

Acoustic Bat Survey Report

SHAW NATURE RESERVE

Gray Summit, Missouri

January 2019

Prepared for:

Shaw Nature Reserve

Missouri Botanical Garden

Prepared by:

Wildheart Ecology

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January 21, 2019

Dr. Quinn Long
Shaw Nature Reserve
307 Pinetum Loop Rd
Gray Summit, MO 63039

RE: Acoustic Bat Survey Report
Shaw Surveys

Dear Dr. Quinn Long:

We are pleased to provide you with an Acoustic Bat Survey Report based on our acoustic bat surveys at Shaw Nature Reserve (SNR), conducted in June and July of 2018. Our surveys included deployment of acoustic detectors throughout SNR and subsequent identification of recorded bat passes. Included in the report are field and analytical methods, a summary of our findings, as well as suggestions for potential future studies. Wildheart Ecology provides consent for SNR to share the contents of this report and the collected data internally or externally with others.

If you have questions or comments regarding the attached report, please contact me at vona@wildheartecology.com or (312) 401-2055.

Sincerely,

Vona Kuczynska
Wildlife Biologist

Jennifer Mullikin
Ecologist

Wildheart Ecology

ACOUSTIC BAT SURVEY REPORT

SHAW NATURE RESERVE GRAY SUMMIT, MISSOURI

1.0 INTRODUCTION

Wildheart Ecology (Wildheart) performed acoustic bat surveys at Shaw Nature Reserve (SNR) to assess bat species richness throughout the reserve. The surveys were triggered by the capture of a post-lactating female Indiana bat (*Myotis sodalis*) in a mist net during an educational survey along Brush Creek on September 22, 2017. Indiana bats are a federally endangered and protected species (USFWS, 2019) and had not been previously recorded to occur at SNR. The post-lactating female was captured in late September and may have been part of a breeding colony at or near SNR or may have been a transient and migrating individual headed to a winter hibernaculum. To determine if SNR supports Indiana bats during the breeding season, Wildheart deployed four acoustic detectors to record bat activity throughout SNR during the summer of 2018. This report provides field and analytical methods, results from the surveys, as well as a discussion on potential next steps to confirm and identify locations of any breeding Indiana bat colonies at SNR.

Study Site

The study site, Shaw Nature Reserve, is located in Gray Summit, Missouri, just south of Interstate 44 and north of the Meramec River. It is part of the Ozark Border ecoregion in the state, a unique buffer zone between the prairies of northern Missouri and Ozark forests of southern Missouri (Chapman et al. 2002). The study site is comprised of hardwood upland forests, bottomland hardwood forests, prairies, streams, and wetlands. SNR is adjacent to the Meramec River, private forested and agricultural land and Pacific, a small residential town. The array of habitats within SNR is ideal as summer habitat. The mature forested areas can provide female bats with adequate roosting habitat to raise young, while streams and wetlands may provide essential water resources. Additionally, local bats are insectivorous and the woodlands, prairies and wetlands provide ideal habitat for insect prey.

To our knowledge, no caves or cave-like structures exist within the limits of the SNR property, with the exception of one abandoned quarry along Quarry Road. Based on e-mail communication with Bailey Keekamp, tri-colored bats (*Perimyotis subflavus*) have been documented within the

quarry during 2016 and again in December 2018 by Bailey Keekamp (Personal Communication, December 2018; Photo 1).

Photo 1. Tri-colored bats hibernating in a quarry at Shaw Nature Reserve, December 2018. Photo credit: Bailey Keekamp.



Other previous studies at SNR include the September 2017 Academy of Science St. Louis BioBlitz, during which Wildheart led a public mist net survey demonstration and survey. Mist nets were set up within Brush Creek as part of the science outreach event. An Indiana bat was caught in a mist net positioned under the footbridge that crosses over Brush Creek. Due to the timing of the event and the sensitivity of the species, the nets were closed after the first capture. To our knowledge, no other bat studies, acoustic or mist net, have been conducted at SNR.

Potential Bat Species at SNR

Species listed in Table 1 are expected to occur in Franklin County during the summer months (approximately April through August) and may be present at SNR. A full list of Missouri's species, including more rare species which may occasionally occur at SNR, can be found online on the Missouri Department of Conservation Field Guide to Bats webpage (MDC, 2019a). Three

federally listed bat species at likely to be found in Franklin County: the Indiana bat (endangered), the gray bat (endangered) and the northern long-eared bat (threatened). These three species are all designated as endangered at the state level (MDC, 2019b). Five of the species are ranked as Species of Conservation Concern by the Missouri Department of Conservation Natural Heritage Program (MDC, 2019b).

Table 1. Species likely to occur within SNR during the summer.

Common Name	Scientific Name	State and Federal Status ^{1,2,3}
Big brown bat	<i>Eptesicus fuscus</i>	None
Eastern red bat	<i>Lasiurus borealis</i>	None
Evening bat	<i>Nycticeius humeralis</i>	None
Gray bat	<i>Myotis grisescens</i>	Federally Endangered, State Endangered & Species of Conservation Concern - Vulnerable
Hoary bat	<i>Lasiurus cinereus</i>	None
Indiana bat	<i>Myotis sodalis</i>	Federally endangered, State Endangered and Species of Conservation Concern - Critically imperiled
Little brown bat	<i>Myotis lucifugus</i>	Species of Conservation Concern - Imperiled
Northern long-eared bat	<i>Myotis septentrionalis</i>	Federally threatened, State endangered - Species of Conservation Concern- Critically Imperiled
Silver-haired bat	<i>Lasionycteris noctivogans</i>	Species of Conservation Concern - Vulnerable
Tricolored bat	<i>Perimyotis subflavus</i>	Species of Conservation Concern - Imperiled

¹ Missouri Department of Conservation – Missouri Species and Communities of Conservation Concern Checklist (MDC, 2019b).

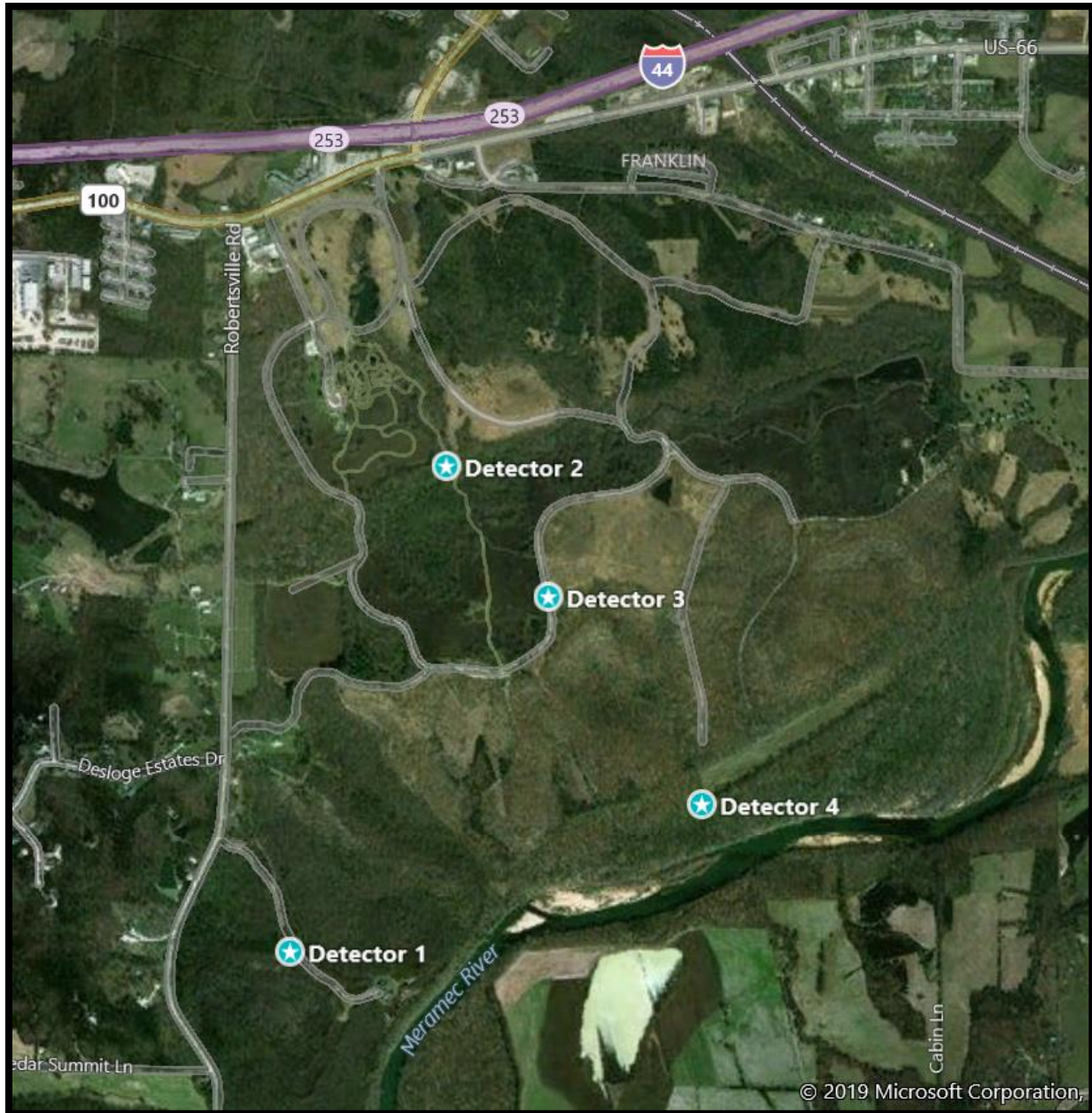
² U.S. Fish and Wildlife Service – Federally listed species (USFWS, 2019b).

