

Citizen Science and Outreach: Gila Monsters in and Near Saguaro National Park



Adult Gila monster encountered by a visitor to Saguaro National Park on April 9th 2010. Location was about 1 mile from beginning of Cactus Forest Loop road at SNP-Rincon Mountain District. Photo courtesy of Phyllis Haight.

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Report to Desert Southwest Cooperative Ecosystem Studies Unit and Saguaro National Park

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Executive Summary

Gila monsters are long-lived, venomous lizards that are difficult to study because they spend so much of their time underground. We initiated a long-term research project on this species in Saguaro National Park in 2009, where this species is relatively common and completely protected. From the start, an important goal was to tap into the great interest in this animal by the public. The specific objective of this CESU project was to gather photographs of Gila monsters from park visitors, develop a web site dedicated to learning about Gila monsters in Saguaro National Park, and increase the knowledge of this species in the park and throughout the Tucson community through education and outreach. We developed a dedicated website to interact with the public about the project (currently <http://www.eebweb.arizona.edu/faculty/Bonine/Welcome.html>), then incorporated it with the University of Arizona's Herpcount project (www.herpcount.org), an online portal for submission of sightings, including uploading photos, locality information, weather, and habitat information. We gave numerous presentations to the public, including at the 2011 BioBlitz, as well as presentations to park staff. We also took citizens and park staff on education field trips to radio track Gila monsters in the park.

Introduction

As one of only two truly venomous lizards in the world, Gila monsters are unusual, almost mythical animals that are revered and protected in Arizona. Although seeing one can be an unforgettable experience, they are highly reclusive and spend long periods in underground burrows (Beck 2005). Recent research has revealed interesting and useful information about Gila monsters, including that a component of their saliva has potential as a treatment for diabetes (e.g., Chen et al. 2006), but they remain largely unstudied.

We initiated a long-term research program with this species in 2009 in Saguaro National Park. The park is an excellent place to study Gila monsters because the species is relatively common and completely protected, and because of the park's interest in conducting long-term studies that are necessary to truly understand and protect this long-lived, sensitive, and protected reptile.

Gila monsters elicit tremendous interest from the public. From irrational fears to zealous charisma, people are fascinated by these colorful and enigmatic lizards. In 1952 the state of Arizona passed legislation making it illegal to collect, kill, or sell Gila monsters – the first venomous animal to be afforded legal protection in North America. Past experience has shown that the public's fascination for this species can help increase support for the national parks, scientific research, and support for non-game wildlife management practices.

Citizen-science initiatives have been employed successfully in a number of contexts to encourage participation in research, foster increased education about natural resources (Cohn 2008), and provide many useful data for documenting changes in species' distribution and abundance (e.g., Cohn 2008, Bonney et al. 2009). For example, the Christmas Bird Count (www.audubon.org/Bird/cbc), has been hosted by the National Audubon Society for more than a century. More than 60,000 volunteers have documented changes in species ranges over time, including declines of native birds and invasions of non-native species, which have in turn

generated further research and subsequent conservation actions. Saguaro National Park has a long history of large-scale citizen science efforts, including with the Saguaro Census, which takes place every 10 years and tracks the abundance and health of the park's namesake species. Data collected by volunteers are invaluable for understanding our native ecosystems and how land use and climate change may impact them.

Gila monsters are venomous, which would not seem to make it an ideal animal for study by citizen scientists. However, they are not particularly aggressive, and can be photographed easily from a safe distance. More importantly, these photographs allow us to identify individual Gila monsters, because each one has a unique skin color pattern – analogous to the studies of whales, tigers, zebras, and many other species, that rely on unique color pattern differences – that does not change over the adult lifetime of the animal (Figure 1). This provides a unique citizen science opportunity for people who are generally interested in photographing Gila monsters anyway.



Figure 1 – These two photos show how a Gila monster can be ‘recaptured’ by photos. On the left is a view of the lizard’s head when found by our field crew in Wildhorse Canyon on 04 October 2010. On the right is the same Gila monster over three months later on 16 January 2011 in the same general area. By using photos and accurate location information we were able to ‘recapture’ this individual. Photo courtesy of Kris Ratzlaff (left) and Mitchell Levitts (right).

The objective of this project was to greatly expand a citizen-science project to involve park visitors and Tucson residents in gathering data on Gila monsters, while gaining and disseminating knowledge about this charismatic species in Saguaro National Park. Our specific goals included:

1. Gather photographs and sighting data of Gila monsters from park visitors and staff for use in identifying individual animals, so that we could study habitat, movement, longevity, and other life-history traits;
2. Develop a web site dedicated to learning about Gila monsters in Saguaro National Park, where photos and information could be uploaded and shared;
3. Provide the park and the public the opportunity to hear about our work through presentations at the park and outside of it;
4. Provide other educational and outreach events for the public; and
5. Expand the scope of this citizen-science census and monitoring project to include other charismatic and readily identifiable reptiles.

Methods

Citizen Science

We asked visitors to Saguaro National Park who see a Gila monster, to contact us with information about their sighting. We advertised this program in a variety of ways, but the most effective was by creating a poster (Figure 2) that we posted at several locations at the park (particularly the entrance station in the Rincon Mountain District), distributed to park staff and volunteers, and passed out to any visitors that we contacted. The poster contained contact information for the crew (updated seasonally) and web site, and requested that people safely try to take photos of Gila monsters that they see at or near the park and to record data such as date and time of sighting, location, estimated body length, behavior and the general weather conditions.

Visitors were encouraged to contact us and upload their photos to the website, where they could learn more about Gila monsters at Saguaro National Park and our research project. University of Arizona student Adrien Pesque developed the web site (initially <http://tiny.cc/GilaMonster>, currently <http://www.eebweb.arizona.edu/faculty/Bonine/Welcome.html>) that allowed us to interact with the public on this project. Later, we collaborated with UA researchers David Parizek and Phil Rosen with a project called Herp Count (www.herpcount.org), that included our Gila monsters sightings as well as sightings and observational data of many other additional reptile and amphibian species. Visitors were also encouraged to turn in NPS Wildlife Observation cards for Gila monsters (as well as other species of interest). David Parizek continues to maintain the herpcount site as a volunteer.

