Responses of *Myotis* bats & their prey to the effects of prescribed fire in the central hardwood forests of Kentucky

Luke E. Dodd[1],
M.J. Lacki[1], N.S. Skowronski[2], D.R. Cox[3], M.B. Dickinson[2], L.K. Rieske[1]

University of Kentucky[1], USFS Northern Research Station[2],
& Kentucky State Nature Preserves Commission[3]

Thanks!

- Funding
  - Joint Fire Science Program
  - USFS & Mac-Stennis
  - UK Grad School
  - Bat Conservation Int'l.
  - Sigma Xi
- UK Entomology & Forestry Departments
- Technicians
  - Josh Adams
  - Elizabeth Carlisle
  - Drew Chalkley
  - Tracy Culbertson
  - Jack Grider
  - Stella James
  - Klint Rose
  - Jennifer Winters

Forest Environment ⟷ Prey Availability

Predator Traits

Photo by Joe Johnson

How do (nocturnal) insects vary over the forest landscape?

How do (nocturnal) insects vary over the forest landscape?

- Over multiple scales
  - Site, landscape, region
  - Consequence of floristic variation

How do (nocturnal) insects vary over the forest landscape?

- Over multiple scales
  - Site, landscape, region
  - Consequence of floristic variation
- Forest Structure
  - Most work done with Lepidoptera
  - Lower abundance & diversity associated with greater disturbance

Further, what prey are available?

Objective

Investigate trends in the foraging ecology of *Myotis* as it relates to insect occurrence & changes in forest structure

Photo by Josh Adams

Objective

Investigate trends in the foraging ecology of *Myotis* as it relates to insect occurrence & changes in forest structure

due to prescribed fire

Photo by Josh Adams

Fire in the Central Hardwoods

- Historic & current roles in eastern North America
  - Maintenance of forest type, oak regeneration
  - Modern prescribed fire ~ pre-fire suppression
  - Reduction of fuel loads
  - Aesthetic tool

CITING THIS POSTER: Woods, A.J., Omernik, J.M., Martin, W.H., Pond, G.J., Andrews, W.M., Call, S.M, Comstock, J.A., and Taylor, D.D., 2002, Ecoregions of Kentucky (color poster with map, descriptive text, summary tables, and photographs): Reston, VA., U.S. Geological Survey (map scale 1:1,000,000).

68 Southwestern Appalachians
- 68a Cumberland Plateau
- 68c Plateau Escarpment

69 Central Appalachians
- 69d Dissected Appalachian Plateau
- 69e Cumberland Mountain Thrust Block

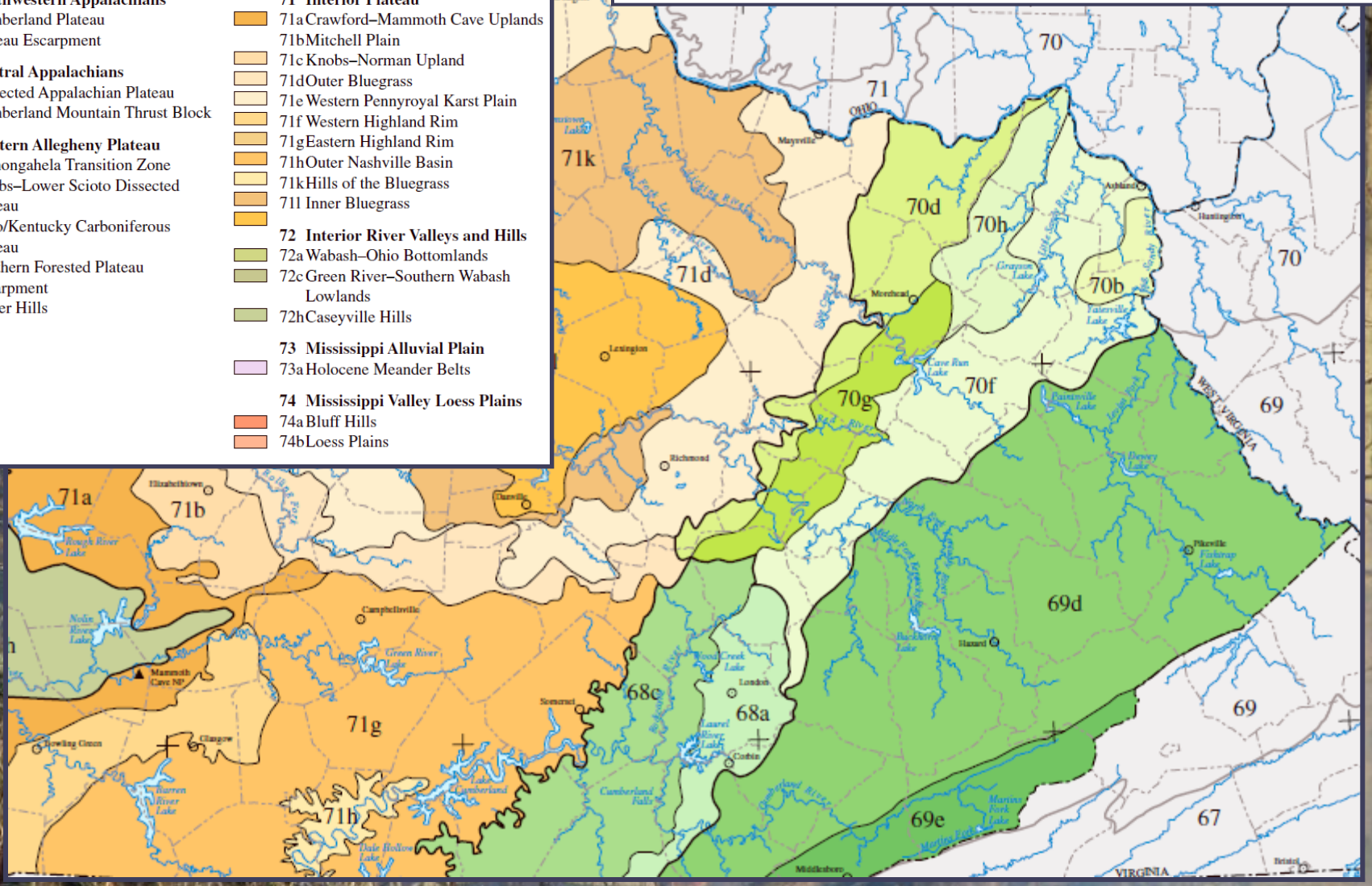
70 Western Allegheny Plateau
- 70b Monongahela Transition Zone
- 70d Knobs–Lower Scioto Dissected Plateau
- 70f Ohio/Kentucky Carboniferous Plateau
- 70g Northern Forested Plateau Escarpment
- 70h Carter Hills

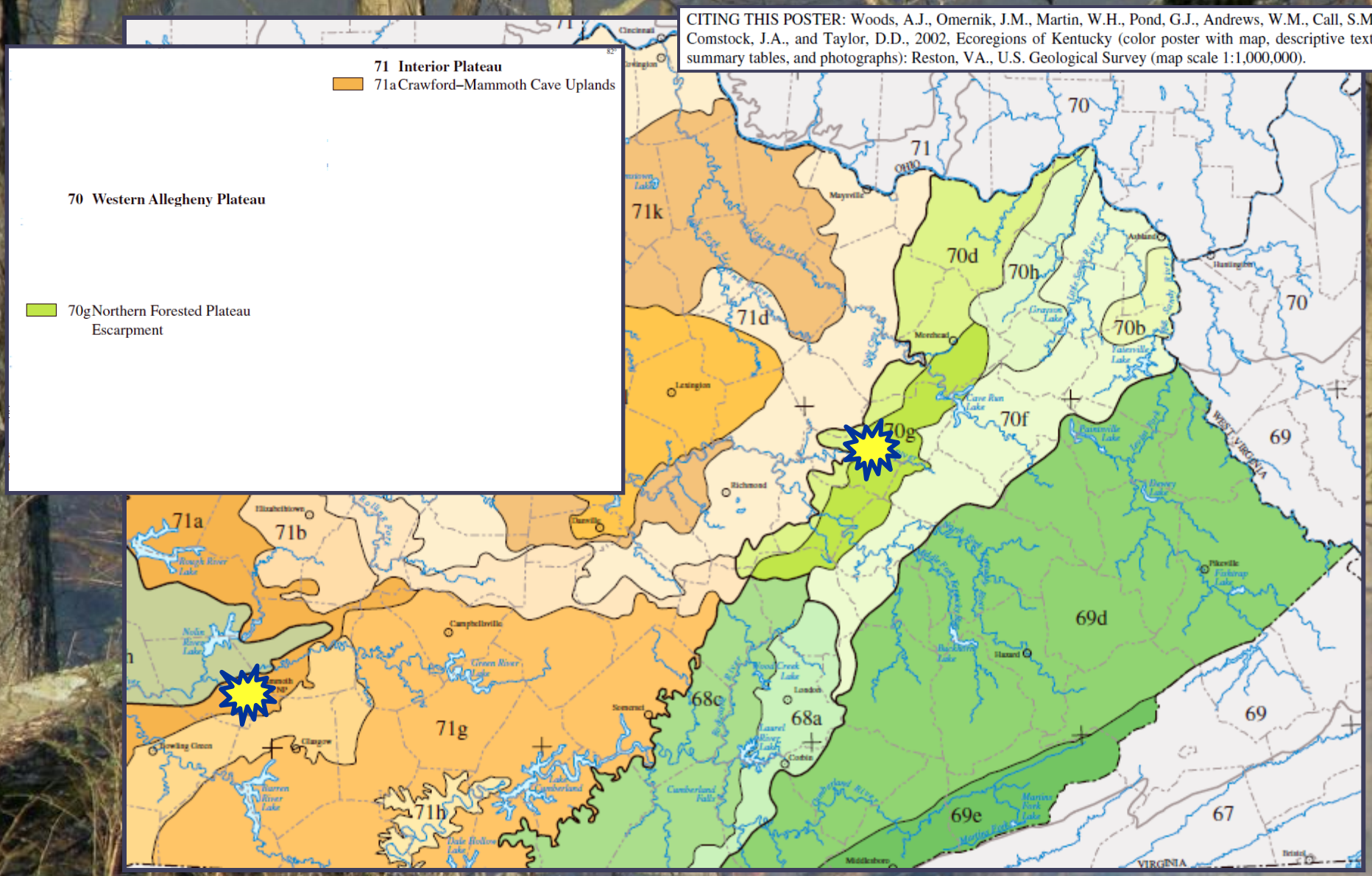
71 Interior Plateau
- 71a Crawford–Mammoth Cave Uplands
- 71b Mitchell Plain
- 71c Knobs–Norman Upland
- 71d Outer Bluegrass
- 71e Western Pennyroyal Karst Plain
- 71f Western Highland Rim
- 71g Eastern Highland Rim
- 71h Outer Nashville Basin
- 71k Hills of the Bluegrass
- 71l Inner Bluegrass

72 Interior River Valleys and Hills
- 72a Wabash–Ohio Bottomlands
- 72c Green River–Southern Wabash Lowlands
- 72h Caseyville Hills

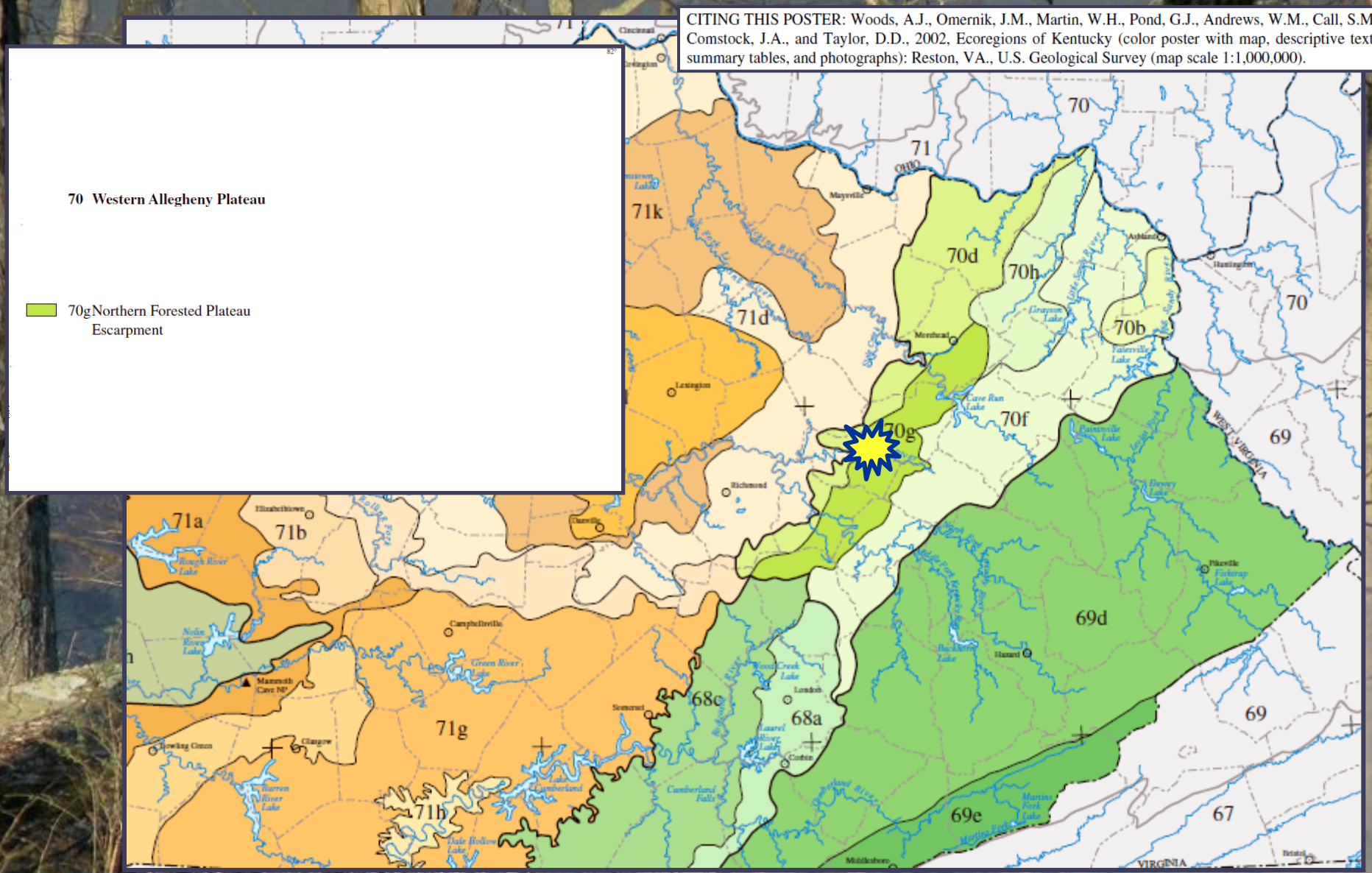
73 Mississippi Alluvial Plain
- 73a Holocene Meander Belts

74 Mississippi Valley Loess Plains
- 74a Bluff Hills
- 74b Loess Plains





- Species-specific study at the Daniel Boone NF
- Expanded, community-level study at Mammoth Cave NP



- Species-specific study at the Daniel Boone NF

Methods

Bat Activity DBNF, 2006-07

- Radio Telemetry

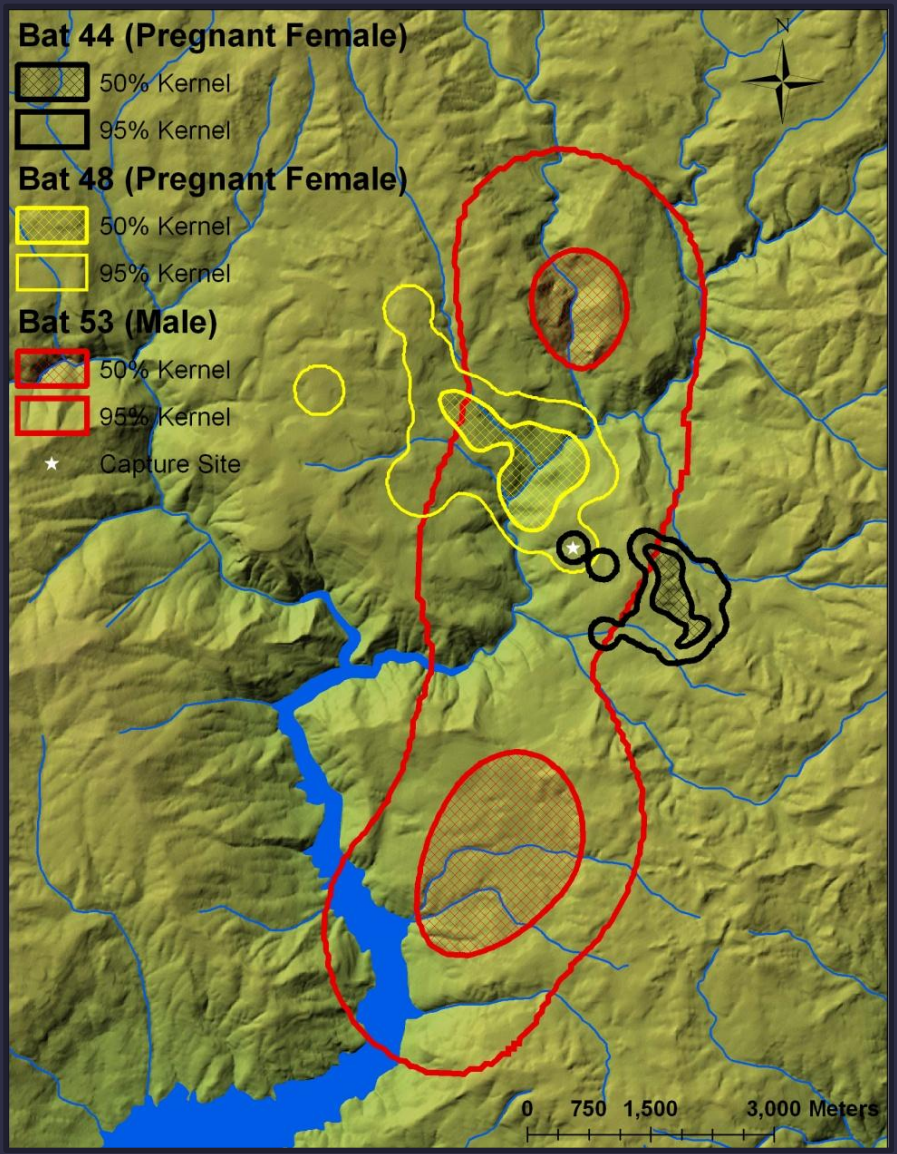
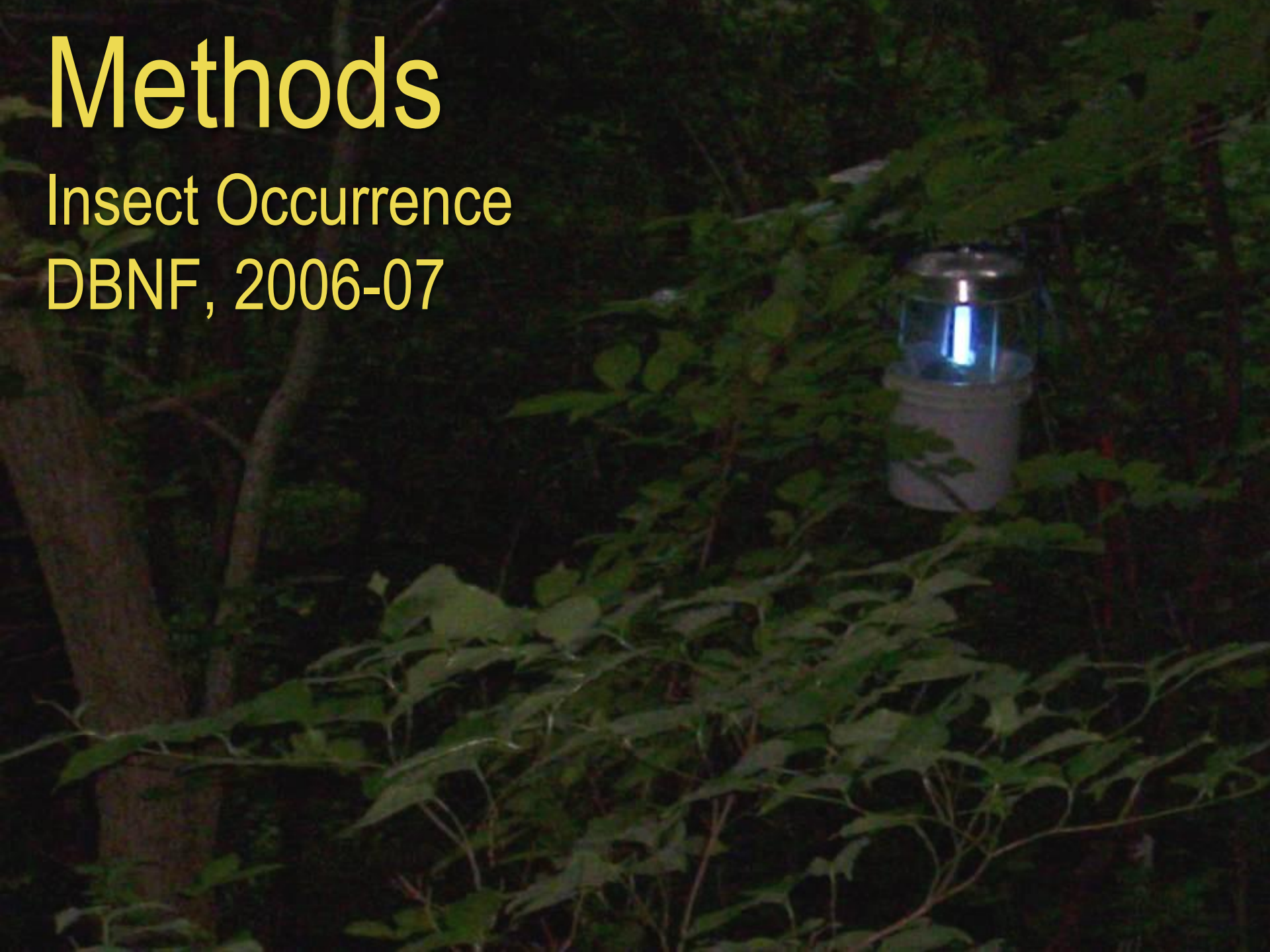


Figure by Joe Johnson; pg. 95 in Lacki *et al.* (2007) in *Bats in Forests*;

Photo by Joe Johnson

Methods

Insect Occurrence
DBNF, 2006-07



Methods

Insect Occurrence
DBNF, 2006-07

Photos by Allison Barlows, Tracy Culbertson, Luke Dodd & BugGuide.Net

Results

2006-07, DBNF

Journal of Mammalogy, 90(5):1165–1175, 2009

RESPONSE OF NORTHERN BATS (*MYOTIS SEPTENTRIONALIS*) TO PRESCRIBED FIRES IN EASTERN KENTUCKY FORESTS

Michael J. Lacki,* Daniel R. Cox, Luke E. Dodd, and Matthew B. Dickinson

Results

2006-07, DBNF

Journal of Mammalogy, 90(5):1165–1175, 2009

RESPONSE OF NORTHERN BATS (*MYOTIS SEPTENTRIONALIS*) TO PRESCRIBED FIRES IN EASTERN KENTUCKY FORESTS

Michael J. Lacki,* Daniel R. Cox, Luke E. Dodd, and Matthew B. Dickinson

	Closest			Farthest
Stand type				
Preburn, 3rd order	Pine[A]	Hardwood[A,B]	Hardwood–pine[A,B]	Pine–hardwood[B]
Postburn, 2nd order	Pine[A]	Pine–hardwood[A,B]	Hardwood[B,C]	Hardwood–pine[C]
Slope position				
Preburn, 2nd order	Midslope[A]	Ridge[A]		Lower slope[B]
Postburn, 2nd order	Midslope[A]	Ridge[B]		Lower slope[C]
Burn condition				
Postburn, 2nd order	Burned[A]			Unburned[B]

Table 1.—Second- and 3rd-order habitat use by stand type, slope position, and burn condition for female northern bats (*Myotis septentrionalis*) on the Daniel Boone National Forest, Kentucky, in 2006 and 2007. Habitats are ranked from closest to farthest from bat locations. Only comparisons where differences were found are shown. Within rows, different letters (A, B, C) indicate habitats that differ significantly ($P < 0.1$) from each other in their distances from bat locations.

Results

2006-07, DBNF

Journal of Mammalogy, 90(5):1165–1175, 2009

RESPONSE OF NORTHERN BATS (*MYOTIS SEPTENTRIONALIS*) TO PRESCRIBED FIRES IN EASTERN KENTUCKY FORESTS

Michael J. Lacki,* Daniel R. Cox, Luke E. Dodd, and Matthew B. Dickinson

	Closest			Farthest
Stand type				
Preburn, 3rd order	Pine[A]	Hardwood[A,B]	Hardwood–pine[A,B]	Pine–hardwood[B]
Postburn, 2nd order	Pine[A]	Pine–hardwood[A,B]	Hardwood[B,C]	Hardwood–pine[C]
Slope position				
Preburn, 2nd order	Midslope[A]	Ridge[A]		Lower slope[B]
Postburn, 2nd order	Midslope[A]	Ridge[B]		Lower slope[C]
Burn condition				
Postburn, 2nd order	Burned[A]			Unburned[B]

Table 1.—Second- and 3rd-order habitat use by stand type, slope position, and burn condition for female northern bats (*Myotis septentrionalis*) on the Daniel Boone National Forest, Kentucky, in 2006 and 2007. Habitats are ranked from closest to farthest from bat locations. Only comparisons where differences were found are shown. Within rows, different letters (A, B, C) indicate habitats that differ significantly ($P < 0.1$) from each other in their distances from bat locations.

Results

2006-07, DBNF

Journal of Mammalogy, 90(5):1165–1175, 2009

RESPONSE OF NORTHERN BATS (*MYOTIS SEPTENTRIONALIS*) TO PRESCRIBED FIRES IN EASTERN KENTUCKY FORESTS

Michael J. Lacki,* Daniel R. Cox, Luke E. Dodd, and Matthew B. Dickinson

Taxon	Percent volume		Percent frequency	
	Preburn	Postburn	Preburn	Postburn
Coleoptera	27.8 ± 2.8	35.5 ± 8.6	100.0	100.0
Diptera[a]	1.4 ± 1.1	11.0 ± 3.6	50.0	100.0
Hemiptera	6.1 ± 3.5	5.6 ± 1.9	83.3	75.0
Hymenoptera	1.4 ± 1.4	0.0	16.7	0.0
Lepidoptera	62.6 ± 5.2	46.4 ± 8.3	100.0	100.0
Neuroptera	0.0	0.2 ± 0.2	0.0	12.5
Trichoptera	0.4 ± 0.4	0.2 ± 0.2	16.7	12.5
Other[b]	0.8 ± 0.6	1.0 ± 1.0	33.3	62.5

[a] Between burn conditions, average percent volume for Diptera is different in fecal samples of radiotracked bats at $P < 0.01$.
[b] Represents unidentified materials, hair, or vegetation.

