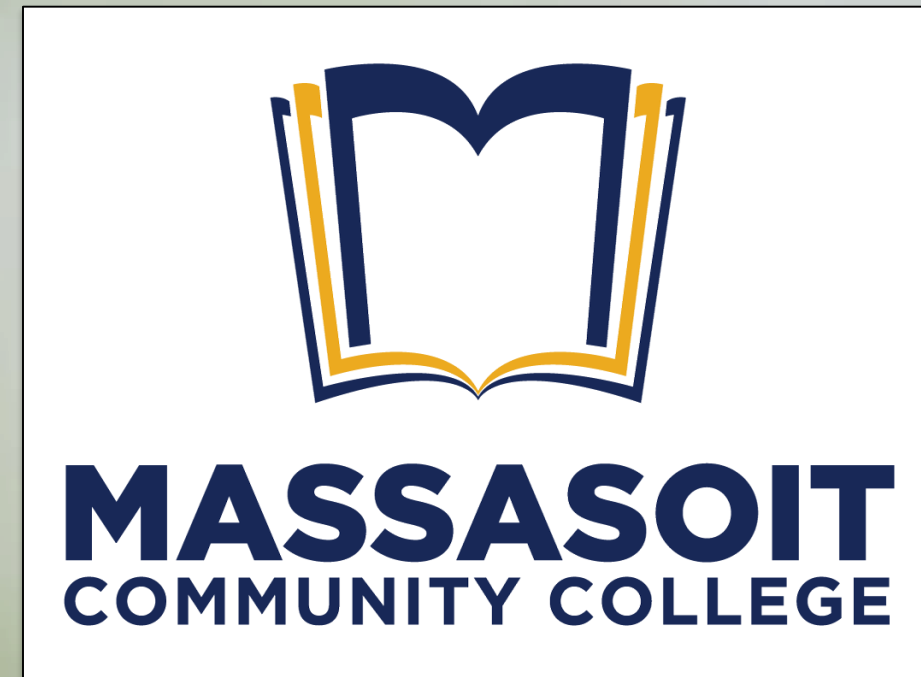


Genera-Specific Analysis of Ground-Nesting Bees on an Urban to Rural Gradient



M. Walsh, J. Palmer, A. Germaine, P. Sanon, A. Oguma, M. Bankson
 Division of Science and Math, Massasoit Community College, Brockton, Massachusetts

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



Why Ground Nesting-Bees?

- Human land usage is altering natural habitats, potentially harming keystone pollinators (De Palma et al., 2016)
- Ground-nesting bees make up around 75% of all bees and may be particularly sensitive to the effects of urbanization due to reduced nesting habitat (Antoine et al., 2021)
- However, abundance of the ground-nesting genus, *Bombus*, was observed to be higher in more urbanized areas (Ahnré et al., 2009)
- Fluctuating abundances of individual ground-nesting genera may indicate a rearrangement within the bee community, even if the total abundance of all ground-nesting bees are stable (Turley et al., 2022).
- This study observes the relationships of three proxies of urbanization on abundances of five ground-nesting bee genera to assess the overall stability of ground-nesting bees in Southeastern Massachusetts.

Relationship of Ground-Nesting Bee Abundance to Proxies of Urbanization

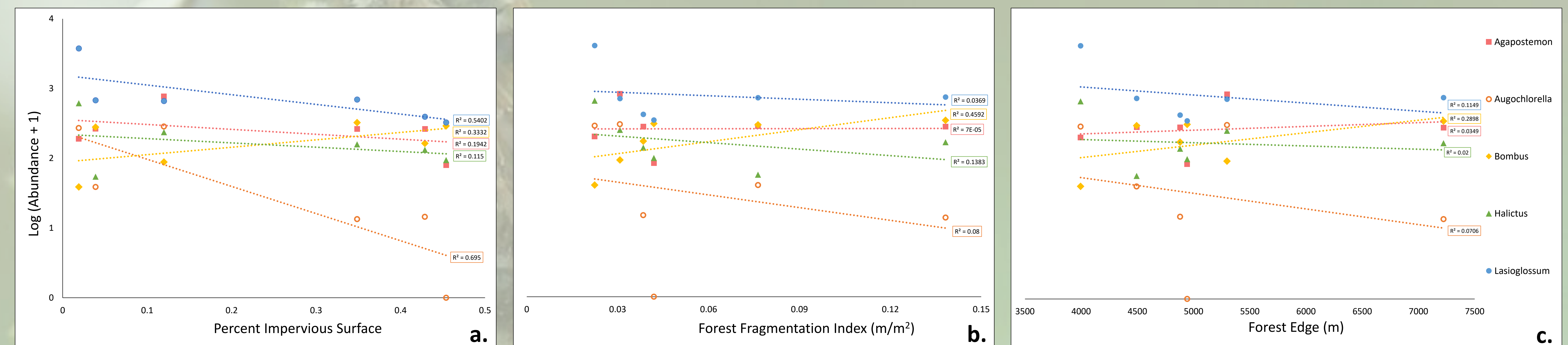


Figure 1: The relationships between (a) percent impervious surface, (b) forest edge (m), and (c) forest fragmentation index (m/m²) to total ground-nesting bee abundance (log-transformed). Each trend line represents one of five ground-nesting bee genera: *Agapostemon*, *Augochlorella*, *Bombus*, *Halictus*, and *Lasioglossum*.

Methods

Sites	Percent Impervious Surface	Forest Fragmentation Index Edge Length (m)/Area (m ²)	Forest Edge (m)	Land Type
Christos	45.39%	0.04195	4943	Urban parking lot
Beaver Brook	42.87%	0.03846	4880	Urban college campus
Native Meadow	34.85%	0.13823	7223	Urban college campus
Sachem Rock	11.98%	0.03074	5297	Suburban park
Leland Farm	3.89%	0.07633	4493	Commercial farm
Dunrovin Farm	1.90%	0.02241	3995	Suburban ranch

Table 1: Summary of study sites in Plymouth County, Massachusetts. Proxies of urbanization were measured within 300-m radii.

- Biweekly sampling occurred in early spring to late fall from 2016 to 2021, on an urban to rural gradient, using sweep-net and pan trap collection methods (Popic, 2013)
- Proxies of urbanization: percent impervious surface (m²), forest fragmentation index (m/m²) and forest edge (m), were analyzed within 300-m radii for each study site using ArcGIS.
- Regression analysis was used to determine the strength of correlations between proxies of urbanization and change in abundance for the five most abundant ground-nesting genera in Southeastern Massachusetts: *Agapostemon*, *Augochlorella*, *Halictus*, *Lasioglossum*, and *Bombus*.

Genus	Percent Impervious Surface	Forest Fragmentation Index (m/m ²)	Forest Edge (m)
<i>Agapostemon</i>	R ² =0.098 <i>p</i> =0.063	R ² =0.001 <i>p</i> =0.838	R ² =0.033 <i>p</i> =0.286
<i>Augochlorella</i>	R ² =0.473 <i>p</i>=5.06E-6*	R ² =0.179 <i>p</i>=0.0113*	R ² =0.109 <i>p</i> =0.053
<i>Bombus</i>	R ² =0.200 <i>p</i>=0.007*	R ² =0.337 <i>p</i>=2.59E-4*	R ² =0.211 <i>p</i>=0.006*
<i>Halictus</i>	R ² =0.080 <i>p</i> =0.099	R ² =0.115 <i>p</i>=0.046*	R ² =0.016 <i>p</i> =0.463
<i>Lasioglossum</i>	R ² =0.292 <i>p</i>=8.10E-4*	R ² =0.001 <i>p</i> =0.866	R ² =0.006 <i>p</i> =0.648

Table 2: Summary of relationships between five ground-nesting genera and three urban proxies. Bolded *p*-values with an asterisk indicate statistically significant correlations (*p*<0.05).

Bee Abundance over Six Years

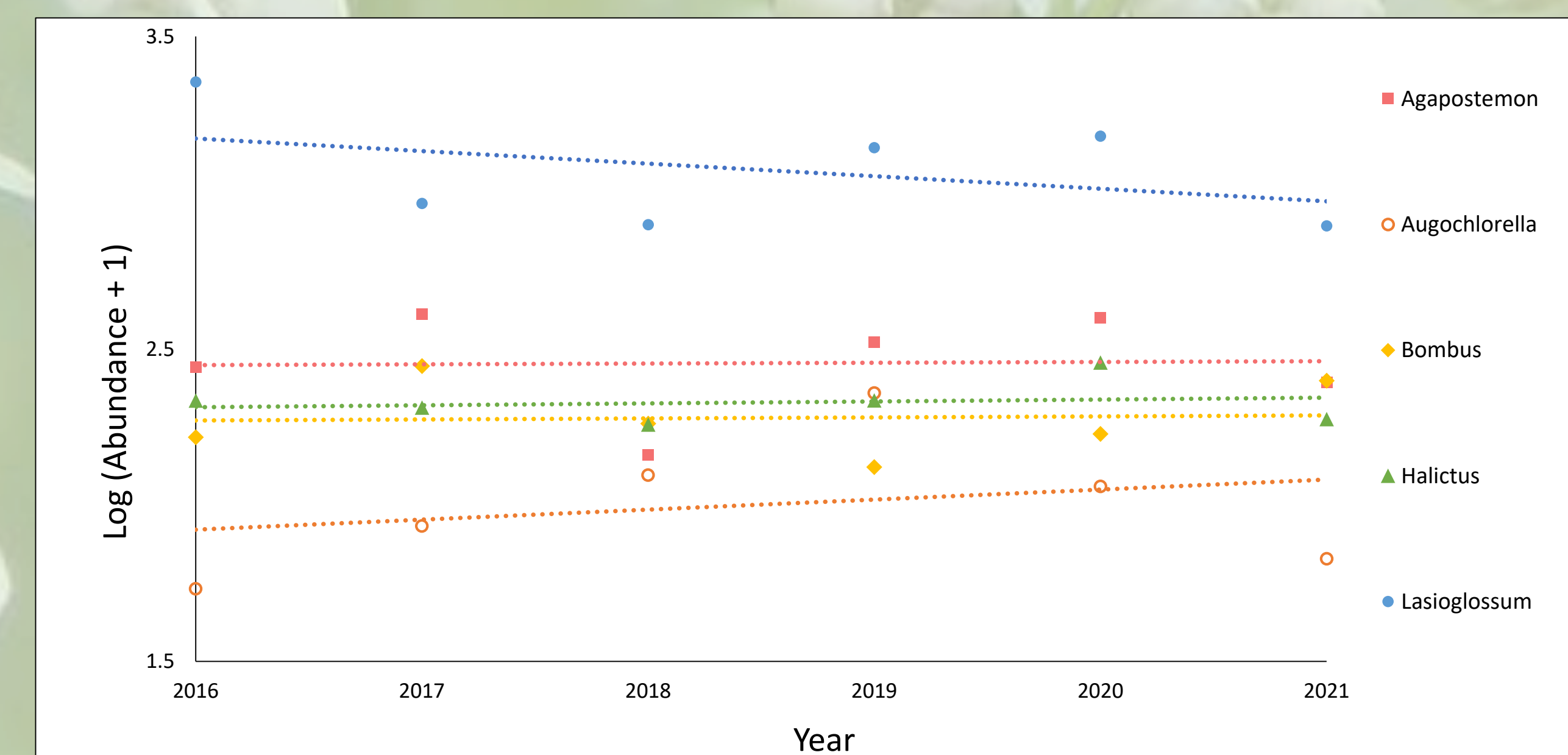


Figure 2: Relationship between total log-transformed ground-nesting bee abundances and year from 2016-2021 (*p*>0.05).

Discussion and Conclusion

- The generally positive relationship between *Bombus* abundance and proxies of urbanization is consistent with previous work (Ahnré et al., 2009).
- Genera within the ground-nesting guild, with the exception of *Bombus*, showed similar trends, suggesting that *Bombus* is unique among the ground-nesting guild and may be more adapted to the urban ecosystem.
- Yearly abundance of the ground-nesting genera was stable over the six year analysis, suggesting that the trends relative to urbanization represent a rearrangement of the ground-nesting community rather than an ongoing decline of total abundance.
- Trends in the wild bee community relative to urbanization should be evaluated separately from changes in abundance over time, on a genera or species-level basis.

References

- Ahnré K, Bengtsson J, Elmqvist T (2009) Bumble Bees (*Bombus* spp) along a Gradient of Increasing Urbanization. PLOS ONE 4(5): e5574. <https://doi.org/10.1371/journal.pone.0005574>
- Antoine, C.M. and Forrest, J.R.K. (2021). Nesting habitat of ground-nesting bees: a review. Ecol Entomol, 46: 143-159. <https://doi.org/10.1111/een.12986>
- De Palma, A., Abrahamczyk, S., Aizen, M. et al. Predicting bee community responses to land-use changes: Effects of geographic and taxonomic biases. Sci Rep 6, 31153 (2016). <https://doi.org/10.1038/srep31153>
- Popic, T. J., Davila, Y. C., & Wardle, G. M. (2013). Evaluation of common methods for sampling invertebrate pollinator assemblages: Net sampling out-perform Pan Traps. PLOS ONE. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0066665>
- Turley, N. E., Biddinger, D. J., Joshi, N. K., & López-Urbe, M. M. (2022). Six years of wild bee monitoring shows changes in biodiversity within and across years and declines in abundance. Ecology and Evolution, 12, e9190. <https://doi.org/10.1002/ece3.9190>

Acknowledgements

This research was supported by the state of Massachusetts STEM Starter Academy grant. Additional thanks goes to A. Petta, E. Oberg, E. Young, O. Alves Jr., P. Culp, M. Healy, B. Moise, A. VanHelene, G. Yaney, C. Orazine, R. Francoisi, K. Ruggieri, and all previous members of the Massasoit STEM Research team