Bee Communities of Flowering Plant Species in Central Kentucky Nature Preserves and Managed Prairies

Foreman, Kristen, Department of Biological Sciences, Eastern Kentucky University
Faculty Mentor: Peters, Valerie
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Introduction

Bee communities differ among habitat types in response to which resources are available. Bee species are closely linked to the various materials they use to construct their nests as well as the different flowering plant species from which they obtain nectar and pollen. For instance, forest habitats tend to have more wood nesting bees than urban habitats due the availability of trees, while ground nesting bees often occur in places with open ground for them to access nest sites (Winfree & et al. 2007; Bogusch & et al. 2015). In regard to floral resources, some flowers are easier for certain species to collect nectar and pollen from. So the availability of a diversity of floral resources in an area is posited to have an impact on the bee species that occur there.

Studies show that bee populations are declining globally in response to climate change and alterations to their habitats, including the availability and diversity of floral resources (Potter & et al. 2019; Elliott B & et al. 2021; Goulson & et al.). But, without more intensive monitoring of bee populations, determining the severity of these declines across the planet is difficult (Winfree 2007; Potter 2019). Other factors may also threaten bee populations, including exposure to pathogens and parasites, pesticide use, fire suppression. These factors have also been found to exacerbate one another, such that exposure to one of these threats leaves a bee more vulnerable to others and lessens the likelihood they will be able to recover (Goulson et al.). For example, nutritional stress can make it difficult to recover from pathogen or pesticide exposure(Goulson & et al.). Therefore, maintaining variety in bee diets by providing diverse floral resources is essential to bee conservation (Theodorou & et al. 2020).

One way to understand what plant species may provide the best diets for bee communities, is to observe the abundance and species richness of bees visiting particular flowers. This data can then be compared between flowers to show which plants are being used for resources more frequently and by the most species. Maintaining these plant species can provide bee species with the nutrients they need and help conserve bee diversity.

Furthermore, protecting bee diversity by providing the floral resources they depend upon, supports those plant populations in the area that rely upon pollination since they are more likely to be pollinated and reproduce. This includes both wild flowers and crops, since crops depend largely upon native bee species for reproduction and crop yield (Reilly & et al 2020). Most conservation efforts in the United States focus on the Western honey bee which is not native, can outcompete native bees, and has been found to be less effective pollinators of many of our crop species (Reilly & et al 2020).

Thus, conservation efforts need to focus more on native bee populations to protect native plant populations and increase crop yield (Reilly & et al 2020). This particular study observed the bee communities visiting plant populations in central Kentucky nature preserves and managed prairies to determine which plant species in these habitats may be more effective in protecting bee diversity and abundance in the area.

Methods

Five sites were selected from central Kentucky nature preserves and managed prairies, including Floracliff Nature Sanctuary, the Berea Forestry Outreach Center, Lower Howard's Creek Nature and Heritage Preserve, Palk State Nature Preserve, and Anglin Falls Forest. These sites were selected with the help of the Office of Kentucky Nature Preserves based on their proximity to EKU and the possibility of finding interesting plants at these locations.

At each location, plant species visited by bees were first identified. For each flowering plant species chosen, the number of blooms were counted and bees were collected during a thirty minute observation period using a kill jar with acetone as the killing agent. Flowers were sampled from multiple times and at various locations if possible, although this was not always possible given the flowering times of the plants observed and differences in plant community composition between sites. The bees collected were then transported back to the EKU campus and placed in a freezer. Later, they were pinned so that important features for identification were visible. Afterward, the bees were identified using Discoverlife.com ID guides.

To compare bee abundance and richness among the plant species samples, linear regression was used. All models included the single categorical predictor variable, plant species ID. The response variables, bee abundance and bee richness were log transformed to meet the assumptions of normality. A Tukey's post-hoc test was used to compare plant species. Bee community composition by site was compared using a Non-multidimensional scaling.

Results

Among sites, 567 bees were caught from eighteen different plant species. In figure 1, the number above each bar indicates how many times a plant was sampled from which varied depending on whether a plant was growing at multiple sites and was flowering during the entire study. The bars show the mean abundance of bees between samples, while the standard error bars indicate the variation in bee abundance a plant experienced during different samples since this changed due to factors such as time of day and weather conditions.

