

A Citizen Science Survey of the Herpetofauna of Scottsdale's McDowell Sonoran Preserve, Arizona, USA

Preserves, parks, and other natural areas in the Sonoran Desert serve as important refuges for herpetofauna; however, the extent to which they conserve herpetofauna is often unknown owing to a paucity of baseline information critical for tracking population changes (Busby and Parmelee 1996). Thomas and Gillingham (2015) demonstrate that a cornerstone of conservation has been the establishment of protected areas, which maintain conditions for endemic species and biological communities to survive. A large amount of protected areas in the United States are situated in the western portion of the country (Jenkins et al. 2015). Despite the prevalence of these protected areas, the Sonoran Desert is under immediate threat from anthropogenic activities (Philips and Comus 2000; Kwiatowski et al. 2008). Urban development and habitat fragmentation present some of the largest challenges to the conservation and management of wildlife (Philips and Comus 2000; Kwiatowski et al. 2008; Rudd and Bateman 2015). In addition, invasive species, climate change, and pollution, can alter the distribution of species, especially those that have high vagility. Lack of understanding of herpetofauna by the general public also presents a conservation challenge. These challenges are more immediate in protected areas that are adjacent to urban development, where roads, pollution, and the probability of human-wildlife conflict are higher. Nonetheless, most herpetofaunal species likely respond more slowly to these types of environmental changes and have more stable distributions (Powney and Isaac 2015).

Scottsdale's McDowell Sonoran Preserve (MSP; 33.648918°N, 111.860096°W) consists of over 30,100 acres (12,140 ha) of the Arizona Upland subdivision of the Sonoran Desert community (Brown 1994), bordered by urban development along 50% of its boundary (McDowell Sonoran Conservancy 2014). The MSP includes the McDowell Mountains and adjacent bajadas, all of which are set aside for permanent, non-motorized use. The MSP is topographically and floristically diverse. It contains a 722-m range in altitude and a 4.3°F difference in average year-round temperature between the north areas (Brown's Mountain/Granite Mountain) and the southern areas (Jones and Hull 2014). North and south sections of the MSP are divided by a two-lane road (Fig.

1). The acquisition of MSP created a permanent corridor between the McDowell Mountain Regional Park to the east and the Tonto National Forest to the north, with the intention of maintaining free movement of organisms and gene flow of the native fauna. The MSP is administered by the City of Scottsdale, with assistance from the McDowell Sonoran Conservancy (MSC), a 501c3 non-profit organization that trains and deploys volunteers to provide maintenance, repair, education, advocacy, and scientific research within the MSP. Scientific data is collected largely by the MSC Field Institute, through its citizen science program.

Volunteers who work with scientists or subject-matter experts on scientific research are generally referred to as citizen scientists (Citizen Science Central 2015). The purpose and role of citizen science and volunteerism in science is reviewed by Dickinson et al. (2010) and Bonney et al. (2014). Bonney et al. (2014) stated citizen science offers opportunities for individuals of many backgrounds and cultures to address scientific problems that can be used directly by the immediate community. Here, we report the results of herpetofaunal surveys at MSP conducted from 2011 to 2013. The primary goal was to establish a baseline list of documented herpetofauna inhabiting the MSP to serve as a basis for further study and monitoring.

METHODS

We conducted herpetofaunal surveys at MSP monthly from March through November over a three-year period (2011–2013) using a variety of minimally-intrusive methods. The most common method was a visual encounter survey which entailed walking slowly and quietly through the survey area, focusing on habitat likely to be productive. Most survey areas were either along trails, in washes, or at locations with unusual geologic features that would be likely to provide habitat for herpetofauna. Additionally, we lifted and inspected under natural and artificial cover to locate more cryptic species. Most field work was conducted over approximately four hours per outing, which included time spent getting into and out of each survey area. In addition, we used road cruising as a survey method when entering and leaving the public parking lot areas of MSP.

When an animal was located, the Principal Investigator (DJW) was called over to identify the species, photograph it, and collect data. Reptiles and amphibians were documented using digital photography and their location recorded using GPS (WGS 84). Additional data recorded were date, time, and ambient and ground temperatures. All data was placed on the Herpetological Education and Research Project (HERP; 2015) database and was shared with MSP management when requested. Scientific and vernacular names follow Crother et al. (2012); also see Stebbins (2003) and Brennan and Holycross (2006).