³ Species of Conservation Concern ranks are assigned and maintained by the Missouri Natural Heritage Program (MDC, 2019b).

2.0 METHODS

Field Methods

Acoustic bat surveys were conducted at four monitoring locations within SNR from June 27, 2018 to July 23, 2018 (Figure 1). Detectors were placed in the types of habitat Indiana bats typically associated with roosting and foraging during the summer breeding season (e.g. mature upland and bottomland forests, along tributaries with standing and running water, forests adjacent to wetlands, prairies, and agricultural fields (edge habitat), and forested access roads.

Figure 1. Detector placement throughout SNR

One Wildlife Acoustics SM2 unit (detector) with an omnidirectional microphone was deployed at each monitoring location. Microphones at ground-based monitoring locations were elevated to a height of 6 to 8 feet on extension poles (depending on location) and connected to detectors using 5-meter cables (Figure 2; Photos 1- 4). Each microphone was assumed to have an approximate 30-meter maximum range of detection, which may in part vary based on relative humidity of the air, and surrounding vegetation structure. Each detector was powered by four internal DD batteries.

Files were recorded on to 16 GB memory cards. Proper detector function was tested and confirmed one week after deployment of each monitoring station.

Figure 2. Photos of Detectors 1 – 4 deployed at SNR.



Photo 1: Detector 1 in a forest clearing near a road and pond, facing southwest into the clearing.



Photo 2: Location of Detector 2 along Brush Creek, facing east. The right descending bank of Brush Creek can be seen in the foreground.

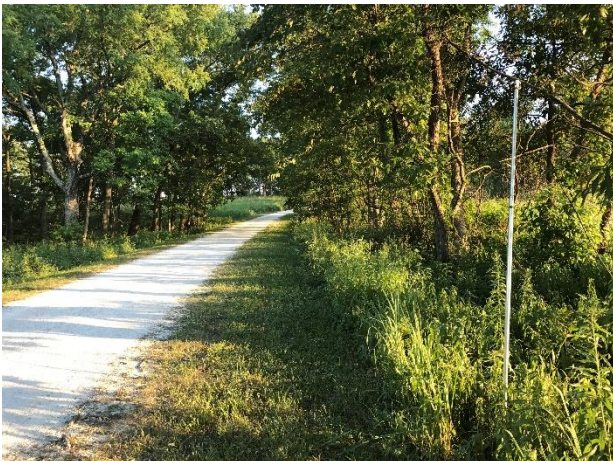


Photo 3: Detector 3 along a forested section of Trail House Loop Road, just north of Mirror Lake, facing southwest along the road.



Photo 4: Along Goddard River Trail just northwest of its intersection with Bard Road, facing west at the trail.

Acoustic Recording Analyses

While foraging and discerning objects in space, flying bats produce “calls”, or a sequence of echolocation pulses, that can be recorded by acoustic detectors. The data is later downloaded and transformed for viewing in a zero-crossings analysis software. In some cases, calls are fairly easily attributed to species due to their distinct characteristic frequency, slope, duration, and other call parameters. However, bats (even those belonging to different genera) often produce calls that are similar and overlap greatly in character and cannot be identified to species. During analyses,

recordings from each Detector were partitioned into 15 second time intervals per night, which are typically referred to as Files. As such, a detector recording constant bat activity for 8-hours (for instance, by a Detector placed inside a cave) could potentially contain a maximum of 1,920 files. We examined all files manually in AnalookW (version 4.3x) in an effort to locate files containing species-specific calls. This involved an initial scan through all files to remove files containing extraneous noise and looking for those containing bat calls.

The files containing bat calls were compared to our comprehensive reference set of calls from midwestern species. For each Detector, we assessed the data set for all potentially present species (Table 1). Once a species was documented, the file was labeled and we continued to scan the data set for remaining potential species. Due to the large number of files in the data set (see Results) and the nature of the research, we did not attempt to identify each file to species. Vouchers for each species per Detector are provided in Appendix A – Acoustic Voucher Files. All species identification was conducted by Vona Kuczynska. All *Myotis* files identified to species were confirmed by Chris Corben of Titley Scientific Inc. (Columbia, Missouri). Additionally, the data set from each Detector was subjected to a filter to remove the remaining noise files and the Scan Tool was used to count the number of files passing the filter and containing bat calls. Filter parameters included characteristic frequency of 15 to 75 kilohertz, call duration of 0.5 to 9999, smoothness of 30, and a minimum of 5 pulses per file (15 second interval). A copy of the data set and filter used is provided via a Google Drive link (Google Drive, 2019).

3.0 RESULTS AND DISCUSSION

Bat Activity Summary

Monitoring at SNR occurred over a total of 38 nights between the four Detector locations. Detector 1 and Detector 2, where the Indiana bat was first captured in 2017, were deployed first for 13 consecutive nights. Detectors 3 and 4 were deployed for six consecutive nights (Table 2). No adverse weather events (rain, storms, strong wind) that may affect bat activity occurred during the surveys. A total of 4,162 files (containing both noise and bat files) were recorded between the four Detectors (Table 3). Detector 1 recorded 800 files, Detector 2 recorded 1,661 files, Detector 3 recorded 138, and Detector 4 recorded 1,1563 files. The sum of bat activity per detector as well

as mean bat activity (sum of files passing filter divided by the number of recording nights) is provided in Table 3.

Table 2. Detector deployment summary for bat acoustic survey, SNR Project, [June 26, 2018 – July 9, 2018, Franklin County, Missouri]

Acoustic Detector	Latitude, Longitude	Habitat type	Nights Deployed	No. Complete Detector-Nights
Detector 1	38.4587, -90.8275	Forest clearing near a pond	June 26 - July 9	13
Detector 2	38.47494, -90.82549	Forested portion of Brush Creek	June 26 - July 9	13
Detector 3	38.469508, -90.817505	Along Trail House Loop Road, just north of Mirror Lake	July 17-22	6
Detector 4	38.463096, -90.811367	Forested Goddard River Trail	July 17-22	6

Table 3. Summary of bat activity at SNR. Raw Files represent the number of files recorded by detector, and include bat and noise files. Files Passing Filter include those passing a filter intended to remove extraneous noise. Mean Files are the sum of files recorded per detector divided by the number of nights of recordings.

Acoustic Detector	Raw Files	Files Passing Filter	Nights of Recordings	Mean Files
Detector 1	800	286	13	22
Detector 2	1,661	645	13	50
Detector 3	138	59	6	10
Detector 4	1,563	349	6	58
Total	4,162	1,339	38	35

Species Richness at SNR

A total of eight bat species were confirmed to occur at SNR. Between the four detectors, the following species were identified in the dataset during analyses: big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), evening bat (*Nycticeius humeralis*), gray bat (*Myotis grisescens*), hoary bat (*Lasiurus cinereus*), Indiana bat (*Myotis sodalis*), northern long-eared bat (*Myotis septentrionalis*), and tri-colored bat (*Perimyotis subflavus*). Silver-haired bats

(*Lasionycteris noctivagans*) may occur at SNR. Based on our experience with other surveys in surrounding counties, the silver-haired bat likely occurs in Franklin County during the spring and fall migration period. While silver-haired bats produce distinguishable calls that can be recognized during analyses, they often also produce calls that are similar and overlap greatly in frequency, slope (and other parameters) to big brown bats. Two files were recorded that could belong to a silver-haired bat by Detector 4, but they could also belong to a big brown bat. Due to the small number of potential recordings of silver-haired bats and large number of recordings from big brown bats, we have assumed this species to be absent from the data set and that the two files belong to a big brown bat.

Detector 1 data included recordings from the following species: big brown bat, eastern red bat, hoary bat, tricolored bat, and potentially evening bat. There was only one potential evening bat file present in the data set, but the call could also have been produced by an eastern red bat. Detector 2 data included calls from the big brown bat, eastern red bat, evening bat, gray bat, Indiana bat, little brown bat, northern long-eared bat, and tricolored bat. Detector 3 data included calls from the eastern red bat, the Indiana bat, and the tricolored bat. Detector 4 included calls from the big brown bat, eastern red bat, hoary bat, Indiana bat, little brown bat, northern long-eared bat, and the tricolored bat.

