National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

Homestead National Monument of America Bat Acoustic Monitoring September 2016

Natural Resource Report NPS/HOME/NRR—2017/1401

ON THE COVER
Homestead National Monument of America
National Park Service

Homestead National Monument of America
Bat Acoustic Monitoring September 2016

Natural Resource Report NPS/HOME/NRR—2017/1401

Daniel S. Licht
National Park Service
231 East Saint Joseph Street
Rapid City, South Dakota 57701

March 2017

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the Natural Resource Publications Management website. To receive this report in a format that is optimized to be accessible using screen readers for the visually or cognitively impaired, please email irma@nps.gov.

Please cite this publication as:

Licht, D. S. 2017. Homestead National Monument of America bat acoustic monitoring September 2016. Natural Resource Report NPS/HOME/NRR—2017/1401. National Park Service, Fort Collins, Colorado.

NPS 368/136848, March 2017

Contents

Figures

Tables

Abstract

Homestead National Monument of America is a 211-acre park located in an agrarian landscape in southeastern Nebraska. From September 16 to October 1, 2016, park staff deployed acoustic monitors at three sites in the park for purposes of monitoring night-time bat activity. The three sites averaged 179, 48, and 33 bat detections per night. Night-time bat activity was generally highest in the 1-2 hours following sunset.

Based on the acoustic surveys the big brown (*Eptesicus fuscus*), eastern red (*Lasiurus borealis*), northern long-eared (*Myotis septentrionalis*) and evening bats (*Nycticeius humeralis*) were present at the park in September of 2016, with the big brown, eastern red, and evening bats most commonly recorded. The hoary bat (*Lasiurus cinereus*) was likely also present although the sample size was small. There was insufficient evidence to conclude the presence of the silver-haired (*Lasionycteris noctivagans*), little brown (*Myotis lucifugus*), tricolored (*Perimyotis subflavus*), and Brazilian free-tailed (*Tadarida brasiliensis*) bats. It's conceivable that all of those species occasionally occur at the park. The presence of the northern long-eared bat (myotis) is notable because it is listed as threatened under the federal Endangered Species Act.

Acoustic monitoring should be conducted at the park again in the future. Summer surveys would identify what species are present during the breeding season. Additional surveys in late September from the same three recording stations could provide information on changes over time. Mist-netting would complement the acoustic surveys and provide other information such as sex and age composition of the bat community.

Introduction

The conservation of bats is a high priority within the conservation community and the National Park Service (NPS). North American bat populations appear to be in decline, probably due to a myriad of reasons including habitat loss, pesticides, and wind energy development (Hayes 2013). However, a new and more serious threat is the recent occurrence of the epizootic disease white-nose syndrome (WNS), caused by the fungus *Pseudogymnoascus destructans* (Langwig et al. 2012). The fungus appears to have been recently introduced to North America from Europe. Since first detected in 2006 in a cave in New York State the disease spread rapidly throughout eastern North America and is now documented throughout the Midwest (**Figure 1**). By 2012 the disease had killed an estimated 5-7 million bats and resulted in mortality rates close to 100% at some hibernacula (U. S. Fish and Wildlife Service 2012). In 2015 the disease was first documented in Nebraska when the fungus was detected on hibernating bats in a mine in Cass County (White-nose Syndrome.org 2015). Partly as a result of the disease the northern long-eared bat (see **Table 1** for bat scientific names) was listed as threatened per the federal Endangered Species Act (ESA). Other bat species have been recommended for listing. To better understand the spread of the disease and the status of bat populations the multi-country multi-agency North American Bat Monitoring Program (NABat) was initiated (Loeb et al. 2015). The NPS made funds available for bat conservation and monitoring.