Field work was conducted by citizen scientists comprised of members from the North American Field Herping Association (NAFHA), the Arizona Herpetological Association (AHA), and MSC, and led by the Principal Investigator. Prior to initiating the surveys at MSP, volunteers from the North American Field Herping

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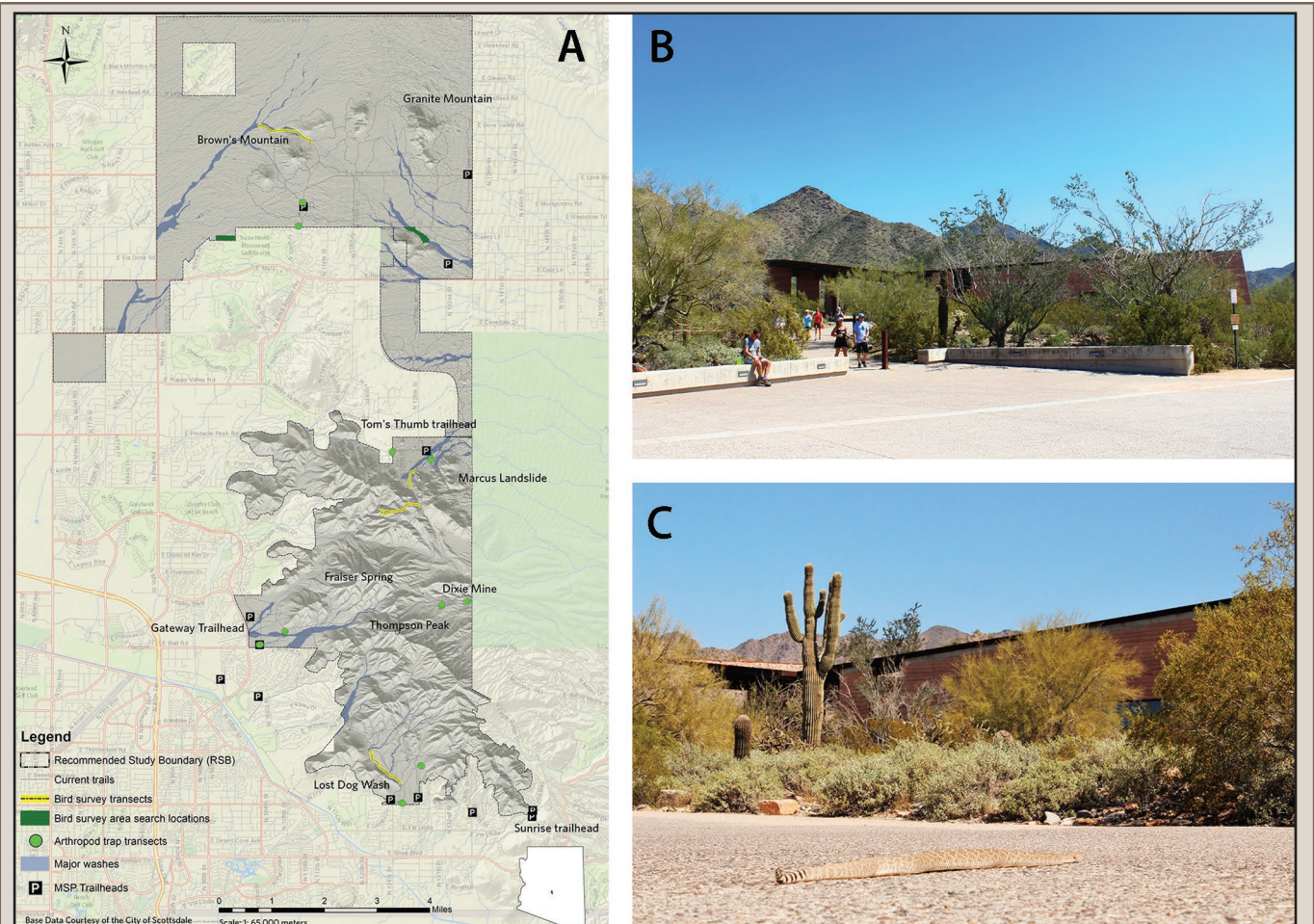


FIG. 1. (A) Map of McDowell Sonoran Preserve (MSP), Scottsdale, Arizona. (B) Entrance to MSP (Gateway). (C) Gateway of MSP with *Crotalus atrox* nearby entrance facility.



