Are Temporal Trends in Bee and Non-Bee Abundances Similar in Plymouth County, MA?

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Introduction

- Non-bee insect pollinators provide pollination services similar to bees when the number of visits and productivity per visit are both considered (Rader et al. 2016).
- Non-bee insects also provide services to plants unfulfilled by bees such as pest control and nutrient cycling (Sluijis 2020).
- Bees and non-bee pollinators may both be declining, however, non-bee insect pollinators may respond differently to ecological changes (Rhodes 2018).
- Non-bee insects could compensate for lost bee pollination or non-bees could decline simultaneously, compounding the loss (Hallet et al. 2017).
- In this pilot study, we compare bee and non-bee abundance trends over time to identify any similarities.

Study Sites

Figure 1 and Table 1: Qualitative and quantitative data for each of the six urban and suburban sites alongside a map of their location in Plymouth County, Massachusetts, USA.

SITES→	Christos (CH)	Beaver Brook (BB)	Native Meadow (NM)	Sachem Rock (SR)	Dunrovin Farm (DF)	Leland Farm (LF)
% Impervious	46.9%	46.0%	32.0%	7.9%	1.9%	0.5%
Terrain type	Urban parking lot	Urban college campus	Urban college campus	Suburban park	Rural power line cut	Commercial farm
Sustainable practice	None	Riparian buffer, reduced pesticides	Native plantings, reduced pesticides	Community garden	Reduced pesticides	None

Methods

- Sampling occurred from April to October 2016-2020 at six sites across an urban to suburban gradient in Southeastern Massachusetts.
- Bees were collected as part of a larger study with pan traps and sweep netting (Popic 2013).
- Non-bees were inadvertently collected during sweep netting.
- Specimens were identified as bee or non-bee and quantified.
- Statistical analysis of bee and non-bee yearly and bi-weekly abundances was performed using two factor ANOVA with repeated measures.

Results

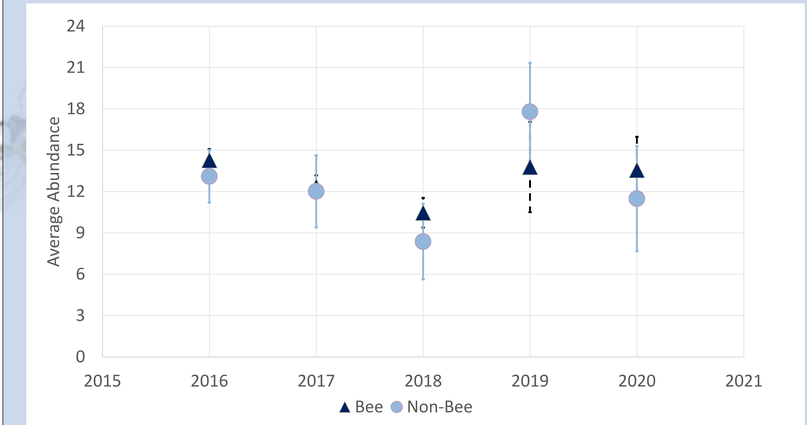

Figure 2: Average bee and non-bee abundance per year. Two factored repeated measures ANOVA shows no significant change in abundance between years ($F_{4,59} = 2.21$, $p = 0.08$). There is no evidence bee and non-bee abundances are not covarying (interaction: $F_{4,59} = 0.66$, $p = 0.62$).

- Bee and non-bee abundances lack a significant trend from year to year.
- Abundances remained relatively stable.

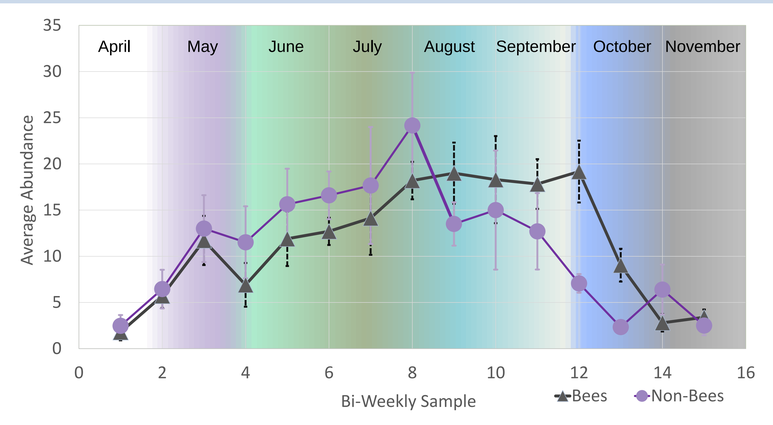

Figure 3: Average abundance of bees and non-bees over five years at every two weeks throughout the sampling season. There is a significant effect of time on abundance ($F_{14,739} = 6.83$, $p < 0.001$; repeated measures ANOVA) and significant interaction between pollinator type ($F_{14,739} = 20.16$, $p < 0.001$; repeated measures ANOVA).

- Non-bees peak in early summer while bees are more abundant in late summer.
- Weekly abundances differ significantly though total seasonal abundances are similar.

Discussion

- Non-bee insect pollinators are more abundant earlier in the season and may be important pollinators of early blooming plants.
- A decline in either pollinator group could leave a portion of the season's plants with diminished pollination.

Conclusion

- While there is no evidence of significant variation in bee and non-bee abundances between years, they differ significantly between weeks.
- Non-bee pollinators differ from bees in abundance trends and provide ecological services not fulfilled by bees (Schowalter 2018), therefore, non-bees may be uniquely important for maintaining plant populations.
- Monitoring both bee and non-bee insect pollinators provides a more complete view of potential changes in pollination and overall ecosystem health.

Literature Cited

1. Rader R, Bartomeus I, Garibaldi LA, Garratt MP, Howlett BG, Winfree R, Cunningham SA, Mayfield MM, Arthur AD, Andersson GK, Bommarco R, Brittain C, Carvalheiro LG, Chacoff NP, Entling MH, Foully B, Freitas BM, Gemmill-Herren B, Ghazoul J, Griffin SR, Gross CL, Herbertsson L, Herzog F, Hipólito J, Jaggar S, Jauker F, Klein AM, Kleijn D, Krishnan S, Lemos CQ, Lindström SA, Mandelik Y, Monteiro VM, Nelson W, Nilsson L, Pattemore DE, Pereira Nde O, Pisanty G, Potts SG, Reemer M, Rundlöf M, Sheffield CS, Scheper J, Schüepp C, Smith HG, Stanley DA, Stout JC, Szentgyörgyi H, Taki H, Vergara CH, Viana BF, Woyciechowski M. Non-bee insects are important contributors to global crop pollination. *Proc Natl Acad Sci U S A.* 113: 146-151
2. Sluijs J. (2020). Insect decline, an emerging global environmental risk. *Curr Opin Environ Sustain.* 46: 39-42
3. Rhodes C. (2018). Pollinator Decline – An Ecological Calamity in the Making? *Sci Prog.* 101: 121-160
4. Hallett A., Mitchell R., Chamberlain E., Karron J. (2017). Pollination success following loss of a frequent pollinator: the role of compensatory visitation by other effective pollinators *AoB Plants.* 9 (3), plx020
5. Popic TJ, Davila YC, Wardle GM. (2013). Evaluation of common methods for sampling invertebrate pollinator assemblages: net sampling out-perform pan traps *PLoS One.* 8 (6), e66665

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