WILDFLOWER RESTORATIONS INCREASE NESTING BY SOIL-DWELLING BEES

Emily May and Rufus Isaacs

Department of Entomology, Michigan State University, East Lansing, MI 48824, USA

INTRODUCTION

The majority of bee species nest in the soil, yet only a handful of studies have attempted to quantify belowground nesting and how that is associated with habitat type or substrate characteristics.[1,2,3] Because bees are central place foragers, returning to a fixed nest site between foraging bouts, the density and quality of nesting and foraging resources are considered the primary drivers of bee abundance and community structure.[4,5] Native forb plantings can increase local bee abundance and richness, increasing pollination and yield in adjacent crops.[6,7] However, it is not clear whether this enhancement of bee populations results from the addition of floral resources that concentrate foraging bees or from the provision of nesting habitat.[8] Preferential nesting by soil-nesting bees in forb plantings compared with nearby unrestored habitats would suggest that these restorations function as source habitats for bee populations to persist in fragmented agricultural landscapes.

RESEARCH QUESTIONS

- Do more bees nest in wildflower restorations compared with other farm habitats?
- Does restoration age affect the abundance of soil-nesting bees?
- Is nesting associated with specific microhabitat or substrate characteristics?

METHODS

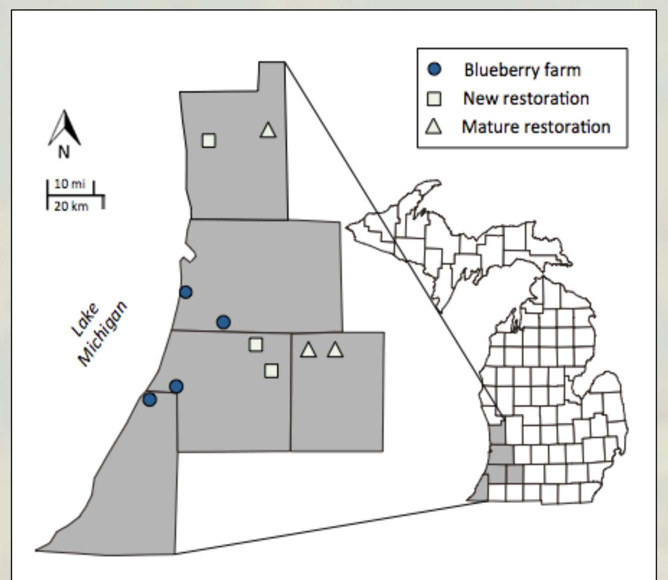

Figure 1. Map of study sites in southwest Michigan. Paired unrestored controls were within 300m of each restoration site (not shown).

Figure 2. Placing collection jar half-filled with 2% soap solution at top of emergence trap in mature wildflower planting.

Emergence traps (60cm^2; Bioquip Products, Inc.) were used to capture soil-nesting bees in:

1) Different habitat types on four blueberry farms: blueberry crop fields, wildflower plantings, grassy field margins, and wooded areas.
2) Newly-established and mature perennial wildflower restorations and paired unrestored habitats (agricultural field margins and old fields).

METHODS

Different habitats on blueberry farms

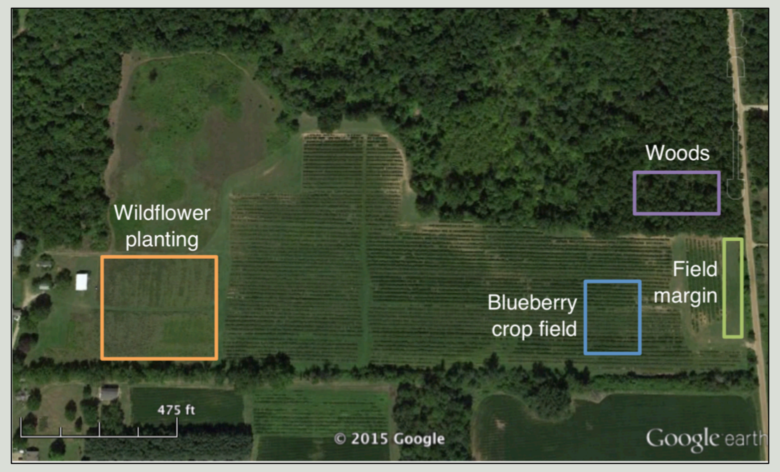

Figure 3. Representative distribution of habitat types on one of four blueberry farms sampled in 2013 and 2014.

- 10 traps per habitat (40 total)
- Traps placed mid-day, left out 2-3 days
- 3 sample rounds from June-September in 2013 and 2014 at four blueberry farms

New and mature wildflower plantings

Figure 4. Representative mature wildflower planting (left) and newly-established planting (right) and paired unrestored control sites sampled in 2014.