FIG. 2. Lost Dog Wash area of MSP. Typical caliche wall along a wash. Numerous winter dens of *Crotalus atrox* were found in this area.

Association (NAFHA), Arizona Herpetological Association (AHA), and MSC attended half-day training courses to assist the Principal Investigator in conducting fieldwork. In this class volunteers learned techniques and safety protocols, especially when dealing with venomous reptiles such as *Crotalus* spp. (rattlesnakes) and *Heloderma suspectum* (Gila Monster). Volunteers also learned to collect data, and were encouraged to collect observations

when hiking and working independently in the MSP. All records derived from the citizen science teams included photographic documentation and GPS coordinates. Records from the general public and trained MSP staff were also included in this survey if their sighting included a clear photograph for positive identification and accurate GPS coordinates. Nine specific survey areas were chosen to gain representation of different habitat types across the MSP (Fig. 1, Table 1). A brief summary of each survey area follows:

Lost Dog Wash.—This area is a system of dry washes leading out to a large bajada located on the southern edge of the MSP at the base of the McDowell Mountains (Fig. 2). The washes are situated primarily north to south and consist of both shallow edges to steep walls of caliche soil. The dominant plant species are *Ambrosia deltoidea* (Triangle-leaf Bursage), *Parkinsonia microphylla* (Foothill Palo Verde), and *Carnegiea gigantea* (Saguaro) (Jones and Madera 2014).

Sunrise Trailhead.—This area is located at the extreme south east corner of the MSP and consists primarily of a single large northwest to southeast oriented canyon wash that begins at a wall of decomposing granite and opens to a small bajada that empties into a larger wash/canyon below. It is bordered by the McDowell Mountains on two sides and a residential neighborhood on the east edge. The dominant plant species are *Encelia farinosa* (Brittlebush), Foothill Palo Verde, and Saguaro (Jones and Madera 2014).

PHOTOS BY DAVID WEBER



FIG. 3. Dixie Mine area of MSP.

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FIG. 4. Tom's Thumb Trailhead area of MSP.

Gateway Trailhead.—This area is located on the western side of the MSP on the edge of a bajada (229 ha). The McDowell Mountains form the eastern boundary (Fig. 1B–C). The dominant plant species are Triangle-leaf Bursage, Foothill Palo Verde, and Saguaro (Jones and Madera 2014).

Marcus Land Slide.—This 500,000 year old landslide is 1.2 km in length and located on the eastern slope of the McDowell Mountains bordered by the McDowell Mountain County Park property on the east. It is comprised of decomposing granite boulders up to roughly 10 m diameter. The dominant plant species are *Simmondsia chinensis* (Jojoba), *Acacia greggii* (Catclaw Acacia), and *Cylindropuntia acanthocarpa* (Colorado Buckhorn Cholla) (Jones and Madera 2014).

Dixie Mine.—This area is located on the eastern slope of the McDowell Mountains, and consists of a partially canyonized dry wash and 0.27 ha cottonwood / willow tree community surrounded by xeric Upland Sonoran Desert flora species (Fig. 3). On the western portion of this section is a dry wash with steep walls of either rock or caliche cut through the large bajada that is on the eastern slope. As its name implies, there is an abandoned mine shaft in the area that has been gated for visitor safety but still allows wildlife to pass through. Dominant plants are *Populus fremontii* (Fremont Cottonwood), *Salix goodingii* (Gooding's Willow), and *Tamarix chinensis* (Five-stamen Tamarisk) (McDowell Sonoran Conservancy 2014).

Fraiser Spring.—This area is located on the west slope of the McDowell Mountains and is the only perennial stream in the MSP.

