Honey Bee Foraging Patterns in Rural and Urban Landscapes

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ABSTRACT

Honey bees are an important insect for crop pollination and honey production, regularly traveling 5km from their hive to forage for nectar and pollen. In agricultural landscapes they forage on crops and the herbaceous plants on field margins. Honey bees also forage on flowering trees at the edges of forests and ornamental and weed species in urban environments. Bees recruit more foragers to resource locations using the waggle dance language. Other bees observe the dance and interpret the duration and angle of the waggle run to determine the location of the resource relative to the hive. Apiarists keep bee hives in both rural and urban environments, but which environment would bees prefer to forage in when given the choice? Does their preferred foraging environment change seasonally? To answer these questions, three glass-walled observation hives were placed at a site along the western edge of the Columbus metropolitan area, with residential development to the east and farmland to the west. Land cover was classified and quantified using GIS. Every week in August and September, 2014, morning and afternoon videos were taken to record dance activity. Videos were then analyzed to create maps of foraging locations for each day. Foraging locations will change throughout the summer, and bees will avoid agricultural areas during harvest and other disruptive times. Bees prefer agricultural areas during fall when goldenrod is blooming. Learning more about honey bee foraging preferences will support the conservation of honey bees and other pollinators through the preservation and enhancement of floral resources in both urban and rural landscapes.

BACKGROUND

Honey bees (*Apis mellifera*) are an important insect species that contribute billions to the US economy by pollinating a variety of crop species.

Communication and Foraging:
- Behavior varies widely throughout different seasons
- Bees use the waggle dance (Figure 1) to share the locations of these crops
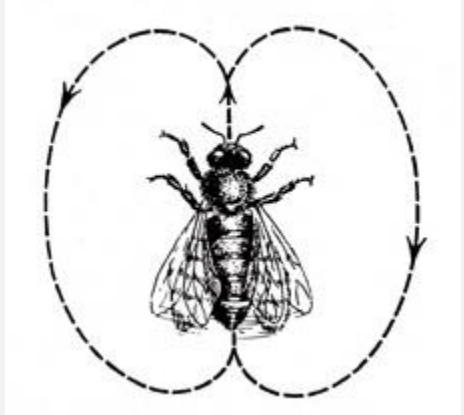- Indicates the location of resources by varying the length of waggle and the angle of the turn.

Figure 1: Waggle Dances, by Karl von Frisch, *Erinnerungen eines Biologen*, Berlin, Göttingen, Heidelberg: Springer, 1957, p. 128.

Goals: As the foraging behavior of bees can vary widely from the availability of flowers in the area, we aim to examine whether honey bees preferentially forage in rural or suburban areas during the late summer.

FIELD METHODS

Three observation hives were set up in a cemetery in Hilliard, OH on the west side of Columbus.

- Hives consist of four frames encased in glass
- Hives were located inside a tent so that light did not interfere with dance behavior
- Cameras were set up facing these hives, with a black backdrop to reduce glare (see Figure 2)
- Pollen traps were used to collect pollen once weekly from other hives also located at the cemetery.

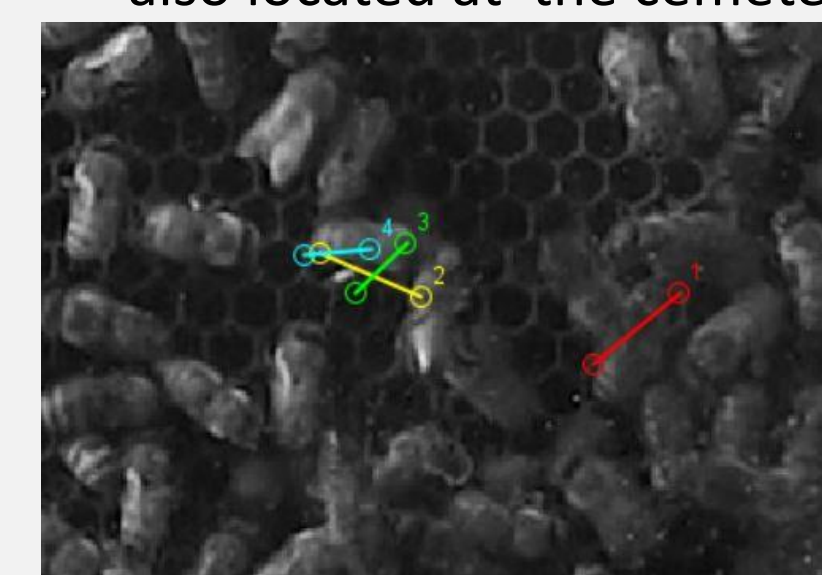Figure 2: Tent with observation hives, black backdrops, and cameras.

