

The Effects of Urbanization on Wild Bees with Differing Functional Traits

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Introduction

- Wild bee community structure is likely to be affected by ongoing urbanization, raising concerns over the potential decline of these essential pollinators (Fortel et al., 2014).
- Functional traits, like nesting habits, may underlie differing adaptability amongst wild bees in urbanizing ecosystems (Wilson et al., 2019).
- Monitoring nesting guild abundance may help explain prior or ongoing changes in the composition of the wild bee community (Williams et al., 2010).
- The present study compared the relationships between nesting guild and proxies of urbanization. For comparison, the six most abundant wild bee genera in Southeastern Massachusetts were similarly assessed in order to compare the predictive value of these two methods of grouping wild bees.

Study Sites

Table 1. GIS-based quantification of percent impervious surface and percent forest cover used as proxies of urbanization. 300m buffers around six sites in Southeastern Massachusetts were analyzed, including two sites on the Brockton campus of Massasoit Community College: Beaver Brook and Native Meadow.

Site	Percent Impervious Surface- 300m radius	Percent Forest Cover - 300m radius
Christos	45.39%	41.67%
Beaver Brook	42.87%	42.87%
Native Meadow	34.85%	18.48%
Sachem Rock	11.98%	60.93%
Leland Farm	3.89%	20.81%
Dunrovin Farm	1.9%	63.05%

Methods

- Bees were sampled at six sites across a peri-urban to urban gradient from 2016 to 2021 using pan trap and sweep netting techniques (Popic, 2013).
- Bees were identified to genus and categorized by nesting guild: ground, cavity, stem, parasitic, and wood (Packer et al., 2007).
- Proxies of urbanization (percent impervious surface and forest cover) were calculated using ArcGIS software within 300-m radii at each site.
- Change in abundance of each nesting guild was observed across increasing impervious surface and forest cover.
- Change in abundance of the most common genera (*Agapostemon*, *Augochlorella*, *Bombus*, *Ceratina*, *Halictus*, and *Lasioglossum*) were also observed across increasing impervious surface and forest cover.
- Regression analysis was used to determine the strength of correlations between proxies of urbanization and the change in abundance of nesting guilds and the community's six most abundant genera.