Table 3. Summary of species richness identified per detector. 1 indicates presence; 0 indicates absence.

Detector	Big brown bat	Eastern red bat	Evening bat	Gray bat	Hoary bat	Indiana bat	Little brown bat	Northern long-eared bat	Tri-colored bat	Silver-haired bat	Total Species
1	1	1	1 ⁺	0	1	0	0	0	1	0	5
2	1	1	1	1	0	1	1	1	1	0	8
3	0	1	0	0	0	1	0	0	1	0	3
4	1	1	0	0	1	1	1	1	1	0*	7
Species at SNR	1	1	1	1	1	1	1	1	1	0	9

⁺ 1 file; species potentially present at Detector 1 location but this file may belong to an eastern red bat.

* 2 files; species potentially present but likely these are big brown bats at Detector 4 location.

5.0 CONCLUSIONS

Overall, species richness was high throughout SNR, and included 9 of the 10 potential species for Franklin County. Using acoustic detectors, we confirmed the presence of Indiana bats at SNR during the breeding season. Of the nine species confirmed via acoustic analysis, three are federally

threatened or endangered: the Indiana, gray and northern-long eared bat (Table 1 and 3). Based on our findings, SNR may also support breeding colonies of northern long-eared bats, which have similar roost requirements to Indiana bats and include dead standing trees with sloughing bark and/or cavities, and live trees with exfoliating bark, such as shagbark hickory (*Carya ovata*) and mature white oak (*Quercus alba*). Gray bats were also detected during our analyses. Because this species uses caves as roosts year-round, and no gray bat hibernacula are known to occur within SNR, they are likely using SNR as a foraging area.

Detectors 2 and 4 indicate higher species richness and activity near forested waterbodies, which is to be expected due to openness of Brush Creek near Detector 2 and habitat diversity that surround both two locations. The lack of vegetation crowding in the forest understory and airspace directly above Brush Creek and along Goddard River Trail likely allows bats to maneuver with relative ease and provides an attractive place for bats to forage for aquatic and woodland arthropods. Both locations also provide canopy cover, which are thought to provide more shelter from predators (owls and other raptors) than agricultural fields, marshes, and prairies. Detectors placed in the upland sites – Detectors 1 and 3 – also boast relatively high species richness, but lower activity based on the number of Files recorded (see Table 3 in Results). Our study suggests that while bats use upland areas throughout SNR, forested bodies of water and trails with canopy cover represent important resources to bats within the reserve. Future studies such as tracking bats using radio-transmitters could gain more insight on specific bat activity, including foraging and summer roost site selection.

The baseline acoustic presence data lends itself to future studies and questions to be explored at SNR. Studies could include projects that SNR staff are already familiar with, such as the management of SNR for the goal of increasing wildlife habitat in both the forested and prairie areas. Additionally, graduate students at local universities or organizations such as Wildheart can offer unique follow-up studies based on the data. SNR could confirm that Indiana and northern long-eared bats roost on-site, rather than utilize SNR solely as a foraging site. Mist net and radio-telemetry studies could be conducted to determine if federally-listed species roost on site and to identify the locations of these important resources. Knowing the locations of roost sites may help SNR protect known roost trees from visitor disturbance to the colonies. Mist net and further

acoustic studies at SNR could help guide habitat management and restoration decisions. By identifying roost and additional important foraging areas, SNR could focus on habitat maintenance where bats tend to spend more time or alternatively drive restoration efforts in areas where detectors indicate bat activity appears to be low to improve conditions. Due to the presence of federally and state listed bat species, coordination with U.S. Fish and Wildlife Service and Missouri Department of Conservation could be beneficial for grant programs or future partnerships.

6.0 CITATIONS

Chapman, S.S., Omernik, J.M., Griffith, G.E., Schroeder, W.A., Nigh, T.A., and Wilton, T.F., 2002, Ecoregions of Iowa and Missouri (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,800,000)

Google Drive. 2019. *Shaw Nature Reserve Acoustic Study*. Full data set available at: <https://drive.google.com/open?id=1wlHRr8TTDsZAO8hU-VSULkv7AJ4Fefol>

Missouri Department of Conservation. 2019a. *Field Guide to Bats*. <https://nature.mdc.mo.gov/discover-nature/field-guide/bats>. Accessed January 13, 2019.

Missouri Department of Conservation. 2019b. *Missouri Species and Communities of Conservation Concern Checklist 2018*. https://nature.mdc.mo.gov/sites/default/files/downloads/2018_SOCC.pdf

U.S. Fish and Wildlife Service. 2019a. *Indiana Bat Fact Sheet*. <https://www.fws.gov/midwest/endangered/mammals/inba/inbafactsht.html>. Accessed January 13, 2019.

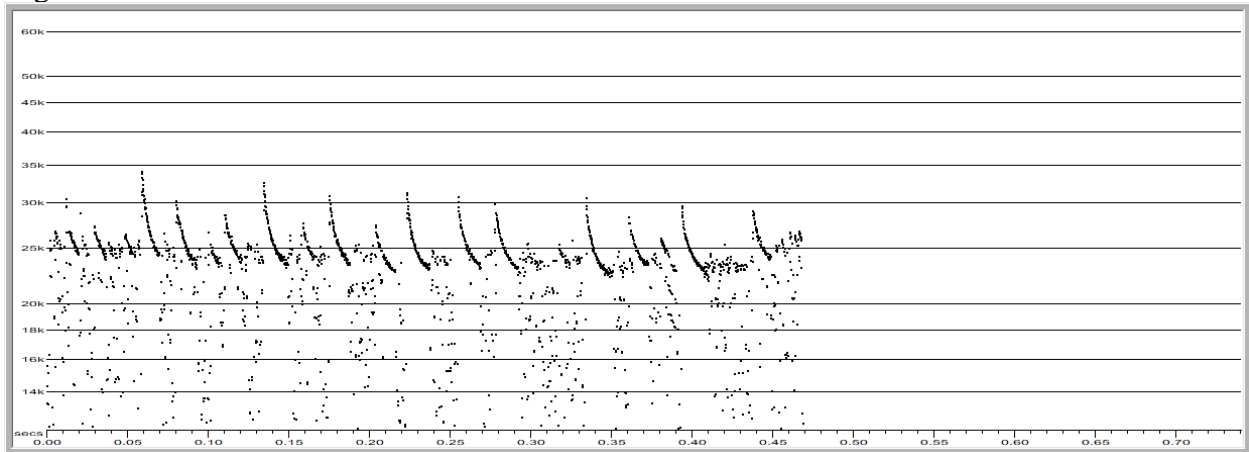
U.S. Fish and Wildlife Service. 2019b. *Federally Listed Species*. https://ecos.fws.gov/tess_public/pub/stateListingAndOccurrenceIndividual.jsp?state=MO

APPENDIX A: ACOUSTIC CALL VOUCHERS

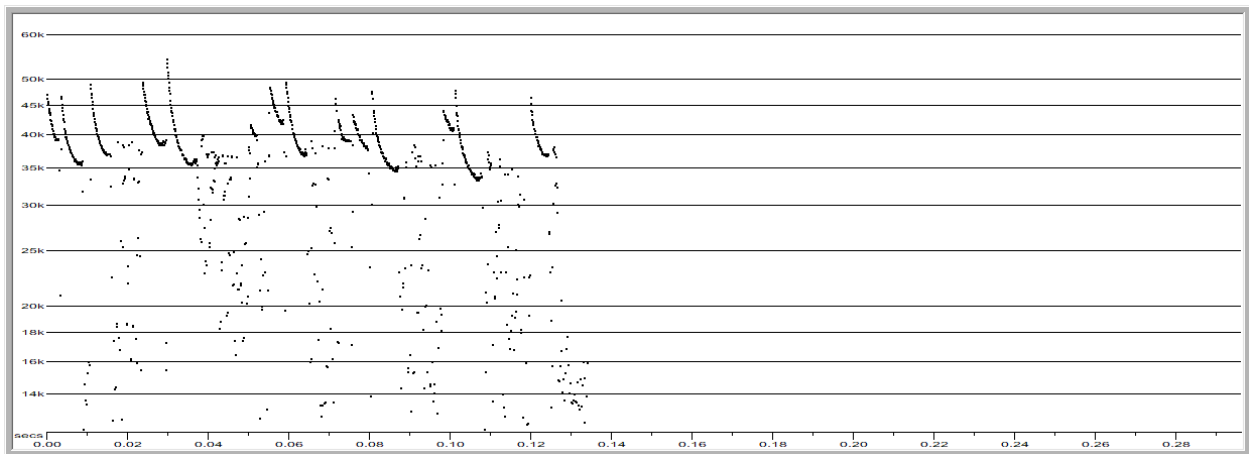
Below are vouchers of species recorded at SNR. The vouchers are organized by Detector and species. The X axis represents time (milliseconds), and the Y axis represents the frequency (kHz). Please note that for viewing purposes, the files are provided in compressed mode (F6 and F7) and do not represent pulses in real time.