- Raw videos were converted into 1min segments
- Image J was used to track each waggle dance including two turns to the right and 2 turns to the left
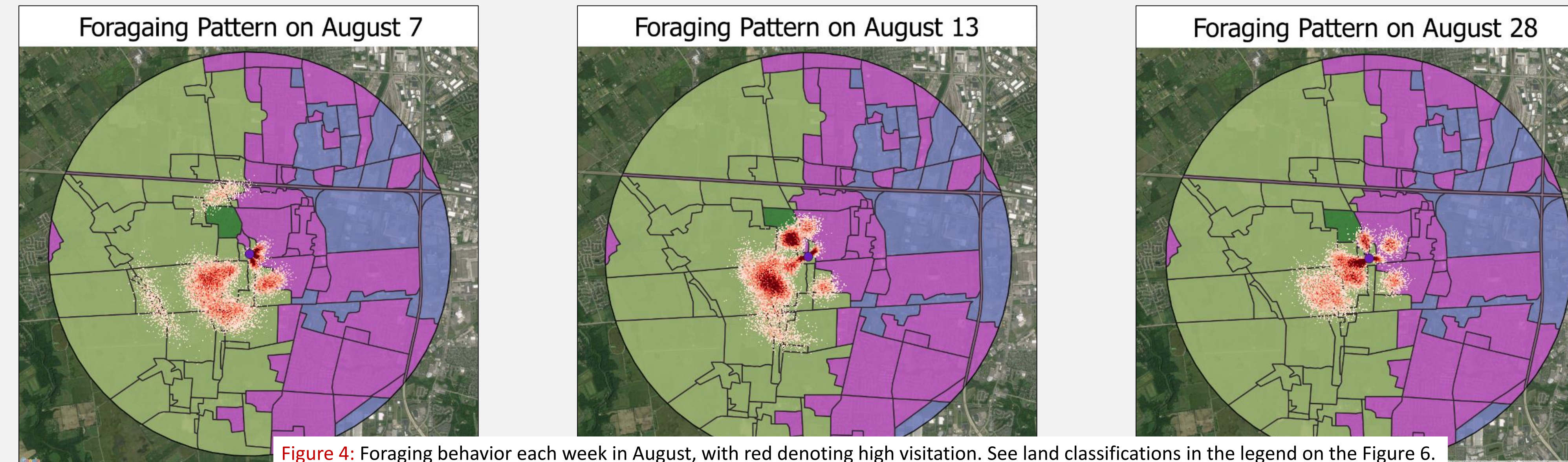- Image J analyzed the angles and duration of waggle runs

Figure 3: Waggle runs traced in FIJI.

Figure 4: Foraging behavior each week in August, with red denoting high visitation. See land classifications in the legend on the Figure 6.

ANALYSIS METHODS

Dance measurements were used to calculate visitation probability using methods popularized by Schürch et al. Red denotes a high probability of bee foraging, and each map in Figure 4 displays dances for a single day. In Figure 4, the visitation map was layered on a 5km radius map centered on the hive, with urban and rural land types classified. See the legend in Figure 6 for color information.

To calculate preference, the visitation probability raster files for each day in August were combined to make one aggregated raster file. Another raster with the probability of visitation based on location alone (See Figure 5) was subtracted from the aggregated visitation raster file. This final raster file shows whether the bees visit a patch more than they could be predicted by distance alone, or in other words, whether the bees prefer or dis-prefer a patch. Preference was plotted on top of the land classification map, and can be seen below in Figure 6.