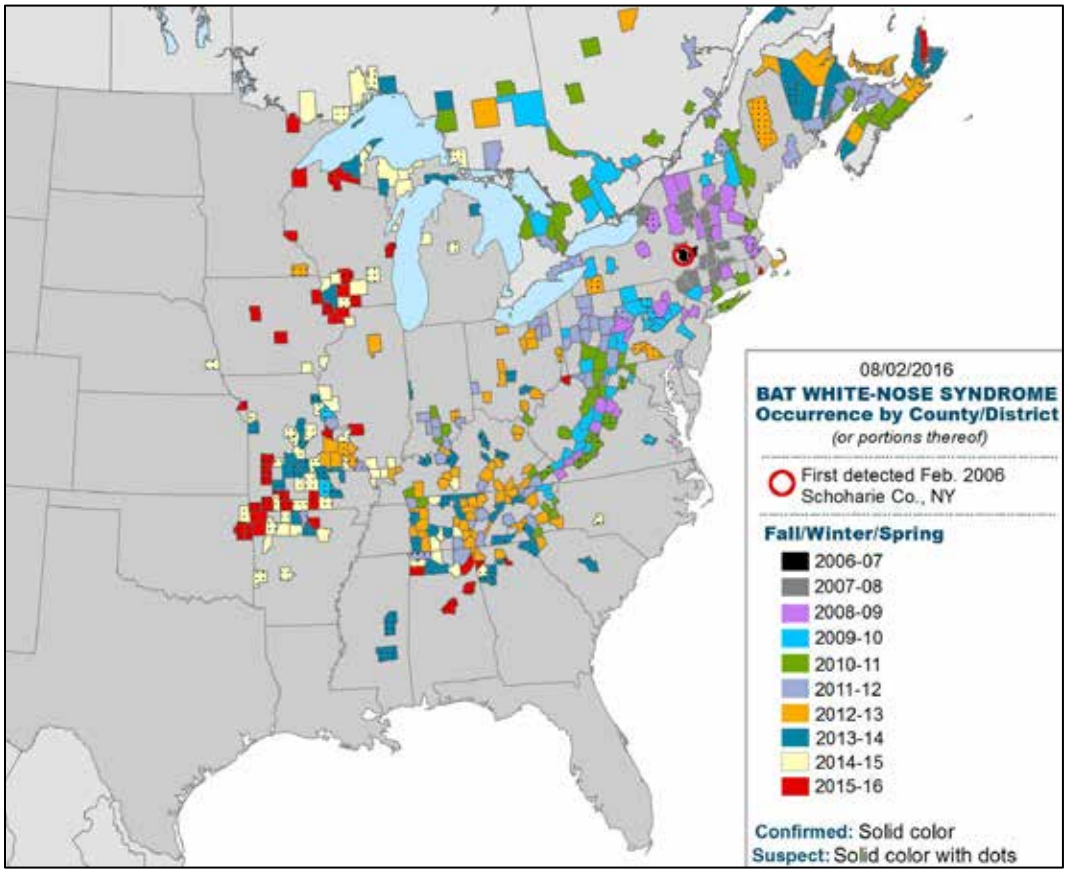

Figure 1. Distribution of white-nose syndrome in eastern North America as of August 2016 (map by Lindsey Heffernan; retrieved from White-nose Syndrome.org 2016).

Table 1. Species potentially at the park and included in the software runs.

Common Name	Scientific Name	Status and Ecology	Kaleid-oscope	SonoBat
Big Brown	*Eptesicus fuscus*	Common and statewide. Roosts under bark, in hollow trees, and structures.	ü	ü
Eastern Red	*Lasiurus borealis*	Statewide and common, but females more so. Roost singly in tree leaves.	ü	ü
Hoary	*Lasiurus cinereus*	Statewide. More females than males. Solitary and migratory. Roost singly in tree leaves.	ü	ü
Silver-haired	*Lasionycteris noctivagans*	Statewide. Most common in spring and fall migrations. Roost under bark.	ü	ü
Little Brown	*Myotis lucifugus*	Localized year-round resident in E. and NW Nebraska. Large colonies. Uses structures.	ü	ü
N. Long-eared	*Myotis septentrionalis*	East half of Nebraska. Roost under bark. Vulnerable to WNS. Listed as threatened.	ü	ü
Evening	*Nycticeius humeralis*	Nebraska is western extent of range. Large nursery colonies in trees.	ü	ü
Tricolored	*Perimyotis subflavus*	Possibly expanding westward. Formerly called eastern pipistrelle.	ü	ü
Brazilian Free-tailed	*Tadarida brasiliensis*	Nebraska is northern extent of range. Also called Mexican free-tailed.	ü	

In the summer of 2016 the NPS Northern Great Plains Inventory & Monitoring (I&M) Program—located in Rapid City, South Dakota—loaned three Wildlife Acoustics[1] bat recorders and associated equipment to Homestead National Monument of America in southeastern Nebraska. The units were deployed by BioTech Miles Lampo under the guidance of Jesse Bolli, the Resource Management Specialist at the park. In the fall of 2016 the units—along with the collected data—were returned to the I&M Program in Rapid City. This document reports on that effort.

[1] Mention of trade names does not constitute endorsement.

Study Area and Methods

Homestead National Monument of America is a 211-acre National Park Service unit located near the town of Beatrice, Nebraska, approximately 40 miles south of Lincoln. About 2/3rd of the park is restored tallgrass prairie and most of the remainder is deciduous forest (**Figure 2**). Cub Creek is a small meandering stream that runs through the park. Surrounding lands consist primarily of cropland. Stands of woody habitat are common, especially near farmsteads and towns. The closest known bat hibernacula are mines in Cass and Sarpy Counties in eastern Nebraska (Benedict 2004).