Outreach

We trained our crew to reach out to visitors, staff, and volunteers whenever we met them in the field and to talk about the project with them. In addition to our citizen-science initiatives and outreach in the park, we enlisted cooperation from SNP neighbors. We reached out to

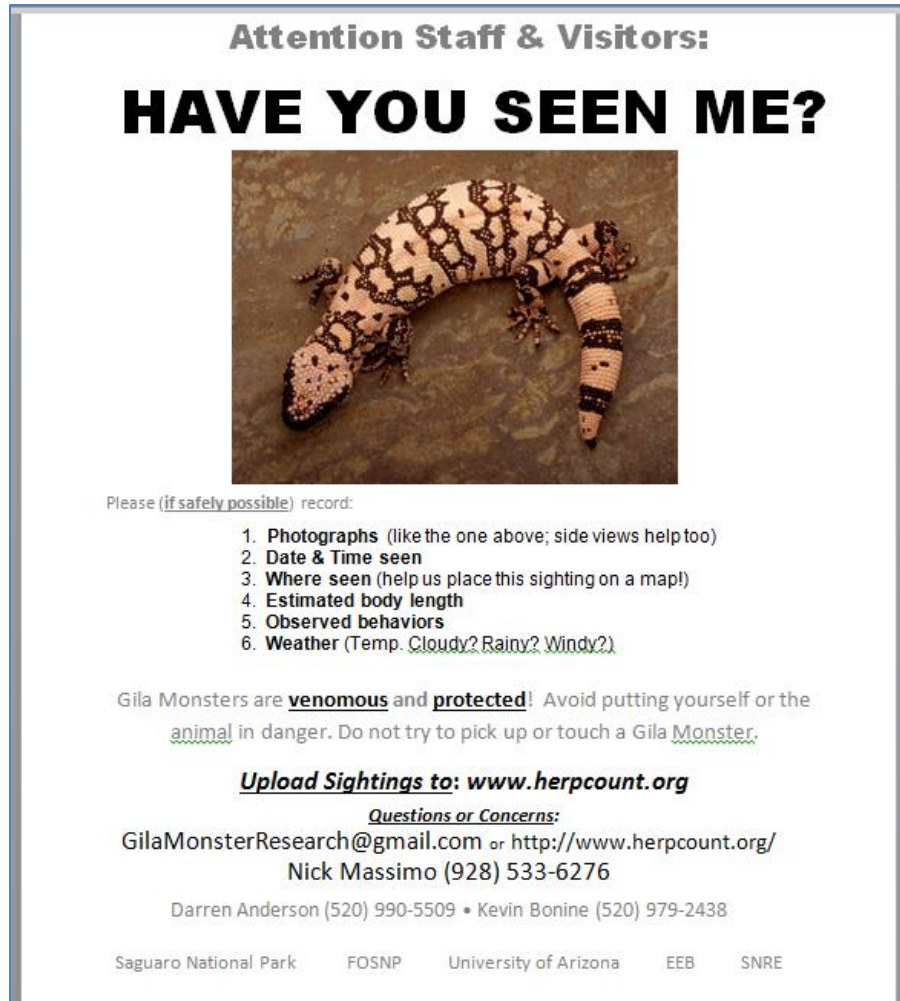


Figure 2. Educational poster created to solicit citizen science and Saguaro National Park sightings and photos of Gila monsters at the park. The poster was updated each season.

residents living in the Historic Notch Neighborhood and one undergraduate student worked specifically with them to study Gila monsters along the park boundary.

As part of this project, we offered a large number of interpretive and outreach programs to Saguaro National Park visitors, staff, and volunteers, and also offered programs outside the park. The main purpose of these programs was to educate people about Gila monsters and their conservation. In addition, we sought and received a great deal of media attention for this project. Education and outreach efforts are summarized in the second section of the results.

Results

Citizen Science

The website proved to be very useful education and outreach tool that allows visitors and staff to see their sighting on a map, along with the data collected. We received more than 403 visitor reports during 2009-2011, including reports to the website as well as a large number of official

NPS wildlife sightings cards. In 2011 we received 177 photos total (see appendix 4 for photo examples), compared to 82 in 2010 and 54 in 2009.

Examples of good and useful, average, and less useful photos can be found in Appendix A, and examples of good and useful, average, and less useful sighting cards can also be found in Appendix B. Figures 3 and 4 are examples of typical “good and useful” visitor sightings.



Figure 3. Typical visitor sighting: Gila monster on the Cactus Forest Loop road on 05 June 2009 at SNP-RMD. Photo courtesy of Gayle Morton.



Figure 4. Typical visitor sighting: adult Gila monster on the Loma Verde trail just before the Pink Hill trail on 12 Aug. 2010 at SNP-RMD. Photo courtesy of Brent Langley.

Data from citizen scientists

In 2009 park staff and visitors altogether recorded 68 Gila monster sightings, with 63 alive and 5 deceased. In 2010 the reported number of Gila monster sightings more than doubled with park staff and visitors reporting 148 sightings, 141 of which were alive and 7 deceased. In 2011, 187 Gila monsters were reported. Staff and visitor sightings are presented in Figure 5.

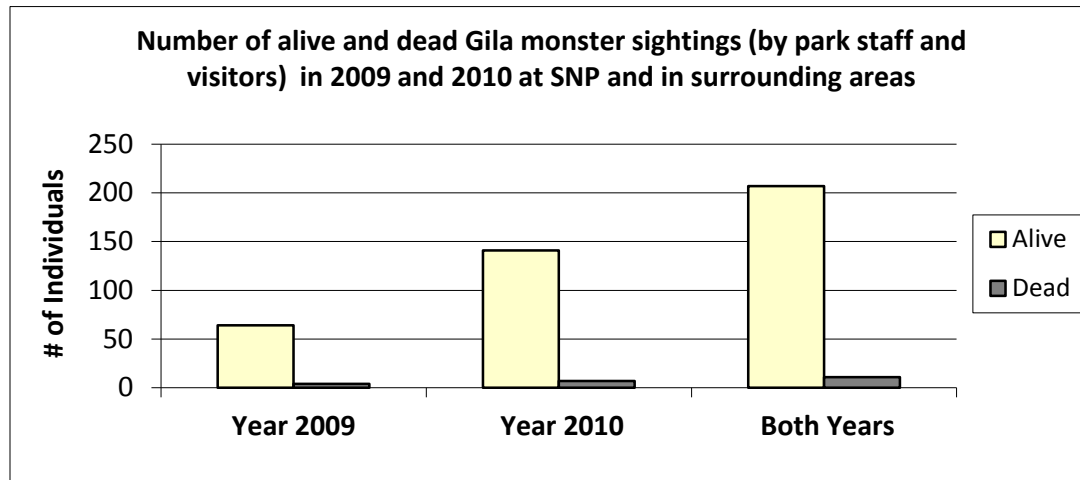


Figure 5 - Number of Gila monsters reported by park staff and visitors, alive or dead, in 2009 and 2010 at Saguaro National Park, Rincon and Tucson Mountain districts, and from adjacent surrounding areas.

