# DoD Environmental Planning and Conservation Webinar Series

## AN AERIAL BAT DETECTION TECHNOLOGY TO INVENTORY DOD INSTALLATIONS FOR THREATENED, ENDANGERED, AND AT-RISK BAT SPECIES

NOVEMBER 29, 2022

***PLEASE MUTE YOUR PHONES***

CONFERENCE NUMBER: 410-874-6749

CONFERENCE ID: 896-616-490#

WWW.DENIX.OSD.MIL/NR/

TWITTER: @DODNATRES

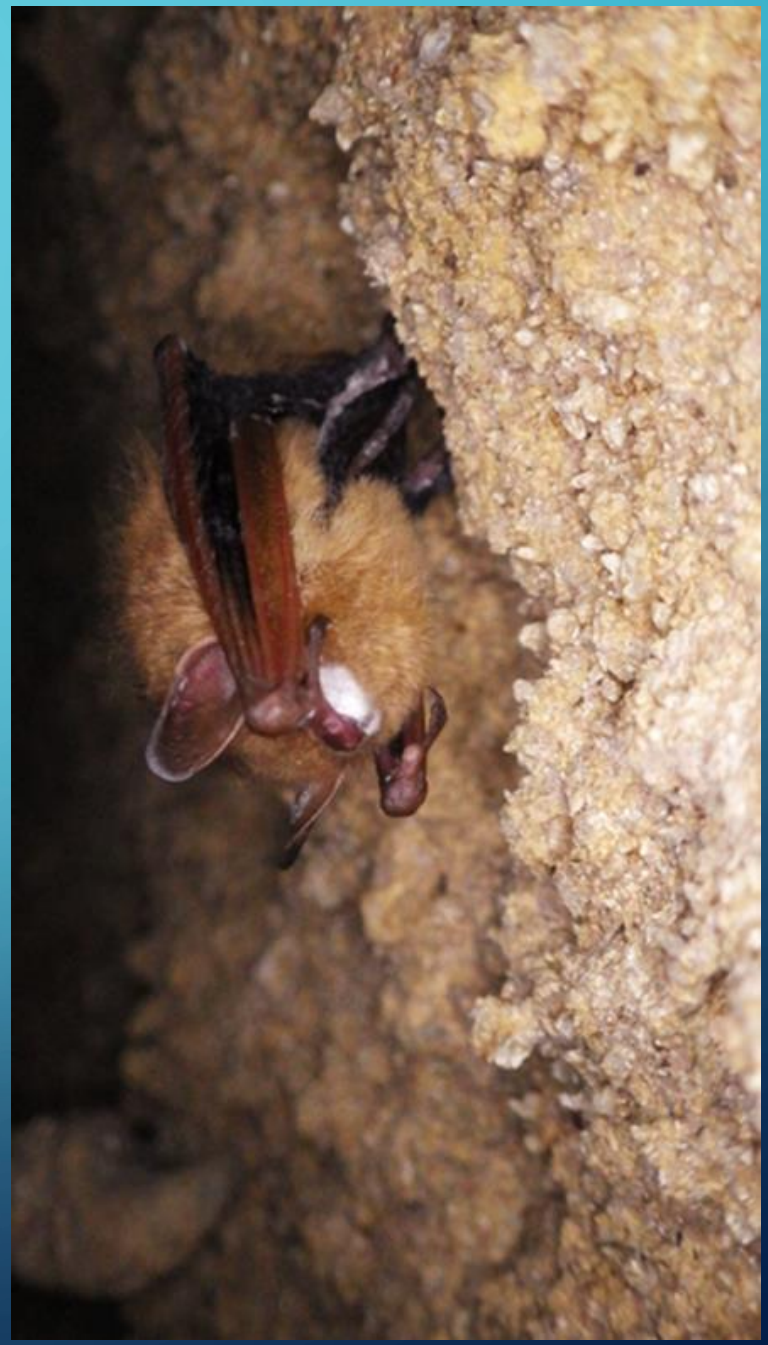
# ENHANCED MONITORING OF IMPERILED BAT SPECIES ON DOD INSTALLATIONS USING AERIAL ACOUSTIC TECHNOLOGY

EMMA V. WILLCOX, DAVID A. BUEHLER, JOHN B. WILKERSON, JONATHAN YODER, AND ASHLEIGH B. CABLE- UNIVERSITY OF TENNESSEE

ERIC R. BRITZKE- US ARMY ENGINEER RESEARCH AND DEVELOPMENT CENTER

# BACKGROUND

- DoD administers ~30 million acres of land
  - Large inaccessible impact areas
  - Support imperiled bat species
  - Regulatory and stewardship responsibilities
    - Endangered Species Act
    - Sikes Act
    - National Environmental Policy Act
  - More important due to white-nose syndrome



# BACKGROUND

- Monitoring and managing bats on DoD installations
  - Difficult as access restricted to impact areas
  - Traditional methods of monitoring ineffective
    - Mist netting
    - Ground-based acoustic bat detectors

AERIAL BAT DETECTION TECHNOLOGY (ABDT)

Legacy Project #16-804

DoD ESTCP #W912HZ1720020

# BACKGROUND

- Advantages of acoustic detection
  - Detect more species
  - Less personnel, training, and permits
  - Reduced time investment and resources
  - Little disruption of bat behavior

