



Smithsonian
*National Zoological Park
Conservation Biology Institute*



VIRGINIA WORKING LANDSCAPES

2025 BAT BIOACOUSTIC
PILOT STUDY RESULTS

KINLOCH FARM

Echoes in the Landscape: Uncovering How Bats Use Working Lands

Among the many ecosystem services that bats provide globally, North American bats serve as an important means of biological insect pest control in agricultural landscapes. However, numerous Virginia bat species have experienced steep population declines over the last decade due to the impacts of White-Nose Syndrome, habitat loss, and pesticide applications.



Research has demonstrated that bats utilize a mosaic of habitats for foraging at their summer roosting sites; however, intensification of agricultural practices and habitat fragmentation may compound these threats to bat populations across rural landscapes. With the majority of Virginia's land area under private ownership, engaging landowners and habitat managers is critical toward advancing statewide bat conservation efforts.

Smithsonian's Virginia Working Landscapes (VWL) collaborates with Virginia farmers and landowners to study and promote native biodiversity on privately-owned lands through annual monitoring surveys. These collaborations offer insights into how land management practices impact the diverse plant and wildlife communities that make up grassland ecosystems. However, bats—despite the critical role they play on our Virginia farmlands—remain locally understudied. This new pilot study seeks to answer the question:

How do habitat and landscape diversity impact bat community structure and foraging activity patterns on working lands?

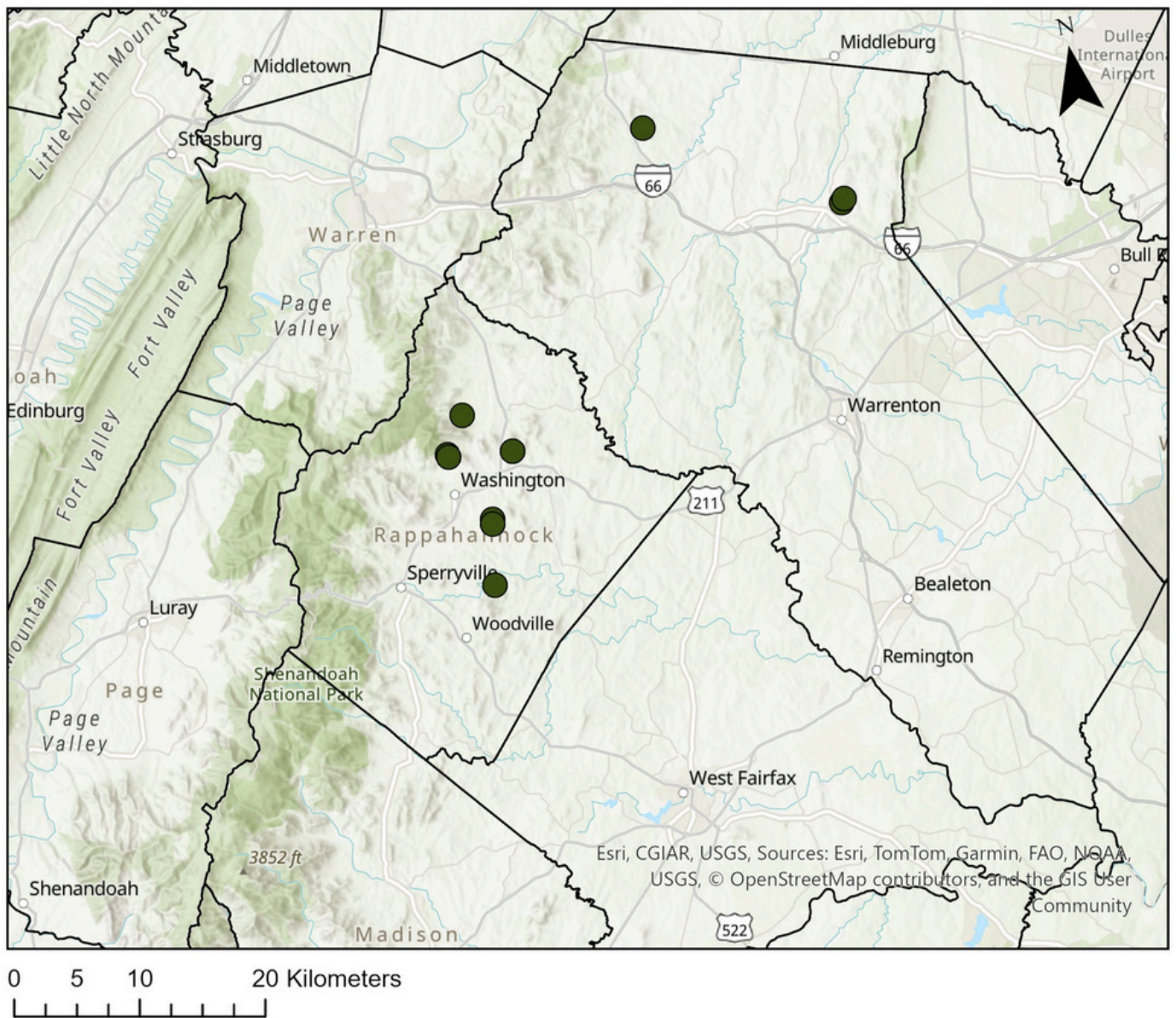
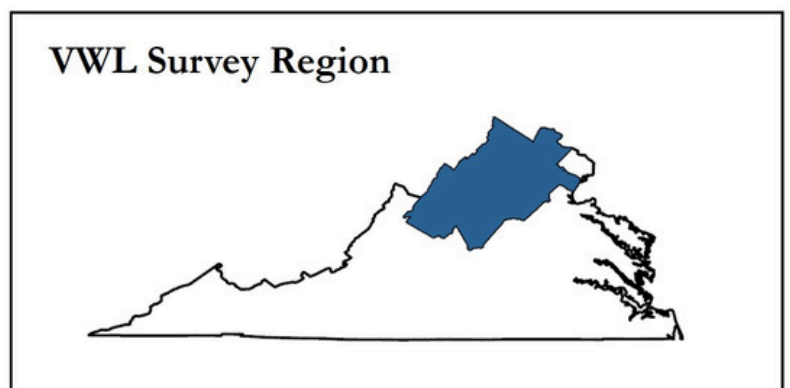


