

Are Native Bees Declining in Southeastern Massachusetts?

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Introduction

- Despite reports regarding global decline in bee abundance and richness (National Research Council 2007), these signals vary among studies with different temporal and spatial scales.
- This variation may be due to lack of studies using consistent sampling techniques over multiple seasons (Bartomeus *et al.* 2013).
- Given increasing impacts of human population growth, it is important to monitor the status of native bees across an urban/suburban gradient (Hernandez *et al.* 2009; Winfree 2011).
- We monitored bees over four years using consistent sampling methods to assess whether the native bee community is in decline in urban and suburban sites in Plymouth County, Massachusetts.

Methods

- We conducted bi-weekly seasonal sampling (April to November) from 2016 to 2019.
- Bees were caught via sweep net and pan trap to reduce collection bias (Roulston *et al.* 2007).
- We combined pan trap and sweep net data by normalizing per sampling effort; one sample (Table 1) was defined as follows:
 - Blue, white, and yellow pan traps were left out for 24 hours (Shapiro *et al.* 2014; Droege 2015).
 - Sweep netting was conducted by two researchers along a 100-m transect for 30 minutes after pan trap collection (Popic 2013).
- Specimens were preserved, identified to genus, and archived.
- We used repeated measures ANOVA to test for a change in abundance and richness over four years at six study sites (Table 1).

Table 1: Assessment of imperviousness and number of samples per year at six study sites located in Southeastern Massachusetts.

Site →	Christos	Beaver Brook	Native Meadow	Sachem Rock	Dunrovin Farm	Leland Farm
% Impervious	46.9%	46.0%	32.0%	7.9%	1.9%	0.5%
Year ↓	Number of Samples per Season					
2016	11	11	12	11	11	11
2017	14	14	14	14	14	13
2018	14	14	14	14	14	14
2019	15	15	15	15	15	13

