Significant correlation between Hymenoptera presence and green roof height

Juniper Setterberg

Introduction

Bumblebee populations have been drastically declining in Europe and North America for decades as a result of habitat degradation and fragmentation. It has become increasingly evident, as with the case of the bumblebee, that conservation efforts for Hymenoptera are necessary in order to protect these species from extinction (Goulson et al., 2008). Green roofs offer a means of utilizing urban space to conserve pollinating species; an increase in the abundance and richness of plant species incorporated into a green roof has shown to be associated with an increase in pollinator richness and abundance (Grimshaw-Surette, 2020). What's more, green roof presence and abundance not only affect the richness of pollinator species that live on the green roof, but neighboring, ground-level invertebrate species (Dromgold et al. 2020; MacIvor, 2016). Though there has been research into the effect of green roof height on insect pollinator populations, with MacIvor identifying a significant correlation between an increase in green roof building height and a decrease in nesting insect populations (2016), these findings were spread out across multiple buildings and did not identify the relationship between the quantity of flowering plants and pollinators. Wild bee population diversity has been shown to increase with the incorporation of flowering *Sedum* plant species in green roofs. However, this data has been largely collected outside of North America (Kratschmer et al., 2018). This paper aims at identifying whether there exists a significant inverse relationship between green roof height in New York City and the ratio of Hymenoptera, namely bees, and flowering *Sedum kamtschaticum*. In studying the relationship between bees, flowers, and green roofs, I aim to reinforce the potential of green roofs as a tool for population conservation and to contribute to our understanding of how green roofs impact pollinator activity.

Materials & Methods

Sedum kamtschaticum and bee abundance were analyzed from two separate terrace levels. The temperature as well as general wind presence and sunlight levels were noted. Each terrace contained saturated beds of flowering *Sedum kamtschaticum*. Five 1m by 1m transects were placed randomly on each terrace's plot of *Sedum kamtschaticum*. The quantity of flowers confined by the transects was counted and recorded, with inflorescent clusters counting for single flowers. The number of pollinators of order Hymenoptera which landed in the survey plots was recorded over 3min.

Results

The mean ratio of bee abundance to *Sedum kamtschaticum* flower abundance were recorded from terrace heights of two and four stories. Data from each terrace were taken from five, randomly-placed transects. This data was collated with 286 other transects taken by previous researchers following identical procedures, and then analyzed. Terrace level two, the lowest terrace level, received a total of 698 bees over a combined 14.4hr of observation, whereas terrace level four, the highest terrace level tested, received a total of 216 bees over the same combined time of observation. The mean ratio of bee abundance to *Sedum* flower abundance at terrace level two was higher than that found at terrace level four (Figure 1). A t-test comparing the two means and their respective standard deviations identified in Figure 1 was conducted, returning a value of zero.

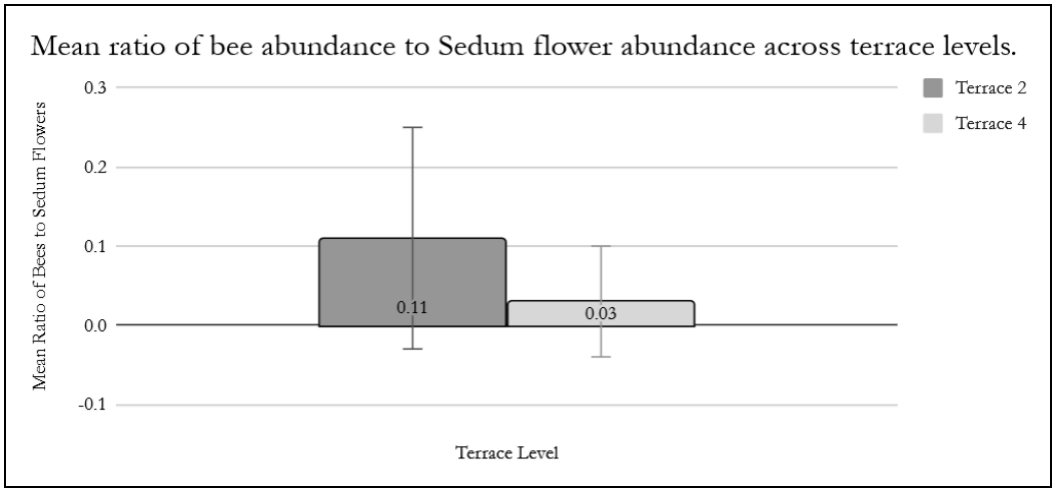

Figure 1. *Mean ratio of bee abundance to Sedum flower abundance across terrace levels*. Two ratios of average Hymenoptera presence to *Sedum kamtschaticum* abundance across terrace levels of heights two and four stories. The mean ratio recorded at terrace level two was 0.11∓0.14. The mean ratio recorded at terrace level four was 0.03∓0.07. *Figure by author.*

Discussion

Though at face value there appears to be a larger population of bees per flower of *Sedum kamtschaticum*, the standard deviations, visualized by error bars in Figure 1, do not overlap. As such, a claim on the proposed hypothesis cannot be made with confidence using purely the information provided by the figure. However, the resulting "0" taken from a t-test comparing both the mean ratios of bee abundance to *Sedum kamtschaticum* abundance and green roof height in regards to their respective standard deviations implies that the null hypothesis must be rejected. As such, it is clear that there exists a significant correlation between an increase in green roof height and a decrease in mean bees per flower. These findings are congruent with what has been found with what has been previously identified in nesting insects and other invertebrates (Dromgold et al. 2020; MacIvor, 2016). What's more, the identified relationship between bees and green roofs can impact how urban greenspaces inform conservation efforts, with lower level green roofs potentially being more beneficial to conservation efforts (Goulson et al., 2008). It remains to be seen how a broader sample of different pollinating species are impacted by green roof building height, and so future research into this can provide a more holistic

understanding of how differing populations interact with green roofs and other urban greenspaces. That being said, this research into how pollinators interact with urban environments demonstrates the potential that cities hold with conservation.

References

Dromgold, J. R., Threlfall, C. G., Norton, B. A., & Williams, N. S. G. (2020). Green roof and ground-level invertebrate communities are similar and are driven by building height and landscape context. *Journal of Urban Ecology*, *6*(1), juz024. https://doi.org/10.1093/jue/juz024

Goulson, D., Lye, G. C., & Darvill, B. (2008). Decline and Conservation of Bumble Bees. *Annual Review of Entomology*, *53*(Volume 53, 2008), 191–208. https://doi.org/10.1146/annurev.ento.53.103106.093454

Grimshaw-Surette, H. (2020). *The effect of green roof characteristics on pollinator communities*. https://library2.smu.ca/xmlui/handle/01/29346

Kratschmer, S., Kriechbaum, M., & Pachinger, B. (2018). Buzzing on top: Linking wild bee diversity, abundance and traits with green roof qualities. *Urban Ecosystems*, *21*(3), 429–446. https://doi.org/10.1007/s11252-017-0726-6

Maclvor, J. S. (2016). Building height matters: Nesting activity of bees and wasps on vegetated roofs. *Israel Journal of Ecology and Evolution*, *62*(1–2), 88–96. https://doi.org/10.1080/15659801.2015.1052635