How Does Percent Impervious Land Cover Affect the Correlation Between Ground-Nesting and Non-Ground-Nesting Bees?

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Introduction

- Bees account for much of the animal-mediated pollination provided to wild flowering plants and food crops, making them an important contributor to ecosystem health (Moisset and Buchmann 2009).
- Due to declines in domesticated honeybee populations, there may be an increased reliance on the pollination services of native and naturalized bees (Winfree *et al.* 2007).
- As urbanization and agricultural intensification increases, it remains unknown if there is competition between ground-nesting and non-ground-nesting bees for habitat resources (Kremen *et al.* 2002, Winfree *et al.* 2009, Geslin *et al.* 2016).
- Therefore, this study investigates the correlation between the abundance, richness, and diversity of ground-nesting and non-ground-nesting bees within six study sites along an urban to rural gradient based on percent impervious ground cover.
- To determine if increasing urbanization leads to enhanced competition between nesting guilds, the present study tests the following hypothesis: sites containing high impervious ground cover will show decreases in the abundance, richness, and diversity of ground-nesting vs non-ground-nesting bees.

Study Sites

Table 1. Assessment of land-use practices for six sites located in Southeastern Massachusetts. Native Meadow and Beaver Brook are located on the Brockton campus of Massasoit Community College.

SITES→	Christos (CH)	Beaver Brook (BB)	Native Meadow (NM)	Sachem Rock (SR)	Dunrovin Farm (DF)	Leland Farm (LF)
% Impervious	46.9%	46.0%	32.0%	7.9%	1.9%	0.5%
Terrain type	Urban parking lot	Urban college campus	Urban college campus	Suburban park	Rural farm	Commercial farm
Sustainable practice	None	Riparian buffer, reduced pesticides	Native plantings, reduced pesticides	Organic community garden	Reduced pesticides	None
Mowed	Never	Annually	Annually	Occasionally	Rarely	Plowed

Methods

- Samples were collected from April to November in the years 2016, 2017, and 2018.
- Bees were caught via sweep nets and pan traps to reduce collection bias (Roulston *et al.* 2007).
- Blue, white, and yellow pan traps (n = 10 per color) were deployed at each study site and retrieved after 24 hours (Droege 2015).
- Sweep netting was performed by two researchers along a 100-m transect for 30 minutes following pan trap collection (Popic 2013).
- Collection methods were normalized to sampling effort to account for damaged pan traps.
- Geographical Information System Software (ArcGIS) was used to estimate % impervious land cover (*e.g.* pavement and buildings) within a 300-m radius around each study site.
- Shannon diversity index was calculated based on genera per site and exponentially transformed (e^H) while abundance was log transformed. ANCOVA was used to find covariance, effect of site, and homogeneity of slopes.