In 2009, forty-three individuals were found by visitors and staff on roads, and 25 were found off road. In 2010, 80 Gila monsters were found on roads, 53 off them, and for 15 sightings the on/off road status could not be determined. Table 1 summarizes the road data for 2009, 2010, and both years combined.

Year	On Road	Off Road	Unknown
2009	43	25	0
2010	80	53	15
Both Years	123	78	15

Table 1 - Number of Gila monsters reported by park staff and visitors on road, off road, or unknown in 2009 and 2010 at Saguaro National Park, Rincon and Tucson Mountain districts, plus sightings in surrounding outside areas.

To determine the approximate age for Gila monsters reported by visitors we used photos (when present) and/or the written description (approximate length). For sightings by park staff we relied on knowledge of the personnel and on photos (when present). When it was not possible to determine age with sufficient confidence we classified the age as “unknown.” To determine the Gila monster’s stage of growth we use the following guidelines: Juveniles have a Snout-to-

Vent length of 0 - 150mm, Subadults are 150 - 220mm, and Adults are 220mm and greater (Beck 2005).

In 2009 park staff and visitors reported 15 juveniles, 6 subadults and 15 adults. For 32 individuals it was not possible to determine the age. In 2010 park staff and visitors identified 14 juveniles, 7 subadults and 63 adults. The ages of the remaining 64 Gila monsters sighted could not be determined (unknown). Table 2 lists the ages of all the Gila monsters park staff and visitors reported in 2009, 2010, and during those two years combined.

Year	Juvenile	Subadult	Adult	Unknown
2009	15	6	15	32
2010	14	7	63	64
Both Years	29	13	78	96

Table 2 - Number of Gila monsters reported by park staff and visitors. Stage of growth in 2009, 2010, and both years combined at SNP and its surrounding areas.

In 2009 most of the sightings occurred during the months of May and June (respectively 29 and 27 Gila monsters); 5 individuals were spotted in April, 2 in July, 4 in August, and 1 in September (Figure 6). In 2010 the majority of the sightings occurred in April and May, unlike in 2009 when the majority of sightings were in May and June. For example, while May continued to have a high number of Gila monster sightings (29 in 2009; 47 in 2010), April of 2010 had 42 more sightings than 2009 (only 5 in 2009, but 47 in 2010). Also, there were 27 sightings in June 2009 but only 9 sightings in June 2010. The sightings for 2010 on a monthly basis are as follows: 1 in January, 16 in March, 47 in April, 47 in May, 9 in June, 8 in July, 15 in August, 4 September, and 1 in November.

In 2009 most of the sightings occurred in the morning hours (47 individuals between 5am and 1pm). Twenty-one (21) sightings were recorded between 3pm and 10pm (Figure 7). In April, July, August, and September park staff and visitors recorded sightings only in the morning hours while in May and June sightings were also recorded in the afternoon hours (Figure 7).

In 2010 most of the sightings occurred in the morning hours (101 individuals between 5am and 1pm, out of a total of 148 sightings). Thirty-seven sightings were recorded between 1pm and 10pm. For 10 individuals, the time of sighting is unknown. The time of the sightings is spread out over the 7 months relatively evenly, except the 5 nighttime sightings, from 7pm through 10pm, were recorded in June and August. Every other sighting in the remaining months took place before 7pm.

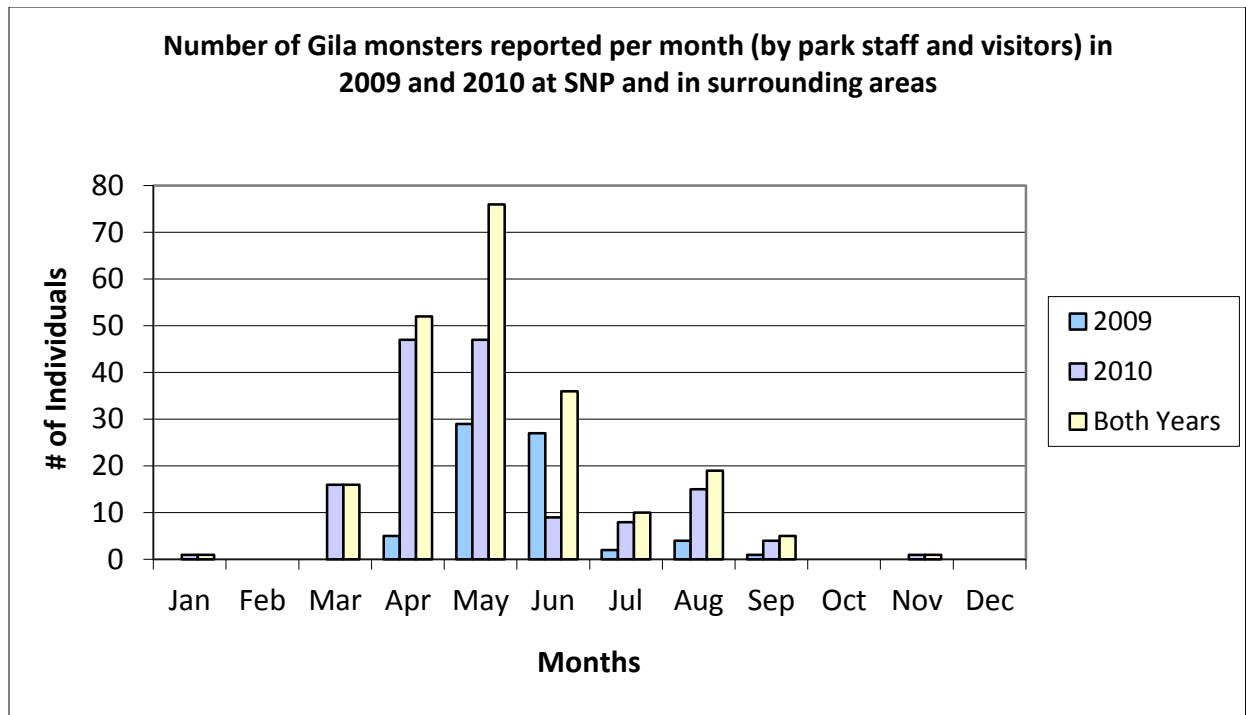


Figure 6 – Temporal distribution of Gila monsters reported by park staff and visitors. Sightings per month in 2009 and 2010 at SNP.