- 20 traps in planting, 20 in control (40 total)
- Traps placed after dusk, left for one week
- 3 sample rounds from June-September 2014 at six plantings and paired controls
- Netted bees on flowers for 50 minutes/site per round

RESULTS

More bees were found nesting in wildflower plantings than in other habitat types on blueberry farms (Figure 5).

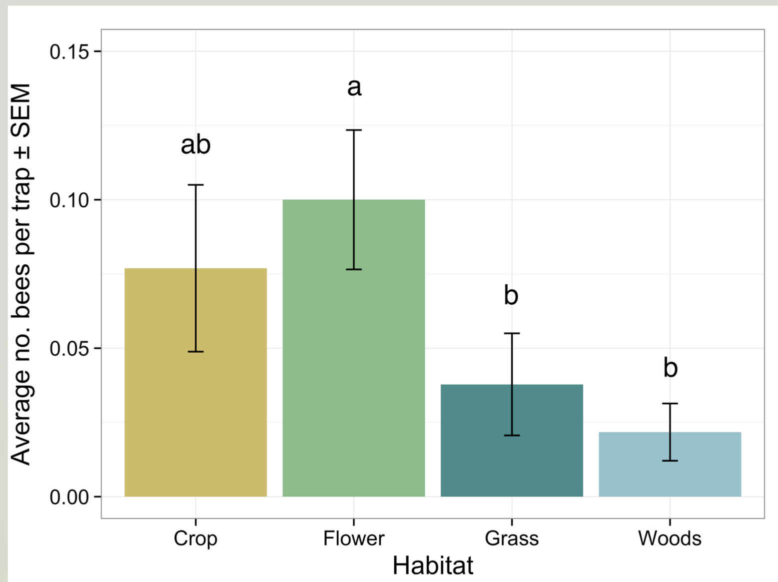

Figure 5. Mean number of bees collected in emergence traps in blueberry crop fields, wildflower restorations, grassy field margins, and wooded areas on four blueberry farms in 2013 and 2014.

Nesting bee abundance was **higher in mature wildflower plantings** than in paired old field controls, new restorations, or blueberry field margin controls (Figure 6).

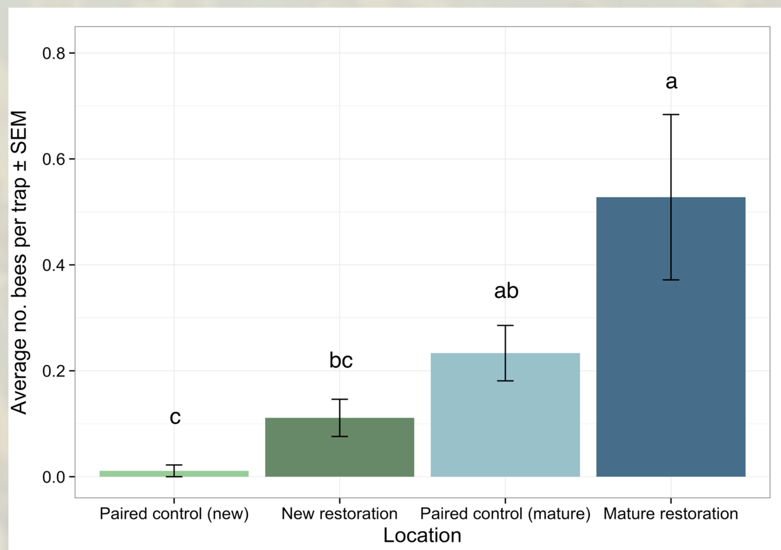

Figure 6. Mean number of bees collected in emergence traps in three mature wildflower plantings, three newly-established plantings, and paired controls in 2014.

Bare ground (% cover) and the number of **small cavities** were the best predictors of bee presence in traps in logistic regression models (Table 1).

Table 1. Model selection table for logistic regressions of microhabitat characteristics as predictor variables for bee presence in emergence traps on blueberry farms.

Model	$\beta \pm$ SE	z	p	Residual deviance	df	AIC
Combined model						
small cavities	0.68 ± 0.18	3.7	<0.001	295.59	833	301.59
bare ground (%)	0.01 ± 0.01	2.21	0.03			
Individual models						
small cavities	0.76 ± 0.18	4.28	<0.001	299.79	834	303.79
bare ground (%)	0.02 ± 0.01	2.99	0.003	307.7	834	311.7
leaf litter (%)	-0.01 ± 0.004	-1.36	0.17	313.32	834	317.32
vegetation (%)	-0.002 ± 0.004	-0.63	0.53	314.84	834	318.84
soil strength (kg/cm^2)	-0.34 ± 0.38	-0.89	0.37	204.17	643	208.17†

RESULTS

Emergence traps captured **different communities of bees** from the bee communities net collected from flowers at the same sites.