Although differences in bee abundance and bee richness by plant species were not statistically significant, they do show trends indicating that with more samples there is a potential to detect differences between plant species.

Based on comparisons of mean bee abundance between samplings, the plants with the highest bee abundance were Coreopsis spp., Monarda fistulosa, rattlesnake master, trumpet creeper, white sweet clover and wild teasel (Figure 1). Of these plants, white sweet clover and wild teasel are not native to the United States, but they were visited by a relatively large number of bees in comparison to many of the native plants that were sampled from. The plants with the lowest bee abundance included Companula spp., Erigeron spp., red clover, and Rudbeckia hirta.

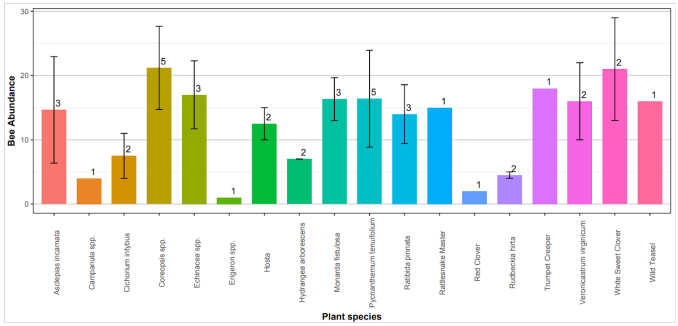

Figure 1: *Bee abundance among the sampled plants.*

Bee species richness was highest among wild teasel, *Veronicastrum virginicum,* rattlesnake master, and hosta spp. observed (Figure 2). Neither the hosta nor the wild teasel are native to the United States, while rattlesnake master is. The plants with the lowest species richness included

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Companula spp., *Chicorium intybus, Erigeron* spp., red clover, and *Rudbeckia hirta.*

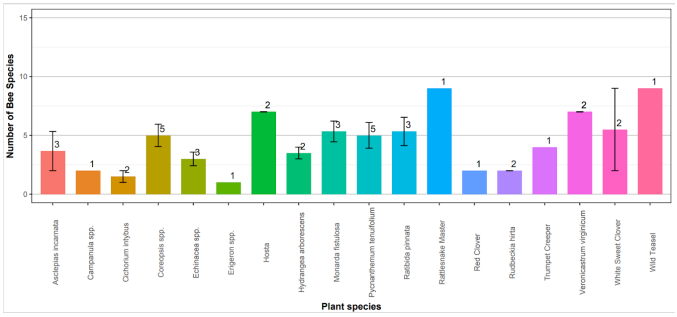

Figure 2: *Bee species richness among the sampled plants.*

When comparing the bee communities among the sites, we found that the Forestry Outreach Center and Floracliff Nature Preserve were closest together, followed closely by Lower Howard's Creek. All of these locations included meadows, although the meadows included different floral resources. Palk Nature Preserve and Anglin Falls have much different community compositions from the other sites and from each other, despite both being forest ecosystems, likely because they have different floral resources and are maintained differently. Unfortunately, only one plant species was able to be observed at both of these locations.

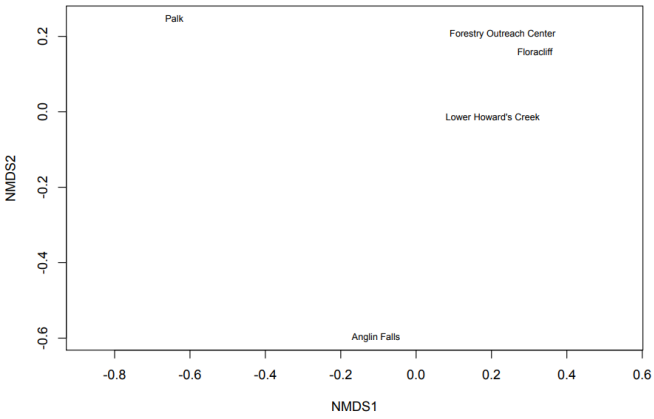

Figure 3: *A comparison of the community composition among sites.*

Conclusions

Although the results were not statistically significant, they do show important trends about which plant species bees in Central Kentucky might be visiting. Further research is needed to understand why particular plants appeared to be preferred over others. Unfortunately, some of the plants that appear to be more preferred by bees in the area are non-native, meaning that many of the native plants at these sites might not be as attractive or beneficial to the bees there, however more research is needed to understand why bees appear to prefer these plants over some of the native plant species. Understanding this could help figure out which other native plant species, along with the ones indicated in this study, are more preferred by bees so we can better determine how to maintain their populations by planting diverse floral communities that can support them.

