but helping out with other projects (Streams and Uplands) as needed. Daniel is on a STEP appointment. Learn more about Daniel at http://science.nature.nps.gov/im/units/sodn/bio_danielw.cfm.

SODN bid farewell to Biological Science Technician **JEFF BALMAT** in July. Jeff is now a permanent hydrologic technician with the U.S. Geological Survey in Tucson.

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New on the Web!

Check out the network's web site for new staff profiles, a new vegetation mapping page, an improved reports & publications page, and a series of monitoring briefs on air quality in SODN parks!

Subscribe to our RSS feed to easily see when new reports, podcasts, or features are added to the site. From the SODN home page, click on "SODN RSS Feed" in the left-hand column. After the feed pops up, click on "Subscribe to this feed" at the top of the page.

To check the feed (to see if there's anything new), click on the *star* Favorites tab just to the left of your left-most Internet Explorer tab, then click on the feed name.

The feed works in Internet Explorer 8, Safari, and Firefox, but not in Google Chrome.

<http://science.nature.nps.gov/im/units/sodn/>

Project Updates

Exotic Plants

In late April, network staff met with our counterparts from the Southern Plains network (SOPN) to conduct some pilot field work for exotic plant early detection and rapid response. All parks in both networks have identified exotic invasive plants as a high priority, yet monitoring can be expensive and time-consuming to implement. SODN has therefore been eager to determine an efficient, repeatable, useful way to provide parks with information on exotic plant abundance and distribution. We decided to adopt the SOPN protocol, which utilizes a linear sampling scheme, wherein vectors that have a high invasion probability, such as roads, trails and riparian corridors, are surveyed using a rapid assessment method. The sampling is conducted from the vector edge, within 50-meter "blocks," with the observer recording species present in the block using five distance and density classes. The method is designed to cover long distances in relatively short amounts of time and to provide manag-



Red brome (*Bromus rubens*), Tonto National Monument.

ers (or EPMTs) with information on locations and densities of species that can then be aggressively and rapidly treated. The sampling blocks are recorded using GPS enabling spatial representation and will be repeated on a 2–3-year basis. We anticipate implementing this protocol at several parks next spring.

Groundwater

Groundwater monitoring is continuing at Fort Bowie NHS, Chiricahua NM, and Coronado NMem. At Coronado NM, an additional monitoring location at the recently installed supply well adjacent to the park water storage tank was added at the park's request. This monitoring location will provide data needed to determine if groundwater supplies to the new well will be sufficient to fulfill park needs sustainably into the future, without supplement from the historical supply well in Montezuma Canyon. Updates of groundwater status at these three parks will be included in hydrological summaries being developed for an ongoing Natural Resource Condition Assessment report for the Southeast Arizona parks. On another front, Mark Jacobson is compiling metadata for SODN wells. The metadata were identified by an interagency group as critical elements for sharing of groundwater level data. Mark will also be updating the SODN groundwater database with a backlog of manual water-level measurements from the 2010 water year. Lastly, Kara Ray-

mond has received hands-on training in field methods for measuring water levels in wells and downloading the most common water-level monitoring instrumentation used at SODN. With the end of the 2010 SODN water year coming up September 30, efforts are underway to update records and prepare for end of year reporting of groundwater status.

Landbirds

Annual landbird monitoring occurred in all SODN parks this year and is now a joint effort between SODN and the Southern Plains Network, with data management assistance provided by the Rocky Mountain Bird Observatory. The 2009 annual landbirds monitoring report is currently being reviewed.



U.S. FISH AND WILDLIFE SERVICE/RYAN HAGERTY

The northern mockingbird (*Mimus polyglottos*) was the most commonly detected species at Fort Bowie NHS in 2009.

Natural Resource Condition Assessments

The search for relevant information for the Montezuma Castle/Tuzigoot NM NRCA is complete, but some document scanning remains to be completed. The scoping meeting for Tumacácori NHP was held, and the management area maps are complete; the information search will begin next month. We

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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.

Staff profile: Steve Buckley



Sonoran Desert Network botanist Steve Buckley was born and raised in Flagstaff, Arizona, where he earned three degrees from Northern Arizona University before moving to Tucson to further his education and join the network in 2008.

Steve is currently a STEP employee through the University of Arizona, where he is pursuing his doctorate in Natural Resource Studies. Steve provides support to SODN's vegetation mapping effort by identifying, verifying, and archiving plant specimens, and is compiling a series of plant field guides for the desert southwest, designed for use by network and park staff and, ultimately, the public.

