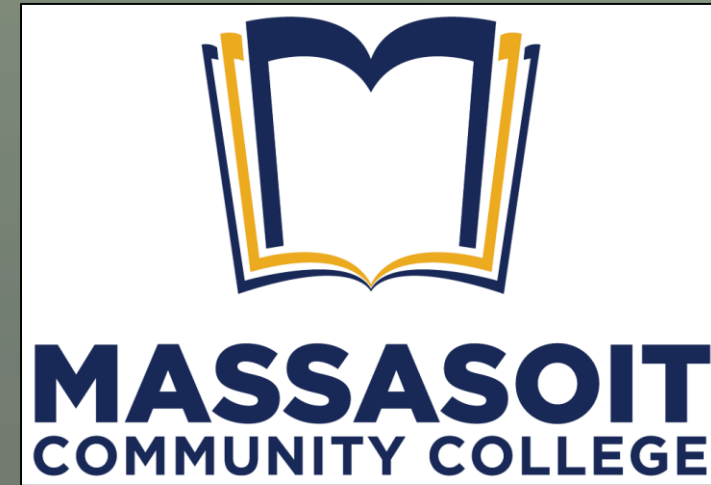


Genera-Specific Analysis of Wild Bees in an Urban Ecosystem

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Introduction

- Human land-use, particularly urbanization, may contribute to reported declines in wild bees (Potts et al. 2016; Cardoso & Gonçalves 2018).
- Wild bees display a variety of physical and behavioral differences (De Palma et al. 2016) and may react differently to environmental changes brought on by urbanization.
- This study investigates the correlation between the dominant wild bee genera in southeastern Massachusetts for each of three proxies of urbanization: impervious land cover, forest cover, and forest fragmentation index (area/edge).

Methods

- Sampling took place biweekly from early spring to late fall for the years 2016 to 2020 using pan trap and sweep netting (Roulston et al. 2007).
- ArcGIS was used to calculate the proportion of forest cover, forest edge, and impervious land cover for each site at a 300-m spatial scale.
- Forest Fragmentation Index (m²/m) was calculated using the ratio of forest edge and forest cover.
- Only bees that made up 5% or more of the total abundance (5 genera) were included in the analysis, with *Apis* being excluded due to their domestic status.
- Relationships between each proxy of urbanization and genus abundance were assessed using Pearson correlations.
- The effects of year and genus (while accounting for the forest cover, impervious land cover and forest fragmentation index) on abundance were evaluated using a two-way ANCOVA.

Table 1. Composition of six bee sampling sites located in Southeastern Massachusetts, taken at a 300-m radius. Native Meadow and Beaver Brook are located on the Brockton campus of Massasoit Community College.

Sites	Beaver Brook	Christos	Dunrovin Farm	Leland Farm	Native Meadow	Sachem Rock
% Impervious	42.8%	45.3%	1.9%	3.8%	34.8%	11.9%
% Forest cover	44.8%	41.6%	63%	20.8%	18.4%	60.9%
Forest Fragmentation Index	0.038	0.041	0.022	0.076	0.138	0.03