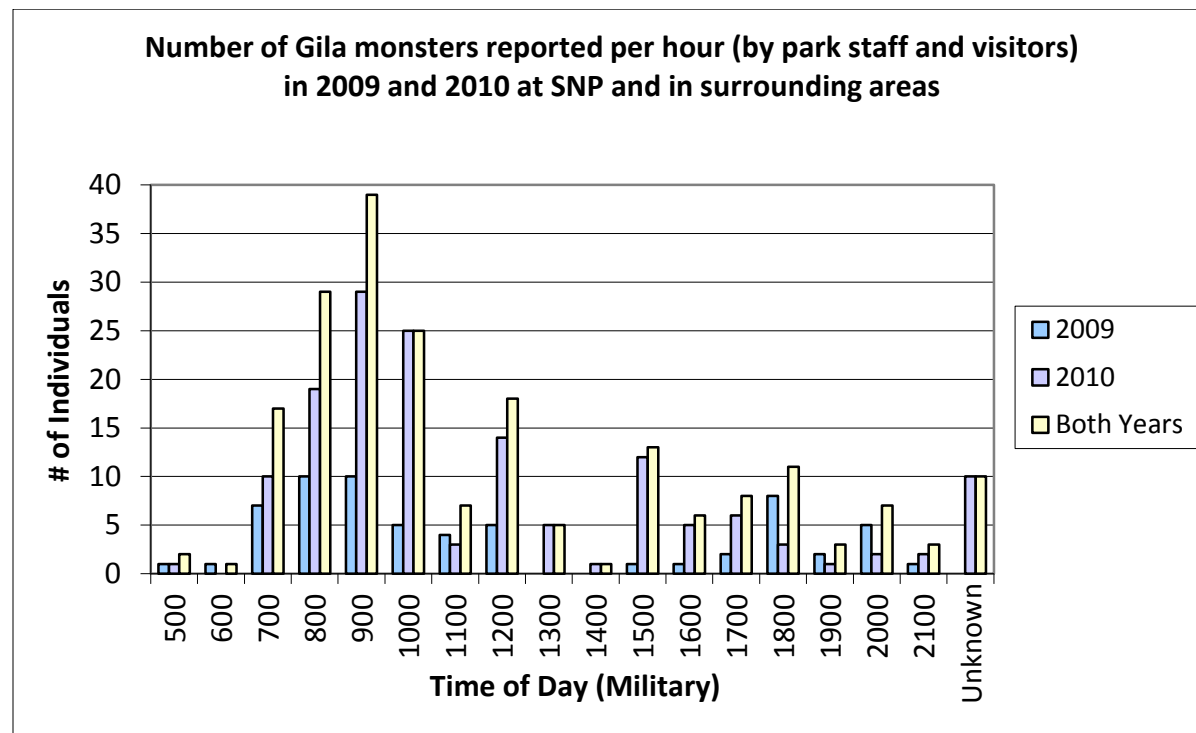


Figure 7 – Diel distribution of Gila monsters reported by park staff and visitors. Sightings per hour in 2009 and 2010 at SNP.

The definition of night for the purpose of the percentage graph below (Figure 8) is 7pm (1900 hours) to 5am (0500 hours), while during the day is defined as between 5am and 7pm. Monthly percent sighting by time of day for both park staff and visitors is presented in Figure 8 below. In both 2009 and 2010 the overwhelming majority of sightings were during the day. In 2010 the stark contrast between daytime and nighttime sightings is even more pronounced than in 2009.

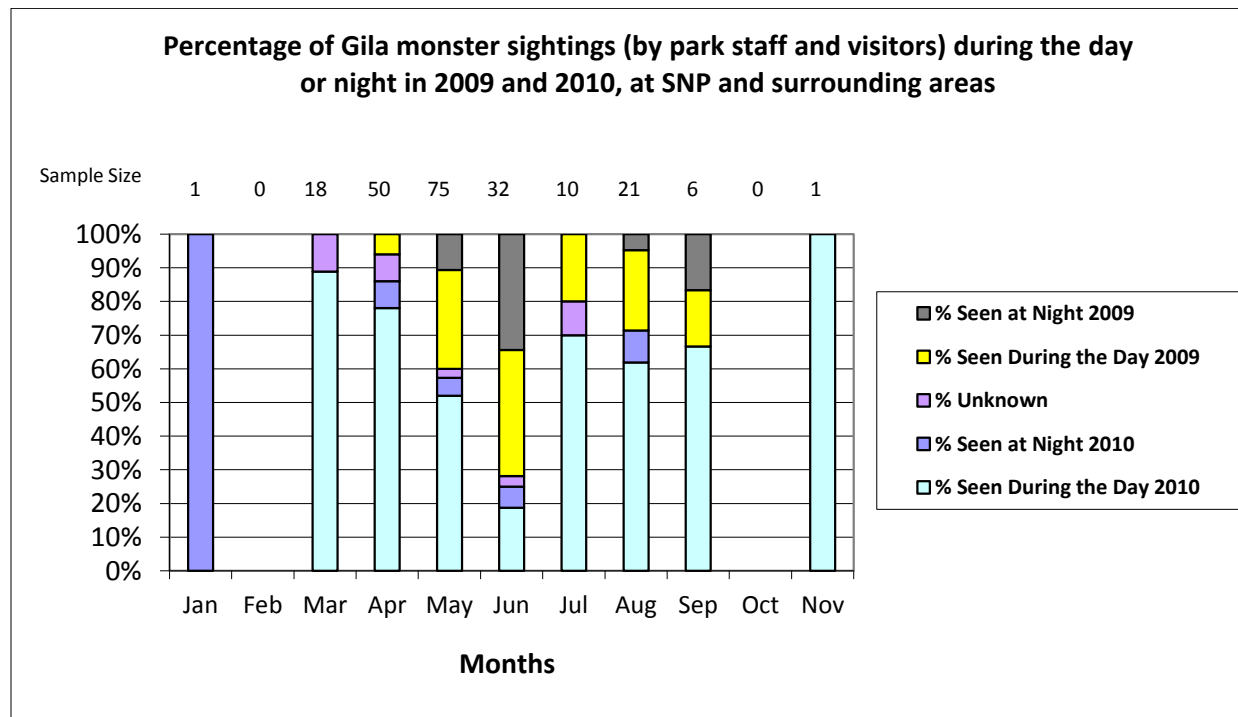


Figure 8 – Percentage of Gila monsters seen by park staff and visitors during the day or night in 2009 and 2010 at SNP and surrounding areas.

