Analysis of Hairy Versus Non-Hairy Bees Across an Urban Gradient

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Introduction

- Wild bees provide pollination services that are essential to ecosystem function (Winfree, 2007).
- Urbanization is thought to negatively impact wild bees (De Palma et al., 2016) by reduction and fragmentation of foraging and nesting habitat (Brown, 2009).
- *Bombus* (bumble bees) have been reported to react differently to urban landscapes than other wild bee genera (Ahrné et al., 2009), with some species showing a preference for more urbanized areas (Healy, et al., 2021).
- Although few studies have associated specific physical traits with adaptation to urban settings, there are reports that *Bombus* size and its hairiness may contribute (Goulson, 2003).
- The present study evaluates hair and non-hairy wild bee abundance in relation to three proxies of urbanization: impervious surface, forest cover, and forest fragmentation index.

Study Sites

Table 1. Assessment of urbanization gradient within a 300-m radius for six bee sampling sites in Southeastern Massachusetts. Native Meadow and Beaver Brook are located on the Brockton campus of Massasoit Community College.

Sites →	Beaver Brook	Christos	Native Meadow	Sachem Rock	Leland Farm	Dunrovin Farm
Impervious surface (%)	42.87	45.39	34.85	11.98	3.89	1.90
Forest cover (%)	44.8	41.6	18.4	60.9	20.8	63.0
Forest fragmentation Index (m/m²)	0.038	0.042	0.138	0.031	0.076	0.022

Methods

- Biweekly sampling occurred in early spring to late fall from 2016 to 2021 on an urban to periurban gradient. Wild bees were caught via pan traps and sweep netting as described elsewhere (Popic, 2013).
- Bee hairiness was characterized based on previously published work from Holm (2017) and Roquer-Beni (2019).
- ArcGIS was used to measure proxies of urbanization: impervious surface (%), forest cover (%), and forest fragmentation index (forest edge (m)/ forest area (m2)) within 300m radii at six sites study sites in Southeastern Massachusetts.
- Change in abundance of hairy bees (*Andrena*, *Anthophora*, *Bombus*, *Colletes*, *Melissodes*, *Peponapis*, and *Xylocopa*) vs non-hairy bees (*Agapostemon*, *Ceratina*, *Nomada*, *Coelioxys*, *Hylaeus*, *Perdita*, and *Sphecodes*) was examined across proxies of urbanization using regression analysis

Results

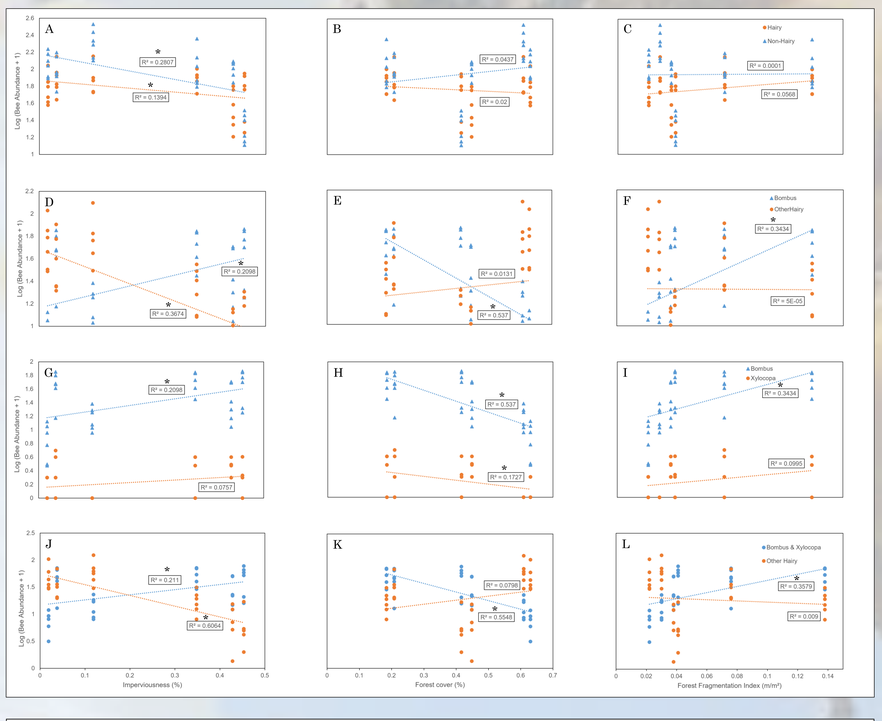

Figure 1. Relationships between log-transformed bee abundance and proxies of urbanization measured within 300m radii. Panels **A-C** compare hairy vs non-hair bees. Panels **D-F** compare *Bombus* vs other hairy bees. Panels **G-I** compare *Bombus* vs *Xylocopa*, both similar in size and hairiness. Lastly, panels **J-F** compare Bombus & Xylocopa vs other hairy bees. * indicates a statistically significant correlation (p<0.05).

Table 2. R^2-values and statistical significance for relationships between log-transformed bee abundance and proxies of urbanization. * indicates a statistically significant correlation (p<0.05).

Abundance ↓	Impervious Surface (%)	Forest Area (%)	Forest Fragmentation Index (m/m²)
Hairy	R^2 = 0.14*	R^2 = 0.02	R^2 = 0.06
Non-Hairy	R^2 = 0.28*	R^2 = 0.04	R^2 = 0.00012
Bombus	R^2 = 0.21*	R^2 = 0.54*	R^2 = 0.34*
Xylocopa	R^2 = 0.08	R^2 = 0.17*	R^2 = 0.05
Bombus & *Xylocopa*	R^2 = 0.21*	R^2 = 0.55*	R^2 = 0.36*
Other Hairy Bees (A) (Excludes *Bombus*)	R^2 = 0.37*	R^2 = 0.013	R^2 = 0.000015
Other Hairy Bees (B) (Excludes Bombus & Xylocopa)	R^2 = 0.61*	R^2 = 0.080	R^2 = 0.009

Discussion & Conclusion

- Although there was a significant negative correlation with impervious surface for both groups, no notable differences between hairy and non-hairy bees were observed.
- *Bombus* showed significant positive relationships with all three proxies of urbanization, which was opposite in slope to the remaining hairy bee group, suggesting that *Bombus* behaves differently than other hairy bees.
- *Bombus* and *Xylocopa* showed similar trends across all three proxies of urbanization, suggesting that these two groups of bees may be similarly adapted to urban settings. This analysis is also supported when *Bombus* and *Xylocopa* are combined and compared to other hairy bees.
- The most striking similarities between *Bombus* (ground-nesting) and *Xylocopa* (wood-nesting) is that they are both large, suggesting that large and hairy bees are well adapted to urban ecosystems.

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