Table 3.—Mean percent volume ± *SE* and frequency of occurrence (%) of insect prey in fecal samples of northern bats (*Myotis septentrionalis*) radiotracked before (n = 6 bats) and after (n = 8 bats) prescribed burning on the Daniel Boone National Forest, Kentucky, in 2006 and 2007.

Results

2006-07, DBNF

Journal of Mammalogy, 90(5):1165–1175, 2009

RESPONSE OF NORTHERN BATS (*MYOTIS SEPTENTRIONALIS*) TO PRESCRIBED FIRES IN EASTERN KENTUCKY FORESTS

Michael J. Lacki,* Daniel R. Cox, Luke E. Dodd, and Matthew B. Dickinson

Taxon	Percent volume		Percent frequency	
	Preburn	Postburn	Preburn	Postburn
Coleoptera	27.8 ± 2.8	35.5 ± 8.6	100.0	100.0
Diptera[a]	1.4 ± 1.1	11.0 ± 3.6	50.0	100.0
Hemiptera	6.1 ± 3.5	5.6 ± 1.9	83.3	75.0
Hymenoptera	1.4 ± 1.4	0.0	16.7	0.0
Lepidoptera	62.6 ± 5.2	46.4 ± 8.3	100.0	100.0
Neuroptera	0.0	0.2 ± 0.2	0.0	12.5
Trichoptera	0.4 ± 0.4	0.2 ± 0.2	16.7	12.5
Other[b]	0.8 ± 0.6	1.0 ± 1.0	33.3	62.5

[a] Between burn conditions, average percent volume for Diptera is different in fecal samples of radiotracked bats at $P < 0.01$.
[b] Represents unidentified materials, hair, or vegetation.

Table 3.—Mean percent volume ± *SE* and frequency of occurrence (%) of insect prey in fecal samples of northern bats (*Myotis septentrionalis*) radiotracked before (n = 6 bats) and after (n = 8 bats) prescribed burning on the Daniel Boone National Forest, Kentucky, in 2006 and 2007.

Results

2006-07, DBNF

Journal of Mammalogy, 90(5):1165–1175, 2009

RESPONSE OF NORTHERN BATS (*MYOTIS SEPTENTRIONALIS*) TO PRESCRIBED FIRES IN EASTERN KENTUCKY FORESTS

Michael J. Lacki,* Daniel R. Cox, Luke E. Dodd, and Matthew B. Dickinson

Table 2.—Means ± *SE* for abundance of insects (≥10 mm in size) captured per trap night in blacklight traps before and after prescribed burning on the Daniel Boone National Forest, Kentucky, in 2006 and 2007. ANOVA test outcomes are included.

	All insects combined	Coleoptera	Lepidoptera	Diptera
Preburn (n = 43)	140 ± 14	8.0 ± 1.47	126 ± 13	1.0 ± 0.25
Postburn (n = 84)	188 ± 14	24.3 ± 3.24	154 ± 13	2.4 ± 0.34
F-statistic (P-value)	4.1 (0.04)	20.3 (0.001)	0.3 (0.6)	12.2 (0.001)

Table 2.—Means ± *SE* for abundance of insects (≥10 mm in size) captured per trap night in blacklight traps before and after prescribed burning on the Daniel Boone National Forest, Kentucky, in 2006 and 2007. ANOVA test outcomes are included.

Results

2006-07, DBNF

Journal of Mammalogy, 90(5):1165–1175, 2009

RESPONSE OF NORTHERN BATS (*MYOTIS SEPTENTRIONALIS*) TO PRESCRIBED FIRES IN EASTERN KENTUCKY FORESTS

Michael J. Lacki,* Daniel R. Cox, Luke E. Dodd, and Matthew B. Dickinson

Table 2.—Means ± *SE* for abundance of insects (≥10 mm in size) captured per trap night in blacklight traps before and after prescribed burning on the Daniel Boone National Forest, Kentucky, in 2006 and 2007. ANOVA test outcomes are included.

	All insects combined	Coleoptera	Lepidoptera	Diptera
Preburn (n = 43)	140 ± 14	8.0 ± 1.47	126 ± 13	1.0 ± 0.25
Postburn (n = 84)	188 ± 14	24.3 ± 3.24	154 ± 13	2.4 ± 0.34
F-statistic (P-value)	4.1 (0.04)	20.3 (0.001)	0.3 (0.6)	12.2 (0.001)

Table 2.—Means ± *SE* for abundance of insects (≥10 mm in size) captured per trap night in blacklight traps before and after prescribed burning on the Daniel Boone National Forest, Kentucky, in 2006 and 2007. ANOVA test outcomes are included.

Results

2006-07, DBNF

Journal of Mammalogy, 90(5):1165–1175, 2009

RESPONSE OF NORTHERN BATS (*MYOTIS SEPTENTRIONALIS*) TO PRESCRIBED FIRES IN EASTERN KENTUCKY FORESTS

Michael J. Lacki,* Daniel R. Cox, Luke E. Dodd, and Matthew B. Dickinson

Table 2.—Means ± *SE* for abundance of insects (≥10 mm in size) captured per trap night in blacklight traps before and after prescribed burning on the Daniel Boone National Forest, Kentucky, in 2006 and 2007. ANOVA test outcomes are included.

	All insects combined	Coleoptera	Lepidoptera	Diptera
Preburn (n = 43)	140 ± 14	8.0 ± 1.47	126 ± 13	1.0 ± 0.25
Postburn (n = 84)	188 ± 14	24.3 ± 3.24	154 ± 13	2.4 ± 0.34
F-statistic (P-value)	4.1 (0.04)	20.3 (0.001)	0.3 (0.6)	12.2 (0.001)

Table 2.—Means ± *SE* for abundance of insects (≥10 mm in size) captured per trap night in blacklight traps before and after prescribed burning on the Daniel Boone National Forest, Kentucky, in 2006 and 2007. ANOVA test outcomes are included.

Results

2006-07, DBNF

Journal of Mammalogy, 90(5):1165–1175, 2009

RESPONSE OF NORTHERN BATS (*MYOTIS SEPTENTRIONALIS*) TO PRESCRIBED FIRES IN EASTERN KENTUCKY FORESTS

Michael J. Lacki,* Daniel R. Cox, Luke E. Dodd, and Matthew B. Dickinson

- Higher use of burned sites for foraging…
  - Correlated with reduced forest structure (despite *Myotis* being clutter-adapted spp.)
  - Increases in prey occurrence (?)

Results

2006-07, DBNF

Journal of Mammalogy, 90(5):1165–1175, 2009

RESPONSE OF NORTHERN BATS (*MYOTIS SEPTENTRIONALIS*) TO PRESCRIBED FIRES IN EASTERN KENTUCKY FORESTS

MICHAEL J. LACKI,* DANIEL R. COX, LUKE E. DODD, AND MATTHEW B. DICKINSON

Can. J. For. Res. 40: 2187–2203 (2010)

Effects of wildland fire smoke on a tree-roosting bat: integrating a plume model, field measurements, and mammalian dose–response relationships

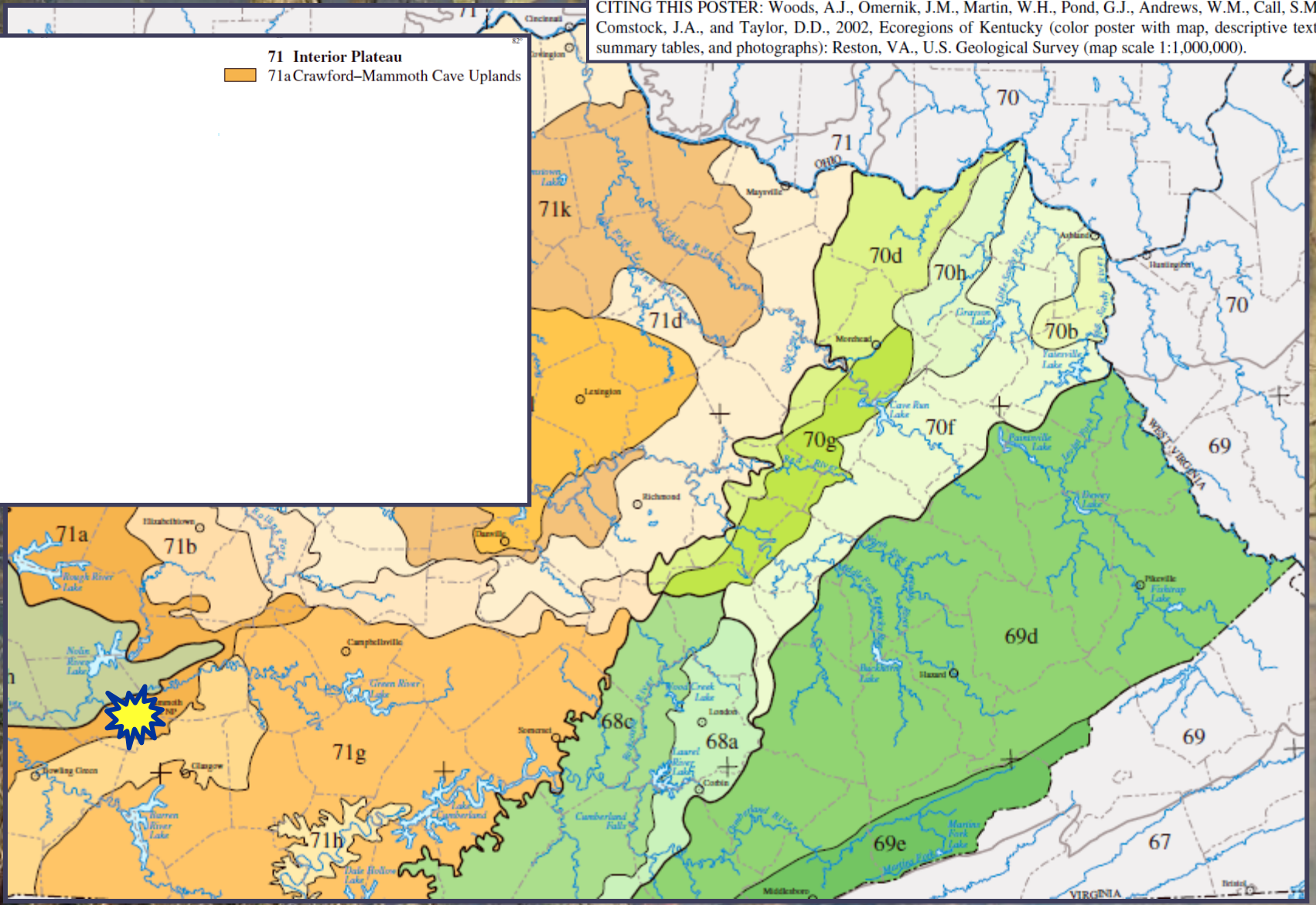
M.B. Dickinson, J.C. Norris, A.S. Bova, R.L. Kremens, V. Young, and M.J. Lacki

Proceedings of the 3rd Fire in Eastern Oak Forests Conference

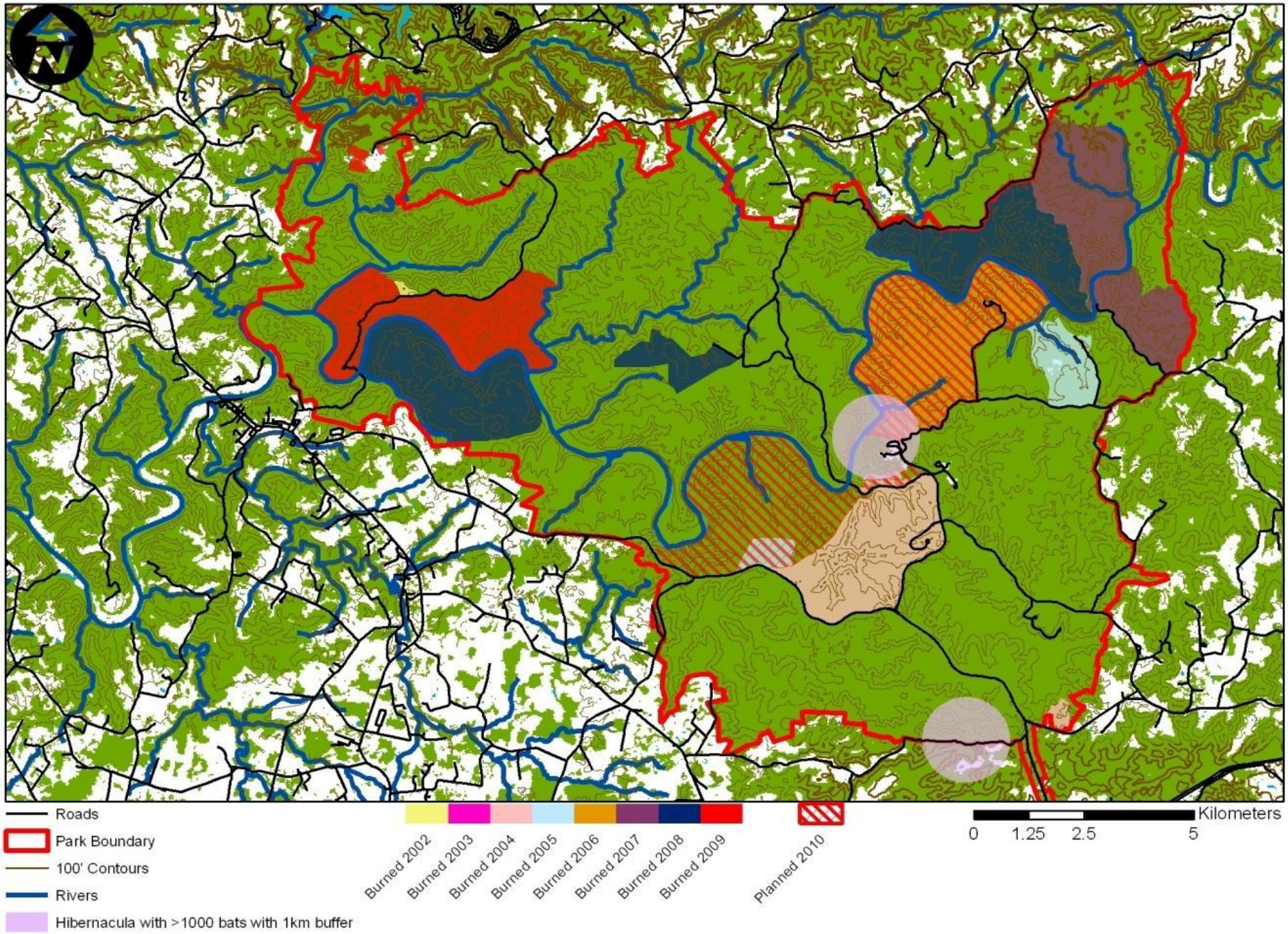
GTR-NRS-P-46

FIRE AND THE ENDANGERED INDIANA BAT

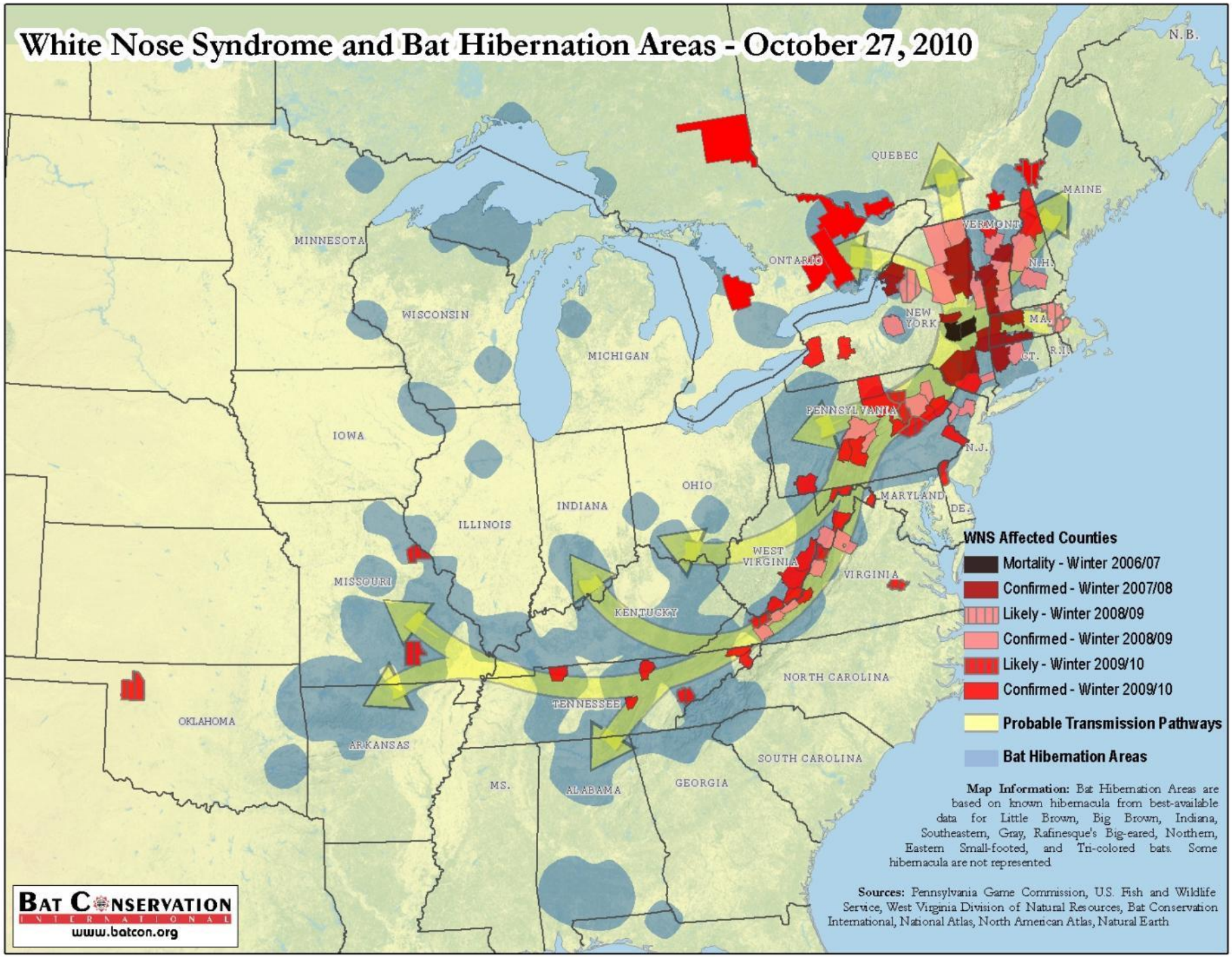
Matthew B. Dickinson[1], Michael J. Lacki[2], and Daniel R. Cox[2]



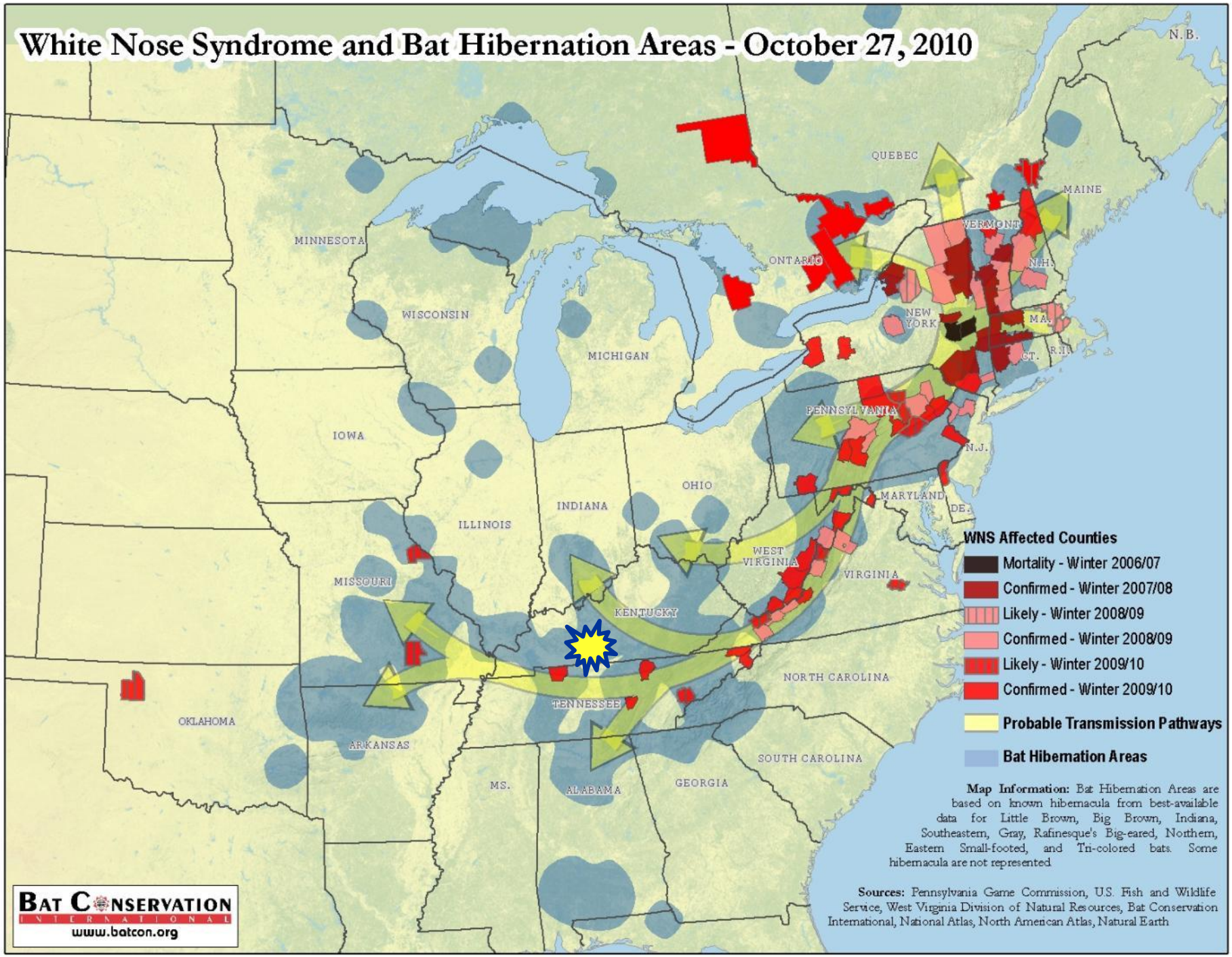
- Expanded, community-level study at Mammoth Cave NP

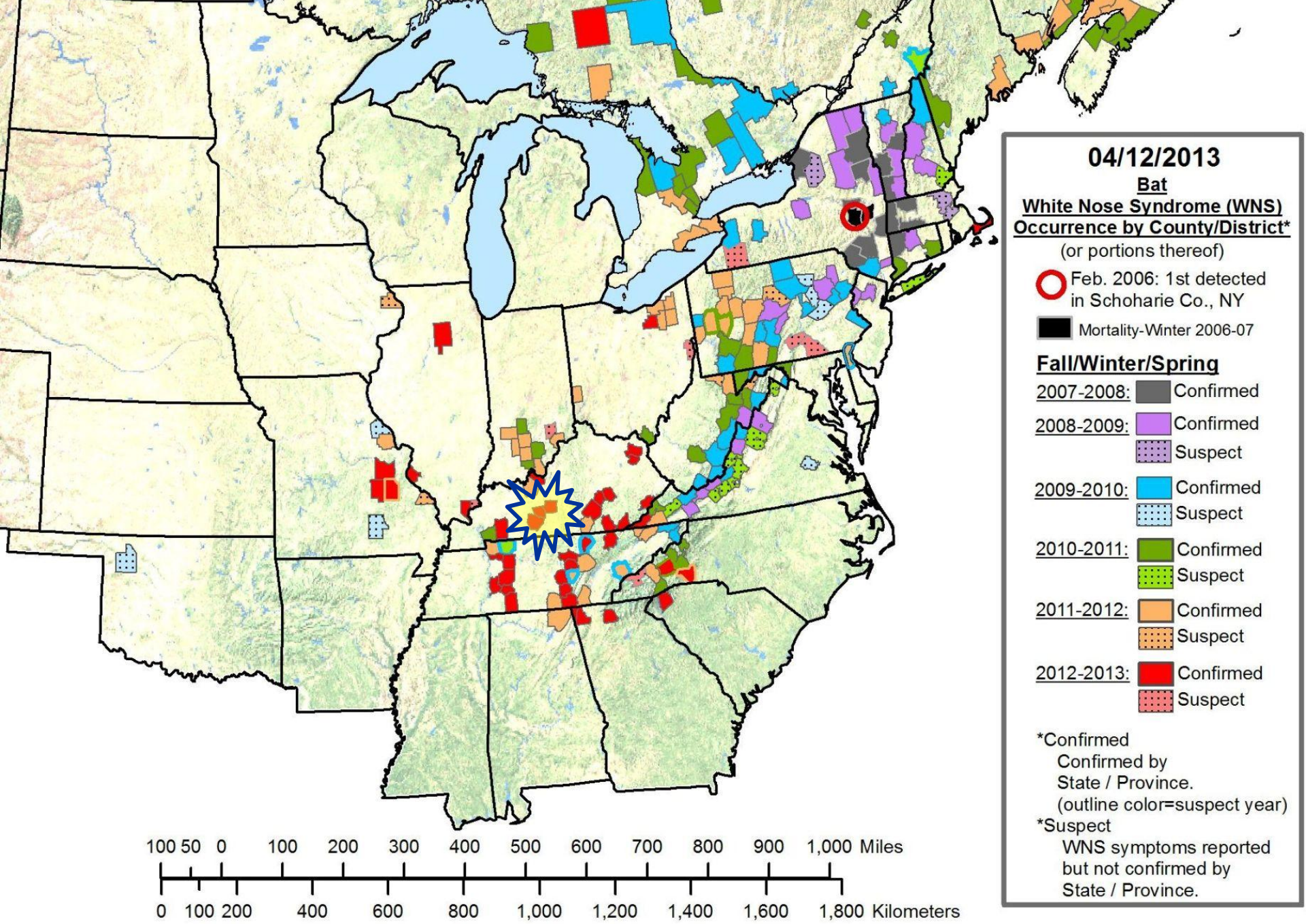

Roads
Park Boundary
100' Contours
Rivers
Hibernacula with >1000 bats with 1km buffer
Burned 2002
Burned 2003
Burned 2004
Burned 2005
Burned 2006
Burned 2007
Burned 2008
Burned 2009
Planned 2010
Kilometers
0
1.25
2.5
5

