Making Bee-friendly yards: occupancy models of urban bees

Evelyn Guerrero[1], Nicole Miller-Struttmann[2] , Adam Smith[3]

[1] University of Texas Permian Basin Organismal Biology [2]Webster University Department of Biological Sciences [3]Missouri Botanical Garden

Why study urban bees?

Bees are our most important plant pollinators on Earth. They are a keystone species, meaning that they ensure the reproduction and survival of plants and all organisms that rely on them. As urbanization expands, it reduces floral and nesting resources. If we want to conserve pollination networks within urban ecosystems, understanding the relationship between bees and urbanization is critical.

The state of Missouri has over 450 native bee species. The nesting behaviors vary widely among taxa. Many species are above ground nesters, using cavities in wood or stems, while other species are ground nesting and burrow into soil to develop their brood.

The diverse behaviors of native bees respond differently to factors related to urbanization, therefore studying the affect of urbanization on distinctive nesting behaviors can lead us to better understand this relationship.

Research question

How does urbanization affect ground nesting and above ground nesting bees?

Study design

- Using citizen science data from the Shutterbee program within the greater St. Louis area, we selected two Tribes of bees native to Missouri with differing nesting behaviors: Tribe *Augochlorini* and Tribe *Osmiini*
  - Tribe *Augochlorini* are primarily solitary ground nesting bees; we are studying the genera *Augochlorella* and *Augochloropsis*
    - the genus *Augochlora* are wood nesting bees in Tribe *Augochlorini* that may be in the data, although they are rare
  - Tribe *Osmiini* have diverse nesting behaviors; we chose to study the cavity nesting bees of genera *Heriades* and *Hoplitis*
- Detection and occupancy were predicted in Occupancy models using Bayesian statistics to calculate species distribution
  - Detection and Occupancy factors are the observational and site elements citizen scientist experience
- Tested which variables related to urbanization most efficiently predicted occupancy for each Tribe

How does urbanization affect below ground and above ground nesting bees?

Tribe *Augochlorini*

Sweat bee
Augochlorella
PC: Paula

Sweat bee
Augochloropsis
PC: Discoverlife.org

Tribe *Osmiini*

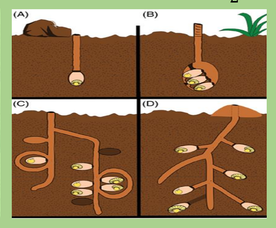
Armored Resin bee
Heriades
PC: nedster

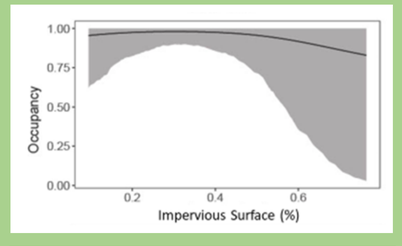
Mason bee
Hoplitis
PC: Eileen

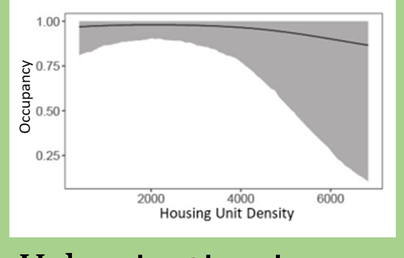
Primarily ground nesting

1

2



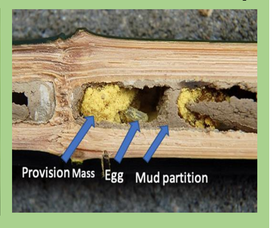


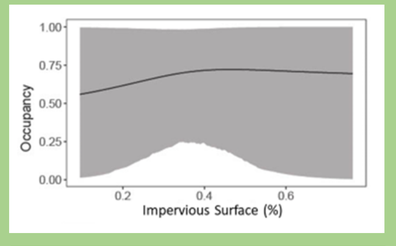


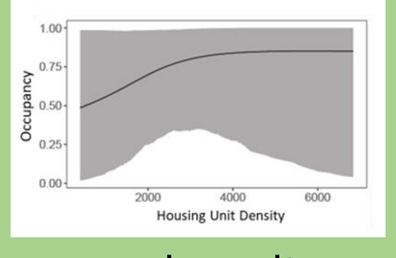
Stem or cavity nesting

3

4







Urbanization increases occupancy in cavity nesting bees and decreases occupancy in ground nesting bees

Results

Figure 1.

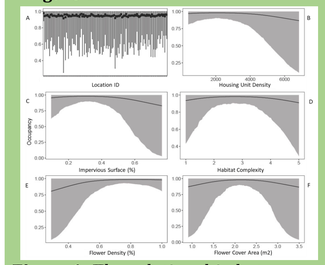


Figure 2.

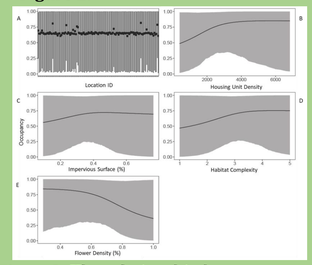


Figure1. The relationship between occupancy and components of the most efficient model for Tribe *Augochlorini*. Occupancy was above 90% at all locations (A) Occupancy decreased with housing density (B) and impervious surface (C) Occupancy was highest at a habitat complexity of 3 (D) Occupancy increased as flower density increased (E) Occupancy was highest at intermediate flower area (F) Detection was determined by observer, duration, and day of year.

Figure 2. The relationship between Occupancy and components of the most efficient model for Tribe *Osmiini*. Occupancy was below 75% at most locations (A) Occupancy increased as housing density (B) impervious surface (C) and habitat complexity (D) increased. Occupancy decreased as flower density increased (E) Observer and duration had no affect on detection. Detection was determined by day of year.

Discussion

- Ground nesting bees responded negatively to urban related factors. Occupancy declined in Tribe *Augochlorini* when modeled against housing unit density and impervious surface. This could be attributed to a loss of suitable nesting resources and floral hosts with heavy urban development. [5]
- Occupancy of the stem and wood nesting bees of Tribe *Osmiini* increased as housing unit density and impervious surface increased. This is likely due to the adaptability of cavity nesters using human made structures as nesting sites. Cavity nesting bees have been reported to nest in brick mortar and fence posts. [6]
- To support greater bee diversity in urban greenspaces, we recommend leaving old stems and wood debris, incorporating bare ground, and having an intermediate to highly complex garden to provide nesting material for ground and cavity nesting bees.

Citations: [1] https://www.princeton.edu/news/2018/10/18/bee-social-or-buzz-study-links-genes-social-behaviors-including-autism [2] Antoine, C.M. and Forrest, J.R. (2021), Nesting habitat of ground-nesting bees: a review. Ecol Entomol, 46: 143-159 [3] https://bugguide.net/node/view/1236850 [4] https://blogs.oregonstate.edu/gardenecologylab/2021/06/28/spring-with-the-mason-bees/ [5] Buchmann, S. & Ascher, J.S. (2005) The plight of pollinating bees. *Bee World*, 86, 71–74. [6] Sexton, A.N., Benton, S., Browning, A.C. *et al.* Reproductive patterns of solitary cavity-nesting bees responsive to both local and landscape factors. *Urban Ecosyst* 24, 1271–1280 (2021).

Acknowledgments

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