Detector 1 – Forest Clearing Near Pond

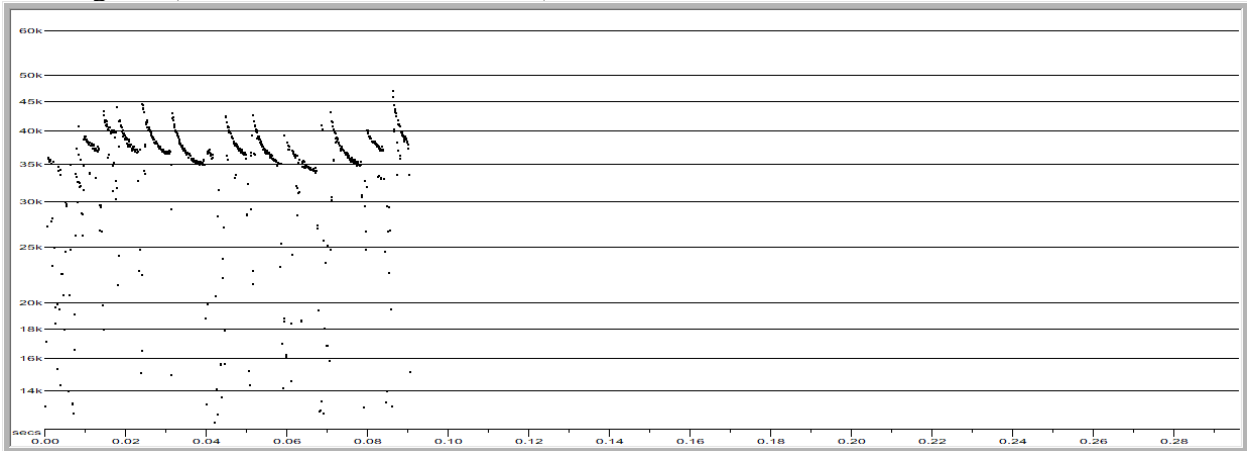
Big Brown Bat



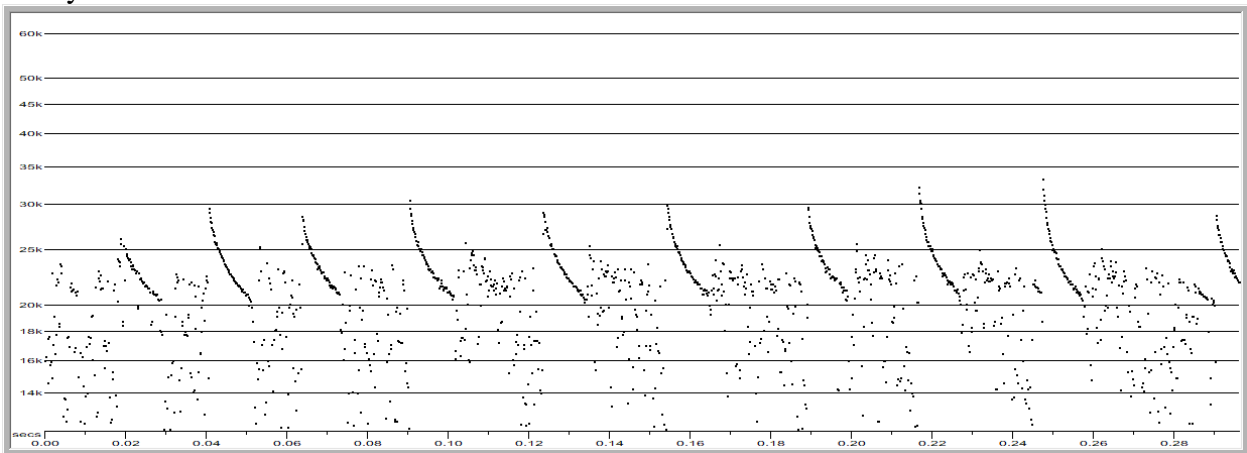
Eastern Red Bat



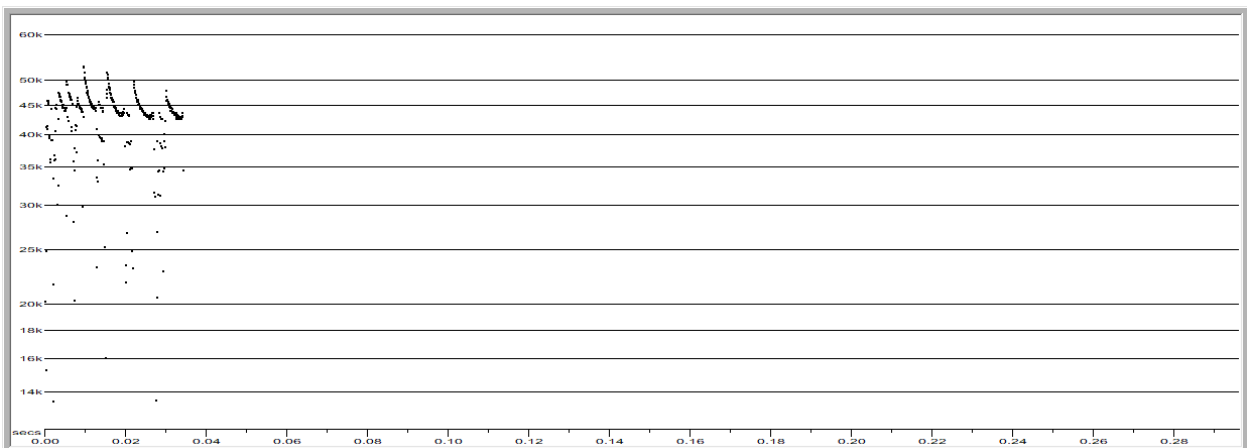
Evening Bat (could be an Eastern Red Bat)



