



MCDOWELL
SONORAN
CONSERVANCY

Mountain Lines

MAGAZINE OF THE MCDOWELL SONORAN CONSERVANCY

FALL 2019



The Deer Collaring Project
The data tells researchers a story

The East End Trail
It's great exercise

The Soil Crust Project
Learn about "Don't bust the crust"



Justin Owen, CNAP

We are excited to welcome the cooler weather and see everyone out enjoying our beautiful Sonoran Desert! As we begin our busy season, we continue to bring new and exciting changes to our programs. A key growth opportunity for this season is an expansion of our educational programs. We are substantially growing our adult, youth, and steward education

programs to increase public understanding and appreciation of our unique desert environment. We are also infusing our educational offerings with our research findings to create learning opportunities based on information from today.

By encouraging engagement in our public lands, our education program differentiates itself by empowering all of us to make adjustments in our lives to preserve and advance all natural open spaces. If we make minor changes individually, the collective result will be very significant. Come and join us at one of our educational offerings to understand what you can do.

The only way that we can continue to empower awareness and actualize global preservation is through the dedication and partnership of our donors, stewards, community, and business partners. We sincerely thank each of you!

Keep hydrated this fall, and I hope to see you out on the trails! ▲▲

About Us

Our goal is to empower awareness and actualize global preservation through science, research, learning and teaching. Through the work of our scientific team and the dedication of more than 650 tireless volunteer outdoor advocates, we care for and study the McDowell Sonoran Preserve.

Connect with us:



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McDowell Sonoran Preserve Mule Deer Movement Study

By Scott Sprague,
Arizona Game and Fish Department projects manager
and road ecologist



The helicopter is an integral part of the capture effort. The pilot and on-board net gunner are specially trained to safely and efficiently capture animals. Animals are safely captured using a net gun fired from a helicopter. Photo courtesy of Arizona Game and Fish Department

February 1, 2016, was a grey and snowy morning. As the sun neglected its daily responsibilities, the cold and unforgiving landscape of north Scottsdale was crawling with 70 representatives from the Arizona Game and Fish Department, the McDowell Sonoran Conservancy, and the City of Scottsdale. The weather delayed the mule deer movement study kickoff, but morning snows gave way to afternoon sun, and the capture effort shifted into gear.

Most participants, tasked with finding and monitoring deer herds, shivered in the snow while peering through binoculars and scopes as planes circled above assisting with detection and tracking of herds. Coordinators huddled around maps consulting a mobile app that displayed observer deer reports. Once deer were located, the helicopter capture crew was dispatched to the site and immobilized target animals. A process team monitored deer welfare and expedited the deployment of GPS collars. Over

three days, we collared 32 mule deer across Scottsdale's McDowell Sonoran Preserve and portions of McDowell Mountain Regional Park. For two years, the collars recorded locations every three hours, capturing important information about deer behavior. In February 2017, we redeployed six of these collars.

Every month or two, we flew a small plane over the area to offload data from the collars. These flights were a test of observer fortitude as they required circling around and around specific locations.

On Tuesday, February 5, 2018, there were several slightly surprised deer as several small catches turned



During the capture, observers perch on high points and peer through optics to locate deer. They upload deer locations to an app that immediately relays the information to the capture coordinator. The coordinator can then send the capture crew to the deer's location. Photo courtesy of Arizona Game and Fish Department



As soon as an animal is caught, a team monitors its health while quickly attaching a collar and ear tag. The animal is then released to collect data. Photo courtesy of Arizona Game and Fish Department

just enough to let several high tech necklaces fall to the ground. With locations from a final flight, project partners scoured the expanse of the Preserve, searching for the released collars. This time, their quarry was less mobile and easier to sneak up on. Although the deer had to give up their fancy necklaces, they kept their ear tags.

The data was now ready to show how human use of the Preserve and surrounding lands affect mule deer behavior across this landscape. Specific-



This buck paused by one of the Conservancy wildlife cameras to show off his collar and ear tag. The collar recorded his GPS location every three hours for two years, while the ear tag allows this individual to be identified as part of this important study. Photo courtesy of McDowell Sonoran Conservancy

cally, does the gooseneck corridor¹ function as a connection between the northern and southern regions of the Preserve?

Although the entire Preserve is important, the gooseneck has critical value when considering the health of the overall landscape because of habitat fragmentation. In an uninterrupted landscape, the ecosystem thrives with complex interactions (think food webs). When that landscape is broken into smaller pieces, the remaining chunks can be too small

for some species to survive. When a species is lost, it disturbs the balance of the ecosystem. The result is further loss of diversity and greater risk to the system.

Roads are barriers to mule deer. The effect increases with the road's traffic volume. During two

years of monitoring 38 individuals (resulting in more than 167,000 deer locations), we documented 203 deer crossings of Dynamite Boulevard/Rio Verde Drive by only five bucks. (No collared females crossed the road.) One buck was apparently trying to decide between membership at the Tonto Verde Golf Club on one side of the road and the Verde River Golf & Social Club on the other side. He was responsible for 178 crossings, all of which were well east of the Preserve. Four bucks were responsible for the remaining 25 crossings around the gooseneck. This level of gene flow should avert issues of genetic isolation and inbreeding. Limited crossings suggest reduced access to resources, but the high deer density indicates that crossing the road isn't necessary to meet daily resource needs.

Although the road hasn't completely isolated the southern herd, we can't expect to hang onto the status quo. As nearby communities grow, vehicle traffic will increase and likely bring additional traffic lanes, which will reduce road permeability and eventually lead to isolation. After a few generations without immigrants, the southern deer will find themselves in a situation where they're all related. This inbreeding would mean an uncertain fate for those deer, and the southern herd could eventually be lost.

The best way to avoid deer population collapse is to begin developing a plan to facilitate movement across Dynamite Boulevard/Rio Verde Drive. Such a plan should include a designated crossing with funnel fencing



Staff and volunteers braved wild weather with snow and low temperatures during the February 2016 capture! Photo courtesy of Arizona Game and Fish Department

to guide animals to the safe passage point.

Of course, the road isn't the only obstacle to movement through the Preserve, especially under future conditions. As development fills in around the gooseneck, deer and other wildlife will eventually be left with only the dedicated corridor to move between the northern and southern regions of the Preserve.

