



**Farmers should think beyond the farm to maximize crop pollination by honey bees**

Crop pollination is critically important for farmers and it's a major revenue source for many beekeepers. Depending on the crop and location, farmers currently pay from ~\$30-250 per hive and stocking densities are recommended at ~1-4 hives per acre for the field where they're placed.

Given the importance of pollination, it's equally important to assess whether stocking-density recommendations are sound. Most fields where pollination-dependent crops are grown exist within mixed agricultural landscapes where one farmer's field may be next to another farmer's field, which may be next to a non-crop field or maybe even a section of woods. Since honey bee foragers commonly travel a kilometer or more to collect pollen and nectar, should farmers who rent honey bees consider their surrounding landscape and hives beyond their fields?

In other words, should farmers consider landscape-scale hive density instead of field-scale hive density if their goal is to maximize crop pollination? This is the topic for the sixty-sixth *Notes from the Lab*, where I summarize "Landscape-level honey bee hive density, instead of field-level hive density, enhances honey bee visitation in blueberry," written by Maxime Eeraerts and colleagues and published in the *Landscape Ecology* [2023].

For their study, Eeraerts and colleagues monitored 16 blueberry fields in western Washington during pollination in 2021 (see Figure 1). Fields ranged in size from 8.9 to 25.2 acres,

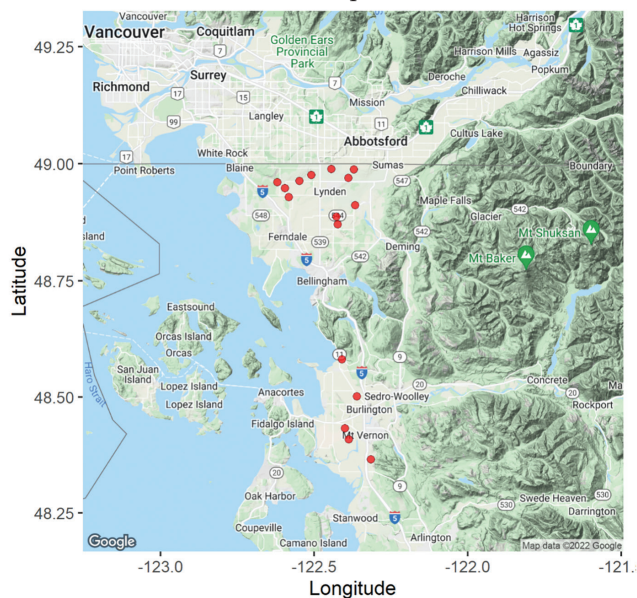
with an average size of 16.8 acres. Three types of data were taken at each location. First, all honey bee hives at a focal field and within a 1 km radius of the field were located and mapped via information provided by farmers, beekeepers, extension agents, and personal experience. In total, 6,340 hives were located across the 16 sites, which ranged from 1.4 to 10.2 hives per acre at focal fields and 16 to 920 hives per 1 km radius.