Results

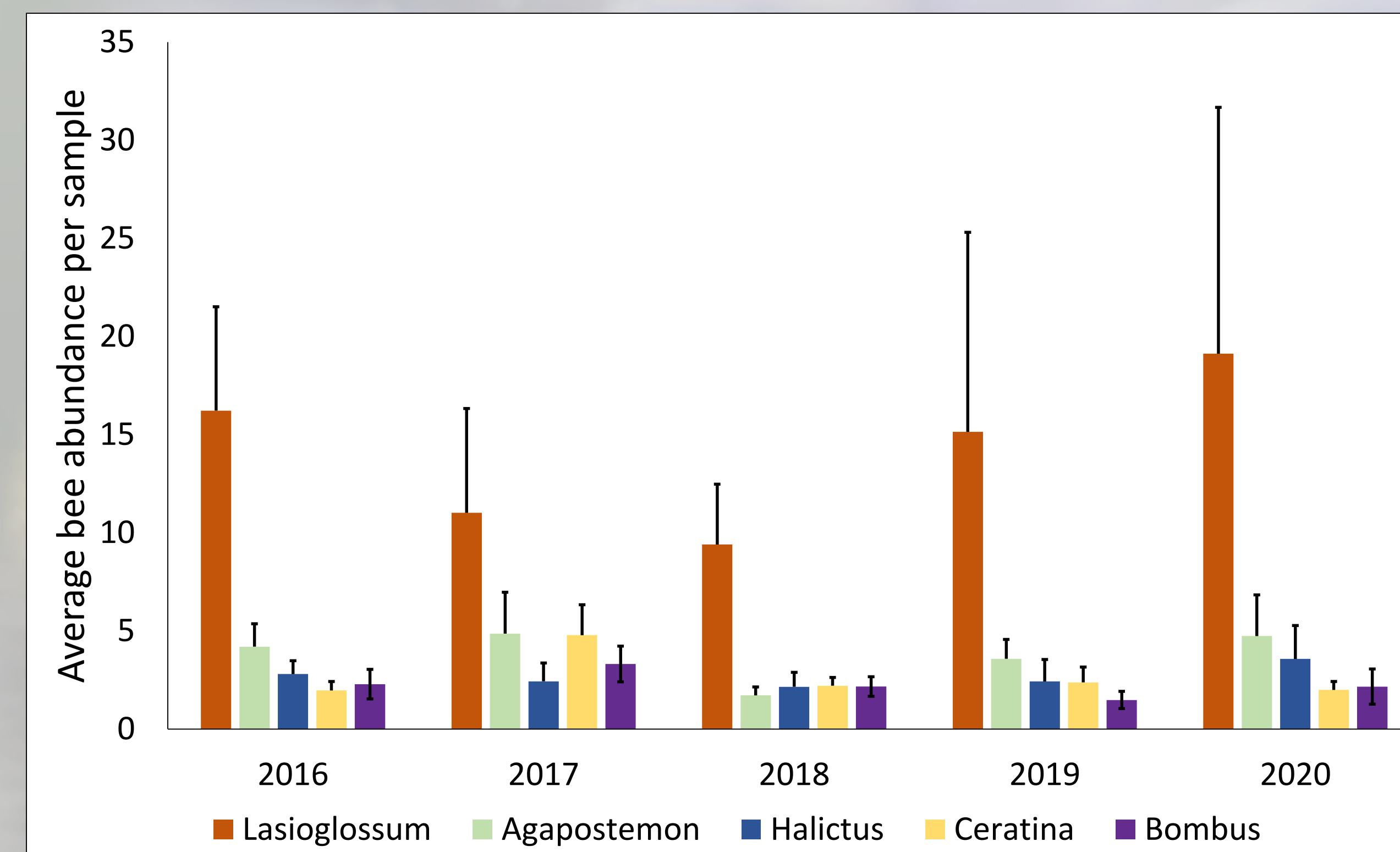


Figure 1. Average abundance per sample of the top five genera over five sampling years. There was a significant effect of genus ($F_{4,122} = 10.37, p < 0.01$), though nonsignificant effect of year ($F_{4,122} = 0.45, p = 0.76$) and nonsignificant interactive effect of year and genus, while controlling for each proxy of urbanization ($F_{16,122} = 0.29, p = 0.99$).

Table 2. Pearson correlations between log transformed average genus abundance per sample and each proxy of urbanization. * indicates $p > 0.05$, ** indicates $p > 0.01$

Abundance	<i>Lasiglossum</i>	<i>Bombus</i>	<i>Agapostemon</i>	<i>Ceratina</i>	<i>Halictus</i>	All Bees
Impervious Land Cover	-0.641**	0.407*	-0.396*	-0.559**	-0.232	-0.696**
Forest Cover	0.393*	-0.74**	0.246	-0.006	0.652**	0.448*
Forest Fragmentation Index	-0.176	0.594**	-0.064	0.225	-0.297	-0.208