In conjunction with surrounding development, recreational use of the gooseneck could increase sharply. Trail use is likely to become an important factor in whether the gooseneck serves its primary function as a wildlife corridor between the two regions of the Preserve. Deer avoidance of



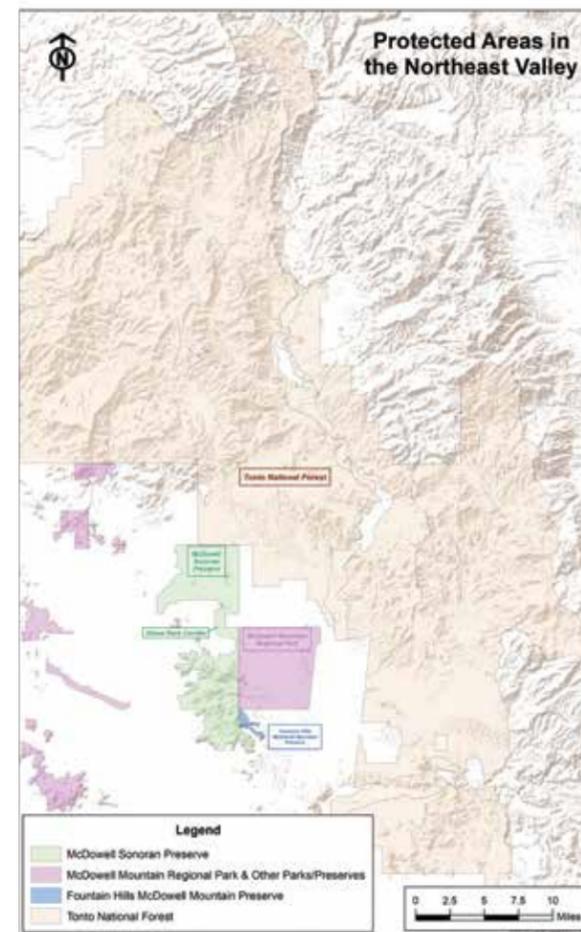
Conservancy stewards and Arizona Game and Fish Department personnel used radio telemetry to locate and retrieve collars after they dropped off the deer in February 2018. Photo by Debbie Langenfeld

a spiderweb of trails could inhibit their use of the corridor. To inform management of the gooseneck, we looked at the interaction of deer and trails across the Preserve.

At first glance, the distribution of deer distances to trails makes it look like deer prefer trails. It turns out that most of the Preserve is near a trail. So, we first identified how much of the Preserve falls within certain distance to trail categories. This gave us our expected ratio of deer locations. If the trails don't matter, the breakdown of deer locations by distance category should align with the relative area of each distance category.

Next, we compiled actual deer locations into the same categories to generate an observed distribution. We compared expected values with observed values for numerous factor combinations.

The results showed a clear avoidance of trails by deer, but the intensity depended on various factors. Every combination of factors showed lower observed than expected deer use of the 25-meter area adjacent to trails. More than 60 percent of the considered permutations showed lower observed than expected levels out to 100 meters. The highest intensity human use trails showed less than a third of the expected deer use within 100 meters

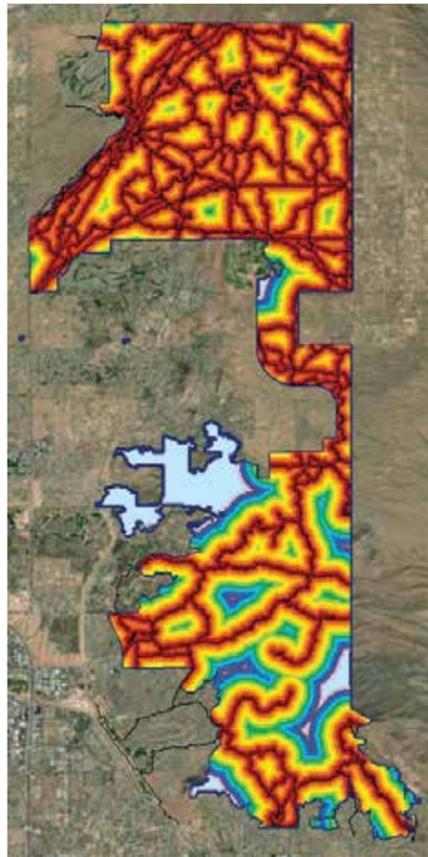


The Preserve is situated adjacent to Tonto National Forest, McDowell Mountain Regional Park, and Fountain Hills Preserve. Together they encompass nearly 3 million acres of protected lands. The narrow gooseneck corridor provides a vital connection for these lands. Map courtesy of McDowell Sonoran Conservancy

from the trails and lower than expected use out to 300 meters.

The deer did shift back toward trails after the Preserve closed at sunset. Although they continued to underutilize areas within 25 meters of the trail, the mean deer distance to trail diminished by 9 meters while the Preserve was closed.

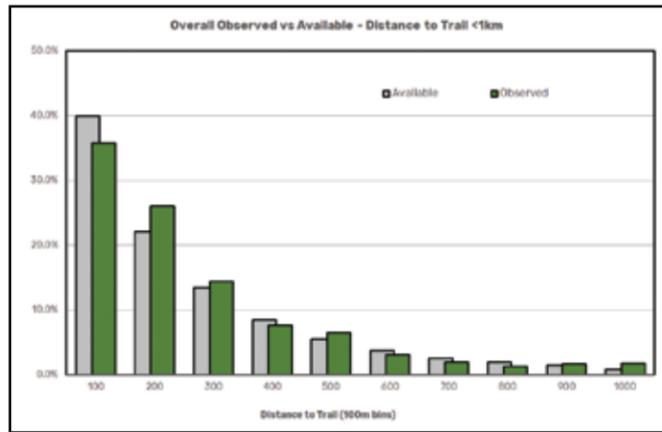
To clarify, deer can and do use areas near trails, and they can certainly get across them. The level to which they avoid trails is important for sensitive areas where even a small reduction in the likelihood of use could affect the long-term resilience of the population. We focused on the gooseneck corridor, but future analyses could



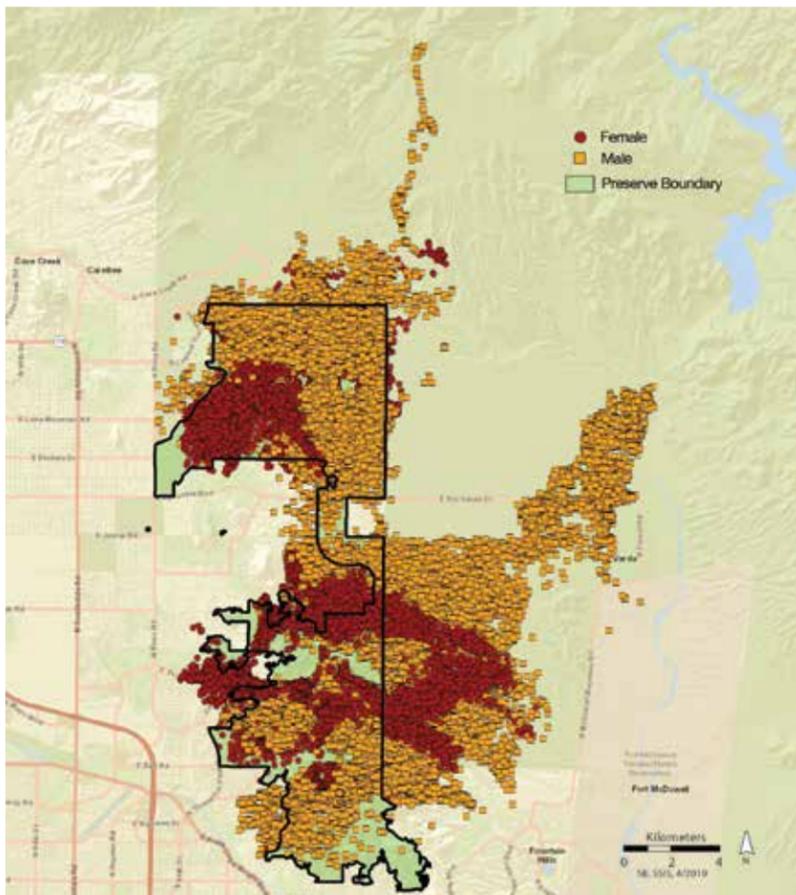
More than 90 percent of the Preserve is within 1 kilometer of a Preserve trail. This map shows the distance of Preserve lands from Preserve trails. Warm colors (red and orange) are closest to trails, whereas cool colors (blue and purple) are more distant. Map courtesy of Arizona Game and Fish Department

also target critical seasonal resource areas. In fact, a graduate student is contemplating a utilization model that incorporates various urban-interface factors, such as the proximity and density of residential infrastructure and water sources. This is just one possible further use for these 167,000 deer locations.

