DEPARTMENT OF ENTOMOLOGY

Bee community form and function in urban vacant land: Implications for managing pollinator friendly cities

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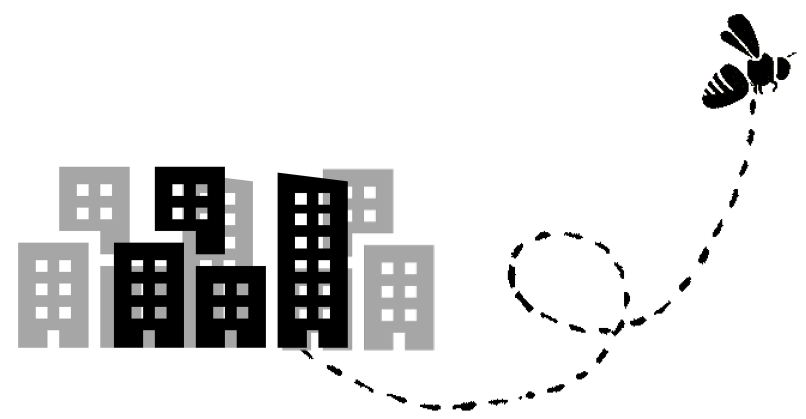


INTRODUCTION

- Rare and diverse bee communities are documented in cities (Baldock et al. 2015), prompting calls for urban bee conservation (Hall et al. 2017), which could mitigate global bee decline (Potts et al. 2010)
- 350 shrinking cities worldwide are prime targets for urban conservation as industrial decline has led to population loss and abundant vacant land (Rieniets 2009, Figure 1)
- If available vacant land is to support bee communities, we need to understand how local habitat features and landscape contexts influence bee communities and their resource use (Turo and Gardiner 2019)

Figure 1. Cleveland, OH contains 27,000+ vacant lots

Vacant land comprises ~10,000 acres and is unlikely to be re-developed (Keating 2010).

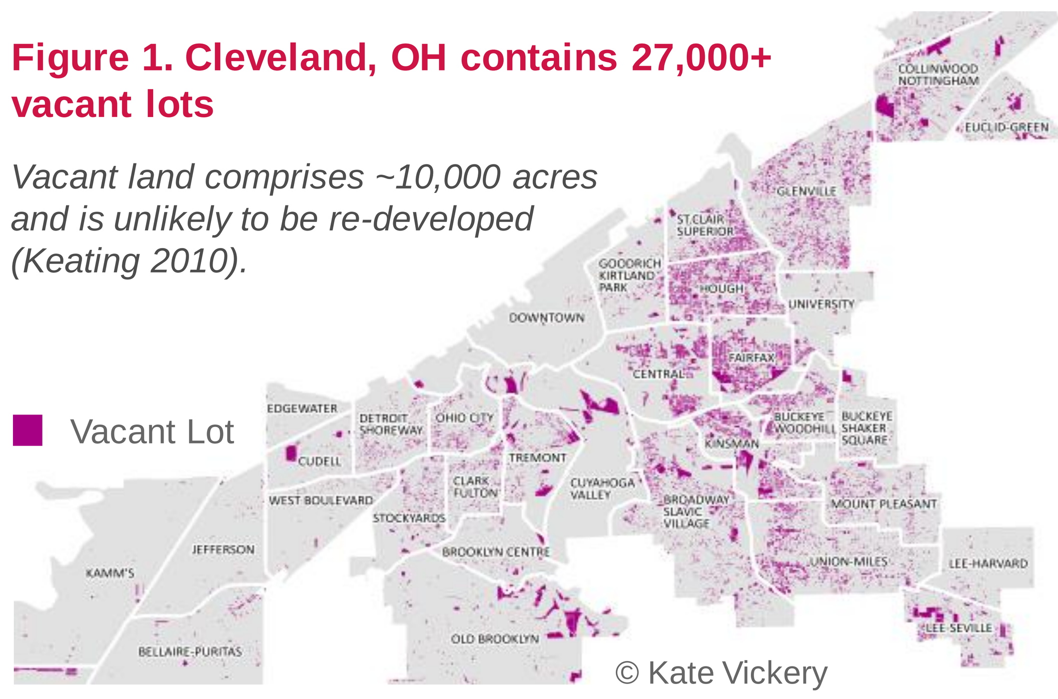
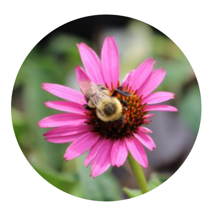


Figure 2. Transforming vacant lots to pocket prairies may conserve urban bees



OBJECTIVE: Examine how green space design and landscape structure influence 1) bee community structure, 2) foraging preferences

HYPOTHESES: (1) Bees will be more abundant in greener landscapes and habitats with high bloom richness (2) Foraging bees will have decreased *niche overlap* in diverse habitats

METHODS : FIELD EXPERIMENT

- We seeded 56 vacant lots in 8 neighborhoods with one of seven plant community treatments, including a turf grass control which was mown monthly (Figure 3)
- Vegetation height, bloom abundance, bloom area, and plant richness was surveyed monthly at each site