Fig. 1. Map of ten bat bioacoustic survey locations at seven participating farms in 2025.

2025 Site List

Raines Property
 Sunnyside Farm & Conservancy
 Jones Nature Preserve
 Whyman Property
 Over Jordan Farm
 Kinloch Farm
 La Drome Farm



METHODOLOGY- FIELD SURVEYS

Bat Survey Methods

Research sites for this initial pilot season included 10 fallow/post-agricultural fields and meadows where management and/or grazing activity were delayed until the completion of the survey period.

Sites were located at least 200m apart, centered within fields, and selected based on the diversity of existing plant communities documented by VWL plant surveys.

At each site, an autonomous recording unit (ARU) was mounted on a 3m high pole. From May 15 through July 31, ARUs operated remotely under optimal weather conditions during the full nightly period of 30 minutes pre-sunset to 30 minutes after sunrise when bats are active.

Recordings were analyzed to assess bat species richness and activity levels at each location.



Big Brown Bat
(*Eptesicus fuscus*)
echolocating



Bat ARU mounted
on a 3m pole



Plant Survey Methods

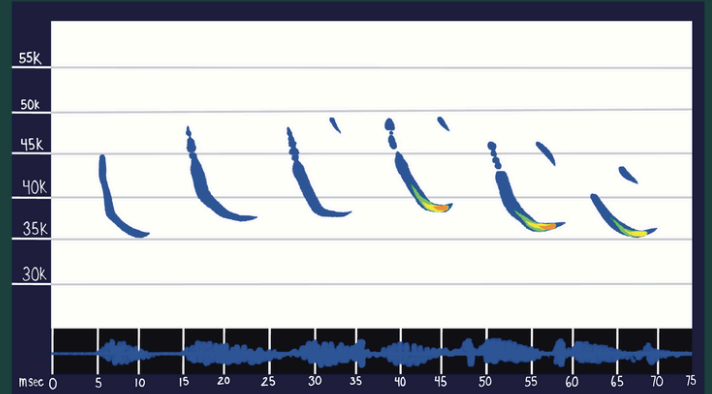
Grassland plant surveys measured plant species composition of each survey site, which can provide insight into habitat quality and the impact of land-use on plant communities. These surveys require 10+ acre fields and are most effective when plants are allowed to reach maturity and management actions such as mowing, grazing, or burning can be delayed until surveys are completed.