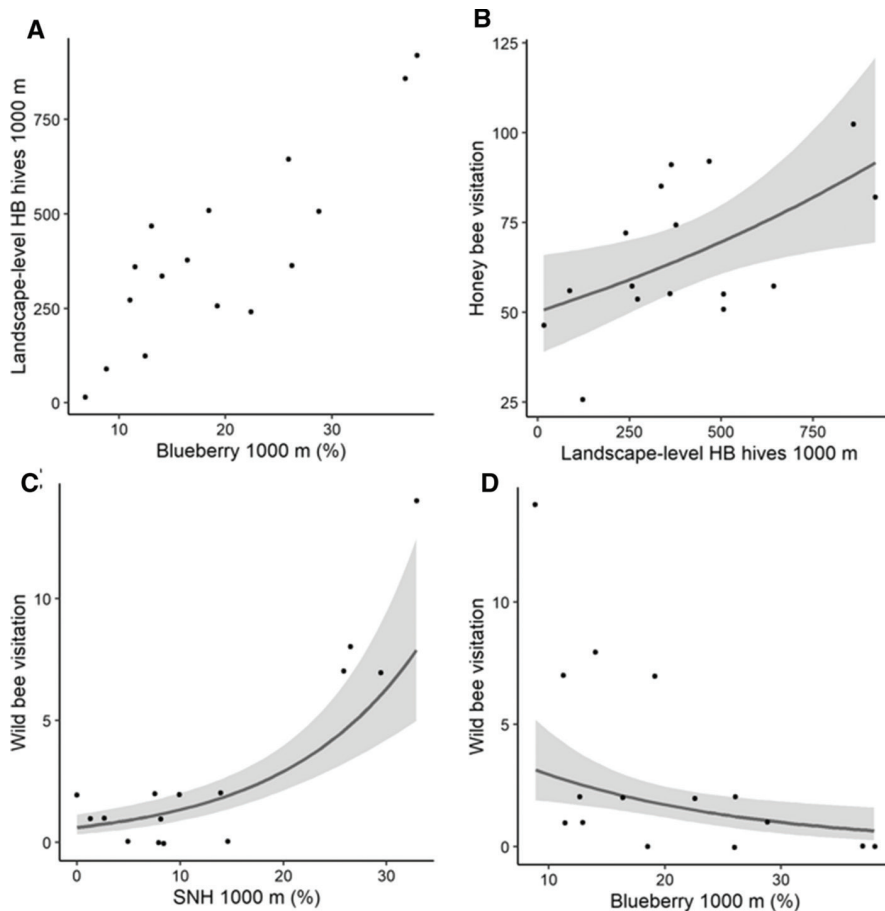
Second, the composition of land within a 1 km radius of each location was determined using the National Land Cover Database and Cropland Data Layer. The amount of focal crop (blueberry) and semi-natural habitat (SNH; shrubland, extensive grassland, woody and herbaceous wet-

lands, and forest) were quantified. Semi-natural habitat was quantified because this habitat type is often associated with wild bee abundance during crop pollination, and it can also potentially influence honey bee visitation to crop flowers (more on that later). The amount of blueberry fields and SNH in the surrounding landscape ranged from 6.8-38.0% and 0.0-32.9%, respectively. Other land-use types in the surrounding landscapes were non-blueberry arable crops, pastures, and other areas (e.g., water bodies, urban areas).

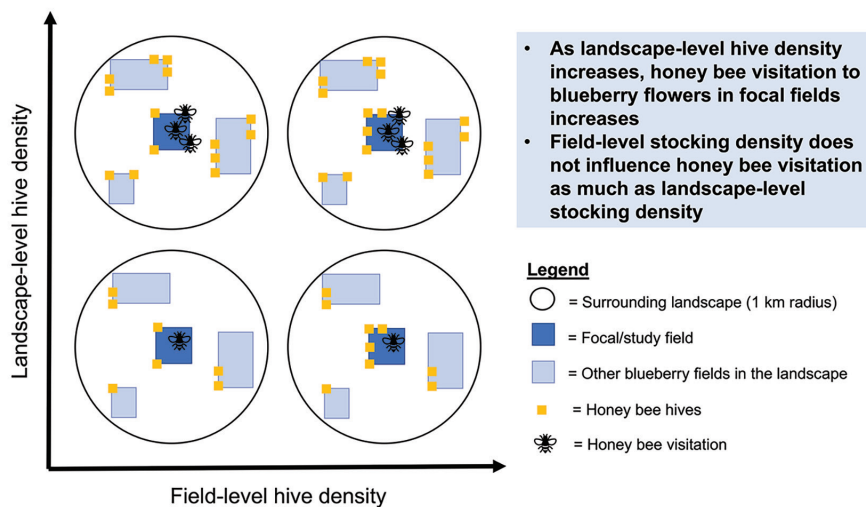
Finally, surveys of honey bees and wild bees foraging at blueberry flowers were conducted in each field during peak bloom using timed transects. In addition, pollination was measured

**Fig. 1** A map of the study region in western Washington state (USA) indicates the location of the blueberry fields used as study sites (red points).





**Fig. 2** (A) Relationship between the proportion of blueberry fields and landscape-level hive density (number of honey bee hives in the surrounding landscape within a radius of 1000 m around the study sites). (B) Relationship between landscape-level hive density and honey bee visitation rate at blueberry blossoms. (C) Relationship between the proportion of semi-natural habitat (SNH) and wild bee visitation rate at blueberry blossoms. (D) Relationship between the proportion of land used for blueberry production within a radius of 1000 m around the study sites and wild bee visitation rate to blueberry blossoms.