BEE SAMPLING

- We quantified bee community composition each month during the summers of 2015-16 with 7 yellow pan traps and 1 malaise trap at 40 sites (trts 1,3,4,5,6)
- Foraging was assessed twice each summer in all flowering sites (trts 1,2,5,6,7) by hand vacuuming bees from blooms for 4.5 minutes per each flowering species

STATISTICAL ANALYSIS

Surrounding landscapes (1500m radii) were analyzed in FRAGSTATs to calculate:

1) *Mean Greenspace Patch Size* (m^2)
2) *ENN*: average isolation between greenspace patches
3) *LPI*: % of landscape comprising the largest greenspace

Bee foraging networks ('bipartitie' package, R) quantified:

1) *Niche Overlap* = similarity of plants visited by bee species
2) *Network Generality* = mean # of plants visited by bee spp.

Generalized linear mixed models (negative binomial dist.) in R determined what landscape and plant characteristics best explained community patterns for bee:

- *Diversity, Richness, Abundance, Size, Nesting guilds*

Figure 3. The Cleveland Pocket Prairie Project tested seven unique urban green space designs

*We examined how greenspace designs influenced bee communities & foraging: **1)** Control: vacant lot seeded with turf grass and mown monthly, **2)** Meadow: control habitat undergoing succession, **3)** Fine-fescue Lawn: low-growing, non-native grass lawn, **4)** Grass Prairie: three tall native grass species, **5)** Flowering Lawn: low-growing lawn with four non-native forbs, **6)** Low Diversity Prairie: tall, flowering habitat with three native grasses and six forbs, and **7)** High Diversity Prairie: tall, flowering habitat with three native grasses and 22 forbs*

RESULTS

- We collected 3,806 bees from 107 species
- 44% ground nesting (*Miners*); 42% cavity nesting (*Renters*)
- Recorded foraging from 76 bee species to 52 plant taxa

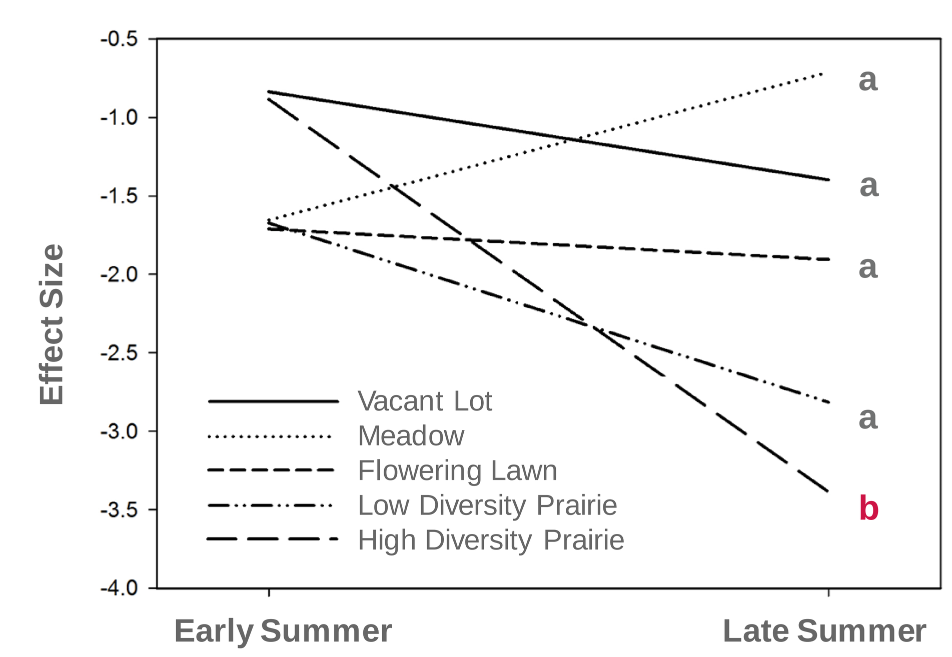
Figure 4.