To determine plant species occurrence and diversity, surveyors assessed plots along a linear transect starting at the designated survey points. Species are identified within seven 1-m² plots arranged along each transect. Each site is visited twice, once in the spring and once in the summer. These data are used to estimate plant species richness and diversity at the overall field level.

METHODOLOGY- BIOACOUSTIC ANALYSIS

Spectrogram and Data Analysis

Standard bioacoustic monitoring protocols pre-established by The North American Bat Monitoring Program were used for spectrogram analysis, and all acoustic data was analyzed using SonoBat. Data visualization was performed using R Statistical Software. Additional landscape-scale assessments using GIS data will be performed to model outcomes from this pilot study and from future research sites to identify best management practices for landowners that are associated with habitat and landscape quality.

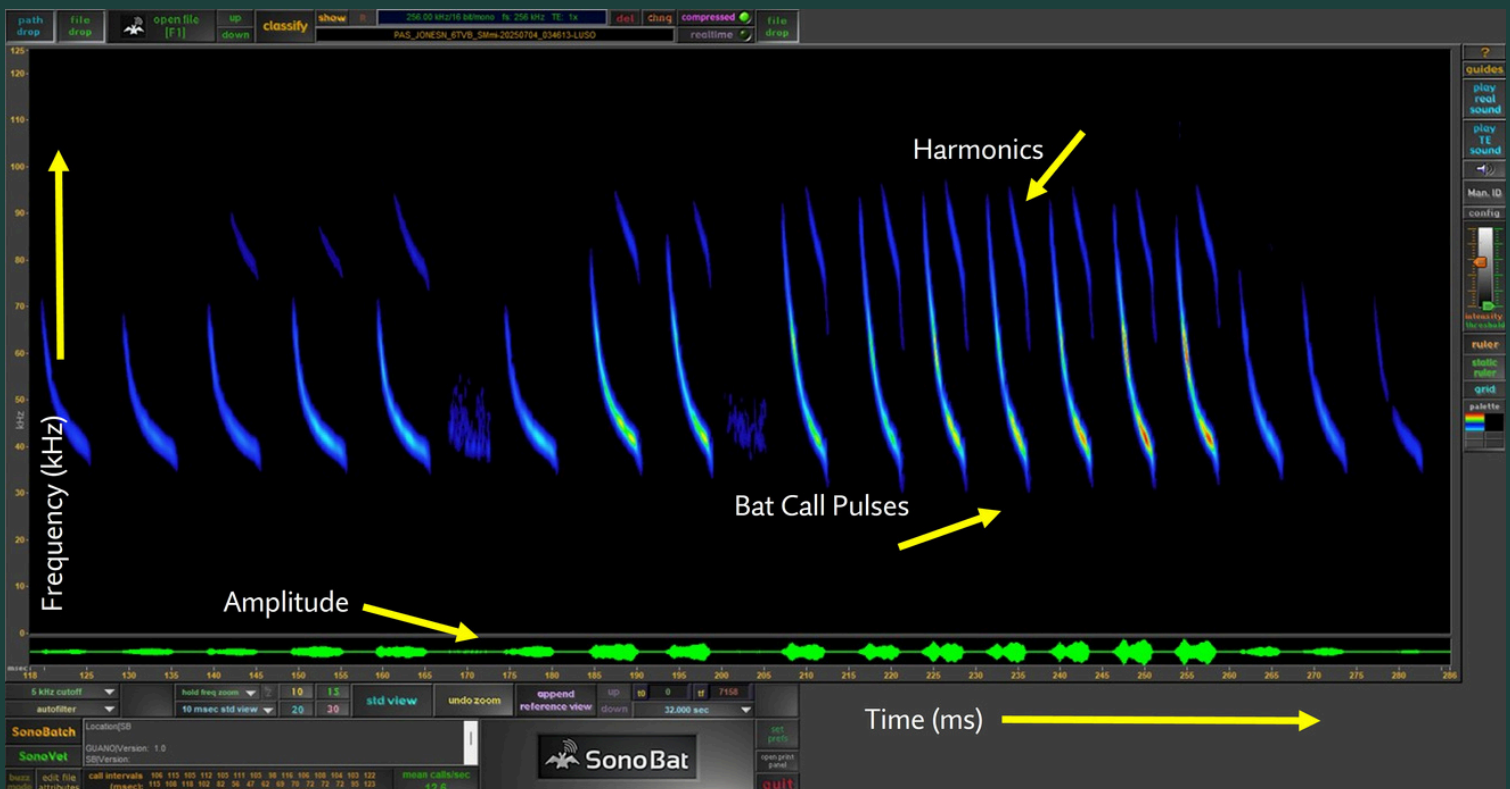