Education and outreach

We did a large amount of education and outreach during this project. For the sake of this report, we have categorized this effort as informal, interpretive programs, and media, although there is considerable overlap between these categories.

Informal. Student biotechs in the field at the park were encouraged to engage visitors in their work wherever possible. While it is not possible to quantify this work, we did a number of programs where we captured Gila monsters and processed them at the Visitor Center. These were very meaningful and successful educational experiences, attracting a number of visitors and receiving praise from the interpretive staff. In addition, on at least 8 occasions we took volunteers and interns at the park out in the field with us (Figure 9). We taught them how to radio track Gila monsters and gather other types of environmental data, and they in turn learned a lot about these animals and their habitat that they could pass on to visitors.

Interpretive programs. During 2009-2011, we made approximately 15 interpretive presentations to the public at Saguaro National Park and elsewhere. These ranged widely in terms of the types of programs and number of participants. For example, we gave presentations at several local elementary schools, to the Sabino Canyon Volunteer Naturalists, and in many University of Arizona courses. In addition, we participated in a major way during the 2011 BioBlitz. Kevin Bonine also was a feature presenter at the BioBlitz base camp (Figure 10) and received considerable media attention, including print, television, and online coverage. Our interns presented two field programs where the public was able to go out into the field and track Gila monsters. These programs were well attended and well-received (Figure 11). In addition, we featured a poster of our project at the BioBlitz (Figure 12), and made another poster for the park's visitor center about reptiles on the Cactus Forest Loop Road (Appendix C).

Other, more recent presentations include June 2013 to the Undergraduate Biology Research Program at the University of Arizona, additional schools and community groups, the annual Tucson Audubon Society wildlife festivals, and a public talk at the UA Medical Center's Duval Auditorium in October 2102 (<http://freethoughtarizona.org/pages/2012pastspeakers.htm>, and Figure 13).



Figure 9 (left). Chantal Hernandez, volunteer student intern in Resource Management at Saguaro National Park, learning to radio track Gila monsters. **Figure 10 (right).** Kevin Bonine's presentation on Gila monsters at the main stage at the base camp, 2011 BioBlitz in Saguaro National Park.

Media and publicity

We received a significant amount of media attention for the educational aspects of this project. They included:



Figure 11. Gila monster biological technician Brian Park tracking Gila monsters with visitors, a special program during the 2011 BioBlitz.

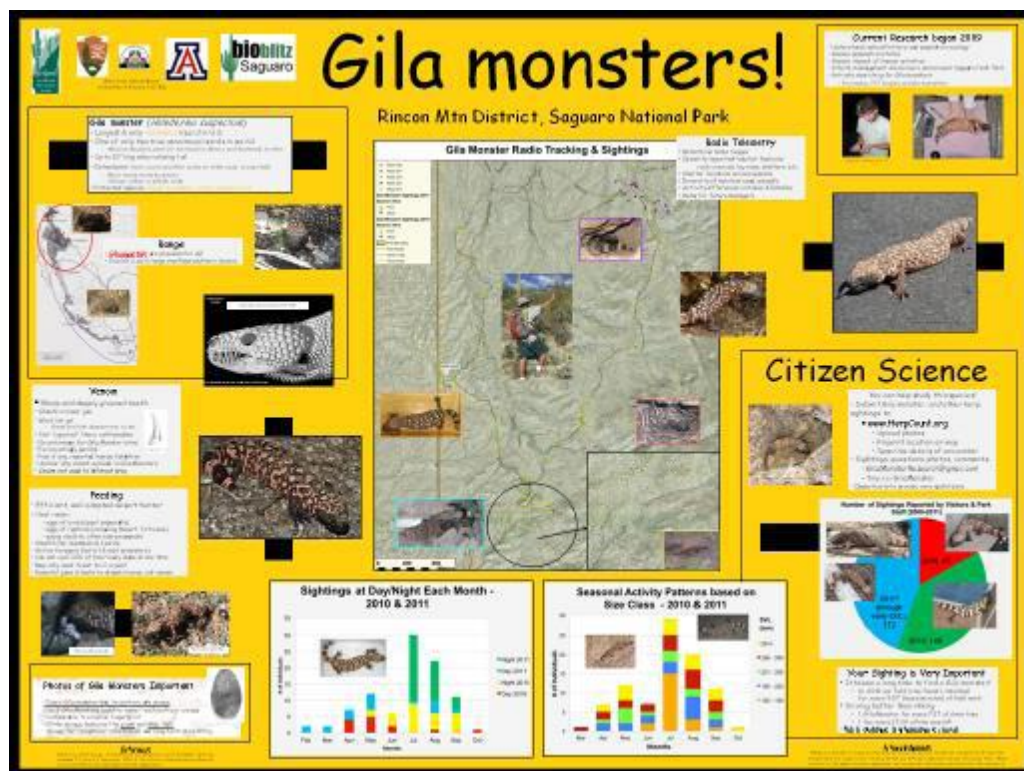


Figure 12. Poster made for the 2011 BioBlitz at Saguaro National Park. Our project prepared these posters to display at our booth at the two-day Biodiversity University festival at the Tucson Mountain District Visitor's Center. The posters have subsequently been used in other outreach and display settings on and off the UA campus.

Desert Leaf – May 2012. “Smile, Gila monsters.” Claire Rogers. Article about Gila monsters, the Herpcount.org website, and our project at Saguaro National Park.

Arizona Daily Star, October 2012: NASA Space Grant student/intern reporter, Brenna Goth. Article about our research at SAGU, with emphasis on the forthcoming genetics results. Because the article included the herpcount.org web address and a request for citizen science contributions that site has seen an increase in traffic, sometimes enough to crash it (Figure 14).

Children’s book chapter. Gila monsters and our research project are featured in a chapter of an upcoming children’s book on science in national parks by Mary Kay Carson (with photographs by Tom Uhlman).