White Nose Syndrome and Bat Hibernation Areas - October 27, 2010



White Nose Syndrome and Bat Hibernation Areas - October 27, 2010





Map by: Cal Butchkoski, PA Game Commission

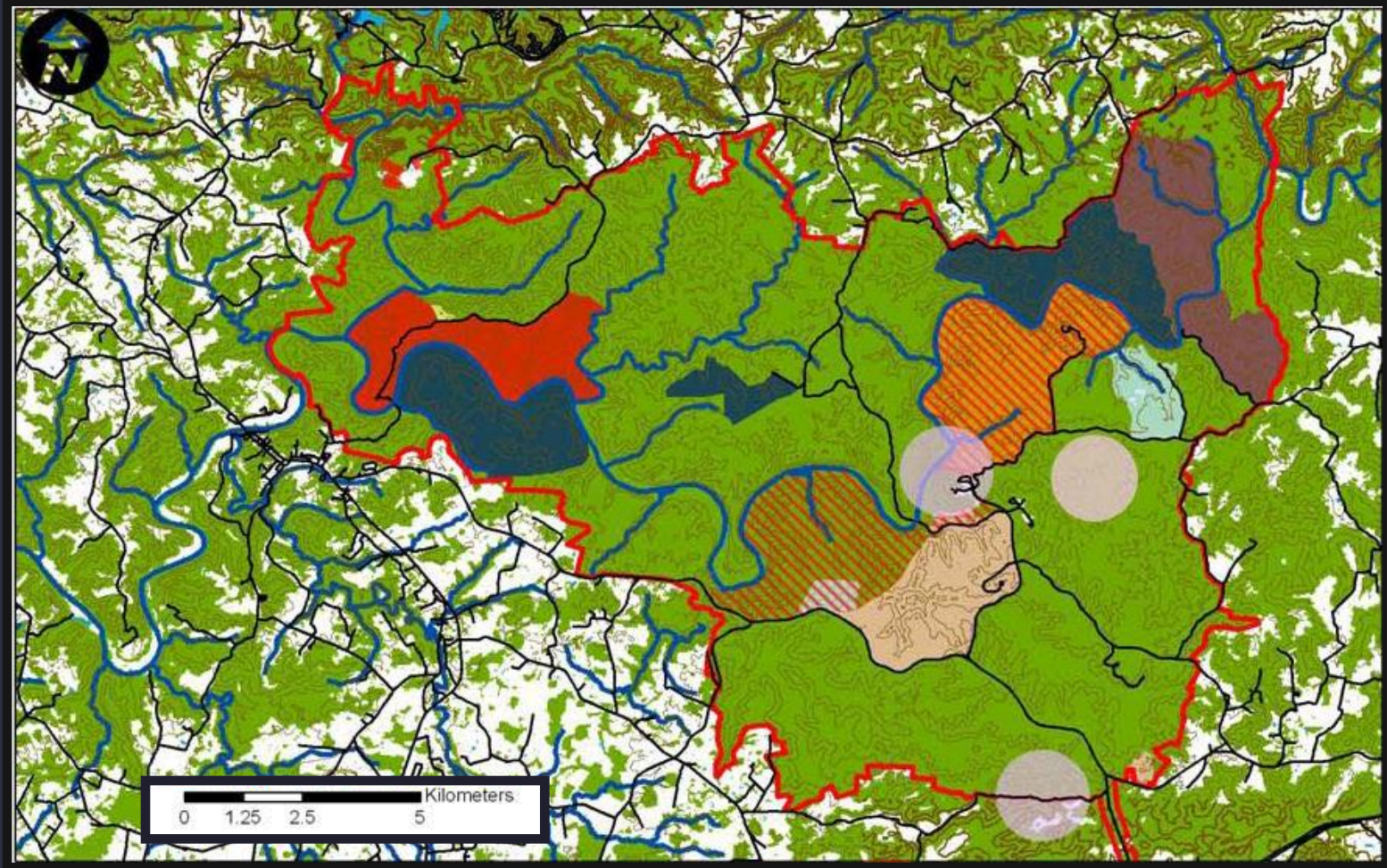
Methods

Mammoth Cave National Park

Burn Areas

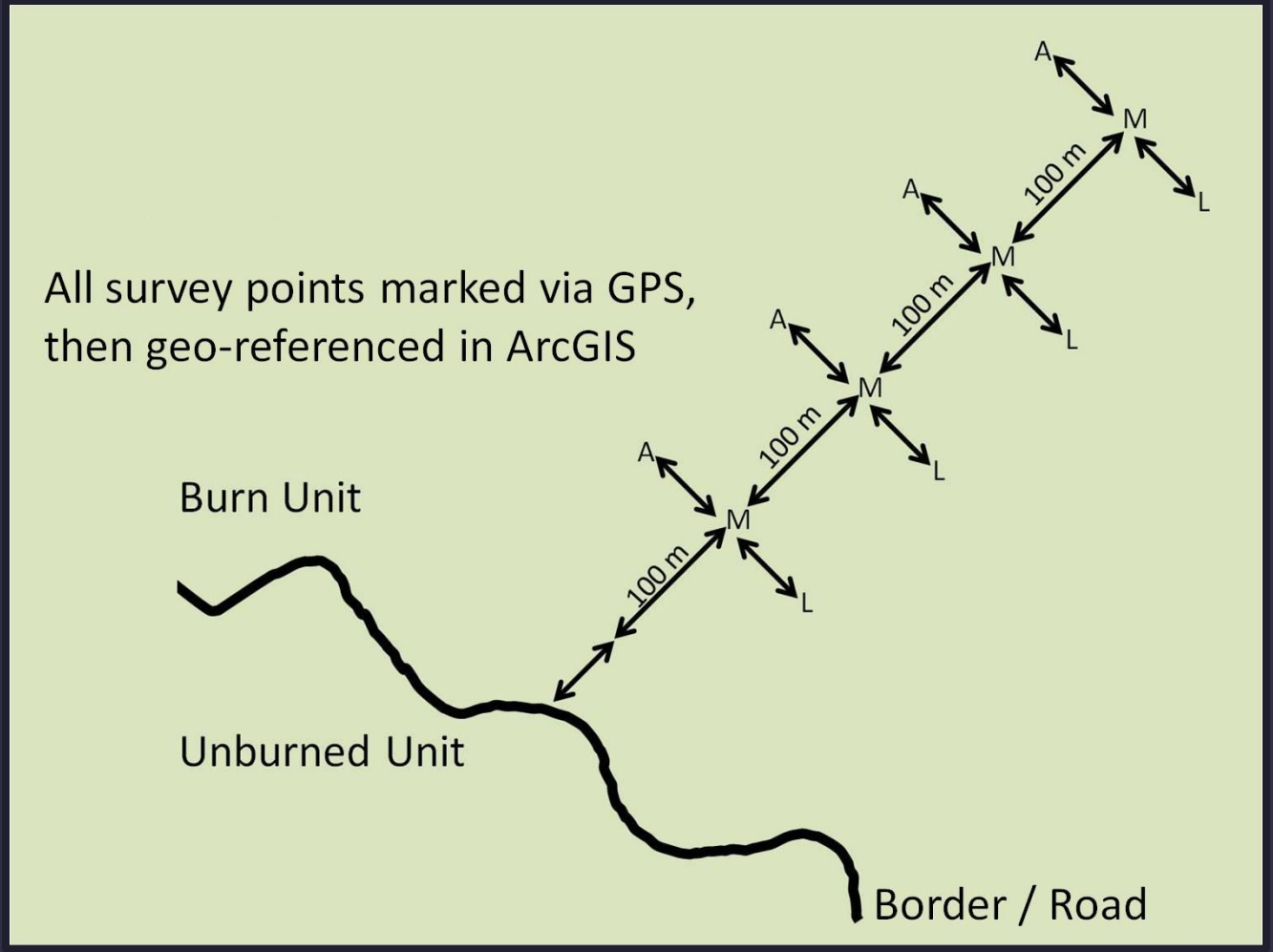
- 2010
- 2009
- 2008
- 2007
- 2005
- 2004

Core Hibernacula



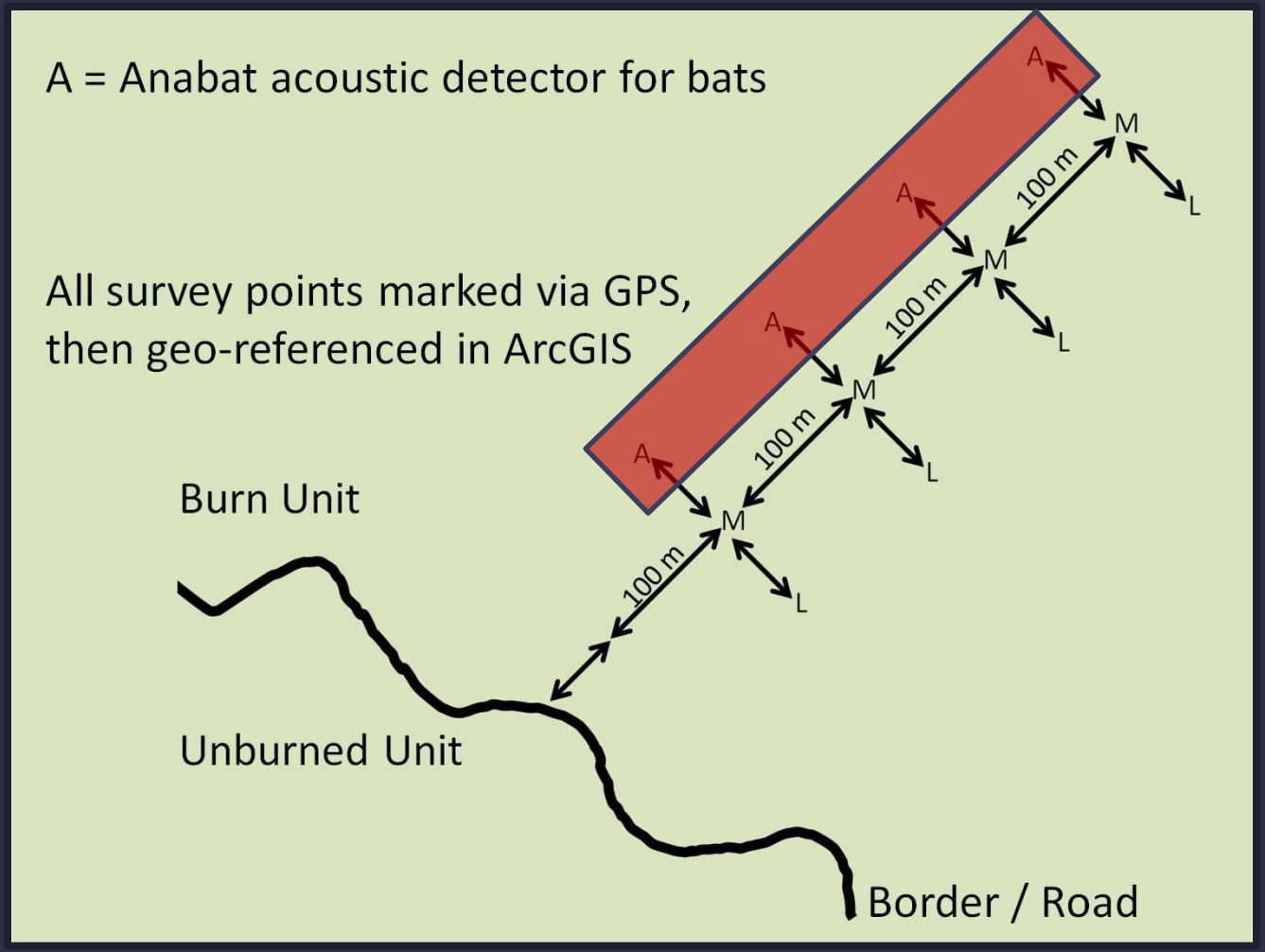
Methods

Mammoth Cave National Park



Methods

Mammoth Cave National Park



Methods

Bat Activity

MCNP, 2010-13

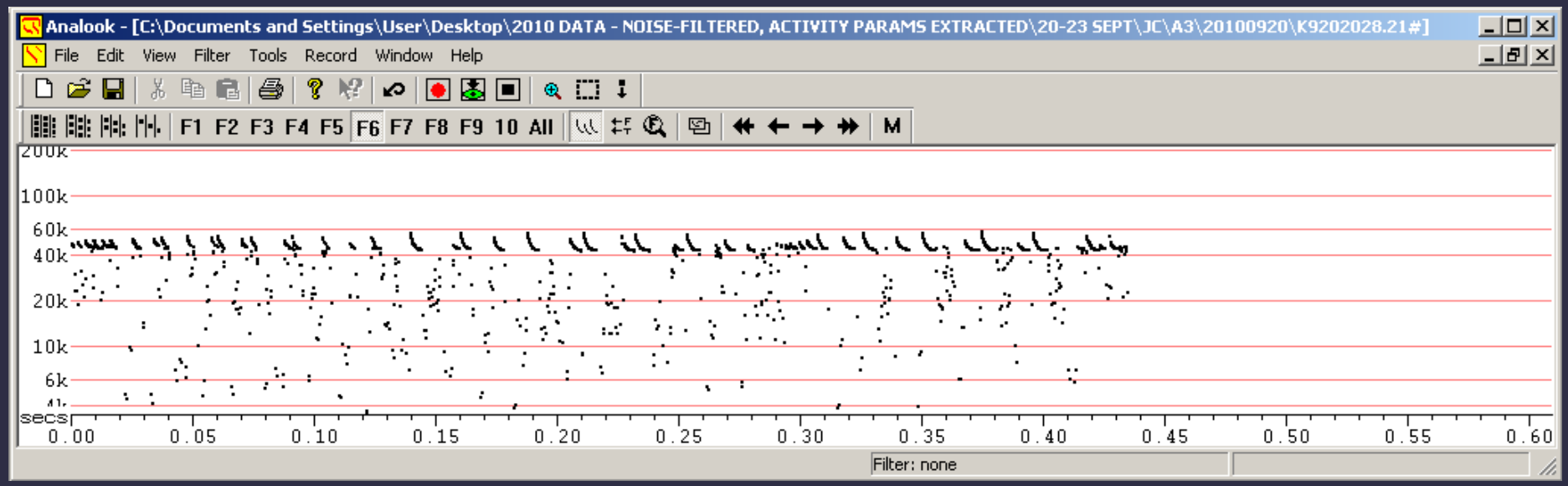
- Acoustic Monitoring

Methods

Bat Activity

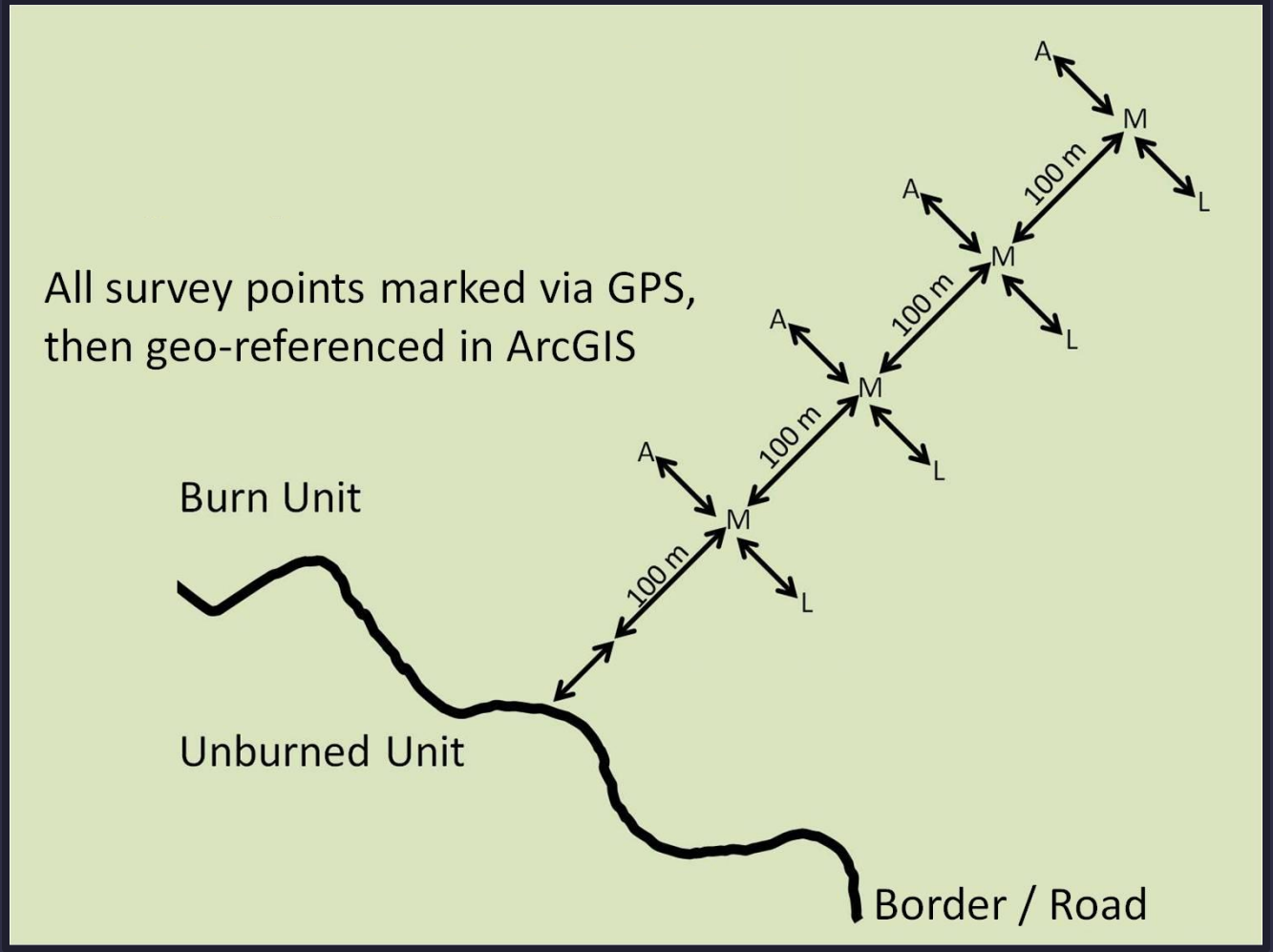
MCNP, 2010-13

- Acoustic Monitoring



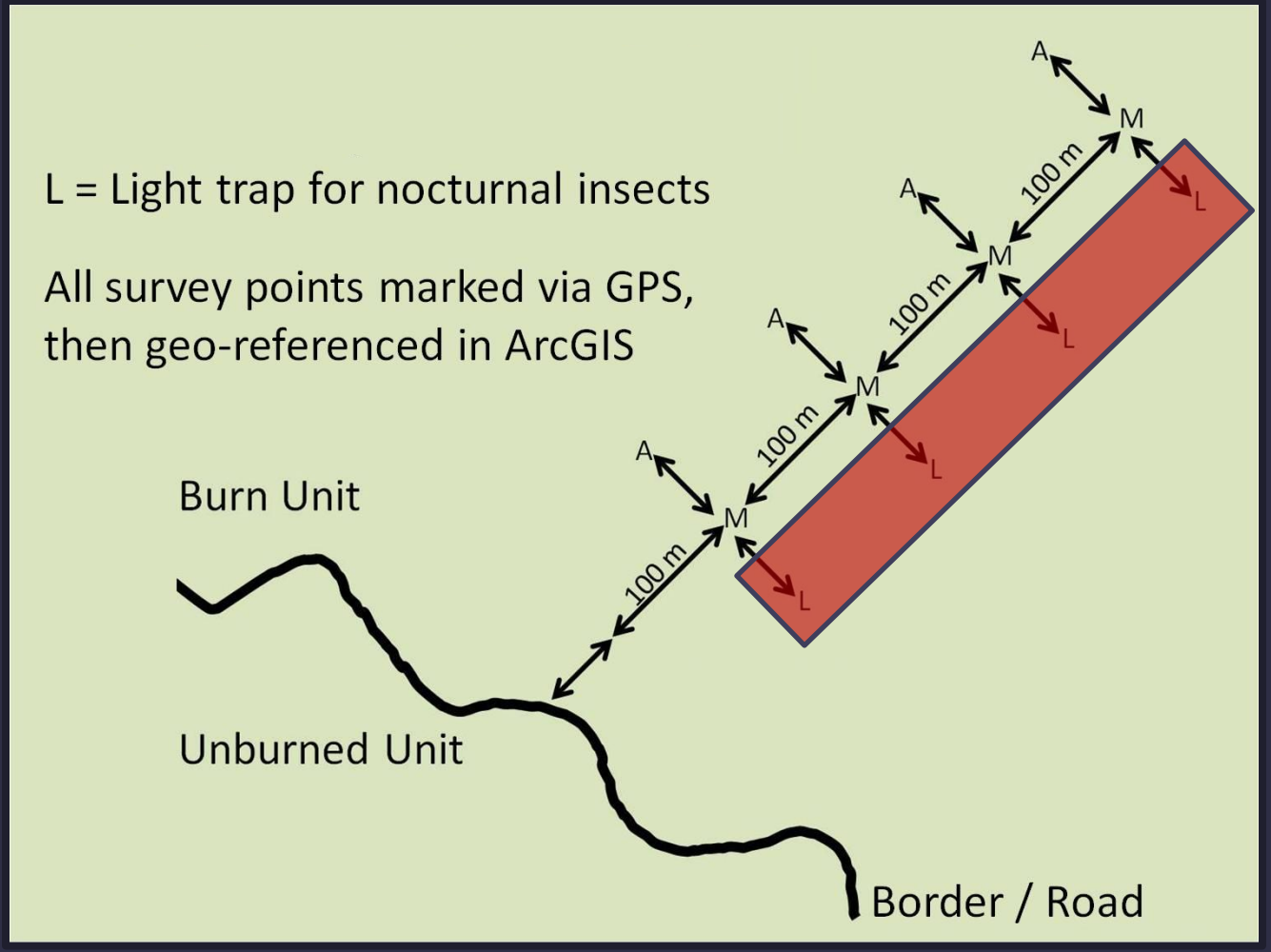
Methods

Mammoth Cave National Park



Methods

Mammoth Cave National Park



Methods

Insect Occurrence

MCNP, 2010-13

Results

MCNP, 2010

- First-year responses
  - Predator
  - Prey
  - Vegetation

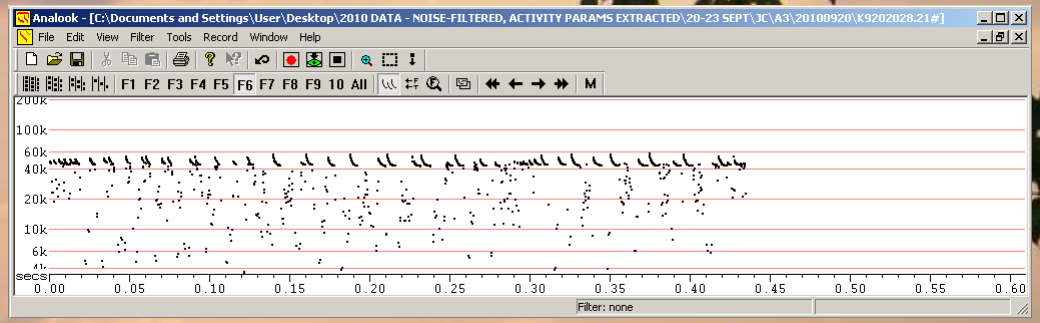
Results

MCNP, 2010

- First-year responses
  - Predator
  - Prey
  - ~~Vegetation~~

Results

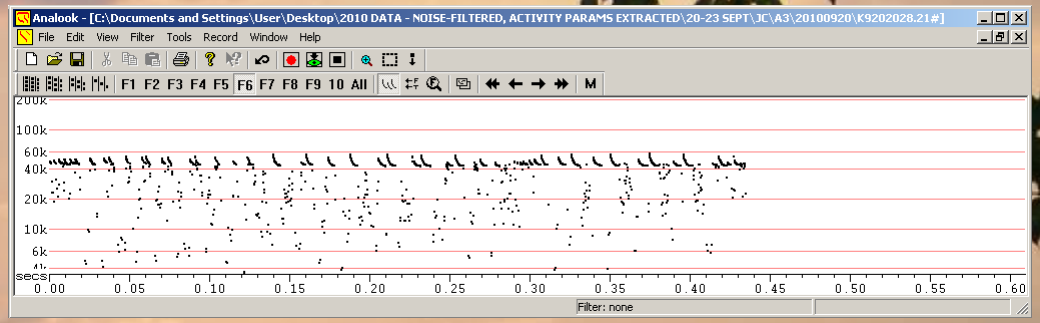
MCNP, 2010

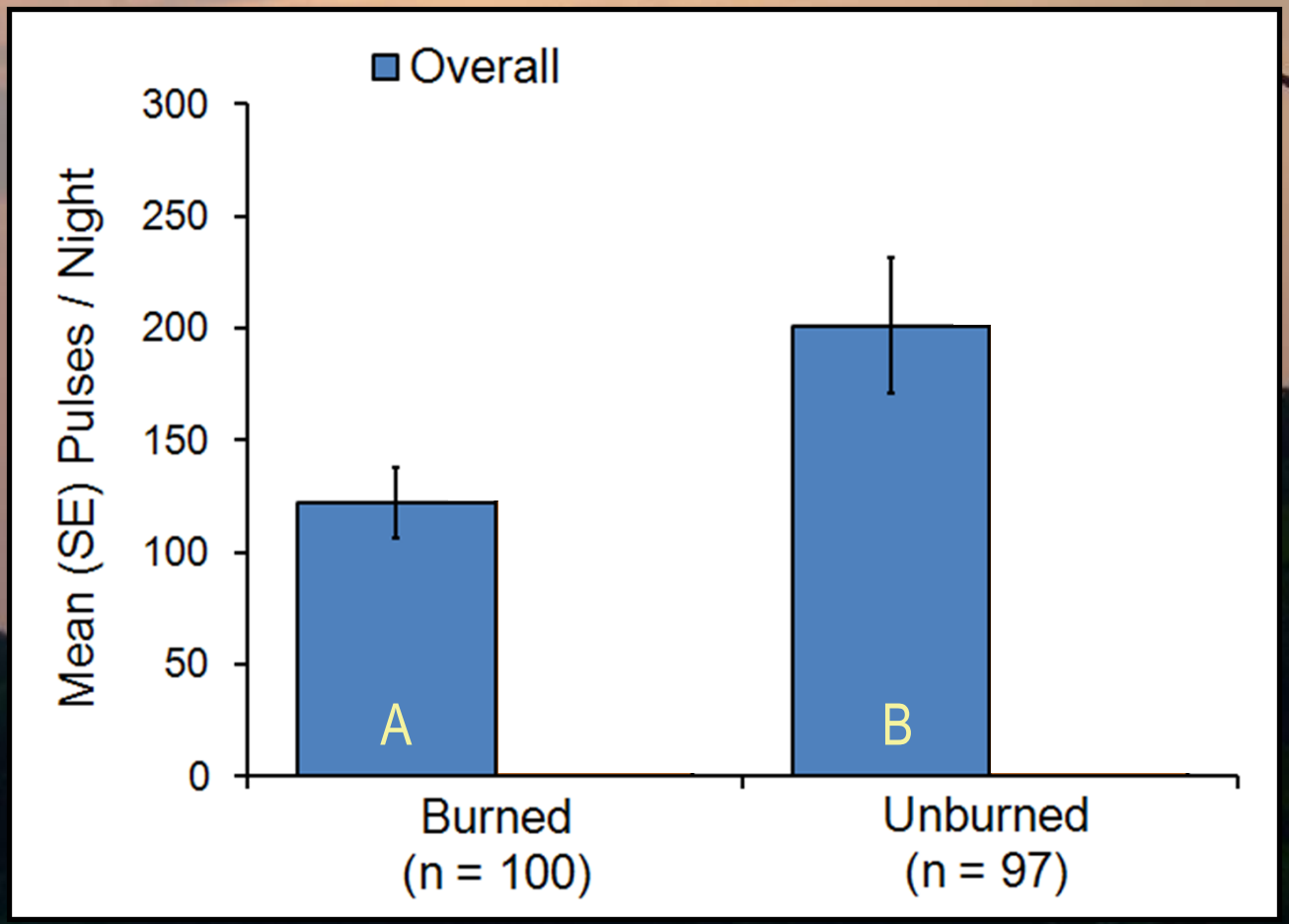


- Preliminary analysis
  - Log transformed data
  - Two-Factor ANOVA
    - Burn vs. unburned
    - Sampling interval
  - Tukey's HSD