Results

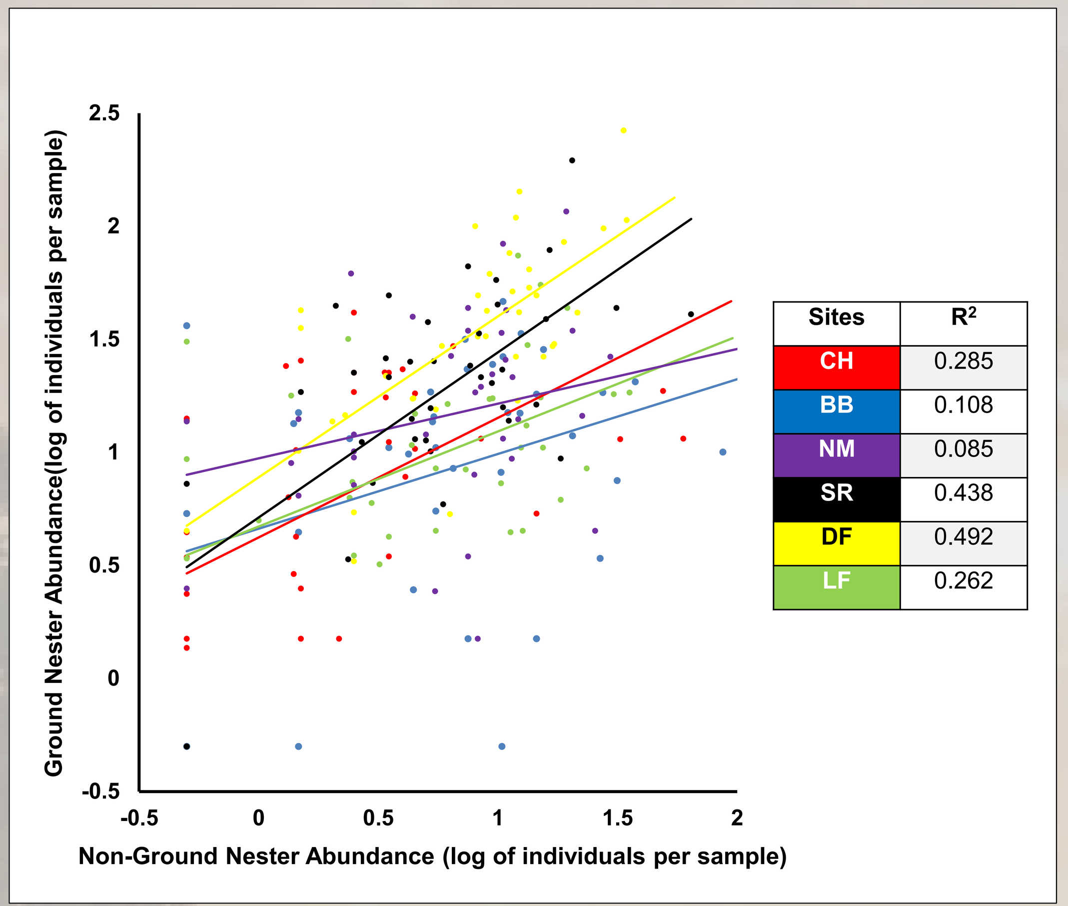

Figure 1. Correlation of ground and non-ground nester abundance per site. Analysis of covariance revealed that log transformed ground nester and non-ground nester abundances covaried ($F_{1,227}$=70.6, p<0.0001), and that ground nester abundance differed among sites ($F_{5,227}$=8.40, p<0.0001). However, the slopes of each trendline did not differ ($F_{5,216}$=1.88, p=0.0987).

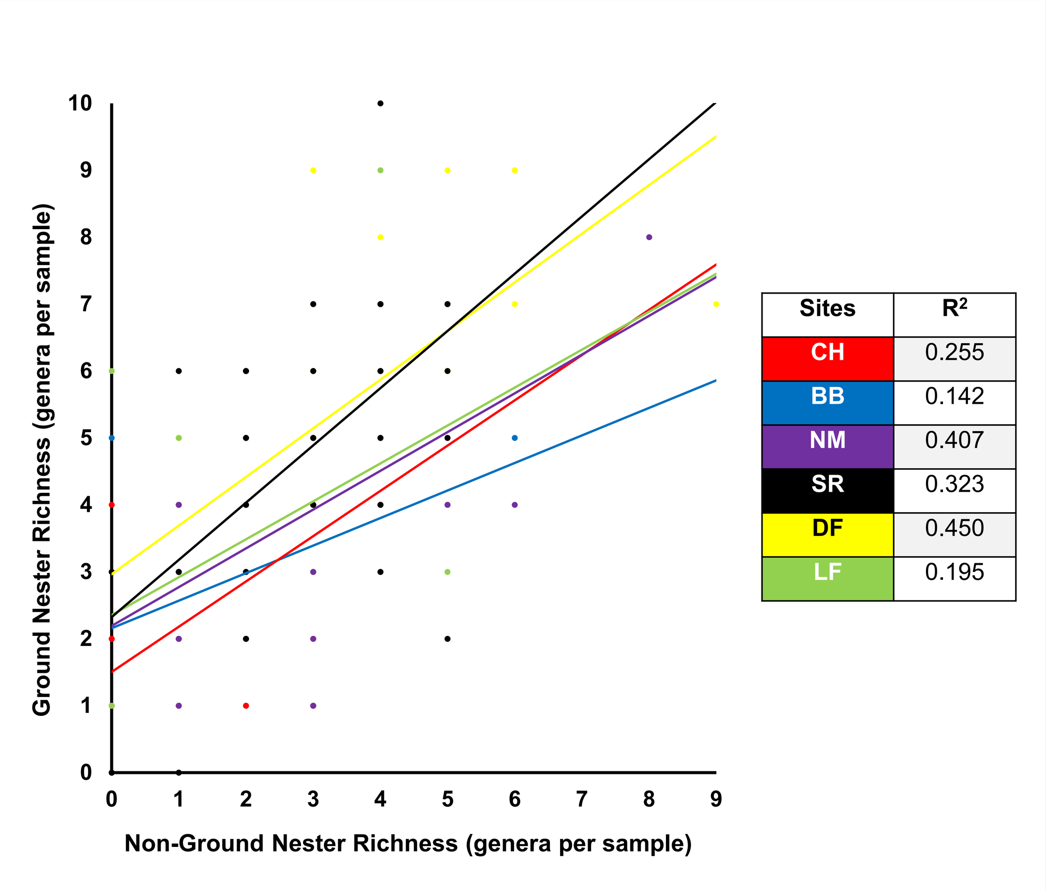

Figure 2. Correlation of ground and non-ground nester genera richness by site. Analysis of covariance revealed that ground nester and non-ground nester richness covaried ($F_{1,227}$=92.2, p<0.0001), and that ground nester richness differed among sites ($F_{5,227}$=6.87, p<0.0001). However, the slopes of each trendline did not differ ($F_{5,216}$=0.83, p<0.5284).