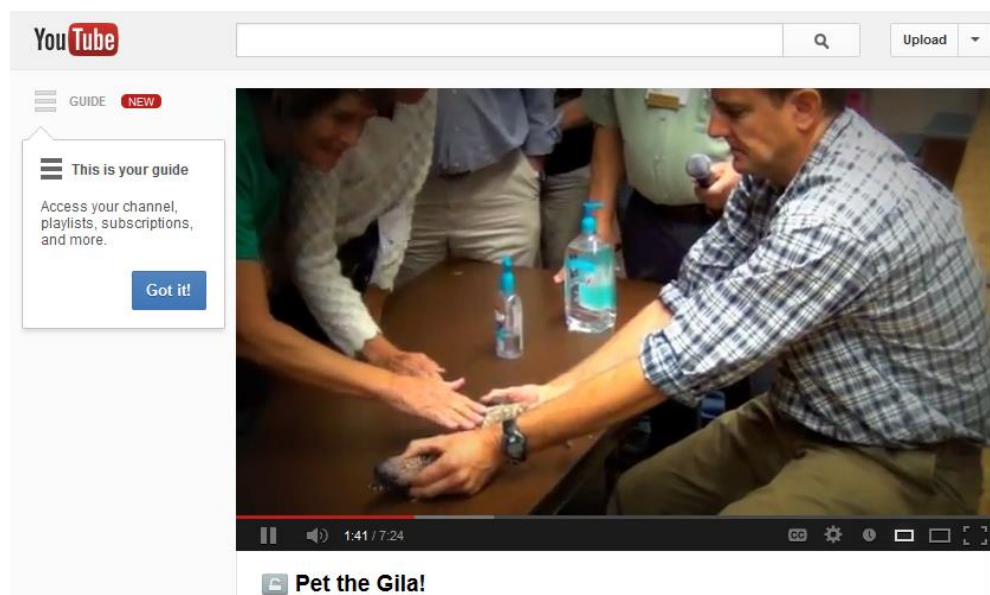
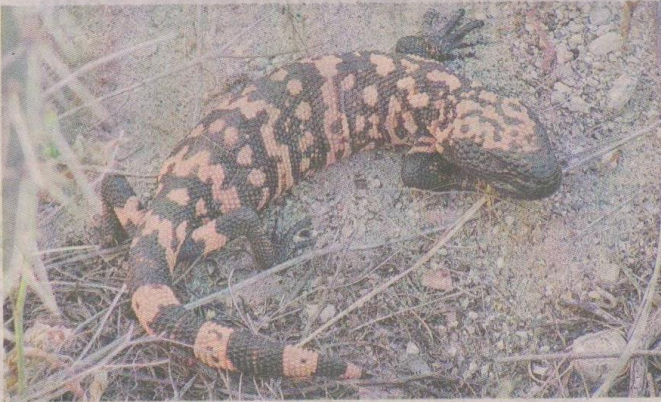


Figure 13. Excerpt from video by Oliver Spires, Tucson FreeThought. October 2012.

Discussion

Comparisons between researcher and visitor/park staff data

Comparing data collected by investigators and from sighting cards has proven to be useful for many purposes, including identification and locations of individuals. However, the data are limited and not always entirely reliable for some uses. The age of individuals spotted by visitors, for example, is usually assessed by gross approximation. Gila monsters are often described as “quite large” or “small,” so that investigators can not readily infer the approximate age. Reporting that a Gila monster was a small juvenile or a large adult is common, with not much mention of any intermediate animals. Data comparison on the behavior of Gila monster is also not relevant mostly because many of the visitors’ sightings lack reliable descriptions.



DOUG KREUTZ / ARIZONA DAILY STAR 2012

They're out there. Gila monsters are elusive and spend a lot of time underground, but now and then, residents come across one, such as this lizard spotted along a trail at Ventana Canyon in the Santa Catalinas.

Gila monsters getting DNA swab treatment

By Brenna Goth
ARIZONA DAILY STAR

Researchers at Saguaro National Park are going where few scientists have been brave enough to go before — into the mouths of Gila monsters.

A project has been tracking the venomous creatures at the park since 2009, but Gila monsters remain some of the Sonoran Desert's most elusive and little known residents. To change that, researchers are — very carefully — taking mouth swabs of the stocky, pink-and-black lizards, which are known for their painful, venomous bite.

The resulting DNA analysis, started this month, will give the Gila Monster Project — a collaboration between the park and a team led by researchers from the University of Arizona — another way to draw conclusions about an enigmatic population, said Kevin Bonine, an adjunct assistant professor in the UA Department of Ecology and Evolutionary Biology.

"The genetics part is neat — it gives us the ability to answer a whole range of questions," said Bonine, the study's principal investigator.

Field biologists are already tracking the movement of five lizards equipped with radio transmitters and hundreds of others with microchip identification.

The creatures are handled carefully by hand or with long, tonglike hemostats — and no one has been bitten yet, Bonine said.

LIVES UNDERGROUND
Gila monsters have rarely been the subject of long-term studies, Bonine said. They spend much of their lives underground and little is known about the size and status of the population around Tucson or the threats posed by urbanization.

The project has collected data

DID YOU KNOW?
Park visitors can help researchers learn more about Gila monsters by submitting their own sightings. Post details of encounters at www.herpcount.org or pick up written forms from park rangers. A cellphone application in development will allow hikers to take a picture of a Gila monster and submit it with GPS coordinates.

CHRIS RICHARDS / ARIZONA DAILY STAR 2005

The DNA study will help assess the lizard population's genetic health.

On StarNet: Search the database to find facts and photos of more Southern Arizona native creatures: azstarnet.com/critters

See LIZARD, C9

Figure 14. Article in Arizona Daily Star, October 14, 2012 on Gila monster research at Saguaro National Park.

Visitors described Gila monsters as “standing in the middle of the path” or “it moved quickly into the brush.” Obviously, the behavior of Gila monsters can be influenced by the interaction of visitors with the animal. A lot of the visitor’s sighting cards also do not contain any information, except for the fact that a Gila monster was seen, and the date and time (usually). We do not have the same information to work with and/or record for each submitted sighting (see Appendix B for various examples of public sighting cards).

Focusing on the more objective data (such as time or location of sightings) held fewer uncertainties; however, differences between researchers’ and visitors’ data may have been influenced by several factors. Comparing the numbers of individuals that are found alive and or deceased, for example, may reflect different search approaches. Researchers are out at night

more often than visitors and were searching for Gila monsters on the roads around the park (which is where most of the roadkill animals were collected) while visitors and park staff were usually in the park in the daylight. The park is also closed to visitors at sunset prohibiting them from driving around at night. The vast majority of people visiting the park do so during daylight hours. Also, summer is not the peak tourist season as the park becomes very hot, so visitation is down, meaning the possible number of people out and about with the opportunity to see Gila monsters decreases. This discrepancy can also be observed in the number of sightings per time of the day where most of the sightings from visitors and park staff occurred in the morning and early afternoon; whereas our summer field data clearly shows we are finding more Gila monsters when we are searching for them at night.