Steve took a generalist, rather than a specialist, route to his current position. His education was largely one of arts and letters when he started working for NAU's Ecological Restoration Institute in 2001. That summer, he became an apprentice field botanist under the tutelage of a friend from ERI's forest research program. After taking some botany courses during the next school year, he returned to ERI the following summer as a field botanist. Drawing on his background in English, Steve also wrote and edited field guides for ERI. The constant repetition of plant systematics required by that position helped to solidify Steve's botanic expertise.

Steve hiked hundreds of miles in the Grand Canyon while growing up in Flagstaff, and getting out into the field is still his favorite part of the job. "The

search," he muses, "is really fascinating. Finding something new or something that hasn't been documented—that, to me, is really the most exciting part of what we do."

At Saguaro NP last season, SODN staff found a plant (*Senecio parryi*, mountain ragwort) that had never before been documented in that range. Days like that are why

Steve loves to be out in the parks looking for plants—and getting to return the following season—more than anything else.



"Finding something new or something that hasn't been documented—that, to me, is really the most exciting part of what we do."

Steve's outside interests include hiking, traveling, gardening (he'd like to have his own farm and orchard someday), and strawbale home-building, an avocation at which he apprenticed for a year. His wife, Natasha, is a program coordinator for the University of Arizona Press, managing a Mellon Foundation grant that encourages the publication of works on indigenous studies and indigenous people. They share their home with Mona, a lab-cross.

Strawbale construction is a green building technique that offers superior insulation value. For instance, the insulation value (measured in R) for each inch of brick is typically 1. Each inch of strawbale construction has an R value of 3, multiplied by a wall thickness of approximately two feet. Strawbale construction requires a high level of technical competence on the part of the builder in order to avoid common pitfalls, such as mold growing within the walls.

After he earns his PhD, Steve eventually hopes to teach, but would first like to stay with the NPS for a while. As someone interested in patterns of plants across huge spatial scales, he finds the "expansive vision" of the I&M approach compelling, and his own role in that effort to be satisfying.

Forced to choose his favorite desert-southwest plant, Steve names *Macrosiphonia brachysiphon* (Huachuca Mountain rocktrumpet), which blooms only at night. "And the orchids. I love the orchids in the desert; they're so rare, and really neat."

—Alice Wondrak Biel



Left: Mountain ragwort (©Mrs. W.D. Bransford; Lady Bird Johnson Wildflower Center).

Right: Huachuca Mountain rocktrumpet (©Patrick J. Alexander).

Project Updates

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expect to hold scoping meetings for Tonto NM in mid-September and for Gila Cliff Dwellings NM in October. A records search at the Western Archeological and Conservation Center for Chiricahua NM/Fort Bowie NHS is almost complete, and scanning is underway.

Springs

During a recent conference of the Desert Landscape Conservation Cooperative (<http://www.doi.gov/what/edo/climate/strategy/Desert.cfm>), arid-land spring ecosystems were identified as susceptible to climate change. In response, SODN, in conjunction with the Chihuahuan Desert and Mojave Desert networks (CHDN and MOJN), conducted an inventory of network springs, using methods comparable to those used in other LLC management areas. More than 70 springs were visited in the SODN, and several more springs are scheduled for visits. Data from the SODN inventory, existing data from MOJN, and upcoming data from CHDN will be analyzed by the Desert Research Institute (<http://www.dri.edu>) and NPS staff. This regional comparison of springs will allow for an assessment of status of spring ecosystems, and provide information for designing a monitoring protocol that can examine trends in spring ecosystems at multiple scales.

Streams

The SODN Streams Monitoring Program is currently implementing most modules of the Streams Protocol, including sampling of core water-quality parameters (quarterly) at all sites; riparian vegetation at Montezuma Castle and Tuzigoots NMs; channel morphology at Montezuma Castle NM; continuous water quantity at Montezuma Castle and Gila Cliff Dwellings NMs; and benthic macroinvertebrates at three sites. Data from existing fish surveys were compiled during the past year. SODN will work with the Arizona and New Mexico state game and fish departments on future fish



Macroinvertebrate sampling.

surveys. SODN will implement streams monitoring in the Southern Plains Network starting this fall, as part of SODN's collaboration with the Southern Plains and Chihuahuan Desert networks.

Uplands

SODN uplands monitoring is now in its third full year of implementation, with long-term monitoring plots having been established at nine of the eleven network parks. Field work is conducted from July through December each year, with crews moving from park to park, aiming to capture the vegetation at peak phenology. This year we are implementing the protocol at one new park, Montezuma Castle NM. Plots are established in a rotating panel design at larger parks, such that a fifth of the total plots are sampled each year. After all plots have been sampled, a status report will be developed. At smaller parks, we are able to sample all plots in one year and then analyze the data to produce a status report. Later this year, status reports will be available for Fort Bowie NHS, Gila Cliff Dwellings NM, Casa Grande Ruins NM, and Tonto NM, with annual data summaries for the larger parks that are sampled annually.