These findings will help guide management of the gooseneck to recognize the potential of human uses to impact deer use of this critical stretch of habitat. This project is a testament to the power of coordination between multiple agencies and individuals. It would not have been possible without the contributions of time and expertise of staff and volunteers of the



Although much of the Preserve is close to a trail, deer selected areas farther from trails. The biggest difference can be seen within the first 100 meters from a trail. Graph courtesy of Arizona Game and Fish Department



This map shows all 167,000 locations from 38 deer (each point is a location). Female locations are red and males are gold. Map courtesy of Arizona Game and Fish Department

Arizona Game and Fish Department, the Conservancy, and the City of Scottsdale, as well as the financial support of the Globe Foundation, the Salt River Pima-Maricopa Indian Community, and the U.S. Fish and Wildlife Service

Wildlife Restoration program. We now have a better idea of how deer use this important landscape and steps we can take to ensure they continue to thrive. ▲▲

1. The gooseneck corridor is a narrow strip of land near Rio Verde Drive that connects the northern and southern parts of the Preserve.

DESERT BOTANICAL GARDEN PRESENTS



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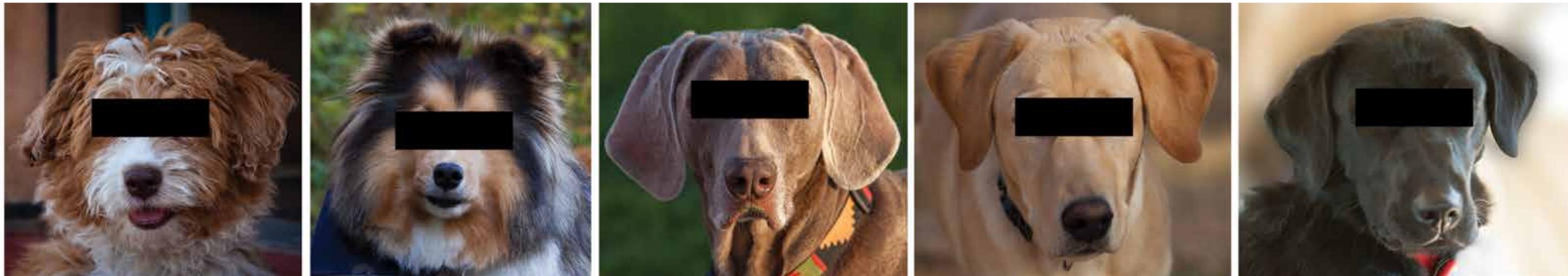
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DOG DUTY...Pet owners, it's your responsibility. Pack out the poop!

Identities concealed to protect the innocent.



What's with All the Flags?

By Kelly Hayes,
McDowell Sonoran Preserve southern region natural resources coordinator

Scottsdale's McDowell Sonoran Preserve is a wonderful network of trails open to horseback riders, mountain bikers, and hikers, as well as dog owners and their beloved pets. Many people hike in the Preserve with their canine companions and are very dedicated to responsible dog ownership. But every dog owner can benefit from knowing how to hike safely and respectfully with a furry friend.

Here are some protocols to follow when hiking with your dog. Keep your dog on a six-foot leash or shorter. A loose dog or a dog on an extendable or long leash is much more likely to

be injured. That injury could be from a prickly cholla ball stuck in its nose, or multiple ones stuck all over its body! Rattlesnakes call the Preserve home. They are easier to see when you are on the trail. When a dog goes off trail, it runs a much greater risk of being bitten by a rattlesnake hiding under a bush. Additionally, some people are frightened by dogs, especially loose ones. They should not have to physically encounter a dog on their hike, even if the dog is friendly. Another important part of ensuring a safe hike is to only hike with your furry friend when the weather is not hot. Dogs do not sweat



Pin flags along a short section of the Brown's Ranch Road Trail give a striking visual of the amount of dog droppings left behind by irresponsible dog owners. Photo by Peggy McNamara

like humans and can be overcome by the heat with little warning. Know the symptoms of heat exhaustion and heat stroke for canines, and don't push it.

Lastly, the Preserve ordinance requires dog owners to immediately bag all dog droppings and deposit

them into a trash receptacle. Each dog owner must carry a bag for that purpose. Not only are dog droppings unsightly, they are also unsanitary! Dog feces can contain Giardia, Salmonella, Leptospira, E. coli, Parvo virus, and roundworms. Yuck! Contrary to popular opinion, dog poop isn't biodegradable like wild animal poop because we feed our dogs differently from the way wild animals eat. Dogs have a high protein-based diet that creates a very acidic excrement or waste product. It can take more than one year for dog waste to decompose. Dog poop is NOT fertilizer like horse manure. Since canine excrement lasts a long time, it accumulates

quickly along busy trail corridors. But dog poop is not a natural component of the desert ecosystem and does not belong there!

Twice a year, the City of Scottsdale oversees a Pin Flag Campaign in the Preserve. This campaign is to bring awareness to the problem of hikers who do not pick up after their dogs. A



Members of the City of Scottsdale staff and Fire Department join Conservancy stewards at Preserve trailheads to talk to visitors about hiking with a dog. Photo by the City of Scottsdale

flag is placed next to each pile and bag of dog poop left along the trails. This campaign creates an ugly visual of just how much dog poop is left behind in the Preserve. The pin flagging occurs for two weeks in the spring and fall, and concludes with a Canine Safety Day at the main trailheads. On that day, Scottsdale staff, Conservancy stewards and Scottsdale Fire Department personnel talk to owners about how to hike with a dog. They cover using a six-foot leash, not hiking with your dog when it is hot, and picking up your dog's poop. A trailhead table has educational displays and free handouts for dog owners.