Pollen was collected from traps weekly. Each week's pollen was photographed against a black backdrop so that the relative abundance of pollen colors could be assessed. Clover appears as brown and goldenrod appears as orange. See all 6 images in Figure 7.
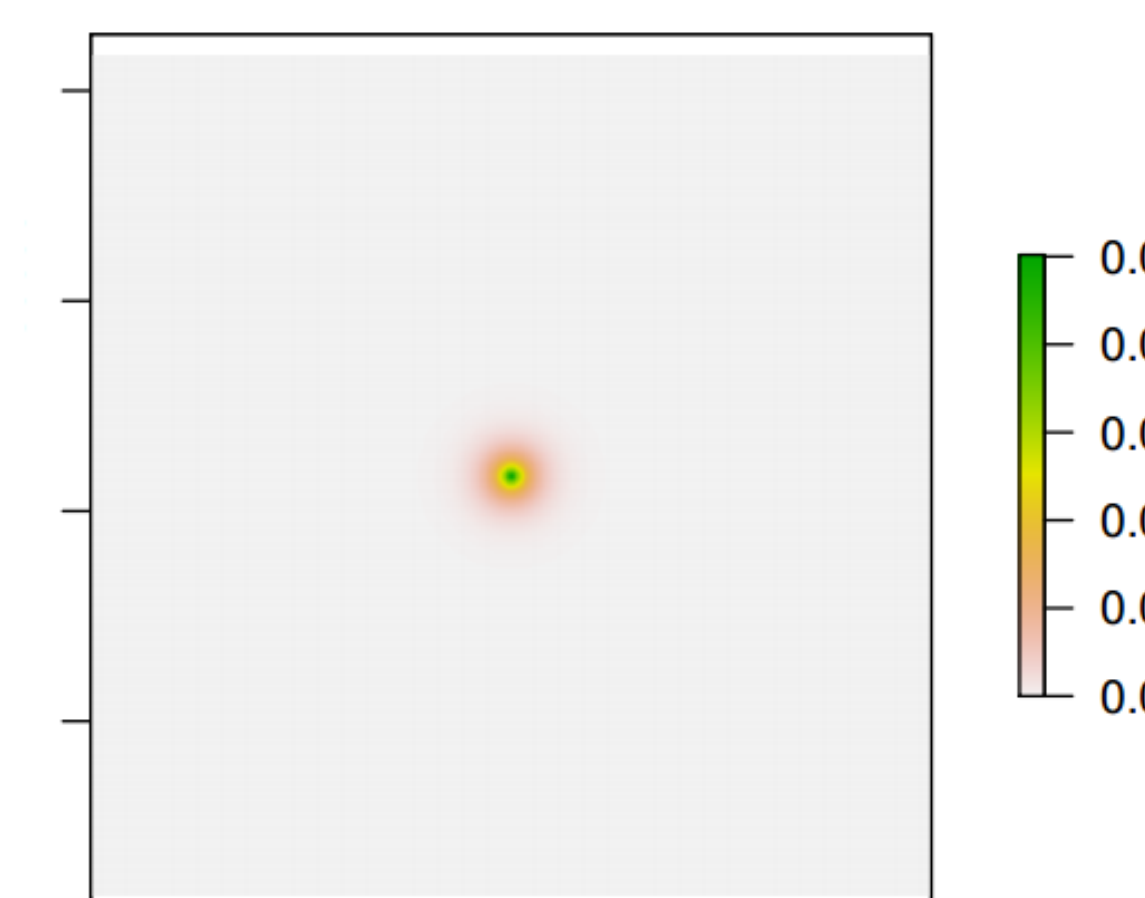
Figure 5: This is the probability that a bee would forage at this location based on distance alone. In other words, if