

The Effect of Urbanization on Bumble Bee Communities in Greater Philadelphia

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INTRODUCTION

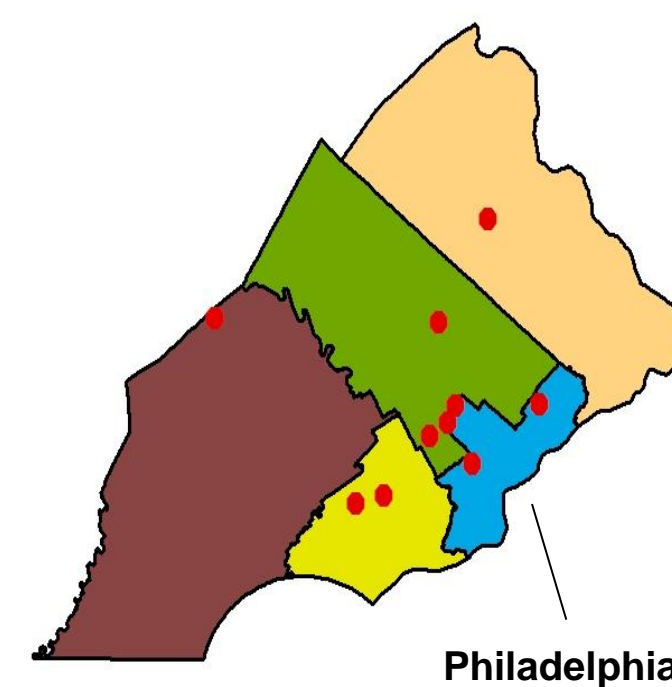
Bumble bees (*Bombus* spp.) are among the most important wild pollinators in temperate ecosystems in North America and Europe, and are believed to be vital to the functioning of the pollination networks in which they occur. Evidence of their overall decline in Europe and more selective decline in the U.S. has raised concern about the long term persistence of many species. Human-induced changes in land use, including the loss of natural and semi-natural habitat and associated floral resources, are purported causes in several cases. Reported declines, including the local extirpation of two once-prominent species (*B. affinis* and *B. pensylvanicus*), prompted an investigation of this potential trend in the urbanized landscape in and surrounding Philadelphia, PA. Like many east coast cities, the greater Philadelphia area has experienced rapid and far-reaching urban sprawl. Our 2006 study is the first in this region to investigate the potential impact of urbanization on local bumble bee abundance and species richness, contributing to the surprisingly small body of work examining east coast bumble bees.

METHODS

The study took place from June 1 to August 15, 2006 in five PA counties of the Delaware Valley.

Site Selection

Chose 10 restored, managed meadows that spanned gradient of urban development (0.16 - 68.18% at 2500 m radius) and marked off half-hectare plots.



Specimen Data

Net-collected on flowers for 2 hour-long periods (AM/PM). Each site was surveyed four times over the summer.



Local Resource Availability

- Surveyed floral abundance and diversity every visit
- Determined overall size of meadow using GPS unit

Landscape-Scale Land Use Quantification

Used land use layer from the Delaware Valley Regional Planning Commission (DVRPC) and ArcGIS (9.1) to quantify the proportion of developed land at spatial scales ranging from 500 to 4000 m from survey sites. Bee abundance was best explained by a model that included the proportion of developed land at the **2500 m** scale.