We hope that through education and awareness, more people can understand the importance of leaving no trace behind with respect to dogs. We can all enjoy this wonderful Preserve safely together... and without dog poop! ▲▲

IUCN SSC Sonoran Desert Plant Species Specialist Group



By Dr. Helen Rowe, Parsons Field Institute at the McDowell Sonoran Conservancy associate director, Dr. Beth Polidoro, Arizona State University School of Mathematical and Natural Sciences assistant professor, and Linda Howard, Arizona State University School of Life Sciences graduate assistant

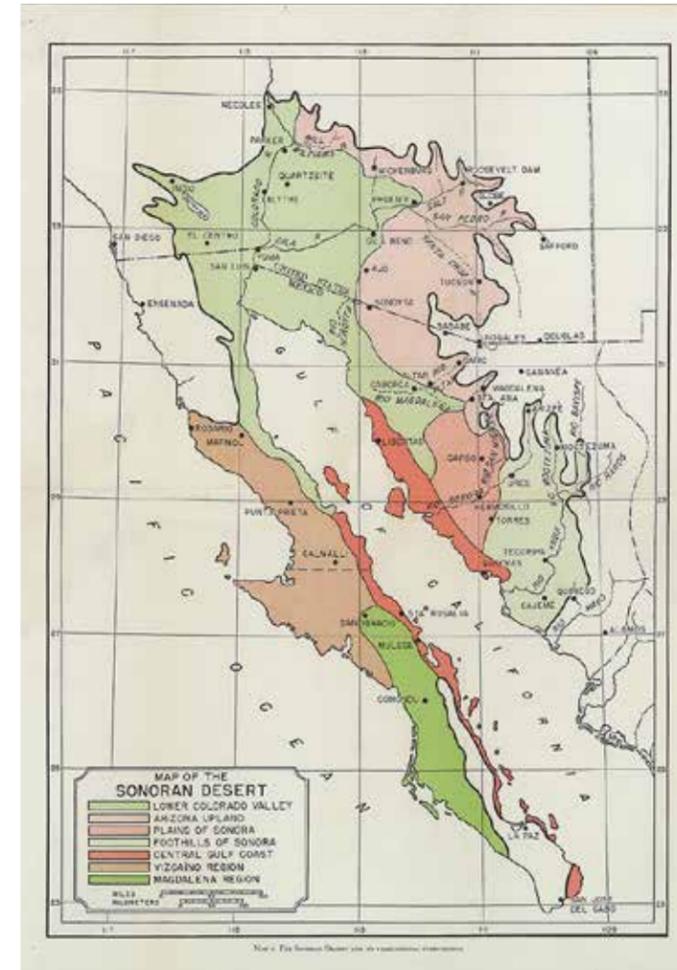
The Parsons Field Institute at the McDowell Sonoran Conservancy recently received approval to become the host organization for the newly established Sonoran Desert Plant Species Specialist Group within the Species Survival Commission (SSC) of the International Union for Conservation of Nature (IUCN). The Conservancy will lead this effort by bringing experts from across the Sonoran Desert (Sonora, Mexico) Arizona, California, and New Mexico, to assess the conservation status of the nearly 4,000 plant species found in this region as part of the IUCN Red List of Threatened Species™. This group is led

by co-chairs Helen Rowe, Parsons Field Institute associate director, and Jose Alberto Burguez Montijo, Universidad Nacional Autónoma de México professor, who will enable strong bilateral representation across the region.

The IUCN Red List of Threatened Species™ is recognized worldwide as the most comprehensive inventory of the global conservation status of plant and animal species. It uses a system based on five criteria to evaluate the extinction risk of species and subspecies throughout all regions of the world. The IUCN Red List is scientifically based and used to track the status of biological diversity worldwide. For more

information about the IUCN Red List, please visit <http://www.iucnredlist.org/about>.

In 2015, two Arizona State University graduates created the first comprehensive list of Sonoran Desert plant species. They used a wide range of sources and references. Botanists in the region were surprised at the findings of almost 4,000 species, as they had previously understood there



Sonoran Desert Ecoregion courtesy of Shreve (1951): The Foothills of Sonora is no longer part of the Sonoran Desert (Felger and Lowe, 1976) and its assessment.

Group is not only completing the red list, it also has the responsibility to conserve and protect a group of species, in this case, Sonoran Desert plants. Our goals for the coming year include conservation action on threats already identified, such as invasive species survey and removals, and conservation planning. As a regional leader in this work, we will continue to expand our efforts by providing training and data support to parks around the region.

As part of the IUCN Red Listing process, when a species is assessed as threatened, a conservation plan is drafted. We plan to review past plans of Sonoran Desert taxa and evaluate progress in implementation. This effort should lead to better understanding the conservation needs and allow for targeting key crosscutting conservation issues that can result in multispecies conservation.

In October, the co-chairs will join all of the other IUCN SSC Species Specialist Group chairs in Abu Dhabi for four days of training, collaboration across groups, and catalyzing initiatives and strategies. As new Sonoran Desert plant assessments are completed, the information will highlight threats across the region and allow us to generate appropriate multispecies conservation responses and outreach. Overall, the information generated by the assessments and conservation plan reviews will lead to targeted conservation planning, education, and action across the Sonoran Desert. ▲▲

to be about 2,000 plant species in the Sonoran Desert. Currently, the Red List Coordinator for the group is vetting the list by comparing each species with accepted flora guides. Once the list has been verified and cleaned, the work of assessing the threatened status of each species can begin. The first step of assessments will involve students and volunteers collating data on each species to be verified and used by experts in a series of red listing workshops. At red list workshops, experts on a group of plants will meet to review and add data, then use the data to assess the extinction status using defined criteria.

An IUCN SSC Species Specialist

We will also collate information about conservation planning efforts across



Mojave milkweed (*Asclepias nyctaginifolia*) has been partially assessed under IUCN protocol by the Sonoran Desert Plants Species Specialist Group. As with other milkweeds, it is an important food source for monarch butterflies. It is present in the McDowell Sonoran Preserve. Photo by Steve Jones



Fishhook barrel cactus (*Ferocactus wislizeni*) is a Pima County relative of Maricopa County's compass barrel cactus (*F. cylindraceus*). Fishhook barrel cactus is listed by the IUCN as Vulnerable to commercial and residential development, and harvesting. Compass barrel cactus is not listed. Photo by Steve Jones



Boajum tree (*Fouquieria columnaris*) is a Mexican relative of the local ocotillo (*F. splendens*). It is listed as Vulnerable due to numerous threats, though the population is considered stable by the IUCN. Photo by Steve Jones



Dutchman's pipe (*Aristolochia watsonii*) is a food host of the larval stage of the pipevine swallowtail (*Battus philenor*) butterfly. Neither has been assessed by the IUCN, though a number of relatives of each are IUCN listed species. Both species are present in the McDowell Sonoran Preserve. Photos by Steve Jones





Midway along the East End Trail, a hiker looks to the east for an unmatched view. Photo by Art Ranz

A Great Hike—East End Offers a Unique, Steep, and Rugged Experience

By Art Ranz,
McDowell Sonoran Conservancy master steward

Do you want a challenging hike? Then you should check out East End Trail. It's one of the more remote and most difficult trails in Scottsdale's McDowell Sonoran Preserve. It's also one of the most rewarding—with fantastic views to the east, ancient geology, and a

heart-throbbing workout.

Setting out from Tom's Thumb Trailhead, this hike takes you on a steep, smooth climb up Tom's Thumb Trail. You'll see the beautiful saddle that is the gateway to the East End coming into view in about 30 minutes. As you reach the beginning of East End Trail,

you'll notice a sign that says, "Alert: This trail is rated as extremely difficult and is steep and rugged."

The trail starts out smooth and level, but quickly dives into the less traveled eastern part of the Preserve. Fields of school bus-sized granite boulders line the descent. You'll see



Hiking poles are very helpful on several sections of the East End Trail. Photo by Dennis Eckel

the namesake Fountain Hills fountain erupt in the distance. Flatiron Mountain and Weaver's Needle in the Superstition Mountains, which are 35 miles away, then come into view.