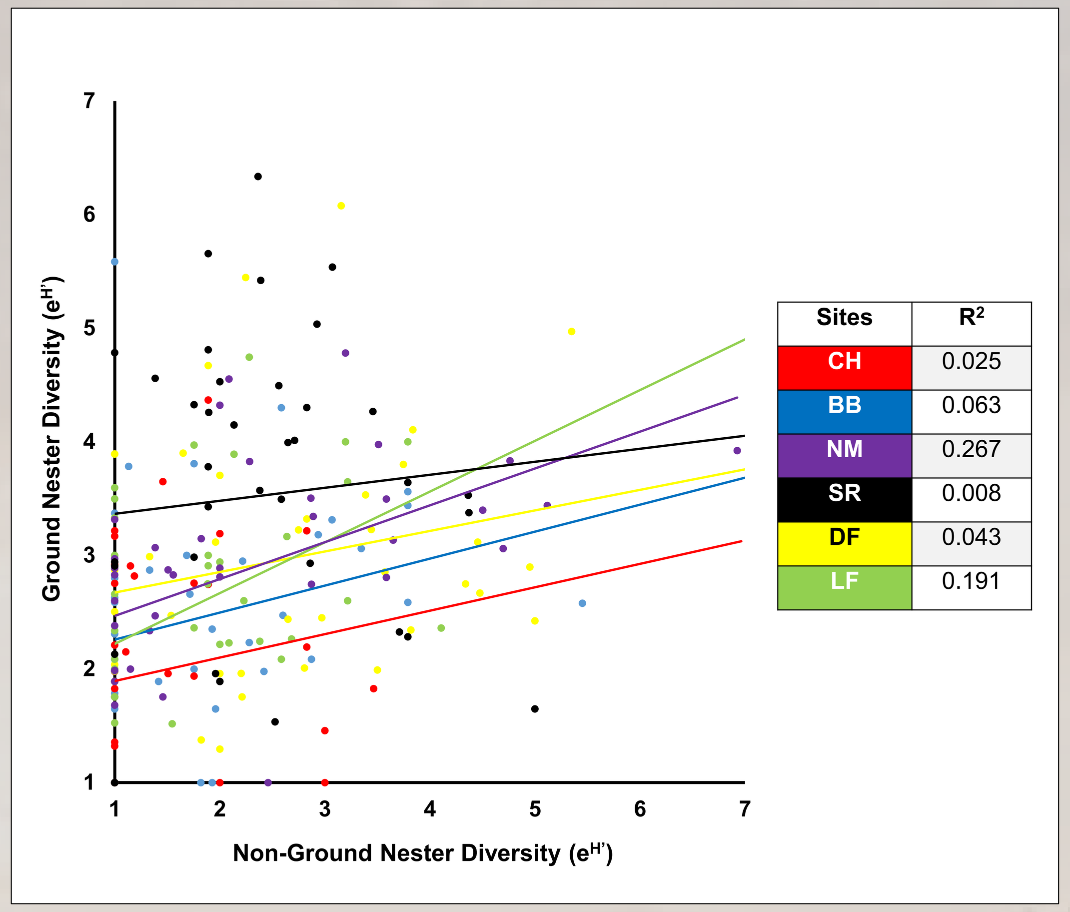

Figure 3. Correlation of ground and non-ground nester diversity by site. Analysis of covariance revealed that genus-based Shannon indices of ground nester and non-ground nester diversity covaried ($F_{1,227}$=16.5, p<0.0001), and that ground nester diversity differed among sites ($F_{5,227}$=6.31, p<0.0001). However, the slopes of each trendline did not differ ($F_{5,216}$=0.50, p<0.7765).

Discussion and Conclusion

- Contrary to the hypothesis, positive correlations between ground-nesting and non-ground nesting bees were observed for abundance, richness and diversity at every site. This suggests no competition between the two guilds in rural or urban settings.
- Generally, the correlations for abundance and richness were stronger at rural sites than urban sites. This suggests that resources at rural sites are beneficial regardless of nesting habitats, whereas resources at urban sites are not equally beneficial.
- The most rural site, Leland Farm, had weaker correlations in abundance and richness compared to the other sites. This could be because plowing and tilling soil can potentially destroy the homes of ground nesting bees.
- The correlation for bee diversity was weak for all sites except Native Meadow, an urban site with sustainable land-use practices. This suggests that sustainable land-use practices in urban areas may support bee diversity.
- Percent impervious land cover does not appear to create competition between ground-nesting and non-ground-nesting bees. Furthermore, sustainable land-use practices may be beneficial for promoting urban ecology and local bee communities, particularly in an urban setting.

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