**Fig. 3** Schematic illustrating how landscape-level hive density (honey bee hives in the surrounding landscape within a radius of 1000 m) are a better predictor of honey bee visitation to blueberry flowers compared to field-level hive density (hives per acre at a focal field). Schematic by Maxime Eraerts.

at each site by comparing the number of berries and berry weights between bushes with open flowers (exposed to pollinators), bagged flowers (pollinators excluded), and hand-pollinated flowers (exposed to pollinators and with supplemental pollen provided via a fine paintbrush).

**So, what did they find? What shaped honey bee and wild bee visitation to blueberry flowers?** For honey bees, landscape-scale hive density was the best predictor of visitation to blueberry flowers (see Figure 2B). Landscape-scale hive density was a better predictor of visitation to blueberry flowers compared to field-scale hive density, and it was tightly linked to the percentage of land used for blueberry production within a 1 km radius (see Figure 2A). Together, these results indicate that when additional hives are at nearby neighboring blueberry farms, honey bee visitation to blueberry flowers is increased at a focal farm, which may improve pollination.

Conversely, wild bee visitation to blueberry flowers decreased when a greater percentage of land was used for blueberry production within a 1 km radius (Figure 2D). For wild bees, the best predictor of visitation to blueberry flowers was the amount of semi-natural land within a 1 km radius (Figure 2C). This means having greater amounts of semi-natural habitat surrounding blueberry fields increases the number of wild pollinators, which may improve pollination.

**Did honey bee or wild bee visitation predict blueberry pollination?** Honey bee visitation did. Greater honey bee visitation was associated with greater seed number per berry, though neither fruit set nor berry weight were strongly predicted by honey bee or wild bee visitation. Honey bees were the dominant pollinator in the blueberry fields monitored in this study with 1,155 individuals caught in total, while only 54 wild bees were caught on blueberry blossoms. In other words, even though wild pollinators can be more effective pollinators that honey bees on a per-visit basis, there were nearly 20 times fewer wild bees compared to honey bees, which meant that honey bees were doing the vast majority of pollination.

**Did semi-natural habitat within a 1 km radius reduce honey bee visitation to blueberry flowers?** No. Some farmers worry about non-crop flowers potentially impacting crop pollination





**Photo 1** Honey bee colonies conduct commercial blueberry pollination in western Washington state (USA).

by drawing pollinators away from the crop, but this concern was not supported in this study. Instead, there were benefits of having semi-natural habitat in the landscape. First, semi-natural habitat was clearly beneficial for wild bees. Second, other studies have shown that honey bees benefit from semi-natural habitat for two reasons: Additional pollen sources can provide improved nutrition, and can dilute pesticide exposure during crop pollination (as long as the pollen and nectar from semi-natural habitat isn't contaminated with pesticides).

**Well this is interesting. What does it mean for farmers who want to**

**maximize pollination in their blueberry fields?** The most important insight from the authors' paper is that hive densities surrounding an individual focal field matter. This means that an individual field may benefit from hives at neighboring farms that are within 1 km of that field. Alternatively, if there are few hives within 1 km of a focal field, the field is unlikely to receive a benefit and should think carefully about stocking density within that field. Figure 3 provides a schematic illustrating how this works.

Perhaps just as important, the number of seeds per berry continued to increase at even the highest rates of

honey bee visitation to blueberry flowers, which occurred when there were 920 hives per 1 km radius. This means blueberry pollination can be improved at well beyond the current field-scale hive density recommendation of 3 hives per acre (Topitzhofer et al. 2020). Does this mean farmers should consider increasing hive densities in their fields? Well, clearly that depends on what their neighbors are doing. In the case of blueberry pollination by honey bees, good fences do not make good neighbors. Just the opposite, in fact!

Until next time, bee well and do good work.

Scott McArt

**REFERENCES:**

Eeraerts, M., E. Rogers, B. Gillespie, L. Best, O. M. Smith and L. W. DeVetter. 2023. Landscape-level honey bee hive density, instead of field-level hive density, enhances honey bee visitation in blueberry. *Landscape Ecology* 38:583-595. <https://doi.org/10.1007/s10980-022-01562-1>

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