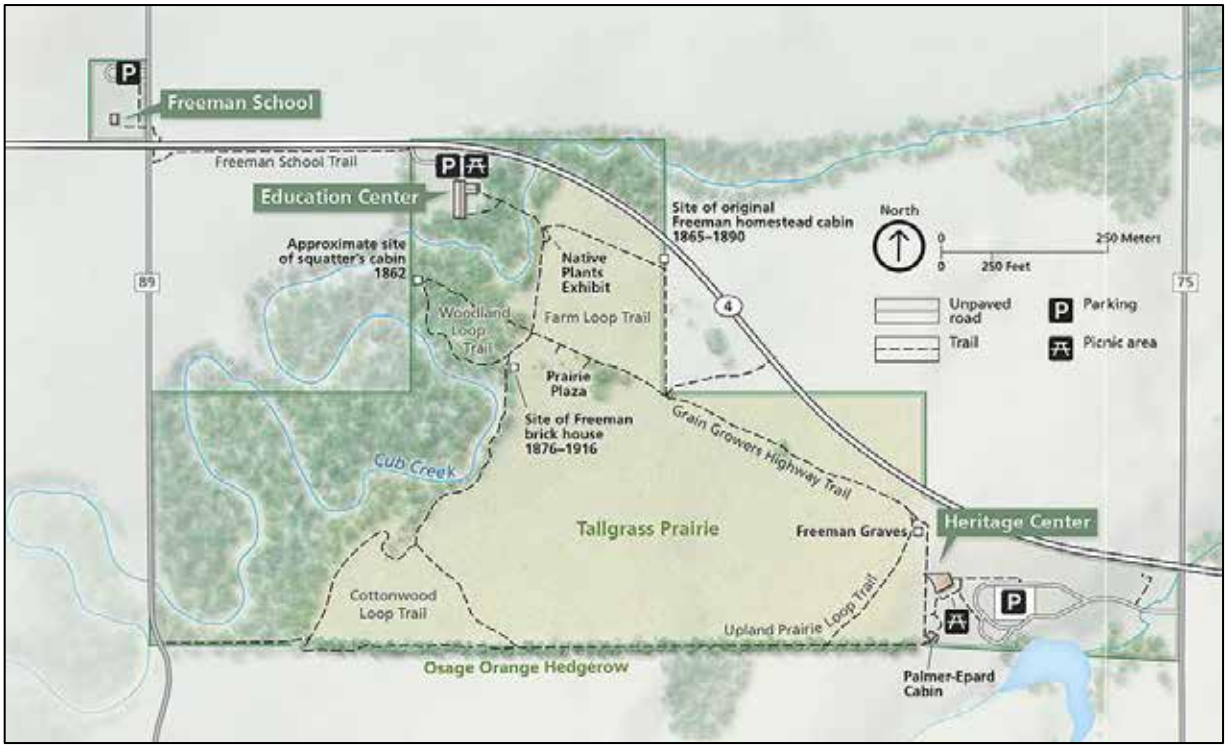

Figure 2. Homestead park boundary and important features.

Park staff deployed Wildlife Acoustics SM3Bat bat recorders in the field from September 19 to October 1, 2016. Three recording stations were arbitrarily selected by park staff. At the stations a Wildlife Acoustics SM3-U1 microphone was affixed to ¾ inch plastic conduit 2 meters above the ground. The recording units were programmed to turn on 30 minutes before sunset and turn off 30 minutes after sunrise. During the active period the units "listened" for the echolocation calls of bats. When a call was detected the unit made a short 2-5 second recording. The systems could detect calling bats up to 50 meters away under ideal conditions; however, typical detection range was likely shorter and influenced by orientation of the bat, the species that made the call, atmospheric conditions, vegetation and other clutter between the bat and the microphone, and other sources of ultrasonic noises (e.g., insects).

The West Water Quality station was located in the extreme southwestern corner of the park (**Figure 3**). The recording assembly was located on a sandbar along the north side of Cub Creek

(N40˚17’07.3” W96˚50’26.5”). Cub Creek has very steep banks approximately 5 meters from the creek bed to top of bank; the banks are 15-20 meters apart. The riparian zone along the creek ranges from 100 to 400 meters wide and contains a mixture of deciduous trees such as hackberry (*Celtis occidentalis*), bur oak (*Quercus macrocarpa*), and green ash (*Fraxinus pennsylvanica*). The understory is composed mainly of herbaceous plants such as stinging nettle (*Urtica dioica*) and wingstem (*Verbesina alternifolia*). A recorder was deployed September 19 and retrieved on the 26th.

Figure 3. Park habitat and location of monitoring stations.

The Woodland Loop station was located by the Woodland Loop of the park trail system, within an old growth forest (N40˚17’21” W96˚50’08”). Aerial images from 1937 show mature woodland at the site. The site is classified as lowland bur oak woodland, which is a rare community type in Nebraska. A recorder was deployed September 30 and retrieved on October 1.

The Cottonwood Tree station was located by a clump of about 6 cottonwood (*Populus deltoides*) trees within a lowland prairie (N40˚17’18” W96˚50’00”). The prairie is dominated by tallgrass species such as big bluestem (*Andropogon gerardii*), Indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). A walking trail and patio with seating are nearby. A recorder was deployed September 19 and retrieved on the 26th.

Bat recordings were analyzed with Wildlife Acoustics Kaleidoscope 4.1.0a and SonoBat 4.1.0 software packages. Both packages have their advocates and their pros and cons. For example, Kaleidoscope is very fast and allows user-customization of the bat species to filter for. Although SonoBat is slower at processing the acoustic files, and requires users to select a fixed regional list of bats, its algorithm uses all of the acoustic spectrograph information which, according to the manufacturer, results in more accurate identification. Licht (2016) conducted a head-to-head comparison of the two packages using a catalog of known bat calls from Midwestern species; although SonoBat was slightly more accurate the difference was negligible and the test was potentially biased by the fact that some of the calls could have been used to train one or both of the software packages. Because neither package is clearly superior or definitively more accurate in classifying Midwestern species, and because bat experts often prefer one package over the other, I generally present the results from both packages. I used the default configuration of both packages.

An important first step in the use of software (or manual vetting) to classify bat calls to species is to establish a universe of bats likely present in the study area. Too large a universe could lead to some calls incorrectly classified to species that could not conceivably be present. Furthermore, a large universe reduces the discriminatory power of the software as there are more species to choose from. This is especially problematic when the universe contains species that have similar call characteristics such as the various species of *Myotis*. Conversely, too small a universe could lead to some species that are actually present in the park not being classified as such by the software.

I considered several published sources of information (Freeman et al. 1997, Benedict 2004, Robbins 2005, Harvey et al. 2011, National Park Service 2016, White et al. 2016) as well as unpublished material (Appendix I) to develop a list of species that could be in the park and should be considered in the software auto-identification runs. My list ultimately included 9 species (**Table 1**). Whereas Kaleidoscope allowed me to customize for those 9 the best fitting SonoBat classifier package (the North Midwest package) did not include a filter for the Brazilian free-tailed bat. However, the park is on the northern periphery of that species range (Genoways et al. 2000) and I did not expect many if any calls to be classified to that species.