Three exotic weeds accounted for > 50% of bee foraging visits

Red Clover **21%** | Chicory **19%** | Queen Anne's lace **13%**

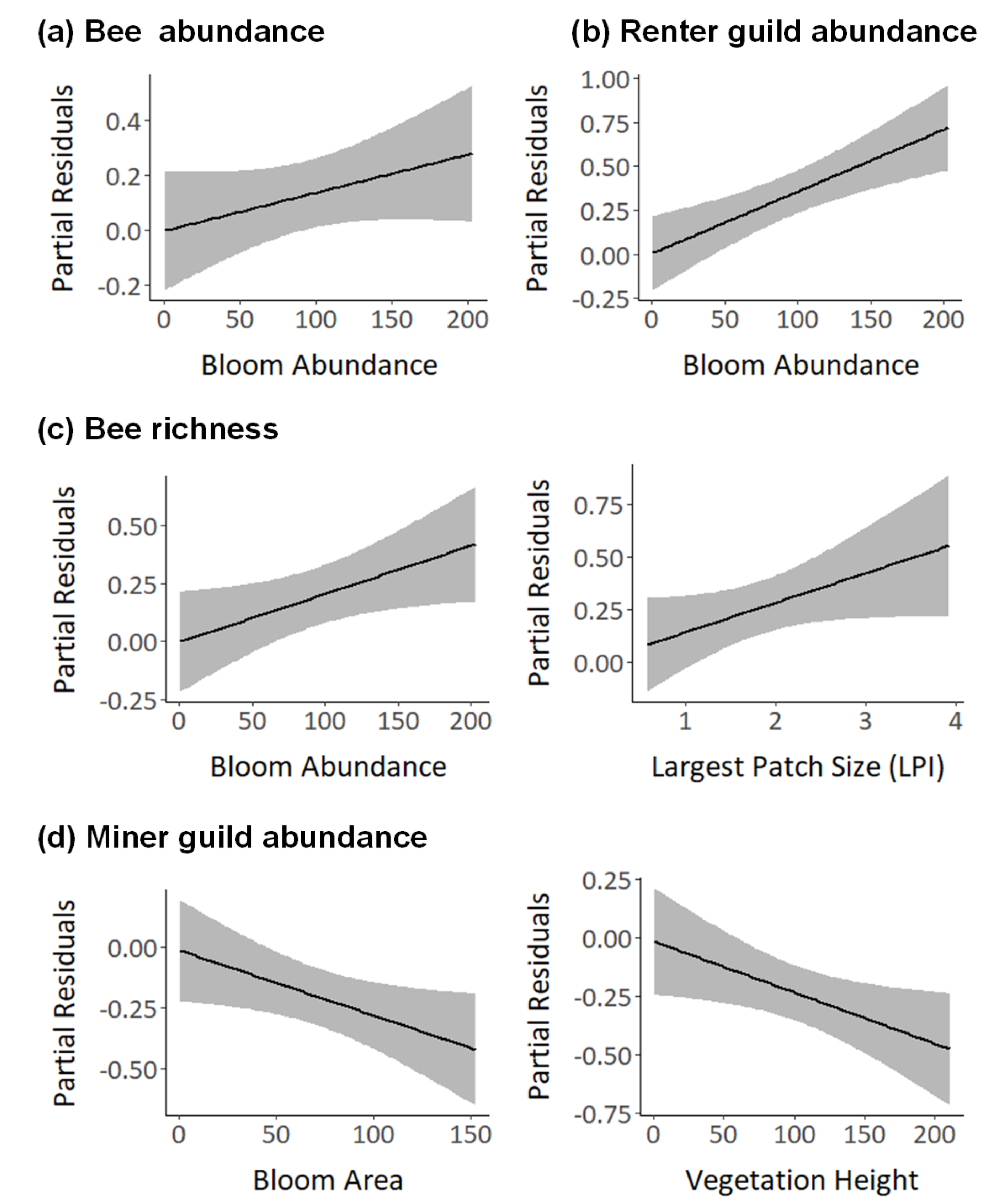
- Foraging was similar across habitats ($p > 0.05$) except for late summer High Diversity pocket prairies when *network generality* decreased (Fig. 5)
- Greater bloom abundance and larger greenspace patches were consistent drivers of the bee community (Figure 6)
- Ground nesting bees preferred habitats with smaller flowers and shorter plants (Figure 6) likely due to increased access to soil for nesting

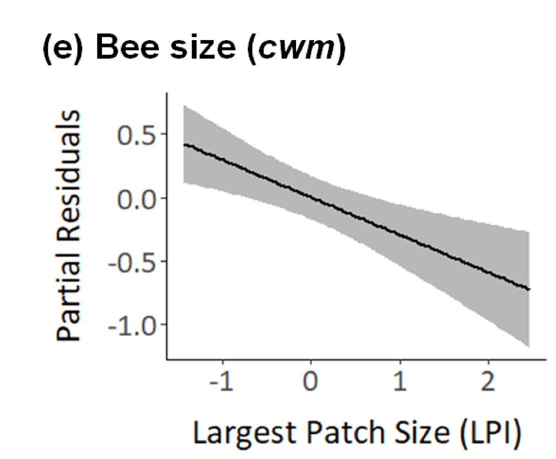
Figure 5. Bee foraging alters with habitat type and season



Network generality, (mean number of plant species visited) decreased in late summer within our high diversity pocket prairies, as compared to our control vacant lots ($p = 0.03$).

Figure 6. Local & landscape characteristics structure urban bee communities





All relationships shown were significant ($p < 0.05$). Plots display individual variables partial correlation to response variables after accounting for variation due to all other variables in the full model. Shaded bands indicate 95% Confidence Intervals.

CONCLUSIONS

Our study identified 3 key recommendations for conserving bees in cities. City planners should:

1. Locate new sites near pre-existing, large greenspaces to accommodate bee richness and especially small bees which might be sensitive to disturbance
2. Plant native wildflowers to provide critical late summer forage for pollinators (Salisbury et al. 2015)
3. Limit management for weeds, which provide critical bee forage, while maintaining a site's appearance for resident's expectations (Turo and Gardiner 2019)

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