Results

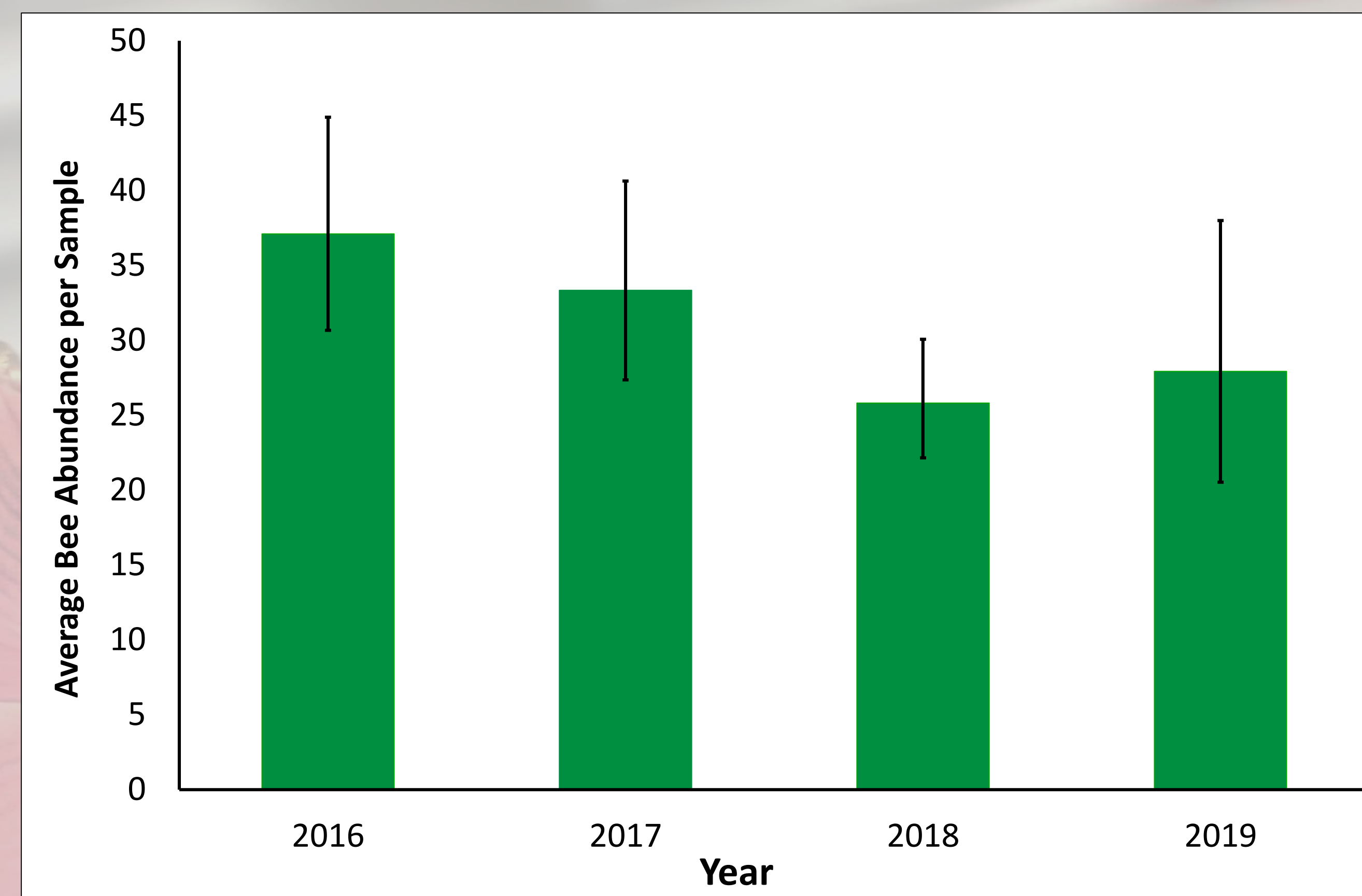


Figure 1: Mean bee abundance (and 95% confidence interval) per sample at six study sites over four years. Repeated measures ANOVA yielded a marginal effect of year ($F_{3,15} = 2.90, p = 0.0698$). Average abundance in samples declined by 30.5% from 2016-2018 (significant in pairwise comparison). Abundance in samples remained stable from 2018-2019.

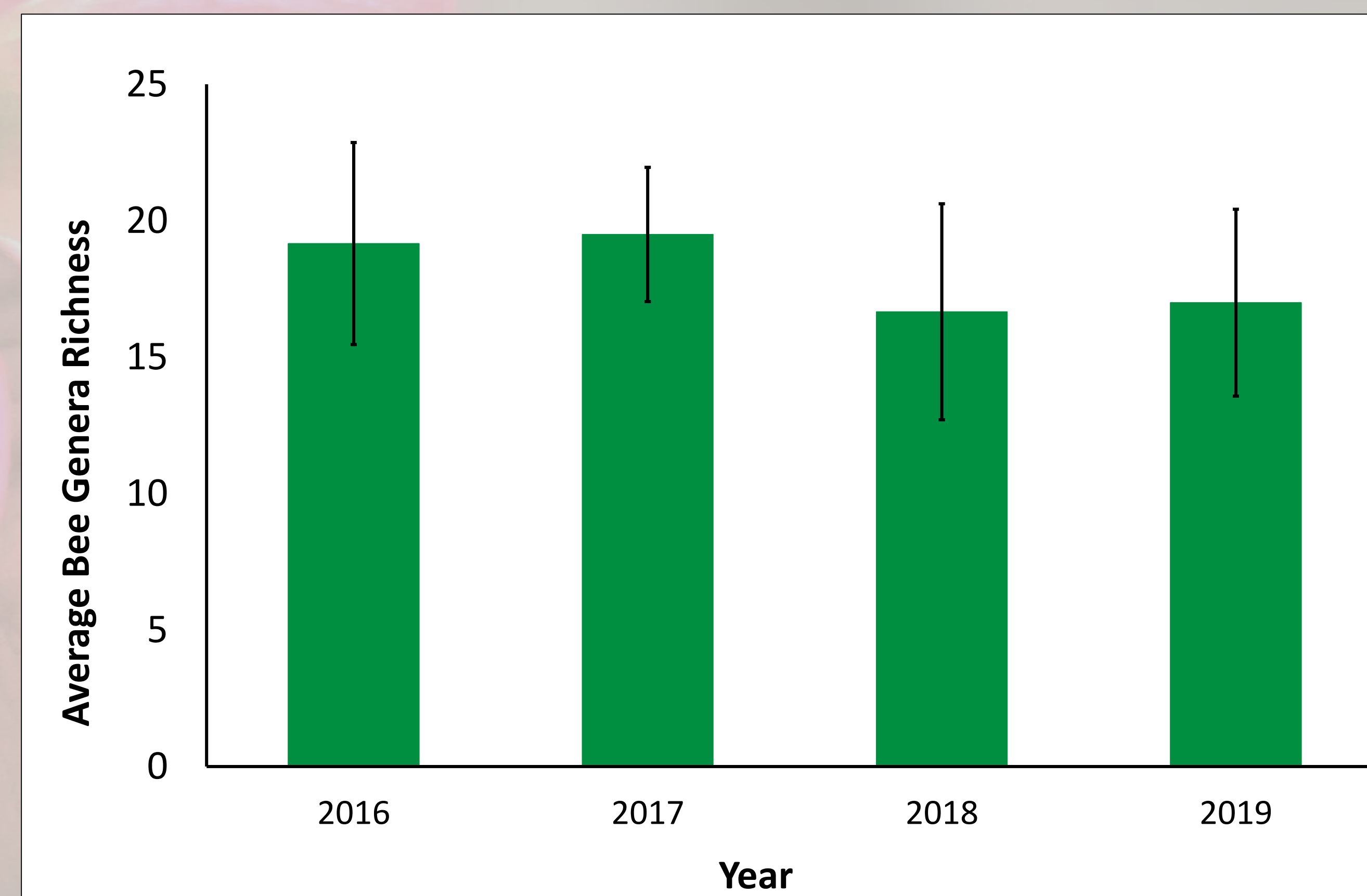


Figure 2: Mean bee genera richness per year (and 95% confidence interval) at six study sites over four years. Repeated measures ANOVA yielded an effect of year ($F_{3,15} = 4.98, p = 0.014$). There was a significant decline in the mean annual richness from 2017-2018 with no other pairwise differences between years (Tukey HSD).