What parameters do scientists use to identify bat calls from a spectrogram?

- Frequency range (Kilohertz)
- Call length and spacing between echolocation pulses (milliseconds)
- Call intensity (decibels)
- Call shape
- Presence of harmonics



Spectrogram recording of a *Myotis* species



RESULTS FROM YOUR PROPERTY



Dominant 2025 Field Vegetation

Field: K1K2 Point A

- Coneflower (*Rudbeckia* spp.)
- Blackberry (*Rubus* spp.)
- Sericea lespedeza (*Lespedeza cuneata*)
- Purple Coneflower (*Echinacea purpurea*)
- Wild Bergamot (*Monarda fistulosa*)

Field: K1K2 Point C

- Coneflower (*Rudbeckia* spp.)
- Purple Coneflower (*Echinacea purpurea*)
- Sericea Lespedeza (*Lespedeza cuneata*)

Fig. 2. Map of bat ARU survey locations on your property indicated by 30m radius microphone reception zones.

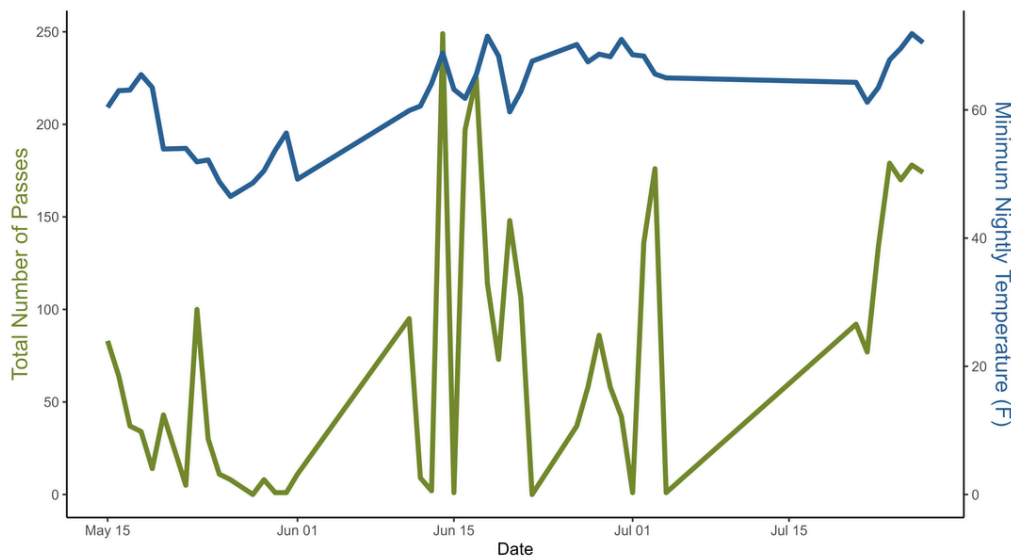


Fig. 3a. Nightly bat activity and minimum nightly temperatures at Kinloch Farm (K1K2- A) from May 15 to July 27.

