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Density and Diversity of Bees in the Midwestern Agricultural Landscape: Influence of Surrounding Agricultural Land Use and Biofuel Candidate Crops

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Background

Recent trends in land management practices have led to dramatic population decline in bees and other insect pollinators (Cameron *et al.* 2011). Concerns about “Colony Collapse Disorder” in domestic honeybees, for example, have received widespread high-profile attention in the scientific community. While concerns have centered mainly on the domestic honeybee, native bees also provide indispensable, cost-free pollination services to crops production. Despite the value of native bee species, little is known about them in the Midwest region, and recent studies suggest their populations may be in decline specifically due to a lack of native vegetation in this highly agricultural landscape. Vegetable farms and lands managed for cellulosic biofuels have the potential to provide usable habitat, but their utility is not well understood.

Methods

Vegetable Farm Study

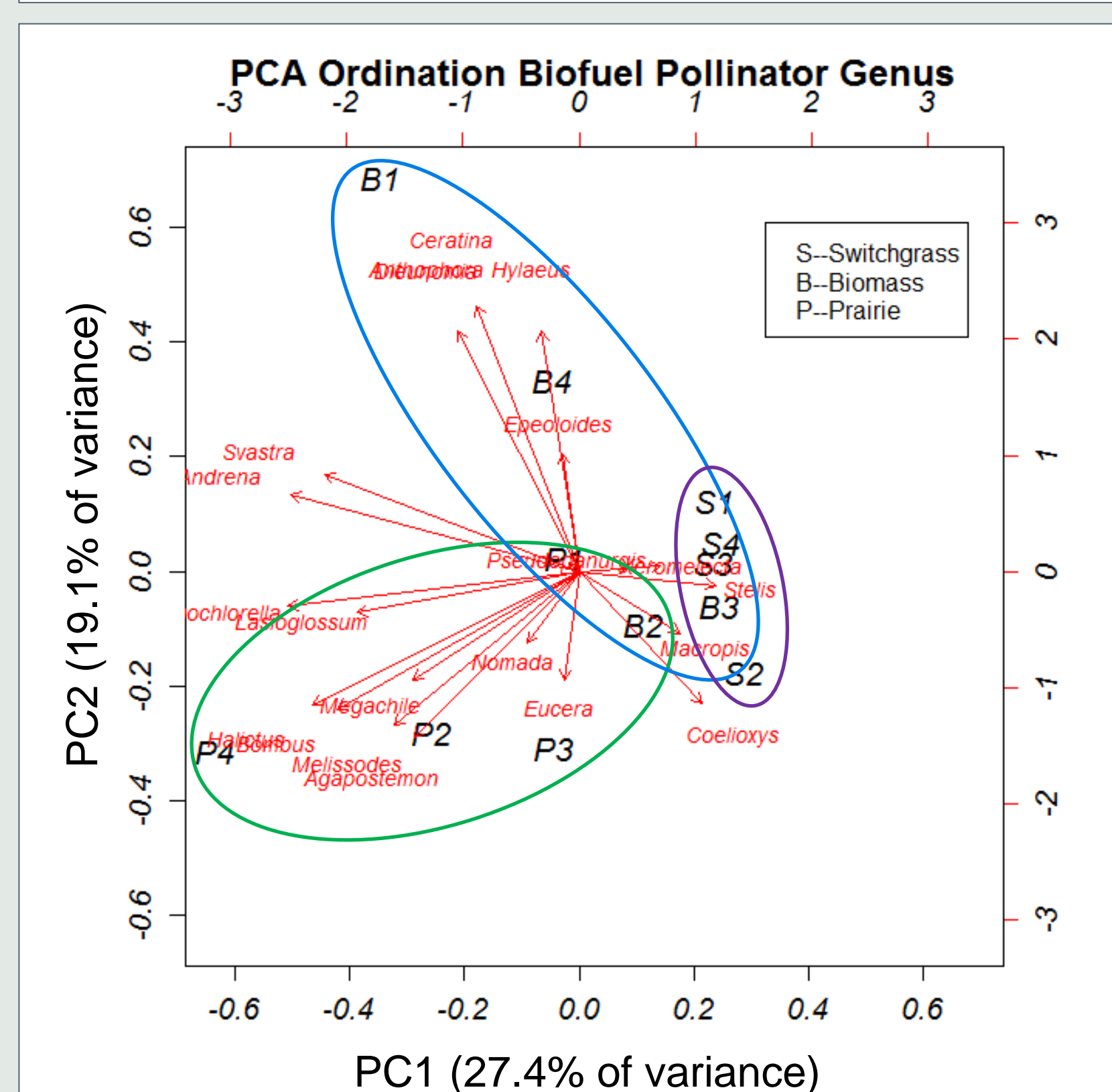
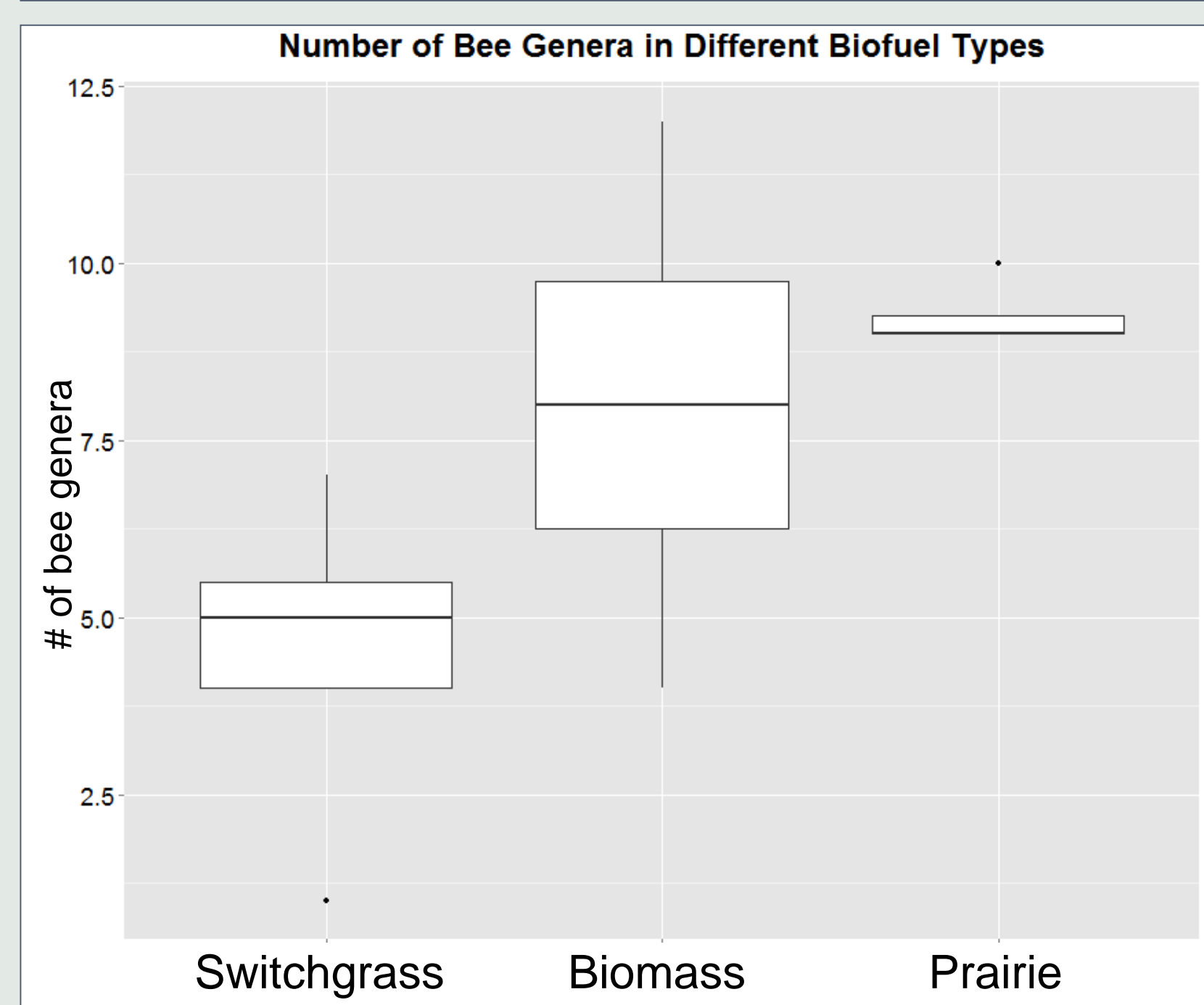
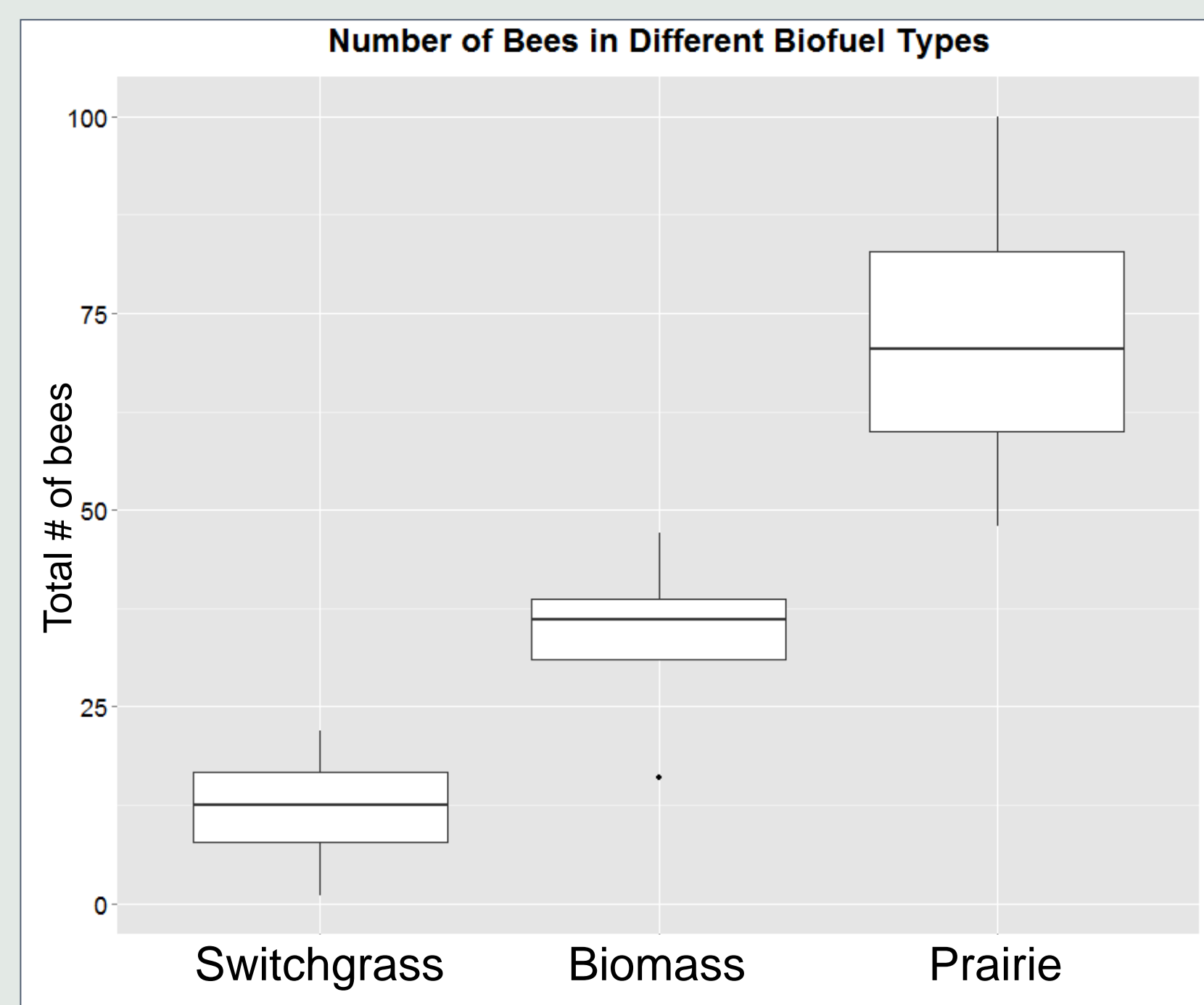
- 18 pan traps were placed within crop rows at each of 10 vegetable farms in East and Central Iowa
- Pan traps were filled with soapy water and left in the field over a 24 hour period
- During each of the 24 hour trapping period, a 20 minute sweep netting of the sampling area was conducted when the ambient temperature was above 26.7°C without wind; bees within 5 meters of the researcher were netted, preserved and identified in the lab
- Each farm was sampled once per month from May to August, 2015
- Bees were identified to genus level; the total bee abundance and diversity from both methods were combined for the data analysis
- The landscape within 1km from each farm was identified using Land Use Land Cover map from Iowa DNR NRGIS library; five Land Cover categories (Forest, Wetland/Water, Corn/Soybean, Prairie, Other) were used to determine correlation with bee community composition