Discussion

- A downward trend in bee richness and abundance was not clear over four years of study; the dip in both metrics in 2018 drives statistical significance.
- Considering natural fluctuations in bee community structure (Oertli *et al.* 2005), our local bee abundance and richness over four years failed to reach a lucid declining trend.
- Williams *et al.* (2001) found that the yearly fluctuations might be caused by the presence of rare bees; therefore, continued extensive and unbiased surveillance of bee communities is essential to detect effects of rare bees on trends in abundance and particularly richness.

Conclusion

- The present four-year study does not prove or disprove long-term native bee decline, but the likelihood of such decline warrants enhanced conservation efforts to protect native bee communities.

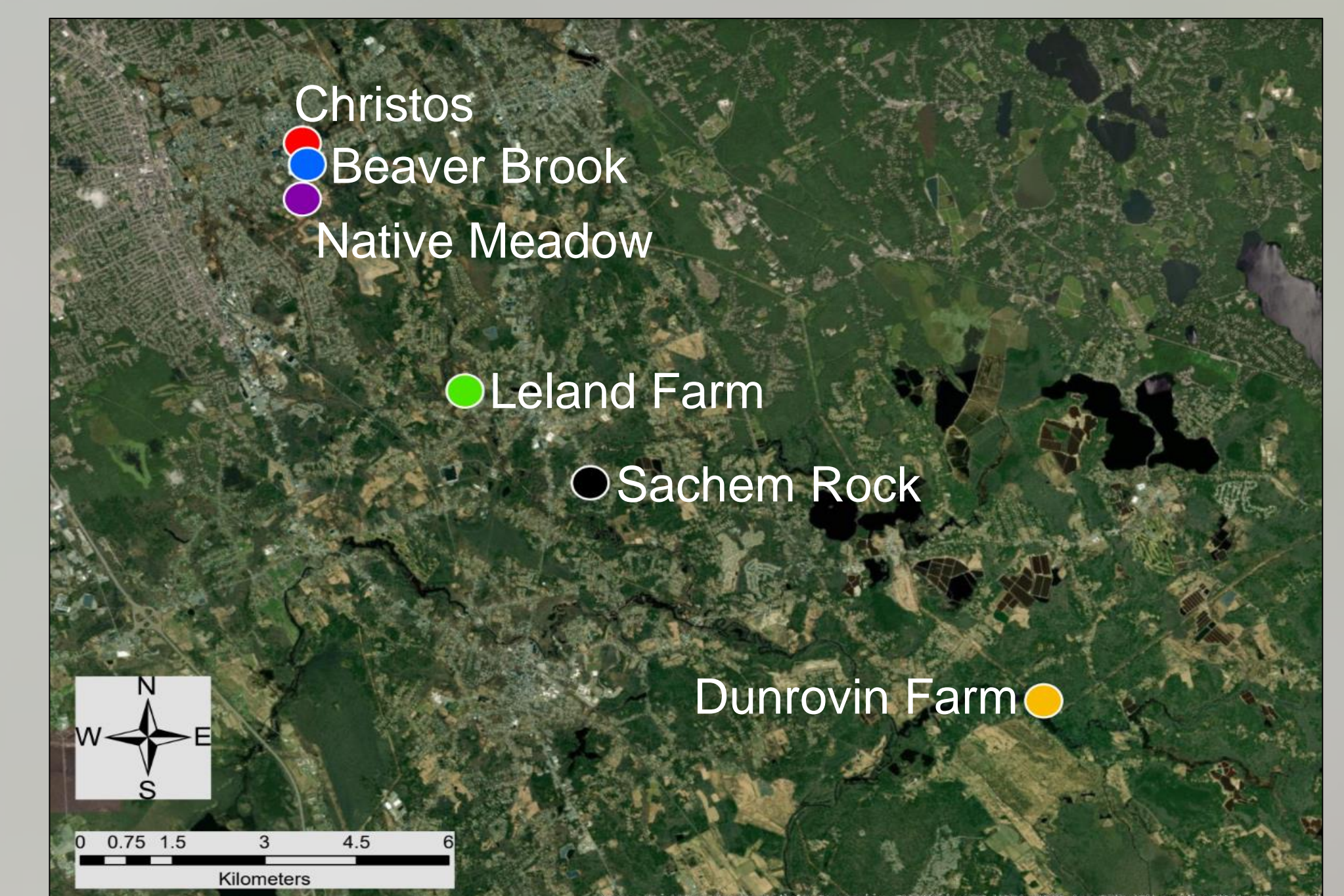


Figure 3: Aerial view of six study sites located in Plymouth County, Massachusetts. Beaver Brook and Native Meadow are located on the Brockton campus of Massasoit Community College.

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