Results

MCNP, 2010



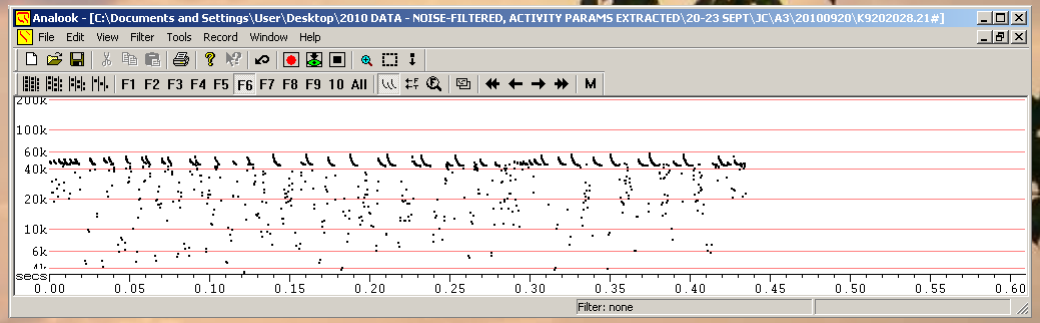


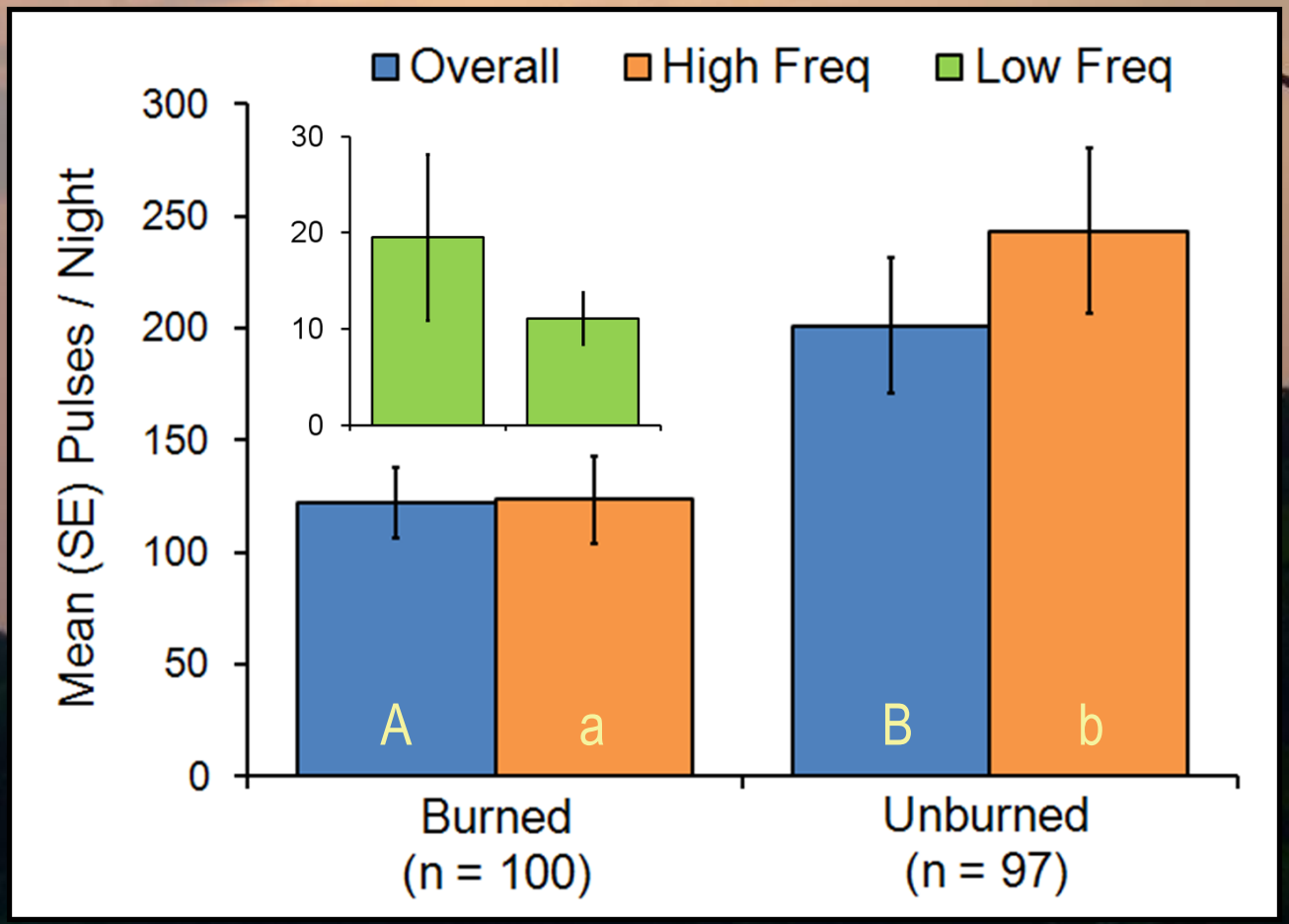
Overall $F_{5,191} = 3.58$

Main Factor within ANOVA; differences at $P < 0.05$

Results

MCNP, 2010



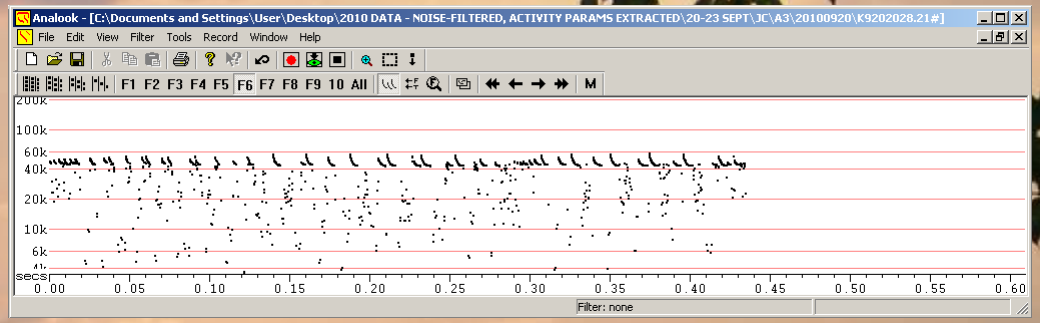


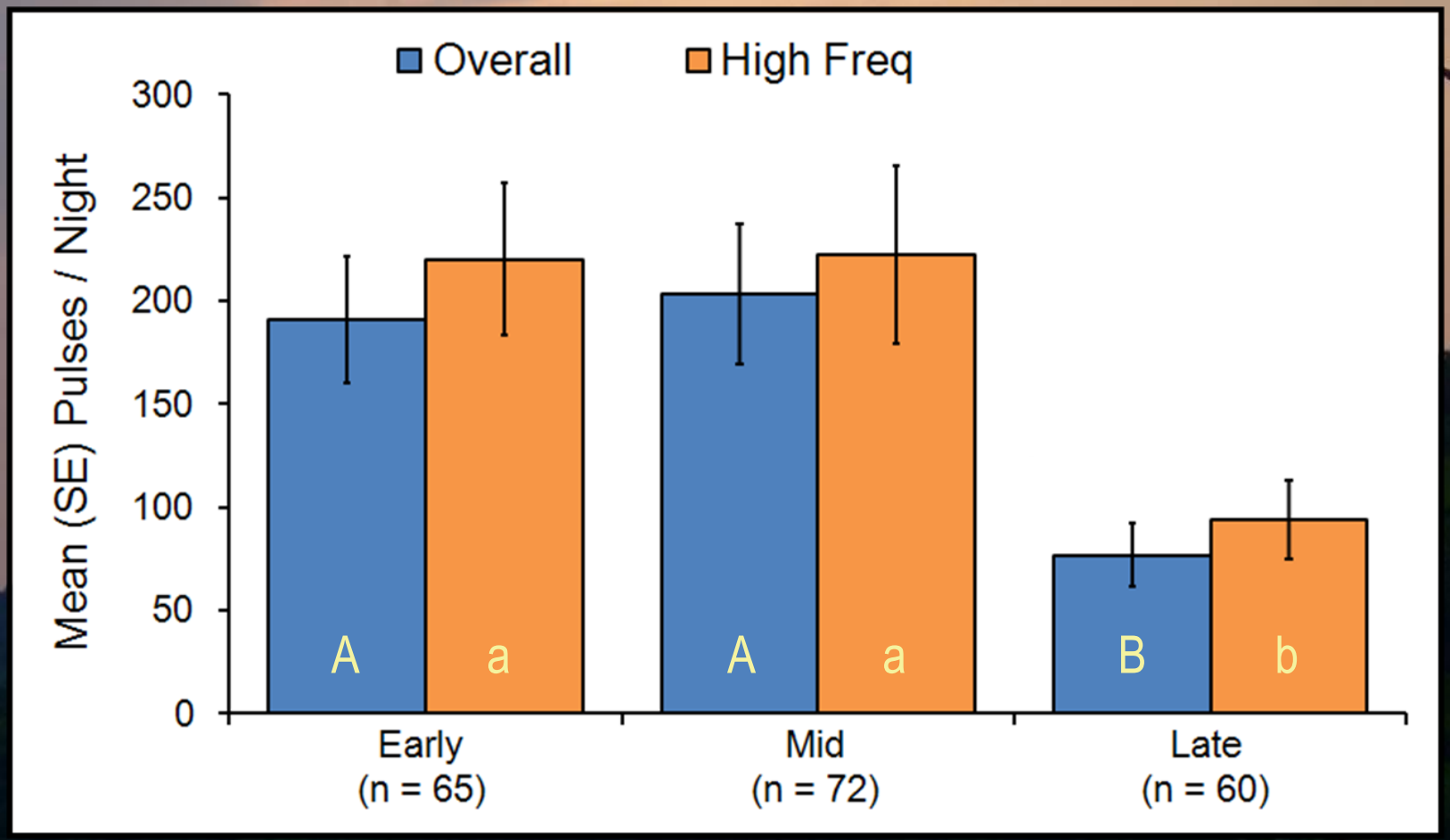
Overall $F_{5,191} = 3.58$
High Freq. $F_{5,191} = 3.49$
Low Freq. $F_{5,191} = 2.31$

Main Factor within ANOVA; differences at $P < 0.05$

Results

MCNP, 2010

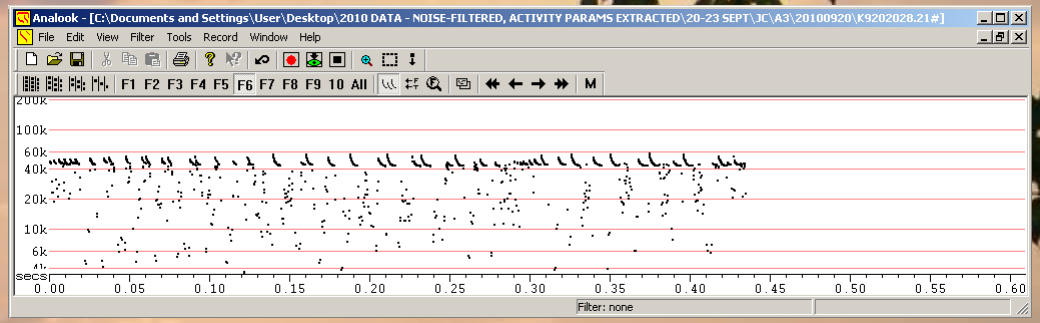




Main Factor within ANOVA; differences at $P < 0.05$

Results

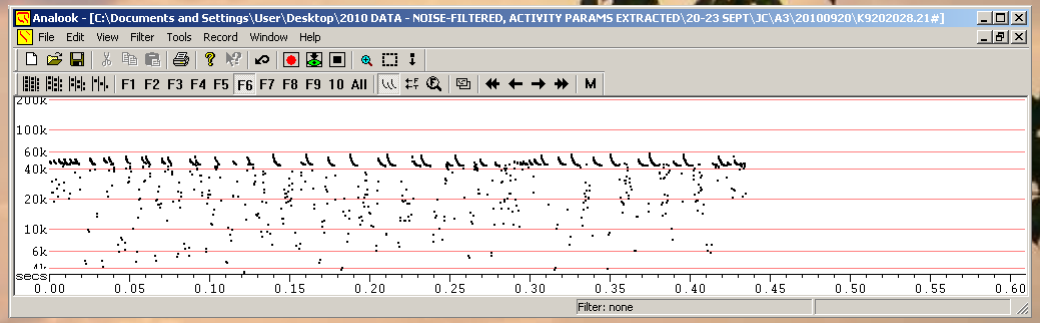
MCNP, 2010



- Activity varied with burn effect

Results

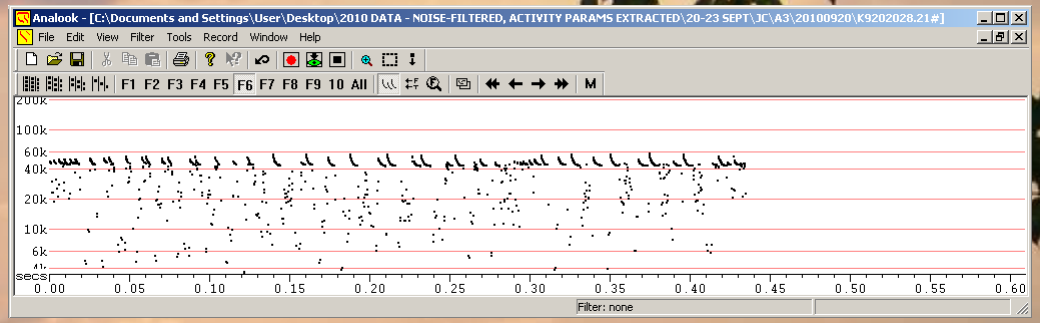
MCNP, 2010



- Activity varied with burn effect
  - High frequency activity likely reflects habitat use by clutter-adapted *Myotis* in unburned sites

Results

MCNP, 2010



- Activity varied with burn effect
  - High frequency activity likely reflects habitat use by clutter-adapted *Myotis* in unburned sites
  - Counter to previous study, yet follows predictions based on ecomorphology…

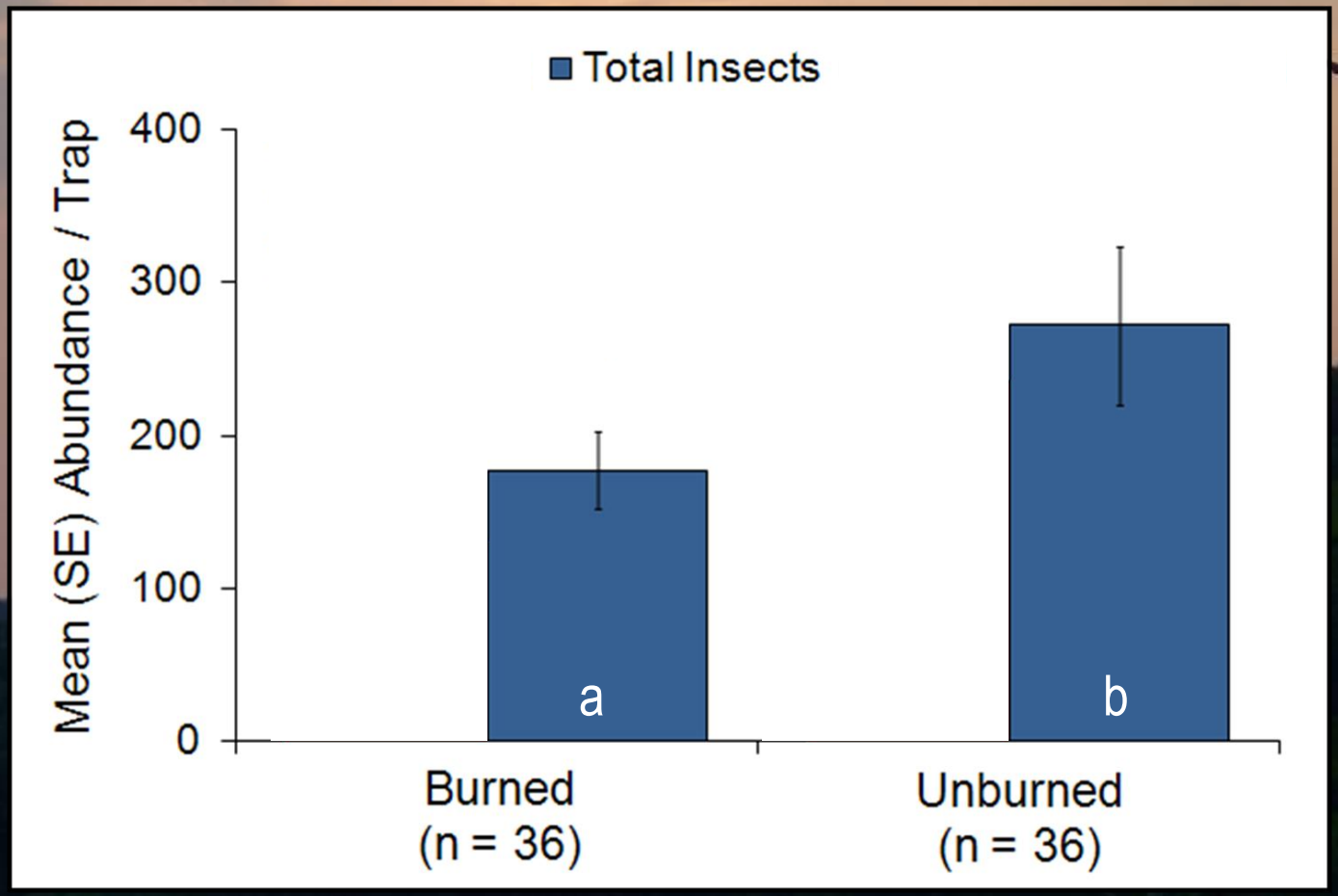
Results

MCNP, 2010

- Preliminary analysis
  - Log transformed data
  - Two-Factor ANOVA
    - Burn vs. unburned
    - Sampling interval
  - Tukey's HSD