Hoary bat

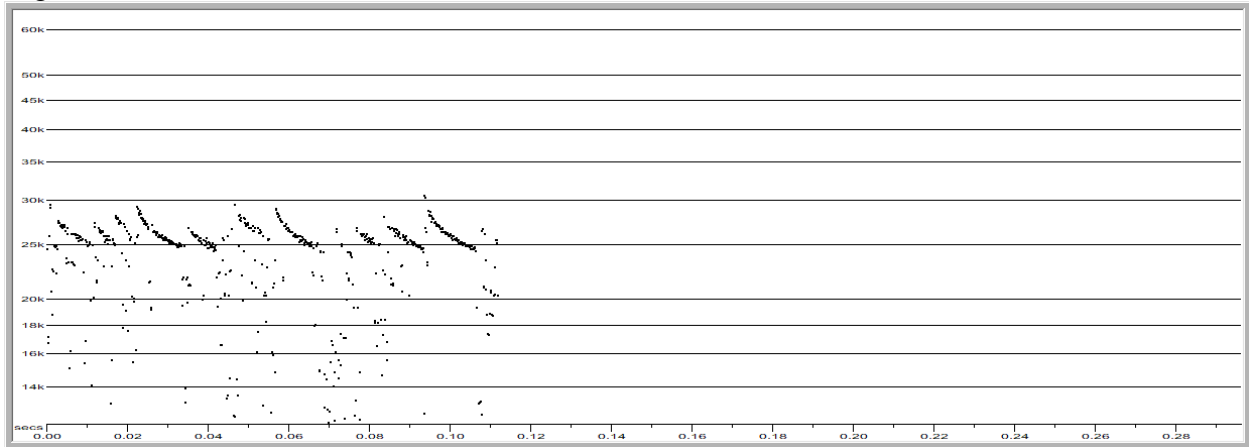


Tricolored Bat

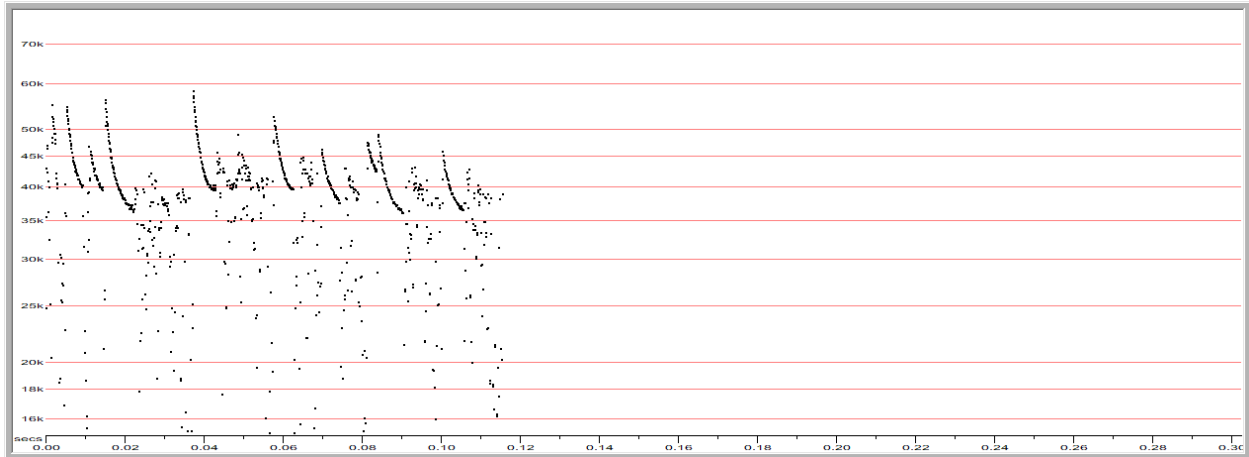


Detector 2 – Brush Creek

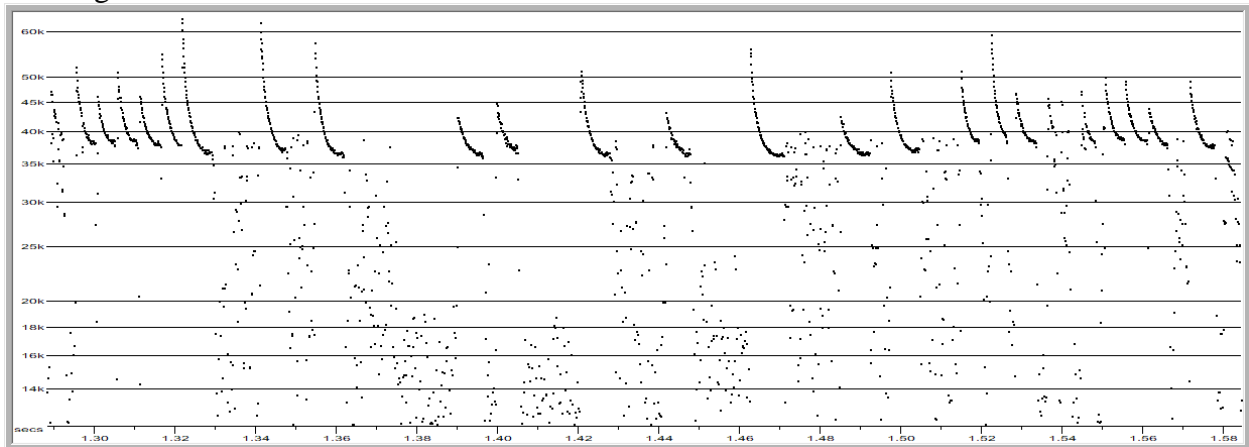
Big Brown Bat



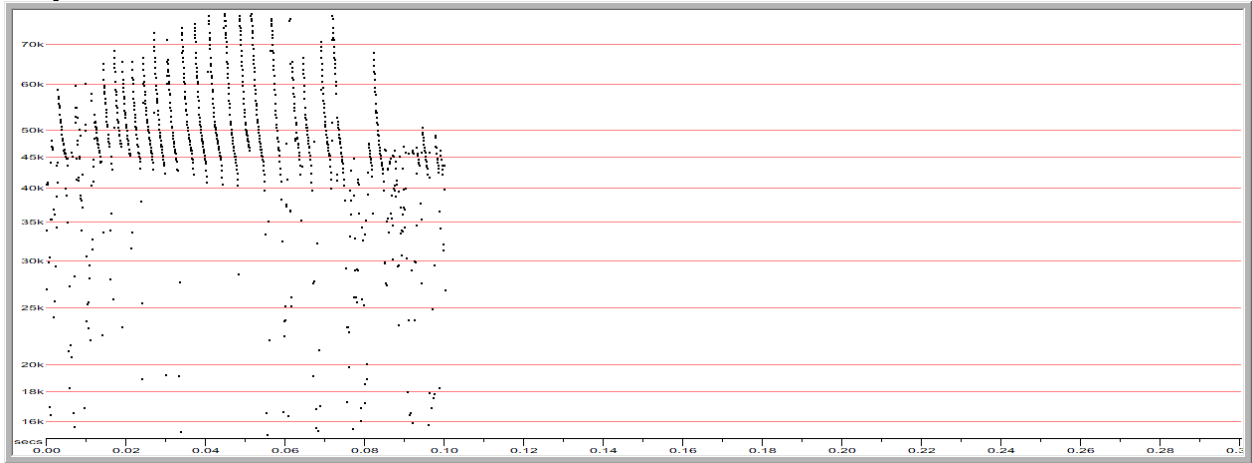
Eastern Red Bat



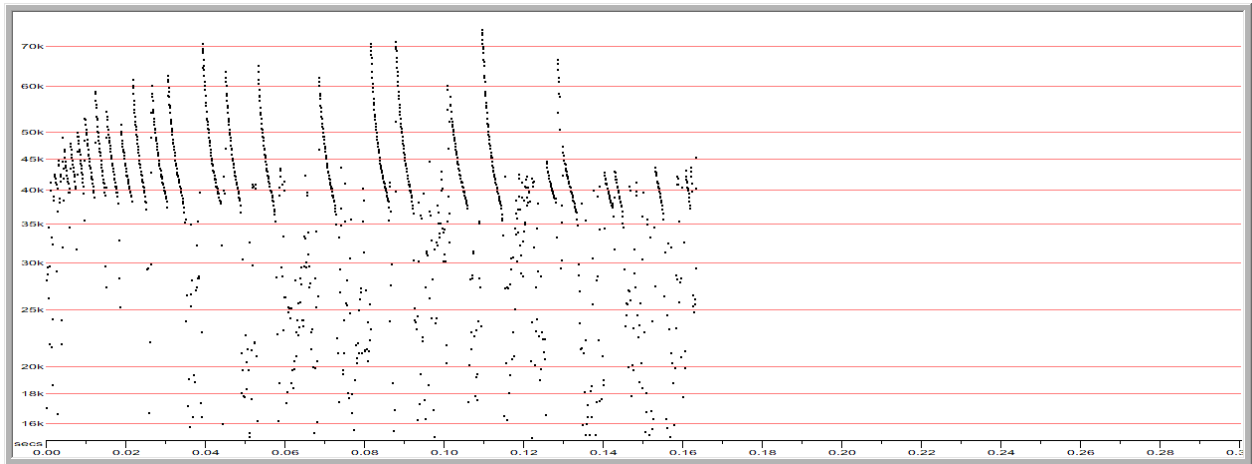
Evening Bat