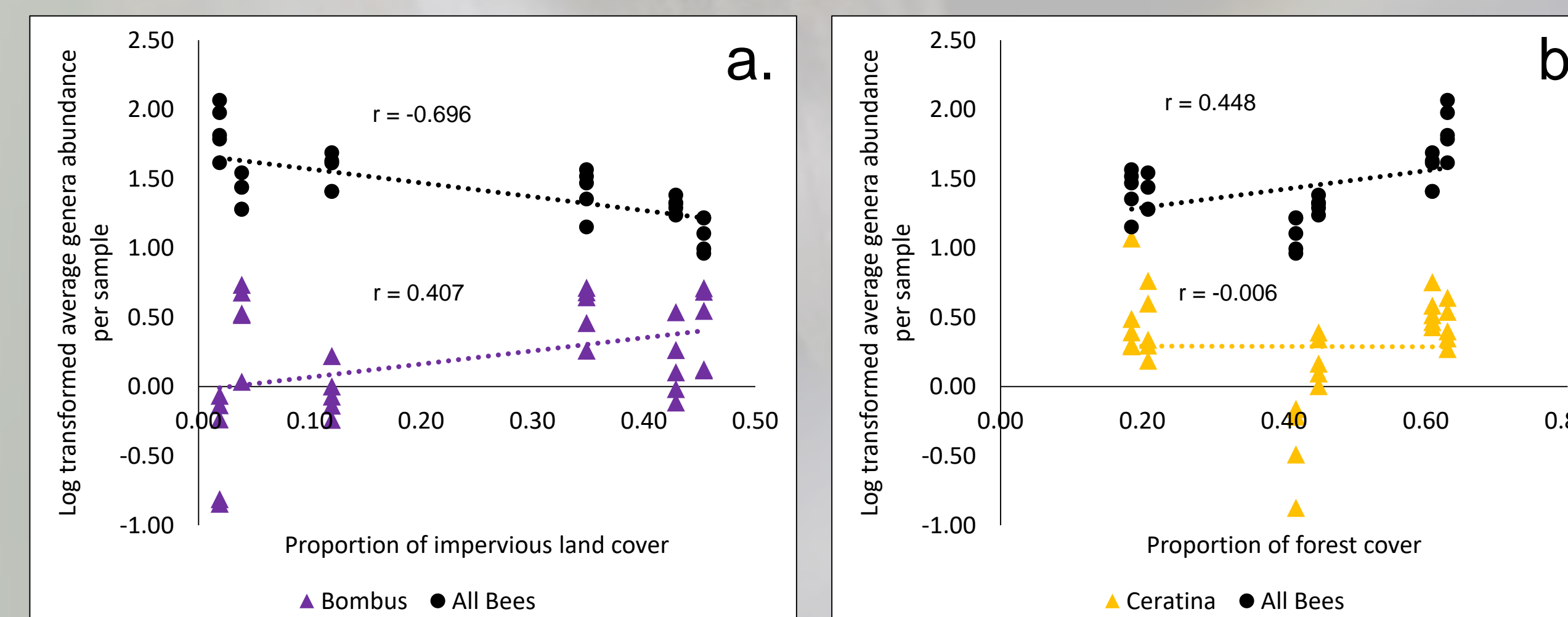


Figure 2. Relationship between (a) log transformed average abundance for all bees and *Bombus* vs. proportion of imperviousness and (b) log transformed average abundance for all bees and *Ceratina* vs. proportion of forest cover. Panel (a) shows a moderate negative correlation between all bees and imperviousness but a weak positive relationship between *Bombus* and imperviousness. Panel (b) shows a weak positive relationship between all bees and forest cover but no correlation between *Ceratina* and forest cover.

Discussion

- Lasiglossum* (39%), *Agapostemon* (10%), *Halictus* (9%), *Ceratina* (7%), and *Bombus* (5%) did not show a significant change in abundance over five years, suggesting that a longer-term monitoring period may be necessary to differentiate between short and long-term trends in the bee community.
- Bombus* had a positive correlation with urbanization while *Lasiglossum*, *Ceratina* and *Agapostemon* had negative correlations, suggesting that not all bees are impacted by urbanization the same.
- There was an inconsistent predictive ability of these urbanization proxies, suggesting that the relationship between each genus and each proxy may vary.

Conclusion

- Continued monitoring beyond five years is needed to assess the long-term changes in wild bee abundance.
- Human activity impacts bees in a genus-specific manner.
- Genus-level analysis should be included in wild bee abundance studies.