Results

MCNP, 2010

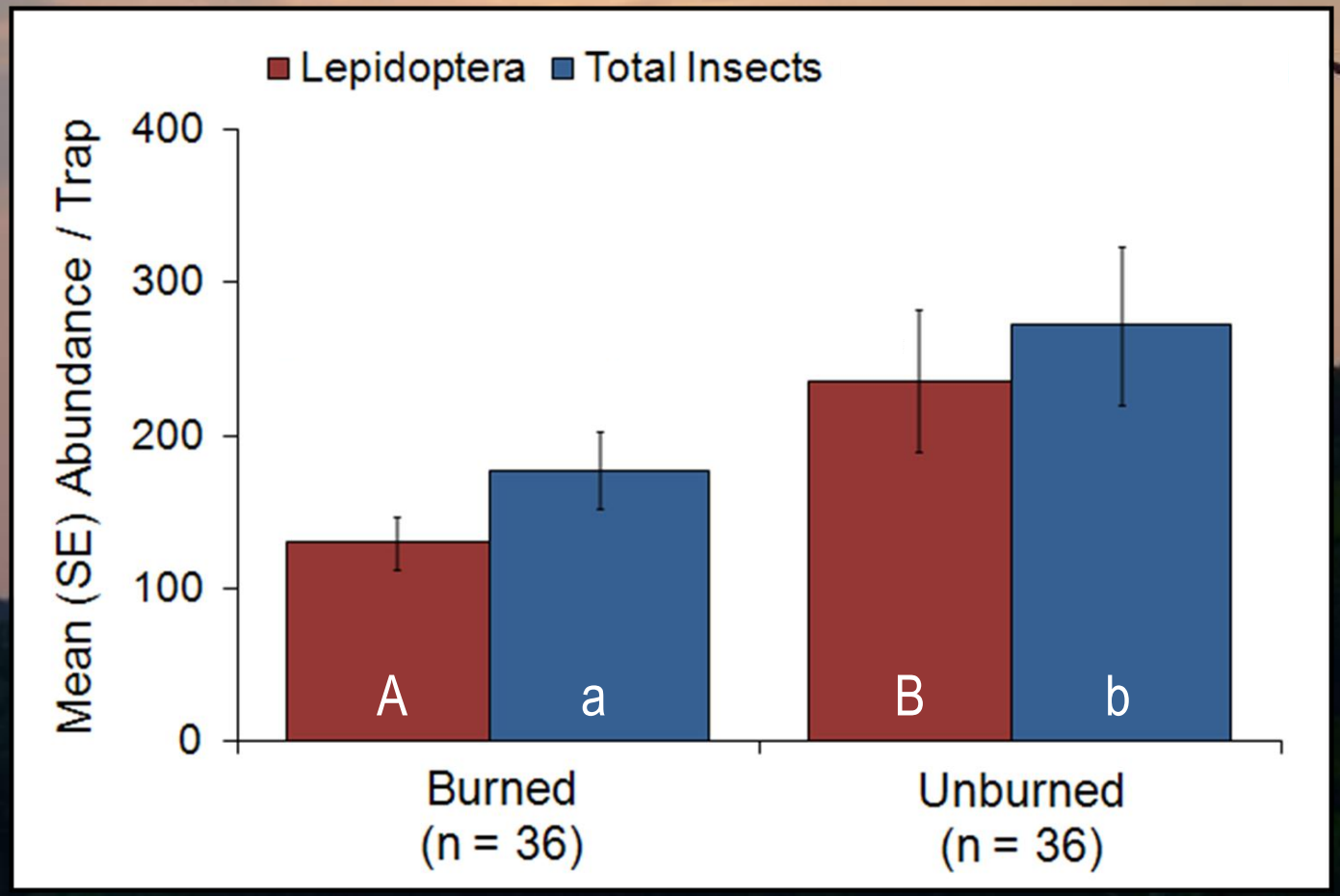


Total $F_{5,66} = 38.0$

Main Factor within ANOVA; differences at $P < 0.05$

Results

MCNP, 2010

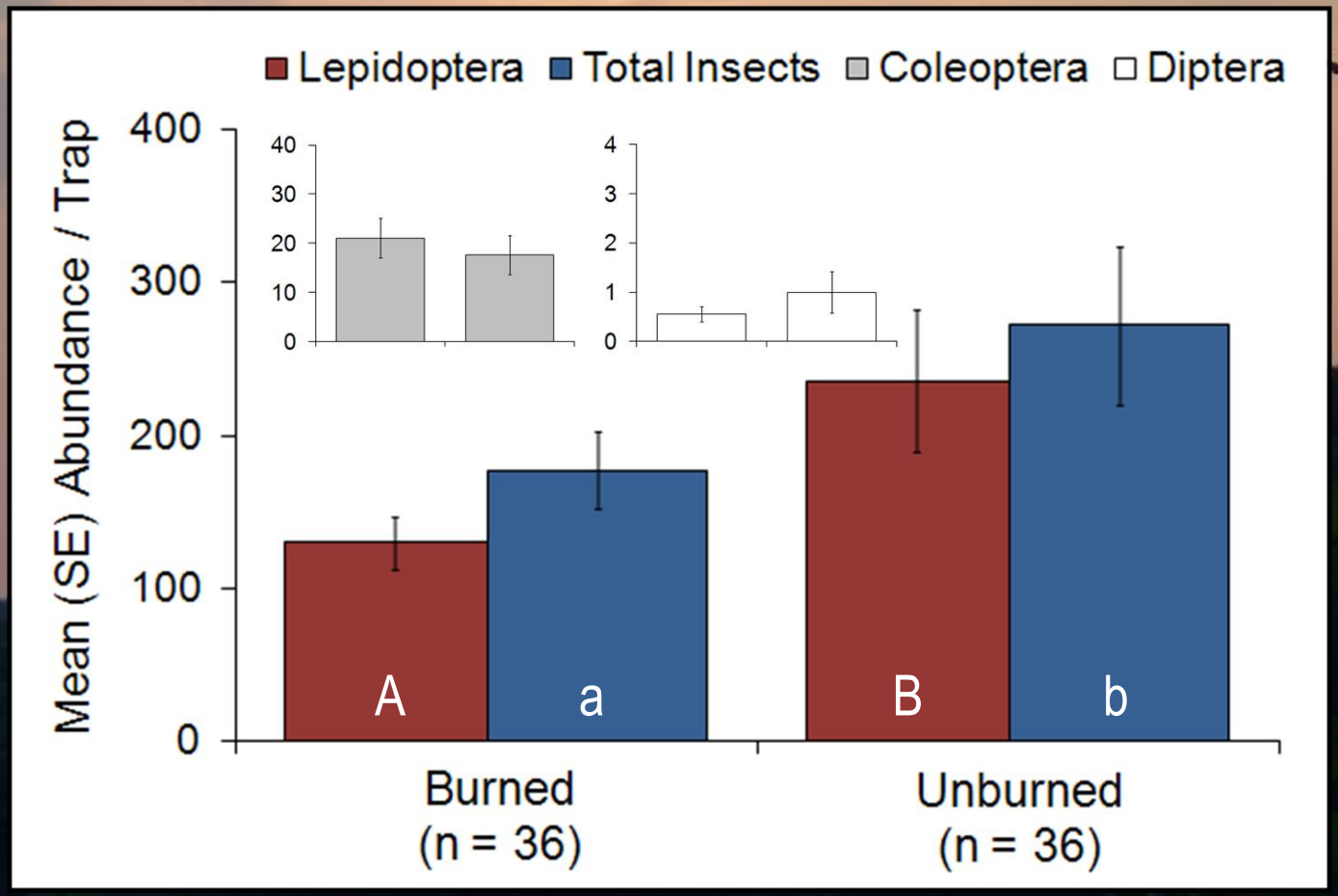


Total $F_{5,66} = 38.0$
Lep. $F_{5,66} = 39.6$

Main Factor within ANOVA; differences at $P < 0.05$

Results

MCNP, 2010

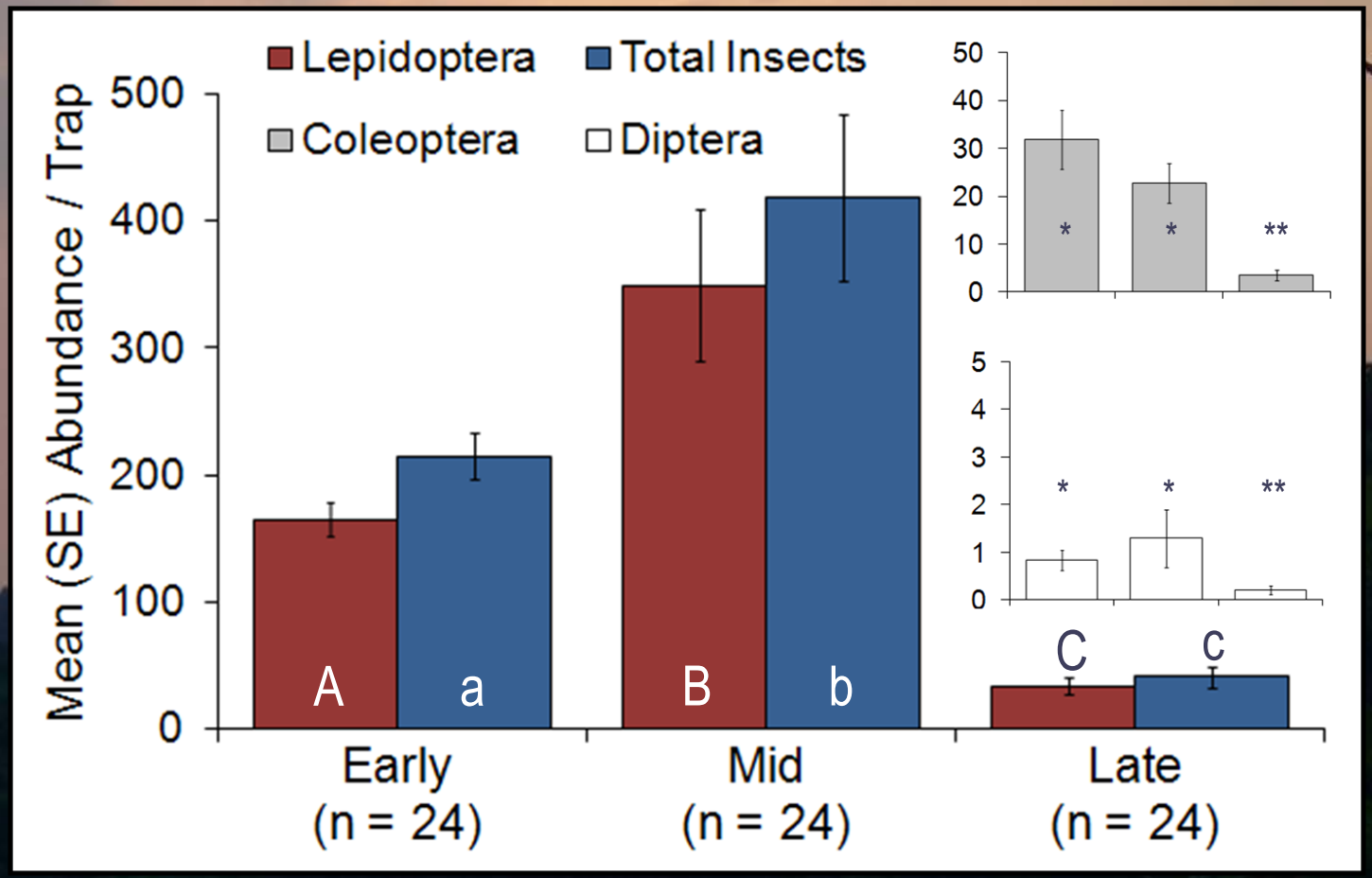


Total $F_{5,66} = 38.0$
Lep. $F_{5,66} = 39.6$
Col. $F_{5,66} = 11.2$
Dipt. $F_{5,66} = 3.09$

Main Factor within ANOVA; differences at $P < 0.05$

Results

MCNP, 2010



Total $F_{5,66} = 38.0$
Lep. $F_{5,66} = 39.6$
Col. $F_{5,66} = 11.2$
Dipt. $F_{5,66} = 3.09$

Main Factor within ANOVA; differences at $P < 0.05$

Results

MCNP, 2010

- Insect occurrence varied with burn effect
  - Results counter to previous study
  - Relationships to vegetation
  - Relationships to resource base

Methods

Mammoth Cave National Park

- Multi-year responses
  - Predator
  - Prey
  - Vegetation

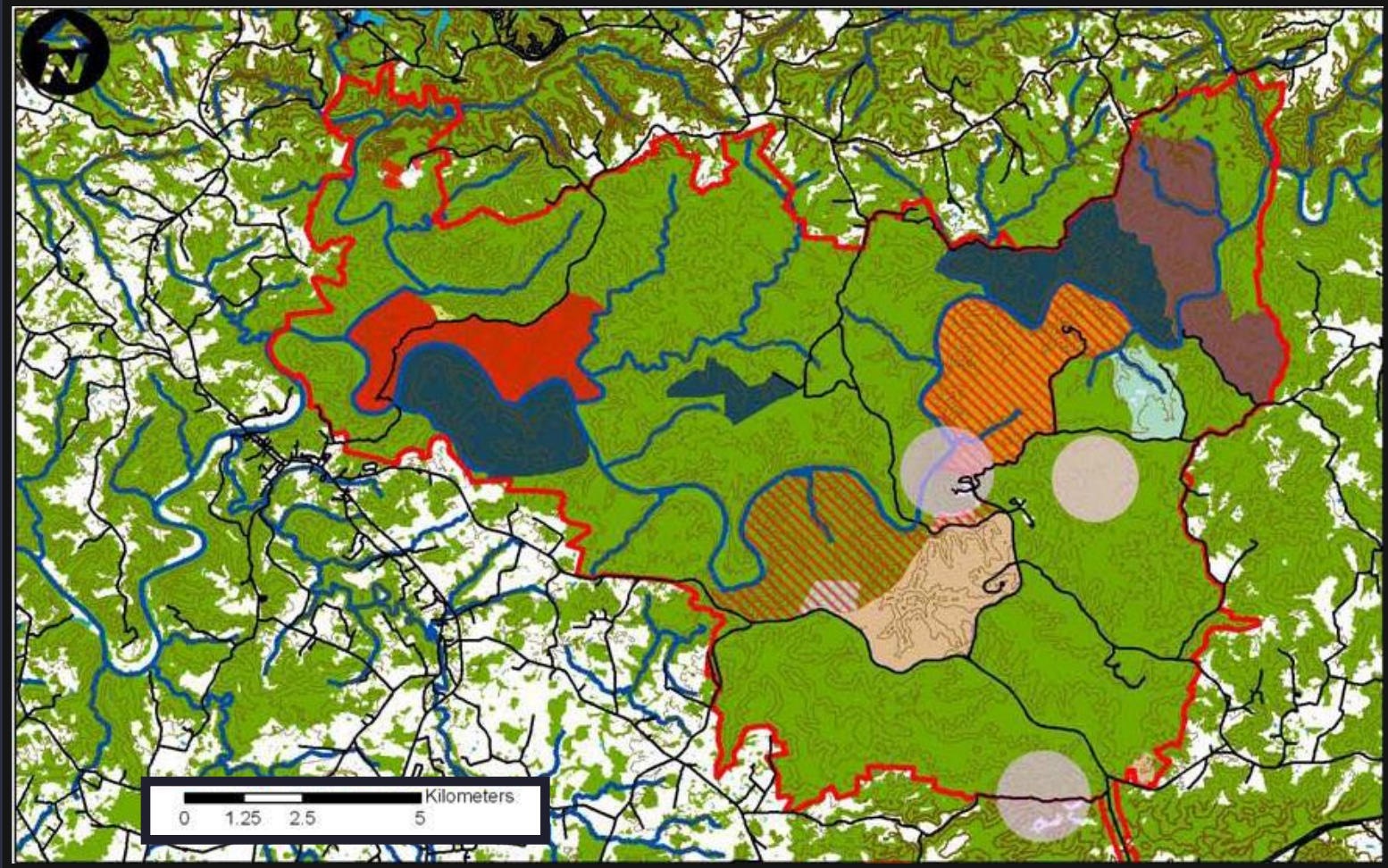
Methods

Mammoth Cave National Park

Burn Areas

- 2010
- 2009
- 2008
- 2007
- 2005
- 2004

Core Hibernacula



Methods

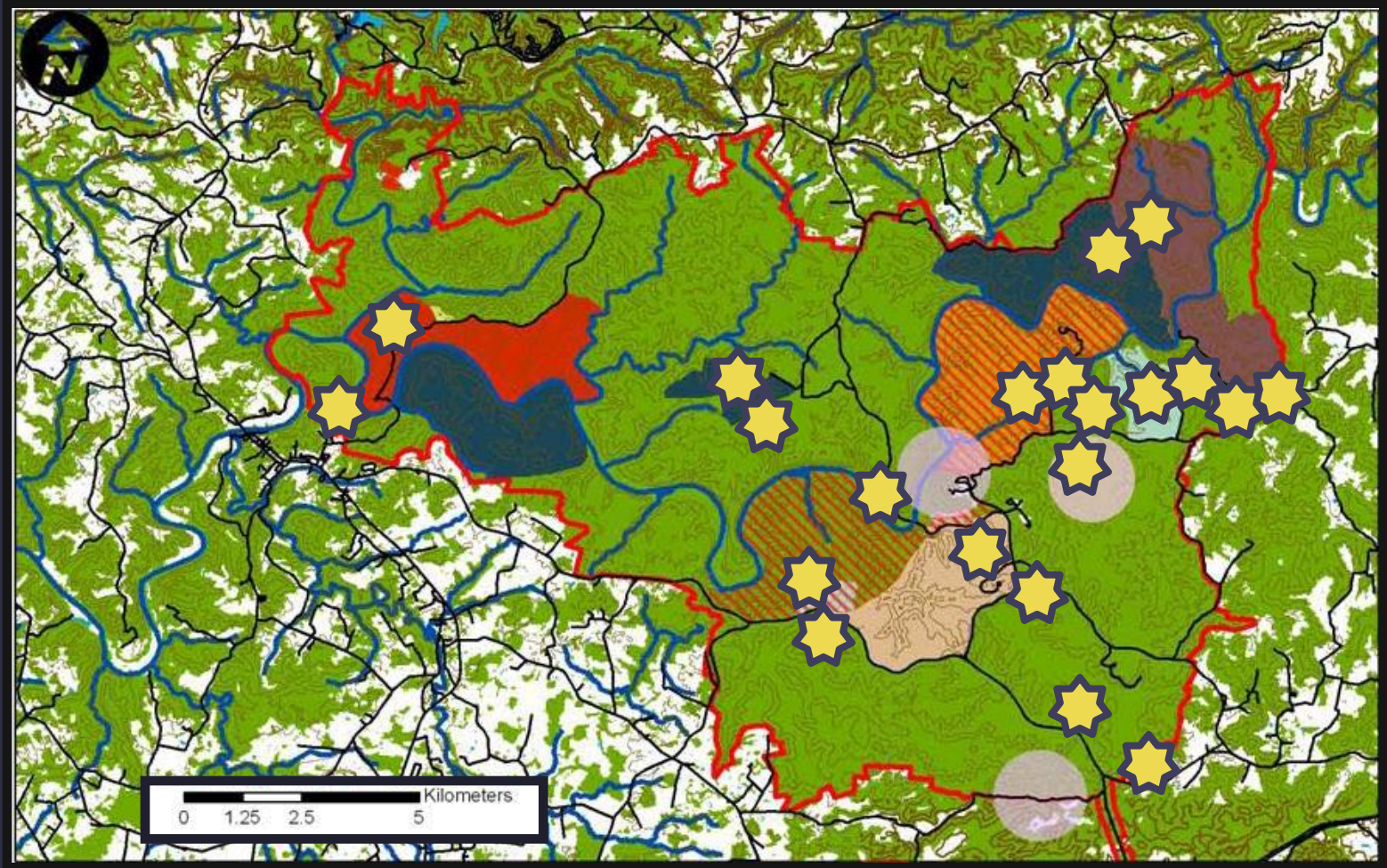
Mammoth Cave National Park

Survey Transect, 2010-2011 (& onward)

Burn Areas

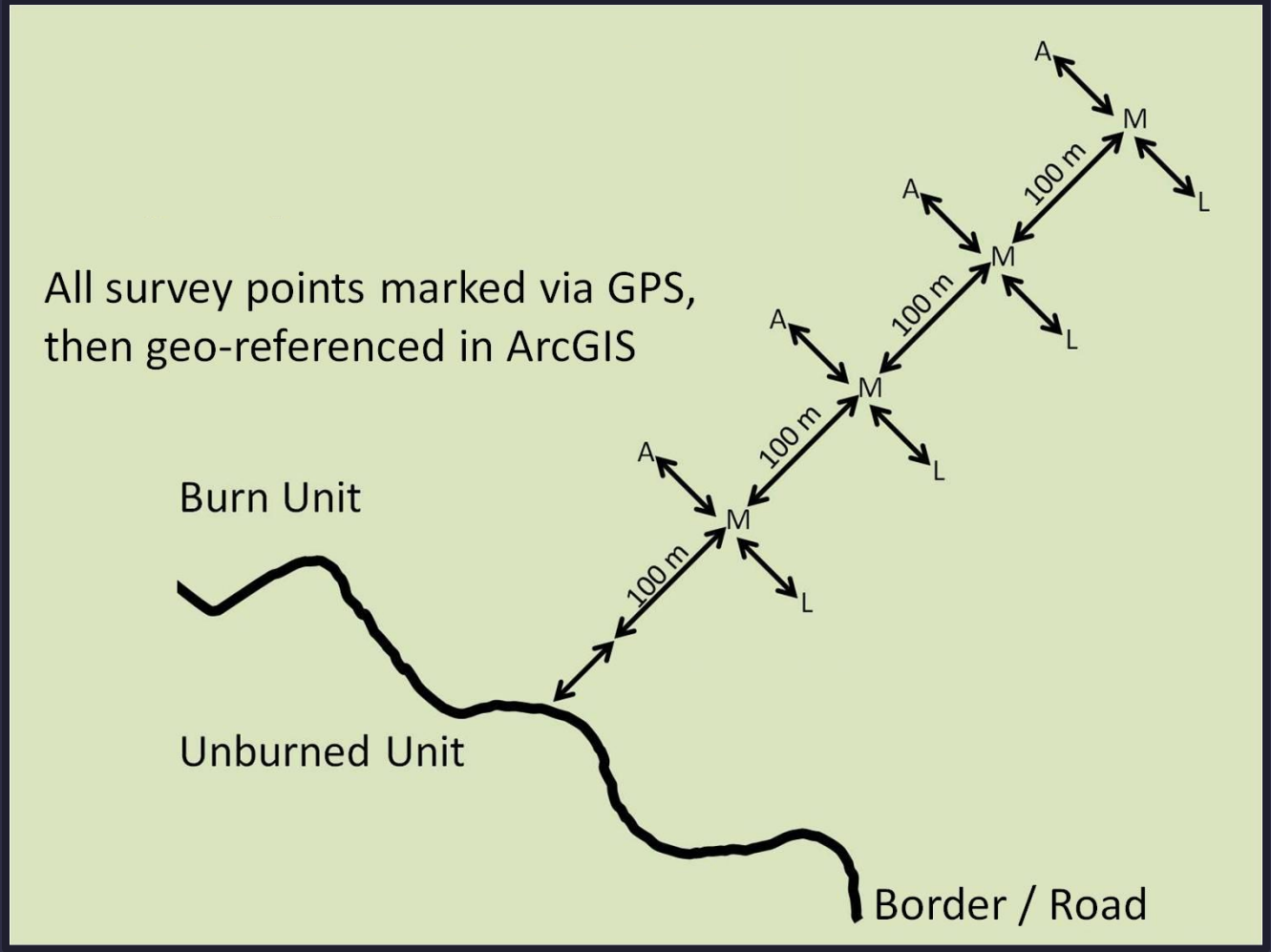
- 2010
- 2009
- 2008
- 2007
- 2005
- 2004

Core Hibernacula



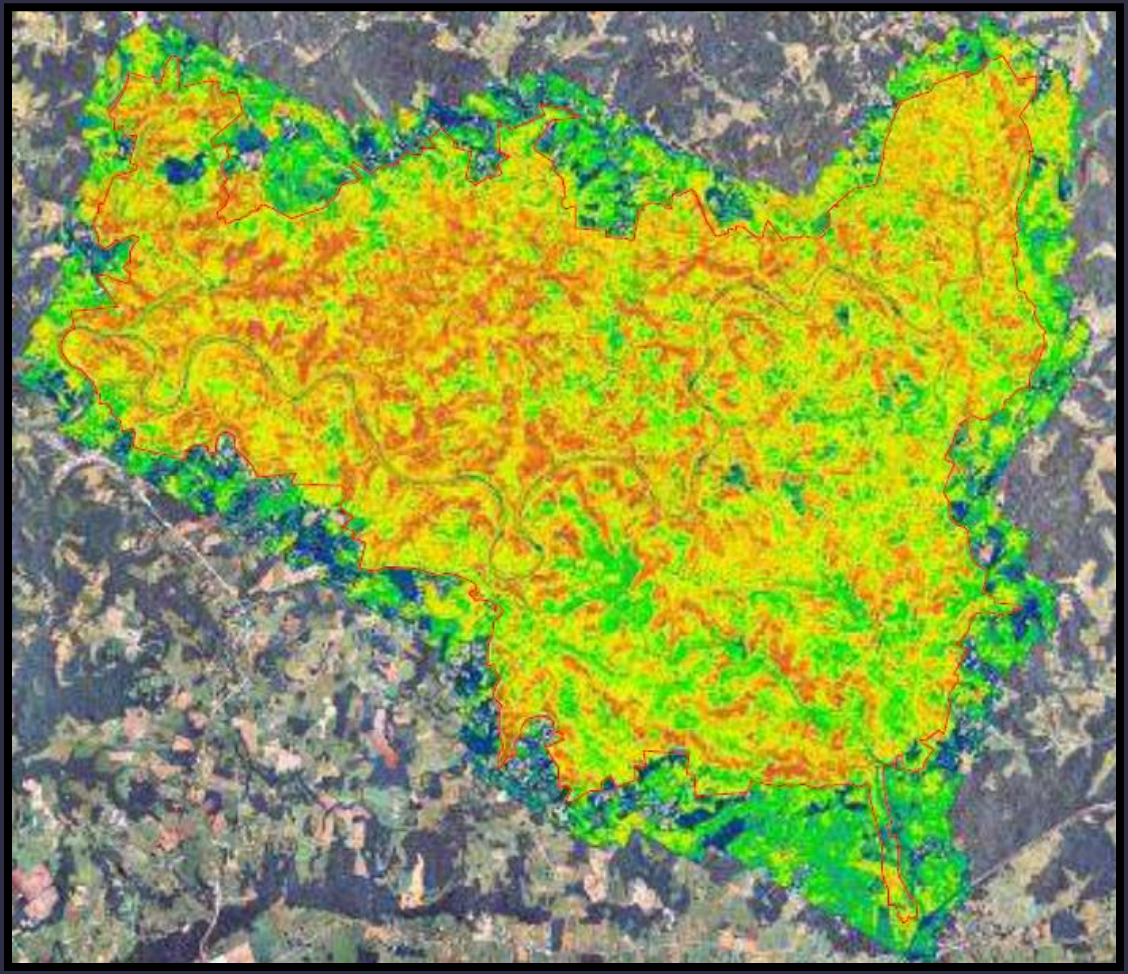
Methods

Mammoth Cave National Park



Methods

LiDAR Mapping



Methods

LiDAR Mapping

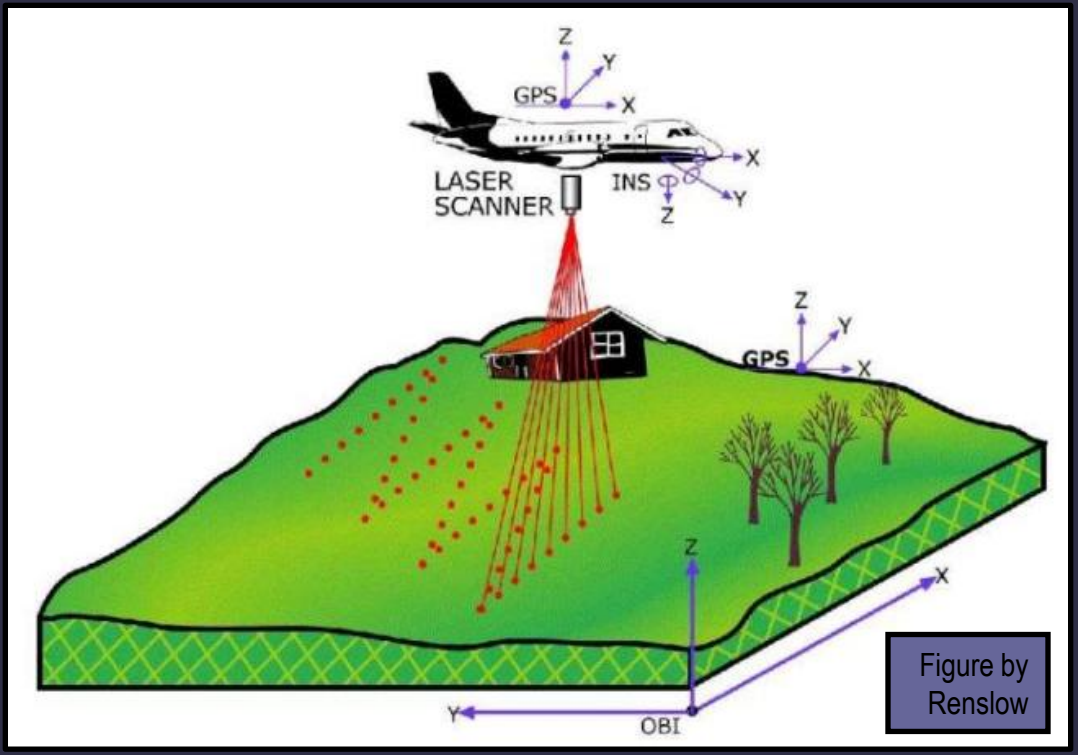


Figure by Renslow

- LiDAR = “Light Detection and Ranging”
- Discrete-return scanning LiDAR[1]
  - 900-1,600 nm wavelength
  - > 4 pulses / m²

[1]Skowronski et al. 2007. Remote Sensing of Environment 108: 123-129.