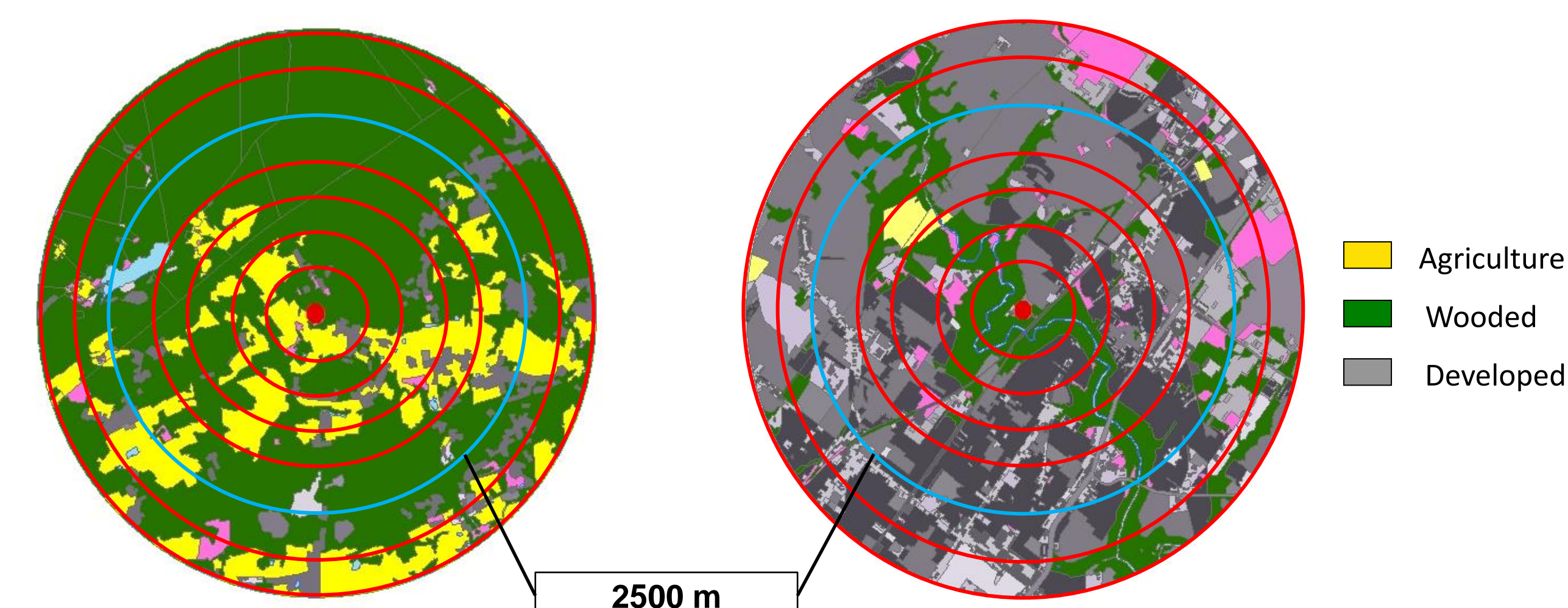


Figure 1. Land use surrounding target meadows (central dots) was assessed at 500 m increments up to 4000 m. The meadow on the left is surrounded largely by wooded and agricultural land, while the meadow on the right is situated in a more urban location. The blue circle highlights the 2500 m spatial scale.

ANALYSIS & RESULTS

A multiple regression model incorporating local and landscape variables was used to assess the effect of these characteristics on both bumble bee abundance and species richness at multiple spatial scales.

