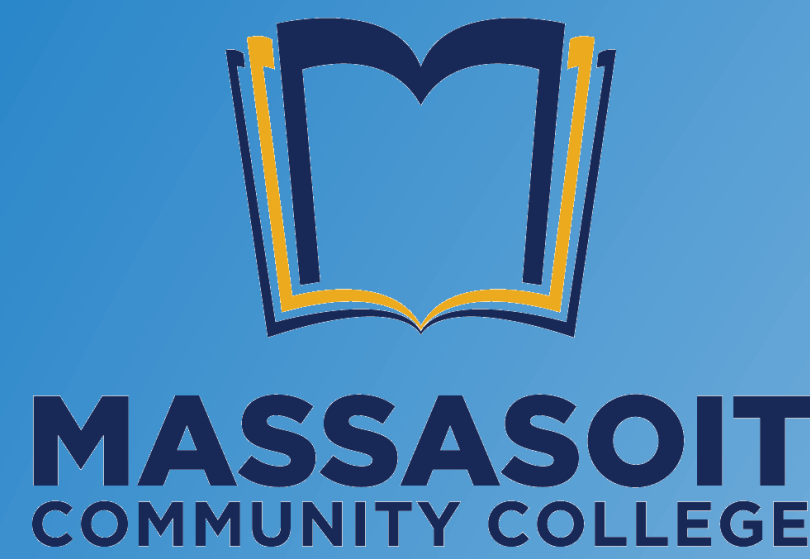


Forest Fragmentation is a Strong Indicator of Bee Abundance and Richness Across an Urban Gradient in Southeastern Massachusetts

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Introduction

- Wild bees are essential to ecosystem function and health as they provide pollination services to wild flowering plants (Winfree 2007).
- The reduction and fragmentation of natural areas due to urbanization are increasing globally and their impact on the bee community is not well understood (Brown 2009).
- To mitigate the impact of urbanization on the local ecosystem, city planners may implement sustainable land use practices that support a resilient ecosystem (Colding 2006).
- When implementing greenspaces with sustainable land use practices, the optimal amount of forest area, size, and edge needs to be taken into consideration to maximize its benefit on the bee community.
- Therefore, this study investigates the effect of forest proportion, forest edge length, and forest fragmentation on bee richness and abundance across an urban gradient in Southeastern Massachusetts.

Study Sites

Table 1. Assessment of land-use practices (within a 750-m radius) for six bee sampling sites located 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	44.66%	44.47%	28.17%	13.11%	8.04%	2.76%
% Forest cover	38.62%	38.57%	28.67%	63.59%	32.22%	69.26%
Forest edge / Forest area	0.036	0.040	0.033	0.025	0.037	0.014
Land use	Urban college campus	Urban parking lot	Urban college campus	Suburban park	Commercial farm	Semi-forested lot

Methods

- Samples were collected from April to November in the years 2016, 2017, 2018, and 2019.
- Bees were collected via pan trap and sweep net to reduce sampling bias (Roulston *et al.* 2007).
- Bee collection occurred every two weeks using a set of 30 pan traps per collection (equal numbers of blue, white, and yellow traps; Droege 2015).
- Sweep netting, was conducted by two researchers along a 100-m transect for 30 minutes following pan trap collection (Droege 2015).
- Forest edge length and forest proportion, both within a 750-m radius of sites, were estimated using Geographical Information Software (ArcGIS; Figure 2).
- Fragmentation index was quantified as the ratio of forest edge length (m) to forest area (m²; Table 1; Nemesio 2010).
- Pearson correlations analyses assessed relationships between bee abundance and forest attributes, as well as between bee richness and forest attributes. Each site over one season was treated as an individual replicate (6 sites, 4 seasons, n=24).

Results

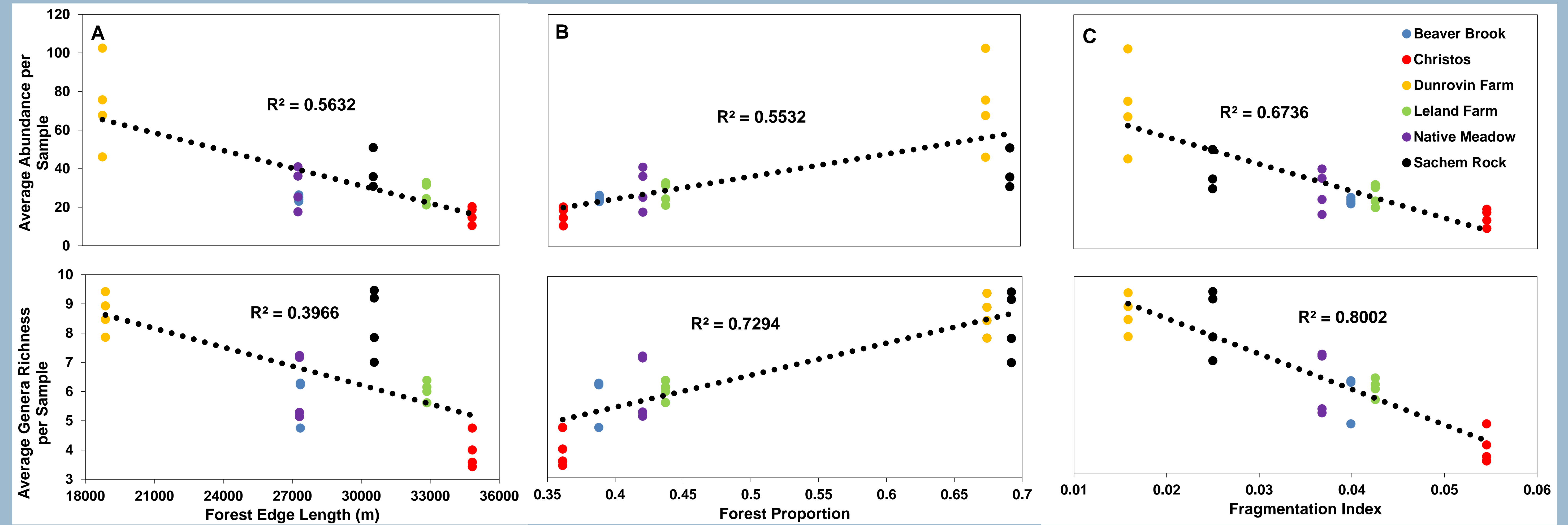


Figure 1. The relationship between yearly mean bee abundance per sample and yearly mean bee genera richness per sample with A) forest edge length, B) forest proportion, and C) fragmentation index at the 750m spatial scale. A greater fragmentation index indicates less contiguous forest patches. All correlations above were statistically significant (Pearson correlation, $p < 0.05$).



Figure 2. Map of two bee sampling sites, A) Christos and B) Dunrovin Farm, within a 750-m radius. Forest area shown in yellow hatch.

Discussion

- Although there were negative relationships between forest edge length and bee richness and abundance, the proportion of forest area had a positive effect on the bee community. This suggests that contiguous forest area may be a strong predictor of bee abundance and richness in an urban setting.
- Wild bees were more abundant and had a greater richness in larger forest fragments. This is consistent with a study in an urban setting, which suggested that large fragments may contain more foraging and nesting resources for the bee community (Neame 2013).

Conclusion

- Conservation of forest area in an urban setting may be beneficial for bee abundance and richness in Southeastern Massachusetts.
- Connectivity of greenspaces may help mitigate the effect of urbanization on bee richness and abundance.
- Further research of how bees with different nesting behaviors react to forest fragmentation is needed to understand the full effect on bee community composition.

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