Methods

LiDAR Mapping

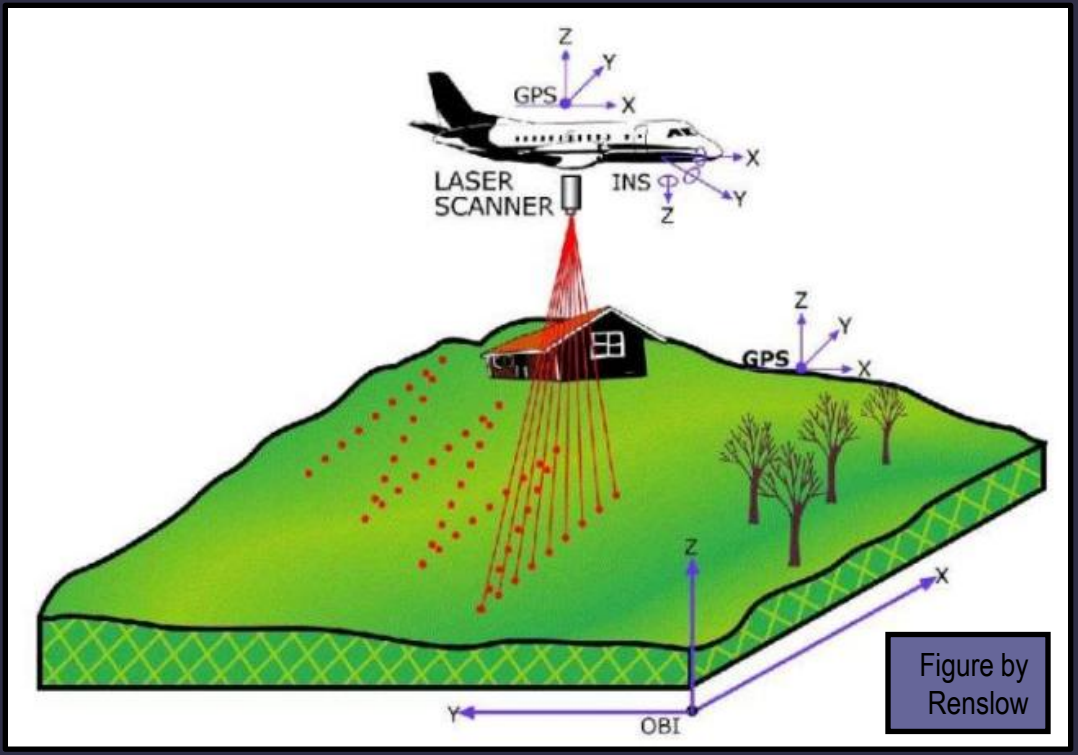


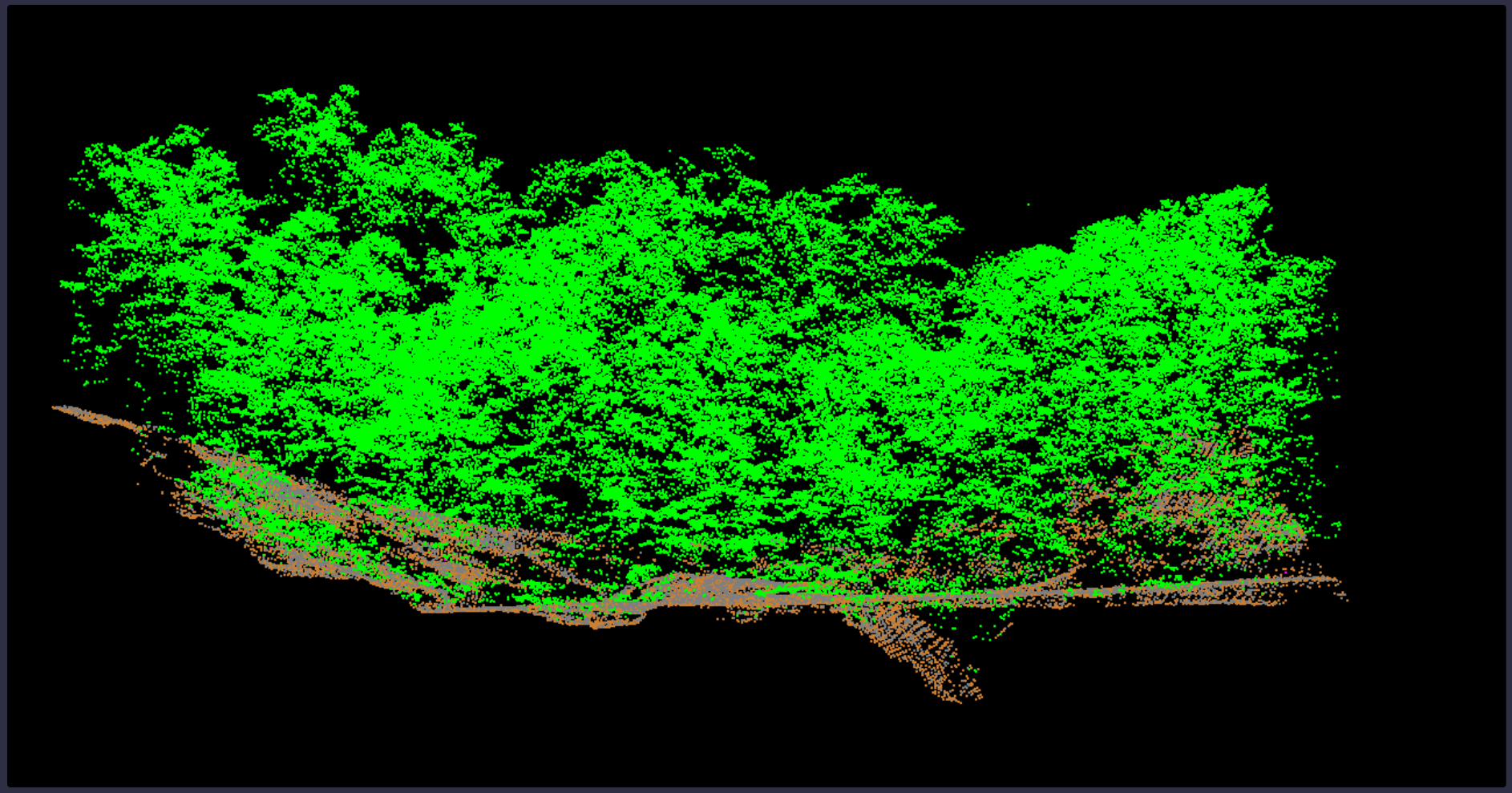
Figure by Renslow

- LiDAR = “Light Detection and Ranging”
- Data collected Oct 2010 (leaf-off) via fixed-wing aircraft

Methods

- What scale is meaningful?

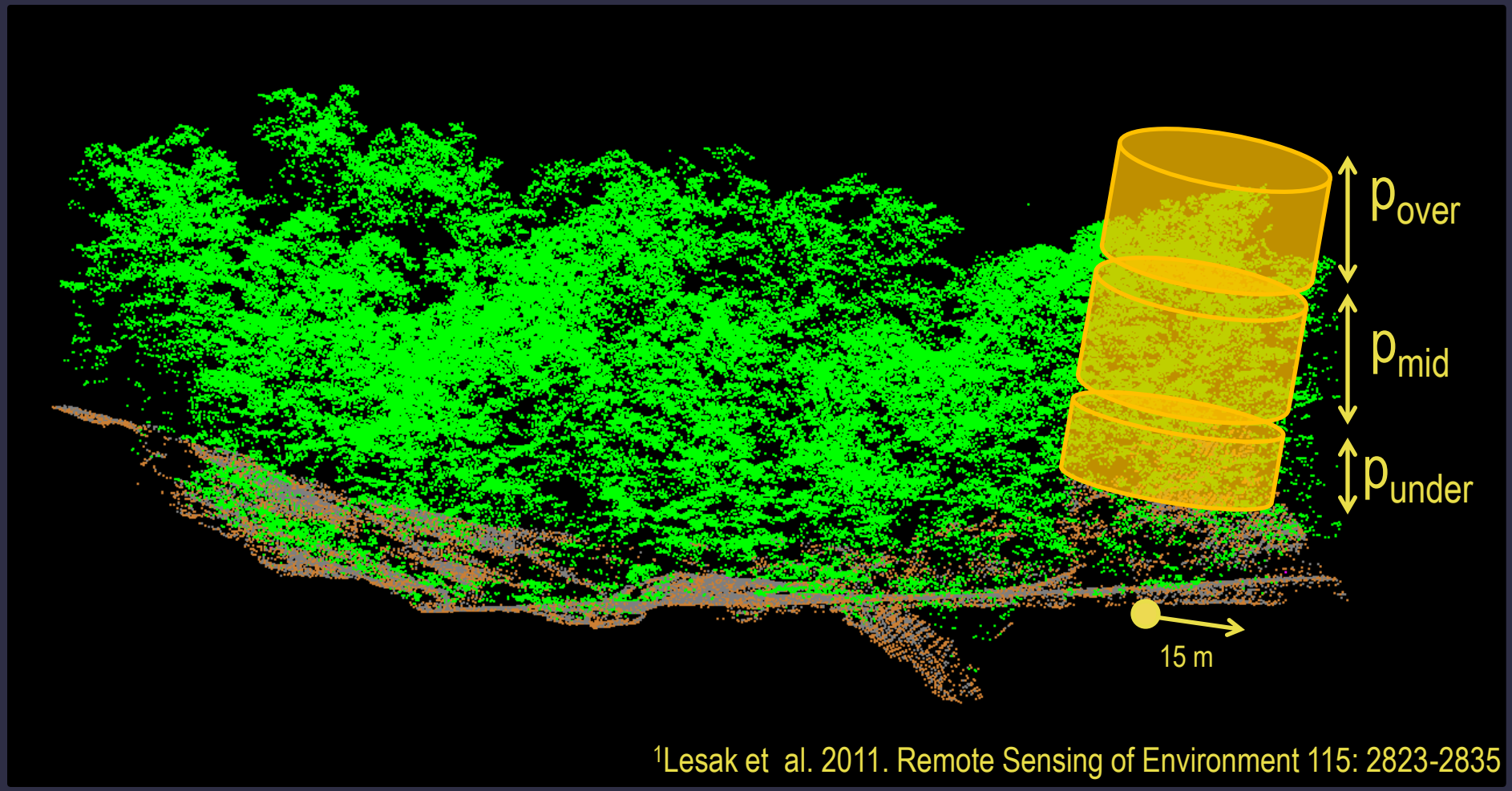
LiDAR Variables



Methods

LiDAR Variables

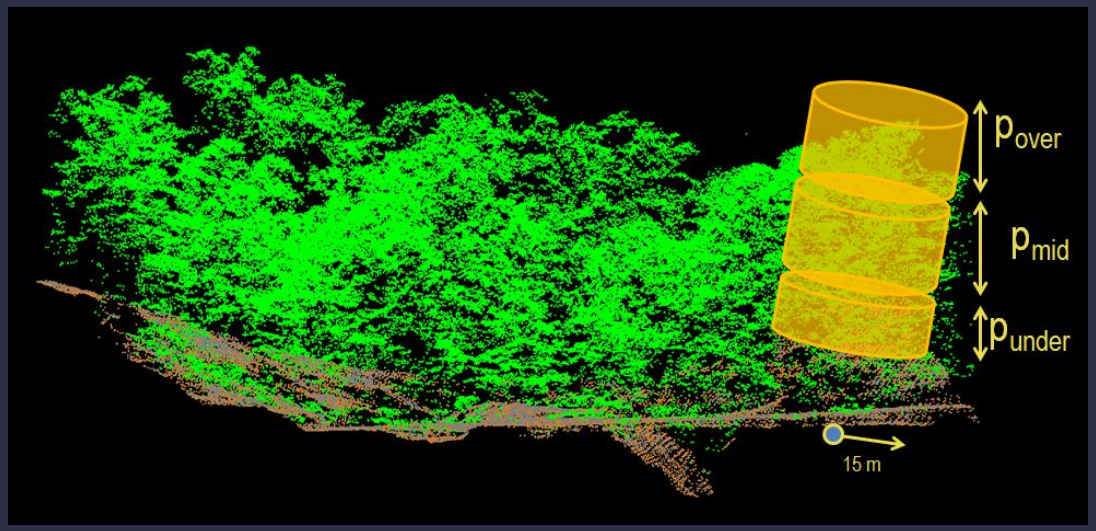
- Laser returns across over-, mid-, & understory strata[1]
- 15 m radii around survey points[1]



[1]Lesak et al. 2011. Remote Sensing of Environment 115: 2823-2835

Methods

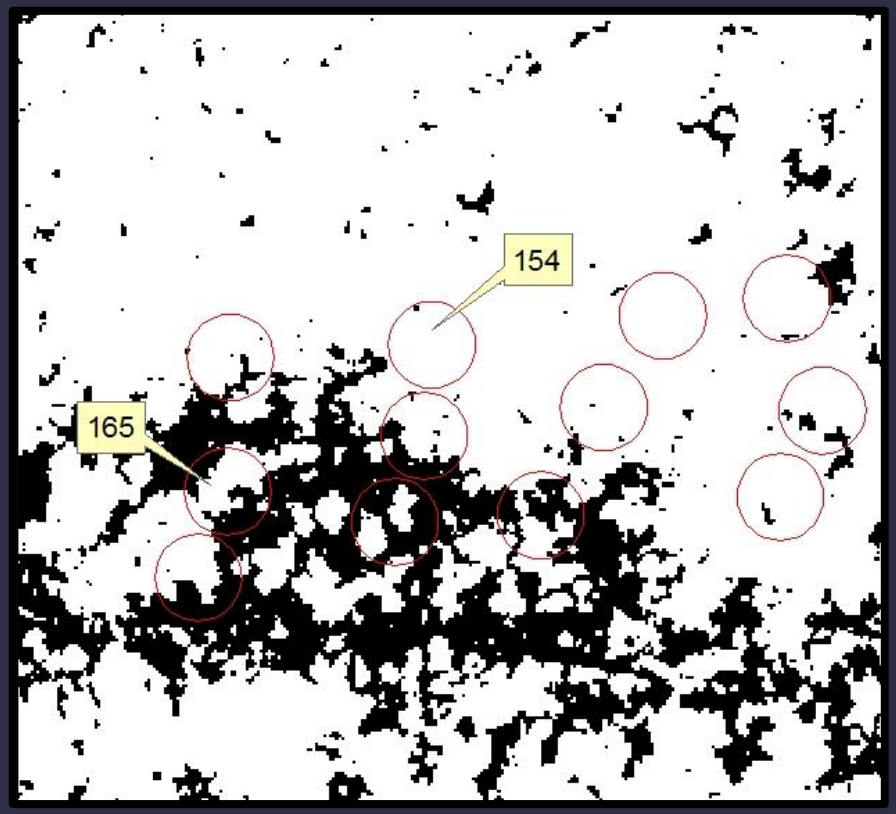
LiDAR Variables



- Strata
  - Over-, mid-, & understory
- Determining canopy shape
  - Mid:Over, Under:Mid, & Under:Over

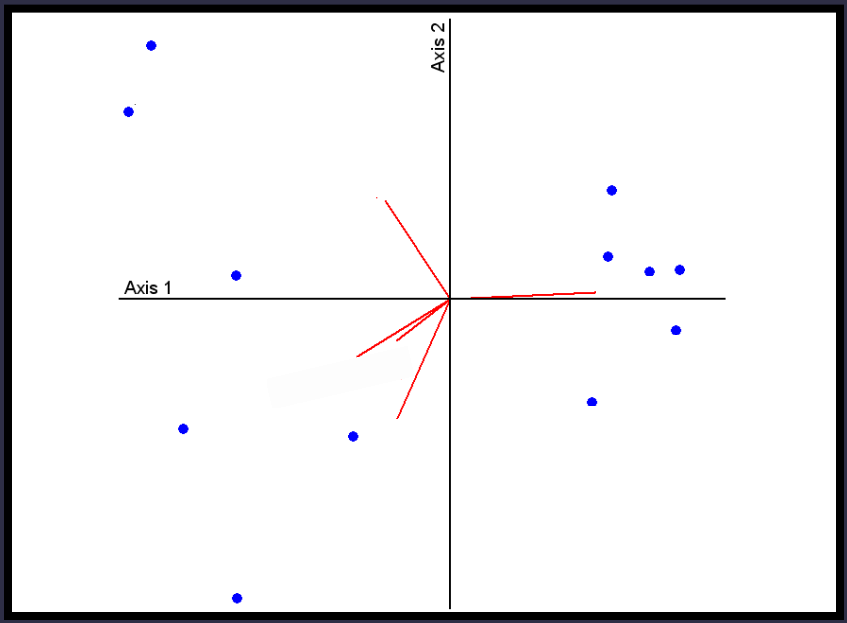
Methods

LiDAR Variables



- Strata
  - Over-, mid-, & understory
- Determining canopy shape
  - Mid:Over, Under:Mid, & Under:Over
- Gap Index
  - Percentage of pixels with no laser returns >3 m height

Analysis



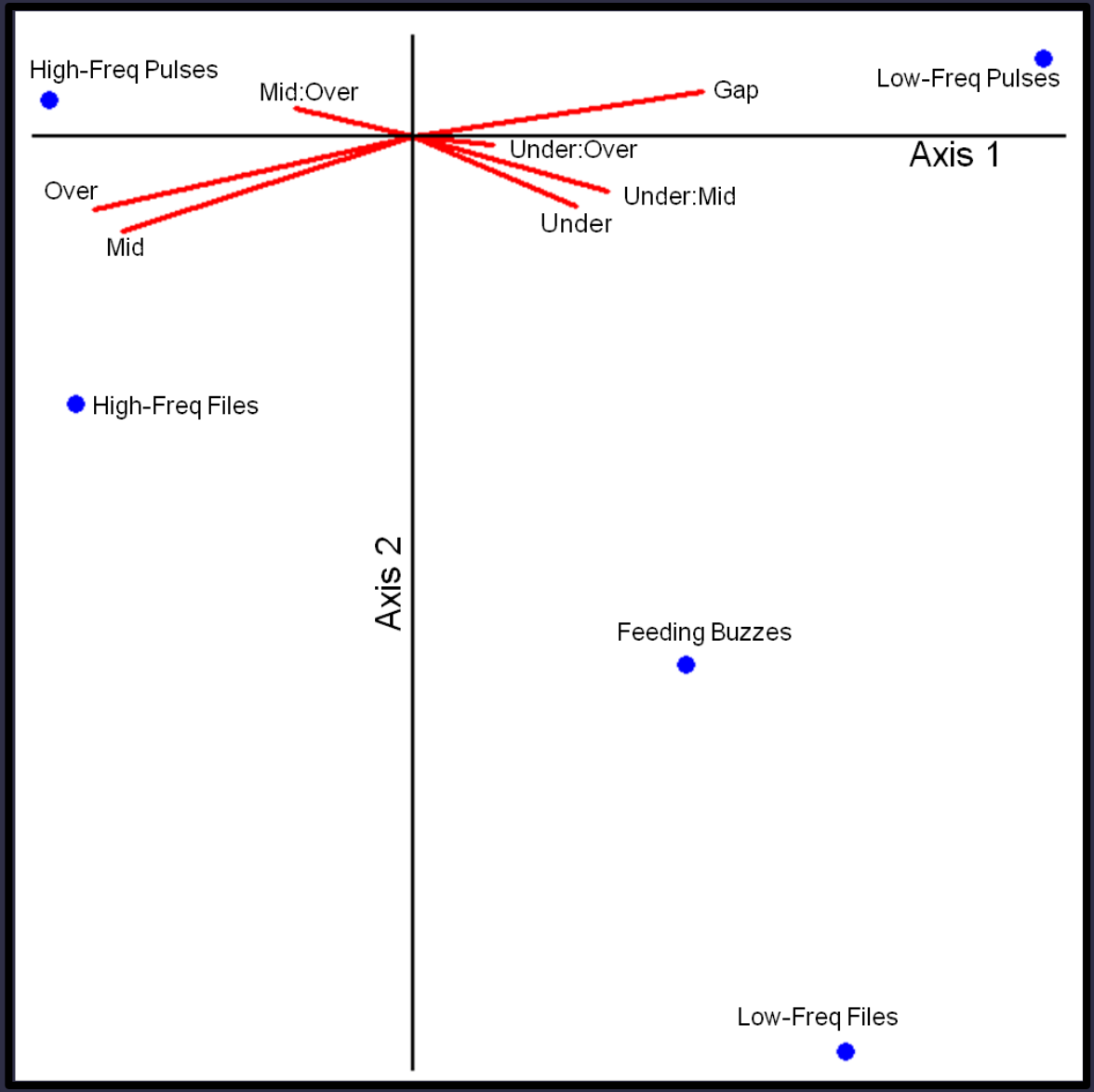
- Today's talk… Canonical Correspondence Analysis
  - Standard ordination techniques following ter Braak[1]
  - PC-ORD v. 4.25; default settings; 300 iterations

- Future… Predictive models & landscape maps

[1]McCune & Grace. 2002. Analysis of Ecological Communities. MJM Software Design

Results

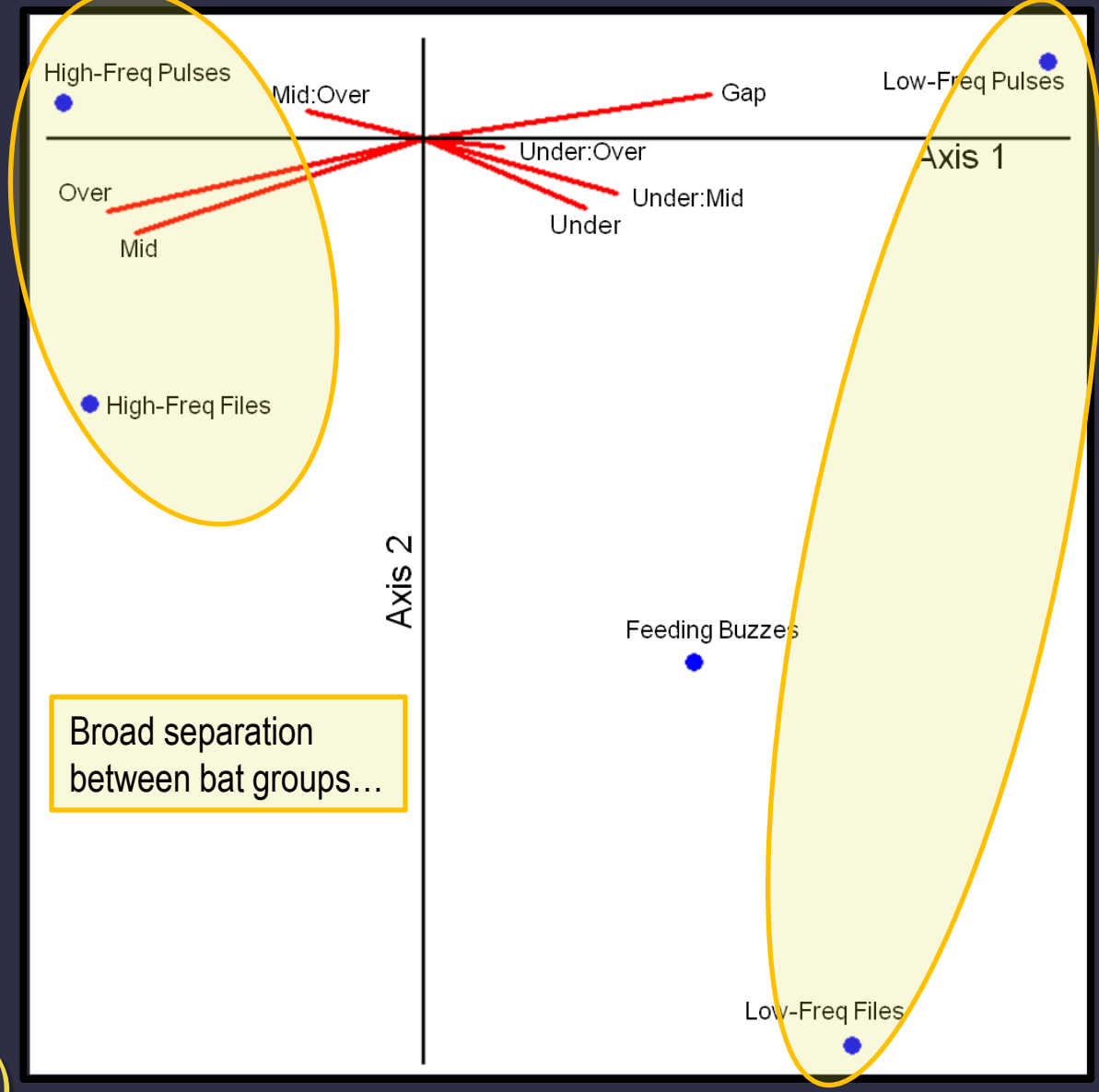
Bats + LiDAR



- 1st & 2nd Axes ($P \leq 0.1$)
- 47% variation explained
- "Inertia" of the data: 0.82

Results

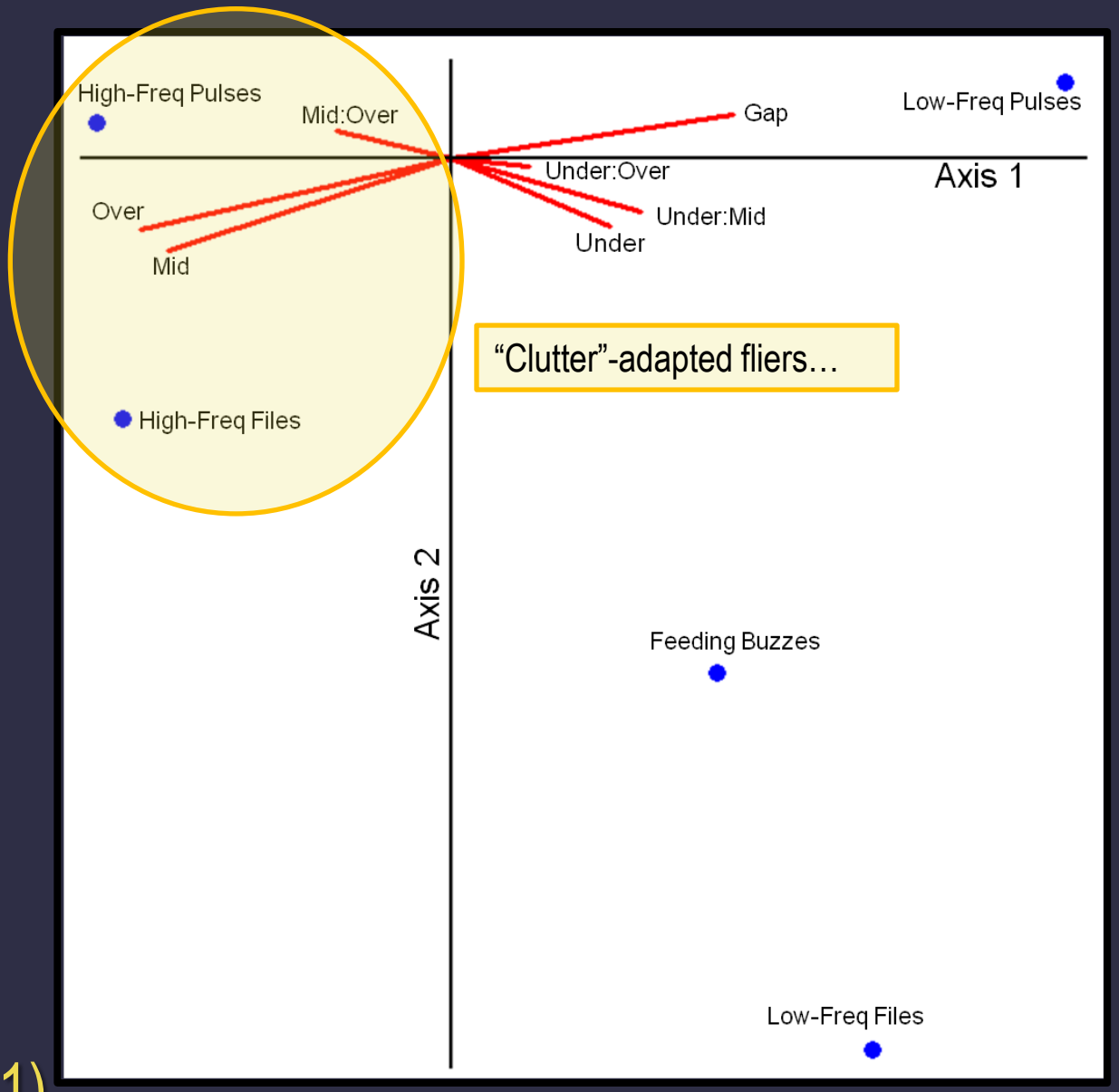
Bats + LiDAR



- 1st & 2nd Axes ($P \leq 0.1$)
- 47% variation explained
- "Inertia" of the data: 0.82

