

The Impact of Urbanization on *Bombus* (Bumblebees) in Southeastern Massachusetts

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Introduction

- Human land-use changes such as urbanization are thought to have a potential negative impact on the bee community (De Palma 2016).
- Reports of high *Bombus* (bumblebee) abundance in urbanized areas suggest that *Bombus* may be more resistant to the impacts of urbanization compared to other wild bee genera (Ahrné 2009).
- Bombus impatiens* may be specifically suited for urban settings as the majority of *Bombus* in most of the eastern United States (Jacobson 2018).
- This study examined the impact of urbanization using percent impervious ground, forest area and fragmentation as proxies for urbanization on *Bombus* compared to other wild bee genera, as well as on *Bombus impatiens* compared to other *Bombus* spp.

Study Sites

Table 1: Quantitative assessment of land-use practices for six study sites located in Plymouth County, Massachusetts. Native Meadow and Beaver Brook are located on the Brockton campus of Massasoit Community College.

Site	Beaver Brook	Christos	Native Meadow	Sachem Rock	Dunrovin Farm	Leland Farm
% Impervious	32.24%	36.82%	27.04%	10.23%	3.20%	13.22%
Forest Area	2661771 (41%)	245044 (37%)	532264 (45%)	186689 (66%)	163362 (66%)	314080 (47%)
Fragmentation	0.03697	0.04065	0.03308	0.02572	0.01471	0.03734

Methods

- Bees were sampled biweekly, from 2016 to 2019, with colored pan traps and sweep nets at six study sites along an urban gradient (Roulston *et al.* 2007).
- Bombus* collected from 2018 to 2019 were identified as either *Bombus impatiens* or other *Bombus* spp.
- Pearson correlation analyses were used to determine the relationship between proxies of urbanization (% impervious, forest area, fragmentation) and bee abundance.
- ArcGIS was used to calculate the percentage of impervious land cover, forest area and fragmentation within a 1000-m spatial scale.
- Fragmentation (m/m^2) was calculated using the ratio of forest edge (m) to forest area (m^2).