The geology along the trail is fascinating. On the north side of the trail you'll notice sprawling, smooth, rounded granite boulders. A few steps to the south you'll spot jagged metamorphic rock. There aren't many places like this, where you can stand with 300 million years between your two feet!

As the metamorphic trail bed becomes rocky, you'll have to pay more attention to your footing. The steep drop-offs to the sides of the trail provide clear views to the east as Four Peaks in the Mazatzal Mountains appears around the corner.

Hiking poles are a vital part of hiking gear for the steepest midsection of the 1.4-mile trail. After traveling just half of the trail you will have descended nearly 900 feet.



Hikers on the East End Trail can see a view of the town of Fountain Hills in the distance. Photo by Dennis Eckel

The vegetation on the eastern slope is different from that in many parts of the Preserve. The usual mix of ironwood, palo verde, and mesquite trees are scattered and small. The few saguaro cacti are small and sparse. The landscape is green and thriving, but has the feel of a fire from generations ago.

Finally, the steepness of the trail abates, and you'll be able to stroll to its intersection with Windmill Trail. To get back home you can take a longer, flatter way back through Maricopa County's McDowell Mountain Regional Park and visit Marcus Landslide along the way. Or you can return via the original route, which

includes a very strenuous climb back to the high point of the East End Trail.

East End can be a challenging hike, but has a lot to offer—particularly during cooler weather when the return climb puts the sun at your back.

Don't forget to bring your hiking poles—you'll need them. Pack your camera too! ▲▲

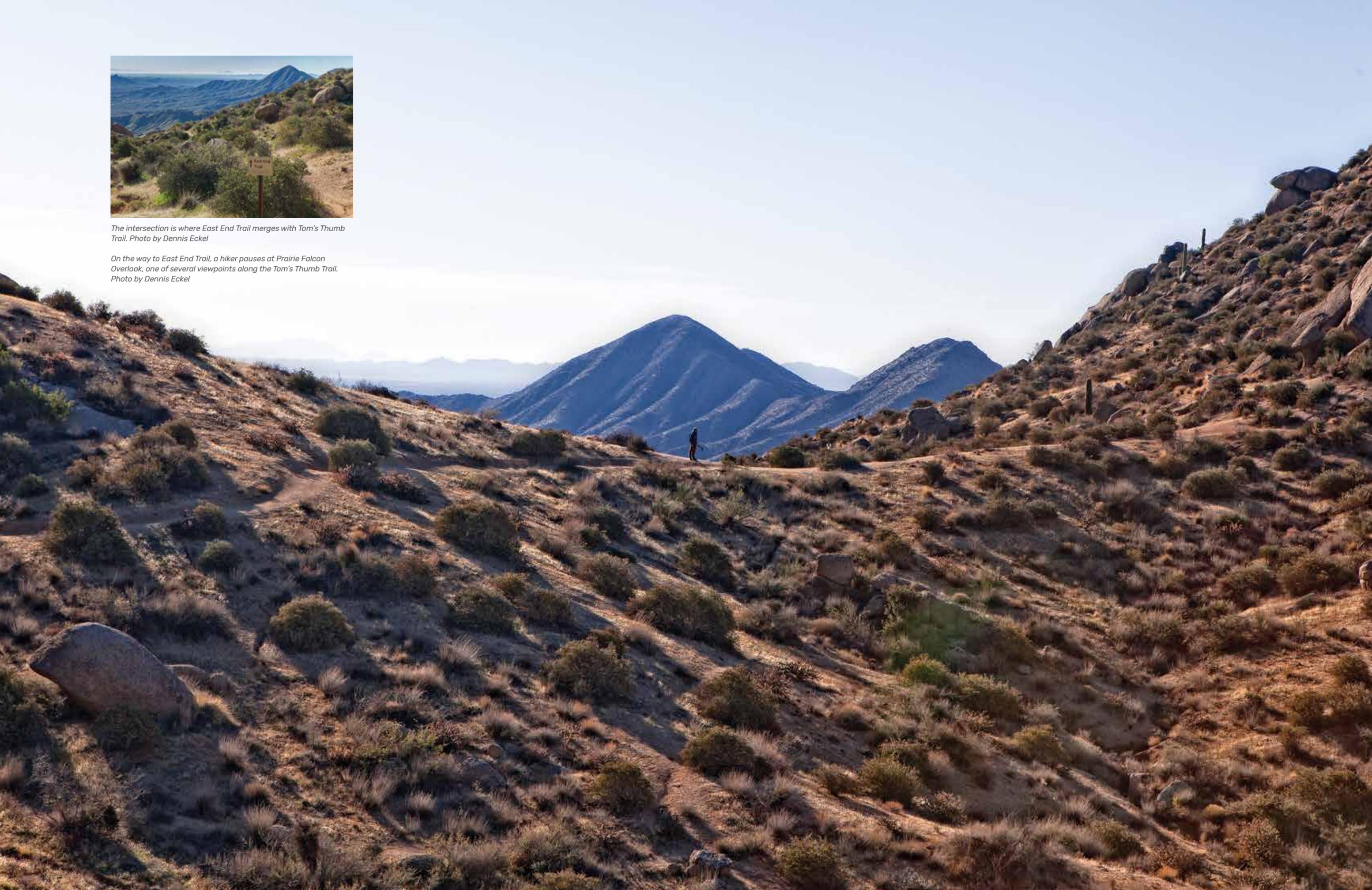


The hike on the East End Trail may be difficult, but these hikers are happy to be doing it. Photo by Dennis Eckel



The intersection is where East End Trail merges with Tom's Thumb Trail. Photo by Dennis Eckel

On the way to East End Trail, a hiker pauses at Prairie Falcon Overlook, one of several viewpoints along the Tom's Thumb Trail. Photo by Dennis Eckel



Hydrating Your Active Dog

By Dr. Shellee Roe,
Doctor of Veterinary Medicine, Desert Sky Animal Hospital

Staying well hydrated is critical in Arizona. This is also true for our four-legged companions. Water needs during outdoor activities increase as the temperatures climb.

On average, a canine needs 1.25 cups (10 oz.) of water per day per 10

pounds of body weight. This water need will increase with exercise and energy expenditure. Therefore, it is important to be prepared when you head out for a hike with your pooch. In addition to planning for your own water needs, you will also need to plan for what your dog



Dr. Shellee Roe

will need during your outing. The longer the hike and the hotter the ambient temperatures, the more water that you will need to carry. I always tend to over-prepare and take more water than I will need in an effort to avoid a dangerous situation. A good rule-of-thumb is to carry your pet's total daily water needs for every 4 hours that you plan to hike. For example, if you have a 50lb dog that requires 6.25 cups (50 oz.) of water per day and you plan to hike for 2 hours, then I would have 3.125 cups (25oz) of water available for your hike. However, it is never wrong to take extra water to allow for loss if there is a spill or to pass on to other hikers that you may come upon who are short on water for themselves or their pets.

There are many convenient ways to give your dog water on the go. Certainly, the collapsible bowl is always an option that can easily be clipped to any pack for easy transport. Other products that are also convenient and will reduce water waste are the water bottle/bowl unit. It is also not out of the question to have your dog carry their own water if you think that they would tolerate wearing a backpack and have no orthopedic or medical issues that would prohibit them from doing so.