the whole landscape were identical other than distance from the hive, this is the probability a bee would use a particular patch.
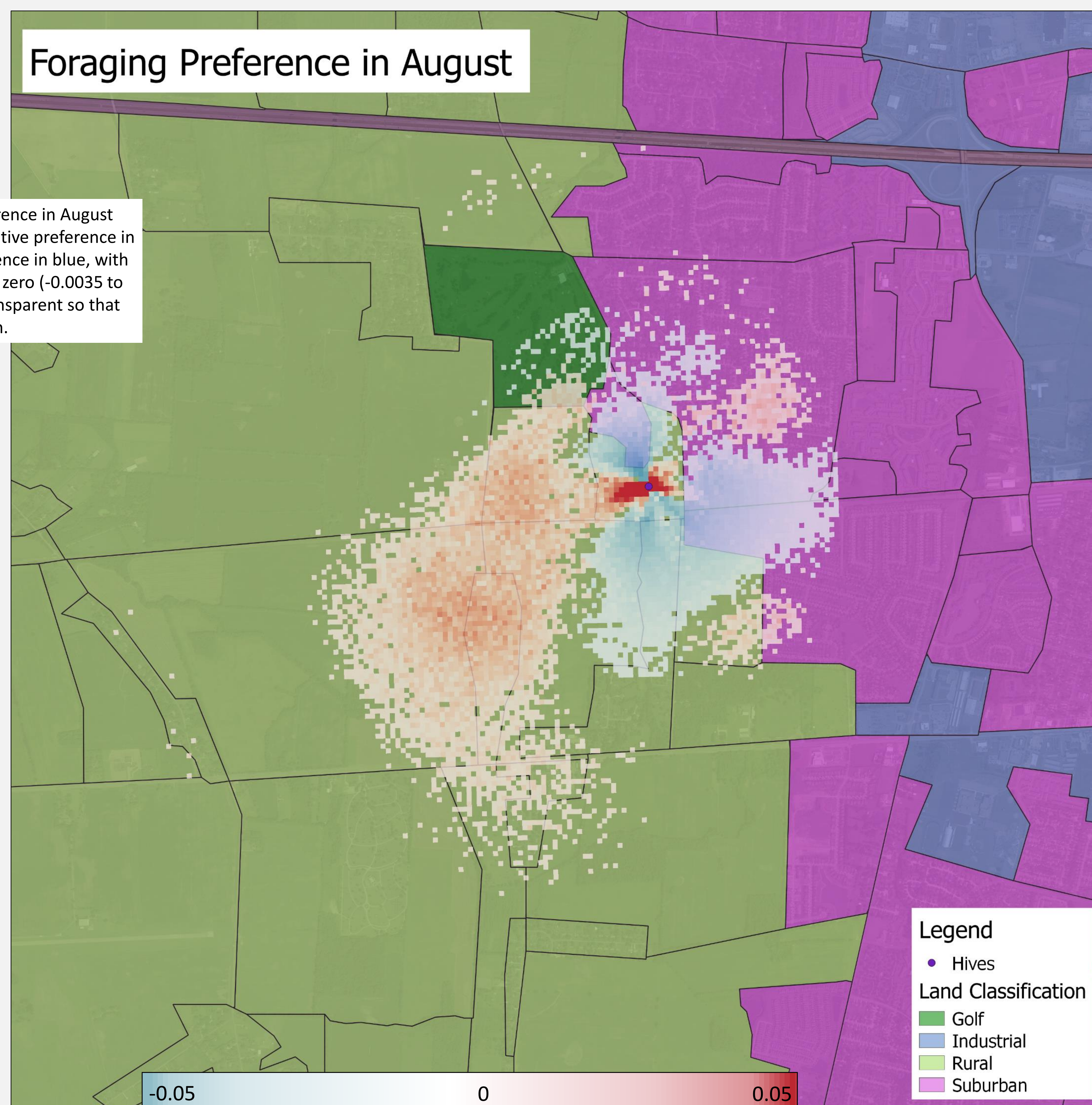
Figure 6: Foraging Preference in August This map shows the positive preference in red and negative preference in blue, with preference very close to zero (-0.0035 to 0.0035) displayed as transparent so that the map can still be seen.