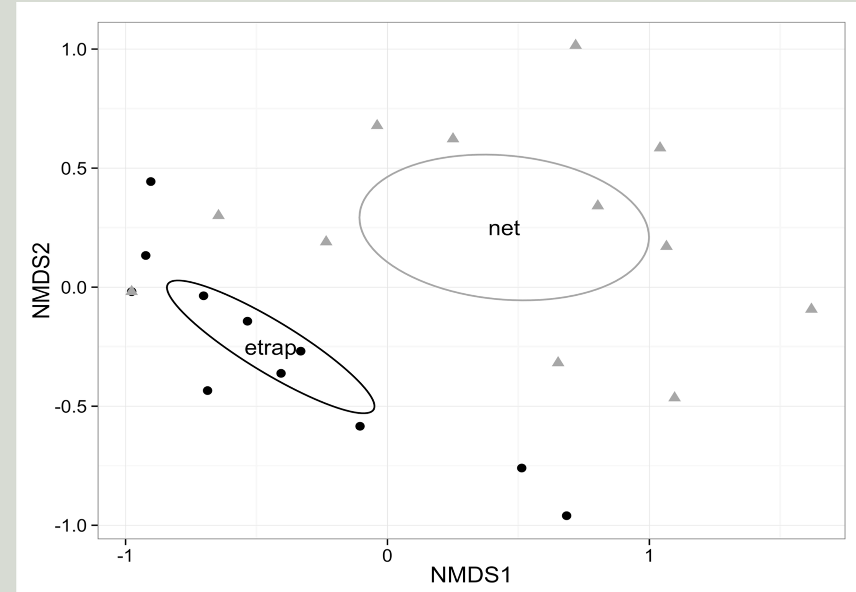

Figure 7. Non-metric multidimensional scaling of Bray-Curtis dissimilarities of bee communities captured in nets (grey triangles) and emergence traps (black circles) at six wildflower plantings and six paired control sites in summer 2014. Sites that are closer together in ordination space are more similar. Ellipses represent 95% confidence ellipses around the group means for trapped and netted bee communities.

CONCLUSIONS

- Wildflower restorations increase nesting by soil-nesting bees. These plantings provide both floral and nesting resources for bees and represent a key conservation strategy for bees in human-altered landscapes.
- Emergence traps are a useful method for assessing bee nesting, particularly when traps are placed after dusk. They capture a subset of the bee community present at a site, distinct from the community of bees netted on flowers.
- More work is needed to determine the density of bee nests in different habitats, and how nest location relates to pollinator abundance and movement in the landscape.

LITERATURE CITED

1. Cane, J. (1991). Soils of ground-nesting bees (Hymenoptera: Apoidea): texture, moisture, cell depth, and climate. *J Kans Entomol Soc*, 6: 406-413.
2. Potts, S.G., Vulliamy, B., Roberts, S., O'Toole, C., Dafni, A., Ne'eman, G., et al. (2005) Role of nesting resources in organizing diverse bee communities in a Mediterranean landscape. *Ecol Entomol*, 30, 78–85.
3. Sardiñas, H.S. & Kremen, C. (2014) Evaluating nesting microhabitat for ground-nesting bees using emergence traps. *Basic Appl Ecology*, 15, 161–168.
4. Potts, S.G., Vulliamy, B., Dafni, A., Ne'eman, G. & Willmer, P. (2003) Linking bees and flowers: how do floral communities structure pollinator communities? *Ecology*, 84, 2628–2642.
5. Roulston, T. & Goodell, K. (2011) The role of resources and risks in regulating wild bee populations. *Ann Rev Entomol*, 56, 293–312.
6. Blaauw, B.R. & Isaacs, R. (2014) Flower plantings increase wild bee abundance and the pollination services provided to a pollination-dependent crop. *J Appl Ecol*, 51, 890–898.
7. Williams, N.M., Ward, K.L., Pope, N., Isaacs, R., Wilson, J., May, E.A., et al. (2015) Native wildflower plantings support wild bee abundance and diversity in agricultural landscapes across the United States. *Ecol Applic* (Accepted).
8. Morandin, L.A., & Kremen, C. (2013) Hedgerow restoration promotes pollinator populations and exports native bees to adjacent fields. *Ecol Applic*, 23, 829-839.

ACKNOWLEDGEMENTS

Thanks to Jason Gibbs for help with identification of bees collected in 2013, and John Ascher for identification of bees collected from 2004-06. We thank our grower cooperators, Kalamazoo Nature Center, and the Southwest Michigan Land Conservancy for providing access to field sites, and Ashley McNamara, Clara Stuligross, Kari Grebe, Nick Blodgett, Adrienne Adamzcyk, and Erin Treanore for their assistance in the field and lab. Thanks to Hillary Sardiñas for providing guidance on emergence trapping protocols. This project was supported with funding from a Michigan State University Plant Science Fellowship, NCR-SARE Graduate Student Grant, the National Institute of Food and Agriculture's North Central Regional IPM Center, Coalition for Urban/Rural Environmental Stewardship, and by Syngenta's Operation Pollinator.