DoD Environmental Planning and Conservation Webinar Series

Building Better Bat Boxes: Recommendations for Artificial Roost Design for At-Risk Bats

Patrick Wolff and Joy O'Keefe

May 29, 2024

Please mute your phones

Audio Dial-In: 410-874-6749

Participant Code: 235 093 958#

www.denix.osd.mil/nr/

Twitter: @DoDNatRes

Thanks to:

NDCEE
National Defense Center for Energy and Environment

MINNESOTA NATIONAL GUARD
ALWAYS READY

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

ILLINOIS STATE WATER SURVEY
PRAIRIE RESEARCH INSTITUTE

Human-Wildlife Interactions

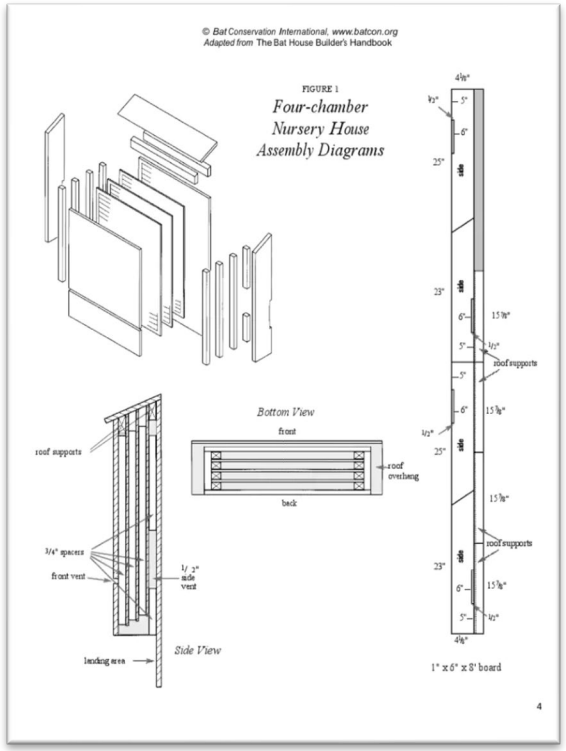
SI VIS PACEM PARA BELLUM
598TH RANGE SQ

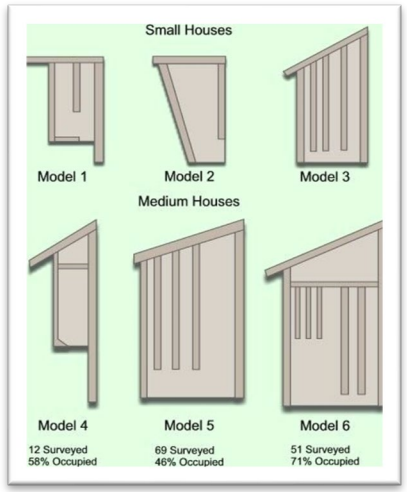
TARPONBLUE
REAL ESTATE SERVICES

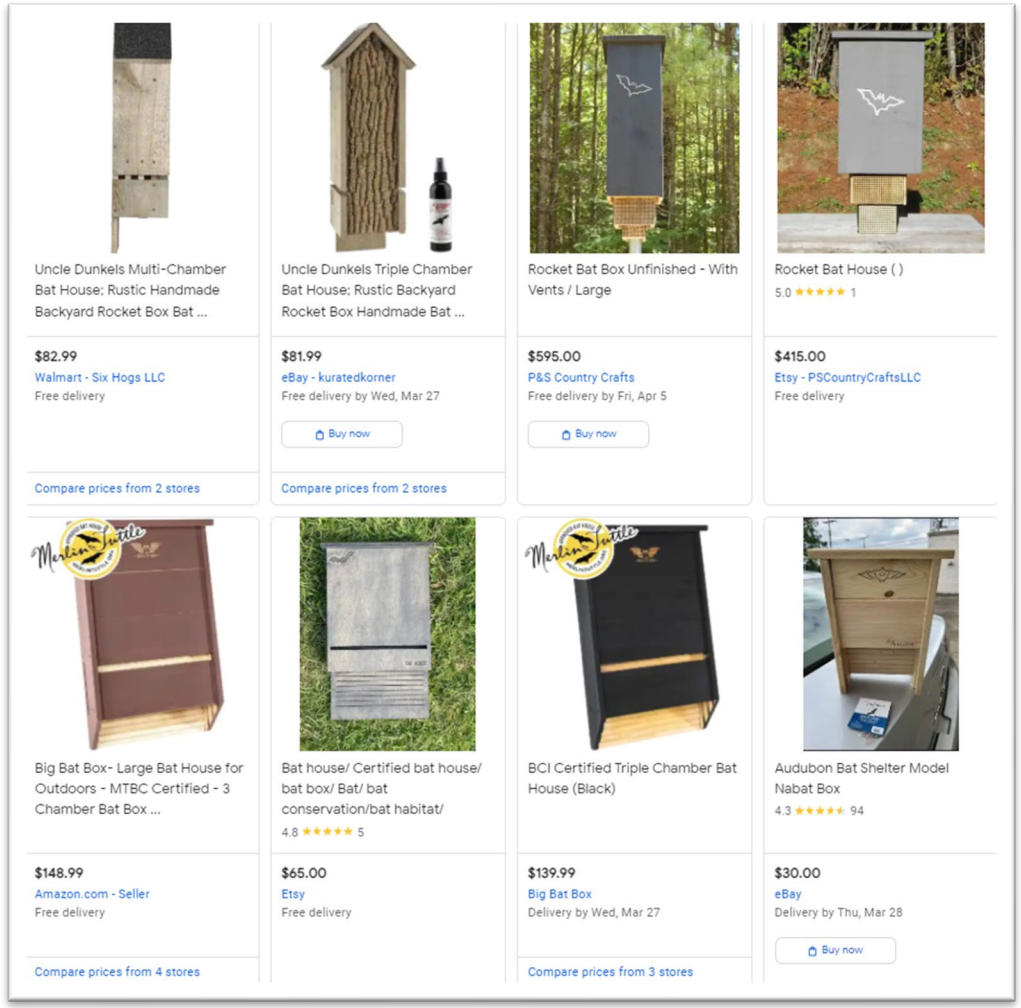
- Bat boxes are surrogate habitat for cavity and crevice dwelling bats
- Bat box users like warm roosts

Federally endangered Indiana bats (*Myotis sodalis*) in tree and bat box

Endless options available to build or buy





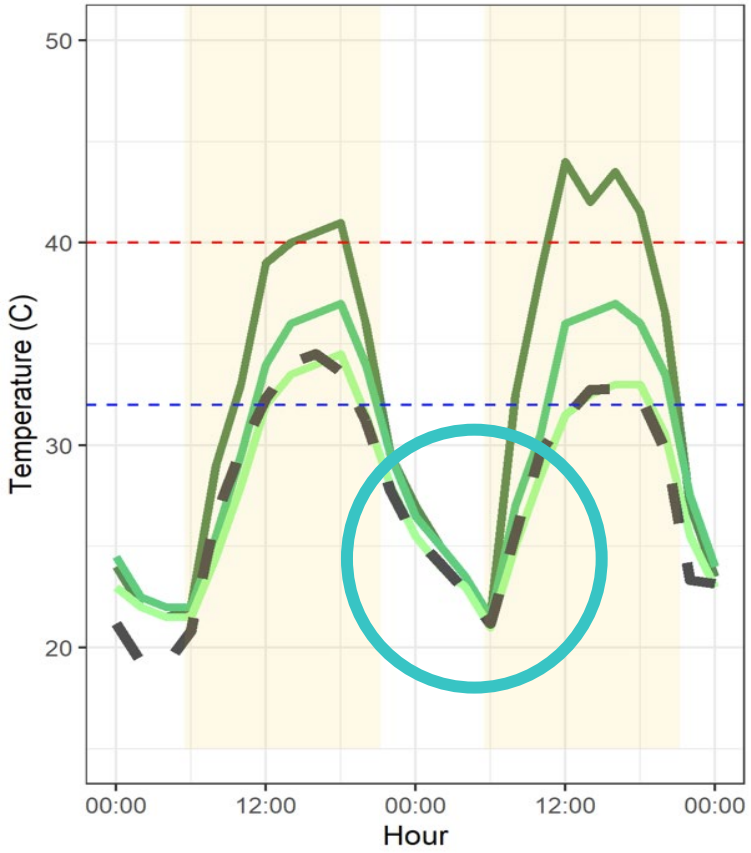


Lack of data to guide design choice

Too hot

Too cold

Minneapolis, MN, July 2021



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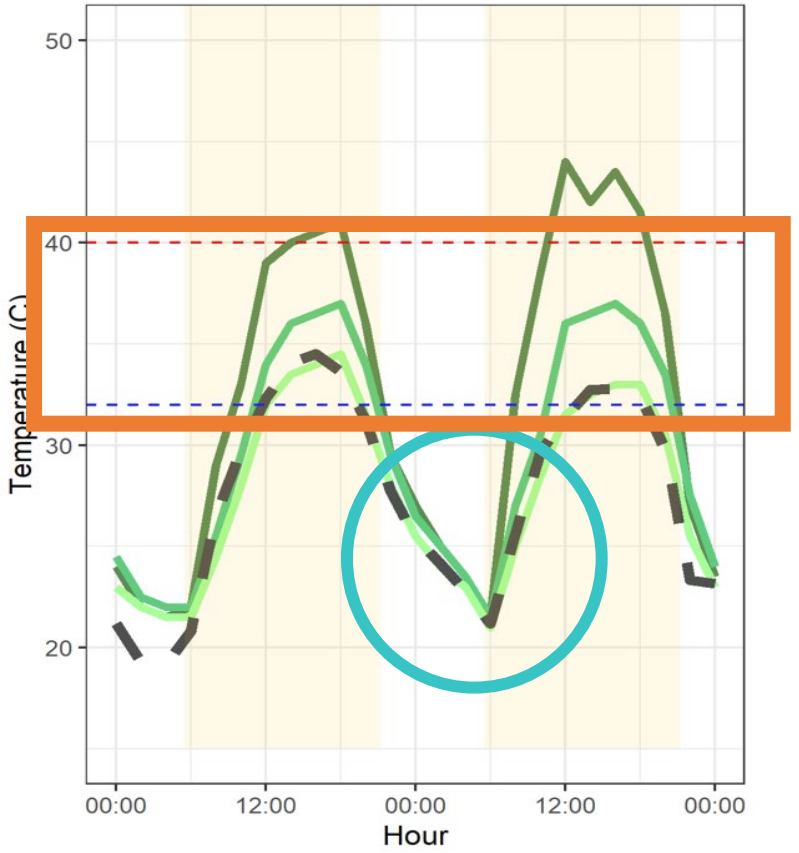
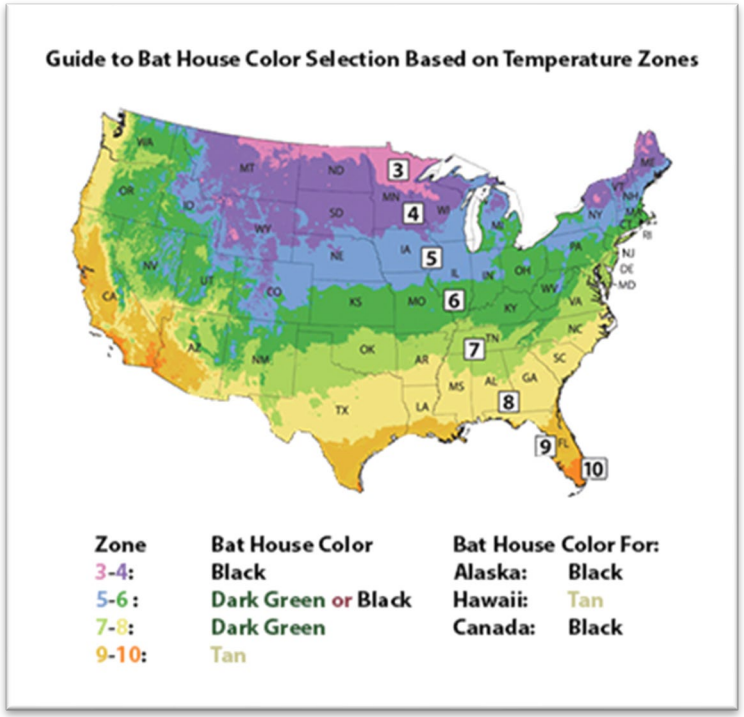
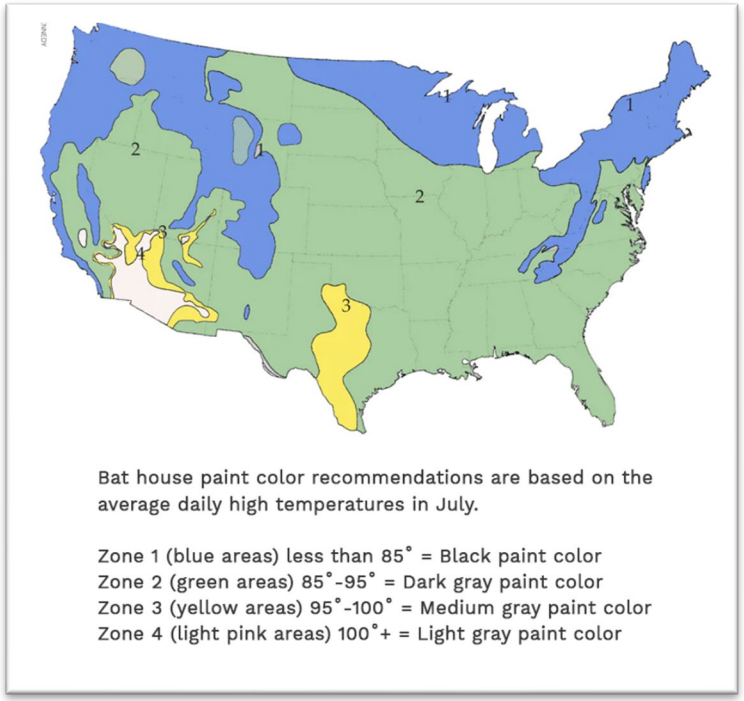


Advice on bat box color is based solely on air temperature





"If in doubt, go with a darker color"

If you build it, will they come?