It was impounded during the 1950s for ranching purposes and now flows from an approximately 1-inch diameter pipe for about 25 m. Dominant plants immediately surrounding the stream are *Typha domingensis* (Southern Cattails), *Prosopis juliflora* (Velvet Mesquite), and *Ambrosia ambrosioides* (Canyon Ragweed) (McDowell Sonoran Conservancy 2014).

Tom's Thumb Trailhead.—This area is located on the north slope of the McDowell Mountains and ranges in elevation from 792–1051 m. It is characterized by granite boulders of various sizes up to roughly 10 m diameter and numerous sandy washes (Fig. 4). The dominant plant species are Jojoba, Catclaw Acacia, and Colorado Buckhorn Cholla (Jones and Madera 2014).

Granite Mountain.—This area is located in the northern section of the MSP and is characterized by decomposing granite surrounded by flat terrain cut through by a number of wide, sandy washes. Prior to inclusion in the MSP, this area was used heavily as an off road vehicle and target practice shooting area by the public. A high tension power line corridor runs southwest to northeast past the southern portion of Granite Mountain. The dominant plant species are *Olneya tesota* (Ironwood), Foothill Palo Verde, and Saguaro, interspersed with small, homogenous patches of Creosote. Also present are small patches of clump grasses, such as *Muhlenbergia porteri* (Bush Muhley) and *Aristida* sp. (three-awn) (Jones and Madera 2014).

Brown's Mountain.—This area is located in the northern portion of the MSP and was a cattle ranch in the first half of the 20th century (Jones and Hull 2014). Among the ruins of the ranch buildings were old pieces of corrugated tin which over time became artificial cover that could be lifted to find herpetofauna. The area surrounding Brown's Ranch is a mosaic of vegetative assemblages unique within the MSP, which include relict semi-desert grassland and chaparral (Fig. 5). The dominant plant species, like Granite Mountain, consists of *Ericameria laricifolia* (Turpentine Bush), Foothill Palo Verde, and Saguaro interspersed with small patches of Creosote (*L. tridentata*) (Jones and Madera 2014).

RESULTS

Between March 2011 and November 2013, we documented 200 individual amphibians and reptiles (Table 2). This included 34 species in 11 families and 29 genera (3 species of amphibians, 31 species of reptiles; 1 species of tortoise, 13 species of lizards, and 17 species of snakes). One species, *Dipsosaurus dorsalis* (Desert Iguana) was sighted by DJW but not photographed and thus was not included in the final survey results. *Crotalus tigris* (Tiger Rattlesnake) was primarily found in the higher elevation areas of the east/ north slopes and the Granite Mountain area. *C. tigris* was found at the Sunrise, Lost Dog, Tom's Thumb, Granite Mountain, and Brown's Mountain; all between 604 m and 1055 m. The elevations of the western areas are substantially lower than the eastern/northern areas (Table 1). Nineteen *C. atrox* were located in the Lost Dog Wash, which included two separate groups of four snakes denning together in separate dens. The anurans were only found in the Frazier Spring area and the flatter sections of the Granite Mountain and Brown's Mountain areas.

One federally protected species, *Gopherus morafkai*, and a state protected species, *Heloderma suspectum*, occur in many areas of the MSP (Table 2). However, poaching continues to be a problem, as MSP staff have apprehended several MSP visitors attempting to poach both species.

TABLE 1. A list of the nine survey areas within the MSP with basic description of area, elevation range, and GPS coordinates. (*GPS coordinates are approximate to define the surveyed area. Precise localities are not provided to protect the inhabitants of the study area.)

Locality	Description	Elevation	GPS Coordinates*
Gateway	West sloping bajada. Main entrance into mountain portion of preserve.	1650 – 2100 ft 503 – 640 m	33.649 -111.858
Frazier's Spring	On western slope between Gateway and Tom's Thumb. Small riparian area.	2500 ft 762 m	33.671 -111.825
Lost Dog	Multiple deep canyon washes on south slope of mountains.	1700 – 2050 ft 518 – 625 m	33.603 -111.811
Sunrise	Extreme southeast corner of mountains with a single wash.	1940 – 2300 ft 591 – 701 m	33.602 -111.773
Dixie Mine	Abandoned mine site surrounded by small population of cottonwoods.	2275 – 2450 ft 693 – 747 m	33.654 -111.787
Marcus Landslide	Massive ancient landslide area on east facing slope of mountains.	2550 – 3900 ft 777 – 1189 m	33.680 -111.790
Tom's Thumb	North facing slope of mountains. Sonoran desert scrub at trailhead to chaparral at top of trail.	2600 – 3450 ft 792 – 1051 m	33.685 -111.804
Granite Mountain	Decomposing granite boulders all over free standing mountain in northern section of preserve.	2560 – 280 ft 780 – 853 m	33.775 -111.798
Brown's Mountain	Ancient volcanic mountain with grassy area and desert scrub at base in northern section of preserve.	2550 – 3050 ft 777– 930 m	33.773 -111.840