Over the past year, SODN has been collaborating with the Chihuahuan Desert (CHDN) and Southern Plains networks to share protocols and expertise. In conjunction with the NPS fire program, the CHDN will pilot the SODN uplands protocol at three parks this year: Guadalupe Mountains, Big Bend, and Carlsbad Caverns. Field crews from SODN will visit Guadalupe Mountains NP for a week in August to assist with training and plot sampling.

Vegetation Mapping

In the early part of the year, vegetation mapping field work focused on the completion of mapping at Chiricahua NM. This large field effort took more than two years to complete, and now will enter a data-analysis and map-validation phase prior to accuracy assessment (another very large effort!). In the spring, the mapping team began to collect classification data from plots at Saguaro NP's Tucson Mountain District (TMD); approximately 130 plots were sampled over two months, and approximately one-third of the district's vegetation communities were mapped. Field work will begin at Coronado NMem in October, with the intent to complete all mapping and plot data collection before the crew returns to complete work at the TMD.

This year, with the help of Danielle Foster and Tina Thompson, the accuracy-assessment phase of the Fort Bowie NHS mapping project was completed! Preliminary results suggest that good accuracy was achieved, and final reporting and map production is underway. Tonto NM is slated for accuracy-assessment field work this coming October and November—look for us out on the hillslopes!

Washes

During the last year, we continued testing methods for examining channel morphology and riparian vegetation in SODN washes. Crews collected vegetation data at Organ Pipe NM, and an analysis examining the power of different methods to detect change in channel morphology and vegetation species abundance and frequency is underway. This information will guide further work in these important arid land systems. The recent NPS and DOI climate change initiative has provided a focus on ephemeral systems. Over the next several months, SODN staff will meet with partners from various federal, state, and academic agencies and organizations to develop an effective way to monitor these systems, and to integrate NPS data sets with those of other land management agencies to look at the impact of climate change at several spatial scales.

The Disappearing River: Recent Hydrologic Changes at Tumacácori NHP

Background

Perennial streams are critical to the ecological integrity of the Sonoran Desert. Human development and demands for water have decreased natural surface waters and threatened the abiotic and biotic resources they support. Therefore, monitoring is imperative to effective protection of streams and their aquatic ecosystems in SODN parks. This is especially true at Tumacácori NHP. The park is located in the riparian area of the Santa Cruz River, which originates in the United States, then flows south into Mexico, then back north across the border at Nogales. Approximately 1.6 km of the Santa Cruz River is included within the boundary of the Mission Unit of Tumacácori NHP and was historically a seasonally intermittent stream.

During the first half of the 20th century, land-use changes in the Santa Cruz valley resulted in a decrease in groundwater levels, and a subsequent dewatering of the river through infiltration (i.e., the water in the river seeping through the bed into the ground). Beginning in 1972, perennial flow was introduced to the Santa Cruz River from the Nogales International Wastewater Treatment Plant (NIWTP) near Rio Rico, Arizona, north of Tubac. The plant discharges roughly 15 million gallons of effluent into the Santa Cruz River each day. This includes the section of the river at Tumacácori NHP.

Although the plant provided a constant flow of water, the water quality was generally poor, characterized by high turbidity (i.e., light was not able to penetrate the water column), microbial pathogens, high ammonia levels, low dissolved-oxygen concentrations, and increased levels of toxic compounds, such as cadmium. The water quality made the aquatic portion of the river generally inhospitable to most animals and plants.

In early summer 2009, the NIWTP adopted a new effluent treatment process, greatly increasing the water quality. Turbidity was low, ammonia was nearly undetectable, dissolved-oxygen concentrations were high. The macroinvertebrate community became much more diverse and fish were noted to be returning to the Upper Santa Cruz.

Citizens and land managers were all very happy with the new water quality. Then, the water started to disappear . . .

The Situation

In summer 2010, it was noted by many along the Upper Santa Cruz that the stream was becoming intermittent—sections of the river were drying up during the day, then flowing again.

Baseflow levels at Tumacácori NHP are tied to the amount of groundwater pumping that occurs in the Upper Santa Cruz basin, and the amount of recharge during the summer monsoon and winter. But something else is happening, as well.

Over the approximately 37 years when increased nutrients were introduced to the system, localized, biologically active layers, called *schmutzdecke*, formed on the river bottom. These layers, composed of bacteria, fungi, other microorganisms, and fine organic and inorganic material, have poor permeability, and can be thought to have acted as an aqueduct, preventing infiltration even though the surrounding groundwater was at a lower elevation. With the improvements in water quality, the *schmutzdecke* is now dissipating, allowing more water to permeate the river bottom and thus reducing surface streamflow and recharging the water table.



In summer 2010, it was noted by many along the Upper Santa Cruz that the stream was becoming intermittent.

