Integrating broad-scale landscape perspectives with bees, floral resources, and fruit crop yields

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USDA Specialty Crop Block Grant
Hatch Grant
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Wild bees and honey bees used for pollination of crops around the world

Garibaldi et al 2013
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<th>TAXA</th>
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<td><em>Halictus</em> (females)</td>
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<td><em>Lasioglossum</em> (females)</td>
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<td><em>Bombus</em></td>
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Landscape structure affects wild bees

- Natural habitat $\uparrow$ wild bees (Kennedy et al. 2013)
- Intensive agriculture $\downarrow$ wild bees
- Context dependent
- Floral resources?
- Effects on crop yields?
Landscape structure affects honey bees

- Monocultures ↓ honey bees
- Non-crop habitats?
- Foraging behavior?
- Effects on crop yields?
1. Landscape structure → wild bees → apple fruit set
2. Landscape structure → honey bees → cranberry yield
Apples are self-incompatible
Require cross-pollination
1. Landscape structure → wild bees → apple fruit set

- Annual crops
- Pasture/hay
- Natural grasslands
- Woodlands
- Developed
- Wetland
Sites selected on 2 gradients: high-low woodland (natural) and high-low landscape diversity at 1 km radius
1. Landscape structure → wild bees → apple fruit set
80 species
13 genera
- Andrena
- Lasioglossum
- Halictus
- Bombus
- Ceratina
- Green sweat bee genera
- Cuckoo bees
- Osmia
- Megachile
- Colletes
Bee abundance increases with natural habitat and with landscape diversity.
Bee species richness increases with landscape diversity
Different habitat types provide floral resources at different times.

1. Landscape structure
   - wild bees
   - apple fruit set

Flowering plant abundance vs. Period:
- Orchard
- Woodland
- Grassland
- Cropland

Flowering plant richness vs. Period:
- Woodland
- Orchard
- Grassland
- Cropland

Habitat: $P=0.002$
Period: $P<0.0001$
Habitat X period: $P=0.0003$

Habitat: $P=0.03$
Period: $P<0.0001$
Habitat X period: $P=0.002$
Landscape diversity increases wild bee abundance and richness

- Potentially through unique and complementary floral resources in different habitat types

Some amount of natural (woodland) habitat increases bee abundance
1. Landscape structure → wild bees → apple fruit set

Measuring fruit set

Open branch

Closed branch
Apples are dependent on pollinators
Wild bee richness increases fruit set

No effect of honey bees
No effect of overall bee abundance

Mallinger and Gratton. 2014. in press.
Journal of Applied Ecology
1. Landscape structure ➔ wild bees ➔ apple fruit set

![Bar chart showing the number of sequential same-tree visits for different bee groups.](chart.png)

- **Bumble**: Number of visits varies around 6.
- **Honey**: Highest number of visits, approximately 7.
- **Mining**: Number of visits around 3.
- **Sweat**: Lowest number of visits, close to 1.
Floral resource continuity and diversity

1. Landscape diversity → wild bee species richness → apple fruit set
2. Landscape structure → honey bees → cranberry yield

How does landscape structure affect honey bees and their role in pollination?
2. Landscape structure ➔ honey bees ➔ cranberry yield
2. Landscape structure → honey bees → cranberry yield
2. Landscape structure → honey bees → cranberry yield

Methods

Cranberry grower surveys
• # of honey bee hives
• Yield
• Multi-year
Land-cover maps (NCDL)
2. Landscape structure $\rightarrow$ honey bees $\rightarrow$ cranberry yield

**EXPECTED RESULTS**

- **Yield (lb/acre)**
  - 50
  - 100
  - 150
  - 200
  - 250
  - 300
  - 350
  - 400

- **Hives/acre**
  - 0
  - 2
  - 4
  - 6
  - 8

Graph showing the expected yield in lbs per acre as a function of hives per acre.
More honey bees = more berries
BUT only in low woodland landscapes
The effectiveness of honey bees for cranberry pollination varies with surrounding landscape.

- Honey bees foraging elsewhere?

Yield not zero without managed honey bees

- Contribution of native, wild pollinators
- Self or wind pollination
1. Landscape diversity \( \rightarrow \) wild bee richness \( \rightarrow \) apple fruit set

2. % woodland \( \rightarrow \) honey bee foraging/efficacy \( \rightarrow \) cranberry yield