If you build it, will they come?

- Maybe…
- Indiana (Whitaker et al. 2006)
  - >3,000 artificial roosts deployed for Indiana bats (*Myotis sodalis*)
  - After **10 years, only 6 roosts** regularly used
- Arizona (Mering and Chambers 2012)
  - **>400 days** between installation and colonization

Can we accelerate time to colonize artificial roosts?

- Acoustic lures can increase capture rates in mist-nets
  - Loeb and Britzke (2010)
  - Quackenbush et al. (2016)
  - Samoray et al. (2019)
  - Braun de Torrez et al. (2017)

Can we accelerate time to colonize artificial roosts?

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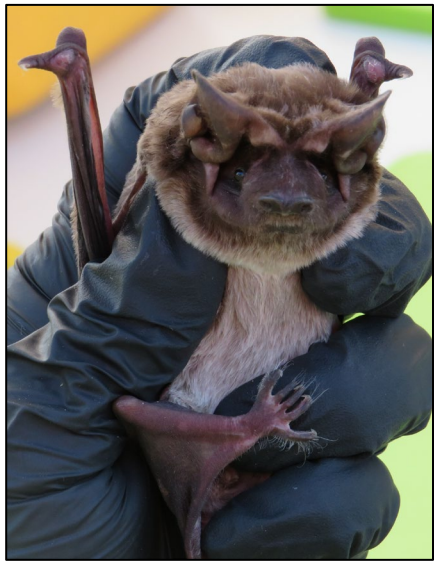
  - **Braun de Torrez et al. (2017)**



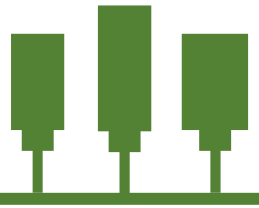
Florida bonneted bat
Eumops floridanus

Photo: Ellen Pierce



Objectives

1. Evaluate acoustic lures for attracting bats to colonize boxes

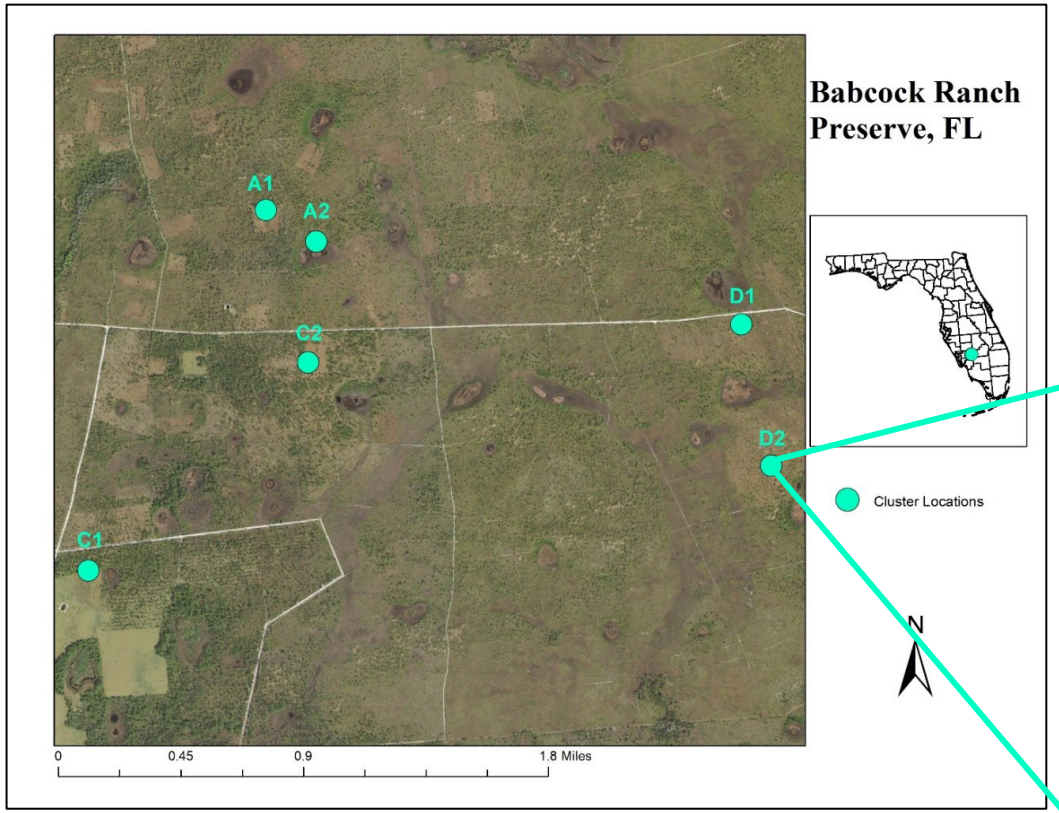


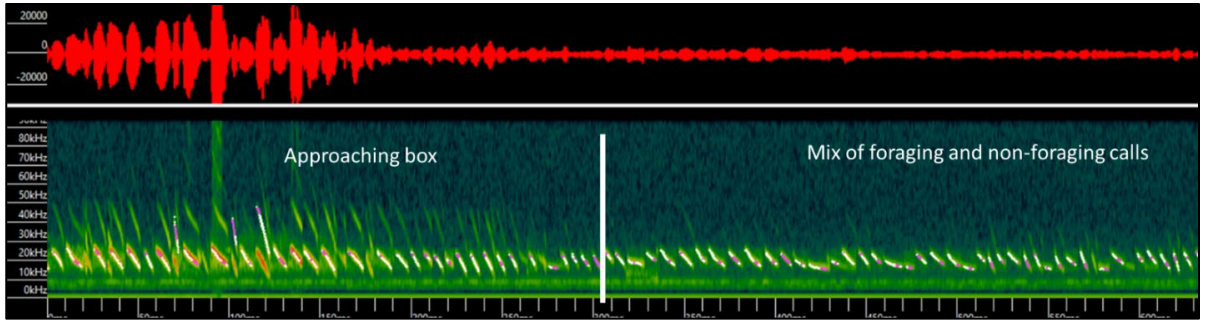
2. Evaluate suitability of bat box designs for housing at-risk bats

3. Measure effect of paint color on box temperatures

4. Provide guidance to DoD natural resource managers

Objective 1. Evaluate acoustic lures for attracting bats to colonize boxes





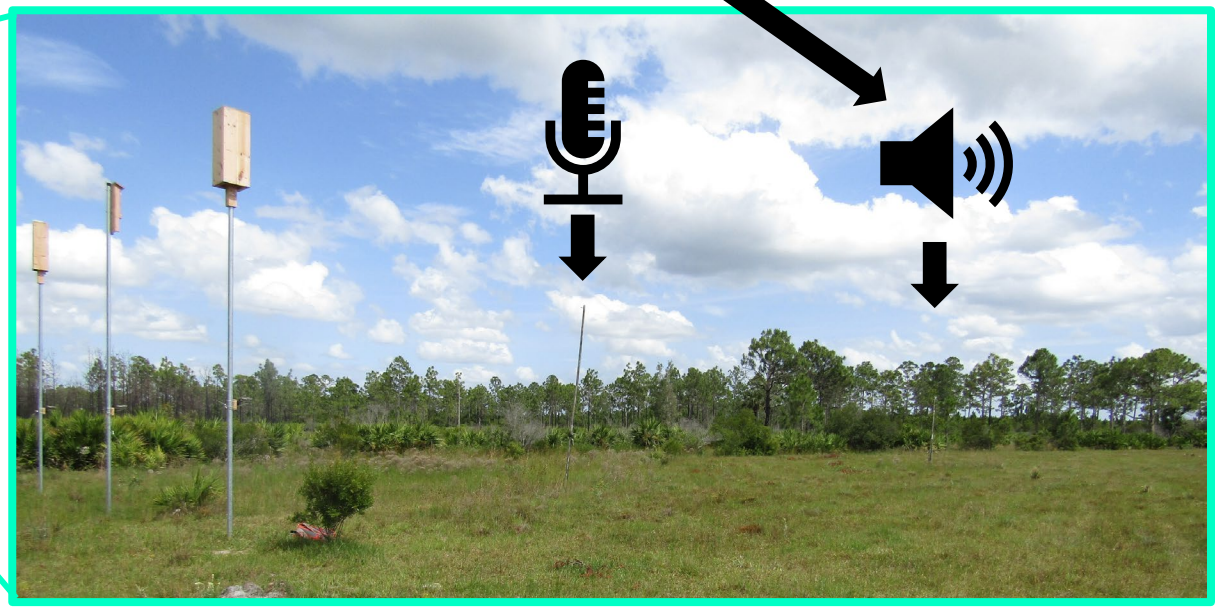


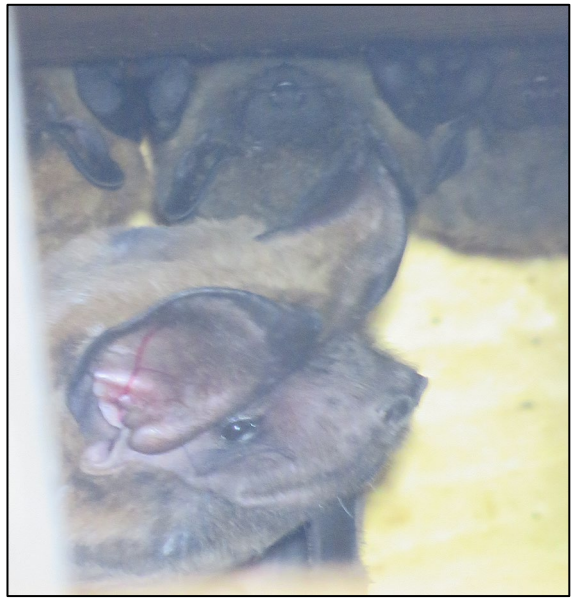
Photo: Ellen Pierce

Bat box use

2021

- No bats in boxes

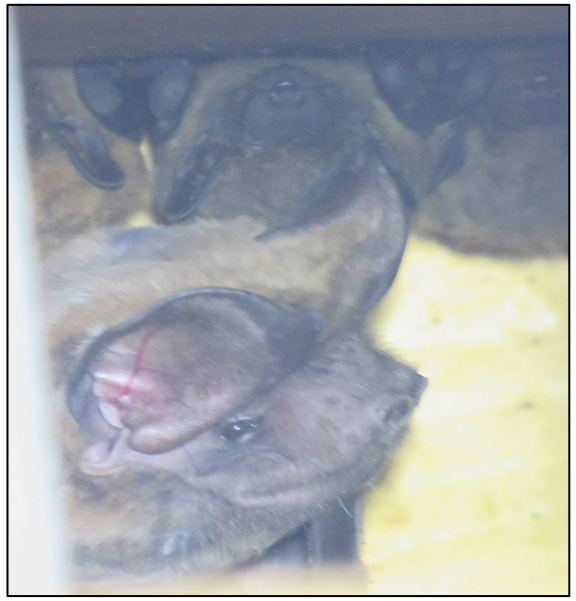
Bat box use



2022

- One Florida bonneted bat moved in 15 months after deployment
  - Joined by 1-2 additional FBB, then harem

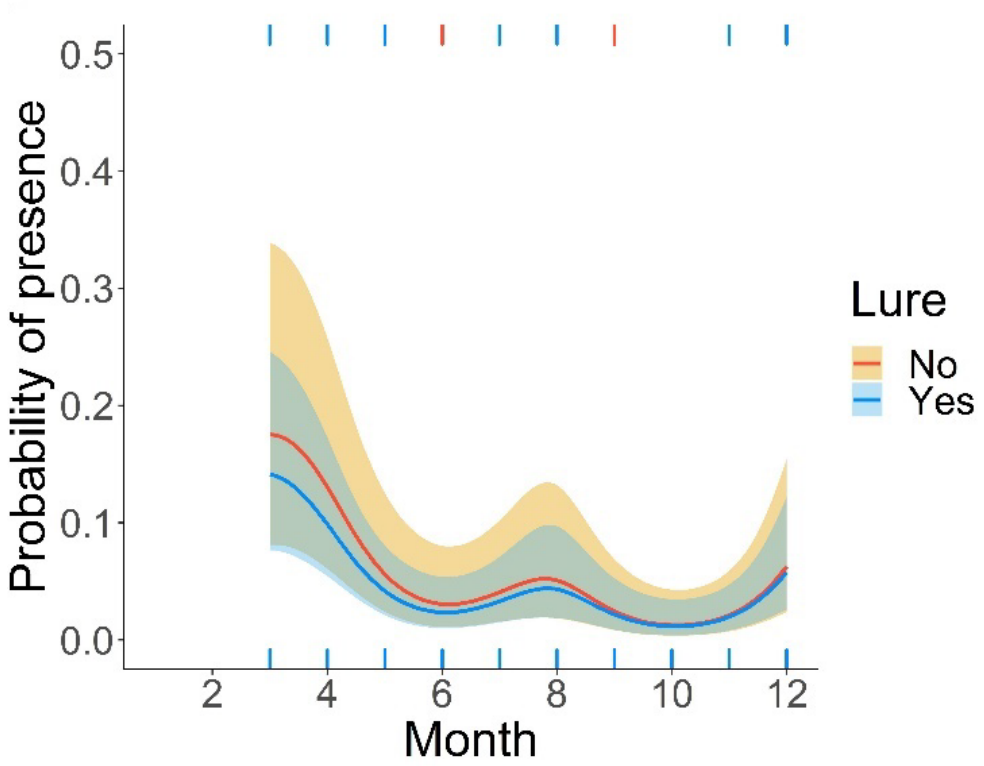
Bat box use



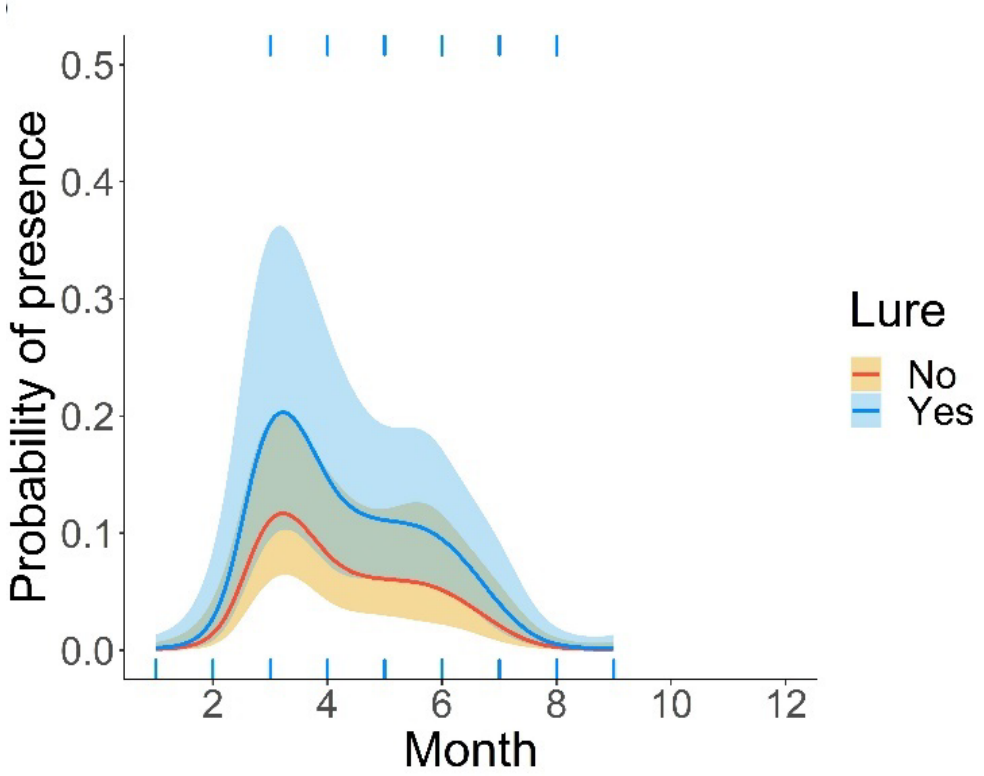
2022

- One Florida bonneted bat moved in 15 months after deployment
  - Joined by 1-2 additional FBB, then harem
- Evening bat (*Nycticeius humeralis*) maternity colony ~100 bats
- Mexican free-tailed bat (*Tadarida brasiliensis*) occasional use in small numbers

No effect of acoustic lure on Florida bonneted bat activity



2021



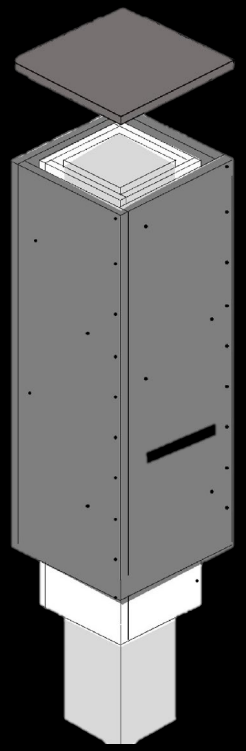
2022

Crawford et al., in prep.

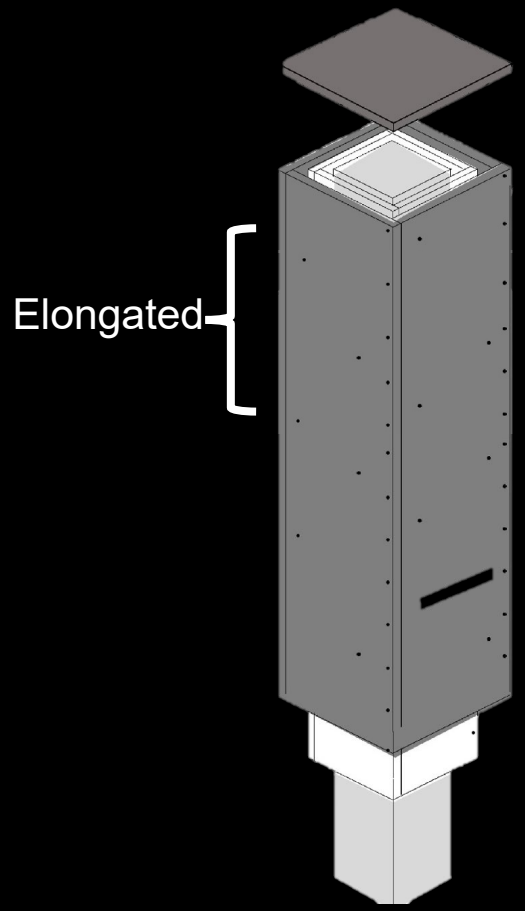
Conclusions

- No clear benefit of acoustic lures for attracting bats to roosts or increasing bat activity
  - Technology requires frequent attention/maintenance
  - Further validation needed before adoption
    - More targeted use during critical periods could elicit positive response
    - Determine call types that may be most effective

Objective 2. Evaluate suitability of bat box designs for housing at-risk bats



Reference (REF)



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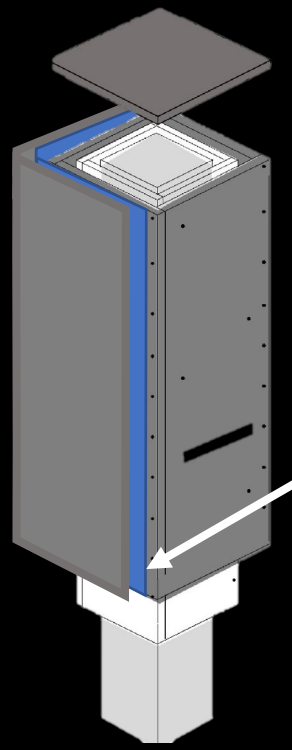
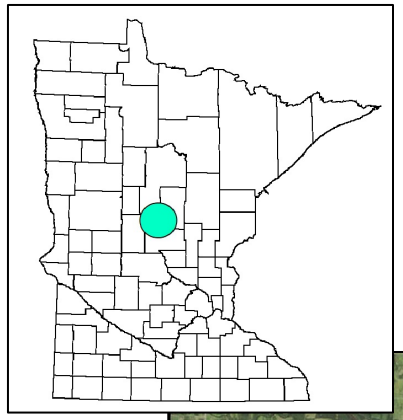
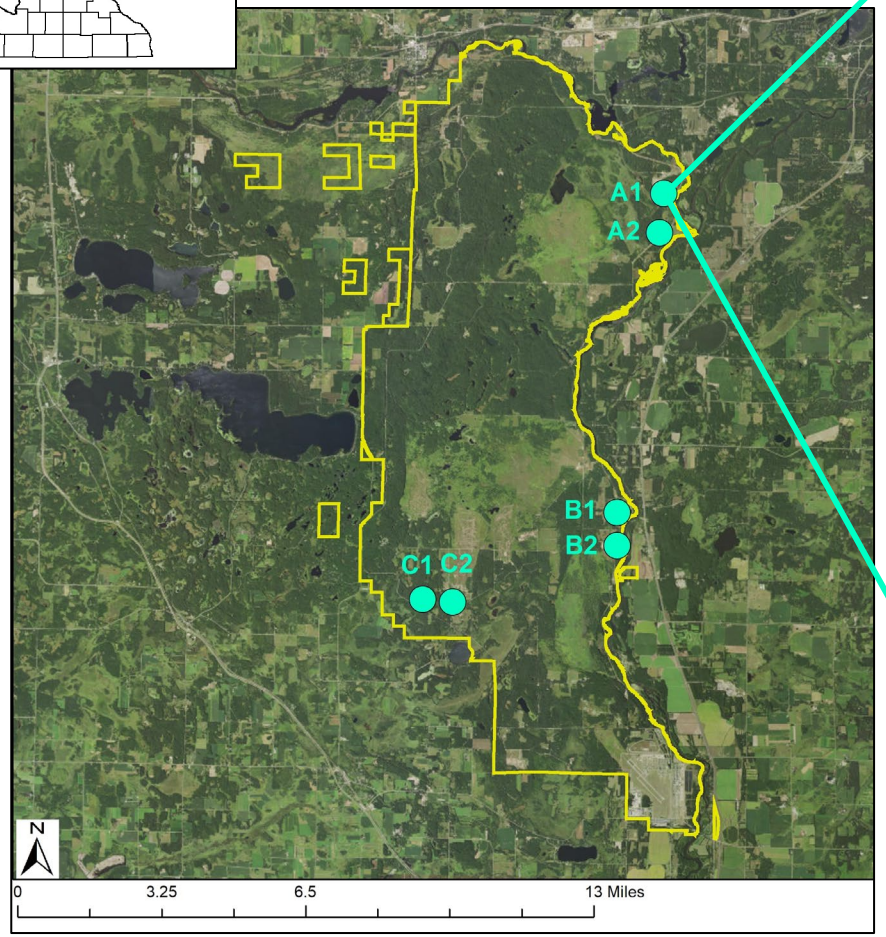
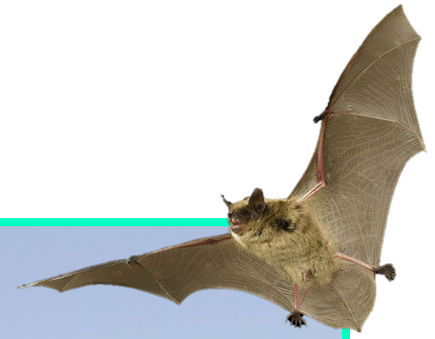


External water jacket (EJW)

Camp Ripley, Minnesota



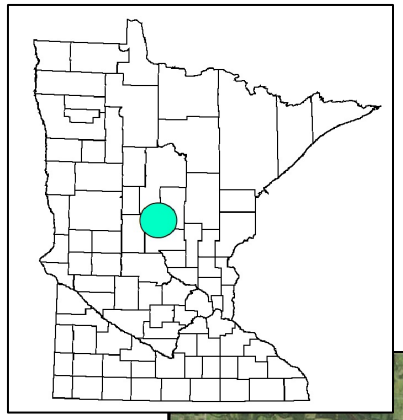


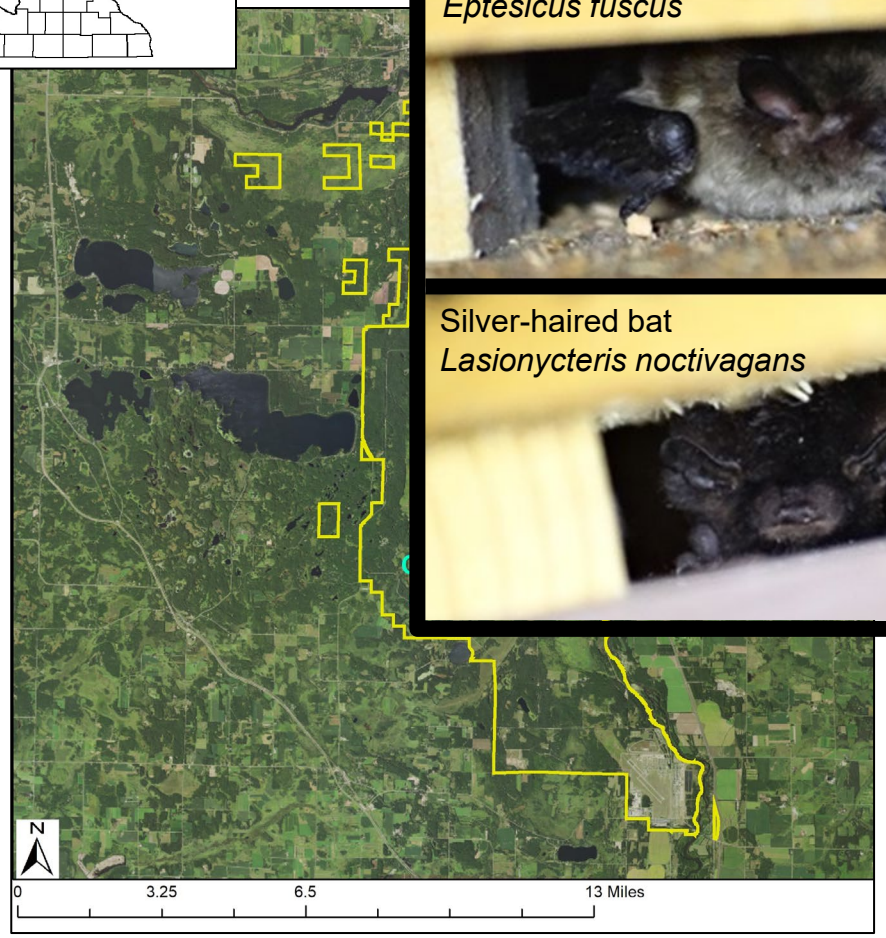


Little brown bat
Myotis lucifugus

Photos: Melissa Boman, Michael Durham

Camp Ripley, Minnesota

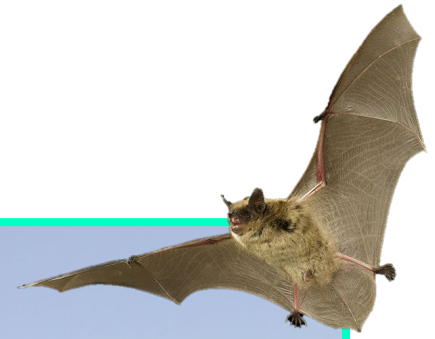





Big brown bat
Eptesicus fuscus

Silver-haired bat
Lasionycteris noctivagans


Little brown bat
Myotis lucifugus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Myotis lucifugus

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Temperature monitoring

- April – September 2021 and 2022
- iButton temperature sensors on lath

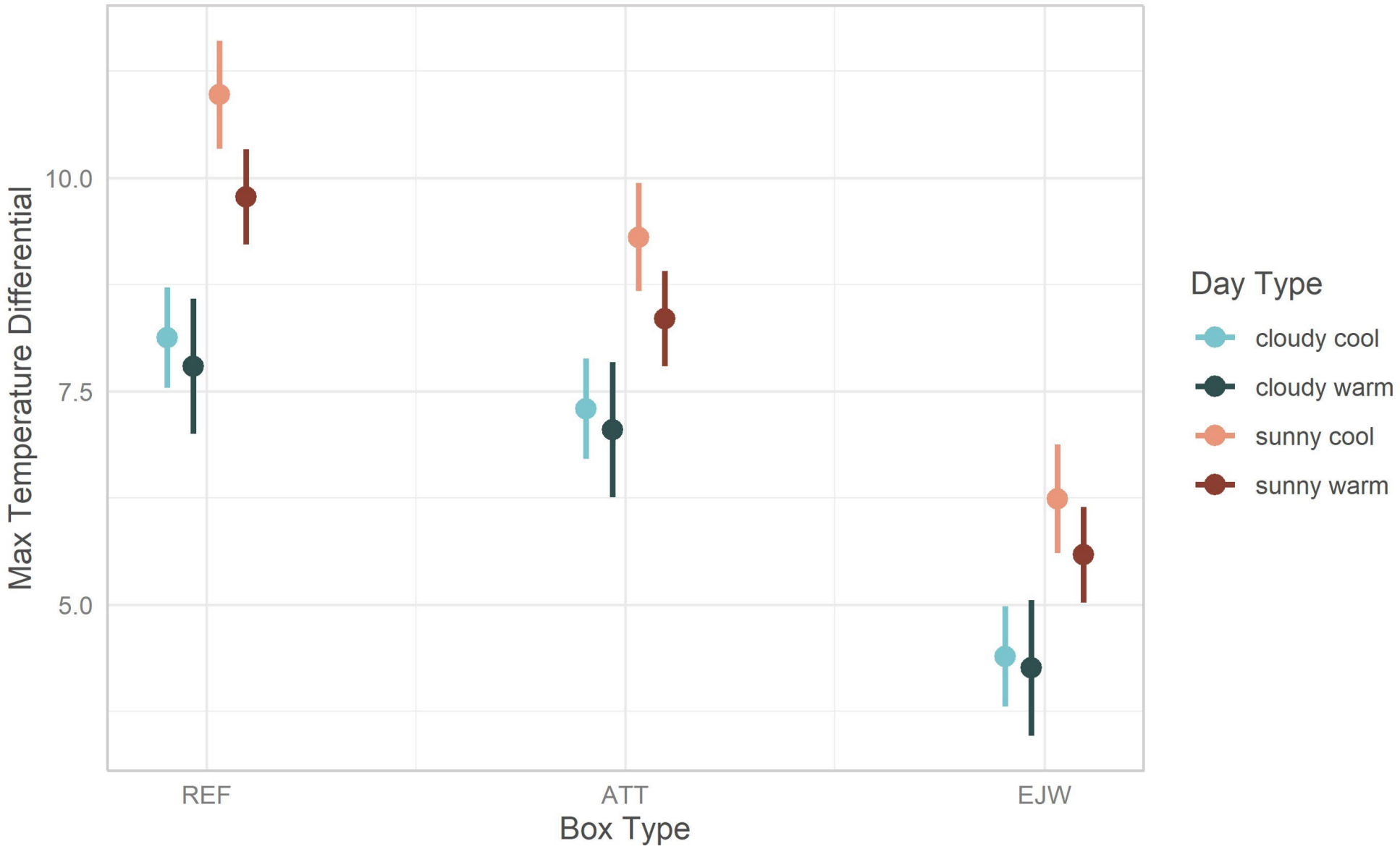
Evaluation criteria

Daytime maximum temperature differential (Max T_{roost} – Max $T_{ambient}$)

Frequency of overheating events (T_{roost} ≥40°C)

Retention of warm temperatures throughout the night

Daytime maximum temperature differential
(Max T_{roost} – Max $T_{ambient}$)



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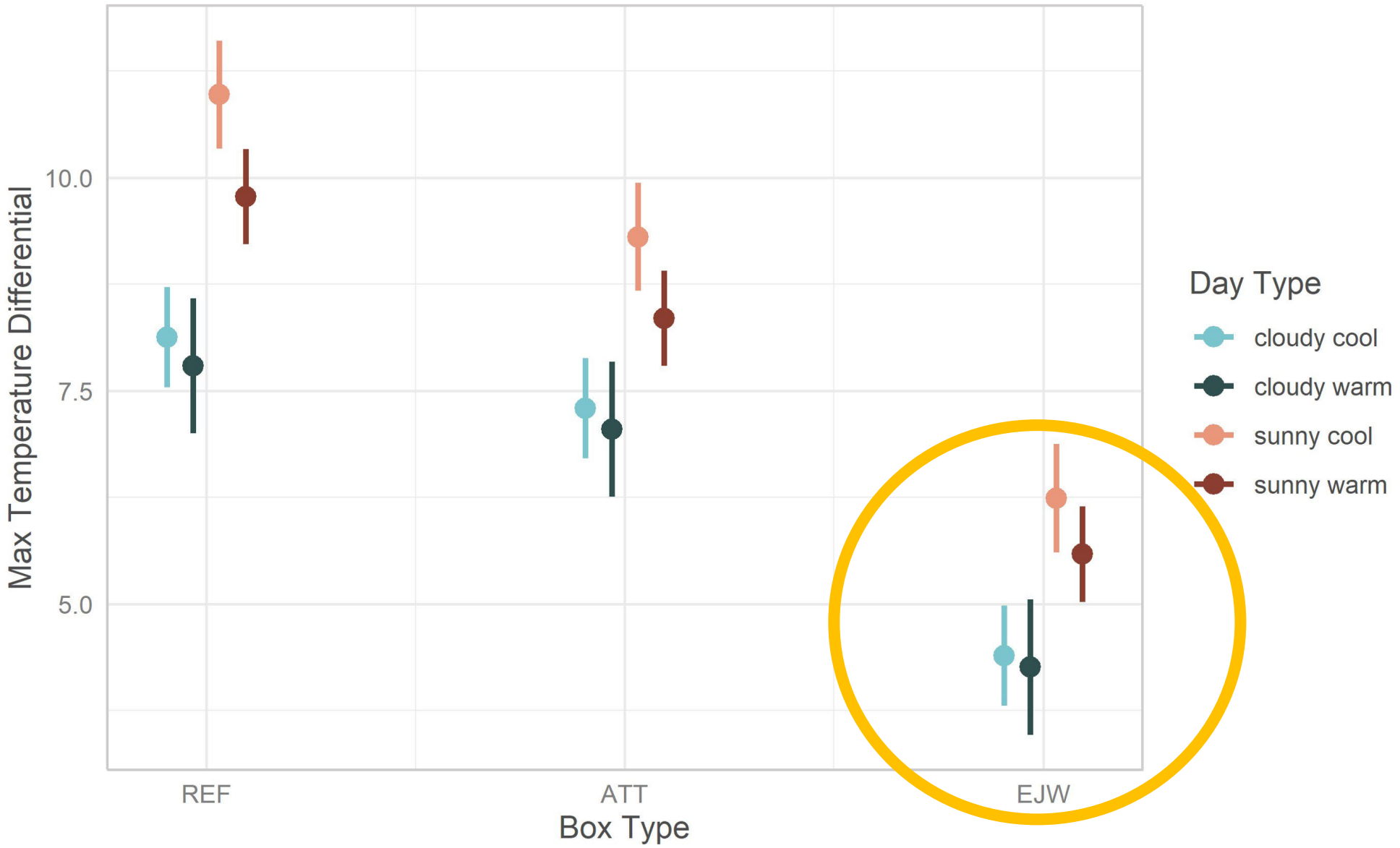

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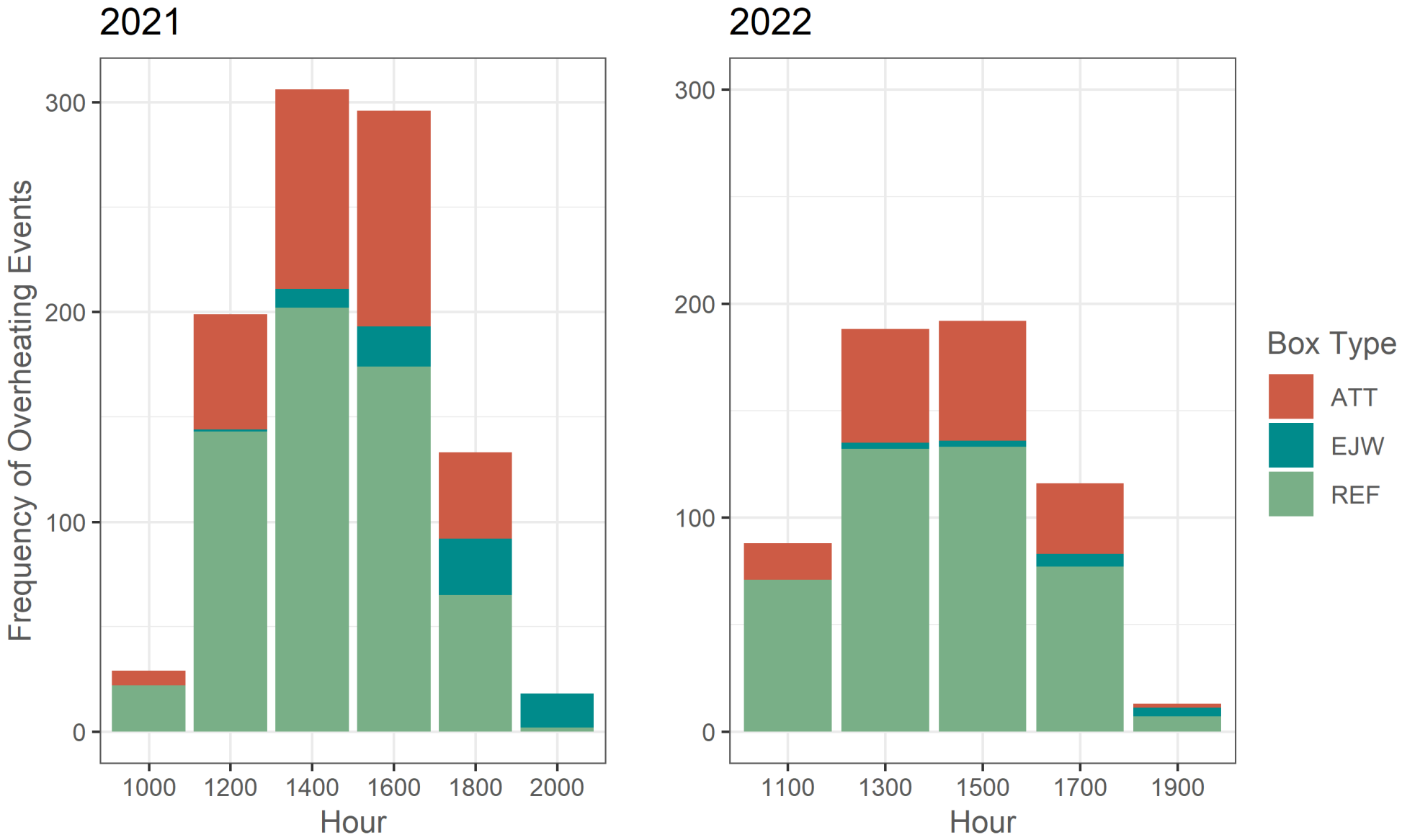

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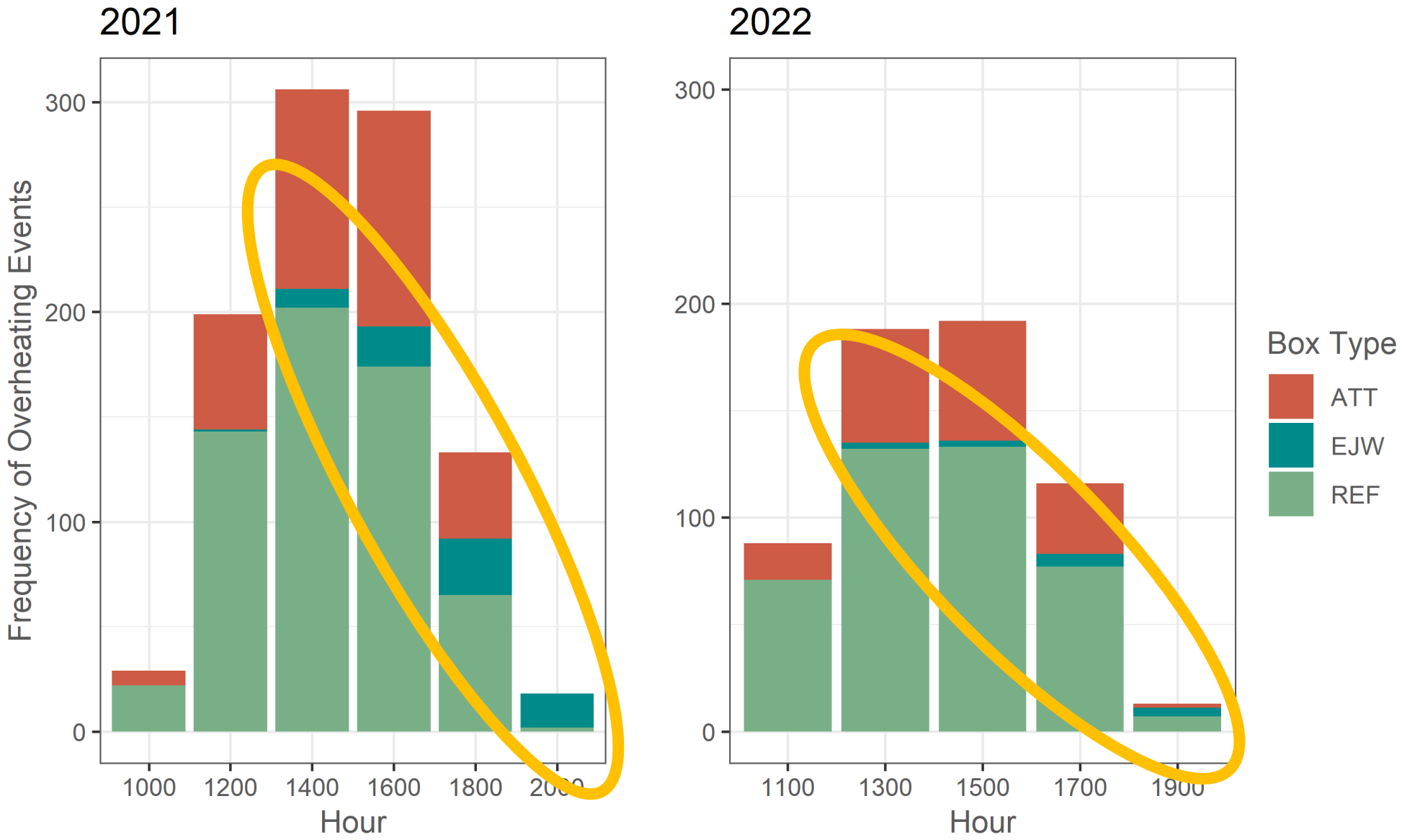
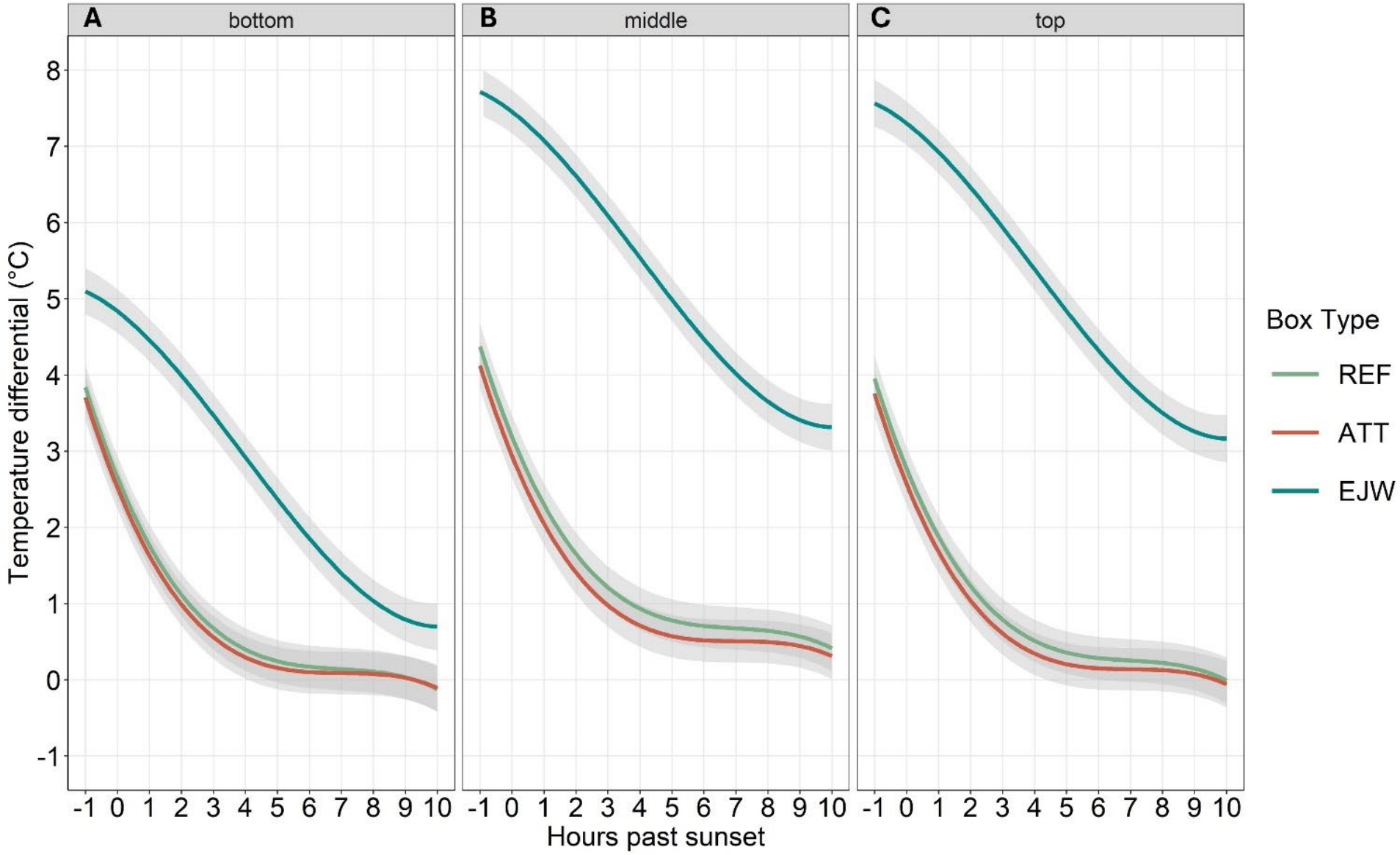
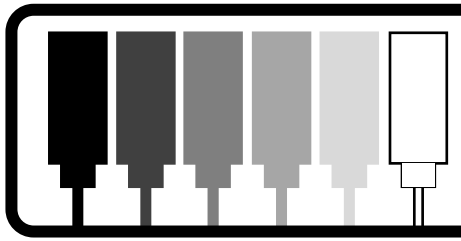


Retention of warm temperatures throughout the night



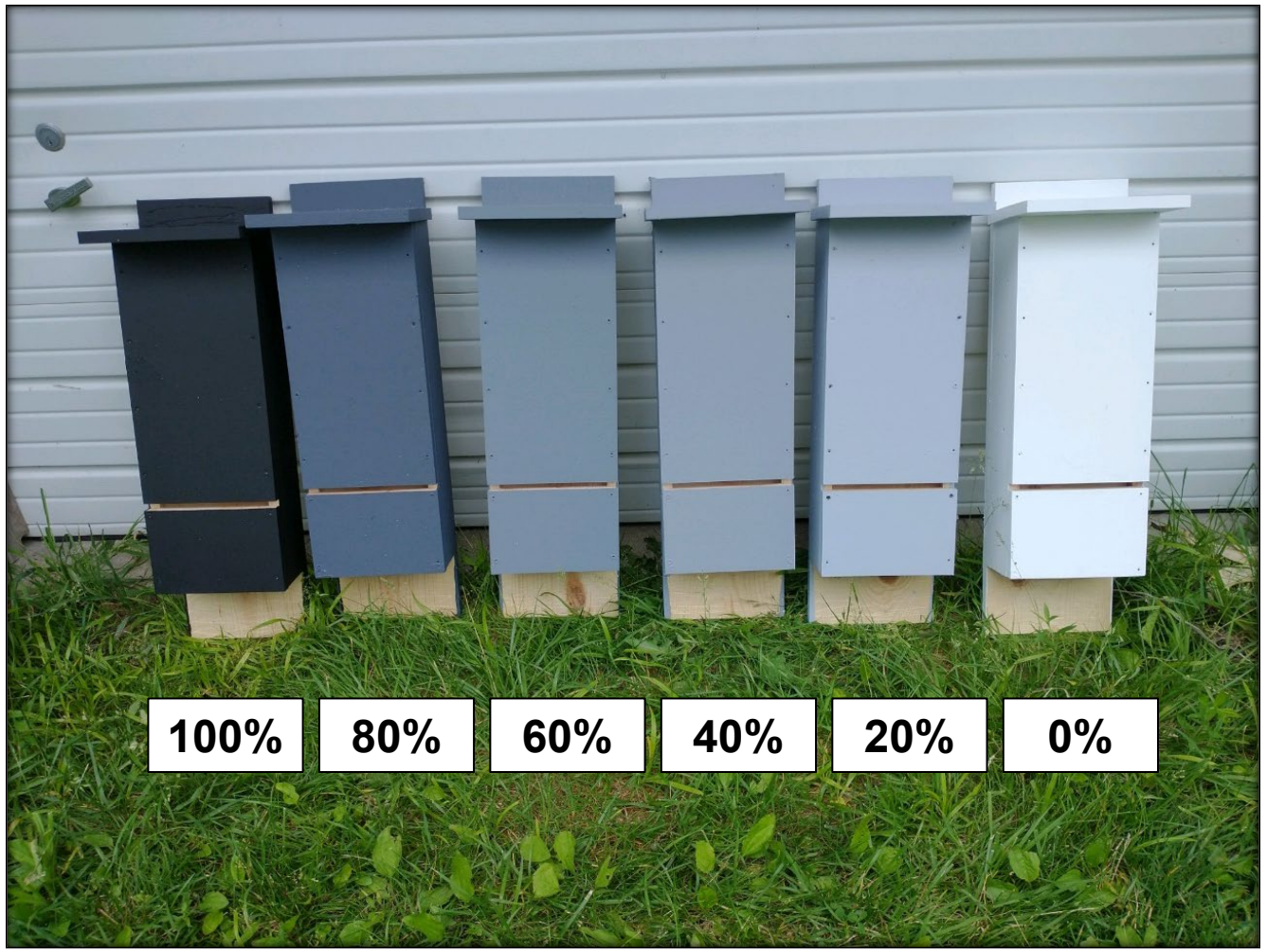
Conclusions

- Improve thermal performance by incorporating heat storage materials into box design
  - Buffer extremely hot temperatures during the day and cold temperatures at night
  - Retain heat longer into the night



Objective 3. Measure effect of paint color on box temperatures

Three-chamber boxes along a black-white color gradient

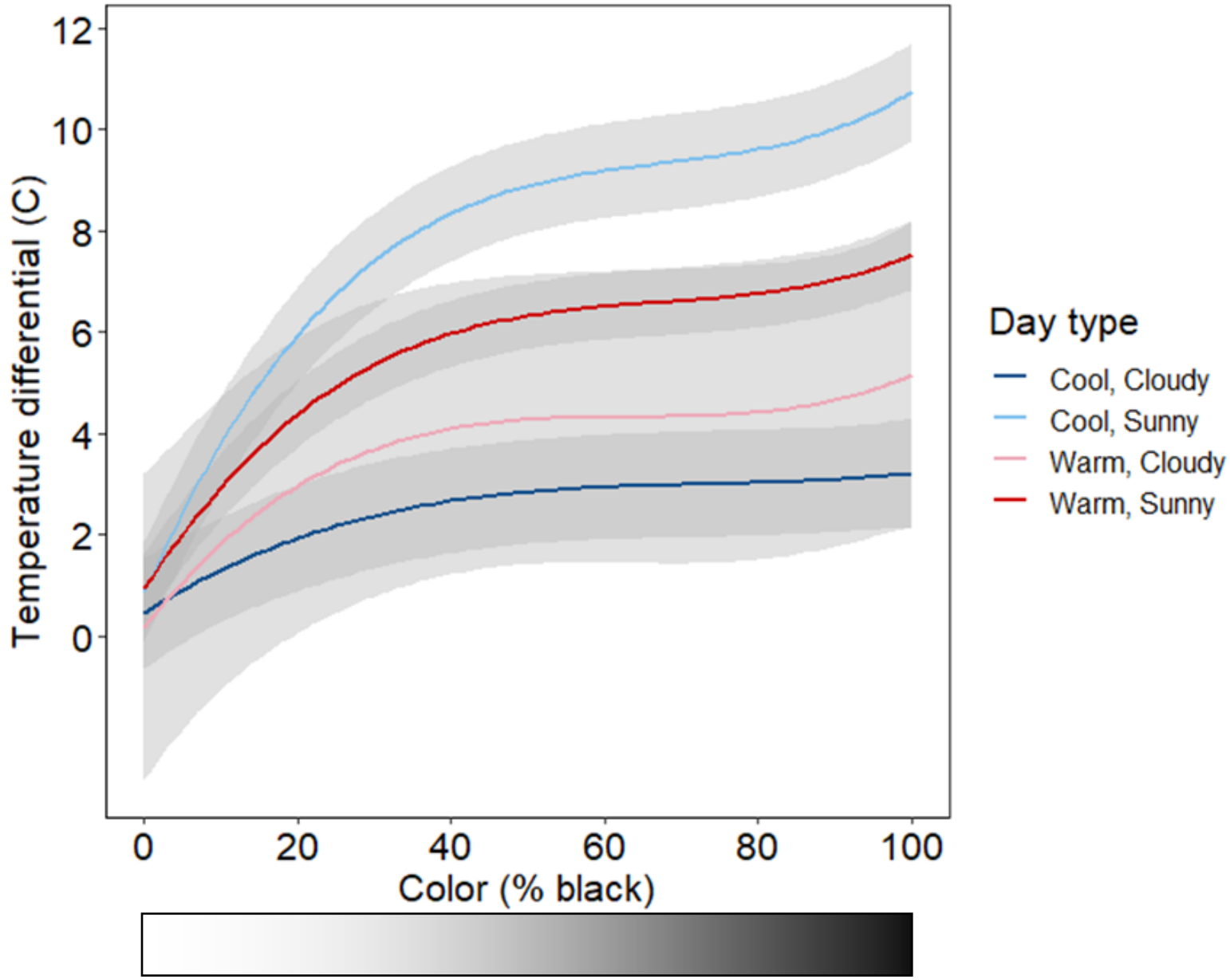


Study Site: Bondville, IL

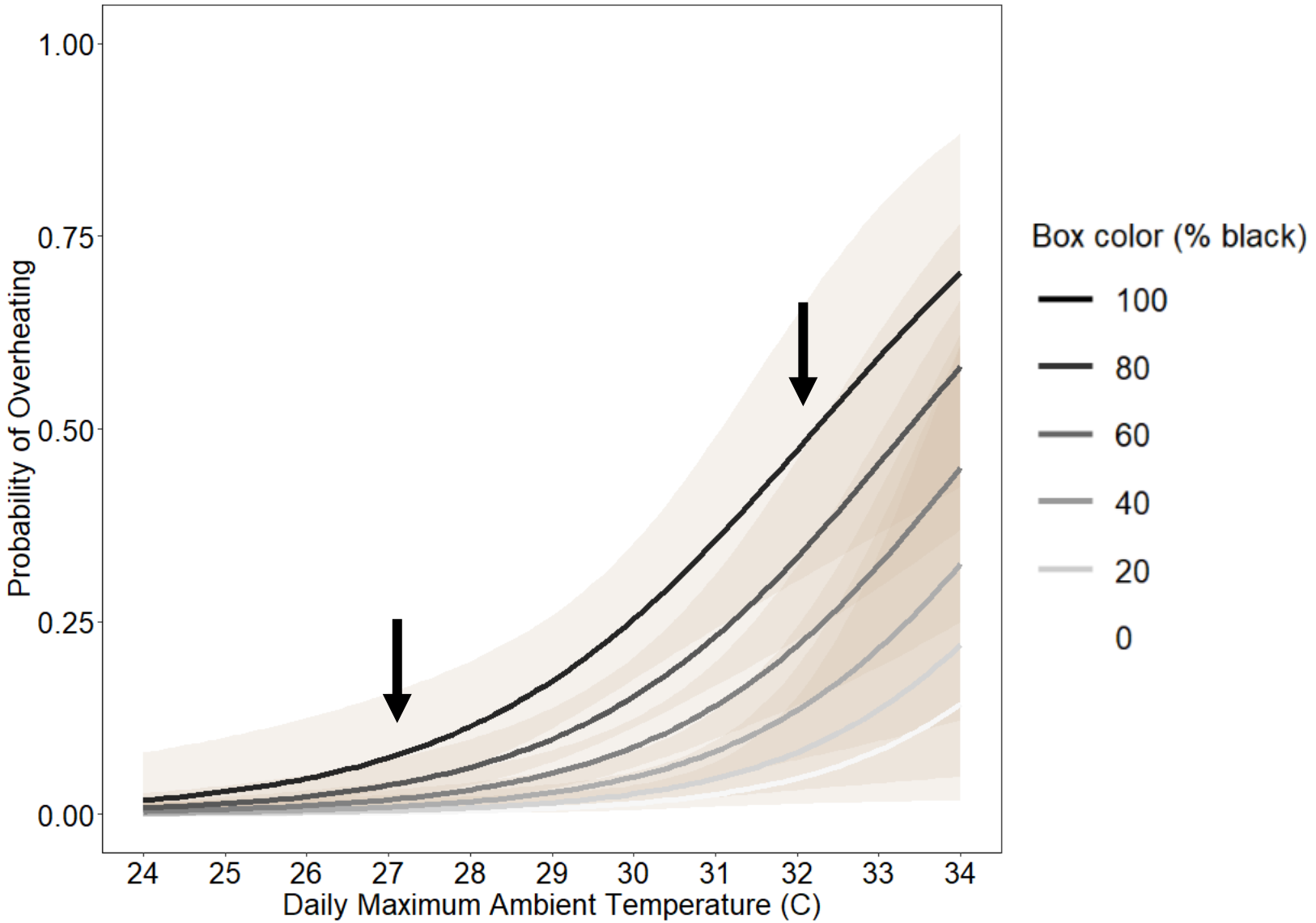
- Adjacent to pro weather station
- No cover from the sun
- June to November 2021
- Bats excluded

Daytime maximum temperature differential
(Max T_{roost} – Max $T_{ambient}$)

Darker paint color warms boxes on sunny days

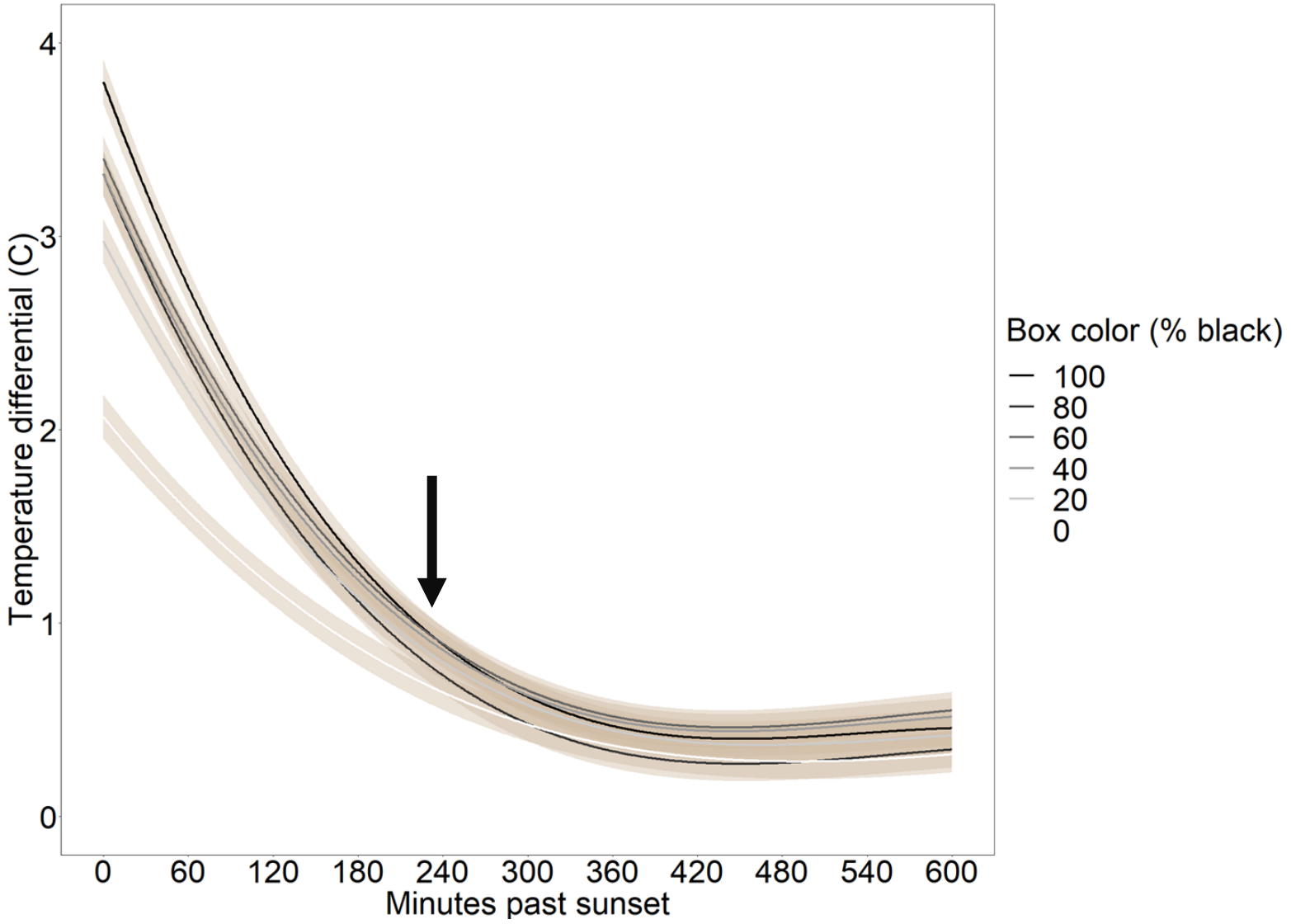


Probability of overheating on sunny days (T_{roost} ≥40°C)



Retention of warm temperatures throughout the night

Regardless of color, boxes cool quickly at night



Conclusions

- Paint color matters on sunny days
- Boxes perform similarly and are likely to overheat if 60–100% black on warm, sunny days
- Paint color matters very little at night

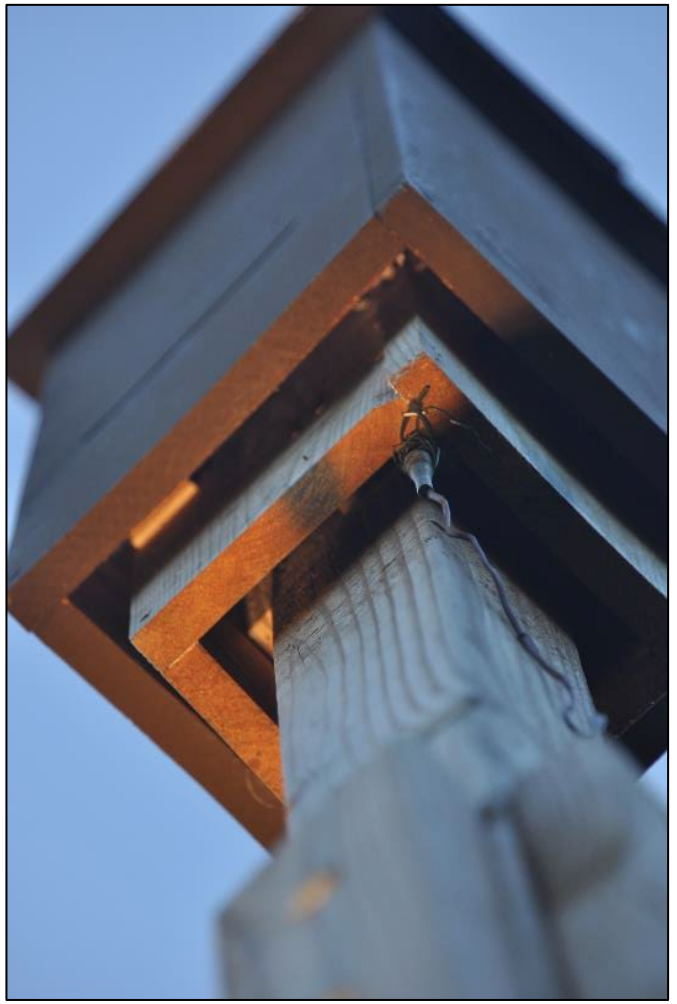
Takeaway:
a lighter color box will be safer in a full-sun deployment