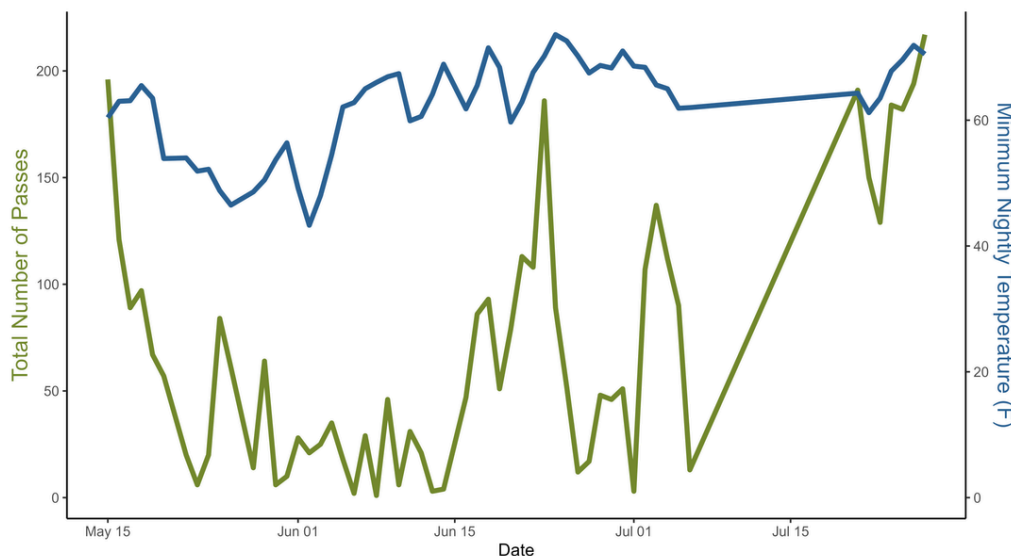


Fig. 3b. Nightly bat activity and minimum nightly temperatures at Kinloch Farm (K1K2- C) from May 15 to July 27.

Meet the Bat Species Detected on Your Property



Big Brown Bat (*Eptesicus fuscus*)

- **VA Conservation Status:**
Not Listed
- **Roosting Habits:**
Hibernates in manmade structures, including old buildings and churches, in addition to caves and rock shelters



Evening Bat (*Nycticeius humeralis*)

- **VA Conservation Status:**
Not Listed
- **Roosting Habits:**
Migratory and roost in hollow trees, behind loose bark, and sometimes in buildings and attics



Eastern Red Bat (*Lasiurus borealis*)

- **VA Conservation Status:**
Virginia Wildlife Action Plan Tier 4
- **Roosting Habits:**
Migratory and roost in the foliage of deciduous or sometimes evergreen trees



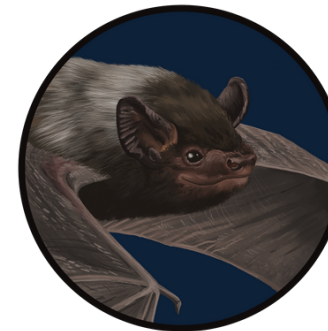
Tricolored Bat (*Perimyotis subflavus*)

- **VA Conservation Status:**
Federal Proposed, State Endangered, Virginia Wildlife Action Plan Tier 3
- **Roosting Habits:** Use a variety of roosts and often hibernate in caves and culverts



Hoary Bat (*Lasiurus cinereus*)

- **VA Conservation Status:**
Virginia Wildlife Action Plan Tier 4
- **Roosting Habits:**
Migratory and utilize tree roosts during both summer and winter



Silver-haired Bat (*Lasiurus noctivagans*)

- **VA Conservation Status:**
Not listed
- **Roosting Habits:**
Migratory and roost in tree cavities, sloughing bark, and rock crevices

Species' Spectrograms Recorded on Your Property

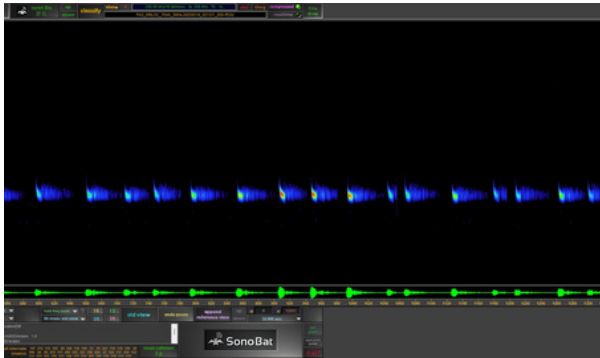


Fig. 4. Spectrogram showing a recording of a Tricolored Bat (*Perimyotis subflavus*).