Results

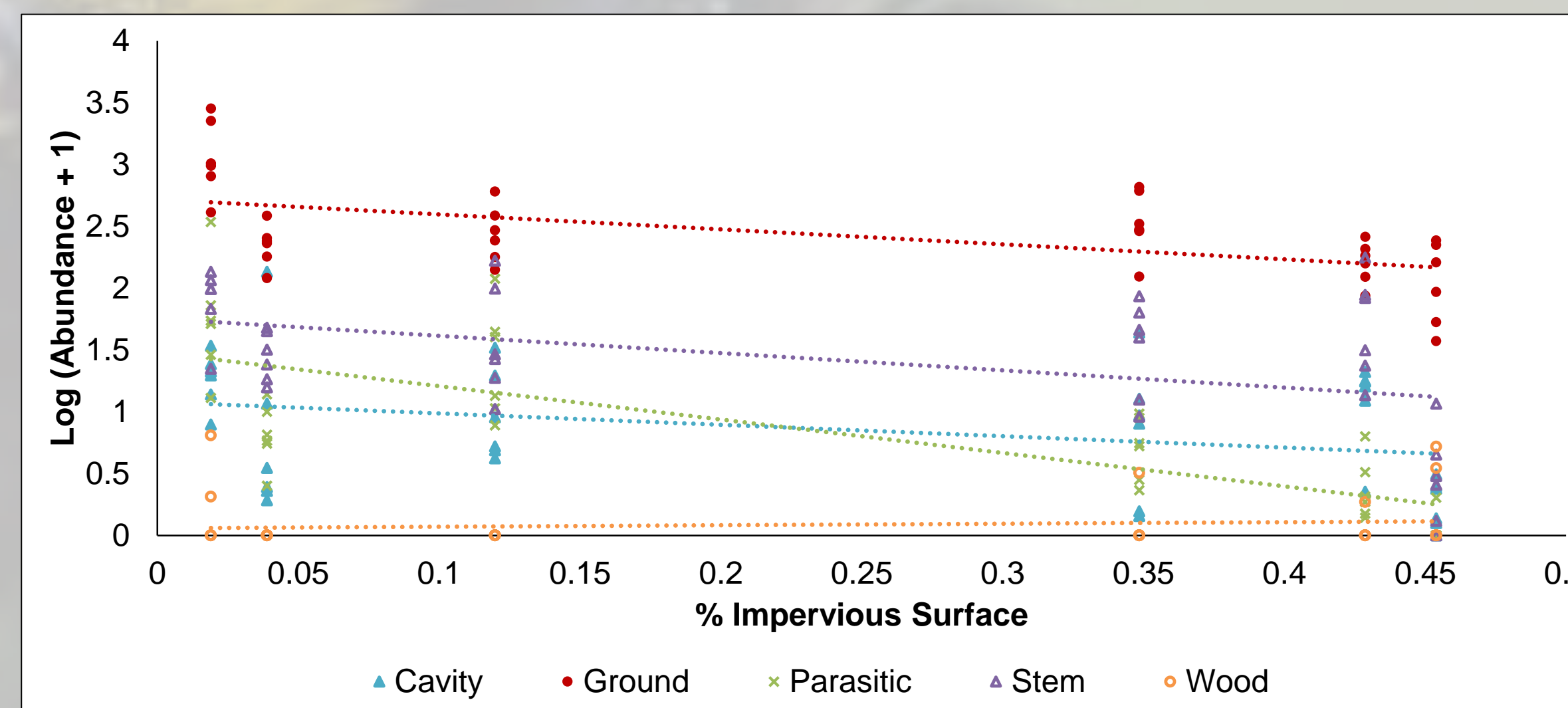


Figure 1. Correlation of log-transformed nesting guild abundance and percent impervious surface across six sampling sites. Cavity ($p > 0.05$, $R^2 = 0.11$), Ground ($p < 0.05$, $R^2 = 0.31$), Parasitic ($p < 0.05$, $R^2 = 0.57$), Stem ($p < 0.05$, $R^2 = 0.20$), Wood ($p > 0.05$, $R^2 = 0.01$).