RESULTS

Throughout the month of August, bees preferred to forage over the rural areas. While bees did forage in suburban areas, particularly in late August, they foraged there less than could be predicted by distance alone, showing that they dis-preferred suburban land types throughout the month. One exception to this pattern is a small patch of preferred suburban area to the northeast of the hive that was heavily foraged on August 28. This area appears to be a small park or an overgrown lawn, which would have a high density of clover.

The area of high visitation just southeast of the hive is very high in clover, and the pollen collected from the pollen traps confirms that bees foraged predominantly on clover until after September 12th (See Figure 7). Clover can be found in rural areas between fields, and in suburban lawns. But, the flowers get cut by lawnmowers more frequently in suburban areas, and thus are less useful for bees. Goldenrod became the predominate pollen source after September 12th, and since goldenrod is generally found in rural areas, it shows that they foraged predominantly in the rural area in late September.
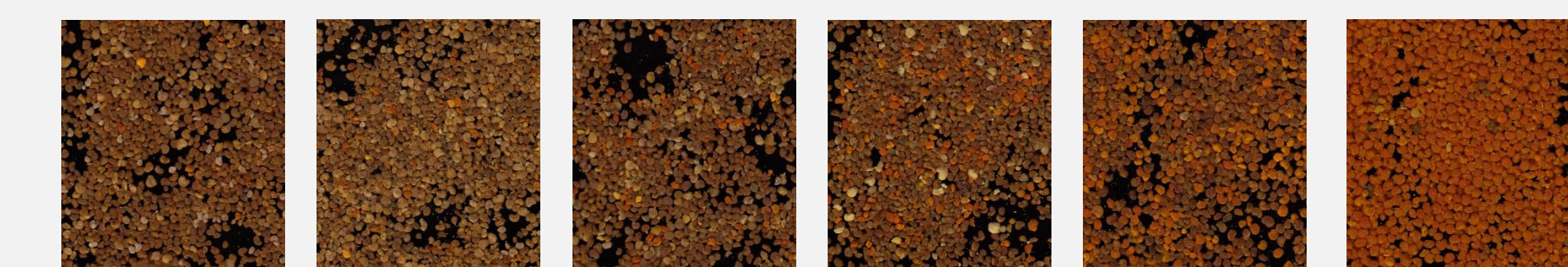
Figure 7: Pollen collected from traps on (from left to right) August 7, August 13, August 28, September 4, September 12, September 19. Clover pollen is brown, and goldenrod is orange.

CONCLUSIONS

- Bees foraged in both suburban and rural land classes
- They foraged less in suburban areas than would be predicted by distance alone
- Over the month of August, bees preferred to forage in rural areas
- Bees did not forage in the golf course
- They foraged mainly on clover in August and switched to goldenrod after September
- Goldenrod is mainly in in rural areas, so into September they are also foraging mainly in rural areas

PRACTICAL APPLICATIONS

- In August, bees in suburban areas would benefit from grass being cut less frequently, allowing clover to bloom
- Planting goldenrod in suburban areas would provide suburban colonies with a good resource after clover stops blooming

FURTHER RESEARCH

- Creating preference maps for later into September and October to compare dance maps to pollen data
- Using quantitative metrics to compare levels of preference between dates and hives
- Analyze differences in foraging behavior between the 3 hives located at the cemetery
- Better identify pollen to determine floral sources
- Determine when bees in urban areas are most lacking in resources, and which species rural bees are using at that time, in order to make recommendations for most effective additions to pollinator gardens

ACKNOWLEDGEMENTS

REFERENCES

Schürch R., Couvillon M.J., Burns D.D., Tasman K., Waxman D., Patnieks F.L. Incorporating variability in honey bee waggle dance decoding improves the mapping of communicated resource locations. Journal of Comparative Physiology A sensory Neural and Behavioral Physiology 199(12):1143-52.

Foragaing Pattern on August 7
Foraging Pattern on August 13
Foraging Pattern on August 28

Foraging Preference in August

Legend
- Hives

Land Classification
- Golf
- Industrial
- Rural
- Suburban

-0.05   0   0.05