

# The Impact of Sustainable Land-Use Practices on Bee Nesting Guild Diversity

A. Schofield, P. Sanon, A. Germaine, A. Oguma, F. Ajayi, and M. Bankson

Division of Math and Science, Massasoit Community College, Brockton, Massachusetts, USA

Twitter: @MassasoitSTEM; Email: STEMstarter@massasoit.edu



## Introduction

- Animal pollination is partially responsible for 35% of the global food supply (Klein *et al.*, 2007).
- Bee communities are the largest contributors to animal pollination (Neff, 1993).
- Reports of declines in bee communities have led to the implementation of bee-friendly land-use practices (Ghazoul, 2005; National Research Council, 2007; Winfree, 2010).
- Many studies have focused on overall diversity of bee communities, but little is known about the effect of land use on nesting guild diversity (e.g. Steffan-Dewenter *et al.*, 2005).
- This study measured the diversity of seven different bee nesting-type guilds at six sites varying in land-use practices.
- Hypothesis: Urban sites with implemented sustainable land-use practices will display nesting guild diversities comparable to those of rural sites with expected high nesting guild diversities.

## Study Sites

**Table 1.** Characteristics of the six study sites located in Southeastern Massachusetts, Plymouth County. Beaver Brook and Native Meadow are located on the Massasoit Community College's Brockton Campus. Classification of urban vs. rural is based on the percentage of impervious land cover.

Location	Christo's	Beaver Brook	Native Meadow	Sachem Rock	Dunrovin Farm	Leland Farm
Sustainable Land-use	No	Yes	Yes	No	No	No
% Impervious Land Cover	46.85%	46.03%	32.03%	7.88%	1.93%	0.50%
Classification	Urban	Urban	Urban	Rural	Rural	Rural

## Methods

- Data were collected from April to October of 2016 and 2017.
- Ten replicates of three pan traps (yellow, blue, and white) were placed five meters apart at each site for 24 h (Droege, 2015).
- Sweep netting was conducted by two collectors, for 30 minutes, along a 100-meter transect spread across the pan trap collection area at each site (Popic, 2013).
- Bees were preserved in ethanol before being processed, pinned, identified to genus and nesting guild, and archived (Packer, 2007).
- Abundances were normalized per sampling effort (combined 24-h pan trapping and 1 collector-hour sweep netting).
- Geographical information system software (ArcGIS) was used to quantify percent impervious within a 300-meter buffer at each site.
- ANOVA was used to test for differences in nesting guild diversity among sites.
- MANOVA was chosen to test for the effects of our study sites on the abundances of bee guilds.

## Results

- There was a significant effect of site on both nesting guild diversity and abundance.
- Beaver Brook and Sachem Rock displayed nesting guild diversities that were statistically higher than Christo's.
- Leland farm and Beaver Brook measured relatively low abundances, but displayed high nesting guild diversities.
- All six sites were dominated by ground-nesters.



**Figure 1:** Data represented are from the 2016-2017 collection period. **Figure 1A:** Bars represent the mean Shannon Diversity Index ( $H'$ ) of each site ( $\pm$  SEM). Shannon Index calculation was based on nesting guilds. **Figure 1B:** Bars represent the mean abundance per sampling effort of each site. Each stacked bar depicts the mean relative abundance per sampling effort of each nesting guild.

## Discussion

- Ground-nesting bees made up the majority of bee abundance at all sites, suggesting that habitat necessary for ground-nesters is available at all sites.
- Christos measured the lowest diversity and abundance, suggesting that urban sites without sustainable practices support less diversity and low abundance in bee communities.
- Beaverbrook, an urban site with a similar impervious land-cover to Christo's but with sustainable land-use practices implemented, displayed the highest nesting guild diversity. This may suggest that sustainable land-use practices positively impact bee communities.
- Beaverbrook showed a relatively low abundance, suggesting that land-use practices may affect nesting guild abundance and diversity differently. Leland farm, a rural site with large amounts of monoculture, displayed similar results.
- Native Meadow was the only urban site to measure both relatively high nesting guild abundance and diversity, suggesting that the land-use practices at this site may help to support both diverse and densely populated communities.

## Conclusions

- These data suggest the possibility that ground-nesting bees make up the majority bee communities in southeastern Massachusetts, which is consistent with other New England findings (Veit, 2018).
- These data are consistent with the notion that nesting guild diversity and abundance may be positively impacted at an urban site through the implementation of bee-friendly land-use practices.
- Land-use practices affect nesting guild diversity and abundance differently.

## Future Work

- Correlating this study's results with plant diversity and water quality data could provide further insight into these conclusions.
- An increased number of sites could provide more understanding of how land use affects bee communities.

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