Results and Discussion

Recorders were deployed from September 19-26 at the West Water Quality and Cottonwood Tree sites (7 survey nights each). At the Woodland Loop site data were collected September 26-30; however, the data from September 26-29 was found to be unusable. Unlike conventional bat recordings, which last only a few seconds (when triggered by a bat pass) the recordings from September 26-29 were continuous, i.e., each of the 52 recordings was about 30 minutes long. I looked for, but could not find any bat signals in the recordings. Nevertheless, the files were archived on the I&M Program server along with the usable data.

Over the 15 survey nights, 5,840 acoustic recordings were made. Of those, Kaleidoscope and SonoBat determined 4,217 (72%) and 4,369 (75%) to be noise files, respectively (**Table 2**). In other words, the recording unit was triggered by something other than a bat flying by or there was so much noise the bat pulses could not be discerned from noise. This is substantially higher than other studies. For example, noise files comprise only about 4% of the one million recordings collected by the Northern Great Plains Inventory & Monitoring Program in 12 Northern Great Plains parks from 2014-16 (Licht in prep.). However, whereas the Cottonwood Tree and Woodland Loop sites had a very high percentage of noise files, the West Water Quality site had only 5% noise files based on Kaleidoscope. The West Water Quality site also had a much larger percentage of recordings that could be classified to a species indicating higher quality recordings. The plausible explanation is that the microphone at the Cottonwood Tree site was placed directly under the canopy of some cottonwood trees. It's possible the rustling fall leaves created the noise files. Conversely, although the West Water Quality site was within the park's forest, the unit was actually in a clearing within the trees.

The two software packages were in general agreement in regards to bat passes. Whereas Kaleidoscope reported 108.2 bats detected per night across all 15 survey nights, SonoBat reported 99.4. Both packages reported the highest nightly rate of activity from the West Water Quality site (**Table 3**).

The night-to-night variability in the number of bat detections was surprisingly small; with the coefficient of variation (also known as relative variability) 25% at the Cottonwood Tree site and 26% at the West Water Quality site based on the Kaleidoscope output (**Table 3**). In contrast, in the Northern Great Plains the average coefficient of variation at stationary point sessions was 53% (Licht in prep.). It's conceivable that the higher variability in the Northern Great Plains study is because many of those stations were established next to water sources where bats forage and a single bat could repeatedly fly over the water greatly increasing detections in some nights. Conversely, the units at Homestead were not placed near point attractants.

Table 2. Recordings as classified by software, location, and quality.

Software	Site	Total # Recordings	# Noise Recordings (%)	# Bat Recordings Not Identified to Species (%)	# Recordings Identified to Species (%)
Kaleidoscope	Cottonwood Tree	4,226	3,887 (92%)	288 (7%)	51 (1%)
	West Water Quality	1,312	61 (5%)	317 (24%)	934 (71%)
	Woodland Loop	302	269 (89%)	27 (9%)	6 (2%)
	Kaleidoscope Total	***5,840***	***4,217 (72%)***	***632 (11%)***	***991 (17%)***
SonoBat	Cottonwood Tree	4,226	3,791 (90%)	397 (9%)	38 (1%)
	West Water Quality	1,312	285 (22%)	479 (37%)	548 (42%)
	Woodland Loop	302	272 (90%)	23 (8%)	7 (2%)
	SonoBat Total	***5,840***	***4,348 (74%)***	***899 (15%)***	***593 (10%)***

Table 3. Bat detections by location and night.

Software	Site	9/19	9/20	9/21	9/22	9/23	9/24	9/25	9/30	Average
Kaleidoscope	Cottonwood Tree	65	34	65	41	40	47	47	–	*48.4*
	West Water Quality	198	150	158	255	169	208	113	–	*178.7*
	Woodland Loop	–	–	–	–	–	–	–	33	*33.0*
SonoBat	Cottonwood Tree	72	19	61	65	178	23	28	–	*63.7*
	West Water Quality	167	132	126	227	150	154	78	–	*147.7*
	Woodland Loop	–	–	–	–	–	–	–	30	*30.0*

Sunset at the park on September 22, 2016 was 7:25pm daylight savings time and sunrise was 7:16am. Bat activity peaked in the 1-2 hours after sunset (**Figure 4**: I did not include the Woodland Loop site because of the small sample size). There was a more modest peak just before sunrise. The pattern is consistent with that found in other acoustic studies (Licht in prep.).