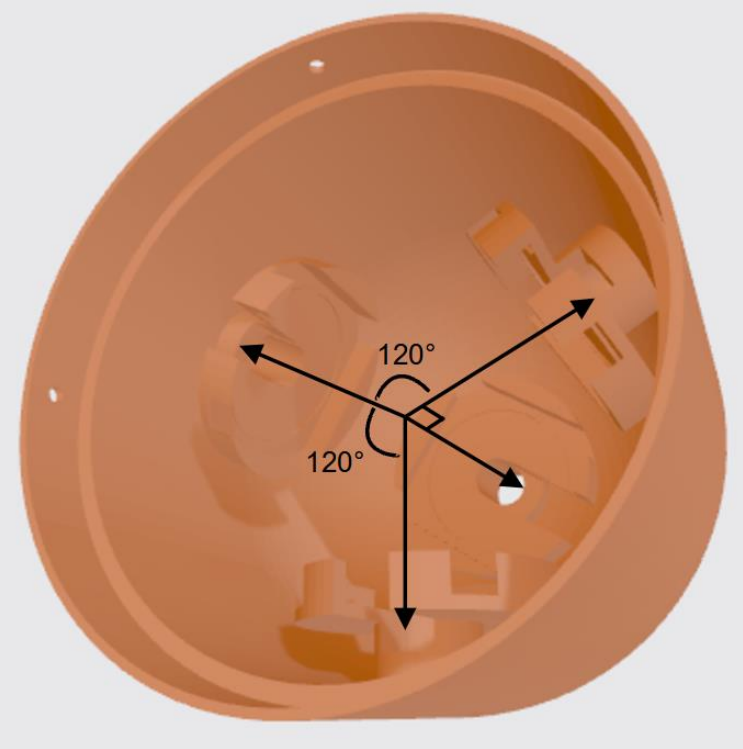
BUT…..

Can’t be used in impact areas

Aerial Bat Detection Technology (ABDT)