Results

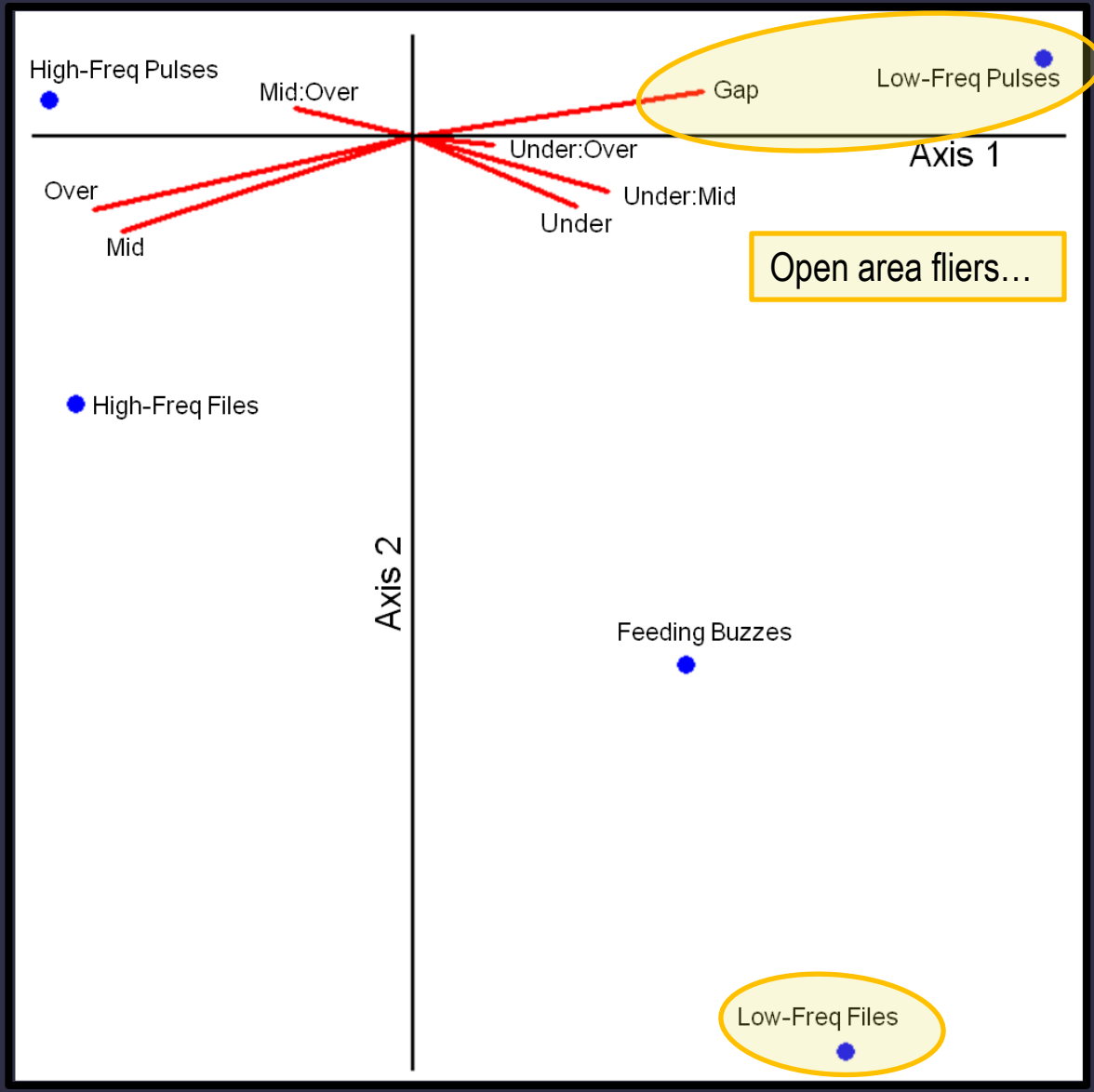
Bats + LiDAR



- 1st & 2nd Axes ($P \leq 0.1$)
- 47% variation explained
- "Inertia" of the data: 0.82

Results

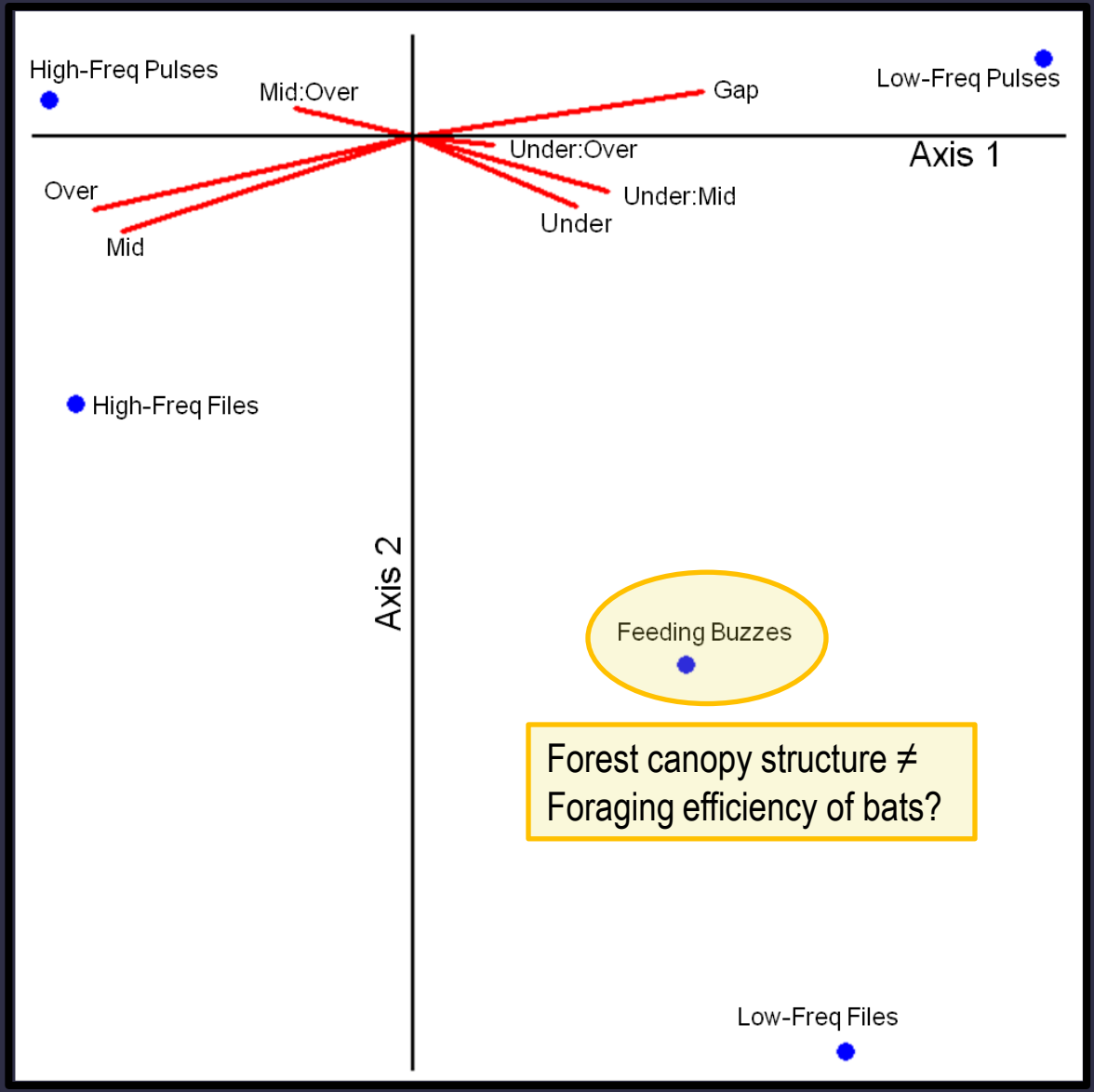
Bats + LiDAR



- 1st & 2nd Axes ($P \leq 0.1$)
- 47% variation explained
- "Inertia" of the data: 0.82

Results

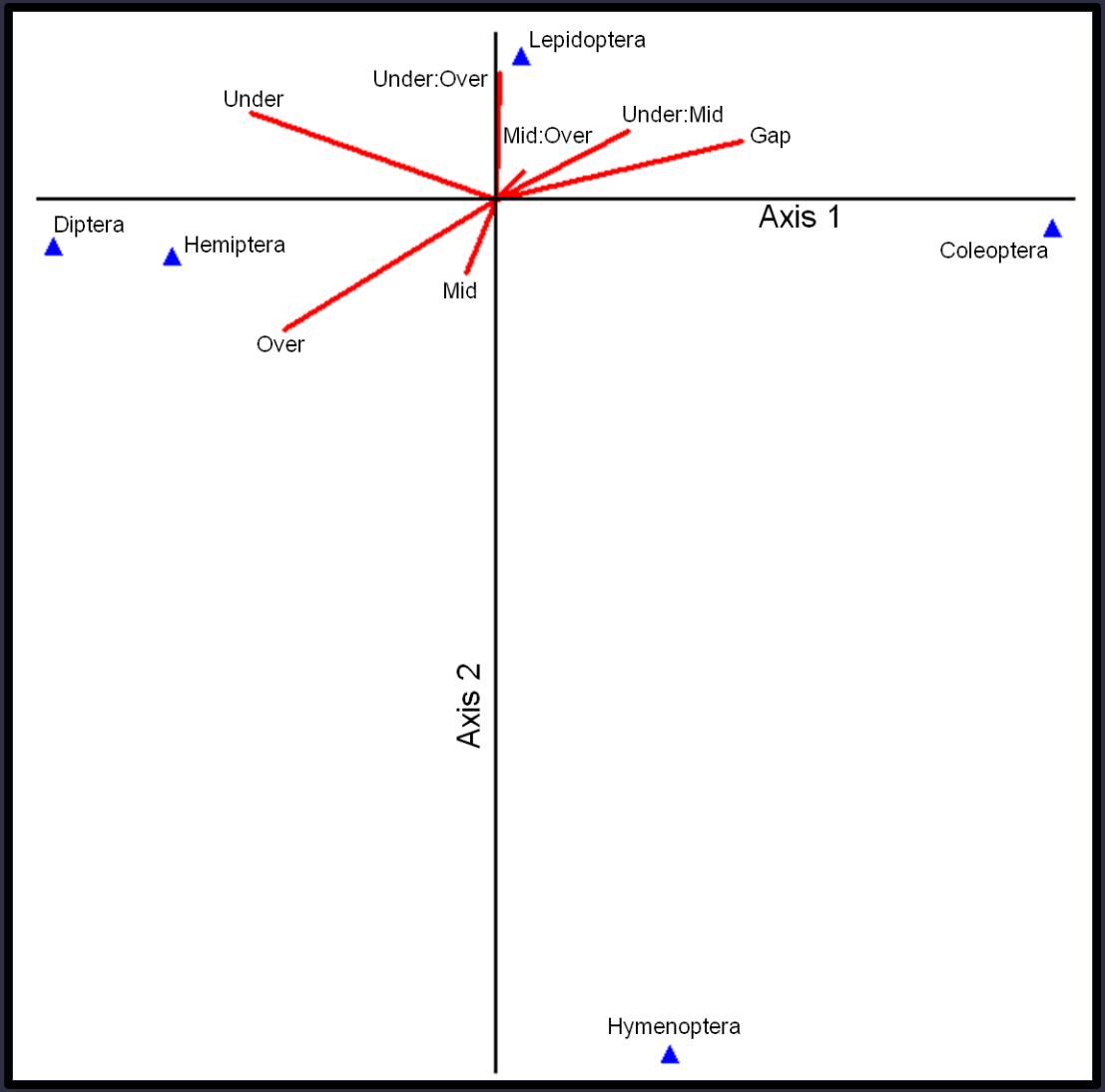
Bats + LiDAR



- 1st & 2nd Axes ($P \leq 0.1$)
- 47% variation explained
- "Inertia" of the data: 0.82

Results

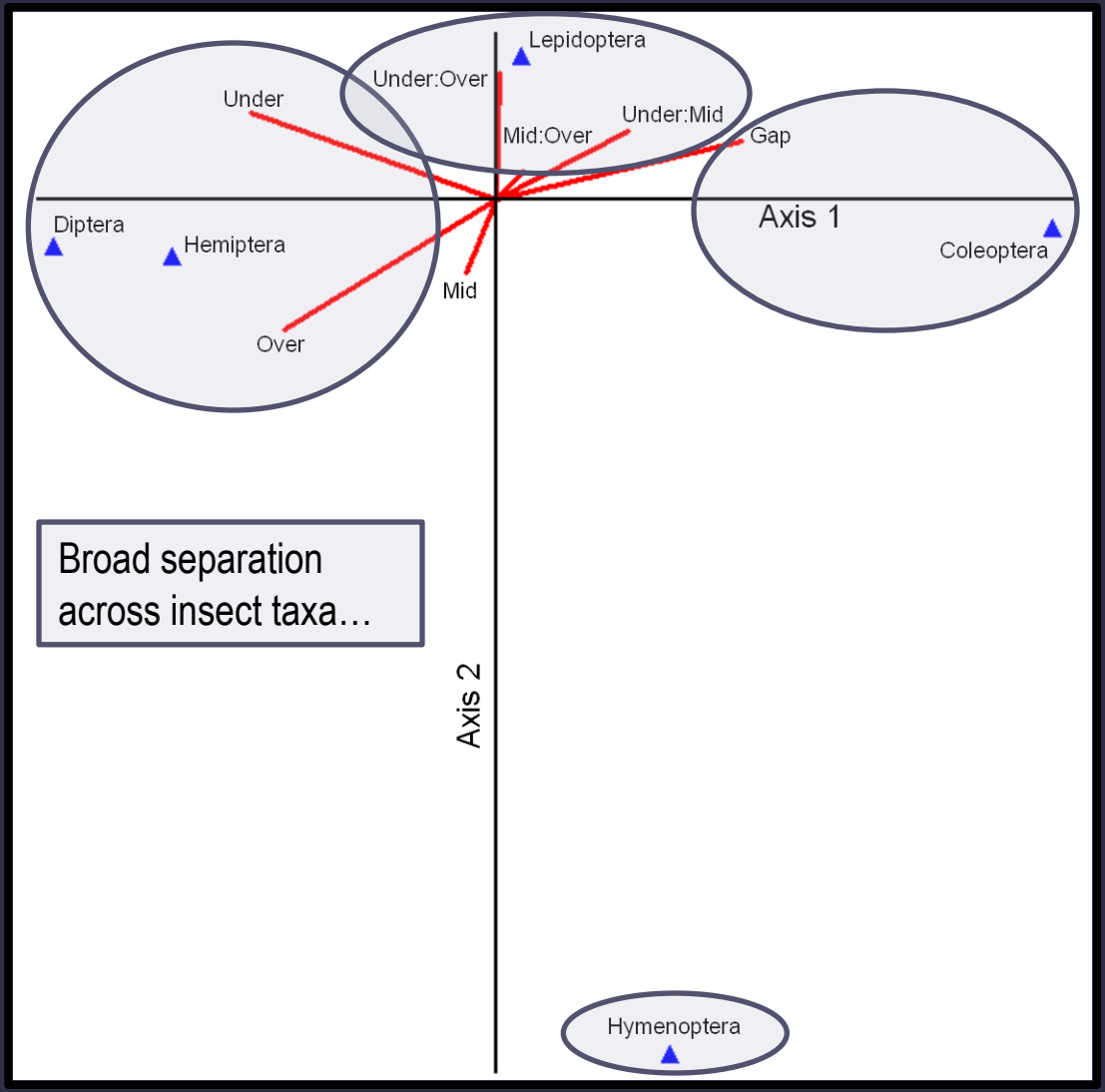
Insects + LiDAR



- 1st Axis ($P \leq 0.05$)
- 11% variation explained
- "Inertia" of the data: 1.03

Results

Insects + LiDAR

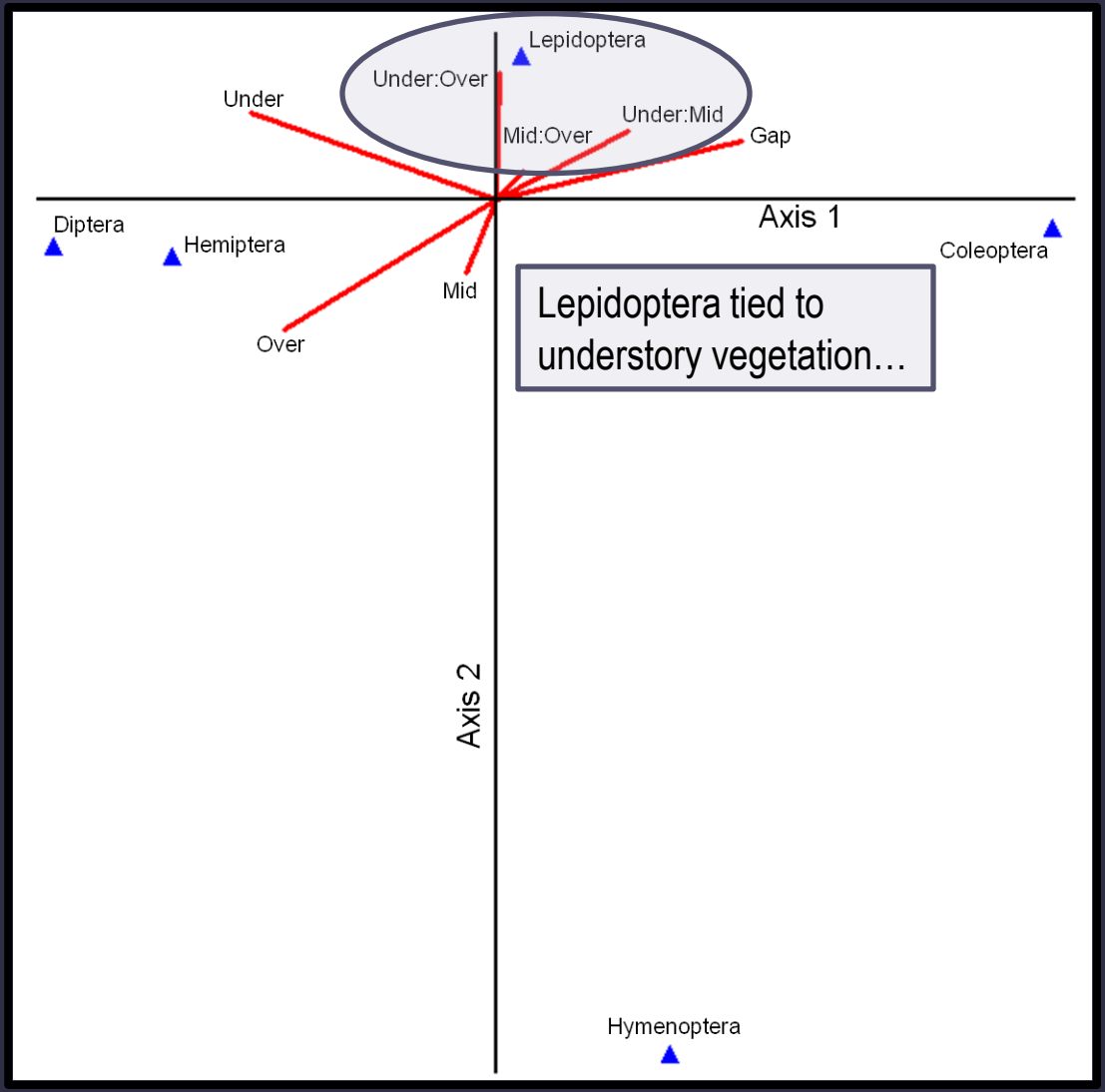


Broad separation across insect taxa…

- 1st Axis ($P \leq 0.05$)
- 11% variation explained
- "Inertia" of the data: 1.03

Results

Insects + LiDAR



Lepidoptera tied to understory vegetation…

- 1st Axis ($P \leq 0.05$)
- 11% variation explained
- "Inertia" of the data: 1.03

Discussion & Implications

- High frequency echolocators positively associated with cluttered forest canopies; not so for low frequency echolocators

Discussion & Implications

- High frequency echolocators positively associated with cluttered forest canopies; not so for low frequency echolocators
- Insect groups variable in their relationships to canopy structure

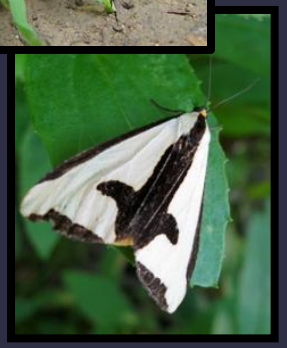


Photo Courtesy of Marvin Moriarty, USFWS

Bat Body Condition

Photo Courtesy of Marvin Moriarty, USFWS

Bat Body Condition

- Changes during staging & swarming

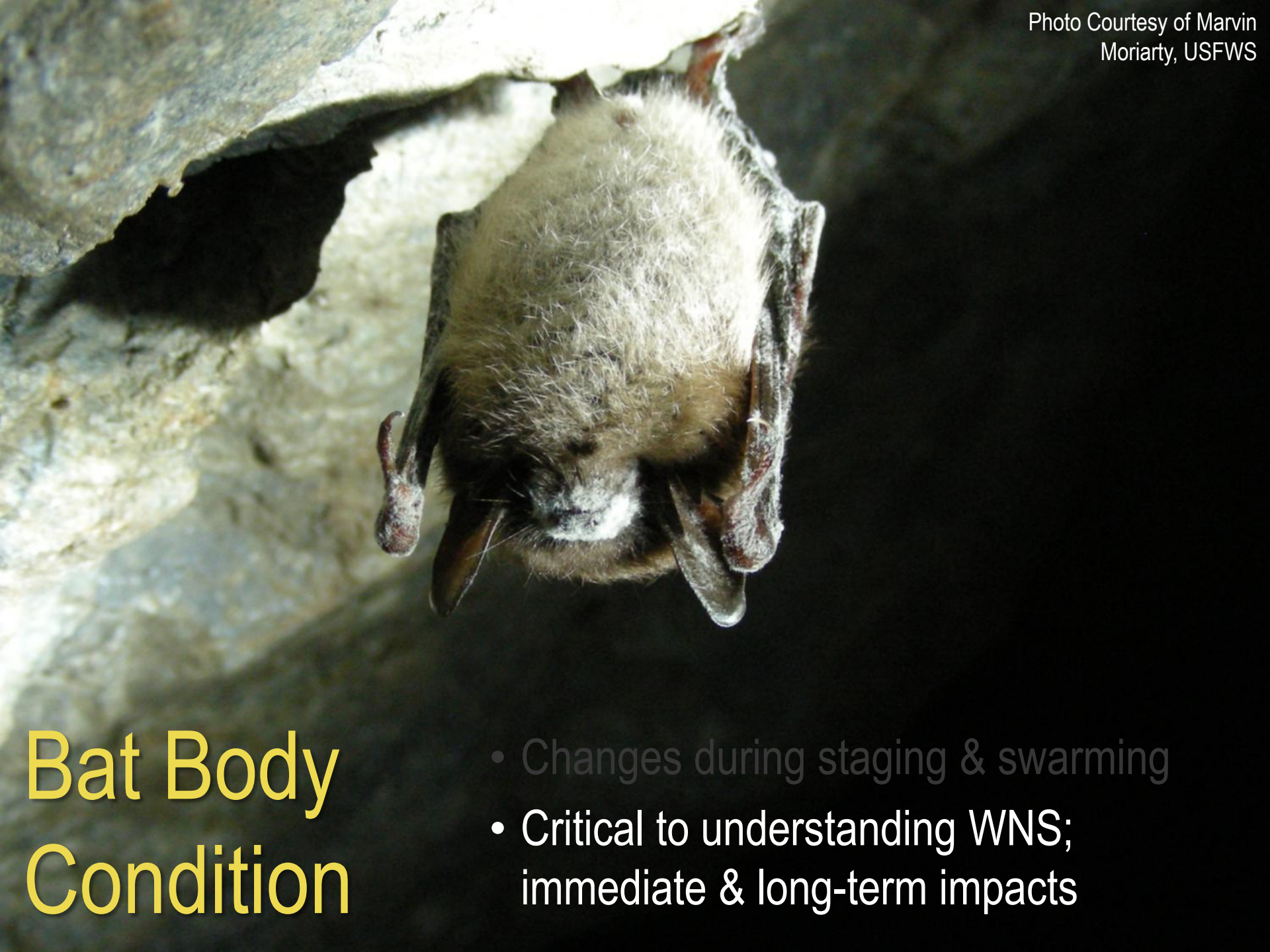


Photo Courtesy of Marvin Moriarty, USFWS

Bat Body Condition

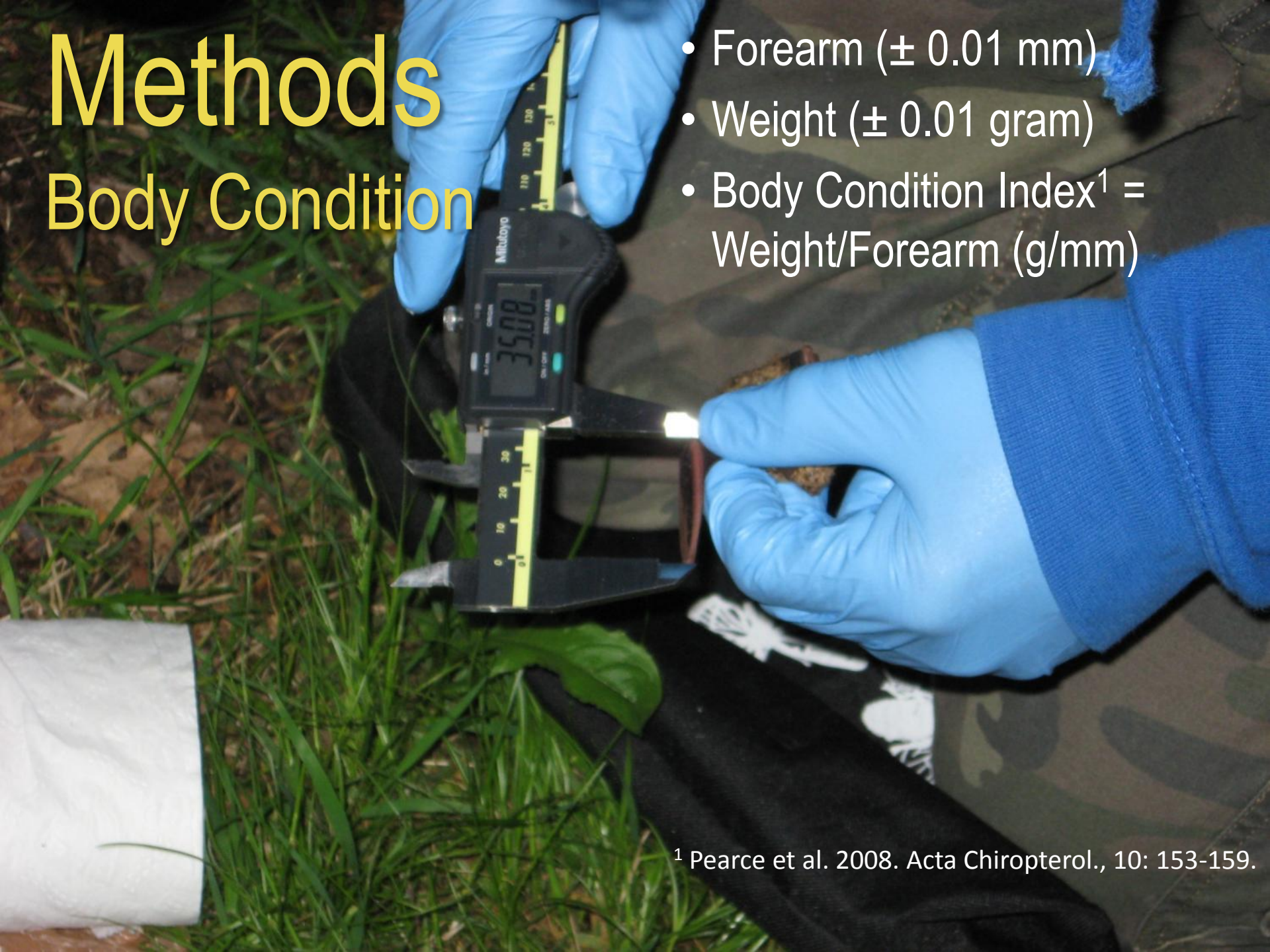
- Changes during staging & swarming
- Critical to understanding WNS; immediate & long-term impacts

Methods

Harp-Trapping

Methods

Body Condition



- Forearm (± 0.01 mm)
- Weight (± 0.01 gram)
- Body Condition Index[1] = Weight/Forearm (g/mm)

[1] Pearce et al. 2008. Acta Chiropterol., 10: 153-159.