The Implications

The SODN Stream Monitoring Project relies on the U.S. Geological Survey (USGS) stream gage at Tubac, Arizona, to provide information on stream discharge. The system is currently undergoing a period of equilibration, as groundwater levels recover and clogging layers are broken down. This new flow regime is expected to impact the riparian vegetation, aquatic vegetation, macroinvertebrate communities, and channel morphology of the river segment, and it is vitally important for the SODN program to understand the new flow regime.

The Plan

Working with partners including the NPS, USGS, and Arizona Department of Water Resources, we plan to conduct discharge measurements at several stations on the Santa Cruz, install a series of shallow piezometers (to monitor water pressure) in the streambed, and install water-level loggers to monitor daily and seasonal water levels. The hope is to be able to establish a relationship with the USGS gage, and to be able to be confident in the data as it related to the discharge at Tumacácori NHP.

—Evan Gwilliam



Santa Cruz River, Tumacácori NHP.

Rethinking Regional Floristics

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SODN is working to bridge this gap on two different fronts. Initially, we research each species to verify whether it's possible for that plant to exist in the park. This includes not only an evaluation of each plant's distribution data based on all known collections, but also an extensive survey of the ecological literature to assess the likelihood of the plant's presence based on its life history and ecology.

Once the likelihood of a plant's presence is verified, we begin the search for a voucher specimen. SODN is actively collecting plants with the intention of documenting all species thought to exist in network parks. Our research thus far indicates that the network flora is composed of more than 2,700 plant species, subspecies, and varieties. These species come from around 130 families across 137 genera. Of these, we have collections for roughly 70% of all plants across all parks.

BEYOND THE PRIMARY floristic research, SODN is also producing field guides for each park in the network.

These field guides are intended to aid future research in the parks and be vital interpretive tools. The guides are written in technical botanical language, illustrated with color photographs, and include a variety of ecological and historical information that makes them useful to researchers, interpreters, managers, and the general public—especially anyone with an interest in botany. Ultimately, the network intends to produce 19 field guides: 12 park-specific guides (one for each park except Saguaro NP, which will get one for each of its two units), and 7 type-based, network-wide guides that together will cover all 2,700 species. SODN is also building databases of all plant species in the network. This information resource will be available through the Learning Center of the American Southwest. Our goal is to streamline the massive amounts of botanical information available into concise products that will improve botanical identification and data collection long into the future. Paralleling the progress of the SODN vegetation mapping program, the Flora of the Sonoran Desert Network is aiming for completion in 2013.

Over the first two years of this project, we have discovered that the metaphor

of pieces is fitting, because many NPS lands are isolated islands in a sea of human-driven landscape fragmentation. Whether because of urbanization, agriculture, or border impacts, NPS lands are pieces of a larger tapestry that is under tremendous stress. By drawing together historical records and collections with contemporary ecological literature, SODN is creating useful tools to improve contemporary collecting efforts and ongoing monitoring. The Flora of the Sonoran Desert Network, as an holistic effort to assess the state of our knowledge about plant composition in network parks, will help us to understand the whole by first getting to know the pieces.

—Steve Buckley

For more information:

USGS-NPS Vegetation Mapping Program

<http://biology.usgs.gov/npsveg/>

Learning Center of the American Southwest

<http://www.southwestlearning.org/>

NPS photos, Organ Pipe Cactus NM and Saguaro NP.



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

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All photos in this document are courtesy of the National Park Service.

Visit us on the web at
<http://science.nature.nps.gov/im/units/sodn>

Where Are We?

Monitoring currently scheduled during the next quarter includes:

Month	Project and Park
September	Springs: Guadalupe Mountains NP (CHDN) Streams: Pecos NHP (SOPN), Chickasaw NRA (SOPN), Lyndon B. Johnson NHP (SOPN)* Vegetation Mapping: Coronado NMem Uplands: Coronado NMem, Saguaro NP (RMD)
October	Ecotonal Vegetation: Saguaro NP (RMD) Streams: Tumacácori NHP, Gila Cliff Dwellings NM*, Montezuma Castle/Tuzigoot NMs* Vegetation Mapping: Coronado NMem Uplands: Chiricahua NM, Organ Pipe Cactus NM
November	Ecotonal Vegetation: Guadalupe Mountains NP (CHDN) Springs: Gila Cliff Dwellings NM* Uplands: Chiricahua NM, Saguaro NP (TMD)
December	Uplands: Chiricahua NM, Saguaro NP (TMD)

*tentatively scheduled

CHDN = Chihuahuan Desert Network; SOPN = Southern Plains Network

For updated calendar information, please visit our SharePoint site,
<http://inpchdnms03/SODN/Lists/FieldWork/calendar.aspx>