# ABDT

- Lifting system
  - Weather balloon




A: Emergency Release Servo

B: Helium Release Servo

C: Flight Control Board

D: Ballast Tank

E: Voltage Regulation Board

F: Batteries

G: Data Collection System

H: Microphone Array

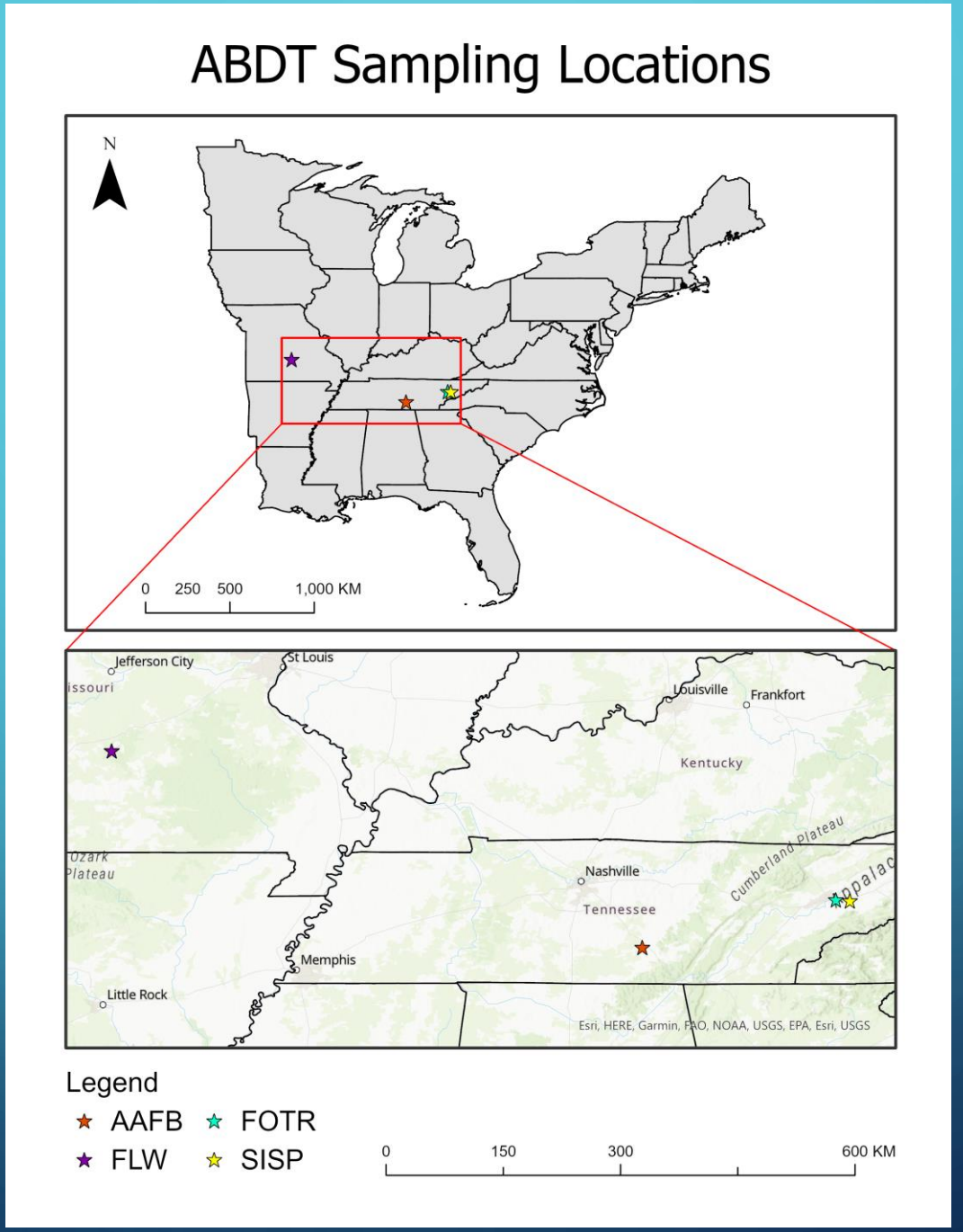
# PROJECT OBJECTIVES

- Validate the ability of ABDT to detect and record ultrasonic calls
- Demonstrate ability of ABDT to collect data on calls of bats
  - On tether
    - Stationary
    - Transect (proxy for free flight over inaccessible areas)
- Establish value of data collect using ABDT to supplement and extend bat monitoring already conducted.

# PROJECT OBJECTIVES

- Validate the ability of ABDT to detect and record ultrasonic calls
- Demonstrate ability of ABDT to collect data on calls of bats
  - On tether
    - Stationary
    - Transect (proxy for free flight over inaccessible areas)
- Establish value of data collect using ABDT to supplement and extend bat monitoring already conducted.

# TEST SITES

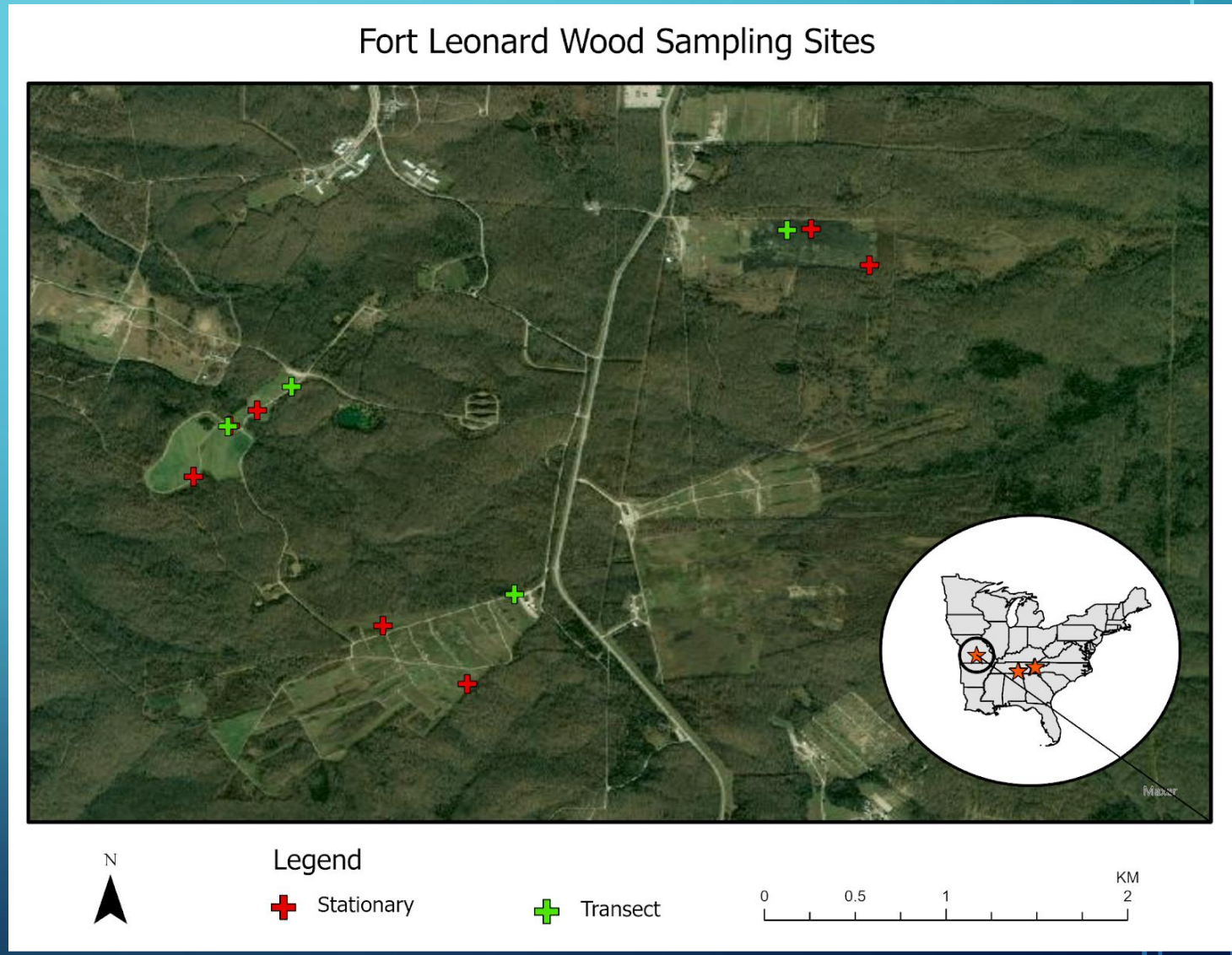

ABDT Sampling Locations
N
0 250 500 1,000 KM
Jefferson City
St Louis
Louisville
Frankfort
Kentucky
Nashville
Tennessee
Memphis
Little Rock
Cumberland Plateau
Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, Esri, USGS
Legend
AAFB
FOTR
FLW
SISP
0 150 300 600 KM