Results

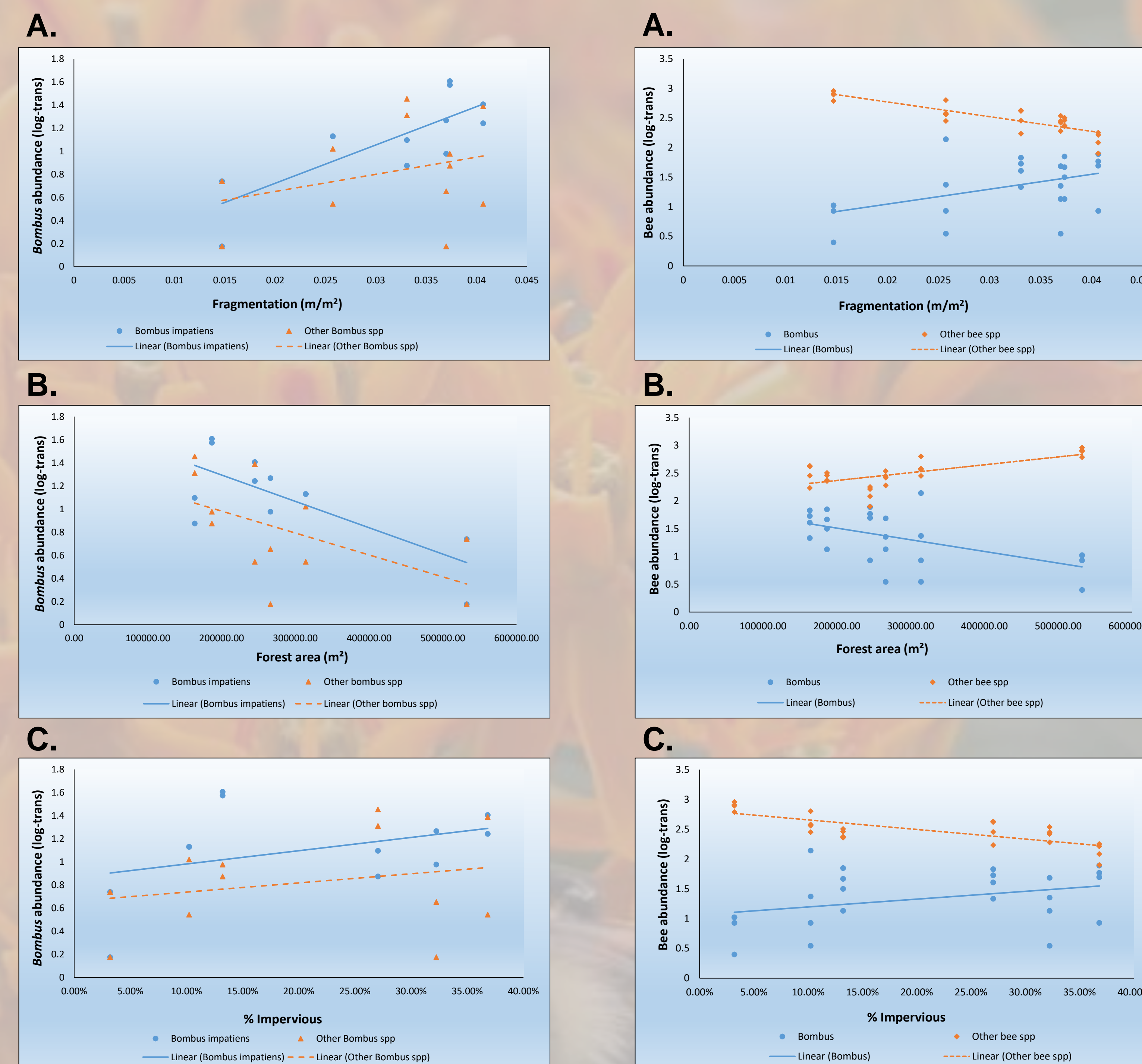


Table 2: Display of r -values and p -values for relationships between abundances of *Bombus impatiens*, other *Bombus* spp. (minus *B. impatiens*), total *Bombus* spp., other bee spp. (minus *Bombus* spp.) and three proxies of urbanization: fragmentation (m/m^2), forest area (m^2) and % impervious.

Abundance →	<i>Bombus impatiens</i>	Other <i>Bombus</i> spp.	<i>Bombus</i> spp.	Other Bee spp.
Fragmentation	$r=0.78/p=0.0026$	$r=0.32/p=0.3158$	$r=0.48/p=0.0184$	$r=-0.85/p=0.0000002$
Forest Area	$r=-0.74/p=0.0078$	$r=-0.56/p=0.06$	$r=-0.55/p=0.01847$	$r=0.67/p=0.0004$
% Impervious	$r=0.38/p=0.2257$	$r=0.24/p=0.4606$	$r=0.35/p=0.972$	$r=-0.76/p=0.00004$

Discussion & Conclusion

- The observation of similar trends between *Bombus impatiens* and other *Bombus* species versus all three proxies of urbanization suggest that all local species of *Bombus* react in a similar and favorable way to increasing urbanization.
- Genus *Bombus* as a whole showed strikingly opposite trends across all three proxies for urbanization compared to all other bees, suggesting that *Bombus* may show a genus-wide adaptation to urbanization.
- The different patterns exhibited by *Bombus* compared to other bee species suggests that analysis of specific genera or guilds may improve the predictive value of land attributes like % impervious ground, forest area and fragmentation.
- More studies are needed to determine if these trends are consistent across different geographies and climates.