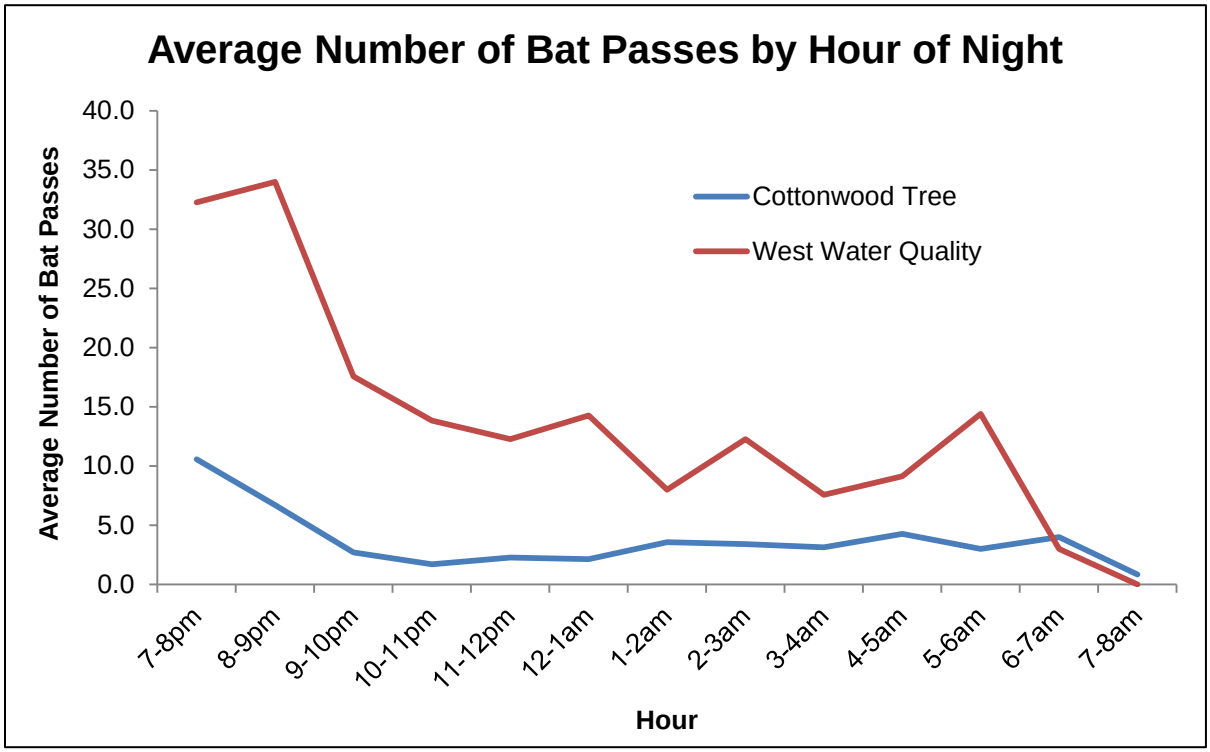

Figure 4. Bat activity by hour of night.

Positive bat species identification based on acoustic calls is problematic; therefore most bat identification software packages produce an estimate of the probability or likelihood that a species was truly detected based on the number or proportion of calls classified to a species and the ability of the software to discern that species from others. For example, in the Homestead data set Kaleidoscope classified 622 calls to the evening bat and said there was a zero percent chance that all of those were misclassifications (i.e., the likelihood it was present was 1). Conversely, even though Kaleidoscope classified 5 calls as coming from the silver-haired bat the software concluded that all of those calls could have actually been made by other species (such as big brown bats as they have a similar call). **Table 4** provides the statistical likelihood of presence output from Kaleidoscope and SonoBat. I also present my qualitative inference that the species was present during the study period based on the software and the ecology of the species. The findings from this study are generally consistent with the park's species list in the NPSpecies database (National Park Service 2016), which was likely populated in part with information from Robbins (2005) 2004 mammal inventory at the park. The four species that I concluded are present (**Table 4**) are the same four that Robbins (2005) listed from his 2004 acoustic surveys. It's important to note that this study was conducted over two weeks in late September. Surveys at other times of the year might yield different results. For

example, the silver-haired bat is known from much of Nebraska, but typically only during migrations (Benedict 2004). I suspect that the species does occasionally pass through the park during migrations. Likewise, it's plausible that the little brown, tri-colored, and Brazilian free-tailed bats all occasionally occur in the park.

Table 4. Bat species listed in NPSpecies as being present at the park, statistical likelihood of species presence based on software, and the author's conclusion of species presence.

Common Name	NPSpecies	Kaleidoscope	SonoBat	Author's Conclusion
Big Brown	Present	1	1	Present
Eastern Red	Present	1	1	Present
Hoary	Probably Present	0	0.99	Probably Present
Silver-haired	Probably Present	0	0.05	Insufficient Evidence
Little Brown	Not Listed	0	0.55	Insufficient Evidence
N. Long-eared	Present	1	0.87	Present
Evening	Present	1	1	Present
Tricolored	Probably Present	0	0.74	Insufficient Evidence
Brazilian Free-tailed	Not Listed	0.58	na	Insufficient Evidence

The following information should be viewed with caution as species identification using acoustic surveys is prone to error (Lemen et al. 2015, Loeb et al. 2015). Furthermore, the rate of calls assigned to a species is not necessarily correlated to abundance. For example, some species are known to be louder callers than other species and therefore more likely to be recorded. With those caveats in mind, classification rates can serve as a qualified index of species activity at a site.

Of the calls that Kaleidoscope classified to species by far the most were classified to the evening bat, a relatively common Midwest species (**Figure 5**). That was followed by the big brown bat, a common species throughout much of North America. Interestingly, the northern long-eared myotis was the next most frequently species. The species is listed as threatened under the federal Endangered Species Act. The eastern red bat was also relatively common. Conversely, SonoBat classified a much smaller percentage of calls to the evening bat, and relatively more of the calls to the eastern red bat (**Figure 6**). SonoBat did not classify about 60% of the calls to a species based on the "corrected count" output. SonoBat provides other forms of output that are less stringent (i.e., more likely to classify to a species), but I opted not to report those.

The biggest discrepancy between the software packages was the relative frequency assigned to the evening and eastern red bats. This is not surprising as these species have similar calls. Consider that of the 622 calls Kaleidoscope classified to the evening bat, in 619 of those the software listed the eastern red bat as an alternate choice. Conversely, of the 256 recordings that SonoBat classified to the eastern red bat, its second choice was the evening bat in 74 instances. In 2004 Robbins (2005)

mist-netted twelve evening bats and no eastern red bats, although he listed both species common, apparently based on concurrent acoustic surveys. His only other captures were four northern long-eared bats, a species apparently still present at the park although perhaps in smaller numbers. Suffice it to say the big brown, evening, and eastern red bats are likely the most common species at the park. Appendix II lists the species-specific output from the two software packages.

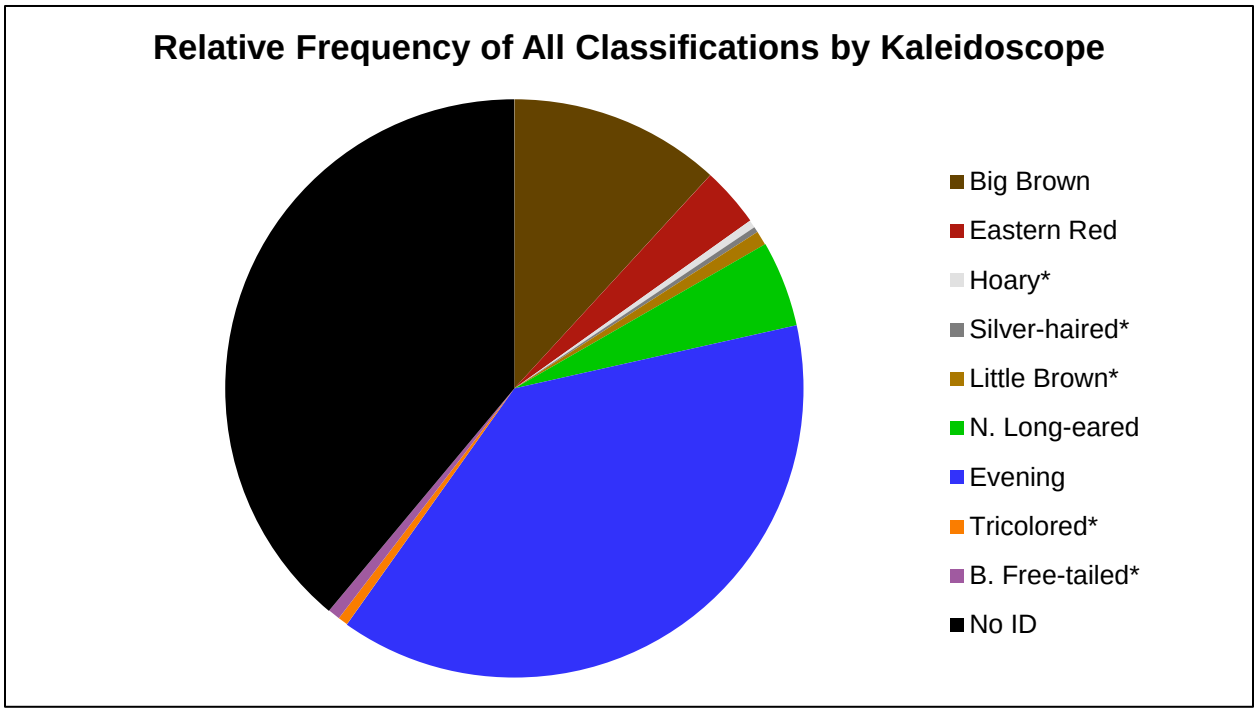

Figure 5. Relative frequency of species classifications by Kaleidoscope. Asterisked species were not documented at statistically significant levels and might not have truly been present during the study.

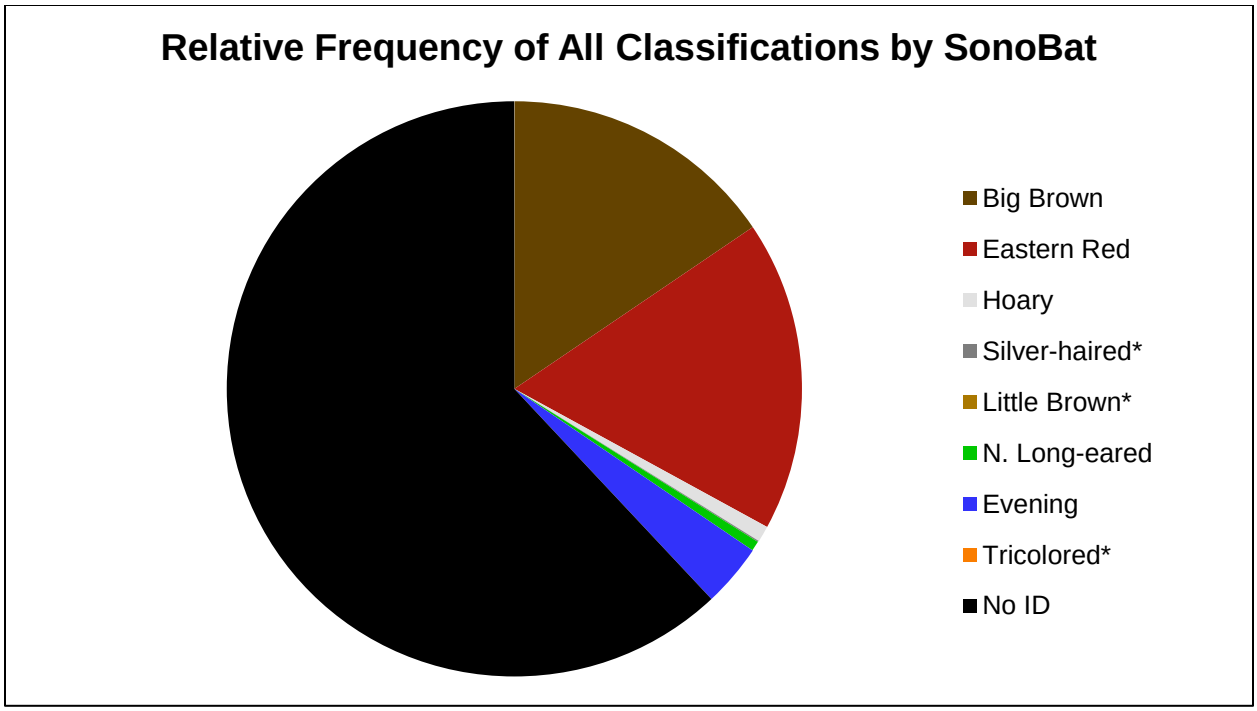

Figure 6. Relative frequency of species classifications by SonoBat. Asterisked species were not documented at statistically significant levels and might not have truly been present during the study.