# METHODS

- Field demonstration tests
  - Tethered stationary flights
    - 4 fixed altitudes
    - 30 minutes at each altitude
  - Tethered transect flights (proxy for free flight)
    - Altitude of 50 m
    - 250 m transect
  - Paired with ground based detectors
  - Analyzed using Sonobat

# METHODS

- 10 of each flight type/site
  - 4-6 sampling locations



# RESULTS

- Bat species detected

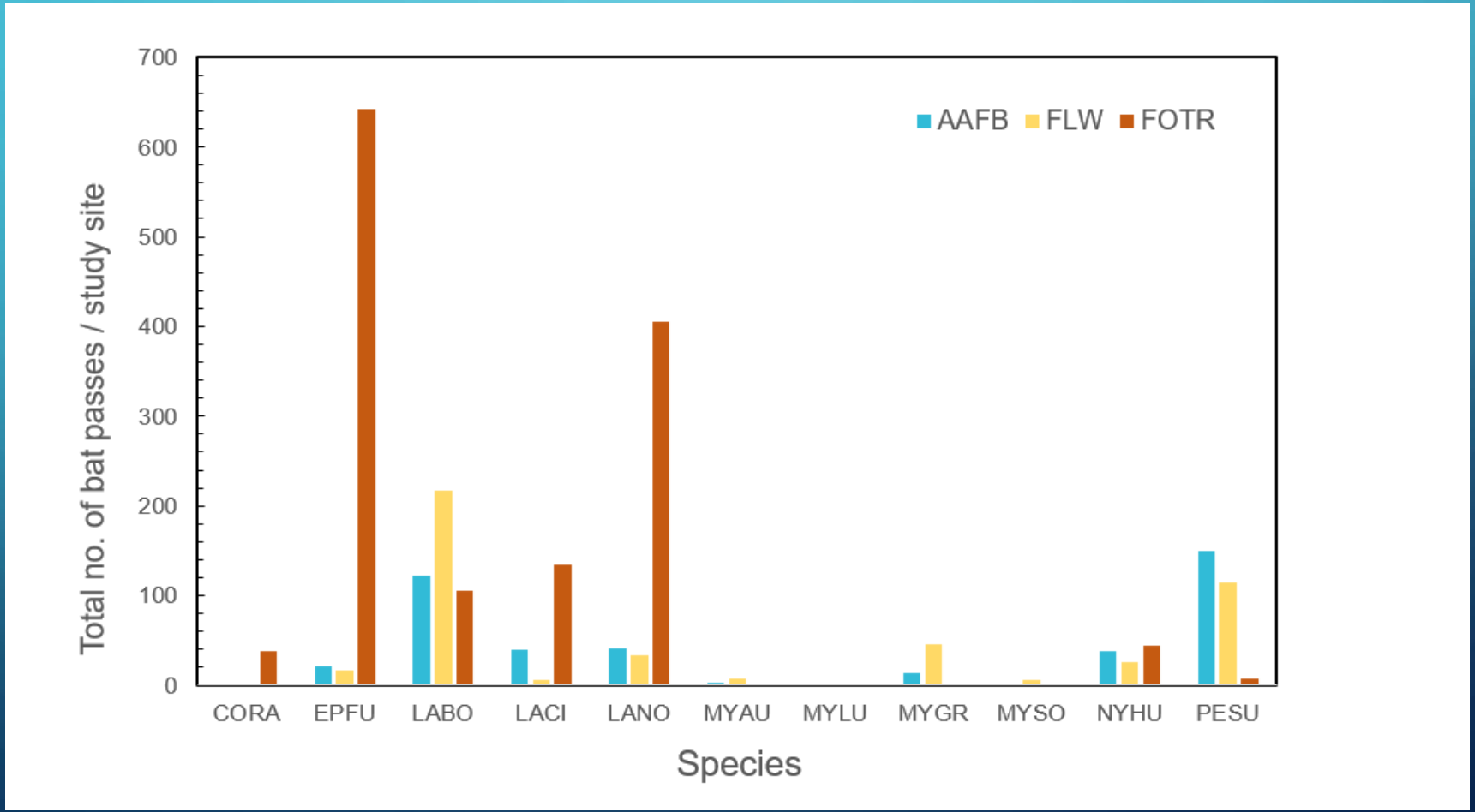
Bat species detected by an Aerial Bat Detector Technology (ABDT) and a ground-based bat detector at 4 study sites in TN and MO, May–August 2021.

| | Site | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SISBP[1] | | | | FOTR[1] | | | | AAFB[1] | | | | FLW[1] | | | |
| | Stationary[2] | | Transect[2] | | Stationary | | Transect | | Stationary | | Transect | | Stationary | | Transect | |
| Species | A | G | A | G | A | G | A | G | A | G | A | G | A | G | A | G |
| Big brown bat *Eptesicus fuscus* | - | - | X | X | X | X | - | - | X | X | X | | X | X | X | X |
| Eastern red bat *Lasiurus borealis* | - | - | X | X | X | X | - | - | X | X | X | X | X | X | X | X |
| Gray bat *Myotis grisescens* | - | - | X | X | X | | - | - | X | X | X | | X | X | X | X |
| Evening bat *Nycticeius humeralis* | - | - | X | X | X | | - | - | X | X | X | X | X | X | X | |
| Hoary bat *Lasiurus cinereus* | - | - | | | X | X | - | - | X | X | X | | X | | | X |
| Indiana bat *Myotis sodalis* | - | - | X | | | | - | - | X | | X | | X | | | |
| Little brown bat *Myotis lucifugus* | - | - | X | | | | - | - | | | X | | X | | | |
| Rafinesque's big-eared bat *Corynorhinus rafinesquii* | - | - | | | X | | - | - | | | | | | | | |
| Silver-haired bat *Lasionycteris noctivagans* | - | - | X | X | X | X | - | - | X | X | X | X | X | X | X | X |
| Southeastern bat *Myotis austroriparius* | - | - | X | | | X | - | - | X | | X | | X | | X | |
| Tri-colored bat *Perimyotis subflavus* | - | - | X | X | X | | - | - | X | X | X | | X | X | X | X |

