Do Native Bee Foraging Behaviors Change with Environmental Factors?

Skyla Sturtevant, Michael Bankson, Adam Germaine

STEM Division, Massasoit Community College, Brockton, Massachusetts, USA

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

Introduction

- Monitoring wild bee abundance has become crucial in developing conservation strategies for potentially declining populations (Acharya et al., 2021).
- Long-term monitoring studies assume that each sampling event captures a similar percentage of the true local population of the bee species in question. Factors that change the ratio of sampled abundance to true abundance (sampling efficiency) may introduce misleading results in long-term monitoring studies.
- Pan trapping, a common technique for sampling pollinator insects, is effective because the traps mimic floral resources (Sircom et al., 2018); however, pan traps are often used in conjunction with sweep netting to achieve a better representation of the pollinator community abundance (Popic et al., 2013).
- Changes in the relative frequency in which specific bees are found in different pan trap colors or sweep netting may reflect changes in bee behavior that may also alter the probability of capture (Leong & Thorp, 1999).
- Environmental impact on sample method effectiveness is not widely explored, though some studies imply a change in sampling efficiency due to environmental factors (Baum et al, 2011; Gerner, 2022).
- In this study, we analyzed the relative frequency of specific bees being captured in different color pan traps or sweep netting as an indicator of changing bee behavior that may be associated with different sampling efficiencies.

Study Area

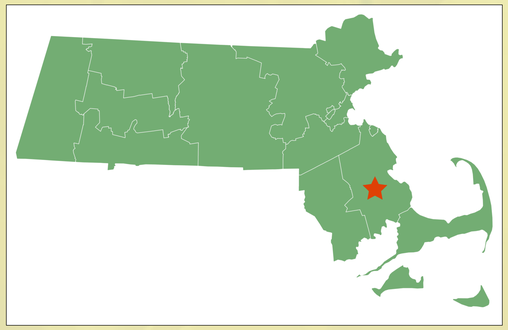

Figure 1: Map of the state of Massachusetts, USA. The present study contains six wild bee sampling locations within Plymouth County, MA – marked by a red star. These six locations range from urban to suburban terrain types.

Methods

- Bees were sampled at six sites across a suburban to urban gradient from 2016 to 2023 using pan trap and sweep netting techniques.
- Bees were then dried and pinned for identification which was then added to a database comprising of over 19,000 native bees that could be accessed for further research.
- Microsoft Access queries were created to simplify and analyze data collected in previous years. Only the top 18 most abundant genera were used in this study.
- Bees found in different pan trap colors and sweep net were calculated to find percent of their total abundance in the collection.
- Friedman test was conducted to determine statistically significance changes in proportional abundance over time for specific bees.

Results

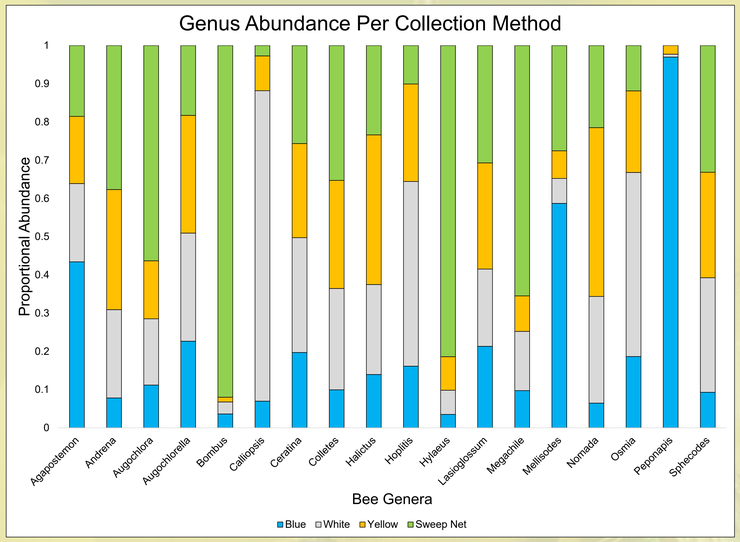

Figure 2: Top 18 most abundant bee genera from 2016-2023 and their proportional abundance found within pan traps (blue, white, yellow) and sweep net.

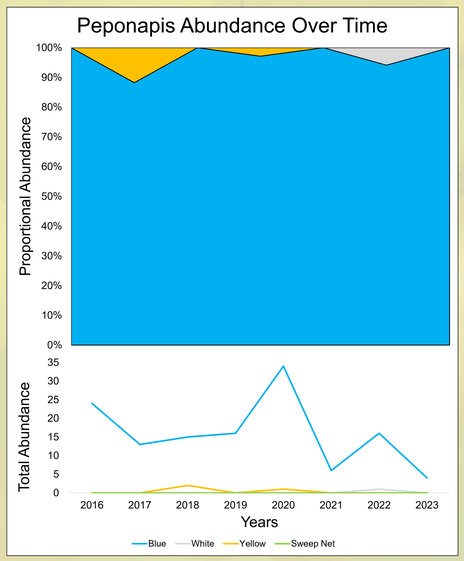

Figure 3: Proportional and total abundance change in *Peponapis pruinsoa* found in pan traps and sweep net between 2016-2023 ($p<0.05$).