Dehydration can occur and

become a life-threatening problem if measures are not taken to ensure that your dog is drinking enough water during any outdoor activity. Signs of dehydration can include excessive panting, slowed pace or reluctance to proceed any further, collapse, vomiting, and diarrhea. Should you notice your dog having these symptoms, stop, take a short break in a shaded area, and offer your dog small sips of water. Avoid letting your dog guzzle water as this will likely cause vomiting which will exacerbate the dehydration and make

the situation worse. Should you have enough water to spare, pour water over your dog's back and underside to help them cool down. If possible, carry your dog back to your vehicle. If this is not possible, then find the shortest route back to your car and proceed at a moderate pace, taking frequent breaks to offer more water and rest in the shade. Carrying an umbrella in your hiking pack can be useful in these situations as you can use it to shade your dog as you proceed back to your car. Avoid running back to your vehicle

with your dog, as this will be a greater expenditure of energy and again exacerbate the dehydration and increase the risk of your dog overheating. Once safely back to your vehicle, take your dog to the nearest veterinarian for an assessment and further care if needed.

Take time to enjoy the outdoors with your dog and remember that being prepared on the front end will make for a memorable, enjoyable day for all. Happy hiking! ▲▲



The author and her best pal love to hike and take selfies. Photo by Shellee Roe



Just by the look on the dog's face, you know he is thanking his best friend. Photo by Dennis Eckel



Figure 1 a) Biocrust covering the soil surface, b) a close up of a hydrated biocrust containing liverworts, mosses and lichens, c) *Peltula richardsonii* and d) *Placidium squamulosum*, common lichen species of the Sonoran Desert. Photos by Anita Antoninka

Biocrust Restoration in the Sonoran Desert

By Anita Antoninka,
Northern Arizona University School of Forestry research associate

It is common knowledge that you must look down as you walk in the Sonoran Desert. This is critical to keep all the pokey things from lodging in your feet and legs. An added bonus of looking down is the mesmerizing variety of biocrust organisms you will find (Figure 1). Biocrusts are communities of algae, cyanobacteria, mosses, lichens, and even liverworts that bind the top millimeters of soil together. What biocrusts lack in stature, they make up for with powerful and critical ecosystem functions. Together, they photosynthesize, fix nitrogen, enhance water retention, reduce soil erosion, interact with plants, and support the soil food web. In the Sonoran Desert, biocrusts fill the gaps below and between plants and stop the soil from

blowing away. However, biocrusts are sensitive to compressional disturbance (e.g., feet, hooves, and vehicles). Disturbed areas are vulnerable to erosion by wind and water. If you have ever experienced a haboob, you know how important it is to keep the soil connected to the ground.

We recently started a project with the McDowell Sonoran Conservancy to investigate ways to cultivate and reintroduce biocrusts back into disturbed areas like the new trailhead construction at Granite, Fraesfield, and Pima-Dynamite Trailheads. Using an army of citizen scientists (Figure 2) armed with buckets and shovels, we collected biocrusts from Fraesfield Trailhead before the construction started. A great feature of biocrust is

that it can be stored dry in the dark indefinitely and reactivate with light and water almost immediately. Thus, it is ready to use to rehabilitate damaged areas once disturbances have stopped. Another nice feature of biocrusts is that all the organisms are totipotent, meaning new individuals can grow from any part. In other words, we don't need to wait for reproduction to collect propagules for cultivation. This is also



Figure 2. Citizen scientists salvage biocrust for restoration. Photo by Anita Antoninka

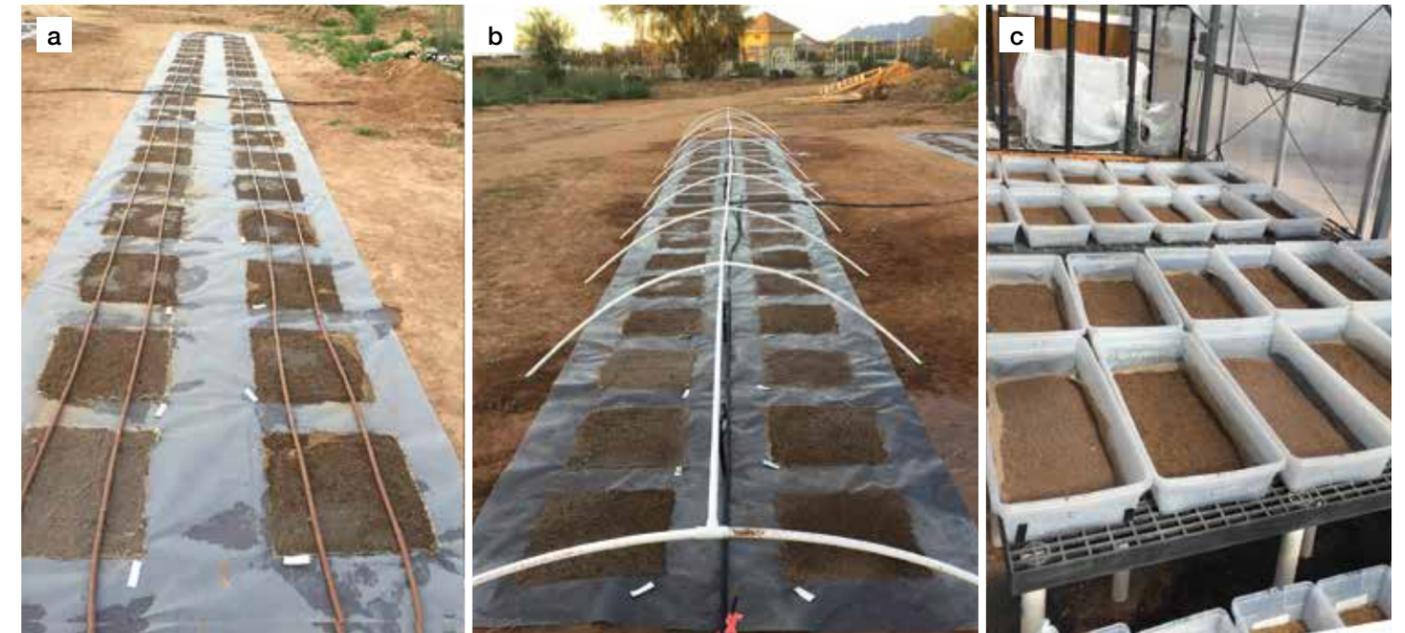


Figure 3. Biocrust cultivation experimental design: a) "layering" in line irrigation covered with shade cloth just above the surface, b) "hoop house" 360 degrees low sprinkler heads under a low hoop house, and c) "greenhouse" wicking irrigation in the NAU greenhouse. All units were covered with 65 percent light colored shade cloth and irrigated five days continuously each week for four months. We tested three irrigation methods, as well as the use of a common sand or home soil for cultivation, and the addition of burlap to reduce soil erosion. Photos by Anita Antoninka

a benefit for cultivation—we don't need the biocrust to reproduce, just to expand from fragments.