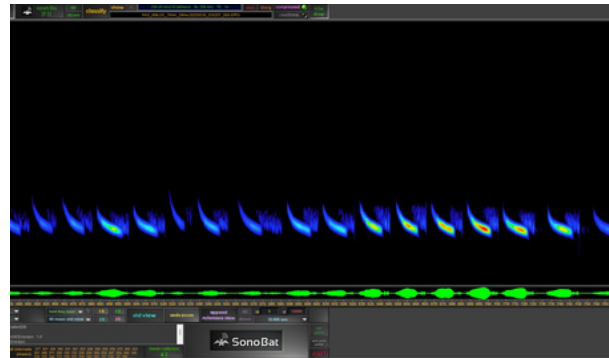


Fig. 5. Spectrogram showing a recording of a Big Brown Bat (*Eptesicus fuscus*).

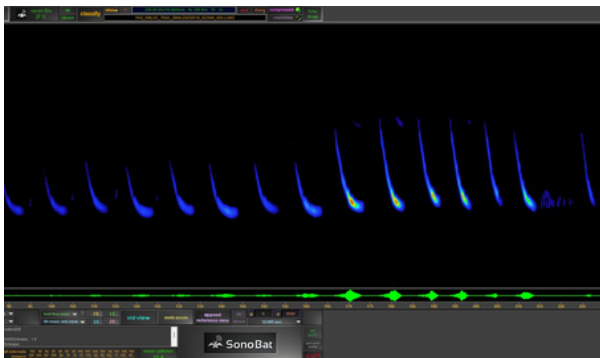


Fig. 6. Spectrogram showing a recording of an Eastern Red Bat (*Lasiurus borealis*).

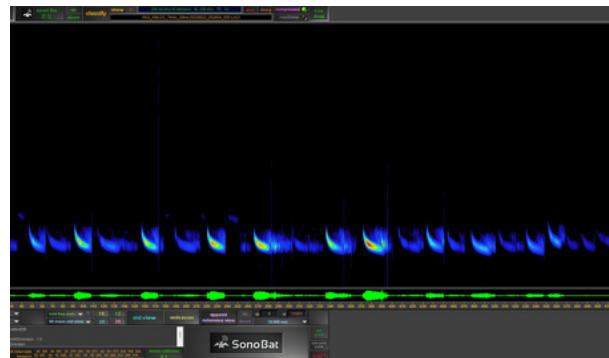


Fig. 7. Spectrogram showing a recording of a Hoary Bat (*Lasiurus cinereus*).

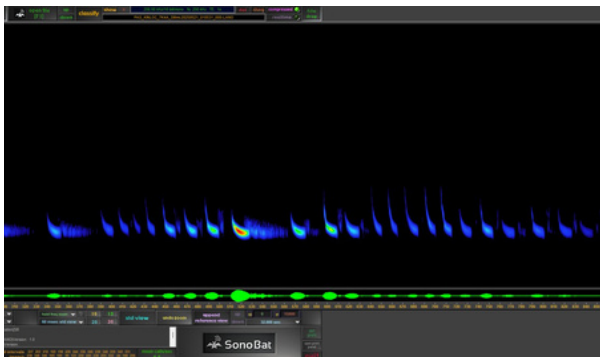


Fig. 8. Spectrogram showing a recording of a Silver-haired Bat (*Lasiurus noctivagans*).