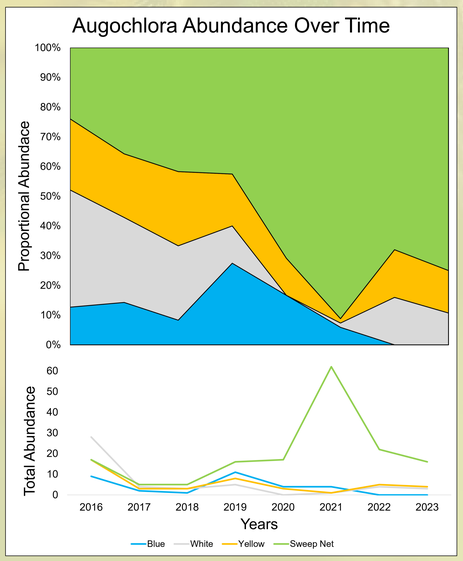

Figure 4: Proportional and total abundance change in *Augochlora prura* found in pan traps and sweep net between 2016-2023 ($p<0.05$).

Results

- Bees with over 40% of their abundance found in blue pan traps were *Agapostemon spp.* (44%), *Melissodes spp.* (60%) and *Peponapis pruinsoa* (97%). Bees with over 40% of their abundance found in white were *Calliopsis spp.* (81%), *Hopilitis spp.* (48%) and *Osmia spp.* (49%). *Nomada spp.* was the only bee with over 40% of their abundance found in yellow (44%). Bees with over 40% of their abundance found in sweep nets were *Augochlora pura* (57%), *Bombus spp.* (91%), *Hylaeus spp.* (80%) and *Megachile spp.* (65%) **(Figure 2)**.
- *P. pruinsoa* displayed a strong preference for blue pan traps despite being a specialist for squash flowers that are yellow-orange **(Figure 3)**.
- *A. pura* showed a steady increase in proportional sweep net capture peaking in 2021 coincident with a large increase in total abundance. In 2016, only 23% of *A. pura* were found in sweep nets, which increased to 75% in 2023 **(Figure 4)**.

Figure 5: *Peponapis pruinsoa* (Squash Bee)

Figure 6: *Augochlora pura* (Sweat Bee)

Discussion

- The different proportions of bees caught in different color pan traps or sweep nets (**Figure 2**) demonstrate a wide variety of foraging behaviors and flight patterns amongst different bee genera. This implies a possible genera or species-specific, behavior-based change in sampling results when using pan traps or sweep nets.
- *P. pruinsoa* preference for pan trap color different from preferred flower color suggests that *P. pruinsoa* forage in ways different from the expected specialist standard (Hall, 2016). Frequency of *P. pruinsoa* found in other pan trap colors is not predictive of changes in pan trap or sweep net abundance.
- *A. pura*'s increase in relative abundance in pan-traps and accompanying jump in actual pan trap abundance demonstrates a link between behavioral changes and sampling results.
- The robust rise in *A. pura* sweep net abundance with no notable change in pan trap abundance indicates either an increase in sweep net sampling efficiency (over representation of true abundance) or a decrease in pan trap efficiency (underrepresentation of true abundance).
- Bees like *A. pura* that demonstrate wide swings in between pan trap and sweep net abundance may be harder to accurately track for abundance because results could be skewed by the current foraging or flight pattern behavior.
- Behavioral observations may provide useful predictive variables when building statistical models of wild bee abundance.

Acknowledgements

Special thanks to Nada Ahmed, Sammy Olsen, Mya Austin, Mika Horton, Thomas Keaney, Jess Beeloo, Dehlia Smith, Katie Ruggeri, Rachel Franciosi, and all interns who contributed to the cultivation of data used in this study. This research was supported by the state of Massachusetts STEM Starter Academy grant.

Literature Cited

1. Acharya, R. S., Leslie, T., Fitting, E., Burke, J., Loftin, K., & Joshi, N. K. (2021). Color of pan trap influences sampling of bees in livestock pasture ecosystem. *Biology*, *10*(5), 445. https://doi.org/10.3390/biology10050445 Droege S. (2015). The Very Handy Manual: How to Catch and Identify Bees and Manage a Collection. Pp 2-69.
2. Baum, K. A., & Wallen, K. E. (2011). Potential bias in pan trapping as a function of floral abundance. Journal of the Kansas Entomological Society, 84(2), 155–159. https://doi.org/10.2317/jkes100629.1
3. Gerner, E. E., & Sargent, R. D. (2022). Local plant richness predicts bee abundance and diversity in a study of urban residential yards. Basic and Applied Ecology, 58, 64–73. https://doi.org/10.1016/j.baae.2021.11.004
4. Hall, H. G. (2016). Color preferences of bees captured in Pan Traps. Journal of the Kansas Entomological Society, 89(3), 273–276. https://doi.org/10.2317/jkesd1600022.1.
5. Leong, J. M., and Thorp. R. W. (1999). Colour-coded sampling: the pan trap colour preferences of oligolectic and non oligolectic bees associated with a vernal pool plant. Econ Entomol. 1999; 24, 329±335
6. Packer, L. (2007). The Bee Genera of Eastern Canada. Canadian Journal of Arthropod Identification. https://doi.org/10.3752/cjai.2007.03
7. 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, 8(6). https://doi.org/10.1371/journal.pone.0066665
8. Sircom, J., Arul Jothi, G., & Pinksen, J. (2018). Monitoring bee populations: Are eusocial bees attracted to different colours of pan trap than other bees? Journal of Insect Conservation, 22(3–4), 433–441. https://doi.org/10.1007/s10841-018-0071-y