We set up an experiment to test best cultivation methods at Scottsdale Community College and the Northern Arizona University greenhouse (Figure 3). We know we can grow biocrust quickly in the greenhouse but have had limited success with transplanting it back into the field. Cultivating in the field subjects organisms to the normal fluctuation in temperature, relative humidity, and UV radiation compared to the greenhouse. After only four months, we were able to increase the biocrust cover from 20 percent to 50-80 percent, a 2.5-4 times increase (Figure 4). Greenhouse and outdoor layering cultivation grew much better than the hoop house. While greenhouse conditions maximized biocrust growth, we suspect that the field cultivated biocrusts will maximize field survivor-

ship when we outplant. The next phase of our research, to begin this fall, will be to test establishment and survival of the differently cultivated biocrusts

in a field restoration experiment. This will allow us to come up with specific restoration protocols for areas of concern within the Sonoran Desert. ▲▲

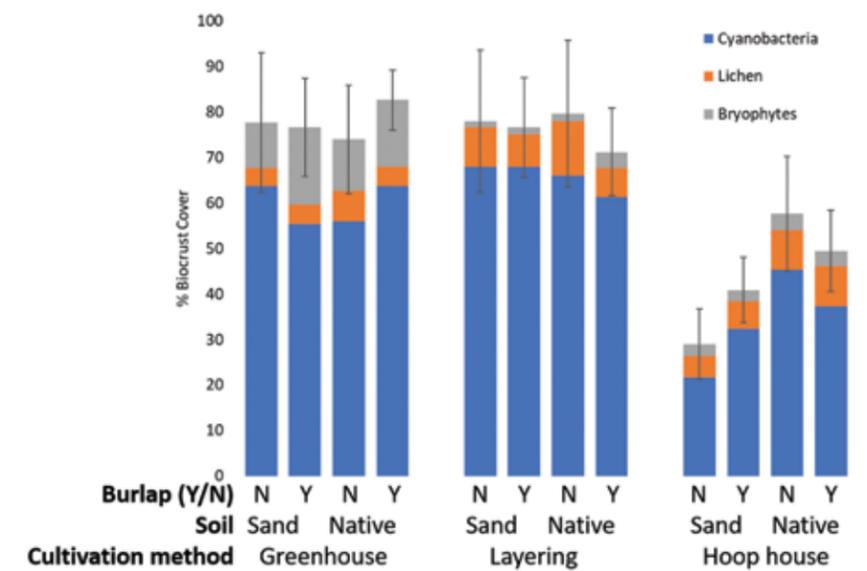


Figure 4. Results show greenhouse and layering cultivation were the best overall. Layering grew more lichen and greenhouse grew more moss. Jute and soil type were less important. Graphs by Anita Antoninka



A Desert Time Machine

By Barbara Montgomery-Ratcliff,
McDowell Sonoran Conservancy lead steward

Pack rats adapted to be able to carry cholla balls in their mouths. Not only do these decorations help us identify middens, but they also ward off predators from the nest. Photo by Randall Babb, Arizona Game and Fish Department

Imagine you have traveled 13,000 years back in time. You are hiking in what is now the McDowell Sonoran Preserve. You see some familiar sights—mountains in the distance, blue sky, and an animal scurrying to a nest—a pack rat! Then you realize the nest isn't under a cholla or a palo verde tree; it is under a pinyon pine tree. You are in a pine and juniper woodland! And it's humid!

The Preserve was very different 13,000 years ago. How do we know? Because that pack rat you saw on your imagined hike was collecting scientific data before the modern concepts of science and data existed! To understand how ancient pack rats assist today's scientists, we need to know about pack rat behavior.

The Sonoran Desert is home to a species of pack rat, *Neotoma albigula*, that has lived here for at least 40,000 years. Also called the white-throated

woodrat, this pack rat weighs about three quarters of a pound and has an 8-inch long body and a 6-inch tail. Its mating season runs from January through August in Arizona, with gestation lasting 30 to 40 days. The young are weaned within two months. Pack rats in the wild live only a few years.

Pack rats are nocturnal and solitary, with one pack rat per nest except when a female has young. Some build their nests in dry, rocky niches. In the Preserve, most build nests slightly underground, tunneling around

tree roots and boulders to create multiple entrances and exits, creating chambers for storage and sleeping. They cover the area above ground with sticks and desert debris, and install a security system on top with cholla balls or prickly pear pads to discourage predators. Pack rats also regularly



Cholla balls atop a mound of twigs is a sure sign of a pack rat's midden. Photo by Art Ranz

move into abandoned nests, resulting in sequential occupancy over many years. In any case, a pile of sticks covered by bright green cholla balls is probably an active pack rat nest.

The chamber where the pack rat stores food waste and collected items is called the midden, an archeological term for trash heap. A midden has layers of leaves, seeds, plant stems, rocks, bones, coins, jewelry—things found on the ground within 50 yards of the nest. The pack rat marks these things by urinating on them. Pack rat urine is very thick and dries to a crystallized substance called amberat, which glues the collection together and preserves it.

For scientists studying the history of desert flora, fauna, and climate, an old midden is not so much a trash heap as it is a data dump. Middens that are 40,000 years old have been studied in the Southwest, especially those in dry, rocky areas, which best preserve the contents. Radiocarbon dating of midden contents indicates that many of the small ground dwelling animal species here today, like chuckwalla and desert spiny lizard, were present 13,000 years ago.

In contrast, the plant population has changed considerably. Much of the northern Sonoran Desert 13,000 years

ago was a woodland of pinyon pine, juniper trees, and shrub oak, indicating a wetter, cooler climate than today. However, things were heating up and the woodland plants began to die while desert plants migrated from the south. For example, brittlebush and saguaros moved in about 11,000 years ago. Juniper disappeared about 9,000 years ago. Palo verde and ironwood trees appeared about 4,000 years ago.

Over the past two million years, plants in the Sonoran Desert have fluctuated between woodlands (90 percent of the time) and desert at least 15 times as ice ages came and went. Our desert continues to change today, with

pack rats keeping a record of it all in their midden collections.

Two excellent sources regarding midden research are *Pack Rat Middens: The Last 40,000 Years of Biotic Change* and Thomas Van Devender's article on "The Deep History of the Sonoran Desert" at https://www.desertmuseum.org/books/nhsd_deep_history.php ▲▲



Children at the Conservancy's Junior Citizen Science Festival have fun and learn pack rat facts with the help of Patrick, the pack rat, and a displayed midden. Photo by Lynne Russell



This pack rat midden on display at the Conservancy's Junior Citizen Science Festival shows some of the items that its owner collected. Photo by Lynne Russell

Palo Verde, or Green Stick Trees, Are Dominant in the Area and the Region

By Steve Jones,
botanist



Blue palo verde leaves (left) have fewer but larger leaflets than the foothill palo verde (right). Leaves of both species drop just before the tree flowers and then regrow with monsoon rains. Photos by Steve Jones

The palo verde is a dominant tree in the Southwest and locally.

Palo verde is Spanish for green stick, describing the tree's green bark. Foothill palo verde (*Parkinsonia microphylla*) and its cousin blue palo verde (*Parkinsonia florida*) are in the bean family (Fabaceae). So are the other two locally dominant tree species, ironwood (*Olneya tesota*) and velvet mesquite (*Prosopis velutina*).

Foothill palo verde is by far the most common of the trees. It is widespread across upland areas and along washes as well. Blue palo verde, on the other hand, is usually found along washes.

This is due to one of the features

that separates the two species—the blue palo verde seed coat is very hard and needs to be damaged (scarified) to allow water in to germinate the seed. Foothill palo verde seed coat is water-permeable, so it does not need

to be scarified.