Similarity between the two sources includes the number of individuals found on and off road. From both sources, the majority of sightings occurred on road, where Gila monsters are easy to spot. These data are likely biased by the fact that both visitors and researchers spent more time on road than off road; however, the data also provides important information on the behavior of Gila monsters and on the impact of modifications of their natural habitats.

Other aspects of the data demonstrate that our sightings often differ from those of the park staff and visitors. For example, in 2009 park staff and visitors reported the most Gila monster sightings in April and May. After that there was a sharp decrease in the amount of sightings reported. This is not because Gila monsters are less active through the summer months: our project found the highest number of individuals in June and July, processing 10 Gila monsters in each month. The 20 total Gila monsters we found in those two months is greater than the total number reported by all park staff and visitors for the same time frame, which was only 17. Once again, there are a variety of reasons for these differences in sightings. The park does not allow cars in after sunset and due to the very hot weather conditions in SNP during the summer, tourist visitation declines. This is one possible downside to citizen science. People are only going to report on sightings when they can be out or if it is desirable for them to be out. Driving or hiking around SNP in the spring is a lot more pleasant to people than doing so in the summer, when daytime temperatures often climb past 105 degrees Fahrenheit (41 degrees Celsius). Thus the ability for visitors to gather data on Gila monster's summer or nocturnal activities is limited.

Education and outreach

An indirect aspect of citizen science is engaging visitors by talking to them about Gila monsters when we are at the park. Whenever we encountered people on trails, at trailheads, at scenic overlooks, at picnic areas, or milling about at the Visitor's Center, we struck up conversations about Gila monsters and our study. Our field crew made it a point to regularly hand out a small version of our outreach flyer. We found that the majority of people were very receptive and interested in Gila monsters and our project. We believe that engaging the public in this way is extremely beneficial. By talking to people about Gila monsters, and taking the time to answer their questions, we are involving them in the project, educating them, and hopefully fostering accommodation of wild Gila monsters.

Most people enjoyed telling us of their own Gila monster sightings, and were appreciative to learn that when they took the time to report their sighting it was being used and catalogued. We also were able to answer basic questions about Gila monsters and provide people with appropriate background information, such as when Gila monsters are most likely to be out, their behavior and hunting habits, and the seriousness of their venom. Since the Gila monster is a very unique, iconic, and venomous species, we have found that a lot of false information circulates about these creatures. For instance some members of the public have stated that Gila monsters charge and attack unsuspecting desert hikers, or believe bites are fatal. Debunking these myths help people better understand Gila monsters and the role these lizards play in our desert ecosystem.

Ultimately, volunteers from the community, Saguaro National Park staff, students from the University of Arizona, interns from multiple universities, and a small, part-time, paid field crew of 1-2 (depending on the year), all worked together to make the research and associated citizen science and outreach for this project possible. Students that volunteered or worked on the project have gained tremendous knowledge and field skills, but also take the knowledge and enthusiasm into the community and K-12 classrooms. Talks to groups at the park and places like Sabino Canyon help us share the research findings and also the outreach message. Impromptu encounters of our field crew, especially when observing a Gila monster, with visitors at Saguaro National Park are especially meaningful and memorable experiences.

Finally, this project provided resources that have allowed for some longevity (we now have nearly 5 years of data on Gila monsters at the park) and to engage the public in creating a long-term research project. We have received support from the Friends of Saguaro National Park and private individuals associated with the Friends. Long-term monitoring of any species is difficult to sustain, but is essential for understanding the major factors that are important in their conservation. For a national park such as Saguaro National Park, where Gila monsters are protected not only for visitors to enjoy now, but in the future, a citizen-based study such as ours is more likely to obtain this long-term information, but to do so in such a way that at the same time enhances conservation through the direct involvement of people who care.

Acknowledgements

In addition to the Desert Southwest Cooperative Ecosystem Studies Unit, the Friends of Saguaro National Park has supported and funded this work. We are grateful to Larry Norris and Pat O'Brien of the DS-CESU, as well as Bob Newton (FOSNP) and many others at the Friends. Employees and volunteers of Saguaro National Park, at both Rincon and Tucson Mountain Districts, notified us of Gila monster sightings, donated field time, collected sighting cards, solicited reports of observations, granted permits, and generally supported the work. Natasha Kline provided myriad Gila monster reports and photos. Dave Parizek is the force and expertise behind HerpCount.org, the citizen-science portal we rely upon. Phil Rosen, Cecil Schwalbe, Roger Repp, and the late Charles Lowe have been valuable resources and have furthered our collective understanding of herpetofauna in the Sonoran desert region. James Jarchow and Dale DeNardo assisted with ecological, veterinary, and surgical expertise. Taylor Edwards, Matt Kaplan, and colleagues at U of A's Bio5 have been invaluable for the genetic aspects of our research. Eric Bjorkstedt provided help with several maps. The School of Natural Resources and the Environment and the College of Science's Department of Ecology and Evolutionary Biology,

both at the University of Arizona, have facilitated our work. Special thanks to the park visitors and neighbors who enthusiastically contributed time, observations, and data. Finally, thanks to all of the students, employees and volunteers who have moved this project forward since its inception in 2009. These individuals include: Brian Park, August 2010-April 2012; Darren Anderson, May 2011-Present; Dave Edmunds, September 2011-December 2011; Nicholas Massimo, February 2011-October 2011; Thomas Conner, February 2011-June 2011; Kris Ratzlaff, August 2010-January 2011; Adrien Pesque, January 2010-February 2011; Kim Baker, January 2010-December 2010; Tommaso Cioni, fall 2009-summer 2010; Jace Lankow, summer 2009; and Sarah Humphrey, spring and summer 2009.

Literature Cited

- Beck D.D. 2005. *The Biology of Gila Monsters and Beaded Lizards*. University of California Press, Berkeley
- Bonney, R., C.B. Cooper, J. Dickinson, S. Kelling, T. Phillips, K.V. Rosenberg, and J. Shirk. 2009. Citizen science: a developing tool for expanding science knowledge and scientific literacy. *BioScience* 59:11, 977-984.
- Chen T., H. Kwok, C. Ivanyi, and C. Shaw. 2006. Isolation and cloning of exendin precursor cDNAs from single samples of venom from the Mexican beaded lizard (*Heloderma horridum*) and the Gila monster (*Heloderma suspectum*). *Toxicon* 47:288-95.
- Cohn, J.P. 2008. Citizen science: can volunteers do real research? *BioScience* 58:3, 192-197.
- Crimmins, T.M., M.A. Crimmins, D. Bertleson, and J. Balmat. 2007. Relationships between flowering diversity and climatic variables along an elevation gradient. *International Journal of Biometeorology* 52:353-366.
- Guido, Z. 2008. Phenology, citizen science, and Dave Bertelsen: 25 years of plant blooms on the Finger Rock Trail in the Santa Catalina Mountains. *Southwest Climate Outlook* August:3-5.
- Lepczyk, C.A. 2005. Integrating published data and citizen science to describe bird diversity across a landscape. *Journal of Applied Ecology* 42:672-677.