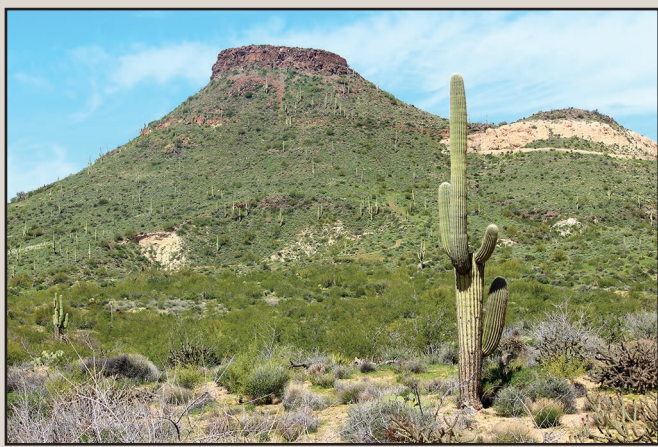


FIG. 5. Brown's Mountain area of MSP.

DISCUSSION

While other studies have been done in small sections of what would become the MSP (Beaupre et al. 1998), no prior survey of this magnitude had been done; therefore, the total number of species cannot be confirmed as a complete and absolute list. However, the range maps published in Brennan and Holycross (2006) provide a basis for comparing what can be expected in MSP with what we found. Brennan and Holycross (2006), show 41 species potentially occurring in the area which includes the MSP. We did not detect seven of these species in the survey. These species are *Spea multiplicata* (Mexican Spadefoot), *Anaxyrus woodhousii* (Woodhouse's Toad), *Anaxyrus cognatus* (Great Plains Toad), *Phrynosoma platyrhinos* (Desert Horned Lizard), *Arizona elegans* (Glossy Snake), *Phyllorhynchus decurtatus*

(Spotted Leaf-nosed Snake), and *Phyllorhynchus brownii* (Saddled Leaf-nosed Snake).

Substantial habitat destruction has occurred due to various anthropogenic influences, including fire (Jones and Hull 2014). The MSP has also been impacted by a long period of drought, decreasing the availability of ephemeral water sources that result from monsoon storms. The limited number of anurans sighted could have been a result of this phenomenon. Also, the southern portion of the MSP was sampled more because the City of Scottsdale had not purchased the northern sections until 2012, one year after the survey had begun, and access to the northern portions was limited until 2013.

This survey resulted in the first list of herpetofauna for the MSP, which will be used as the basis for long-term ecological monitoring of herpetofauna diversity and sensitive species on the MSP. Further survey studies will be needed to investigate species not encountered during these surveys as well as species that may be extirpated from the area due to prior and present human influences or an increase in rainfall negating the current drought conditions of the general area.

Baseline information such as this is often not available for parks and preserves due to lack of funding and personnel. The use of citizen scientists allowed us to gather much more information than would otherwise have been possible. Over the three year survey period we organized 25 survey days and collected 90 independent observations from trained volunteers, resulting in approximately 700 man hours in field research time. By including training and volunteer contributions to administrative duties, and time spent on public education, volunteers provided a grand total of 1,029 hours to the survey. At a rate of US \$22.37 (The Independent Sector 2015) per hour volunteers provided a net benefit of US \$23,018.73. Volunteer observations made up nearly 50% of the 200 observations.

TABLE 2. Survey results listing species encountered, number of animals found in each of the nine survey locations. This includes random sightings by trained preserve volunteers in areas outside the nine survey areas. (P) signifies protected species.