Blue palo verde trees are more common along washes because when water flows it carries the seed with it, and sharp-edged gravel performs the service of scarifying the seed.



Blue palo verde fruit (left) are flat, wide, and beige. Foothill palo verde fruit (right) are dark and have constrictions between each seed. Photos by Steve Jones

Curiously, blue palo verde are occasionally dominant in upland areas, mostly at slightly higher elevations. An example of this is found in Scottsdale's McDowell Sonoran Preserve along Tom's Thumb, Feldspar, and Mesquite Canyon



Blue palo verde (left) blooms early and has yellow flag petals, often with small red dots below. Foothills palo verde (right) blooms later and has white flag petals that turn yellow with age. Photos by Steve Jones

trails on the bajada south of Tom's Thumb Trailhead.

Leaves, flowers, and fruit are useful in differentiating blue and foothill palo verde. Both have pinnate (featherlike) leaves with multiple leaflets. Foothill palo verde leaflets are tiny. The species name *microphylla* means tiny leaf.

Blue palo verde blooms in March and April. Its flower has a yellow flag (upper) petal, often with small red dots. Foothill palo verde blooms later and its flag petal is white when fresh, fading to yellow after pollination. The white flag petal gives the tree in bloom a buttery yellow appearance in contrast to the lemon yellow of blue palo verde.

Fruit of the blue palo verde are beige, flat, and often retained on the tree after ripening. Foothill palo verde fruit are red-brown and have narrow

constrictions between seeds. They drop soon after ripening.

Age is another difference between the two species. Blue palo verde, though growing to a larger size, rarely live beyond 100 years. Foothill palo verde grow more slowly and are estimated to live as long as 400 years. The two rarely hybridize. But there is a hybrid individual in the Preserve along the Marcus Landslide Trail.

Speaking of hybrids, there is a triple-hybrid cultivar known as the Desert Museum palo verde. It is a cross among blue and foothills palo verde, plus a third species native to Sonora and southern Arizona, the Mexican palo verde (*Parkinsonia aculeata*). First cultivated at the Arizona-Sonora Desert Museum, it has characteristics that make it a desirable landscape plant: vigorous growth, thornless



Hybrid palo verde leaves, flowers, and fruit show intermediate characteristics between their blue and foothill palo verde parents. Photos by Steve Jones

branches, and upright branching.

Palo verde trees provide several ecological services within their ecosystems. Flowering coincides with the adult stage of native bees such as digger bees. These bees store palo verde nectar and pollen in underground cells along with eggs to produce the next year's generation. Many rodent species such as ground squirrels, pack rats, and mice gather and store the seeds.



The Desert Museum palo verde is a cultivated hybrid found in metropolitan landscapes. It has three parent species—blue, foothills, and Mexican palo verde. Its virtues include thornless stems, vigorous growth, and an upright growth form. Photo by Steve Jones

As with other members of the bean family, palo verde trees host specialized bacteria in nodules on their roots. The bacteria convert elemental nitrogen from the atmosphere into nitrogen compounds that are vital to plant growth. As leaves drop and biodegrade, these nitrogen compounds are released and enrich the soil. This allows other plant species to thrive in notoriously nitrogen poor desert soils. ▲▲

Discovering a Career

By Justice Hoyt,
McDowell Sonoran Conservancy intern

My name is Justice Hoyt. I worked this spring and summer as an intern at the McDowell Sonoran Conservancy. My internship is through CREST (Center for Research in Science, Engineering, and Technology). This is a specialty program at my high school. I am required to take one elective class per semester that falls underneath the requirements of my strand and complete a 200-hour internship.

The strands of CREST are the different programs in which a student can participate. They include engineering, biotechnology, and computer science. I am in the engineering program, but I was never completely sure that I wanted an engineering career. As I began to learn more about the engineering internship, I decided to explore a different interest so I could expand my options. I have always loved nature and find myself constantly wanting to find ways to help the environment. When I heard the Conservancy was accepting interns, I jumped at the opportunity, even though I didn't quite know what work it entailed.



Justice Hoyt prepares to help gather data about bats when they leave their cave in the evening to feed on insects. The information is part of a long-term study to help scientists monitor the bats using this site. These bats are an important component of the Preserve and the local environment. Photo by Debbie Langenfeld



Justice deposits soil crust into a bucket. She and other Conservancy volunteers salvaged the crust from the area where the parking lot for the new Pima Dynamite Trailhead will be. These crusts will be used to help restore degraded lands in the Preserve, including around the new trailhead after it is completed. Photo by Debbie Langenfeld

During my first week as a Conservancy intern, I spent five days in the field assisting with two different plant studies and working at the Junior Citizen Science Festival. The first day, I helped with a trail restoration project. We went to closed trails accompanied by two botanists and recorded what plants were growing in plots that had received different restoration treatments. The next two days, I spent at Brown's Ranch working on an invasive plant study. We mainly focused on studying the regrowth of buffelgrass that had received different removal treatments. I greatly enjoyed these first three days and discovered that my love for plants and the environment was bigger than I had originally thought. The last two days of that week, I helped at the festival in an array of booths and met the elementary school students who attended.

After this first week, I knew I had chosen the right internship. The following weeks I was in the office



Justice stands at the far left of some of the members of the soil crust crew. Photo by Leona Weinstein

whenever possible because I was still in school. I worked on data input from several different studies, sorted and verified images from wildlife cameras, made donor calls, and completed various other tasks. Outside of the office, I was able to help with soil crust salvaging and bat counts, both of which I found extremely interesting.

I've learned quite a bit from this internship. Before starting, I didn't realize how extraordinary the Sonoran Desert truly is. I've learned more about different plant species, such as which ones are highly invasive, like



There was more than just work to do when out in the field. Justice found master blister beetles among these purplestem phacelia (*Phacelia crenulata* var. *ambigua*) flowers. Photo by Justice Hoyt

buffelgrass, and which ones we want more of in the desert. More recently, I've begun to see what it's like to be a part of a nonprofit organization, and how much effort goes into making everything work. As I mentioned earlier, prior to coming into this internship, I wasn't completely sure what I wanted to do in college and as a career. Through interning at the Conservancy, I have been able to explore one of my interests. Now I know that I want to major in environmental sciences and sustainability or possibly environmental engineering. ▲▲



Brown's Mountain is one of the Conservancy's study sites for controlling nonnative plants. Justice snapped this photo while working on the study. Photo by Justice Hoyt



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Conservancy Coalition members are the backbone of the McDowell Sonoran Conservancy who provide a significant portion of the organization's annual funding. By becoming a Conservancy Coalition member your investment helps to ensure the Conservancy has the tools necessary to safeguard Scottsdale's McDowell Sonoran Preserve and educate the community on its wealth of native resources.

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Facebook Fundraising

You can create a Facebook fundraiser in support of the Conservancy. Just log into Facebook and click "Fundraiser" under "Create" in the left column. Click on "Nonprofit" and then search for "McDowell Sonoran Conservancy." from the dropdown list under "Nonprofit." Share your fundraiser with friends and family and let them know why you support our mission.



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Tom's Thumb Trail heading toward East End Trail. Photo by Dennis Eckel