[1] SISBP = Seven Islands State Birding Park, TN; FOTR = Forks of the River Wildlife Management Area, TN; AAFB = Arnold Air Force Base, TN; FLW = Fort Leonard Wood, MO.
[2] Stationary = Tethered stationary ABDT flight; Transect = Tethered transect ABDT flight.

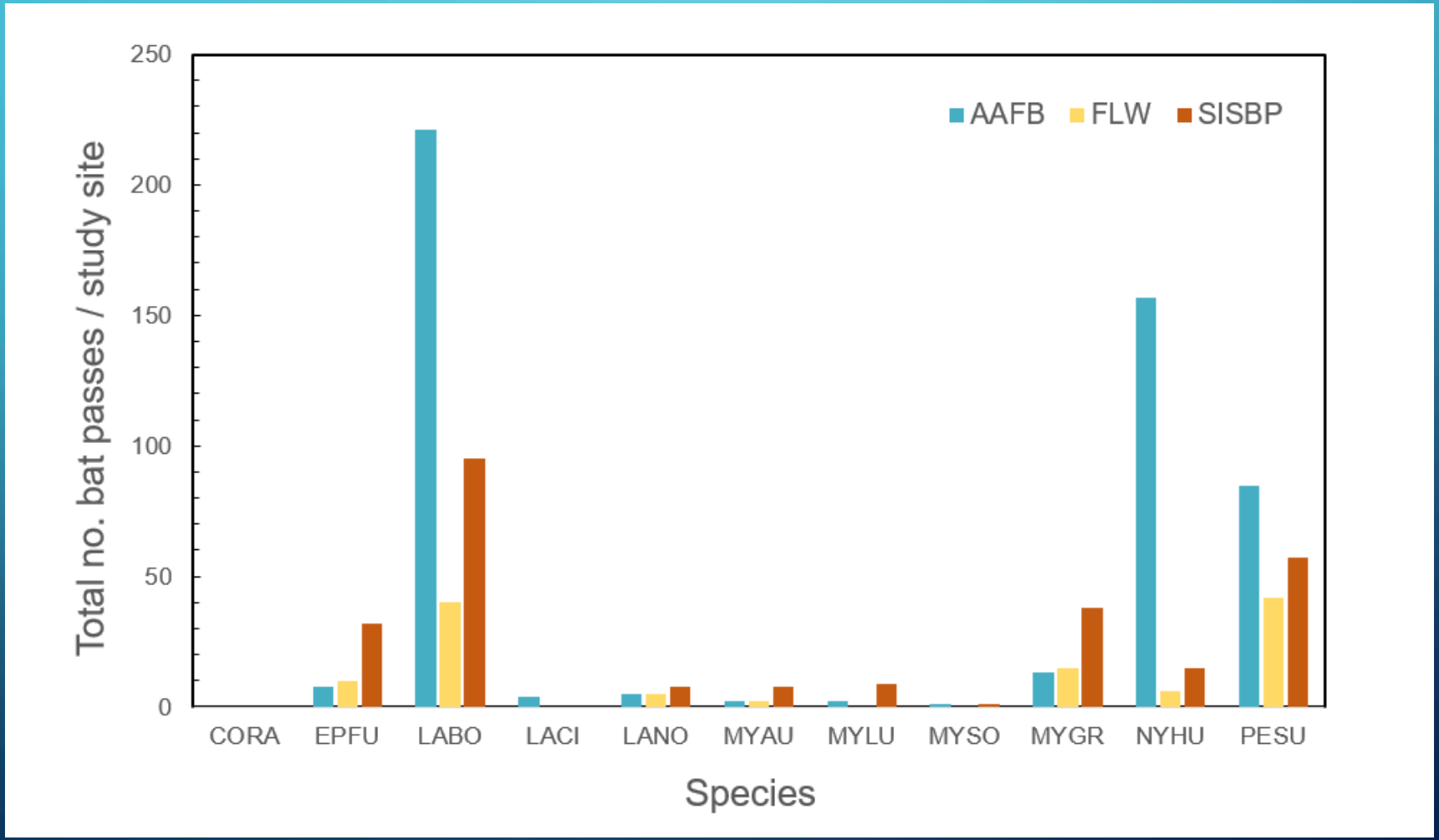
# RESULTS

- Bat activity- Tethered stationary



# RESULTS

- Bat activity- Tethered transect



# RESULTS

- ABDT comparisons only- Tethered stationary

Effect of microphone orientation and flight altitude on the mean raw no. of bat passes (passes/30 min) and maximum species richness (species/30 min) recorded by an Aerial Bat Detection Technology (ABDT) flown on tether at sampling locations on 3 study sites in TN and MO, May–August 2021.