Staging Results

- Three surveys: April 6th, 12th, & 28th
- Total capture of 168 bats

Staging Results

- Three surveys: April 6th, 12th, & 28th
- Total capture of 168 bats
  - *Corynorhinus rafinesquii* (2)
  - *Eptesicus fuscus* (2)
  - *Myotis leibii* (4)
  - *M. lucifugus* (10)
  - *M. septentrionalis* (118)
  - *M. sodalis* (4)
  - *Perimyotis subflavus* (28)

Staging Results

- Three surveys: April 6th, 12th, & 28th
- Total capture of 168 bats
  - *Corynorhinus rafinesquii* (2)
  - *Eptesicus fuscus* (2)
  - *Myotis leibii* (4)
  - *M. lucifugus* (10)
  - *M. septentrionalis* (118)
  - *M. sodalis* (4)
  - *Perimyotis subflavus* (28)

No models significant for effects of sample interval or sex ($P > 0.05$)

Swarming Results

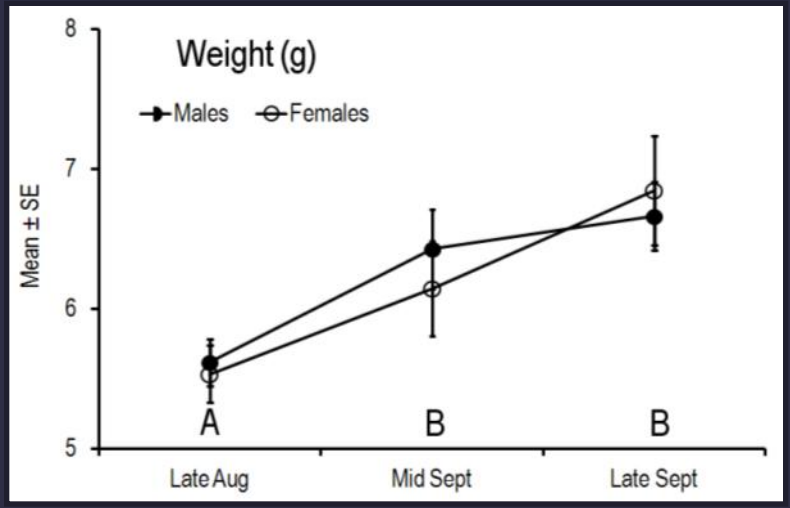
- Three surveys: August 23rd, September 13th, & 21st
- Total capture of 260 bats

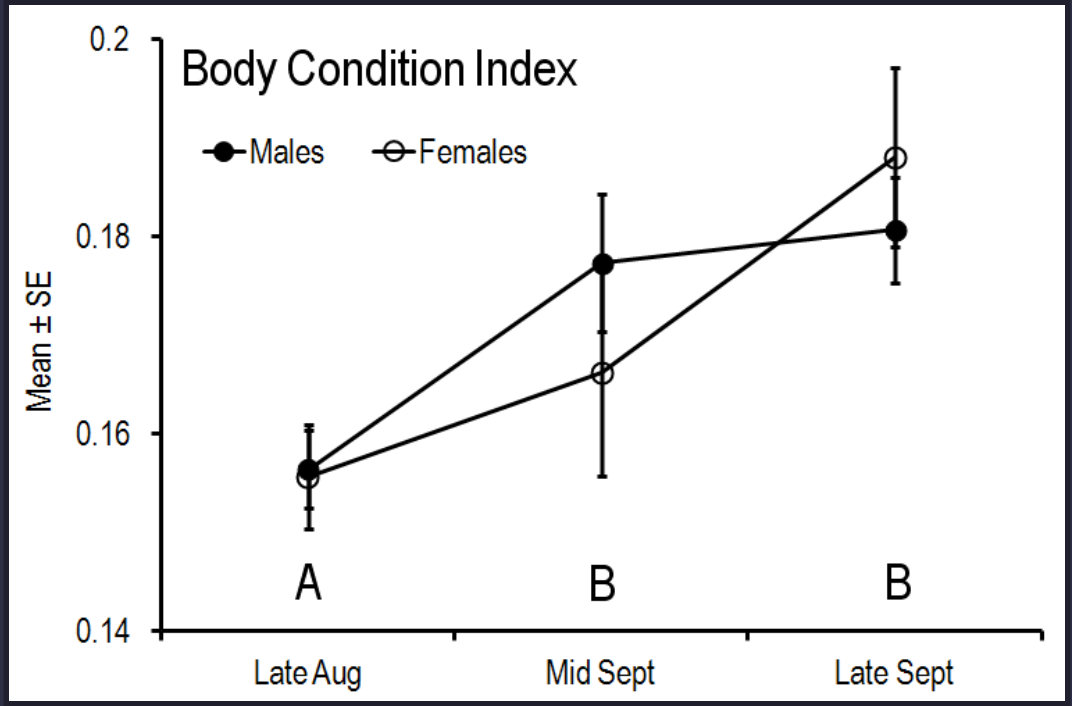
Swarming Results

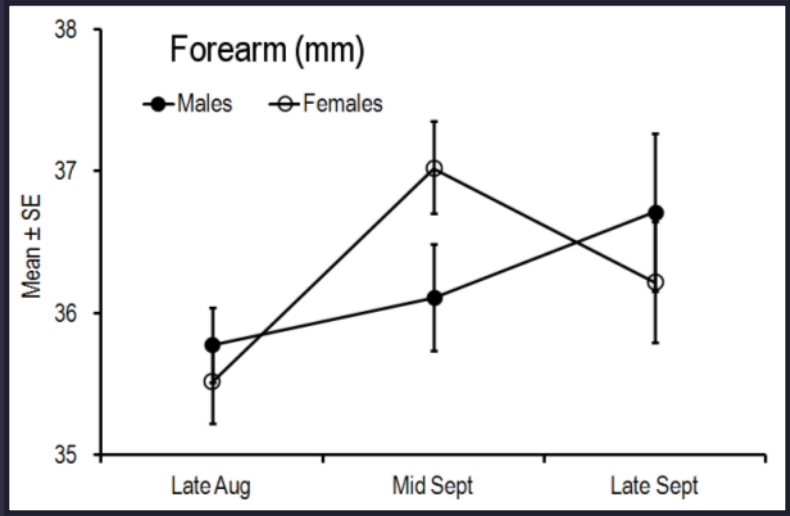
- Three surveys: August 23rd, September 13th, & 21st
- Total capture of 260 bats
  - *Myotis leibii* (3)
  - *M. lucifugus* (17)
  - *M. septentrionalis* (63)
  - *M. sodalis* (10)
  - *Perimyotis subflavus* (167)

Swarming Results

Myotis



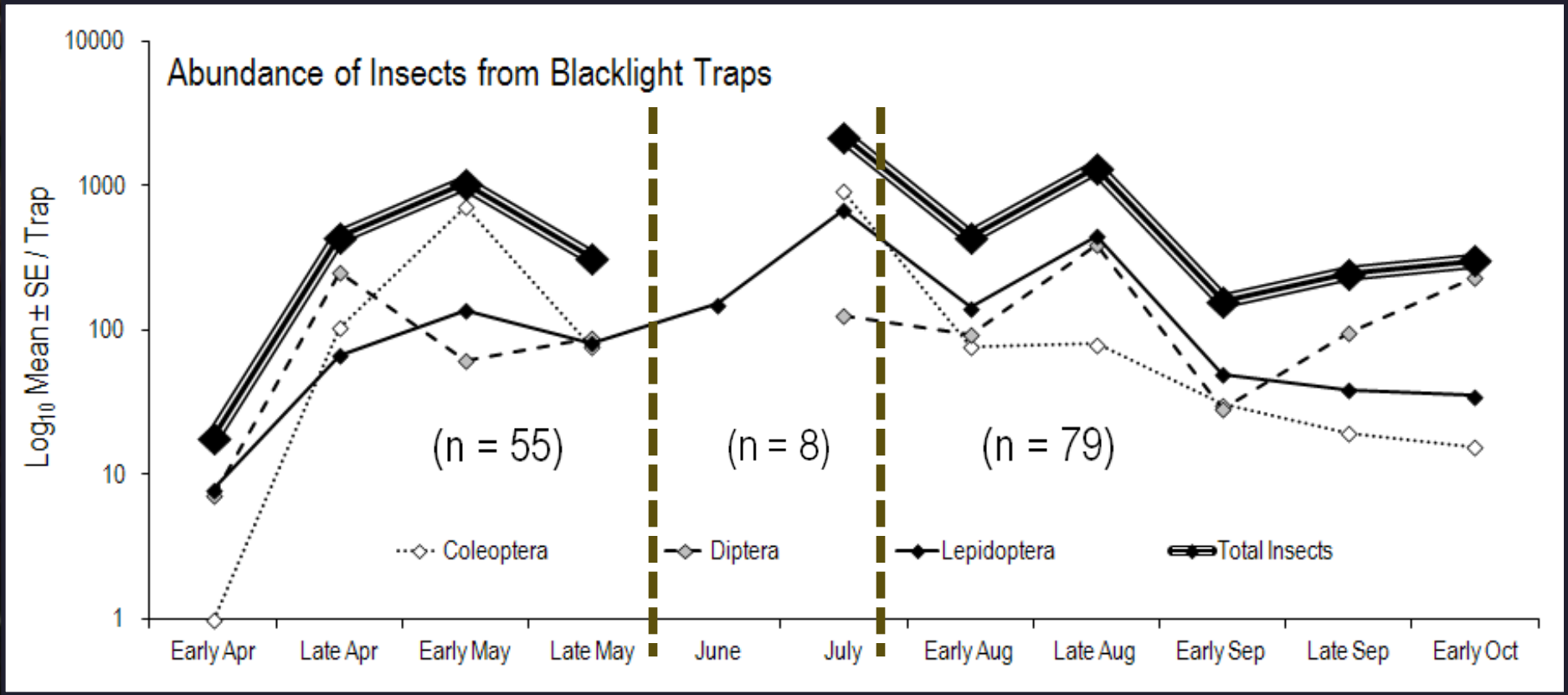




2x3 ANOVAs, Untransformed data (n = 91)
No differences between sexes for any model ($P > 0.05$)
Letters denote differences across survey dates ($P \leq 0.05$)

Results

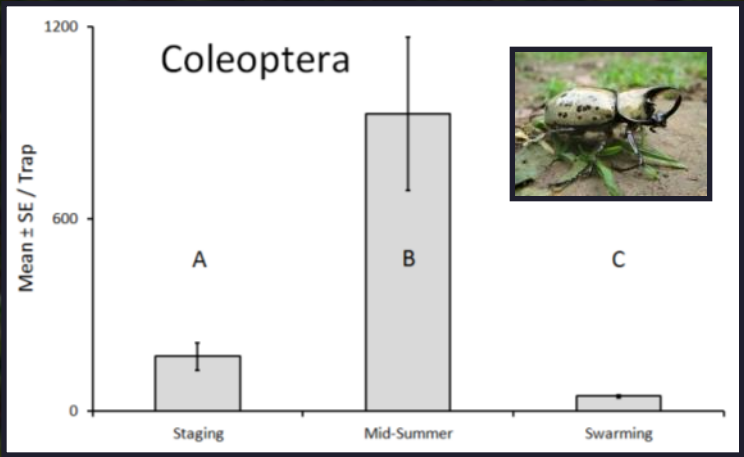
Insect Occurrence

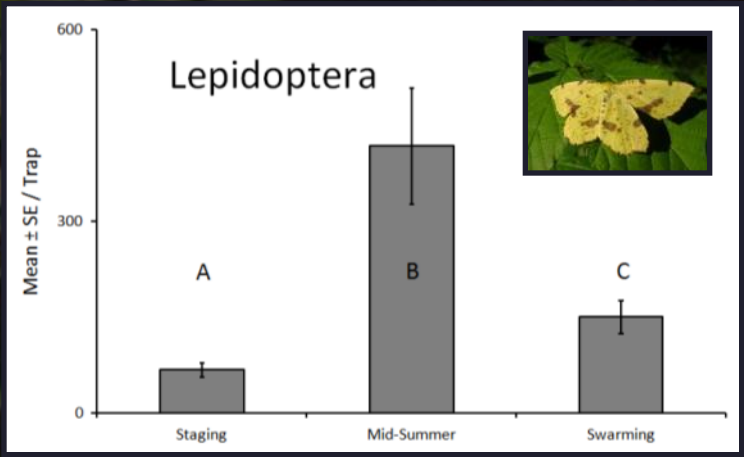


Results

Insect Occurrence Across Seasons

- Strong differences for Coleoptera & Lepidoptera



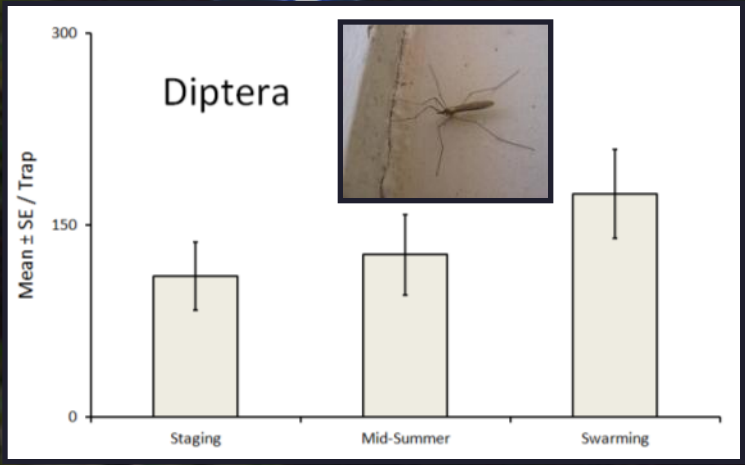


One-way ANOVAs, Untransformed data (n = 142)
$P \leq 0.05$ for all models

Results

Insect Occurrence Across Seasons

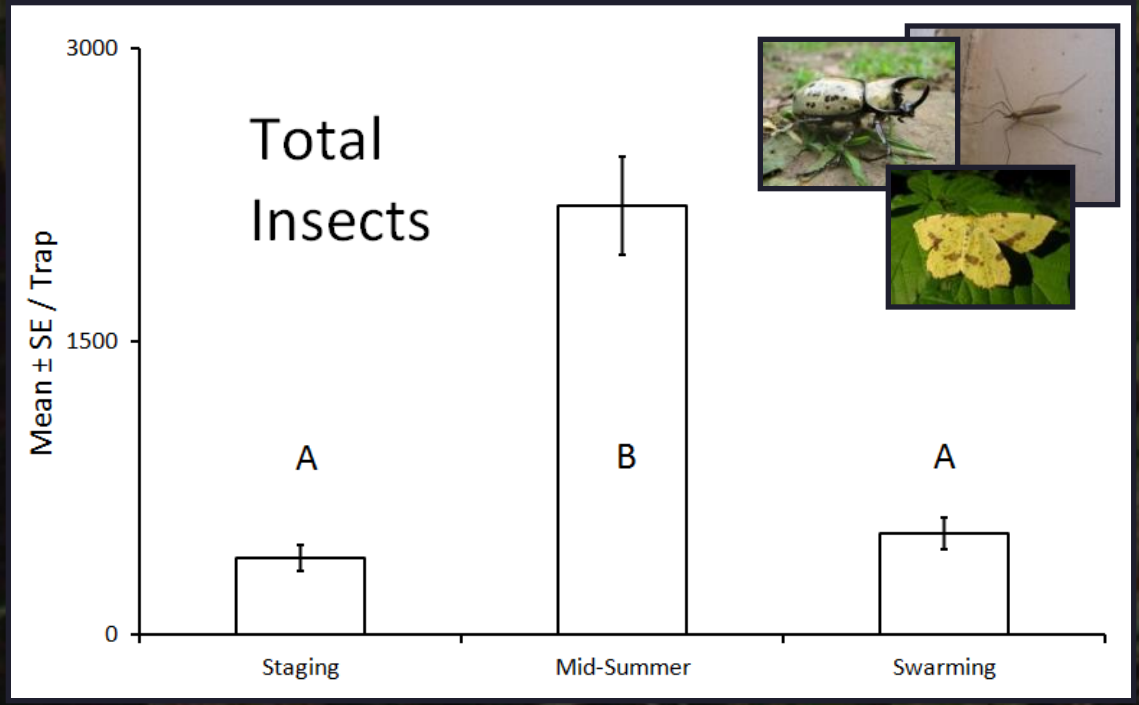
- Strong differences for Coleoptera & Lepidoptera
- Variation in Diptera; consistent resource for bats?



One-way ANOVAs, Untransformed data (n=142)
$P > 0.05$ for this model

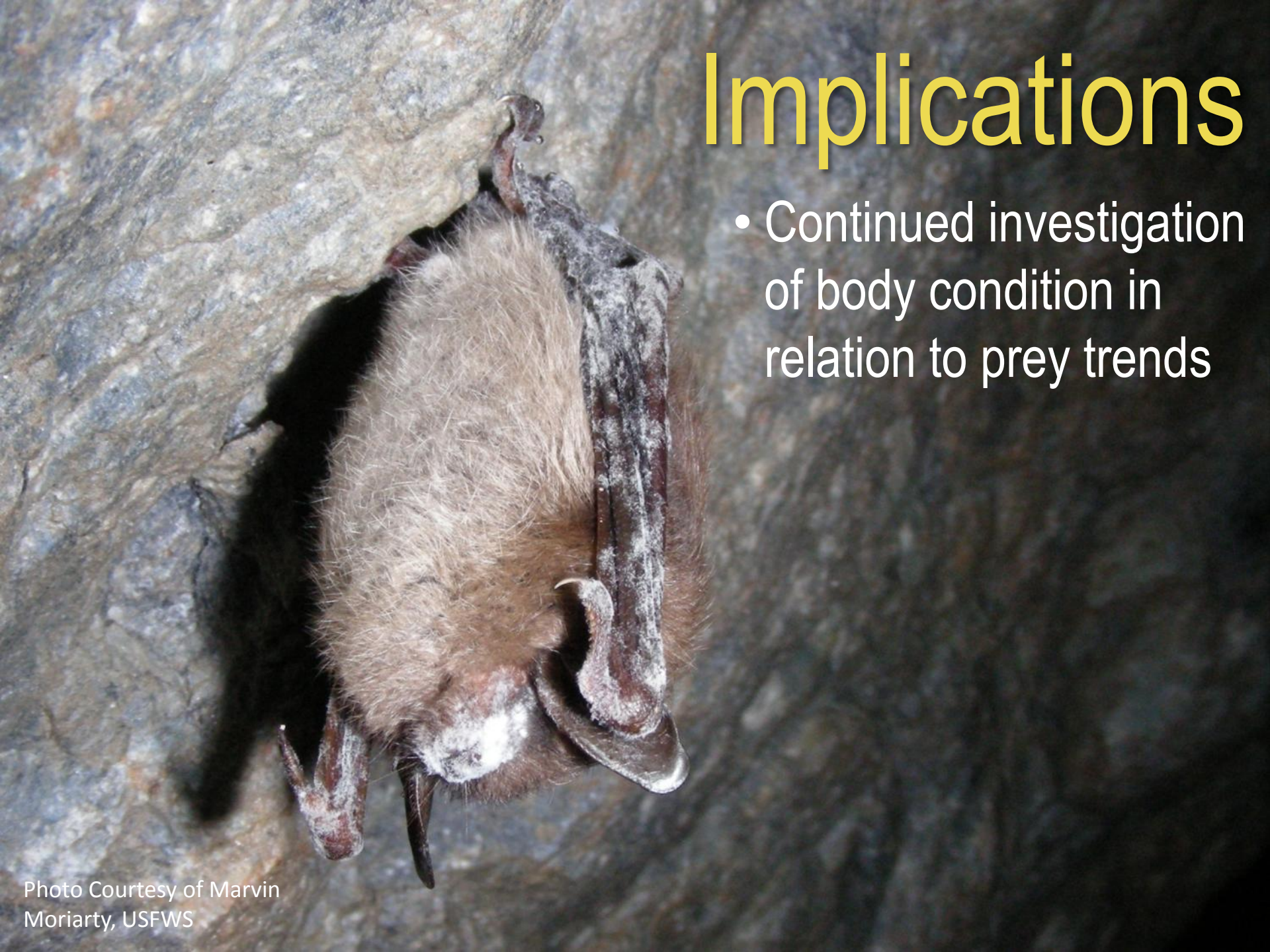
Results

Insect Occurrence Across Seasons



One-way ANOVAs, Untransformed data (n=142)

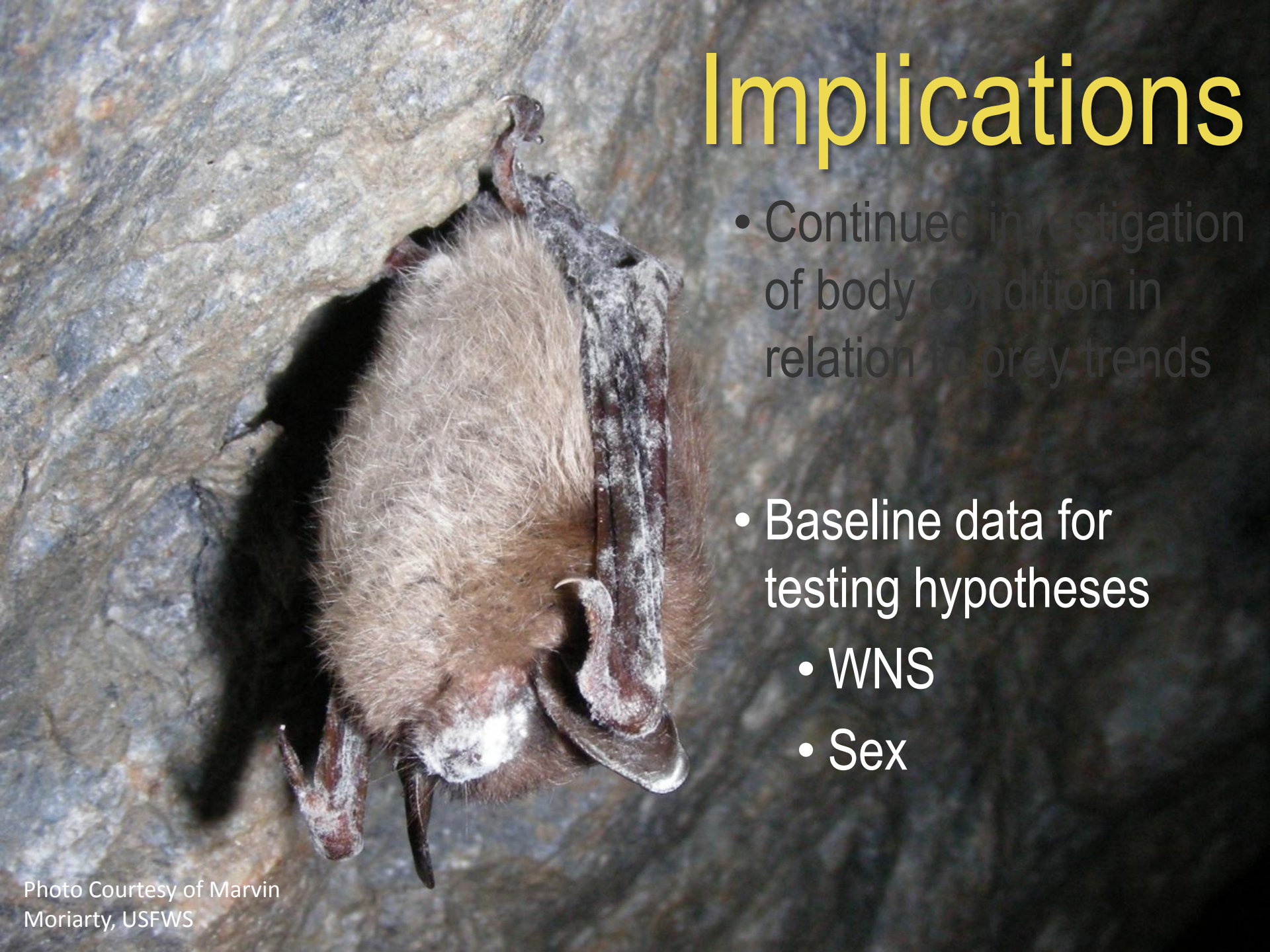
$P \leq 0.05$ for this model



Implications

- Continued investigation of body condition in relation to prey trends

Photo Courtesy of Marvin Moriarty, USFWS



Implications

- Continued investigation of body condition in relation to prey trends
- Baseline data for testing hypotheses
  - WNS
  - Sex

Photo Courtesy of Marvin Moriarty, USFWS