Appendix A: Examples of photos sent in by the public

Figure A-1 – Good and useful photo from the public. This Gila monster was spotted on 22 Aug. 2009 at SNP-RMD. With this photo we can see the Gila monster's pattern on its head, back and tail. We also can estimate its body size, as well as its health because the tail is rather plump looking. Components of the habitat are visible as well. Photo courtesy of Greg McCown.



Figure A-2 – Average photo from the public. This Gila monster was found 19 Apr 2010 at SNP-RMD. A lot of the photos we receive are not too close up, because people do not want to get too close to Gila monsters for obvious reasons. Also, a lot of the photos we receive are of Gila monsters crossing the road. While this photo is not as up close as the photos we take of the Gila monsters we find, it is good enough to record some of its pattern, its behavior, and the relative size of the animal. Photo courtesy of Kathleen Cricket Windsong.



Figure A-3 – Less useful photo from the public. This Gila monster was found on 28 Apr. 2010. The Gila monster is hard to identify in this photo. It is too far away and the photo is too muddled to distinguish its back pattern. You can make out some of the tail pattern, but not much. It is very hard to see any features on the Gila monster. While we do regularly receive photos that are obviously taken from inside an automobile, this is one of the less useful, although still appreciated, ones we have been sent.



Appendix B: Examples of wildlife observation cards sent in by the public (to respect privacy, names and contact information is excluded from each card).

Figure B-1 – Good and useful sighting card – The observer has listed a specific location, what district the sighting was in, the date, time, and weather. The description is also very detailed, complete with an easy to read drawing of the Gila monster's distinctive tail. The observer also left contact information (masked here in this report) if we need to follow up with them.

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Natural History Field Observation

Observation: Gila Monster

Location: 5 mi E Garwood Dam Carrillo (RMD) TMD

Date: 4/26/10 Time: 4:20 a.m./p.m.

Weather: Clear/Sunny 88°F

Description, Behavior, Number, Sketch, Map, Etc. (use reverse if necessary)
If you have a digital photograph, please send it to SAGU_Information@nps.gov

14" black with pink/orange mottling. Broad head with spots. It was in middle of trail walking E. Heard me coming, only moved a few feet off trail →

BE ACCURATE - DO NOT GUESS

Observer: _____ (cont.)



The card continues on the back:

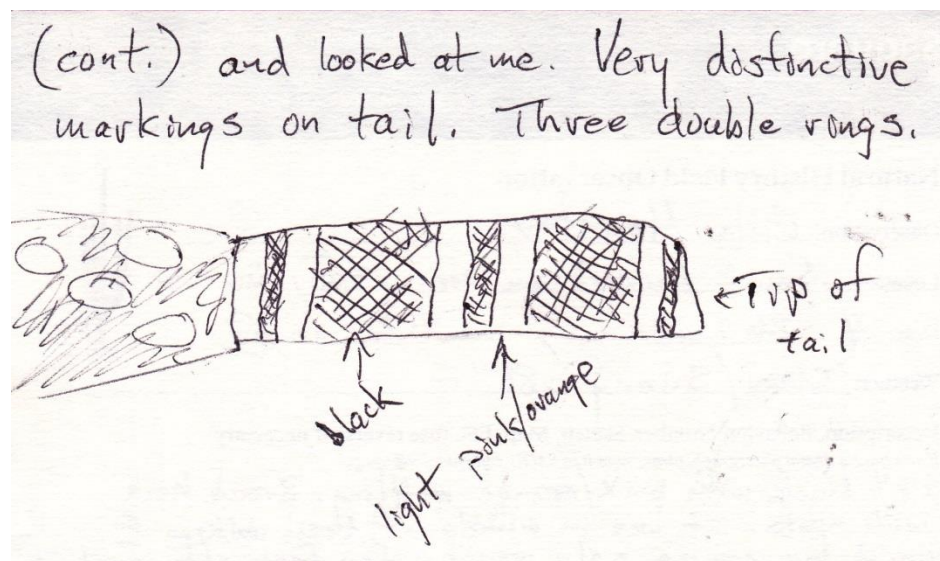


Figure B-2 – Average sighting card - The location, date, park district, time, and weather are listed. On average cards the descriptions are usually vague. For example, we cannot quantify what the observer means by “normal pace.” Most people do leave contact information, which is very useful if we need to follow up.

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Natural History Field Observation

Observation: saw gila monster

Location: near Freeman Hemstead Trailhead RMD / TMD

Date: 4 / 8 / 2010 Time: 4:30 a.m. / p.m.

Weather: sunny, beautiful 80°+

Description, Behavior, Number, Sketch, Map, Etc. (use reverse if necessary)
 If you have a digital photograph, please send it to SAGU_Information@nps.gov

*crossing the road at a normal pace
close to one foot*

BE ACCURATE - DO NOT GUESS



Figure B-3 – Less useful sighting card – The location is only listed as “Rincon Saguaro NP.” This is not specific and in reality could be anywhere in the park. The date and time are listed along with a very general weather description. But besides that the rest of the card is blank. No description at all of the Gila monster, of its length or behavior. Also no contact information is listed so there is no way for us to follow up and gather more information on this sighting.

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Natural History Field Observation

Observation: GILA MONSTER.

Location: RINCON SAGUARO NP. RMD / TMD

Date: 02 / 05 / 2010 Time: 1 pm a.m. / p.m.

Weather: CLOUDY

Description, Behavior, Number, Sketch, Map, Etc. (use reverse if necessary)
 If you have a digital photograph, please send it to SAGU_Information@nps.gov

BE ACCURATE - DO NOT GUESS

Observer:
 Name: _____
 Address: _____

Phone: (____) _____ - _____
 Email: _____

Please return cards to the visitor center



Appendix C. Educational poster on wildlife observed on the Cactus Forest Loop Road.