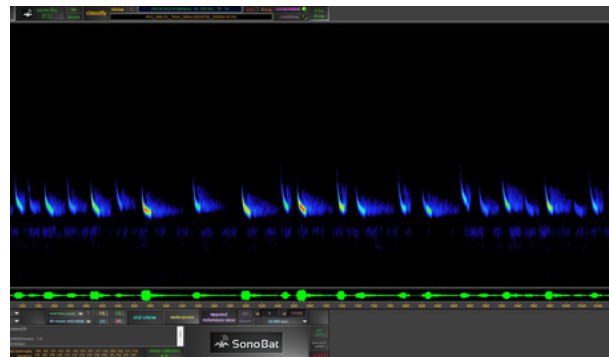
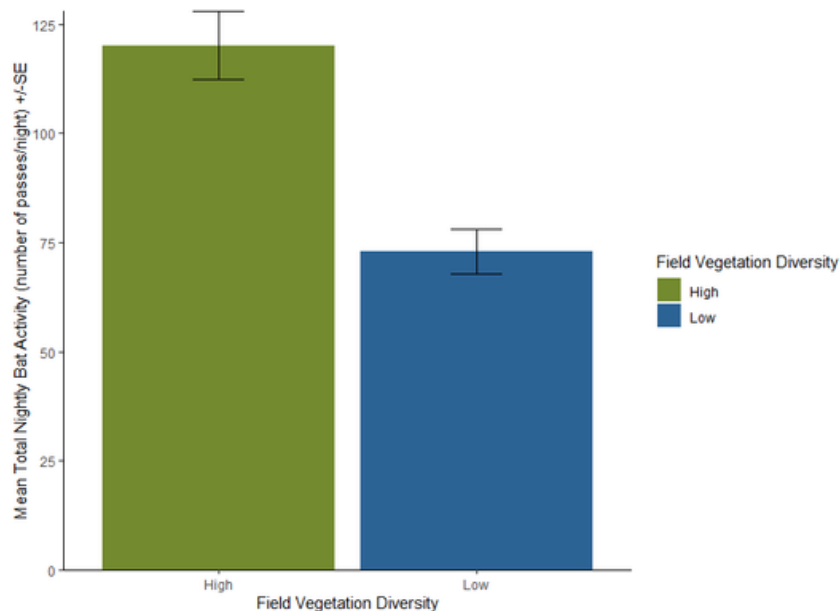


Fig. 9. Spectrogram showing a recording of an Evening Bat (*Nycticeius humeralis*).

OBSERVATIONS ACROSS ALL SITES

Fig. 10. Comparison of bat activity across all 10 pilot study sites along a gradient of field vegetation diversity and species richness levels. Pilot sites consisted of either post-agricultural fields with intermittent management that have not been planted or fields that have been planted with a native seed mix to promote wildlife habitat and are managed intermittently. Sites were binned into one of two field vegetation diversity categories (High or Low), based on falling within the 75th or 25th percentile, respectively, of all VWL vegetation survey sites of similar management regimes. Only survey nights with optimal weather conditions (minimum nightly temp above 50 degrees F and no rainfall) were included in analysis.



Interpreting Results from Acoustic Surveys

Acoustic sampling is not an exact science, and there is considerable interpretation and post analysis necessary to verify results. There are multiple detector models and analysis software programs available that vary in recording quality and classification of bat calls. The data collected during our surveys were auto-classified by SonoBat version 30 and manually vetted by the author of this report. This pilot study included a small sample size across 10 initial participating research sites. More sampling across additional future research sites will be needed to make inferences about the relationships between bat activity and the surrounding habitat and overall landscape. Additionally, more sampling will be necessary to confirm the presence of hard to detect and/or uncommon bat species in the region.

WHAT'S NEXT?

Our team is excited to announce that newly awarded funding from the **National Geographic Society** is allowing us to amplify our bat research and outreach efforts in 2026!



Bat acoustic monitoring surveys will continue in 2026 at new research locations. Additional monitoring sites will contribute to a more robust analysis of how bat activity is influenced by varying landscape conditions and field management practices. We aim to interpret study outcomes to inform best land management practices for private landowners to support conservation efforts of these rapidly declining populations.

Additionally, the VWL team will further engage the local community in bat conservation efforts through public talks, volunteer training, community workshops, nighttime field walks, and the development of outreach materials. We are planning several public outreach events in 2026, so stay tuned!

Learn more at: vaworkinglandscapes.org/bats-working-lands/

HOW CAN YOU HELP BATS AT HOME?



Protect water quality

Maintaining water quality not only provides clean drinking water for bats, but it also directly supports macroinvertebrate communities that bats depend on. Reducing runoff into natural waterways can lessen bats' susceptibility to consuming water or insects contaminated by chemicals, such as pesticides. On farms, installing exclusion fencing and planting stream buffers can help reduce runoff, livestock waste, and stream erosion.



Leave snags standing

Snags, or standing dead trees, are an important resource for many different species, including bats. They provide critical roosting habitat for bats and also support a diverse insect community. Snags should be left where they are if they don't pose a threat to human safety or structures, but if one must be taken down, leaving it on the ground still provides valuable resources for insects.



