Bat research and interpretive programming

Increasing public interest in Pipe Spring National Monument

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WATER PLAYS THE STARRING role in the history of Pipe Spring National Monument in northern Arizona. The natural springs that emerge here are one of the few stable water sources in an arid strip of desert sandwiched between Grand Canyon and Zion National Parks. Wildlife, prehistoric people, Paiute Indians, Mormon pioneers, and national park visitors have all used this oasis as a life-sustaining rest area. Here the Sevier fault routes groundwater from an adjacent aquifer to the surface, where three springs emerge from the sandstone.

Mormon pioneers developed the springs around 1880, catching the water in basins or ponds and diverting it for irrigation and for cattle and sheep. They also constructed a fortress-like structure directly over the main spring. Known as Winsor Castle (fig. 1), this historical building is symbolic of the struggle over water rights that ensued and is a central feature in the story of Pipe Spring National Monument.

The ponds continue to provide a constant supply of water for livestock and irrigation for the gardens and fruit trees that reflect the park's rich history. These open water sources also benefit local wildlife. At least 21 species of squirrels, rats, shrews, and mice are present in the area, all of which are food sources for coyotes, bobcats, badgers, and foxes (Bogan and Haymond 2001). Red-tailed hawks and great horned owls also spend time in the trees surrounding the ponds in hopes of gaining an easy meal. Additionally, bats rely on the ponds as a place to hunt insects.

Repairs

Over time the stone masonry of Winsor Castle and the nearby ponds has deteriorated and is in need of repair. Cracks in the mortar and leaks in the clay-bottom pond basins have led to water loss in the surrounding soil, muddied the area, and left less water for garden and orchard maintenance. The ponds need to be drained in order to fix these problems. While the repairs are important for the park, draining the ponds in summer when water is especially critical to wildlife could be devastating. Unfortunately summer is also the best time of year to carry out the rehabilitation work. This conflict prompted park staff to review options for timing of the construction to minimize the associated impacts it would have on wildlife.

Of all the wildlife that depend on the ponds, bats are the only ones that need an open water source with a calm surface. While a small squirrel or fox may be able to obtain water from a small puddle or stream, bats require a water source that will allow them to drink on the wing. Furthermore, the bat diversity at Pipe Spring National Monument is represented by some of the largest and smallest bats in the states of Utah and Arizona. Much like airplanes, big bats require a larger flyway when drinking, while the smaller, more agile bats can often drink from small cattle troughs. Park

Figure 1. Historical Winsor Castle and one of two ponds at Pipe Spring National Monument where the bat surveys and interpretive activities took place.

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officials decided that if the ponds required draining for maintenance, these repairs should be made when bats' use of the ponds is at its lowest level for the year.

Need for bat research

Bat surveys at the monument have been going on for more than 30 years, but nearly all of this work has taken place from June through August, the peak time for bat activity (Kim and Johnson 2004; Johnson 2005; and Tyburec 2011). To identify optimal timing for pond maintenance, surveys needed to begin in early spring, when migratory bat species arrive at the monument, and continue until late November, when their activity sharply declines. Our intention was to determine whether some bat species use the ponds year-round or they only rely on the ponds in the hot summer months. We also wanted to know how much seasonal variation in use by different bat species exists.

The surveys began in September 2011 and ended in November 2012. Over this time we made acoustic recordings of bat activity at the ponds for one night every two weeks. This gave us the data we would need to determine species and numbers of bats. This technique involves coupling a full-spectrum ultrasonic bat detector (Petterson D240X, Pettersson Elektronick) to an H2 (Zoom) digital voice recorder. We placed the detector 3 m (9 ft) aboveground by strapping it to a large cottonwood tree and facing it toward the ponds. It was protected from the elements by a PVC housing constructed from a large electrical junction box. The audio signal was routed through a 4-meter-long (12 ft) audio cable to the recorder, which was housed in a weather-resistant toolbox at the base of the tree. This setup allowed both the recorder and the detector to run off of a stable power source and facilitated data downloading and periodic changing of digital storage media (8 GB flash memory) used by the recorder.

The bat detection system was turned on at sunset and run continuously through the night to provide approximately 12 hours of monitoring. Analysis of the data was achieved using Sonobat 3.03 software (USWest 2010). We note that acoustic identification such as this is probabilistic, and not as reliable as identifying bats through morphological or genetic methods. For this reason we conducted mist-netting events each month, as close to the new moon phase as possible. A typical survey consisted of deploying three nets, 6–9 m (19–30 ft) in length, in the following array: one net on the sidewalk passing between the two ponds and two nets around the pond perimeter (fig. 2). We opened the nets at sundown and closed them three hours later. During this time handlers carefully removed bats caught in the nets, took measurements, weighed and identified them to species, examined them for parasites, and released them. Bats were also inspected for signs of white-nose syndrome, a fungal infection that is sweeping across the nation, reducing bat populations. The bat handlers took precautions to guard against spreading disease between bats by using disposable gloves for each capture. Furthermore, all research crew members were vaccinated for rabies and were trained in bat handling.

A focal point for interpretive programs

Netting generated a fair amount of excitement among park staff and visitors, and it quickly became apparent these periodic events could serve as a foundation for new interpretive programs to increase public awareness of and appreciation for bats. Thus the park interpretive team quickly went about creating posters and sending out e-mails advertising these public events.

In the survey's first year a group of college students who were visiting as part of the Partners in Parks program attended one of the mist-netting events. A number of Boy Scouts participated in the evening activities to fulfill requirements for the mammal study merit badge. We also began to bring in droves of introductory biology students from Southern Utah University (SUU) who, despite varying career interests, might benefit from engaging in the scientific research. Others served as interns under the SUU–National Park Service Intergovernmental Internship Cooperative. We soon expanded these public netting events to include other topics, such as "Bats and the Night Sky," which paired an evening of astronomy with bat natural history. "Bats and Bugs" soon followed, allowing the public to view insects caught at the same time as bats. Finally, "Bats and Salamanders" allowed participants to net salamanders from the ponds and learn about their life histories.

In all, approximately 600 participants enjoyed an evening under the stars learning about bats and a variety of other topics. We drew participants from nearly 100 miles (161 km) away, not to mention travelers who just happened to be at the monument and decided to wait for the evening programs. These engaging experiences help visitors connect to the monument in a very personal way (fig. 3).

Results of bat research

One of the most astounding features of Pipe Spring National Monument is its bat species diversity (table 1, page 18; fig. 4, facing page; and fig. 5, page 19). In summer we often captured more than 20 bats per night, representing eight to nine species. Though we caught fewer bats in spring and fall, we often documented different species with each capture. For example, one evening we netted only four individual bats, yet remarkably all four were different species. As expected, summer months were the most species-rich; diversity plum-

meted by mid-November and remained low until the following May (table 1, fig. 5).

Netting events also resulted in capturing one of the largest and the smallest bat species known in the area. The smallest bat species in the United States, the western pipistrelle, has a light yellow or grayish coat with dark black wings, ears, and rostrum (tail area) (Whitaker 1998). Forearm measurements typically range from 27 to 33 millimeters (1.1–1.3 in); by comparison, forearm measurements of the much larger pallid bat are typically twice (50–60 mm [2.0–2.4 in]) that length. This type of observation created an outstanding backdrop for the interpretive programs and facilitated discussions about how each species interacts differently with its environment. Accordingly, program attendees experienced the great variety of bats firsthand and seemed to develop an appreciation for the area's biodiversity.

Though 18 of the 28 bat species known in Arizona were identified at Pipe Spring, some were more prevalent than others. Our acoustic and netting data suggest that far more western pipistrelles and Mexican free-tailed bats use the ponds than do any other species (acoustically 22% and 24%, respectively; see fig. 4). Pallid bats, fringe-tailed myotises, California myotises, and big brown bats are the next most plentiful species. The remainder are in relatively small abundance.

We also learned that Pipe Spring National Monument may serve as a migratory stopover for spotted and western mastiff bats. These species were captured or detected only in late spring; they then disappeared and reappeared in August or September. This pattern also fit for Allen's big-eared bats; however, earlier mark-and-capture research of this species associated it with a nearby day roost that could also possibly have served as a maternity roost. Acoustic and mist-netting data also suggest that a number of species were transitory in their use of the ponds, as they were present one month, gone the next, and then reappeared the following month (see table 1 for long-eared myotis and Townsend's big-eared bat). This come-and-go pattern may suggest that Pipe Spring is one of several areas used by these bat species in their overall foraging habitat on the Arizona strip. In contrast, pallid bats, California myotises, fringe-tailed myotises, Yuma

Figure 2. Researchers erected a mist net adjacent to one of the ponds for the evening bat surveys. The need for pond repair stimulated the surveys, with the goal of determining the best time of year for facilities management work.

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Figure 3. Park visitors inspect a bat netted during one of the popular interpretive programs that coincided with the bat surveys at Pipe Spring.

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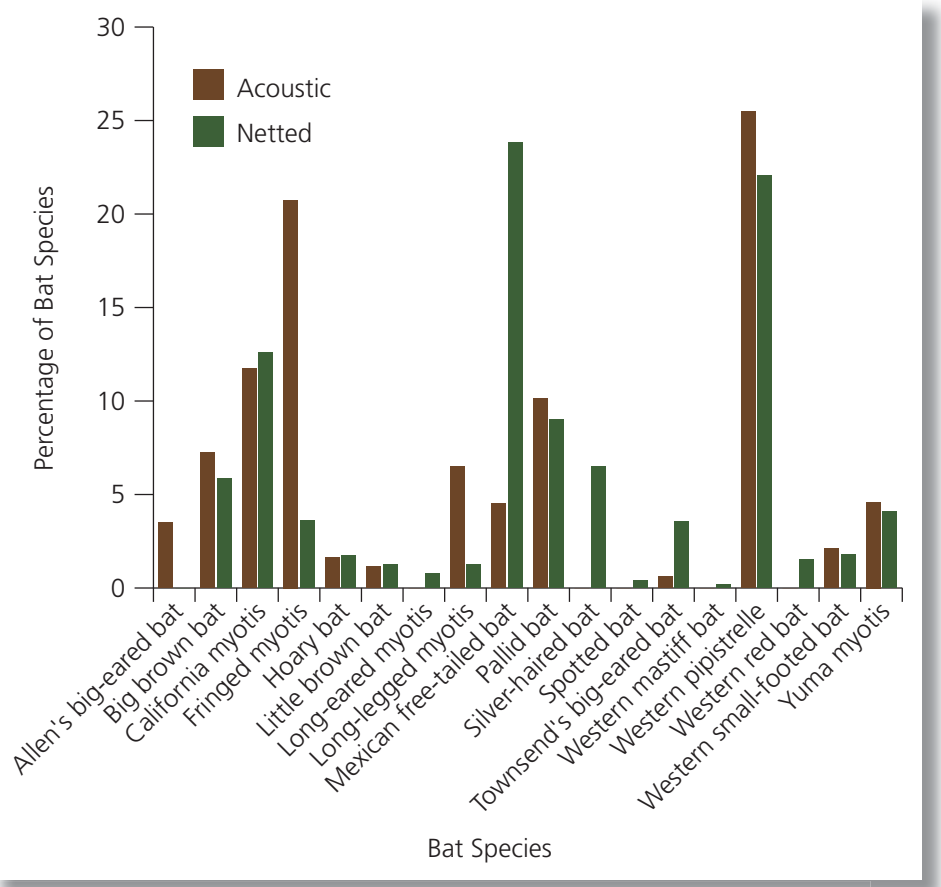

Figure 4. Percentage of bat species netted and detected acoustically during 2011–2012 surveys at Pipe Spring.

Table 1. Bat species detected acoustically (✓) and number of individuals net-captured by month, 2011–2012, Pipe Spring National Monument, Arizona

Species	Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Total Netted
Allen's big-eared bat (*Idionycteris phyllotis*)		0		0	✓	1	✓	1	✓	4	✓	1		0		0		0	7
Big brown bat (*Eptesicus fuscus*)		0	✓	0	✓	5	✓	7	✓	0	✓	1	✓	0	✓	1		0	14
California myotis (*Myotis californicus*)	✓	0	✓	0	✓	6	✓	4	✓	3	✓	3	✓	3	✓	7		0	26
Fringed myotis (*Myotis thysanodes*)		0	✓	1	✓	13	✓	8	✓	4	✓	5	✓	7	✓	3		0	41
Hoary bat (*Lasiurus cinereus*)		0		0	✓	1	✓	1		1	✓	0	✓	0	✓	0	✓	0	3
Little brown bat (*Myotis lucifugus*)		0		0	✓	0	✓	0	✓	0	✓	1	✓	1	✓	0		0	2
Long-eared myotis (*Myotis evotis*)	✓	0		0	✓	0	✓	0	✓	0		0	✓	0		0		0	0
Long-legged myotis (*Myotis volans*)		0		0	✓	7	✓	1	✓	2	✓	1	✓	0	✓	2		0	13
Mexican free-tailed bat (*Tadarida brasiliensis*)		3	✓	1	✓	0	✓	1	✓	0	✓	0	✓	2	✓	3		0	10
Pallid bat (*Antrozous pallidus*)		0	✓	1	✓	4	✓	6	✓	6	✓	2	✓	0	✓	1		0	20
Silver-haired bat (*Lasionycteris noctivagans*)		0		0	✓	0	✓	0	✓	0	✓	0	✓	0	✓	0		0	0
Spotted bat (*Euderma maculatum*)		0		0	✓	0		0		0		0	✓	0	✓	0		0	0
Townsend's big-eared bat (*Corynorhinus townsendii*)		0		0	✓	0	✓	1		0	✓	0	✓	0	✓	0		0	1
Western mastiff bat (*Eumops perotis*)		0		0	✓	0		0		0	✓	0	✓	0	✓	0		0	0
Western pipistrelle (*Pipistrellus hesperus*)	✓	1	✓	1	✓	8	✓	9	✓	19	✓	9	✓	3	✓	1	✓	0	51
Western red bat (*Lasiurus blossevillii*)		0		0	✓	0	✓	0	✓	0	✓	0	✓	0	✓	0		0	0
Western small-footed bat (*Myotis ciliolabrum*)		0		0	✓	0	✓	3	✓	1	✓	0	✓	0	✓	1		0	5
Yuma myotis (*Myotis yumanensis*)	✓	0	✓	0	✓	2	✓	0	✓	1	✓	3	✓	1	✓	1	✓	1	9
Total bats net-captured	4		4		47		42		41		26		17		20		1		202
Total bat species captured	2		4		9		11		9		9		6		9		1		18
Percentage diversity[1]	11		22		50		61		50		50		33		50		6		100

[1]Figured as bat species captured divided by 18 acoustically detected species.

myotises, and western pipistrelles appear to stay in the area year-round.

One particularly frustrating facet of this study was the acoustic detection of species we were never able to capture (see fig. 5). Acoustic records indicate that spotted bats, western mastiff bats, silver-haired bats, long-eared myotises, and western red bats are all present in the area. Some of these bats share commonalities in that they are high-altitude, fast-flying species that typically forage well aboveground. However, both silver-haired bats and long-eared myotises do not fit this description, and we had high expectations of capturing these species at this location. Western red bats, on the other hand, have never been captured in this or the surrounding area. The inability of researchers to net this species has led us to think that acoustic reference files labeled in the Sonobat software as belonging to western red bat could actually be other species, such as western pipistrelle, with similar acoustic attributes.

Outcomes

What began as a straightforward research project blossomed into the synergistic development of engaging interpretive programs. The research provided the National Park Service with the timing information it needed to maintain the ponds and nearby facilities that bats and other wildlife are known to use. The inventory details which bat species use the monument and how this use changes throughout the year. Finally, the National Park Service plans to continue this

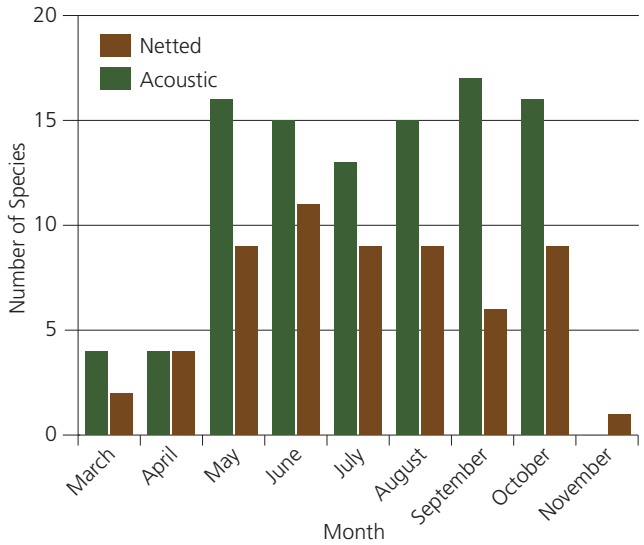

Figure 5. Number of bat species netted and detected acoustically during 2011–2012 surveys at Pipe Spring.

monitoring program, along with the especially meaningful educational opportunities not typically experienced by park visitors.

One college student who attended the bats and salamanders program wrote a paper explaining the "profound effect" the experience had had on him. It helped him decide that a career in science may be exactly what he has been searching for. Another student wrote to say she had never seen a bat before and loved learning about them and listening to their calls. By the end of the night she had found herself referring to them as "cute little guys" and realized that, as she said, "this is exactly why I've come to college . . . to explore new things." The possibilities of expanding interpretive programs in conjunction with park research are being realized in Pipe Spring National Monument and are a bright and refreshing way to engage the childlike curiosity in all park visitors.

So what became of the ponds and their maintenance? We have found that bats' use of the ponds is steady, beginning in May and lasting through October. Bat activity and diversity drop off sharply by mid-November and stay low until spring. Pipe Spring National Monument appears to be an important water and food source for bats and should be treated with care. Maintenance that requires pond drainage should occur in November, when daytime temperatures average 13°C (56°F) and nighttime lows are around freezing, and should be avoided from May through late October, especially during birthing periods for particular wildlife species. In the summer of 2012 the rock walls surrounding the ponds were excavated, reinforced, and reconstructed. However, this work did not require the ponds to be drained. Repair of the pond basins is scheduled for the next couple of years should funding be available.

The excitement generated by this program has spread to other nearby parks, which also see this format as offering great possibilities. This field season we are doing bat inventory work and similar interpretive programs at nearby Zion and Bryce Canyon National Parks and Cedar Breaks National Monument. Unlike Pipe Spring, these parks experience much higher visitation, which necessitates limiting the number of participants. Nevertheless, the goal is the same: to help visitors connect physically and emotionally with the public lands they love. We hope these connections will last a lifetime, influencing participants to continue to protect and care for their national parks.

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