Biofuel Study

- Three types of biofuel production were studied: a switch grass monoculture; a 16 species biomass mix, and a 32 species prairie diversity mix; each biofuel type has 4 plots (0.5 ha each) as replicates
- 3 pan traps were placed in each of the 12 biofuel plots; in addition, each plot was sweep netted for one hour
- The biofuel plots were sampled once per month; pan trapping and sweep netting followed the same protocol as described above



Biofuel Results



Rare rusty patch bumble bee (*Bombus affinis*) collected from the high diversity biofuel treatment on July 23, 2015

Bee abundance

- Measured by sweep netting
- Weeds in the switchgrass monoculture provided sparse floral resources for bees
- Biomass treatment (16 species) had few early-summer flowers and lower bee abundances
- Prairie mix (32 species) had consistent and abundant floral resources, and higher bee abundance

Bee diversity

- Switchgrass had low bee diversity
- The 16-species biomass treatment had higher diversity, but also showed high variability
- The 32-species prairie treatment had the highest diversity
- The 32-species prairie treatment was also consistently diverse and had low variability
- Higher diversity mixes might yield an even higher number of genera if this study were continued further

Community composition

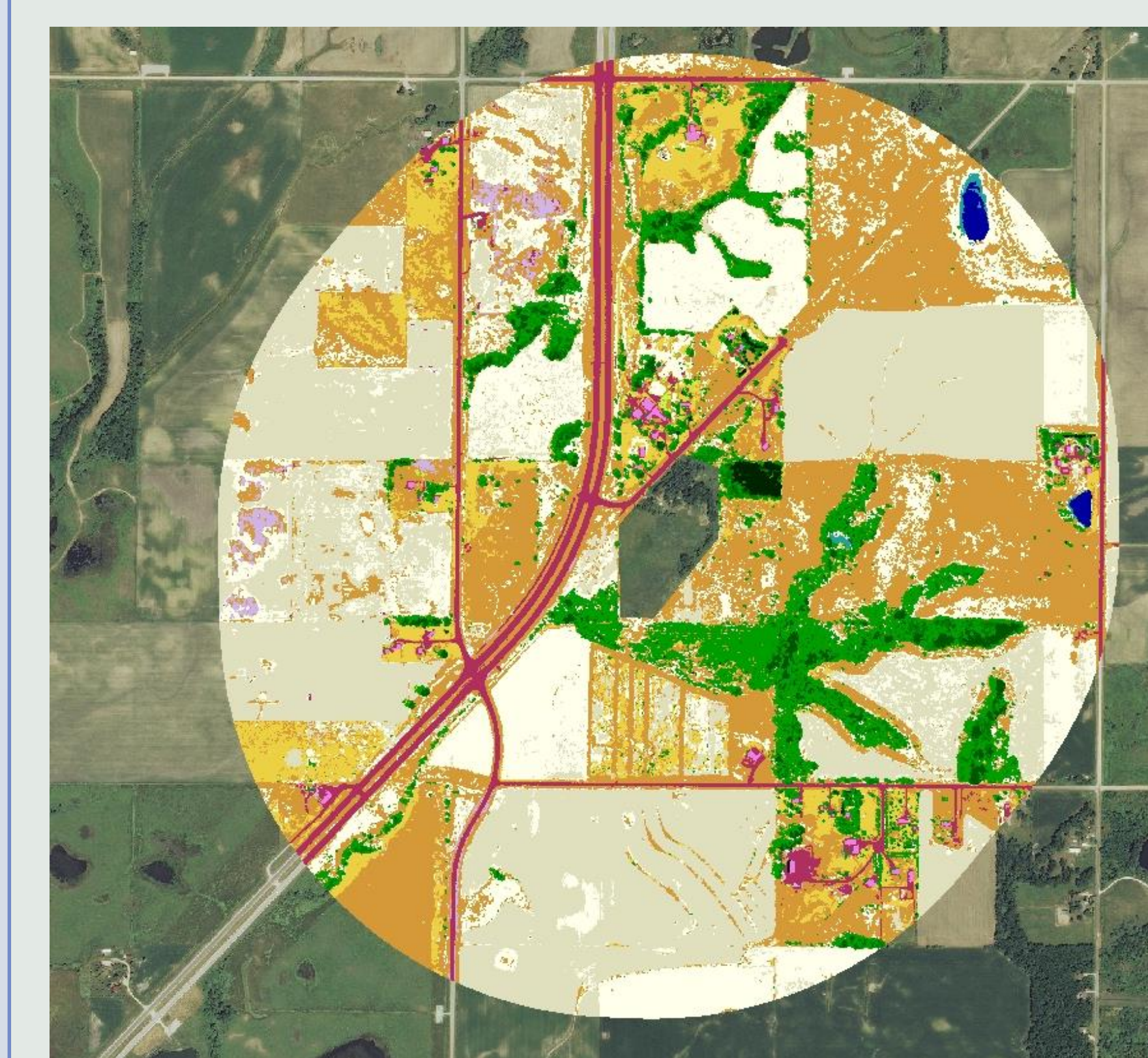
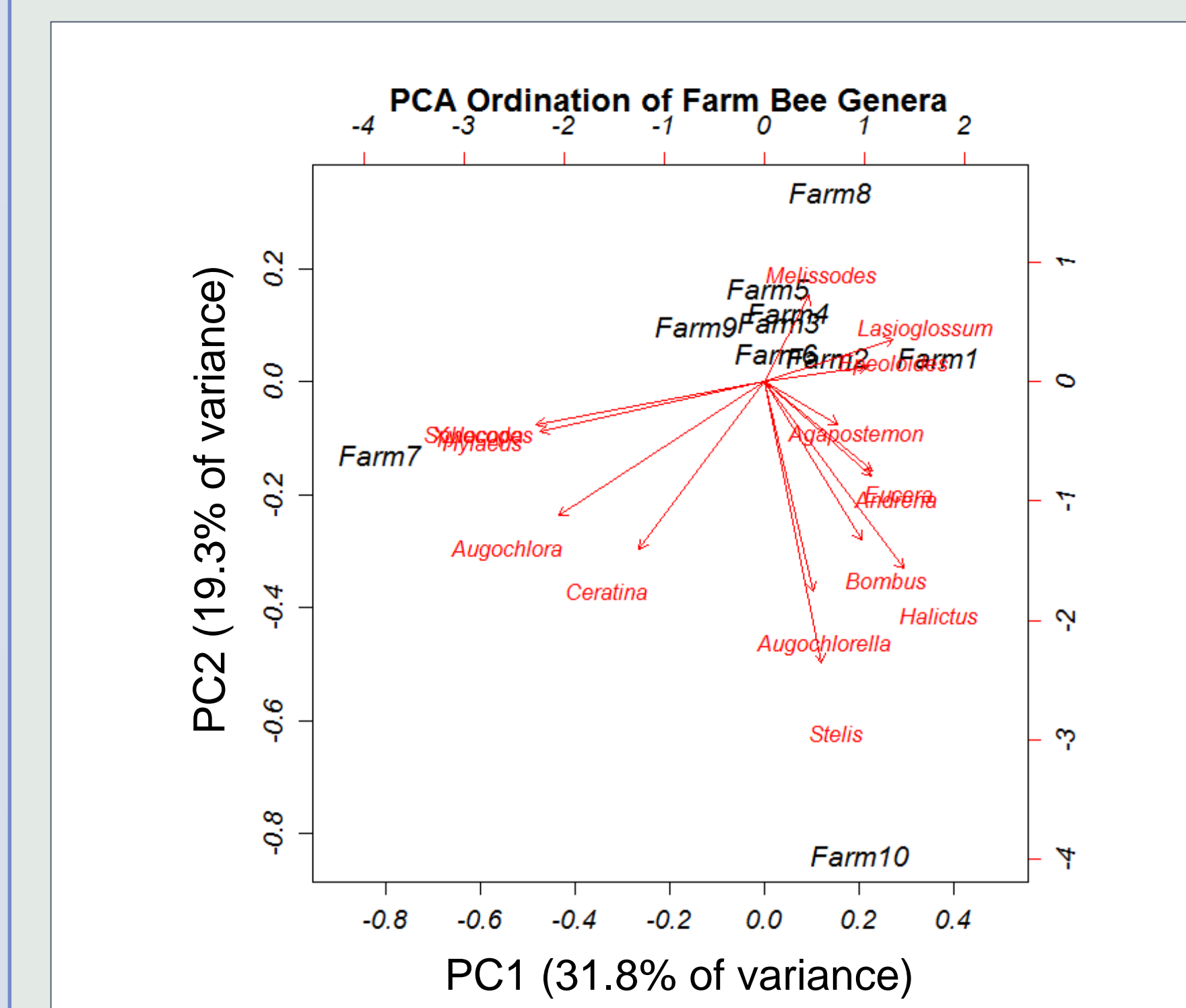
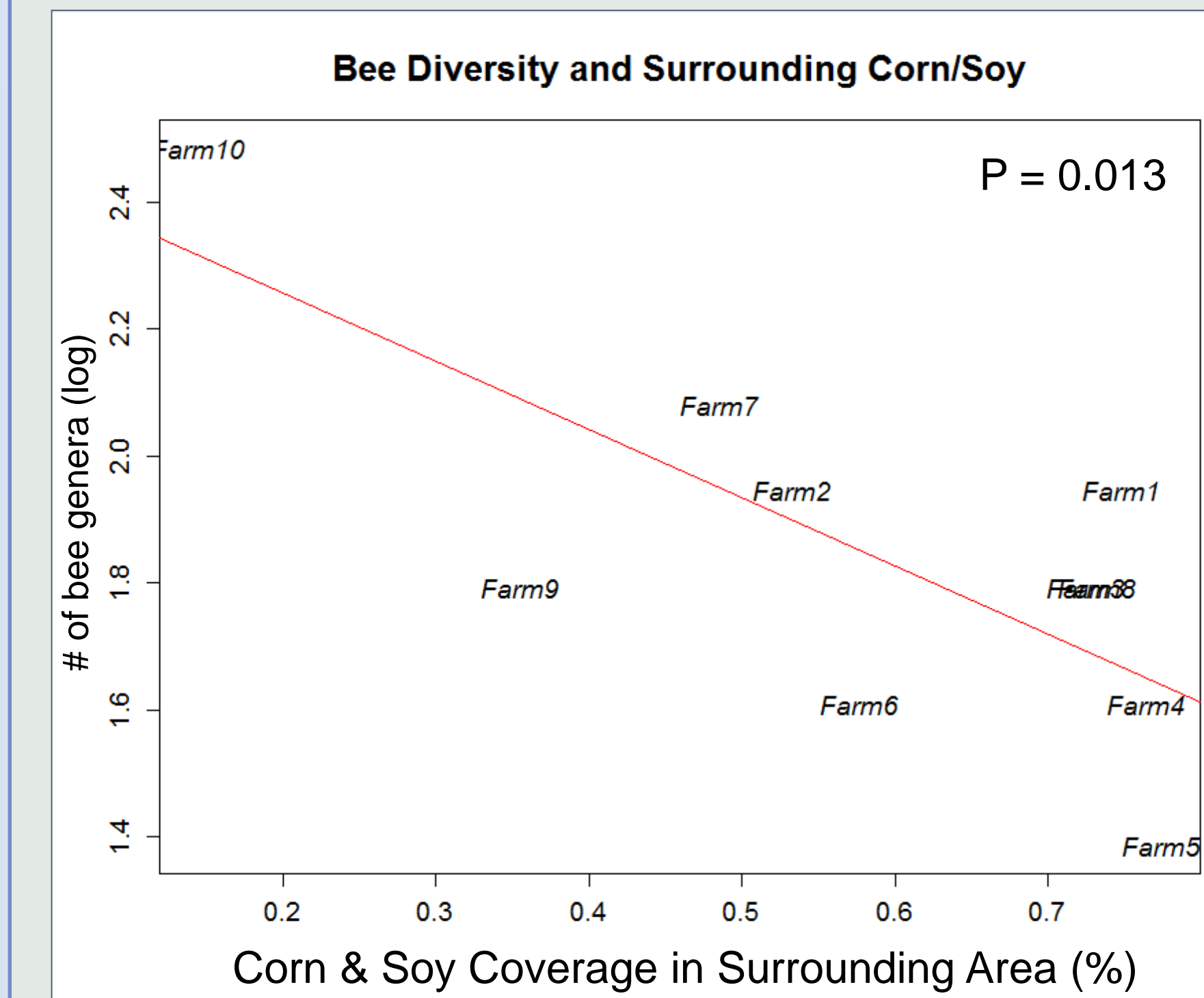
- This PCA shows the differences in bee community composition between the switchgrass (S), biomass (B), and prairie (P) treatments
- The high diversity prairie treatment has a different bee community than the other two treatments
- Bees in the switchgrass monoculture represent a subset of the biomass treatment
- The prairie and biomass treatments overlap somewhat in their community composition

Total Abundance/Diversity

Farms – 867 total bees from 15 genera
Agapostemon, Andrena, Augochlora, Augochlorella, Bombus, Ceratina, Epeoloides, Eucera, Halictus, Hylaeus, Lasioglossum, Melissodes, Sphecodes, Stelis, Xylocopa

Biofuels – 481 total bees from 20 genera
Agapostemon, Andrena, Anthophora, Augochlorella, Bombus, Ceratina, Coelioxys, Epeoloides, Eucera, Halictus, Hylaeus, Lasioglossum, Macropis, Megachile, Melissodes, Nomada, Pseudopanurgis, Stelis, Svastra, Xeromelecta

Farm Results

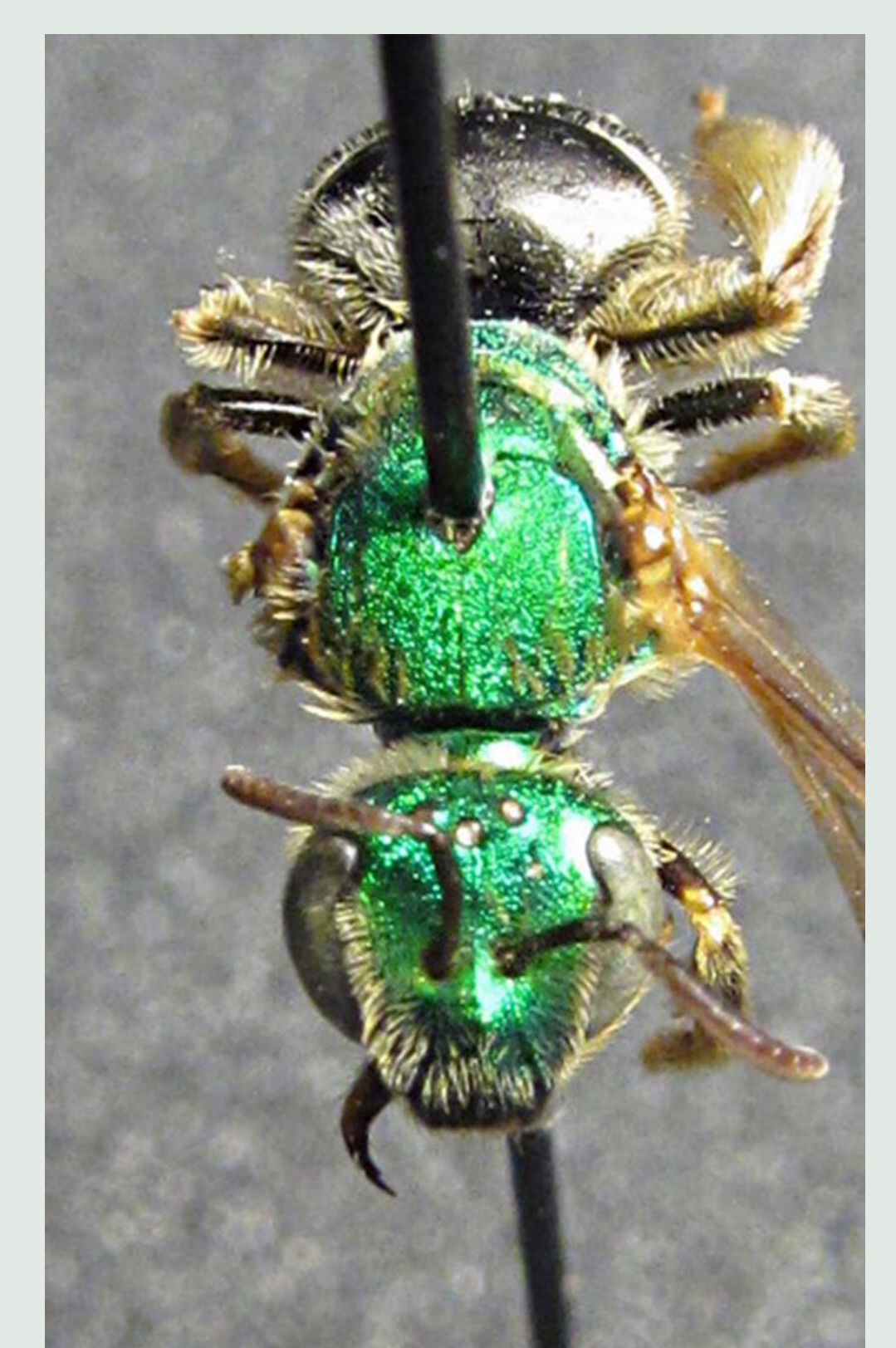


Landscape factors

- Classified land cover within 1 km as soy/corn production, forest, prairie, water/wetland, and others
- Overall abundance at each of the farms is not correlated with the surrounding landscape and may be the result of more specific, on-farm factors
- Diversity, however, is negatively correlated with the soy/corn landscape factor
- Extensive corn/soy production inhibits diverse communities of bees in the Midwest

Community composition

- Bee communities vary significantly among farms
- Farms with similar amounts of surrounding corn/soy have similar community composition
- 2 of the farms with low surrounding corn/soy production have communities that lie outside of the main cluster.
- This suggests that lower surrounding corn/soy supports unique bee communities
- Farms with higher surrounding corn/soy may yield low diversity bee communities with lower capability of providing adequate pollination services



Future Directions

We were unable to relate abundance of bees on each farm to surrounding landscape factors within one kilometer, suggesting that more localized habitat factors may influence the abundance of species whose flight range is limited to the on-farm area. We have identified and mapped on-farm landscape and vegetation factors which will be used to explain bee community composition and functional diversity in the future.

Acknowledgements

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