Reduce or eliminate pesticide use

All species of bats in Virginia are insectivorous, so reducing pesticide use around your home use can support a more diverse insect population. After all, bats provide an important ecosystem service of natural insect pest control!



Install a bat box

Installing a bat box on your property may not necessarily *attract* bats, especially if they have a preferred natural roost available nearby, but it can be a great way to provide an alternate roost location following an exclusion from a home or barn or the loss of natural habitat. It is important to keep in mind that not all bat species will use artificial roosts. Sun exposure and choice of paint color are important considerations, and bat boxes should be well sealed to trap warm air and retain heat. Bat boxes should be mounted at least 10 feet above the ground on a manmade structure or pole. Mounting boxes on trees is not advised, as bats are more vulnerable to predation.

HOW CAN YOU HELP BATS AT HOME?



Leave the leaf litter

Leaving leaf litter, even in just a portion of your yard, can support numerous wildlife species during the harsher winter months. In addition to providing overwintering habitat for bats' insect prey, leaf litter provides an insulated environment that protects foliage-roosting tree bats, like Eastern Red Bats, from the cold temperatures. The moisture in leaf litter allows roosting bats to stay hydrated while they lower their metabolism during periods of temporary hibernation.



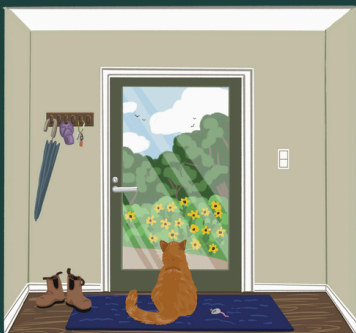
Plant native plants

Planting a diverse array of native plants can help support a more biodiverse insect community, which Virginia's insectivorous bats depend upon. Native plants with blooms that remain open for at least part of the night, have light-colored flowers, and have a strong fragrance can be particularly attractive to the night-flying insects that bats predate, such as moths and beetles.



Turn off lights at night

Light affects bats' foraging behaviors, with some species being less active on full moon nights. Research has shown that artificial light pollution negatively impacts the relationship between bats and the lunar cycle, potentially disrupting bats' natural foraging behaviors. Turning off unnecessary lights and using down shield exterior lights at night can help reduce negative impacts to bat activity.



Keep cats indoors

Free roaming domestic cats predate upon *billions* of wildlife each year, including birds, small mammals, and bats. Keeping cats indoors or constructing an enclosed outdoor "catio" can help reduce wildlife mortality across numerous species.

RESOURCES & SERVICES

Ending Bat Extinctions Worldwide
[Bat Conservation International](#)

A Guide to the Bats of Virginia
[Virginia Department of Wildlife Resources](#)

Guide to Gardening for Bats
[Bat Conservation International](#)

How to Build a Bat Box
[USFWS](#)

2023 State of the Bats Report
[Bat Conservation International](#)

Bat Conservation and Rescue of Virginia
[Link](#)

Leaf Litter Keeps Ground-Roosting Bats Warm
[U.S. Department of Agriculture](#)

Blue Ridge Wildlife Center
[Link](#)

ACKNOWLEDGEMENTS



We would like to extend a big thank you to **you**, the landowners and land managers, for participating in this research. Bat surveys and data analysis were led by Erin Shibley with support from VWL staff and interns. Vegetation surveys were conducted by teams of VWL Community Scientists and staff members.

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Illustrations by Nick Garnhart; Photos by Brooke McDonough and Erin Shibley

Resilient funding builds resilient landscapes—and a future where both people and nature thrive.

The surveys and conservation efforts highlighted in this report are made possible through community support.

100% of Virginia Working Landscapes' funding comes from grants, donations, and the generosity of people like you. Your donation ensures these vital surveys continue, creating a lasting impact on biodiversity for generations to come.

The Smithsonian is a 501(c)3. All contributions are tax deductible.

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- To donate online, visit <https://www.vaworkinglandscapes.org/donate/>
- To donate by mail, please write checks out to "Smithsonian Institution" with "Virginia Working Landscapes" noted on the reference line and send to:

Attention: Amy Johnson
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- To donate over the phone, please call our Advancement Team at 202-633-3027