| | | $\bar{x} \pm$ SD | | | | Maximum |
|---|---|---|---|---|---|---|
| **Microphone** | **Altitude** | **Total no. passes** | **No. passes id to species** | **No. low freq. passes id to species[1]** | **No. high freq. passes id to species[2]** | **Species richness** |
| All | 25 | 14.25 ± 18.13 | 10.93 ± 13.52 | 5.76 + 11.85 | 5.17 ± 7.25 | 5 |
| | 50 | 14.72 ± 21.90 | 11.31 ± 16.47 | 7.23 + 16.44 | 3.70 ± 4.68 | 5 |
| | 75 | 10.00 ± 20.76 | 7.38 ± 14.18 | 4.52 + 13.84 | 2.87 ± 4.54 | 6 |
| | 100 | 8.28 ± 17.03 | 6.17 ± 12.84 | 4.44 + 12.51 | 1.53 ± 2.14 | 5 |
| Lateral | 25 | 14.11 ± 18.38 | 10.80 ± 13.65 | 5.68 ± 11.85 | 5.12 ± 7.21 | 5 |
| | 50 | 14.30 ± 21.29 | 10.93 ± 15.91 | 7.13 ± 15.95 | 3.43 ± 4.09 | 5 |
| | 75 | 9.63 ± 20.71 | 7.07 ± 13.93 | 4.39 ± 13.59 | 2.68 ± 4.51 | 6 |
| | 100 | 8.13 ± 17.23 | 5.98 ± 12.86 | 4.32 ± 12.53 | 1.46 ± 2.13 | 5 |
| Downward | 25 | 14.67 ± 17.67 | 11.30 ± 13.33 | 6.00 ± 12.04 | 5.30 ± 7.48 | 5 |
| | 50 | 16.00 ± 24.00 | 12.45 ± 18.29 | 7.53 ± 18.13 | 4.50 ± 6.13 | 5 |
| | 75 | 11.10 ± 21.21 | 8.33 ± 15.10 | 4.90 ± 14.81 | 3.43 ± 4.65 | 6 |
| | 100 | 8.76 ± 16.69 | 6.76 ± 12.98 | 4.80 ± 12.66 | 1.73 ± 2.20 | 5 |

[1] Species producing low frequency passes include: big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*), Rafinesque's big eared bat (*Corynorhinus rafinesquii*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*).

[2] Species producing high frequency passes include: Eastern red bat (*Lasiurus borealis*), gray bat (*Myotis grisescens*), evening bat (*Nycticeius humeralis*), Indiana bat (*Myotis sodalis*), little brown bat (*Myotis lucifugus*), Southeastern bat (*Myotis austroriparius*), tri-colored bat (*Perimyotis subflavus*).

# RESULTS

- ABDT comparisons only- Tethered stationary

Effect of microphone orientation and flight altitude on the mean raw no. of bat passes (passes/30 min) and maximum species richness (species/30 min) recorded by an Aerial Bat Detection Technology (ABDT) flown on tether at sampling locations on 3 study sites in TN and MO, May–August 2021.

| | | $\bar{x} \pm$ SD | | | | Maximum |
|---|---|---|---|---|---|---|
| **Microphone** | **Altitude** | **Total no. passes** | **No. passes id to species** | **No. low freq. passes id to species[1]** | **No. high freq. passes id to species[2]** | **Species richness** |
| All | 25 | 14.25 ± 18.13 | 10.93 ± 13.52 | 5.76 ± 11.85 | 5.17 ± 7.25 | 5 |
| | 50 | 14.72 ± 21.90 | 11.31 ± 16.47 | 7.23 ± 16.44 | 3.70 ± 4.68 | 5 |
| | 75 | 10.00 ± 20.76 | 7.38 ± 14.18 | 4.52 ± 13.84 | 2.87 ± 4.54 | 6 |
| | 100 | 8.28 ± 17.03 | 6.17 ± 12.84 | 4.44 ± 12.51 | 1.53 ± 2.14 | 5 |
| Lateral | 25 | 14.11 ± 18.38 | 10.80 ± 13.65 | 5.68 ± 11.85 | 5.12 ± 7.21 | 5 |
| | 50 | 14.30 ± 21.29 | 10.93 ± 15.91 | 7.13 ± 15.95 | 3.43 ± 4.09 | 5 |
| | 75 | 9.63 ± 20.71 | 7.07 ± 13.93 | 4.39 ± 13.59 | 2.68 ± 4.51 | 6 |
| | 100 | 8.13 ± 17.23 | 5.98 ± 12.86 | 4.32 ± 12.53 | 1.46 ± 2.13 | 5 |
| Downward | 25 | 14.67 ± 17.67 | 11.30 ± 13.33 | 6.00 ± 12.04 | 5.30 ± 7.48 | 5 |
| | 50 | 16.00 ± 24.00 | 12.45 ± 18.29 | 7.53 ± 18.13 | 4.50 ± 6.13 | 5 |
| | 75 | 11.10 ± 21.21 | 8.33 ± 15.10 | 4.90 ± 14.81 | 3.43 ± 4.65 | 6 |
| | 100 | 8.76 ± 16.69 | 6.76 ± 12.98 | 4.80 ± 12.66 | 1.73 ± 2.20 | 5 |

[1] Species producing low frequency passes include: big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*), Rafinesque's big eared bat (*Corynorhinus rafinesquii*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*).