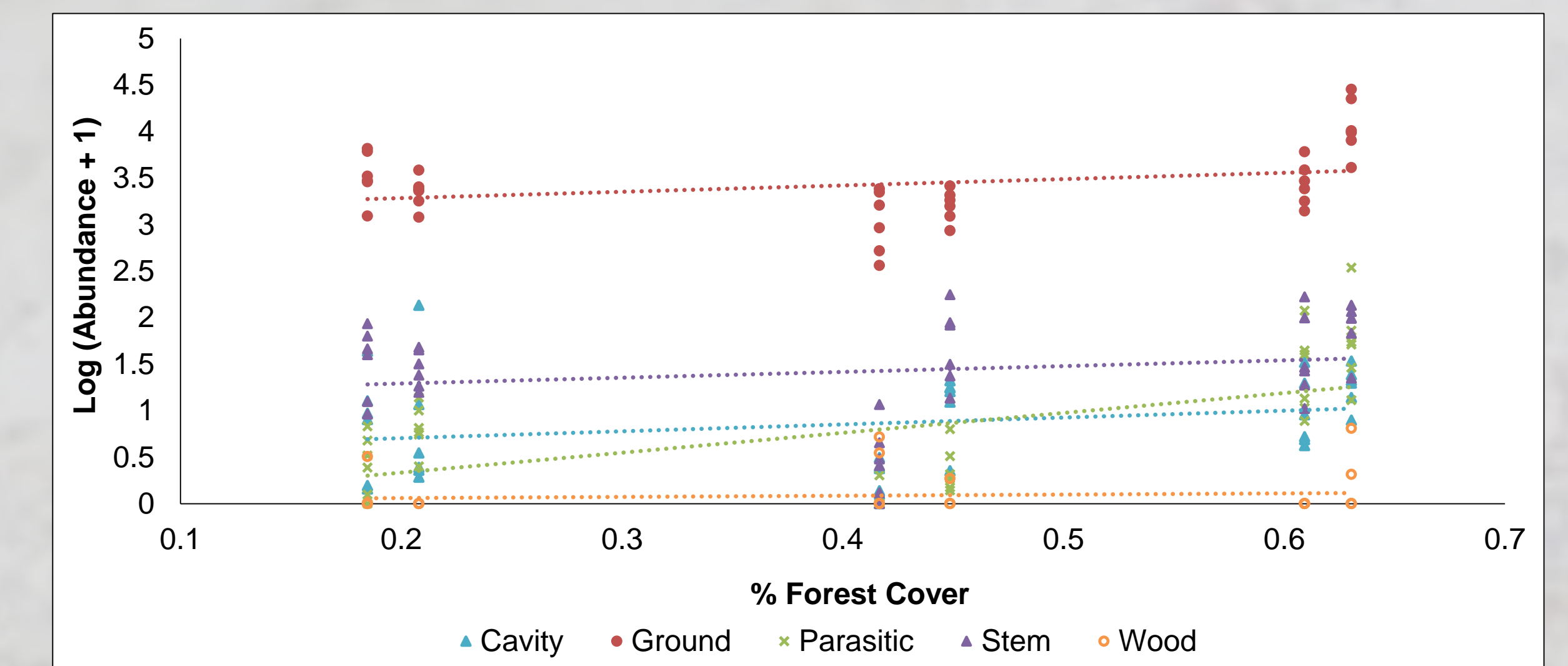


Figure 2. Correlation of log-transformed nesting guild abundance and percent forest cover across six sampling sites. Cavity ($p > 0.05$, $R^2 = 0.06$), Ground ($p > 0.05$, $R^2 = 0.09$), Parasitic ($p < 0.05$, $R^2 = 0.3$), Stem ($p > 0.05$, $R^2 = 0.04$), Wood ($p > 0.05$, $R^2 = 0.02$).

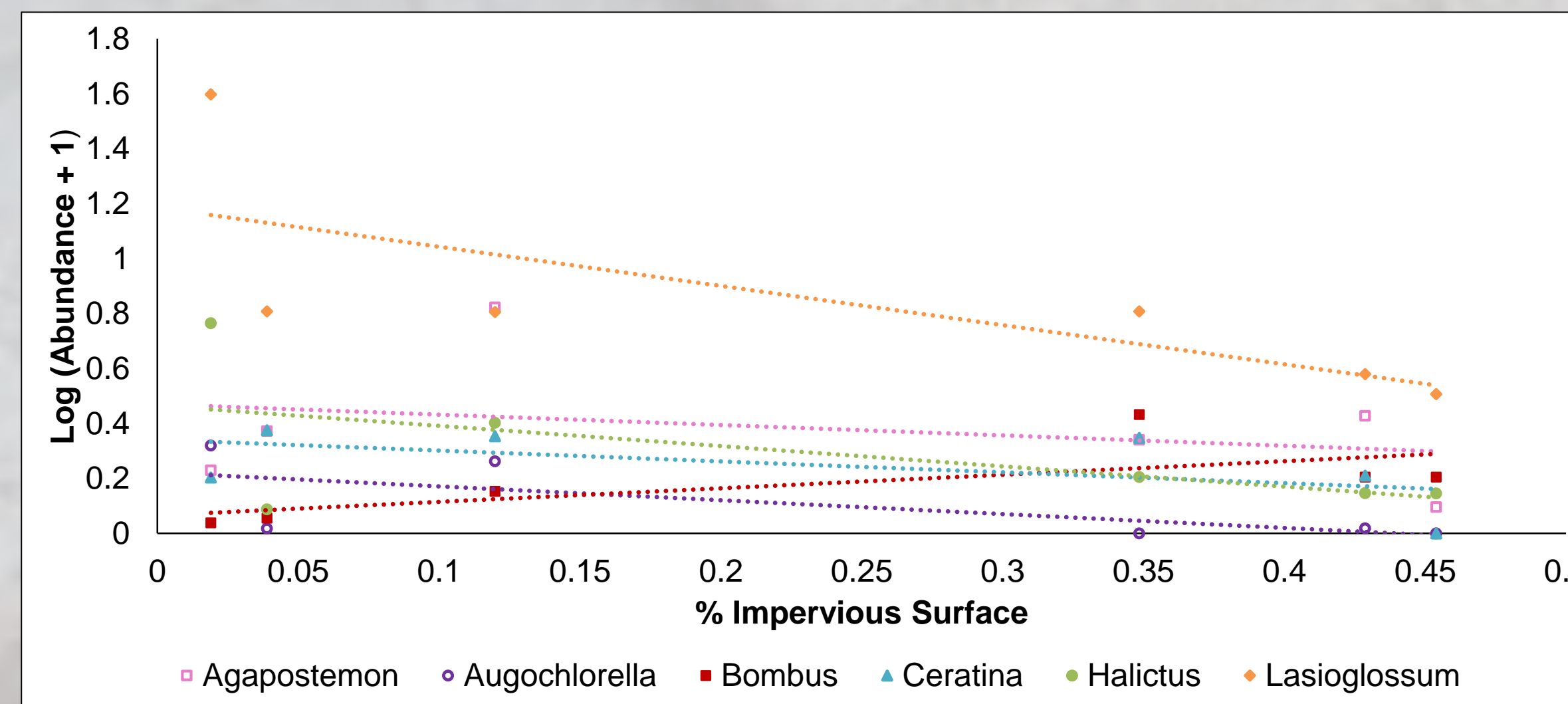


Figure 3. Correlation of log-transformed genera abundance and percent impervious surface across six sampling sites. *Agapostemon* ($p > 0.05$, $R^2 = 0.02$), *Augochlorella* ($p < 0.05$, $R^2 = 0.28$), *Bombus* ($p < 0.05$, $R^2 = 0.11$), *Ceratina* ($p > 0.05$, $R^2 = 0.09$), *Halictus* ($p < 0.05$, $R^2 = 0.21$), *Lasioglossum* ($p < 0.05$, $R^2 = 0.26$).

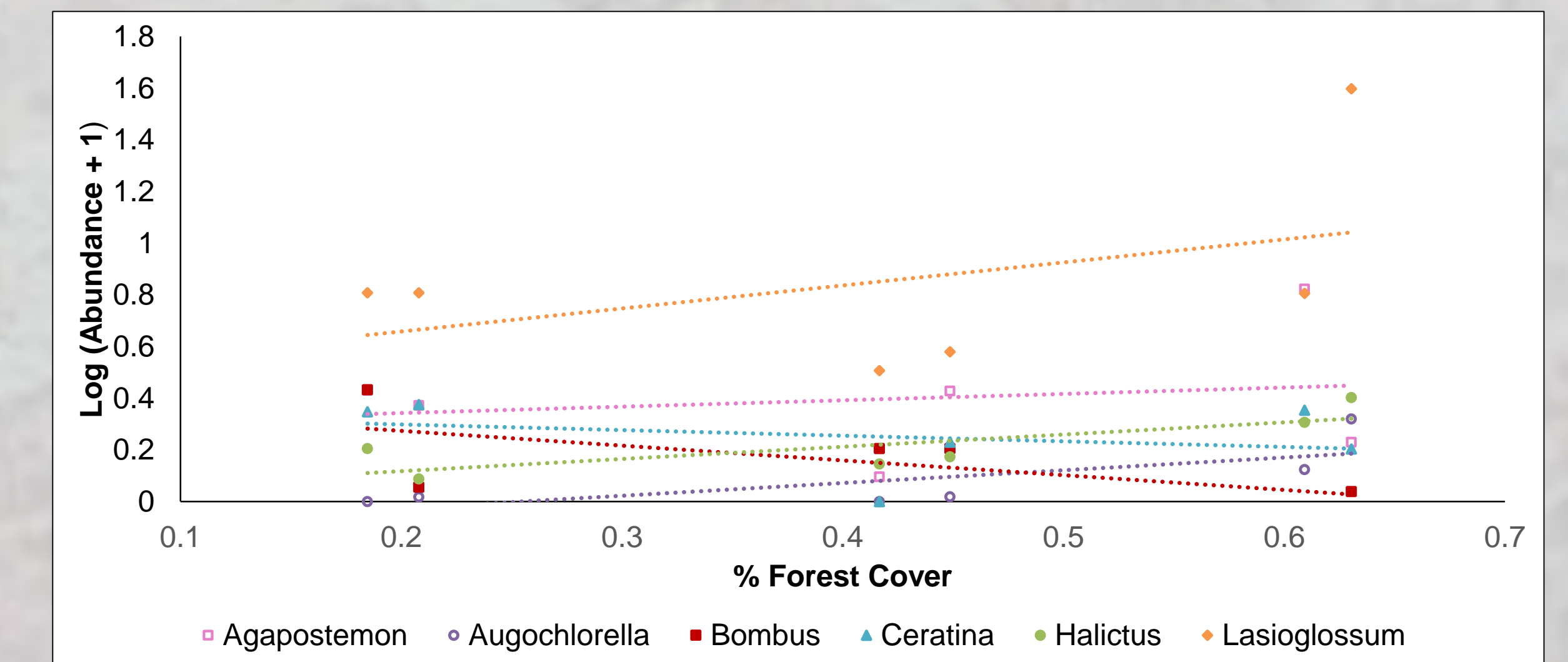


Figure 4. Correlation of log-transformed genera abundance and percent forest cover across six sampling sites. *Agapostemon* ($p > 0.05$, $R^2 = 0.04$), *Augochlorella* ($p < 0.05$, $R^2 = 0.41$), *Bombus* ($p > 0.05$, $R^2 = 0.09$), *Ceratina* ($p > 0.05$, $R^2 = 0.04$), *Halictus* ($p < 0.05$, $R^2 = 0.30$), *Lasioglossum* ($p < 0.05$, $R^2 = 0.20$).

Discussion & Conclusion

- All nesting guilds had a negative or neutral relationship between abundance and increasing impervious land cover. Similarly, all nesting guilds had a positive or neutral relationship between abundance and increasing forest cover. This suggests that all nesting guilds have a generally similar relationship to proxies of urbanization.
- The observed decline of parasitic bees in response to urbanization may be an early indication of decline in the wild bee community (Sheffield et al., 2013). However, this warrants an assessment of parasitic bees over time to rule out a rearrangement of abundance relative to urban ecosystems versus an ongoing decline of urban parasitic bees.
- The six most abundant genera, excluding *Bombus*, were less abundant with increasing impervious land cover. The trend with *Bombus* is inconsistent with other ground-nesting bees.
- The six most abundant genera, excluding *Bombus* and *Ceratina*, were more abundant with increasing forest cover. Although not statistically significant, the trends with *Bombus* and *Ceratina* are inconsistent with other ground-nesting and stem-nesting bees, respectively.
- Nesting guilds generally decline in relation to increasing urbanization, but analysis by genus or species may be necessary to fully understand changes within the wild bee community in response to urbanization.

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Literature Cited

- Ahmé, K., Bengtsson, J., & Elmqvist, T. (2009, May 15). Bumble Bees (*Bombus* spp) along a gradient of increasing urbanization. PLOS ONE. <https://doi.org/10.1371/journal.pone.0005574>
- Fortel, L., Henry, M., Guitaud, L., Guirao, A. L., Kuhnemann, M., Muret, H., Rollin, O., & Vaisière, B. E. (2014, August 13). Decreasing abundance, increasing diversity and changing structure of the Wild Bee Community (Hymenoptera: Anthophila) along an urbanization gradient. PLOS ONE. <https://doi.org/10.1371/journal.pone.0104679>
- Holm, H. (2017). Bees: An identification and native plant forage guide. Pollination Press.
- Packer, L., Genaro, J. A., & Sheffield/Canadian Journal of Arthropod Identification No.3 (2007), C. S. (2007). The Bee Genera of Eastern Canada. Canadian Journal of Arthropod Identification No.3 (2007). https://www.researchgate.net/publication/237841490_The_Bee_Genera_of_Eastern_Canada
- Popic, T. J., Davila, Y. C., & Wardle, G. M. (2013, June 17). Evaluation of common methods for sampling invertebrate pollinator assemblages: Net sampling out-perform Pan Traps. PLOS ONE. <https://doi.org/10.1371/journal.pone.0066665>
- Sheffield, C. S., Pindar, A., Packer, L., et al. The potential of cleptoparasitic bees as indicator taxa for assessing bee communities. *Apidologie* 44, 501–510 (2013). <https://doi.org/10.1007/s13592-013-0200-2>
- Williams, N. M., Crane, E. E., Roulston, T. H., Minckley, R. L., Packer, L., & Potts, S. G. (2010, April 24). Ecological and life-history traits predict bee species responses to environmental disturbances. *Conservation Biology*. <https://doi.org/10.1007/s11595-010-0011-3>
- Wilson, C. J., & Jamieson, M. A. (2019, December 2). The effects of urbanization on bee communities depends on floral resource availability and bee functional traits. PLOS ONE. <https://doi.org/10.1371/journal.pone.0225822>