Conclusions and Recommendations

The bat community at the park appears healthy. The species detected in this study are those that one would expect in southeastern Nebraska (Benedict 2004, Harvey et al. 2011). Interestingly, the four species that the software identified as present using a likelihood estimator are the same four that Robbins (2005) reported in his 2004 field work at the park and the same four that were captured by mist nets on July 23, 2015 (Appendix I). The number of bat detections per night, although several-fold less than reported by some other studies in the Northern Great Plains (Licht in prep.), is not unreasonable considering the location of the deployments (e.g., not near surface water).

The data reported here were collected from September 19-30, 2016. Late September is well beyond the reproductive season for bats in southeastern Nebraska. It's possible that the bat community will look different in May-August when reproduction is occurring. Therefore, acoustic monitoring should also be conducted at the park during that period. Robbins (2005) confirmed the presence of pregnant female evening bats and northern long-eared myotis in his May-June 2004 mist netting.

The quality of the recordings collected in September 2016 was generally poor, with a large percentage of noise files and bat recordings that could not be reliably classified to species. This might have been due in part to the deployment locations. Future surveys should be designed to place recorders about 20-50 yards from the edge of the forest, as recommended by the NABat protocol (Loeb et al. 2015). Such locations can still detect forest bats while minimizing the harmful effects of vegetation clutter on call quality.

Automated-identification software for bat calls has improved greatly in recent years and will likely continue to improve in the future. When new versions of the software are released the Homestead 2016 data set could be analyzed again, hopefully resulting in more accurate species classifications and a more confident understanding of the bat diversity at the park. Furthermore, if future acoustic surveys replicate the 2016 field work (i.e., same locations and time of year) then a comparison to the 2016 results could track changes over time.

Acoustic monitoring is an inexpensive way to monitor bat activity at a site. However, acoustic methods cannot collect demographic information such as sex and age of individuals, reproductive status, and individual health. Furthermore, acoustic recordings are generally not accepted as definitive proof of the presence of rare species and species with calls similar to other species. Therefore, mist-netting is often conducted to better understand bat communities at a site. The park should consider a mist-netting effort to collect the data listed above. Furthermore, it appears that Gage County, the county the park is located in, is under-represented in mist-netting surveys in Nebraska (Benedict 2004).

The park's forest, which has old growth characteristics, is likely important bat roosting habitat and should be protected. Specifically, old decadent trees with exfoliating bark and cavities need to be conserved for roosting bats. These trees are sometimes removed in NPS units, especially when they are near trails and other places used by people. Their removal should be weighed against the value they can provide to the park's bat community.

Literature Cited

Benedict, R. A. 2004. Reproductive activity and distribution of bats in Nebraska. Western North American Naturalist 64:231-248.

Freeman, P. W., K. N. Geluso, and J. S. Altenbach. 1997. Nebraska's flying mammals. Nebraskaland 75:38-45.

Genoways, H. H., P. W. Freeman, and C. Grell. 2000. Extralimital records of the Mexican free-tailed bat (*Tadarida brasiliensis mexicana*) in the central United States and their biological significance. Transactions of the Nebraska Academy of Sciences 26:85-96.

Harvey, M. J., J. S. Altenbach, and T. L. Best. 2011. Bats of the United States and Canada. John Hopkins University Presee, Baltimore MD. pp.

Hayes, M. A. 2013. Bats killed in large numbers at United States wind energy facilities. BioScience 63:975.

Langwig, K. E., W. F. Frick, J. T. Bried, A. C. Hicks, T. H. Kunz, and A. Marm Kilpatrick. 2012. Sociality, density-dependence and microclimates determine the persistence of populations suffering from a novel fungal disease, white-nose syndrome. Ecology Letters 15:1050-1057.

Lemen, C., P. Freeman, J. A. White, and B. R. Andersen. 2015. The problem of low agreement among automated identification programs for acoustical surveys of bats. Western North American Naturalist 75:218-225.

Licht, D. S. 2016. Acoustic bat surveys at Tallgrass Prairie National Preserve, 2014-15. National Park Service, Fort Collins, Colorado.

Licht, D. S. in prep. A monitoring protocol for acoustic surveys of bats at Northern Great Plains parks and preliminary results from 2014-16. National Park Service, Fort Collins, CO.

Loeb, S. C., T. J. Rodhouse, L. E. Ellison, C. L. Lausen, J. D. Reichard, K. M. Irvine, T. E. Ingersoll, J. T. H. Coleman, W. E. Thogmartin, J. R. Sauer, C. M. Francis, M. L. Bayless, T. R. Stanley, and D. H. Johnson. 2015. A plan for the North American Bat Monitoring Program (NABat). June, U.S. Department of Agriculture, Asheville, NC.

National Park Service. 2016. NPSpecies online application. Available at: https://irma.nps.gov/NPSpecies/ (accessed 31 December 2016).

Robbins, L. 2005. Inventory of distribution, composition, and relative abundance of mammals, including bats at Homestead National Monument of America. July 2005, Southwest Missouri State University, Springfield, Missouri.

U. S. Fish and Wildlife Service. 2012. North American bat death toll exceeds 5.5 million from white-nose syndrome. Arlington, VA. January 17, 2012

White-nose Syndrome.org. 2015. Fungus that causes bat disease detected in Nebraska. U.S. Fish and Wildlife Service. https://www.whitenosesyndrome.org/news/fungus-causes-bat-disease-detected-nebraska.(accessed January 4, 2017).