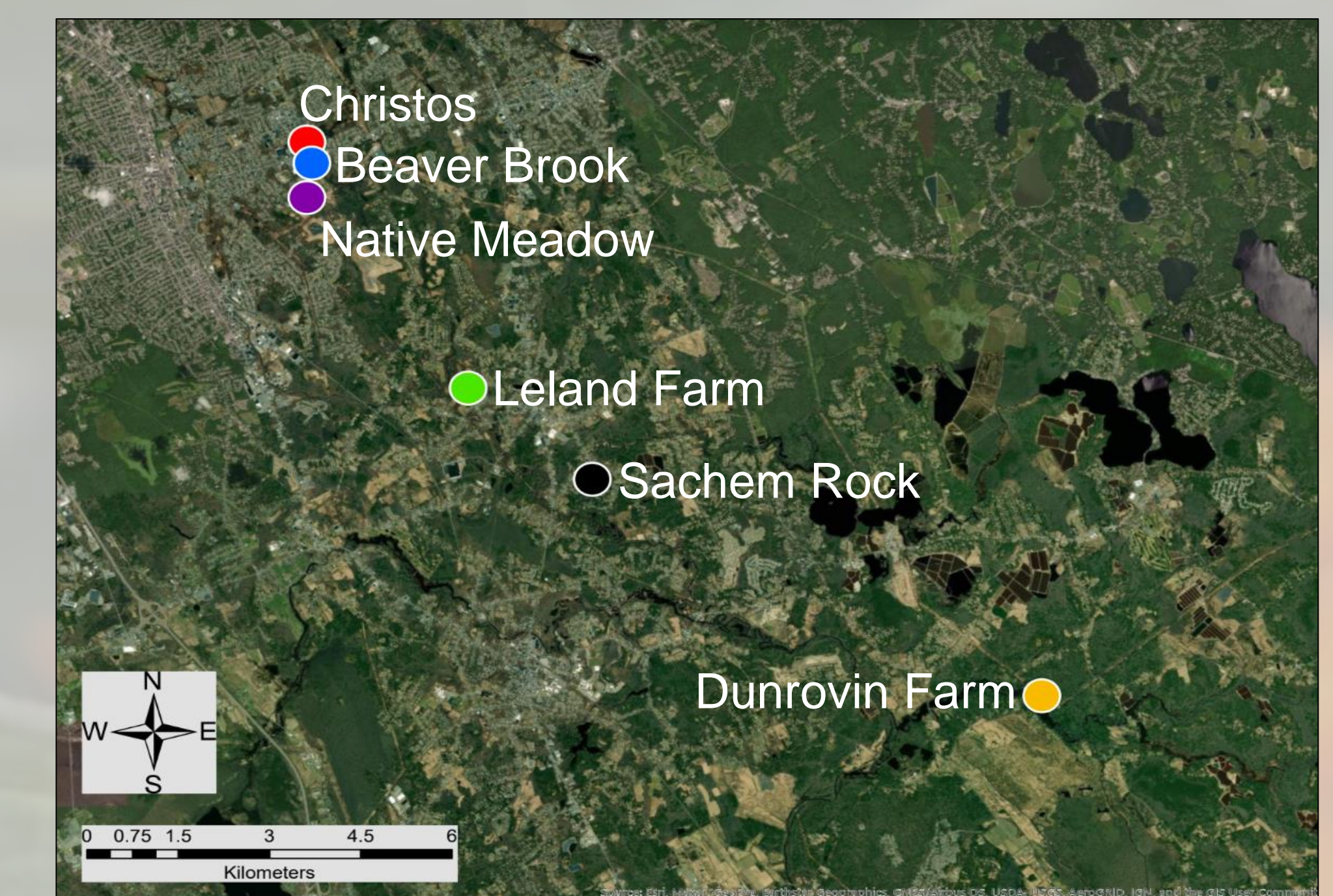


Figure 3: Aerial view of six study sites located in Plymouth County, Massachusetts. Beaver Brook and Native Meadow are located on the Brockton campus of Massasoit Community College.

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