Taxon	Study area									Other Sightings	
	Sunrise	Lost Dog	Gateway	Spring	Dixie Mine	Tom's Thumb	Granite Mountain	Brown's Mountain	Marcus Landslide		
Amphibia											
<i>Anura</i>											
<i>Anaxyrus punctatus</i>				9			1				1
<i>Ollotis albaria</i>								1			1
<i>Scaphiopus couchii</i>											
Reptilia											
Testudines											
<i>Gopherus morafkai</i> (P)	1	4	1				3	3	2		1
Squamata — Lacertilia											
<i>Aspidoscelis tigris</i>		<10	<10			<10		<20			
<i>Callisaurus draconoides</i>		1			1	1		1			1
<i>Coleonyx variegatus</i>		1	2								
<i>Cophosaurus texanus</i>	1	1	2								
<i>Crotaphytus collaris</i>								2			
<i>Gambelia wislizenii</i>		1	1		1	4	4	2			
<i>Heloderma suspectum</i> (P)			2			2	2	9			
<i>Phrynosoma solare</i>	6	1	1					2			1
<i>Sauromalus ater</i>											
<i>Sceloporus magister</i>	1		1				1	2			
<i>Urosaurus graciosus</i>		<10	<10					<20			
<i>Urosaurus ornatus</i>	<10	<11	<8		<10	<20	<10	<20	<20		
<i>Uta stansburiana</i>											
Squamata — Serpentes											
<i>Chilomeniscus stramineus</i>								2	1		
<i>Coluber bilineatus</i>			1					1			
<i>Coluber flagellum</i>						1		1	1		
<i>Crotalus atrox</i>		19	5	1	1	7	5	6	6		2
<i>Crotalus molossus</i>		1	1			1	3				1
<i>Crotalus scutulatus</i>						1					
<i>Crotalus tigris</i>	2	1	1			2	2				
<i>Hypsigena chlorophaea</i>		1	1								
<i>Lampropeltis getula californica</i>	1							1	1		1
<i>Micruroides euryxanthus</i>				1				1	1		
<i>Pituophis catenifer affinis</i>		1	3				1	4			2
<i>Rena humilis</i>											
<i>Rhinocheilus lecontei</i>							1	1			
<i>Salvadora hexalepis</i>	1		1			1	1				
<i>Sonora semiannulata</i>			1		2		1	2			
<i>Tantilla hobartsmithi</i>								1			1
<i>Trimorphodon lambda</i>											1

Providing training and opportunities for volunteers to participate in baseline surveys such as this is a low-cost option for organizations to gather baseline information, with the benefits of providing public education and increasing data collection

Long-term goals of MSP and the McDowell Sonoran Field Institute include efforts to assure those areas are protected from negative anthropogenic influence (e.g., poaching, urban encroachment). Additionally, the MSP serves as an area where the community gains educational information and hands-on experiences otherwise unobtainable in a traditional classroom. Importantly, our citizen science model enabled volunteers to participate under the direction of scientists and subject matter experts, which resulted in a 50% increase in data collection while providing a deep level of education for the public.

Acknowledgments.—We thank the Citizen Scientists of the North American Field Herping Association, the Arizona Herpetological Association, and the McDowell Sonoran Field Institute for the many hours of field work. We especially appreciate the support of Lesley Forst of the McDowell Sonoran Conservancy. We extend thanks to Claire Miller and the late Robbin Schweitzer for providing access to the remote areas of the MSP and to Scott Hamilton and Kroy Eblaw of the City of Scottsdale for providing permits and to Deke Jorelman for assisting in writing the initial survey permit proposal. We appreciate the efforts of MSC stewards and visitors to the MSP for countless hours of volunteering to assist in this survey, your extra eyes and ears in the field were invaluable. Steve Jones helped in plant identification and review. Randy Babb provided valuable comments on the draft. DJW thanks Bryan Grieg Fry and Jeff Lemm for their support of the survey and patiently tolerating endless questions. Wolfgang Wüster was generous with his time in discussing an earlier version of this manuscript. We would also like to thank Dan Saenz and anonymous reviewers for their insight and assistance in helping to improve this manuscript.

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