White, J. A., C. A. Lemen, and P. W. Freeman. 2016. Acoustic detection reveals fine-scale distributions of *Myotis lucifugus*, *Myotis septentrionalis*, and *Perimyotis subflavus* in eastern Nebraska. Western North American Naturalist 76:27-35.

Appendix I

The following email documents a night of mist-netting that was conducted at the park in July of 2015.

****

From: **Jeremy White** <jeremywhite@unomaha.edu>
Date: Tue, Jul 28, 2015 at 3:19 PM
Subject: Re: Bat Workshop
To: "Bolli, Jesse" <jesse_bolli@nps.gov>
Cc: Andrea Bornemeier <andrea_bornemeier@nps.gov>

Hi Jesse,

I really enjoyed helping with the workshop, exploring Homestead a bit, and meeting you and Andrea. Thank you Andrea for helping with the nets, bats, and notes! Here are the results from the workshop on 23 July 2015:

We set up a single 6 meter net across the trail at the edge of the forest and a double-high 9 meter net set across the trail in the forest. I did not take lat/long coordinates for the nets but I can estimate them from Google Earth if you need that data. All bats were captured in the double high net at 2115. The double high net was closed after removing the bats from the net and the single net was taken down about 2230.

Species	Sex	Age	Reproductive condition	Weight (g)	Right Forearm (mm)
Myotis septentrionalis	Male	Adult	—	7	36
Eptesicus fuscus	Female	Young of the year	Non-reproductive	19	48
Nycticeius humeralis	Female	Adult	Non-reproductive	9.5	38
Lasiurus borealis	Male	Young of the year	—	11	40

Let me know if there is any additional information you need. We never set acoustic detectors at Homestead last year.

Jeremy

Appendix II

Table 5. Output from Kaleidoscope (Auto ID column).

Site	Date	Big Brown	Eastern Red	Hoary	Silver-haired	Little Brown	N. Long-eared	Evening	Tri-colored	B. Free-tailed	No ID	Total
Cottonwood Tree	9/19/2016	–	–	–	–	2	2	11	–	–	50	*65*
	9/20/2016	–	–	–	–	1	–	1	–	–	32	*34*
	9/21/2016	–	–	–	–	1	–	1	1	–	62	*65*
	9/22/2016	–	–	–	–	1	2	4	–	–	34	*41*
	9/23/2016	–	1	–	–		–	–	–	–	39	*40*
	9/24/2016	–	–	–	–	1	5	3	–	–	38	*47*
	9/25/2016	–	–	–	–		11	2	–	1	33	*47*
	Cottonwood Tree Total (all dates)	–	***1***	–	–	***6***	***20***	***22***	***1***	***1***	***288***	***339***
West Water Quality	9/19/2016	25	11	1	1	–	12	95	1	2	50	*198*
	9/20/2016	16	2	–	–	1	4	90	2	1	34	*150*
	9/21/2016	23	1	–	–	1	7	83		1	42	*158*
	9/22/2016	43	8	–	–	2	10	140	3	1	48	*255*
	9/23/2016	40	2	–	–		3	87		1	36	*169*
	9/24/2016	33	17	5	3	1	2	79	1	2	65	*208*
	9/25/2016	11	12	1	1	1	16	26	1	2	42	*113*
	West Water Quality Total (all dates)	***191***	***53***	***7***	***5***	***6***	***54***	***600***	***8***	***10***	***317***	***1251***
Woodland Loop	9/30/2016	1	–	–	–	1	4	–	–	–	27	*33*
All Sites	**Total**	***192***	***54***	***7***	***5***	***13***	***78***	***622***	***9***	***11***	***632***	***1623***

Table 6. Output from SonoBat (SppAccp column). Does not include B. free-tailed bat.

Site	Date	Big Brown	Eastern Red	Hoary	Silver-haired	Little Brown	N. Long-eared	Evening	Tricolored	No ID	Total
Cottonwood Tree	9/19/2016	6	–	2	–	–	–	4	–	57	*69*
	9/20/2016	–	–	1	–	–	–	–	–	18	*19*
	9/21/2016	–	1		–	–	–	–	1	59	*61*
	9/22/2016	–	–	4	–	–	–	1	–	58	*63*
	9/23/2016	4	–	9	1	–	–	–	–	157	*171*
	9/24/2016	–	–	–		–	–	–	–	24	*24*
	9/25/2016	1	–	–	1	–	1	1	–	24	*28*
	Cottonwood Tree Total (all dates)	***11***	***1***	***16***	***2***	–	***1***	***6***	***1***	***397***	***435***
West Water Quality	9/19/2016	34	46	–	2	–	2	25	1	57	*167*
	9/20/2016	24	42	–	–	–	–	7	2	57	*132*
	9/21/2016	24	39	–	–	–	–	2	–	61	*126*
	9/22/2016	59	59	1	–	1	–	7	2	95	*224*
	9/23/2016	42	37	–	–	–	–	7	–	61	*147*
	9/24/2016	17	18	–	4	–	–	3	–	111	*153*
	9/25/2016	13	14	–	1	2	4	6	1	37	*78*
	West Water Quality Total (all dates)	***213***	***255***	***1***	***7***	***3***	***6***	***57***	***6***	***479***	***1027***
Woodland	9/30/2016	3	–	2	–	–	2	–	–	23	*30*
All Sites	**Total**	***227***	***256***	***19***	***9***	***3***	***9***	***63***	***7***	***899***	***1492***

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 368/136848, March 2017

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov