Improving urban flyways for bats: The importance of tree canopy structure.

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Introduction

- The expansion of urban areas is a threat to wildlife because it fragments habitat and reduces the access to resources (Park et al. 2021).
- There is a need to improve the quality of urban habitats by increasing connectivity between habitats and resources.
- Corridors increase connectivity in urban environments (Gregory et al. 2021).
- Trees in the urban forest can create corridors allowing wildlife to access resources (Von Thaden et al. 2021).
- Thus, there is a real need to first determine which tree characteristics in combination can create an effective movement corridor.
- Characteristics include 1) total canopy cover, 2) size of gaps between tree canopies, 3) number of gaps along a corridor, 4) rugosity of the canopy, and 5) tree height.
- To address this, we conducted a study to explore these five tree metrics that could influence bat movement in an urban landscape.
- It may then be possible to make recommendations on to how to plan and manage the urban forest to improve urban areas for wildlife

Materials and Methods

Survey Period: 1 June 2022 – 28 September 2022.

Study Area: Fort Worth, Texas (32°41'21.17" N, 97°22'46.75" W; Fig. 1).

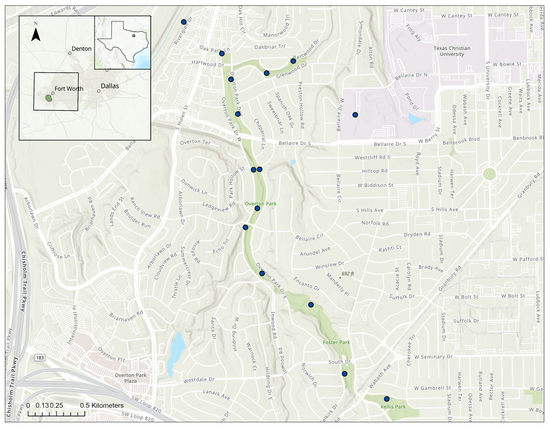

Figure 1: 15 study sites spread across an urban park system in Fort Worth, TX. Sites differed in vegetation characteristics (see below).

Tree Metrics Collected:

- In ArcGIS Pro, we used tree canopy layer derived from NAIP imagery to measure four tree metrics.
- We measured a fifth tree height in the field using a Nikon Forestry Pro II rangefinder.

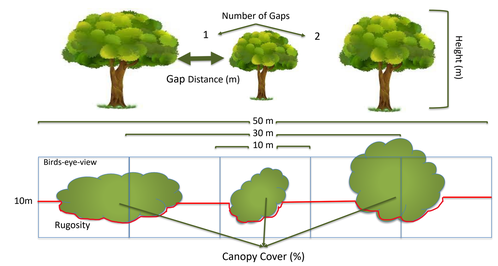

Figure 2: Image shows the five tree metrics that were collected at distances of 10 m (i.e., the survey site), 30 m, and 50 m. We used average, max and mean values for height and gap distance creating a total of 33 independent variables

Behavioral Observation and Acoustic Monitoring:

- Thermal cameras were used to observe bats commuting along 10 m by 10 m stretches of potential movement corridors at each study site (Fig. 2).
- AR125 acoustic bat detector was used to identify observed bats to species (where possible).

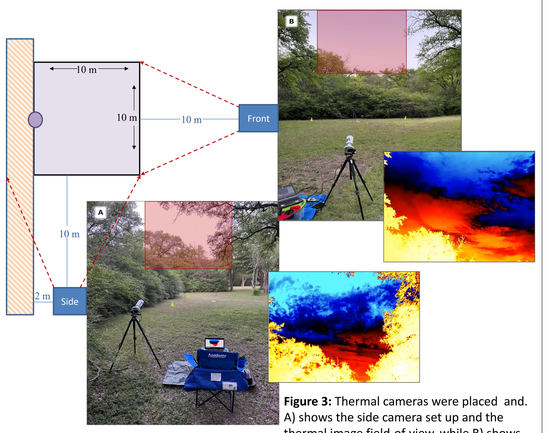

Figure 3: Thermal cameras were placed and. A) shows the side camera set up and the thermal image field-of-view, while B) shows the front camera set up and thermal field-of-view.

- We used StudioCode video analysis software to determine when the bats in 3D field-of-view (Fig. 4).

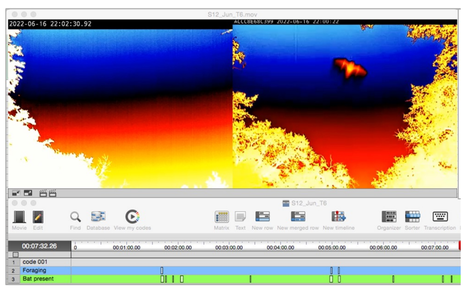

Figure 4: Side and front thermal footage views were watched in sync side-by-side. Bats were in both field-of-views were recorded along a timeline.

- **Dependent variable:** Total time spent commuting.

Results

- We observed bats commuting on 27 of 32 surveys nights at 12 of the 15 sites.
- We identified **five species,** evening (*Nycticeius humeralis*), eastern red (*Lasiurus borealis*), Mexican free-tailed (*Tadarida brasiliensis mexicana*), silver-haired (*Lasionycteris noctivagans*), hoary (*Aeorestes cinereus*), and tricolored (*Perimyotis subflavus*) bats in our surveys.
- Four of the 33 independent variables were found to be influence bat commuting.

1. As total percent canopy cover at 10 m increased, commuting activity decreased (*t=2.687 , p=0.01, 95% CI={.035 , 0. 240}*; Fig. 5).
2. As average height at 50 m increased, commuting activity increased (*t= 3.343 , p=0.002 , 95% CI={0.026 , 0.102};* Fig. 6).
3. As the rugosity value at 10 m increased, commuting activity decreased. (*t= -2.769 , p=0.008 , 95% CI={-3.201 , -0.510};* Fig. 7).
4. As gap distance at 30 m increased, commuting activity decreased (*t= 0.797 , p=0.429 , 95% CI={-0.302 , 0.699};* Fig. 8).

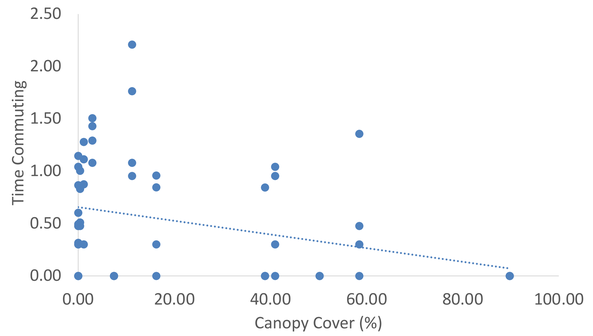

Figure 5. Comparison between total time bats were observed commuting (log10(sec)) and total percent canopy cover at 10 m.

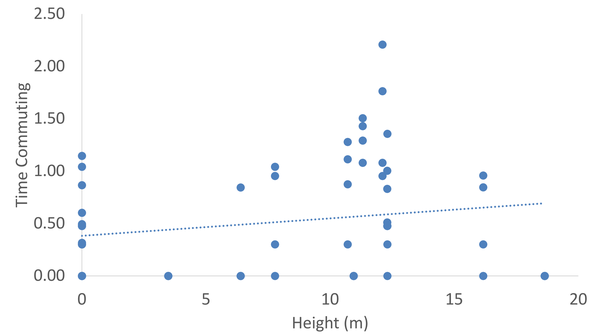

Figure 6. Comparison between total time bats were observed commuting (log10(sec)) and mean height at 50 m.

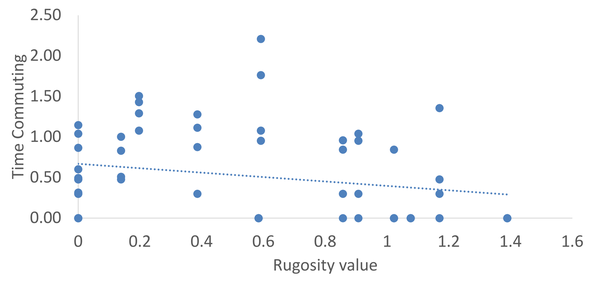

Figure 7. Comparison between total time bats were observed commuting (log10(sec)) and the rugosity value at 10 m.

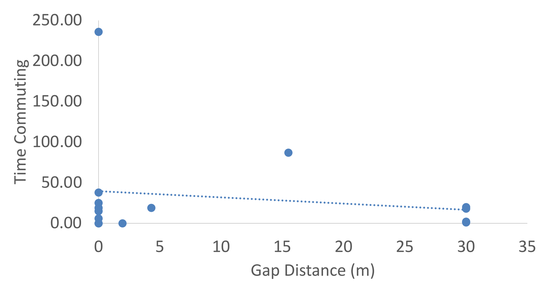

Figure 8. Comparison between total time bats were observed commuting (log10(sec)) and gap distance at 30 m.

Conclusions

- **Four tree metrics influenced bat commuting activity.**
- Tree heights between 7 to 17 m encourage bat movement.
  Rationale: Bats fly at these heights and use the tree canopy to protect them from predators while commuting (Fern et al. 2018).
- Gap distances of <20 m are better for commuting bats.
  Rationale: Bats avoid open areas including gaps because they are more exposed to predators (Erasmy et al. 2021).
- Fuller canopies create clutter and increase obstacles which bats must fly around (i.e., increases rugosity).
  Rationale: Straight flight paths are more efficient for commuting (Heim et al. 2018).
- Our study identified tree metrics that increase bat movement through an urban environment and potentially can **help make urban landscapes better for bats** and other wildlife.

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