Floracliff Nature Preserve and the Forestry Outreach Center likely had similar community compositions because they were both meadows with an abundance of floral resources since they had both been seeded in the past. These locations had the highest bee abundance and bee species richness likely due to the floral diversity and abundance available at these locations. Lower Howard's Creek, on the other hand, was a former pasture and has not been seeded so it has become overgrown with mostly weedy and invasive plant species. The majority of the floral diversity at this location was in a very small plot of the land compared to the more weedy majority. The small portion with high floral diversity is also where the majority of bees at this location were collected. Since seeding at Floracliff and the Forestry Outreach Center appears to have helped maintain bee abundance and species richness at these locations, doing the same at Lower Howard's Creek with the preferred native plants mentioned in this study could help to improve this habitat for the bees there.

Palk and Anglin Falls were both very low on floral diversity because they were mostly closed canopy forests. This could explain why these two sites had a much different bee community

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compared to the other locations (Winfree & et al. 2007). While they are both forested sites, the bee community of two sites also differed from each other and this is likely due to differences in the ways they are maintained. Anglin Falls is forested, not managed, and is open to the public. Contrastingly, Palk is a site that is closed to the public and at which land managers are working to restore pine/oak barrens using prescribed burns. Palk was likely low on floral resources since it was burned earlier this year. But, as more the understory grows and fills in with more diverse flora, it is likely that there will be an increase in bee abundance and species richness (Bogusch & et al. 2015).

References

Bogusch P, Blažej L, Trýzna M, Heneberg P. 2015. Forgotten role of fires in Central European forests: critical importance of early post-fire successional stages for bees and wasps (Hymenoptera: Aculeata). Eur J For Res. 134(1):153–166. doi:10.1007/s10342-014-0840-4.

Elliott B, Wilson R, Shapcott A, Keller A, Newis R, Cannizzaro C, Burwell C, Smith T, Leonhardt SD, Kämper W, et al. 2021. Pollen diets and niche overlap of honey bees and native bees in protected areas. Basic Appl Ecol. 50:169–180. doi:10.1016/j.baae.2020.12.002.

Goulson D, Nicholls E, Botías C, and Rotheray E.L. Combined stress from parasites, pesticides and lack of flowers drives bee declines. Angew Chemie Int Ed 6(11), 951–952.

Potter C, De Vere N, Jones LE, Ford CR, Hegarty MJ, Hodder KH, Diaz A, Franklin EL. 2019. Pollen metabarcoding reveals broad and species-specific resource use by urban bees. PeerJ. 2019(2):1–22. doi:10.7717/peerj.5999.

Reilly JR, Artz DR, Biddinger D, Bobiwash K, Boyle NK, Brittain C, Brokaw J, Campbell JW, Daniels J, Elle E, et al. 2020. Crop production in the USA is frequently limited by a lack of pollinators: Pollination limitation in US crops.

Theodorou P, Herbst SC, Kahnt B, Landaverde-González P, Baltz LM, Osterman J, Paxton RJ. 2020. Urban fragmentation leads to lower floral diversity, with knock-on impacts on bee biodiversity. Sci Rep. 10(1):1–12. doi:10.1038/s41598-020-78736-x.

Winfree R, Griswold T, Kremen C. 2007. Effect of human disturbance on bee communities in a forested ecosystem. Conserv Biol. 21(1):213–223. doi:10.1111/j.1523-1739.2006.00574.x.

KRISTEN FOREMAN is a Senior at EKU studying Biology and English.

VALERIE PETERS is a Professor of Biology at EKU. She is a mentor of the REU program.

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