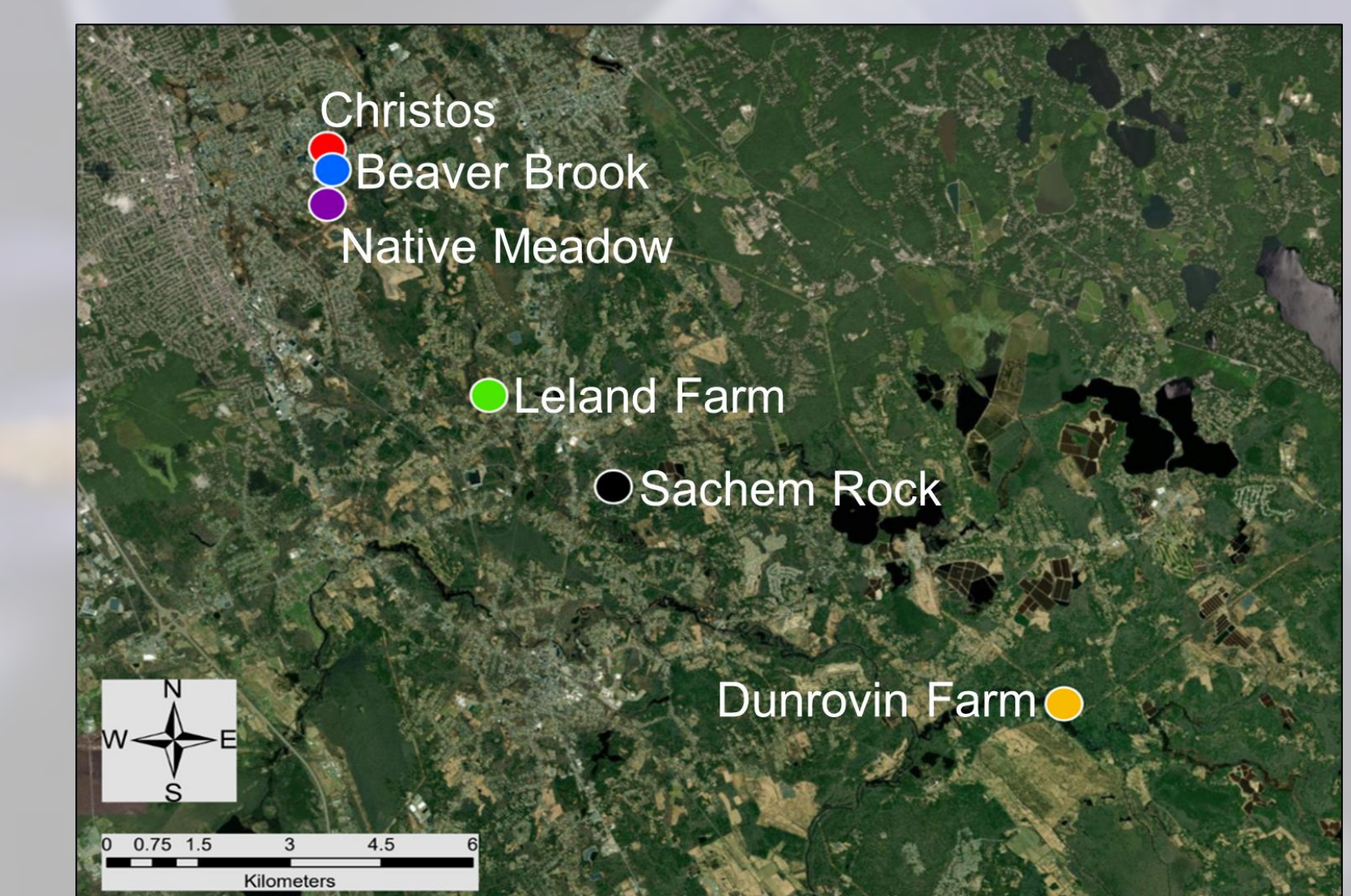


Figure 3. Aerial view of six study sites located in southeastern Massachusetts. From southeast to northwest represents an increasing urbanization gradient.

Acknowledgements

This research was made possible thanks to the state of Massachusetts STEM Starter Grant, the National Science Foundation, and Massasoit STEM. Additional thanks go to D. Brown, N. Hayes-Huer, R. Franciosi, A. Vanhelene, B. Moise, D. Tao, E. Visser, F. Lyncee, G. Sandefur, J. Keady, K. Vaz, L. Riberio, M. Arif, M. Demaesschalck, N. Jean, R. Hayes-Huer, S. Wong, V. Lopes, and Z. Thoutte.

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