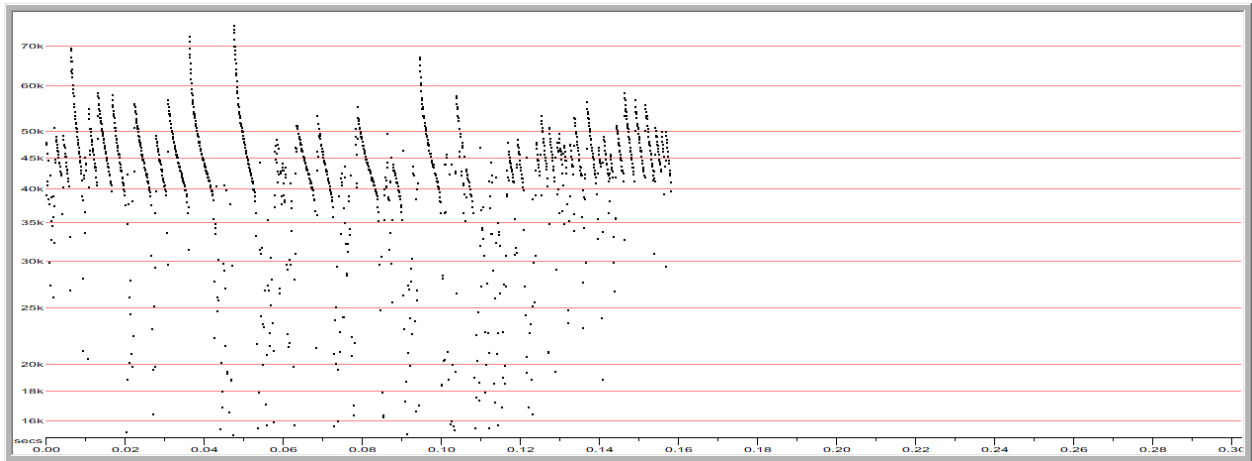
Gray bat



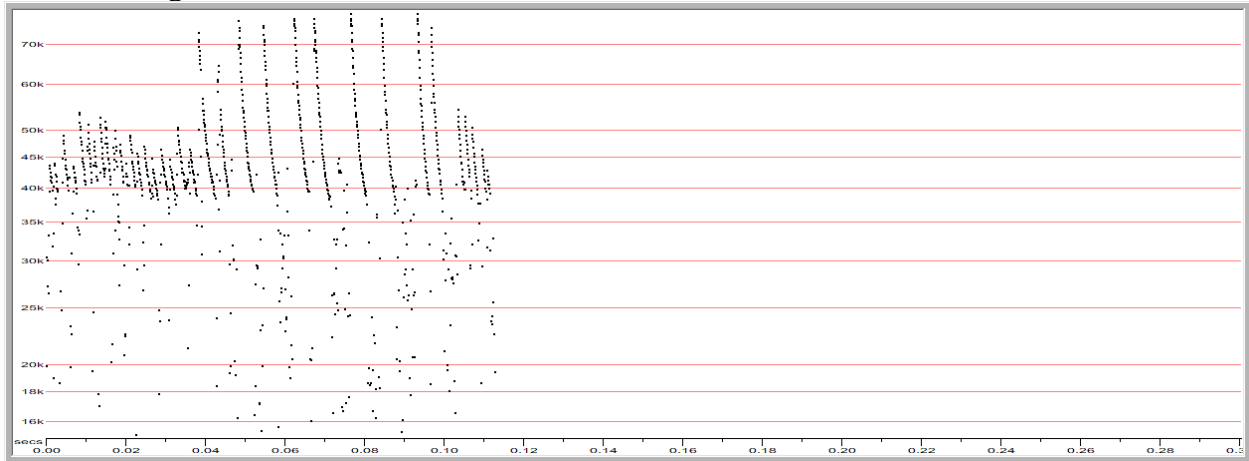
Indiana bat



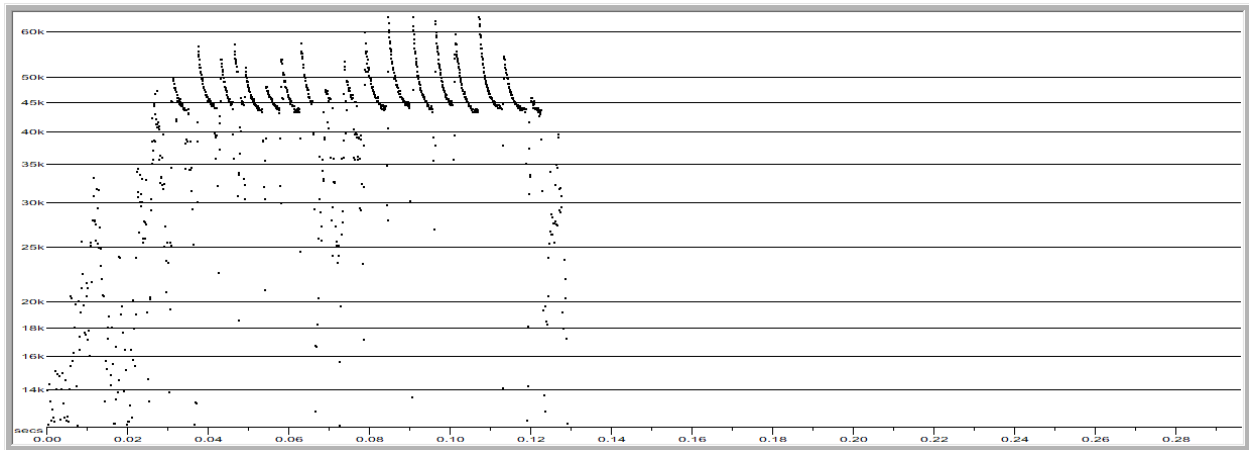
Little Brown Bat



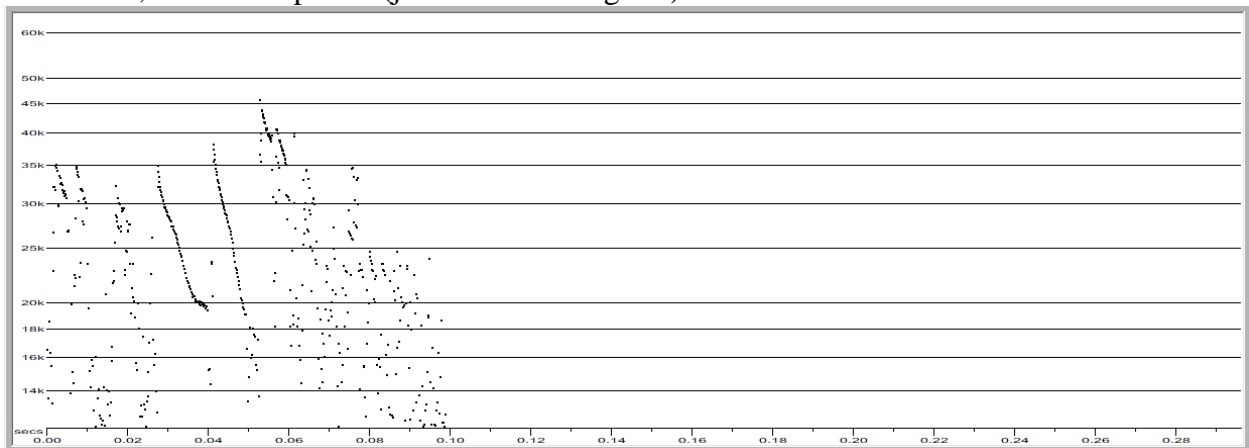
Northern long-eared bat



Tricolored Bat

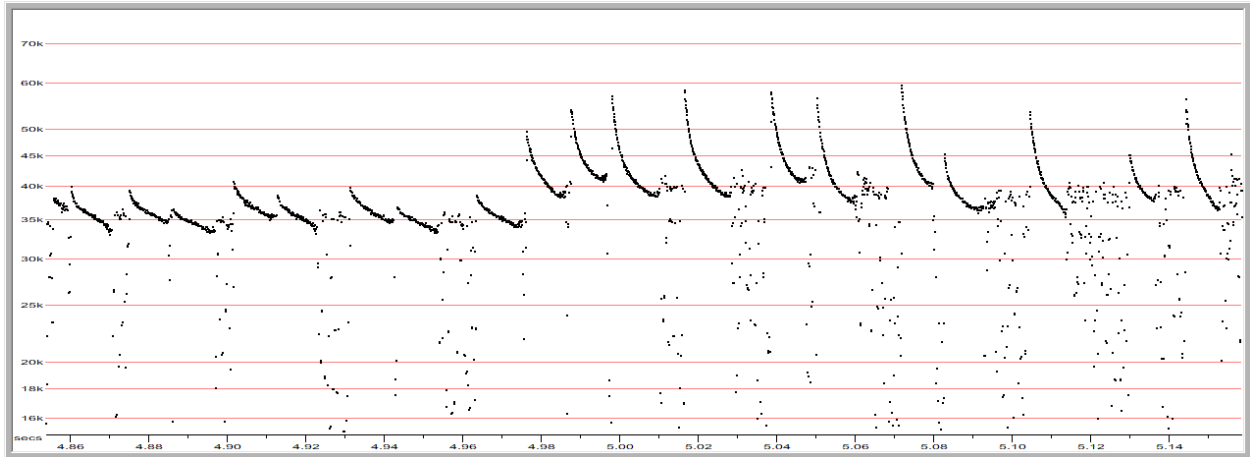


Social call, unknown species (just an interesting file)

