Do Income-Driven Differences Between Urban Neighborhoods Shape Prey Availability and Bat Foraging Activity?

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Introduction

- Bats perform the critical ecosystem service of pest control in urban areas (Maslo et al. 2022).
- For humans to benefit from this ecosystem service, suitable foraging sites must be provided.
- Bats are known to roost and forage in urban areas (Aguiar et al. 2021).
- Prey abundance and diversity creates suitable foraging opportunities for bats (Nelson et al. 2017).
- However, human activity has the potential to influences invertebrate abundance and diversity in urban areas (Jessamy et al. 2024).
- One theory is that household income may be associated with landscaping practices and pesticide use that impact invertebrates (Locke et al. 2019 and de Vries et al. 2020).
- To explore this potential effect, our study aims to investigate whether invertebrate diversity and availability vary among neighborhoods based on income and how this variation influences bat activity.
- For this, we conducted invertebrate sampling and behavioral surveys using acoustic monitoring.

Materials and Methods

Study Site: Tarrant County, Texas USA

- Median household income for Tarrant County was retrieved from 2022 U.S. census data.
- We then created low and high income brackets.

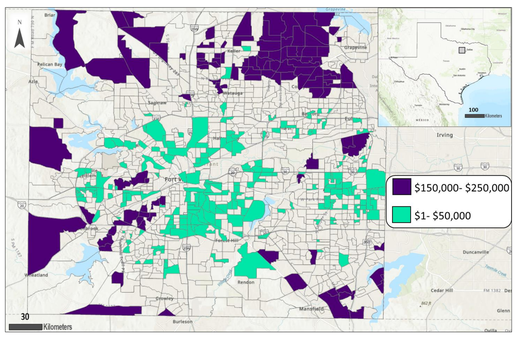

Figure 1. Map of Tarrant County (gray square) in Texas, USA (see insert) depicting areas that have high (purple) and low (teal) median household income.

- We used these areas and ArcGIS to determine areas that represented a suitable foraging areas, had adequate roosting opportunities, had accessible and available water, and was accessible to bats.
- We then ground truthed and choose 10 sites, 5 in high-income areas and 5 in low income areas (Fig. 2).

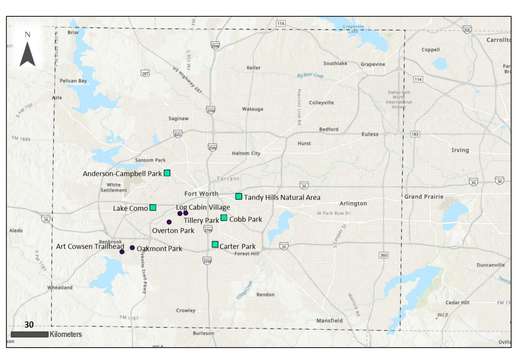

Figure 2. Map of Tarrant County (dotted line) with survey sites located in high income areas shown in purple circles and low income areas in teal squares.

Invertebrate and Acoustic Surveys

- We conducted monthly surveys at each site from March–September 2024 & 2025, beginning at dusk and lasting for 3 hours.

Figure 3. Custom built light traps were used to capture invertebrates commonly found in bats diets (Zhou et al. 2023). A voucher specimen per unique individual caught was collected and duplicates were tallied at 30 min intervals.

- We placed a BAT iFR-IV field acoustic detector ≥100 m from light traps and angled upwards towards the edge of the tree canopy to record bats foraging.

Data Processing and Analysis

- We identified vouchers to order, family, and species (where possible) using iNaturist and available field guides.
- Acoustic files (.wav) were identified to species (if possible) and activity using Sonobat bat call analysis software.

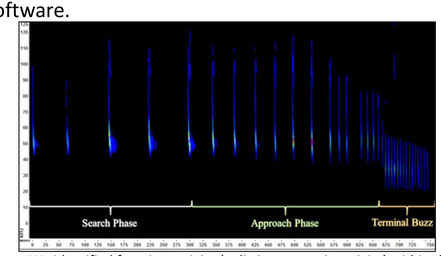

Figure 4. We identified foraging activity (a distinct acoustic activity) within the bat calls (Nystrom and Bennett 2019).

- We used Shannon's Diversity Index (H) and Principal Component Analysis (PCA) to compare invertebrate communities, bat communities, and bat foraging activity across low and high income neighborhoods.

Results

- 35 surveys were conducted across 5 sites (Art Cowsen Trailhead, Lake Como, Tillery Park, Overton Park, and Cobb Park), with each site surveyed 7 times in 2024.
- 370 vouchers were collected, representing 28,615 invertebrates observed during the study.
- 23,814 bat calls were recorded.
  - ~80 bat calls were recorded per survey on average.
- 1,409 foraging calls were recorded.
  - ~40 foraging calls were recorded per survey on average.
- We recorded all 6 local bat species, as well as the big free-tailed bats (*Nyctinomops macrotis*), a species not previously recorded in the area.
- Foraging activity was detected in all species except the Mexican free-tailed bat, likely because they do not often forage near tree canopies.

Figure 5. An image of a big free-tailed bat in flight.

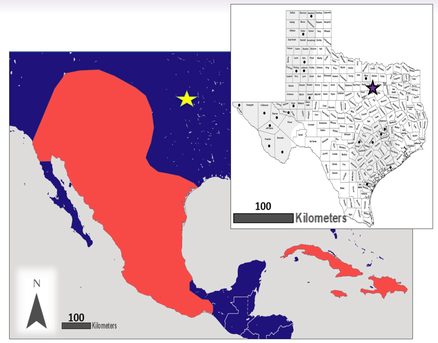

Figure 6. Range map of the big free-tailed bat. Red indicates its known range, black dots represent recorded observations in Texas, and the stars mark our study location in Tarrant County.

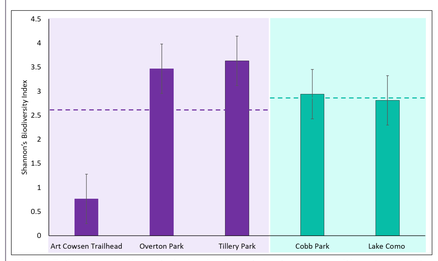

Figure 7. Shannon's diversity index for invertebrate communities at each site (bars) with average across sites (dotted line) in high (purple) and Low (teal) income neighborhoods.

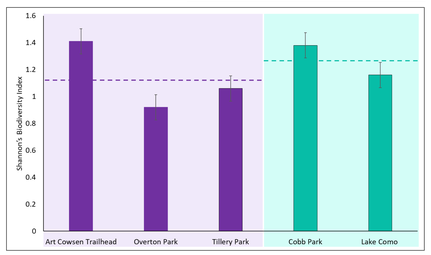

Figure 8. Shannon's diversity index for bat communities at each site (bars) with average across sites (dotted line) in high (purple) and Low (teal) income neighborhoods.

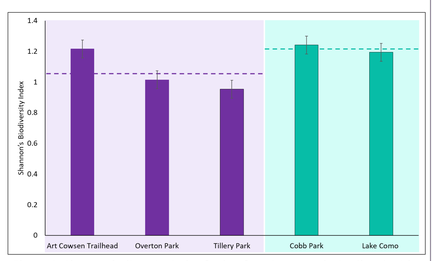

Figure 9. Shannon's diversity index for bat foraging at each site (bars) with average across sites (dotted line) in high (purple) and Low (teal) income neighborhoods.

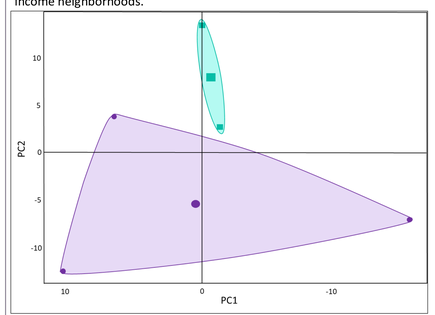

Figure 10. PCA for invertebrate communities showing high (purple) and low (teal) income groupings.

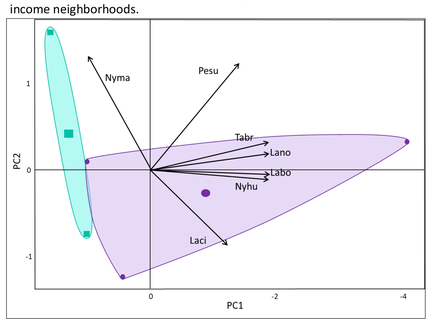

Figure 11. PCA for bat communities showing high (purple) and low (teal) income groupings. .

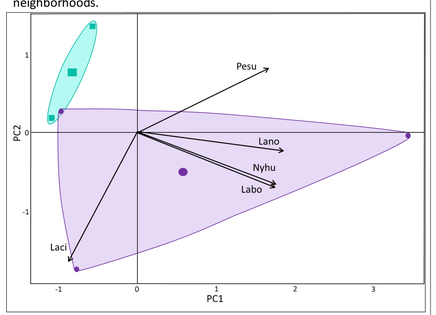

Figure 12. PCA for bat foraging showing high (purple) and low (teal) income groupings.

Conclusion

- Given this preliminary data only includes 5 of 10 sites we plan to survey, it is not surprising that there are not yet clear distinctions in the diversity indices between low and high income sites.
- In contrast, our PCAs suggests that while both high and low income sites may both have an abundance and diversity of invertebrates and bats, these communities are distinctly different from one another.
- We anticipate that ongoing data collection will reveal more pronounced differences in invertebrate communities and bat activity between high and low income sites.

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Map Credits: The City of Fort Worth and 2022 U.S. Census Bureau (Fig 1). Texas Tech University and Bat Conservation International (Fig 6).