[2] Species producing high frequency passes include: Eastern red bat (*Lasiurus borealis*), gray bat (*Myotis grisescens*), evening bat (*Nycticeius humeralis*), Indiana bat (*Myotis sodalis*), little brown bat (*Myotis lucifugus*), Southeastern bat (*Myotis austroriparius*), tri-colored bat (*Perimyotis subflavus*).

# RESULTS

- ABDT comparisons only- Tethered stationary

Effect of flight altitude on the mean cumulative no. of bat passes (passes/30 mins) and maximum species richness (species/30 min) recorded by an Aerial Bat Detection Technology (ABDT) flown on tether at sampling locations on 3 study sites in TN and MO, May–August 2021.

| | | $\bar{x} \pm$ SD | | | Maximum |
|---|---|---|---|---|---|
| **Altitude** | **Total no. passes** | **No. passes id to species** | **No. low freq. passes id to species[1]** | **No. high freq. passes id to species[2]** | **Species richness** |
| 25 | 36.80 ± 46.17 | 24.17 + 28.72 | 12.63 ± 25.28 | 11.60 ± 15.88 | 6 |
| 50 | 33.83 ± 49.62 | 21.97 + 31.23 | 13.57 ± 31.04 | 7.80 ± 8.58 | 6 |
| 75 | 25.10 ± 50.36 | 16.77 + 31.83 | 10.17 ± 31.83 | 6.60 ± 8.66 | 7 |
| 100 | 21.14 ± 43.85 | 14.00 + 28.17 | 9.63 ± 26.50 | 4.20 ± 7.25 | 6 |

[1] Species producing low frequency passes include: big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*), Rafinesque's big eared bat (*Corynorhinus rafinesquii*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*).

[2] Species producing high frequency passes include: Eastern red bat (*Lasiurus borealis*), gray bat (*Myotis grisescens*), evening bat (*Nycticeius humeralis*), Indiana bat (*Myotis sodalis*), little brown bat (*Myotis lucifugus*), Southeastern bat (*Myotis austroriparius*), tri-colored bat (*Perimyotis subflavus*)

# RESULTS

- ABDT comparisons only- Tethered stationary

Effect of flight altitude on the mean cumulative no. of bat passes (passes/30 mins) and maximum species richness (species/30 min) recorded by an Aerial Bat Detection Technology (ABDT) flown on tether at sampling locations on 3 study sites in TN and MO, May–August 2021.

| | | $\bar{x} \pm$ SD | | | Maximum |
|---|---|---|---|---|---|
| **Altitude** | **Total no. passes** | **No. passes id to species** | **No. low freq. passes id to species[1]** | **No. high freq. passes id to species[2]** | **Species richness** |
| 25 | 36.80 ± 46.17 | 24.17 ± 28.72 | 12.63 ± 25.28 | 11.60 ± 15.88 | 6 |
| 50 | 33.83 ± 49.62 | 21.97 ± 31.23 | 13.57 ± 31.04 | 7.80 ± 8.58 | 6 |
| 75 | 25.10 ± 50.36 | 16.77 ± 31.83 | 10.17 ± 31.83 | 6.60 ± 8.66 | 7 |
| 100 | 21.14 ± 43.85 | 14.00 ± 28.17 | 9.63 ± 26.50 | 4.20 ± 7.25 | 6 |

[1] Species producing low frequency passes include: big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*), Rafinesque's big eared bat (*Corynorhinus rafinesquii*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*).

[2] Species producing high frequency passes include: Eastern red bat (*Lasiurus borealis*), gray bat (*Myotis grisescens*), evening bat (*Nycticeius humeralis*), Indiana bat (*Myotis sodalis*), little brown bat (*Myotis lucifugus*), Southeastern bat (*Myotis austroriparius*), tri-colored bat (*Perimyotis subflavus*)

# RESULTS

- ABDT comparisons only- Tethered transect

Effect of microphone orientation on the mean raw no. of bat passes (passes/10 mins) and maximum species richness (species/10 mins) recorded by an Aerial Bat Detection Technology (ABDT) flown on tether along transects at an altitude of 50 m on 3 study sites in TN and MO, May–August, 2021.

| | $\bar{x} \pm$ SD | | | | Max |
|---|---|---|---|---|---|
| **Microphone** | **Total no. passes** | **No. passes id to species** | **No. low freq. passes id to species** | **No. high freq. passes id to species** | **Species richness** |
| Lateral | 19.14 ± 26.92 | 14.72 ± 20.10 | 1.11 ± 1.82 | 13.61 ± 20.74 | 6 |
| Down-facing | 18.97 ± 27.02 | 14.54 ± 20.66 | 1.13 ± 1.83 | 13.40 ± 19.87 | 6 |

[1] Species producing low frequency passes include: big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*), Rafinesque's big eared bat (*Corynorhinus rafinesquii*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*).

[2] Species producing high frequency passes include: Eastern red bat (*Lasiurus borealis*), gray bat (*Myotis grisescens*), evening bat (*Nycticeius humeralis*), Indiana bat (*Myotis sodalis*), little brown bat (*Myotis lucifugus*), Southeastern bat (*Myotis austroriparius*), tri-colored bat (*Perimyotis subflavus*).

# RESULTS

- ABDT vs ground comparisons- Tethered stationary

Comparison of raw no. of bat passes (passes/30 min) recorded by the downward-facing microphone of an Aerial Bat Detection Technology (ABDT) flown on tether at an altitude of 25 m with those recorded by a ground-based detector at the same sampling location on 3 study sites in TN and MO, May–August 2021.

| | | ABDT | Ground | *P* |
|---|---|---|---|---|
| $\bar{x} \pm$ SD | Total no. passes | 14.25 ± 18.13 | 3.51 ± 5.73 | <0.001 |
| | No. passes id to species | 10.93 ± 13.52 | 3.28 ± 5.10 | <0.001 |
| | No. low freq. passes id to species[1] | 5.76 ± 11.85 | 1.83 ± 3.98 | 0.029 |
| | No. high freq. passes id to species[2] | 5.17 ± 7.25 | 1.34 ± 3.53 | 0.001 |
| Max | Species richness | 6 | 4 | - |

# RESULTS

- ABDT vs ground comparisons- Tethered stationary

Comparison of cumulative no. of bat passes (passes/30 min) recorded by the downward-facing microphone of an Aerial Bat Detection Technology (ABDT) flown on tether at 4 flight altitudes with those recorded by a ground-based detector at the same sampling locations on 3 study sites in TN and MO, May–August 2021.

| | | 25 m | | | 50 m | | | 75 m | | | 100 m | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **ABDT** | **Ground** | ***P*** | **ABDT** | **Ground** | ***P*** | **ABDT** | **Ground** | ***P*** | **ABDT** | **Ground** | ***P*** |
| **$\bar{x} \pm$ SD** | Total no. passes | 36.80 ± 46.17 | 3.51 ± 5.73 | <0.001 | 33.83 ± 49.62 | 3.92 ± 5.69 | <0.001 | 25.10 ± 50.36 | 2.89 ± 5.00 | <0.001 | 21.14 ± 43.85 | 3.20 ± 5.10 | <0.001 |
| | No. passes id to species | 24.17 ± 28.72 | 3.28 ± 5.10 | <0.001 | 21.97 ± 31.23 | 3.31 ± 4.63 | <0.001 | 16.77 ± 31.83 | 2.55 ± 4.26 | <0.001 | 14.00 ± 28.17 | 2.83 ± 4.25 | <0.001 |
| | No. low freq. passes id to species[1] | 12.63 ± 25.28 | 1.83 ± 3.98 | <0.001 | 13.57 ± 31.83 | 2.00 ± 4.04 | <0.001 | 10.17 ± 31.83 | 1.45 ± 2.77 | 0.002 | 9.63 ± 26.51 | 0.93 ± 2.62 | 0.002 |
| | No. high freq. passes id to species[2] | 11.60 ± 15.88 | 1.34 ± 3.53 | <0.001 | 7.80 ± 8.58 | 1.21 ± 2.39 | <0.001 | 6.60 ± 8.66 | 0.98 ± 1.67 | <0.001 | 4.20 ± 7.25 | 1.14 ± 1.83 | <0.001 |
| **Max** | Species richness | 6 | 4 | - | 6 | 4 | - | 7 | 4 | | 6 | 4 | |

[1] Species producing low frequency passes include: big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*), Rafinesque's big eared bat (*Corynorhinus rafinesquii*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*)

[2] Species producing high frequency passes include: Eastern red bat (*Lasiurus borealis*), gray bat (*Myotis grisescens*), evening bat (*Nycticeius humeralis*), Indiana bat (*Myotis sodalis*), little brown bat (*Myotis lucifugus*), Southeastern bat (*Myotis austroriparius*), tri-colored bat (*Perimyotis subflavus*)

# RESULTS

- ABDT vs ground comparisons- Tethered transect

Comparison of cumulative no. of bat passes recorded by an Aerial Bat Detection Technology (ABDT) flow on tether along a transect at an altitude of 50 m with those recorded by 3 ground-based detectors on the same transect at sampling locations on 3 study sites in TN and MO, May–August 2021.

| | | ABDT | Ground | *P* |
|---|---|---|---|---|
| $\bar{x} \pm$ SD | Total no. passes | 46.67 ± 64.30 | 1.39 ± 2.97 | <0.001 |
| | No. passes id to species | 29.37 ± 37.22 | 1.12 ± 0.26 | <0.001 |
| | No. low freq. passes id to species[1] | 2.40 ± 3.22 | 0.37 ± 1.20 | 0.002 |
| | No. high freq. passes id to species[2] | 26.97 ± 36.65 | 0.76 ± 2.00 | <0.001 |
| Max | Species richness | 8 | 4 | <0.001 |

[1] Species producing low frequency passes include: big brown bat (*Eptesicus fuscus*), hoary bat (*Lasiurus cinereus*), Rafinesque's big eared bat (*Corynorhinus rafinesquii*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*)

[2] Species producing high frequency passes include: Eastern red bat (*Lasiurus borealis*), gray bat (*Myotis grisescens*), evening bat (*Nycticeius humeralis*), Indiana bat (*Myotis sodalis*), little brown bat (*Myotis lucifugus*), Southeastern bat (*Myotis austroriparius*), tri-colored bat (*Perimyotis subflavus*)

# SUMMARY

- ABDT detected 11 species
  - 3–10 species detected/site (depending on flight type)
- Greatest number of bat passes
  - Downward-facing microphone
  - 25-50 m flight altitude
- Compared to ground-based detectors
  - More bat passes
  - Greater species richness

# SUMMARY

- Potential for ABDT
  - Supplement and extend bat monitoring on DoD installations
  - Access impact areas and monitor bats
    - Need to free-fly

# QUESTIONS?