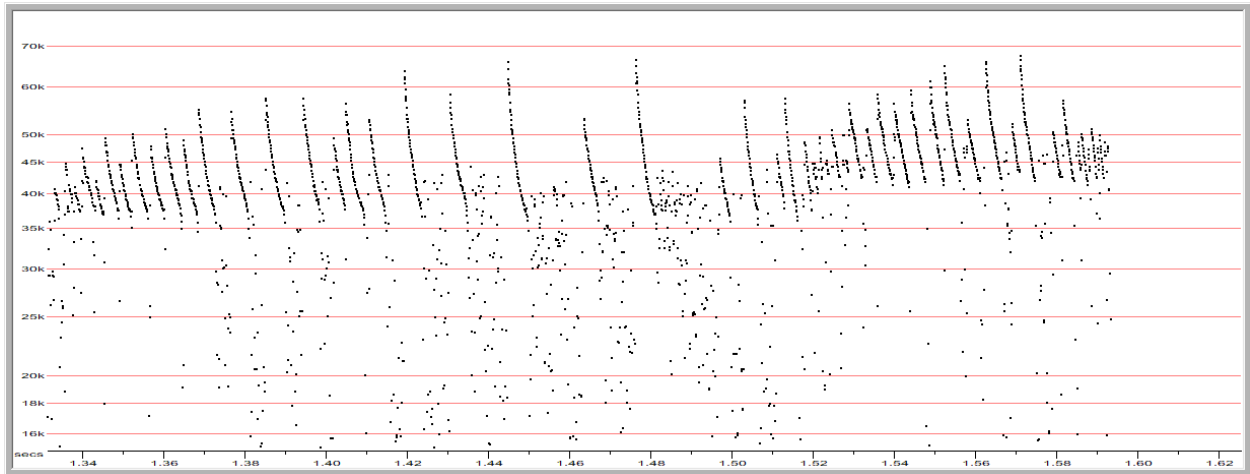


Detector 3 – Trail House Loop Road

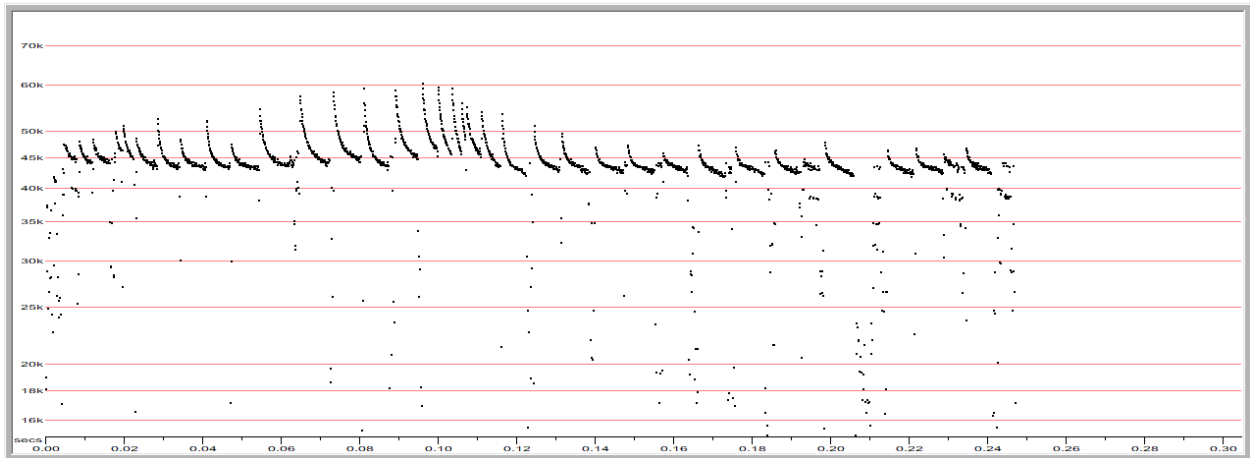
Eastern Red Bat



Indiana Bat

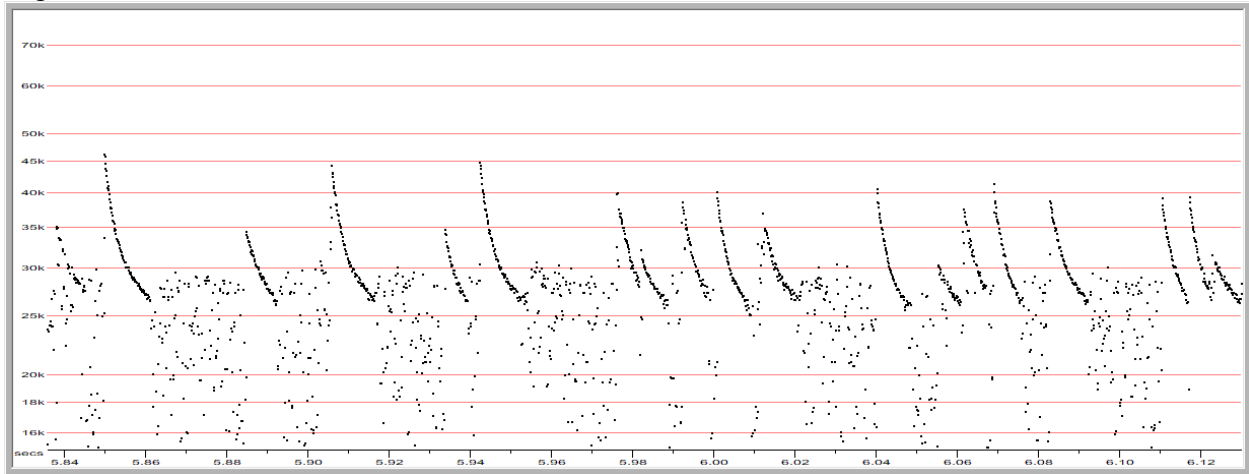


Tricolored Bat

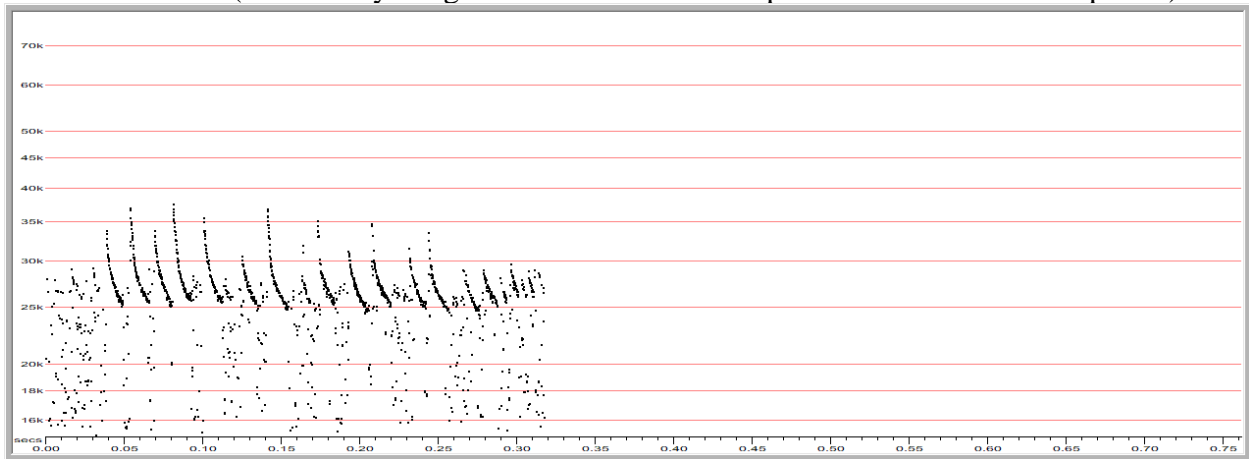


Detector 4 – Goddard River Trail

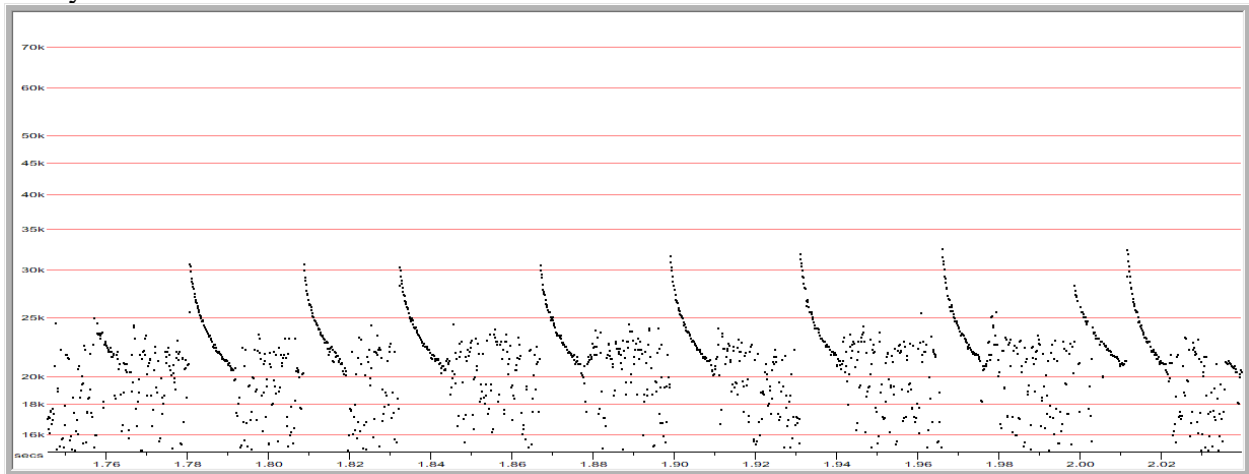
Big Brown Bat



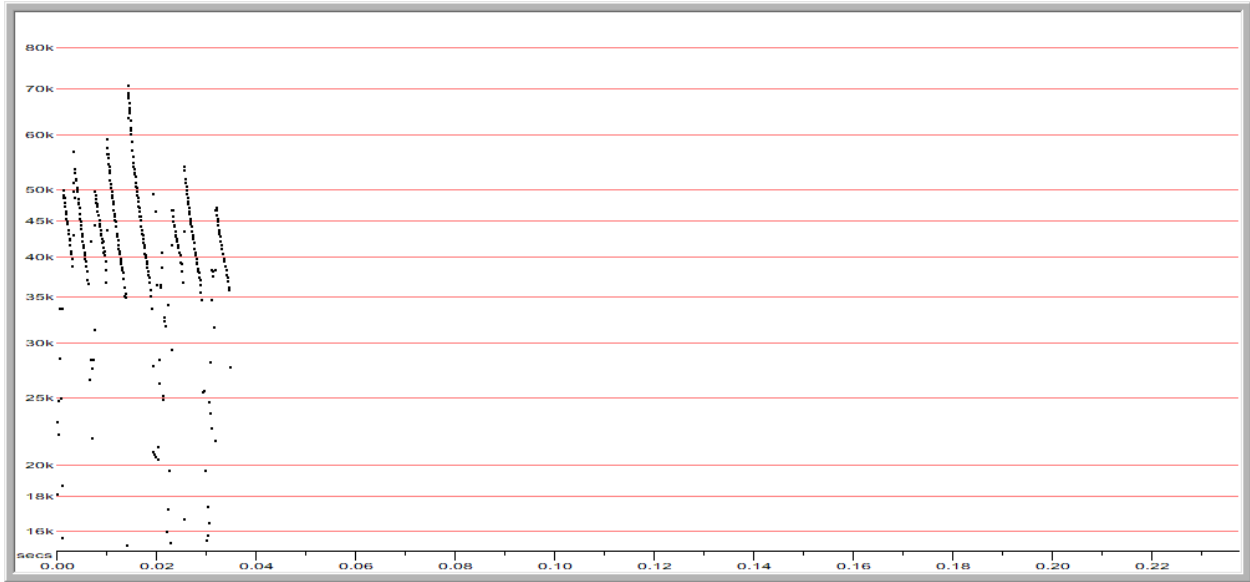
Silver-haired Bat (more likely a big brown bat but in overlap zone between the two species)



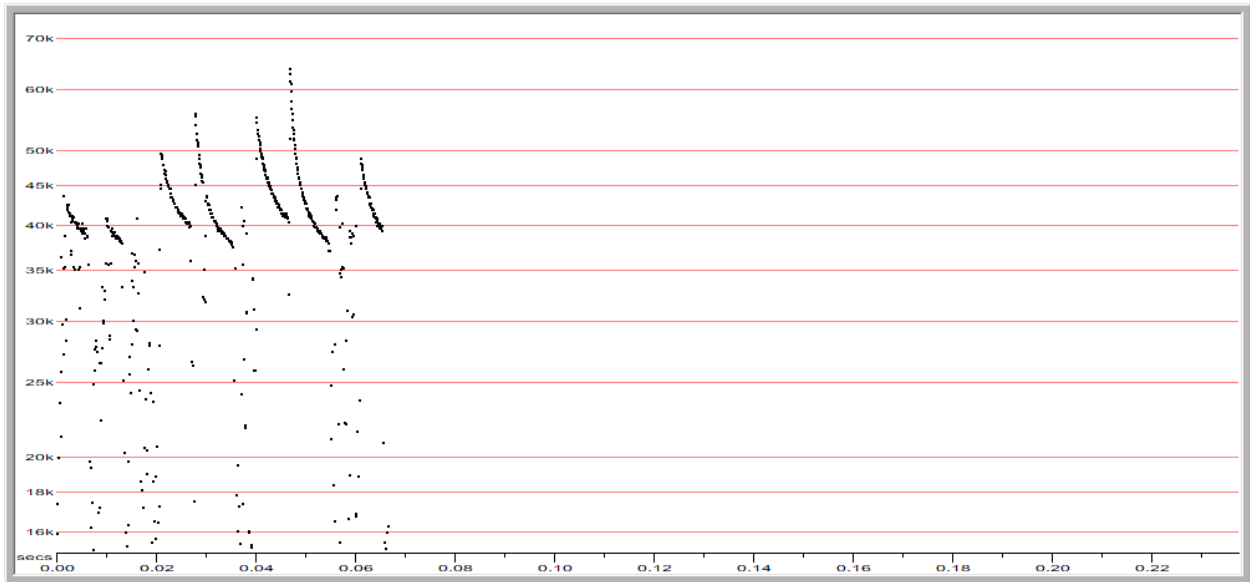
Hoary Bat



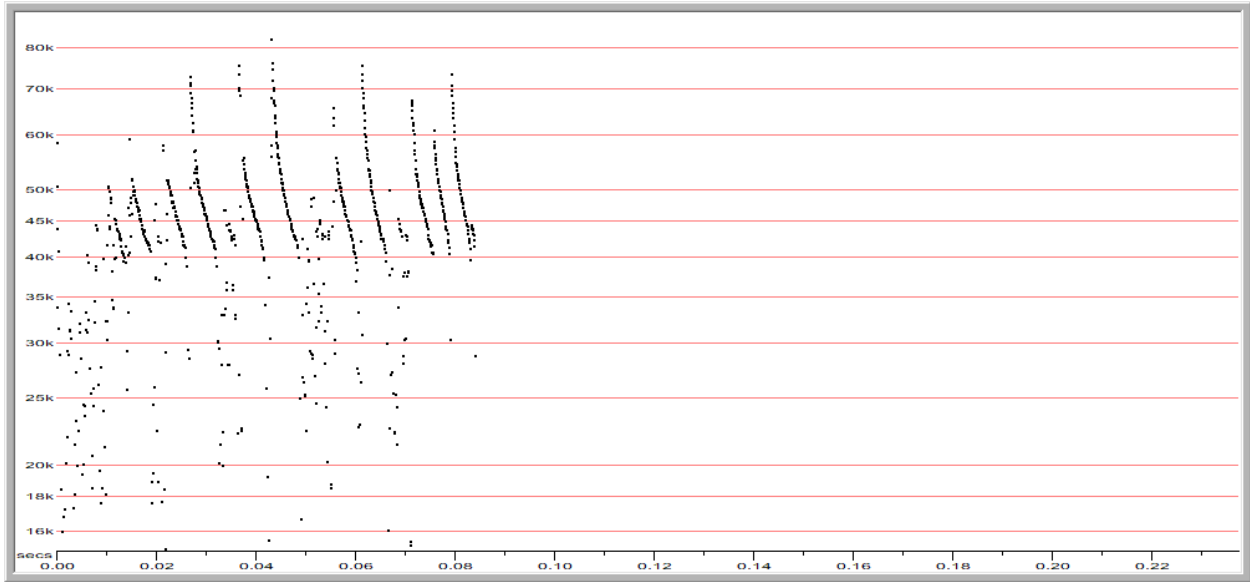
Indiana Bat



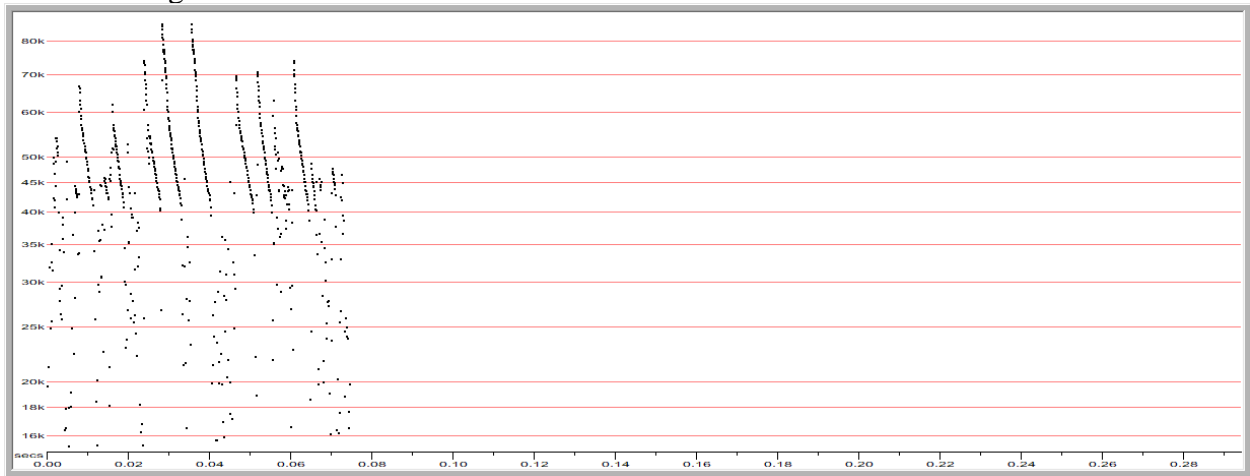
Eastern Red Bat



Little Brown Bat



Northern long-eared bat



Tricolored Bat