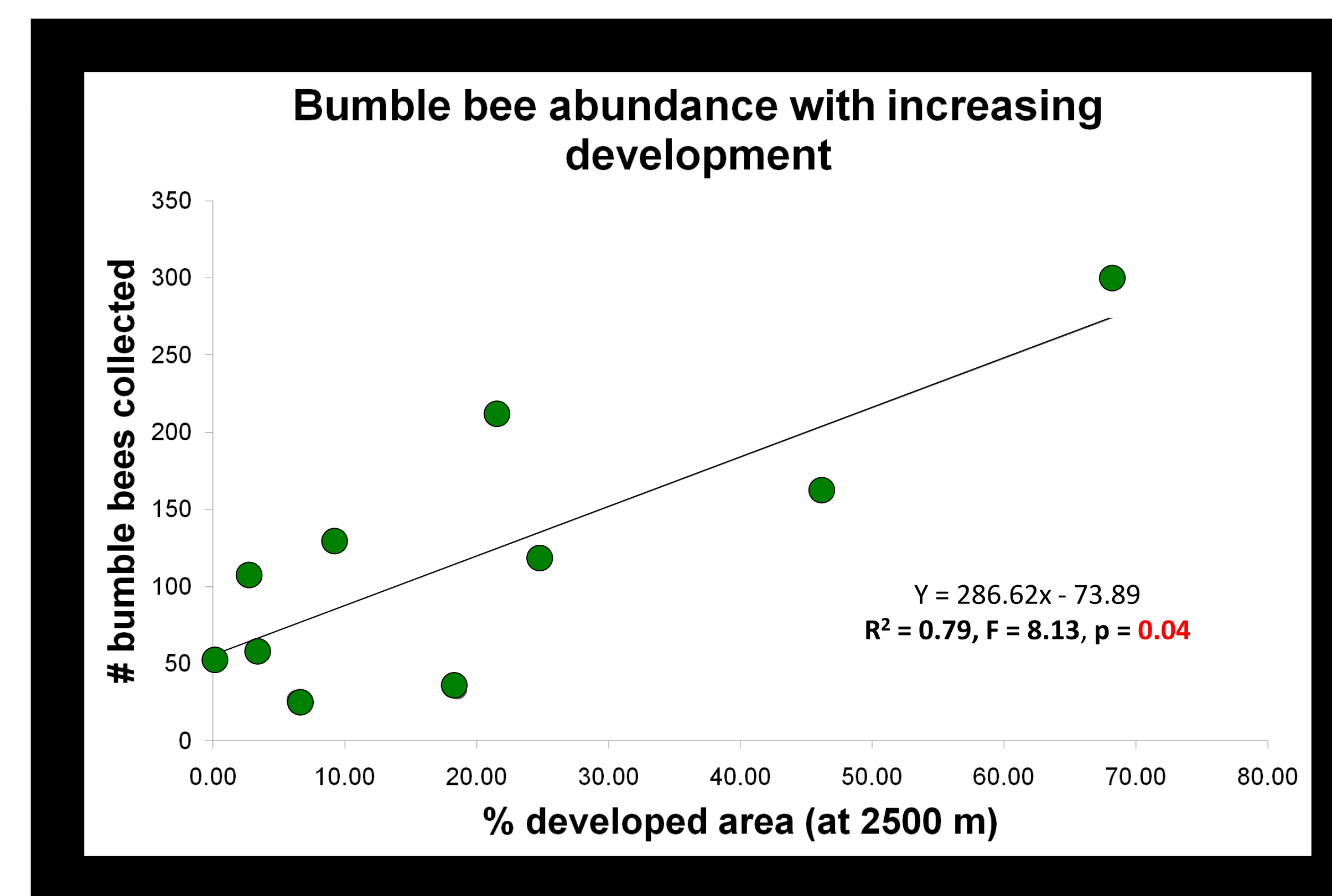
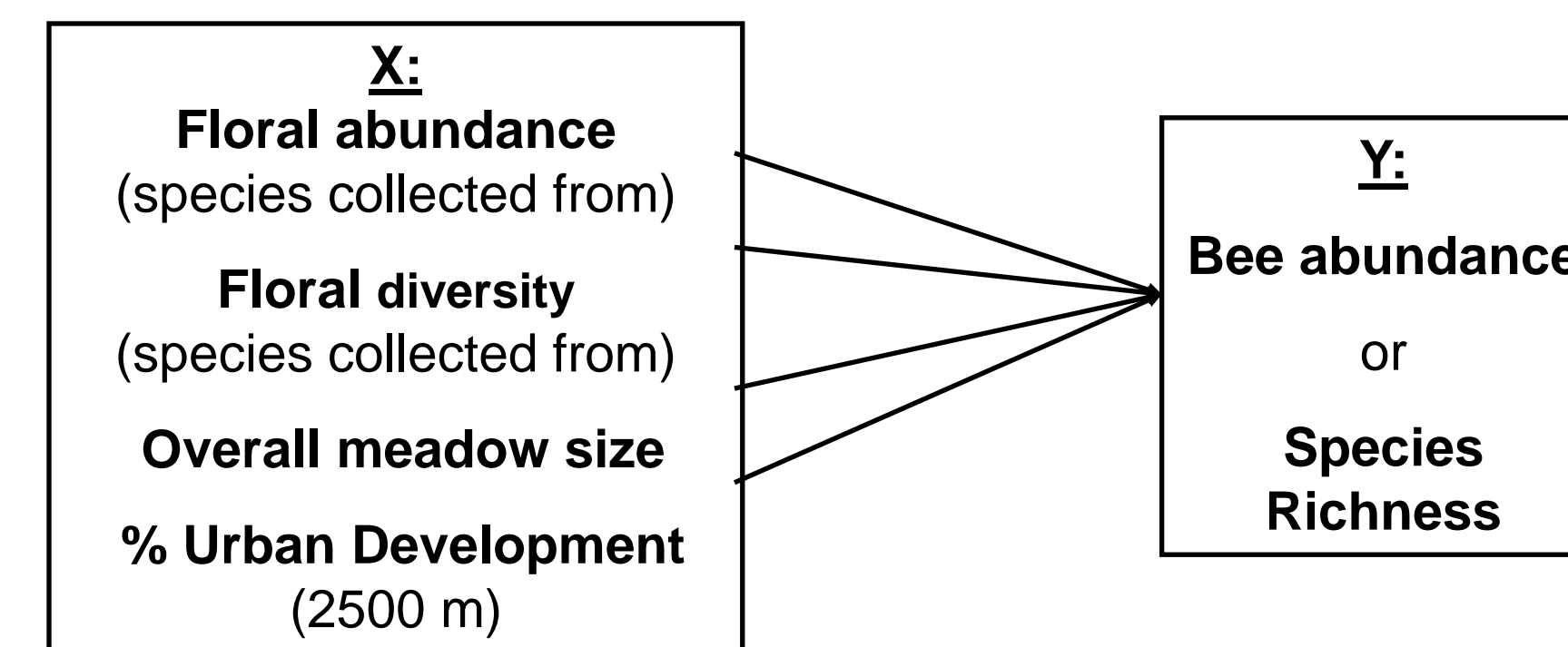


Figure 2. Total bumble bee abundance was **significantly higher** in meadows with a higher proportion of developed land surrounding the site.

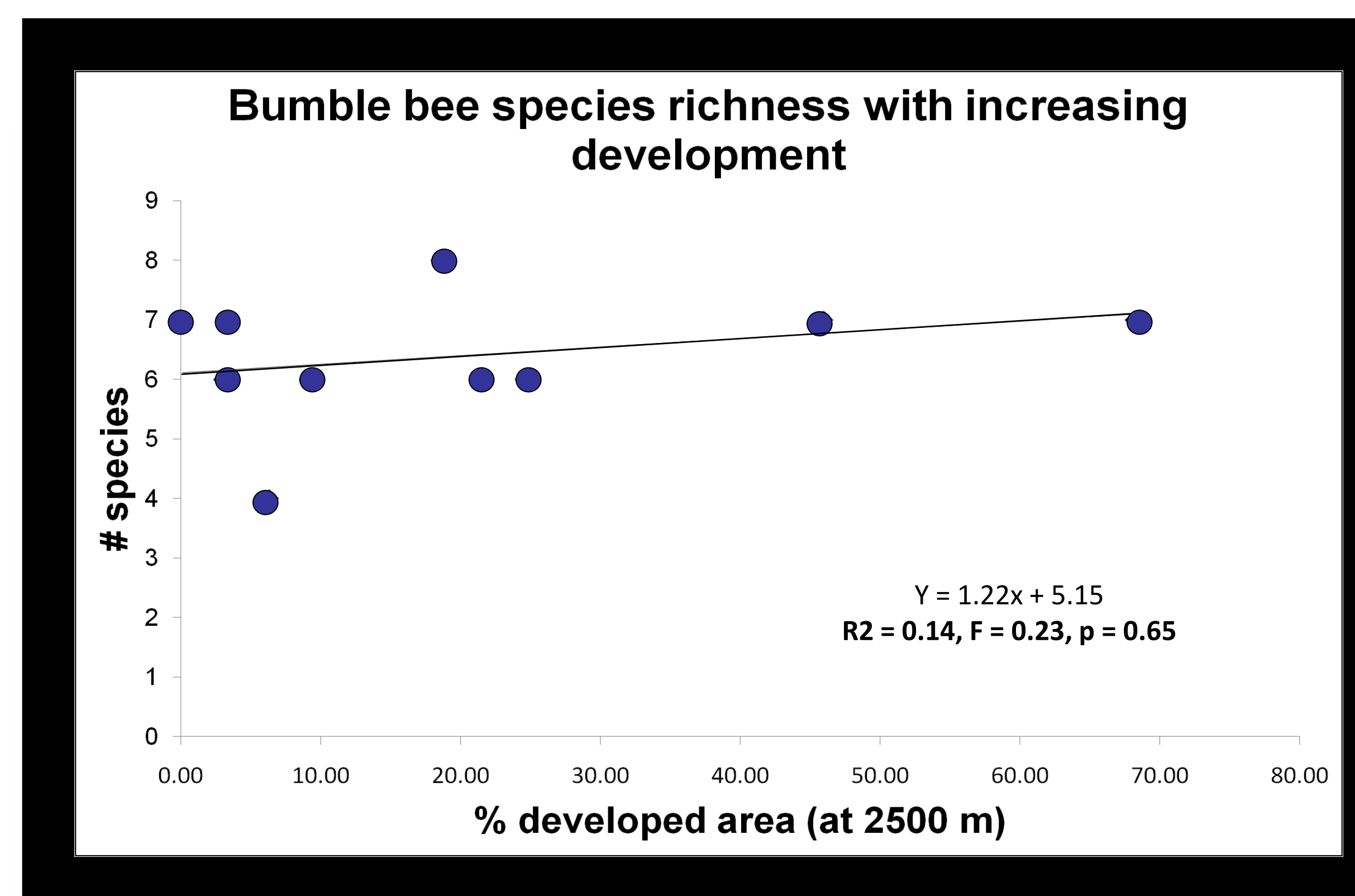


Figure 3. Species richness was **maintained** across a gradient of urbanization. Species-specific responses to development were not found; composition was similar across all sites.



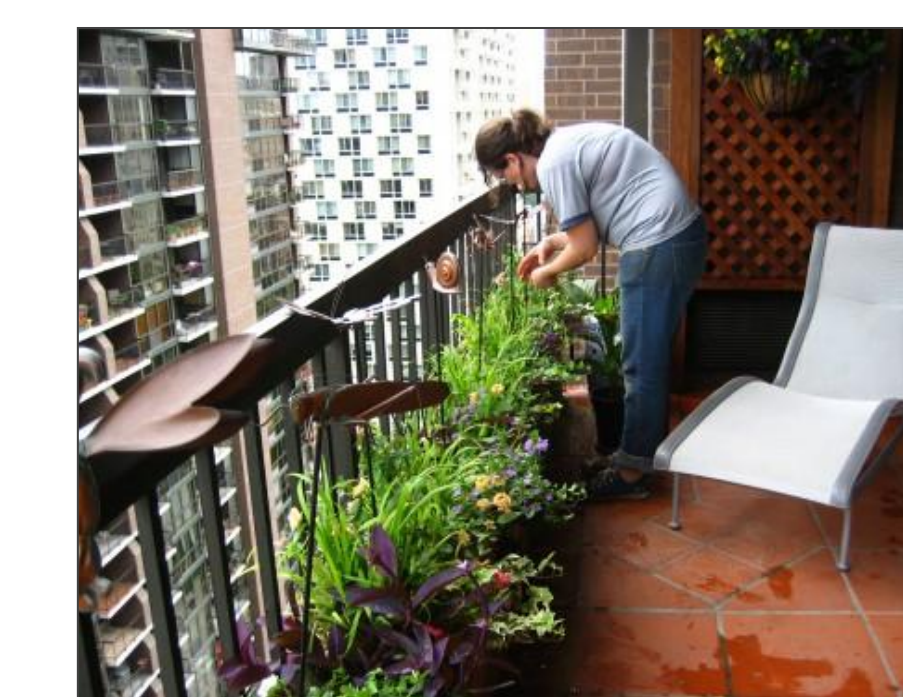
CONCLUSIONS AND DISCUSSION

Our findings indicate that ...

- **Bumble bees are robust in the face of change.** Species composition and richness were maintained across a gradient of increasing urbanization.
- **Bumble bees are “urban-adaptable.”** Abundance increased with proportion of developed area; no evidence of urban-avoider species.
- **Restored meadows are excellent habitat for bumble bees** and thus possess high conservation value in an urban matrix.

Why would abundance increase with urban development?

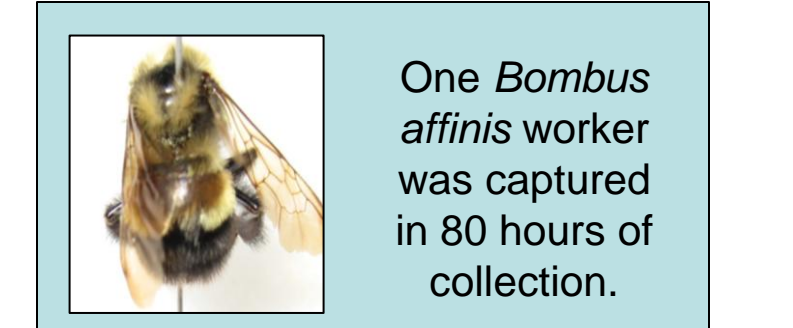
Gardens are designed to flower over the entire growing season, supplying a constant food source. Similar to a finding by Goulson et al. (2002), our study suggests that *Bombus* populations may be positively influenced by human-maintained gardens in suburban and urban areas.



It's possible that this trend is at least partially driven by a **concentration effect**. In a more urban matrix where floral resources are patchily distributed, high-reward areas may be saturated with visitors. Such an effect is described by Tøtland & Matthews (1998).

Photo credit: Philadelphia Gardens, Inc.

Forested land surrounding less developed sites may act as barrier to bumble bee travel (Keyer et al. 2004).



One *Bombus affinis* worker was captured in 80 hours of collection.

What are the conservation implications of this research?

Restored, managed meadows promote *Bombus* populations and should be considered in plans for “greening” urban centers. Often restored meadows are seeded with butterfly plants; choosing plants that are attractive to bumble bees would increase their ecosystem service worth.

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