Objective 4. Provide guidance to DoD natural resource managers

Putting it all together…

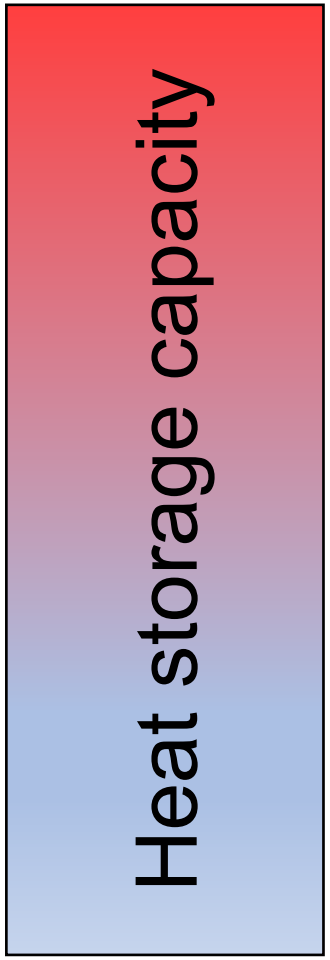
Best practices for *building* bat boxes

- Use quality wood
  - Untreated lumber, not plywood
  - Materials will be $150-200 for a large box
- Construct a tall box (3’ or higher)
  - Multiple ¾” chambers
- Small entrance to keep predators out
- Don’t use mesh inside

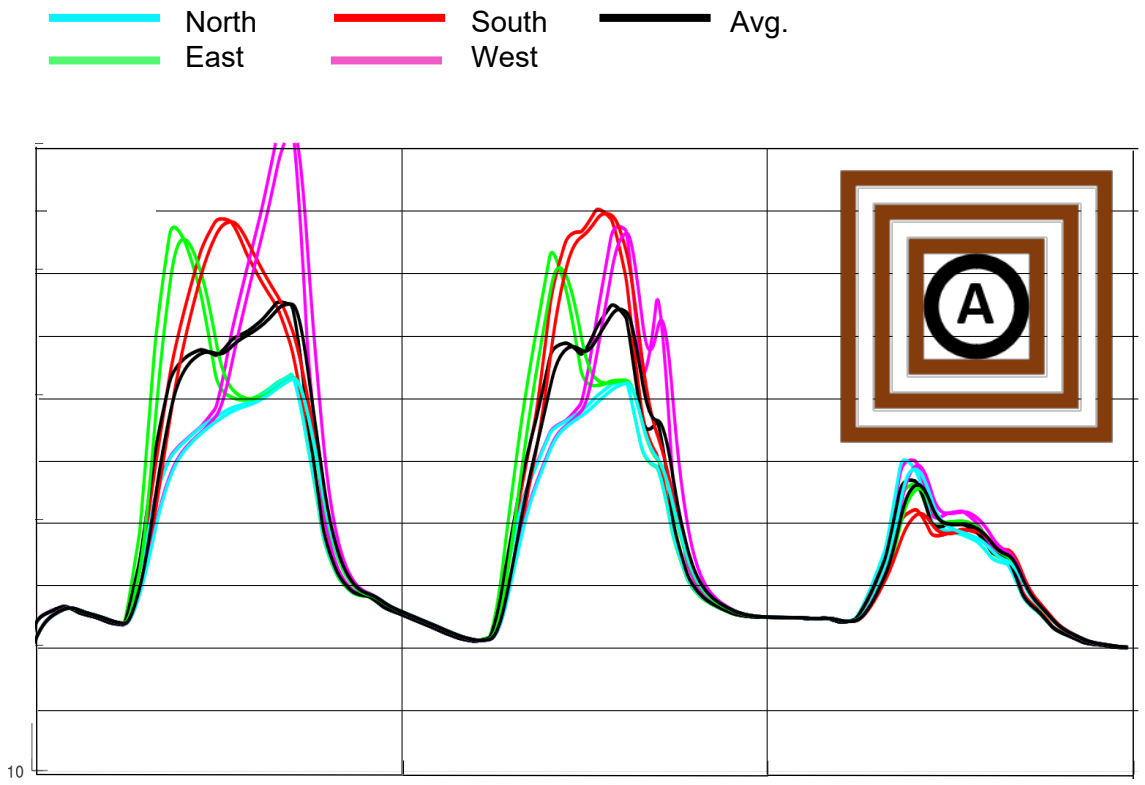


Design components essential to building a warm, stable bat box

Hoeh et al. 2018
Crawford & O'Keefe 2021
Tillman et al. 2021
Bakken et al. 2022
Crawford et al. 2022
Crawford & O'Keefe 2023

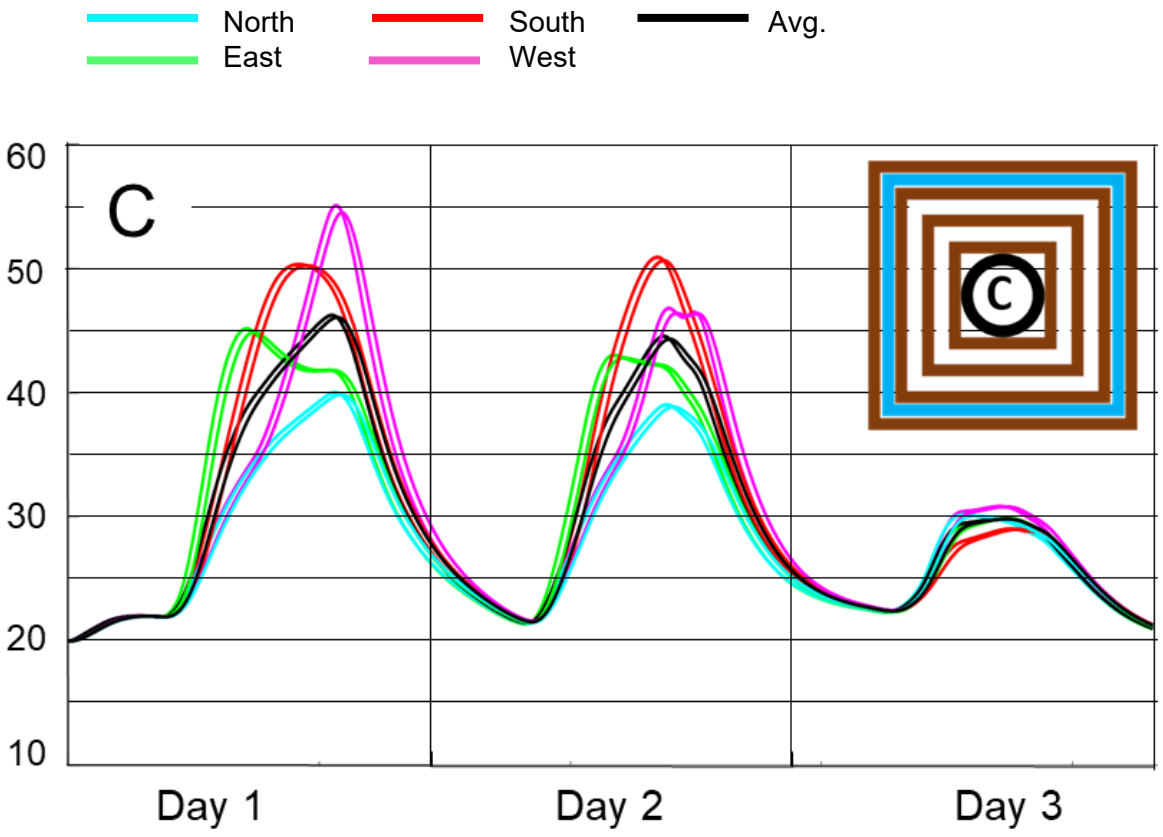


Simulated temperatures in 2-chamber rocket box



From Bakken and O'Keefe, in prep.

Simulated temperatures with added water jacket



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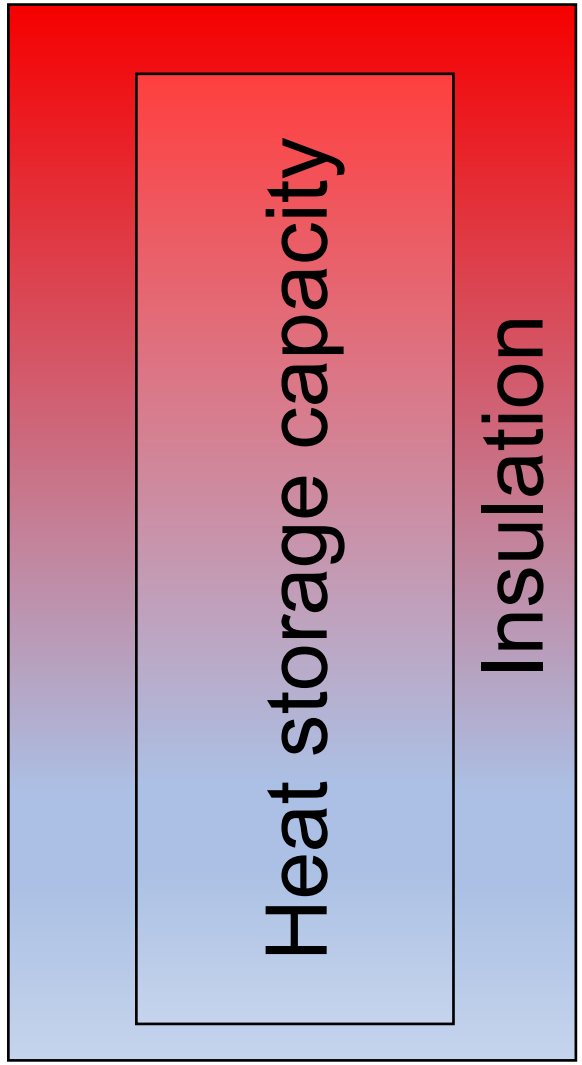
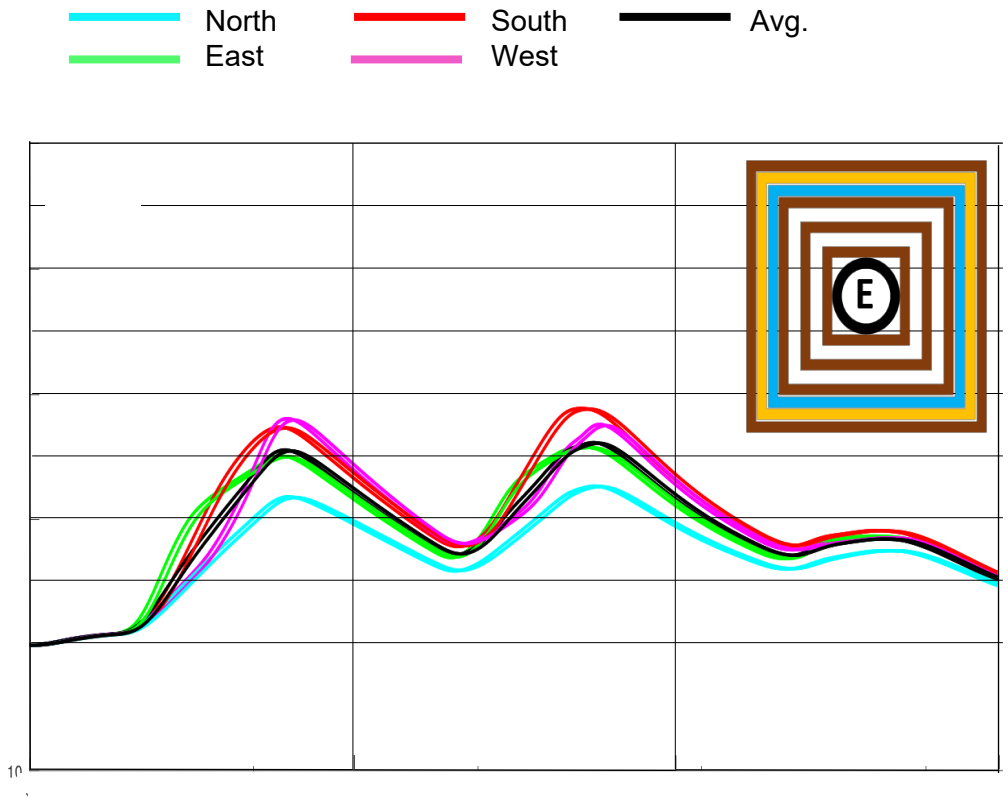


Simulated temperatures adding insulation over heat storage



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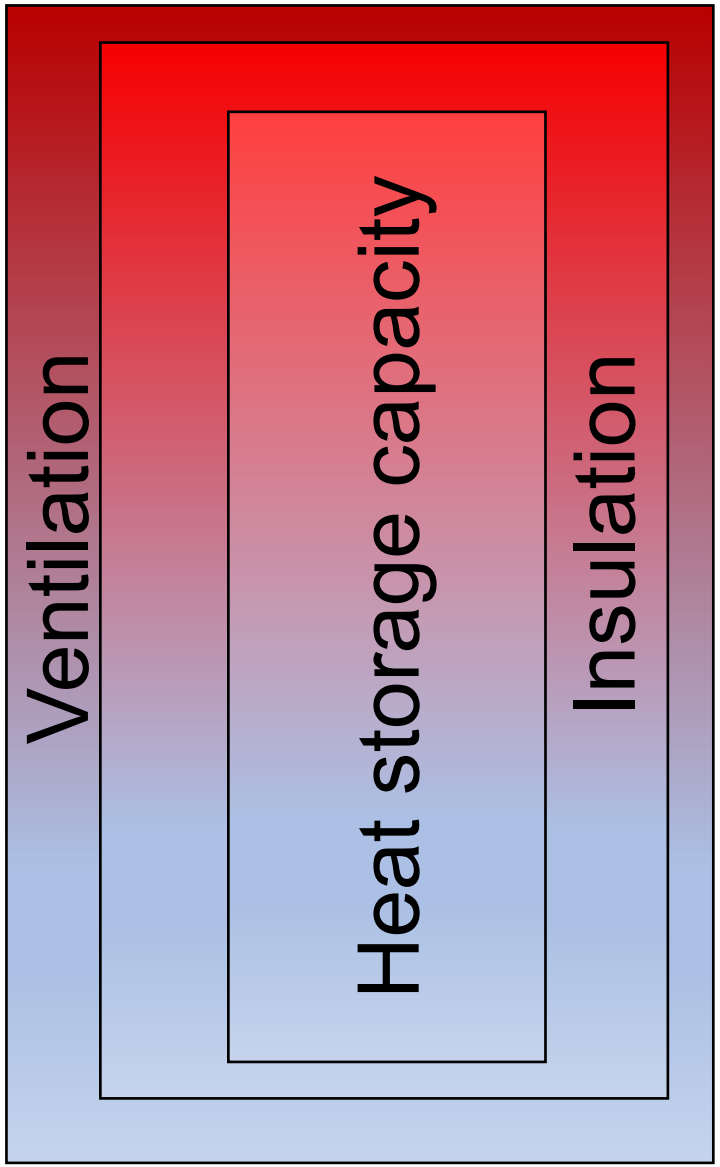
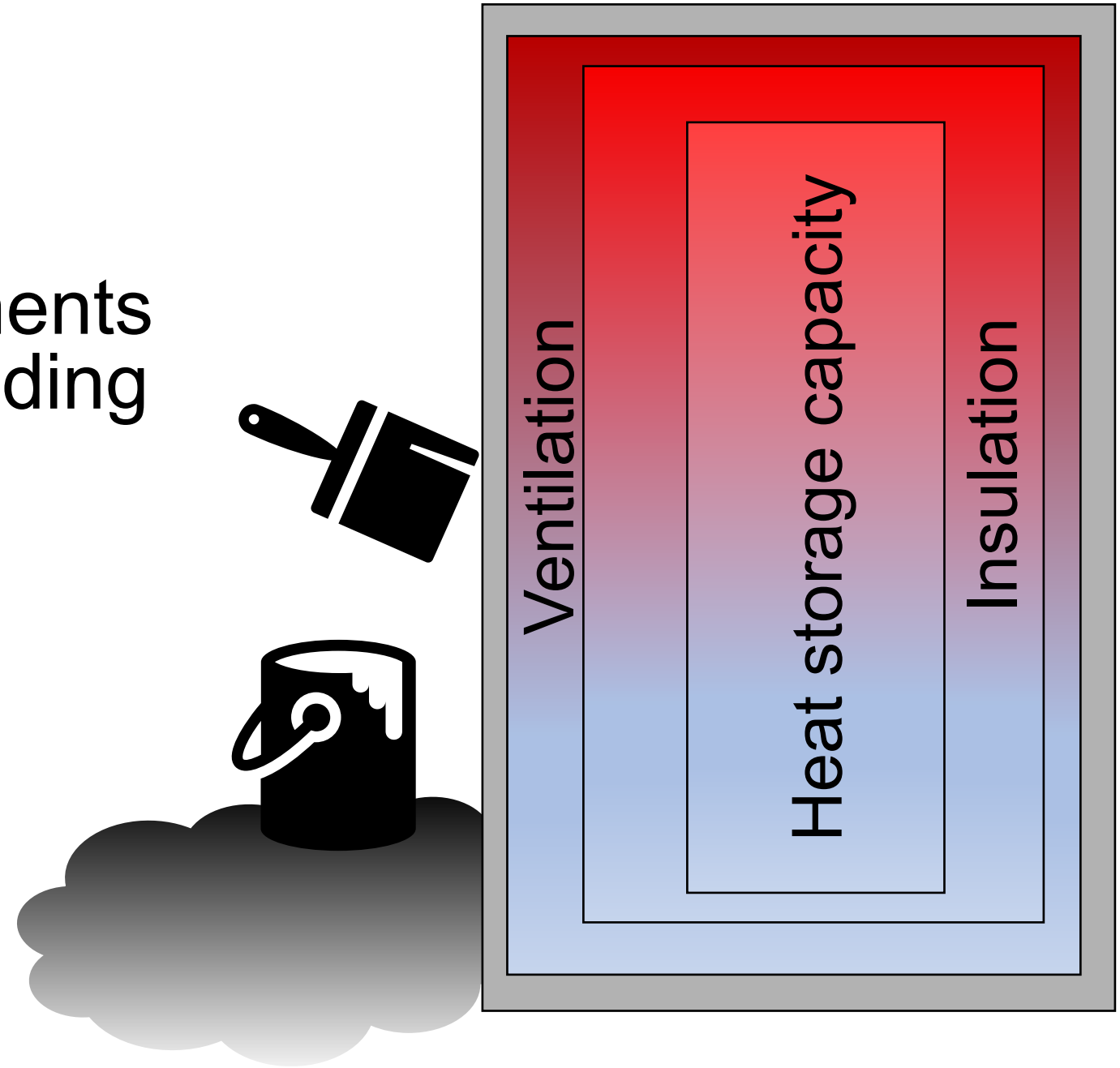
Design components essential to building a warm, stable bat box



Design components essential to building a warm, stable bat box

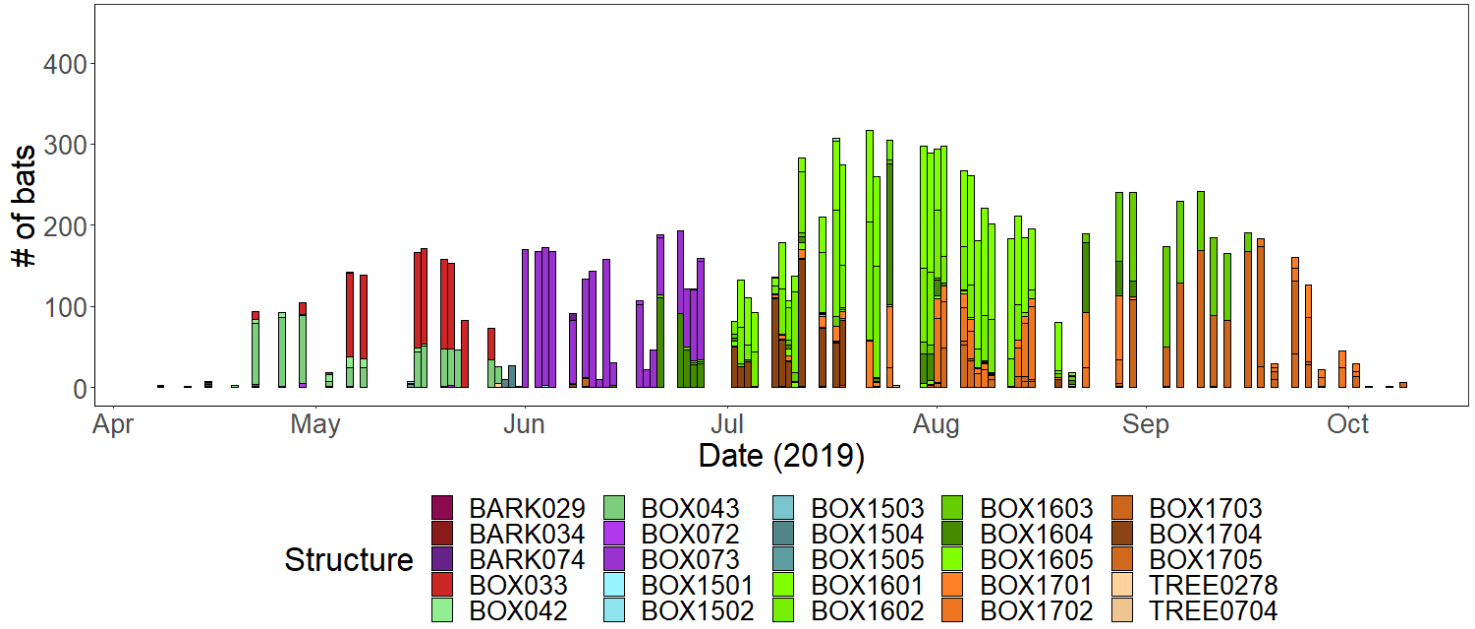


Best practices for *installing* bat boxes

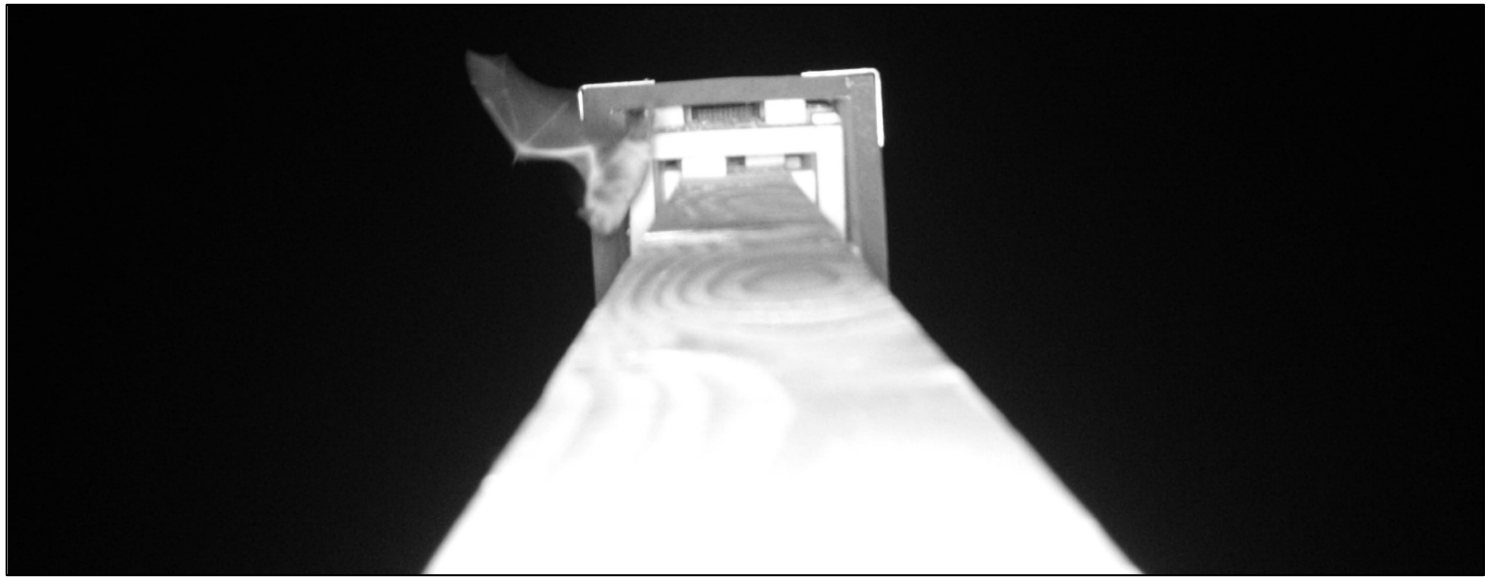
- Deploy multiple roosts to give bats options
- Box facing south or east (ideally not west)
- Post or pole with entrance 12’ or higher above ground
- Avoid tree mounts but do place boxes *near* trees when possible
- Mounted on a building is good but consider guano buildup below
- Away from bright lights (bats may avoid)

Monitor boxes and count bats

- Use a spotlight to check for bats
- Arrive 30 min before sunset
- Stay until 30 min after
- Use standard protocols (datasheet, multiple counters)



- Use trail cameras to observe bats, predators, and people around boxes
- Test predator guards to find out if they work



Measure temperature inside and outside boxes

- Top of the box is most important if you can only measure in 1 position
- Protect sensor so bats cannot contact it
- Pair with exit counts to learn how bat numbers affect temperatures

Maintain boxes over time!

- Clean boxes of parasites if possible or replace as needed
- Measure lifespan of a box by tracking deterioration
- Be careful around guano piles – wear N95

Guidance and Resources

- NDCEE final report and recommendations for bat box use
  - https://www.denix.osd.mil/ndcee/denix-files/sites/44/2024/04/Guidance_Artificial-Bat-Roost-Construction-Monitoring-Temperature-Acoustic-Lure.pdf
  - Not covered today:
    - Testing different acoustic lure playback types for FL bonneted bats
    - Acoustic lure efficacy for little brown bats in MN
    - Bat box microclimates for different designs in FL
  - Be on the lookout for future journal articles on:
    - Bat box design and microclimate in MN (Boman et al.)
    - Acoustic lure efficacy for FL bonneted bats (Crawford et al.)
    - Paint color and temperature (O'Keefe and Wolff)
    - Bat box design and temperature simulations (Bakken and O'Keefe)

For tips on making bat boxes safer: