Floral resource utilization by *Bombus spp.* across three distinct garden sites at Dalhousie University: a comparative study

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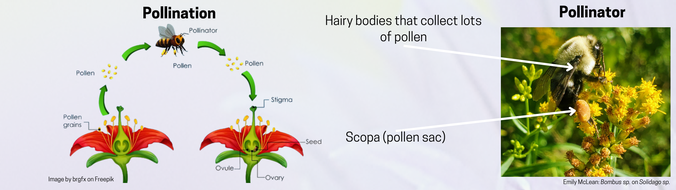
Introduction

Widespread species losses and ecosystem changes are occuring. Among these losses, insect pollinators, particularly bees, face significant threats (Frankie et al., 2019).

Bee pollination is very important for plant reproduction, especially by *Bombus spp.* (Cameron, et al., 2011).



This study explores the relationship between native *Bombus spp.* and their floral preferences at three distinct sites on Dalhousie University's Studley campus, recognizing the significance of floral resources for native pollinators.

Research Questions:

- Which of the three sites at Dalhousie University exhibits the highest *Bombus spp.* abundance during the spring, summer, and fall months of 2023?
- Is there higher native flowering species at the Butterfly site compared to the other two sites?
- What is the foraging preference of *Bombus spp.* for native flowers compared to non-native flowers at the three unique sites?

Methods

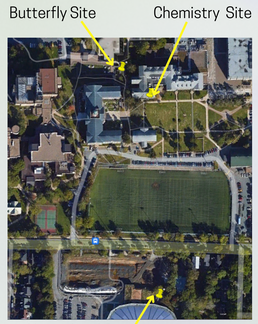
Data Collected:

- *Bombus spp.* abundance in sampled quadrat
- *Bombus spp.* visitation to flower species in sampled quadrat
- Percent of flowering species in bloom and richness in sampled quadrat
- Overall plant species richness at each site
- Additional field notes on pollinators

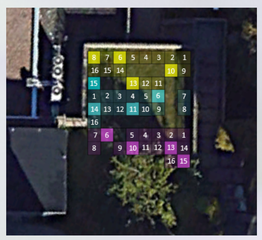
Statistical analysis:

- Descriptive statistics
- One-way ANOVA and independent t-tests
- Logistic regression
- Chi-square tests

Snapshot of a field day



All three sites sampled in one field day. Site order randomly selected.



Example of coloured quadrats randomly selected for butterfly site sampling. The site was divided into three subareas, each represented by a different colour. Data collected for four quadrats for each subarea.
16 quadrats sampled for each site in one field day.

Example of 1m² quadrat, divided into four subsections to estimate bloom density. Species name recorded for each flower species.

Results

1) Plant Visitation Frequency:

- Native plant species exhibited higher visitation rates compared to non-native plants overall (Figure 1). However, one site (Chemistry) deviated from this trend in summer (Figure 2B).

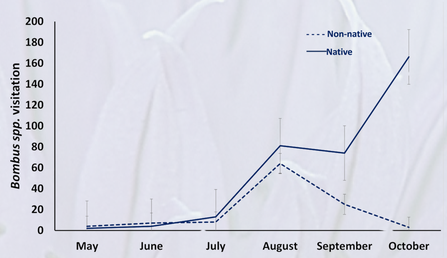


Figure 1: A t-test indicates a significant preference for native flowers over non-native ones during the summer and fall months (t=2.211, df=4, p=0.0458). No statistically significant foraging preference between native and non-native flowers observed in spring months. Solid line represents visits to native flowers, dotted lines to non-native flowers. Standard error bars shown.

2) Seasonal Abundance Trends:

- During spring, non-native plants dominated in abundance, while native flowers reached their peak abundance in the summer and fall months (Figure 2A).

Native flower bloom density highest in August at chemistry site

Higher visitation at the chemistry site to non-native flowers in August, even though native species in high bloom. 37/39 *Bombus* visitation to **purple** flowering species in August

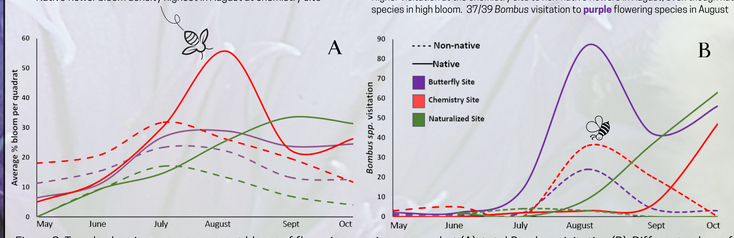


Figure 2: Trends showing average percent bloom of flowering species per quadrat (A), total *Bombus* visitation (B). Different colours for each site, solid and dotted line indicates flower type (native or non-native). Butterfly site has the highest *Bombus* visitations throughout summer/fall, Naturalized site had no visitations until June, as no flowers were in bloom until June. Non-native flowers decrease in bloom by end of season, whereas native flowers continue to have a high amount of blooms in late season.

3) Flower Colour Preference:

- Purple flowers demonstrated statistically significant higher visitations at the Butterfly and Chemistry sites.
- Purple flowers did not have the highest bloom percentage across all sites.
- There was a deviation in colour preference at the the Naturalized site, which exhibited predominantly yellow blooms from August to October.

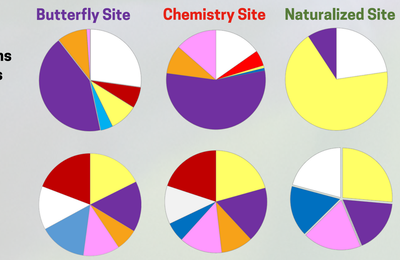


Figure 3: Pie chart displaying the % of total *Bombus spp.* visitations to flowers, categorized by colour (top), along with the average % of bloom per flower colour (bottom). The Butterfly and Chemistry sites exhibited a continuous mix of bloom colours, while the Naturalized site had a predominance of yellow flowers from August onwards. Purple flowers were found to outcompete other colours. Chi-square tests comparing purple and white flowers yielded significant results for the Butterfly site ($\chi^2 = 6.222$, df = 1, $p < 0.01$), Chemistry site ($\chi^2 = 26.614$, df = 1, $p < 0.0001$). At the Naturalized site, yellow outcompeted other colours ($\chi^2 = 27$, df = 1, $p < 0.0001$), as it was the predominant bloom colour at time of highest abundance of *Bombus* visits at the site.

Key Takeaways

- **Spring Dynamics**:
  - Non-native weeds, such as dandelions, dominate over native plants.
  - Low nutrition in dandelion for bees (Julean et al., 2022), (Loper & Cohen, 1987).
- **Passive Naturalization Impact:**
  - Naturalized site had no blooms until June.
  - Raises questions about the effectiveness of passive naturalization as a planting practice to support *Bombus* foraging.
- **Timing Matters for Pollinators:**
  - Early and late blooms are vital for *Bombus* queens, as they facilitate foraging during nest search or winter preparation.
  - There is a critical link between early queen nutritional conditions and long-term fitness, implicating declining food resources in the decline of wild bee populations (Woodard et al., 2019).
- **Native Plants Endurance:**
  - Native flowers extended later into the season compared to non-native species, highlighting their suitability for supporting pollinators.
- **Bee Colour Preferences:**
  - Bees are attracted to shorter wavelengths, including UV light (Chen et al., 2020).
  - Despite red flowers' large blooms, low amount of bee visits.
  - Bees exhibited a preference for purple non-native flowers, even amidst abundant native yellow species, *R. hirta,* emphasizing their colour preferences during foraging. This study indicates a strong preference among *Bombus spp.* for purple flowers.

Research Applications

Strategic planting can address challenges posed by climate change, such as phenotypic mismatch. Recommendations include:

- Planting native flowers that bloom in early spring to supplement nutrition when non-native weeds are abundant but less nutritious
- Implementing active naturalization by planting a variety of species that bloom from spring to fall to fulfill the diverse needs of pollinators
- When feasible, prioritize planting native species for their co-evolution with the local ecosystem and prolonged blooming periods

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References