Distribution and Habitat Use of Critically Imperiled Bumble Bees in Central Appalachia

Cameron Garland, Grace Avalos, Mark Hepner, Karen Goodell, & Rodney Richardson

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INTRODUCTION

- Approximately 75% of global terrestrial plants rely on pollinators.
- Bumble bees offer effective pollination services through buzz pollination.
- Native ranges of multiple species in the subgenus *Bombus* have significantly contracted.
- Isolated populations persist in the highest elevations of the Appalachian region.
- We assessed detection probabilities for bumble bees in the subgenus *Bombus* and employed landscape metrics to quantify habitat preferences.

Figure 1. *Bombus affinis* foraging on *Monarda fistuloa* (A). Montane understory of *Actaea racemosa* (B). *Bombus terricola* nectaring on *Prunella vulgaris* (C)

STUDY QUESTIONS

Q_1: Are mountains acting as a climatic refugia for subgenus *Bombus*?

Q_2: What are the detection probabilities of RTE pollinators in central Appalachia?

METHODS

- 10-minute standardized netting surveys were conducted at each site, on clear, rain-free days with low cloud cover.
- Sampling occurred primarily between 0900 and 1700 hours and targeted the greater pollinator community, with a focus on bumble bees.
- Bees were captured using nets and placed in plastic bags, and species of conservation concern were nonlethally removed (Figure 2).

Figure 2. Nonlethal netting method. Moving bees to the back of the net (A). Shake net releasing bees into the bag (B). Carefully removing net from the bag (C). Checking bag for threatened *Bombus* (sp.). Roadside field site dominated by *Actaea racemose* (E).

STUDY SITES

Figure 3. Maps of all study sites(black) *Bombus affinis detections* (A) and *Bombus terricola* detections (B).

RESULTS

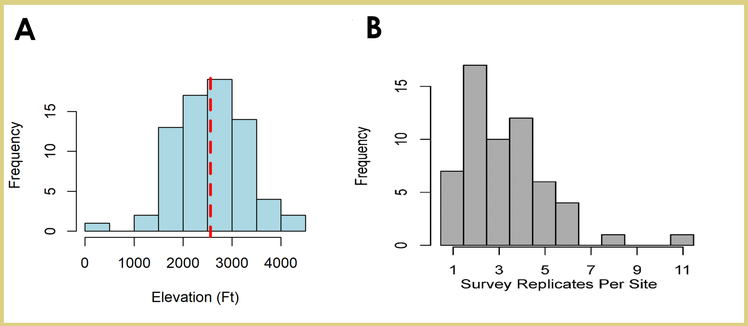

Figure 4: Number of 10-minute survey replicates per site (A). Distribution elevation across sites (B). The red dotted line represents the mean elevation across all sites (C).

MODEL SELECTION

A

Model	AIC	Δ.AIC	Log..Lik.Ratio
I(AllForest)^2 + day_of_year + I(day_of_year)^2 + elev_3000m + LogBio9	154.9523	0.0000	0.3227604
AllForest + day_of_year + I(day_of_year)^2 + elev_3000m + LogBio9	155.8076	0.8553	0.3227604
AllForest + I(AllForest)^2 + day_of_year + I(day_of_year)^2 + elev_3000m + LogBio9	156.5617	0.7541	0.3227604
day_of_year + I(day_of_year)^2 + elev_3000m + LogBio9 + slope_3000m	156.7589	0.1972	0.3488576
I(AllForest)^2 + BTBA + day_of_year + I(day_of_year)^2 + elev_3000m + LogBio9	156.7644	0.0055	0.3286682
I(AllForest)^2 + day_of_year + I(day_of_year)^2 + elev_3000m + LogBio9 + slope_3000m	156.8141	0.0497	0.3498840

B

Model	AIC	Δ.AIC	Log..Lik.Ratio
day_of_year + I(day_of_year)^2 + elev_3000m + LogBio1	62.39071	0.0000000	0.7159321
bio1_3000m + day_of_year + I(day_of_year)^2 + elev_3000m	62.49188	0.1011667	0.7153815
day_of_year + I(day_of_year)^2	62.88609	0.4953801	0.6908230
bio1_3000m + day_of_year + I(day_of_year)^2 + elev_3000m + LogBio1 + slope3000m	63.27994	0.8892304	0.7338003
day_of_year + I(day_of_year)^2 + elev_3000m + LogBio1 + slope3000m	63.38929	0.9985744	0.7218141
bio1_3000m + day_of_year + I(day_of_year)^2 + LogBio1 + slope3000m	63.63420	1.2434901	0.7204811

Figure 5: Generalized Linear Models for each species were dredged . Each model incorporated biologically relevant predictor variables. The figure represent the top six models *for Bombus terricola* (A) and *Bombus affinis* (B).

RESULTS (cont.)

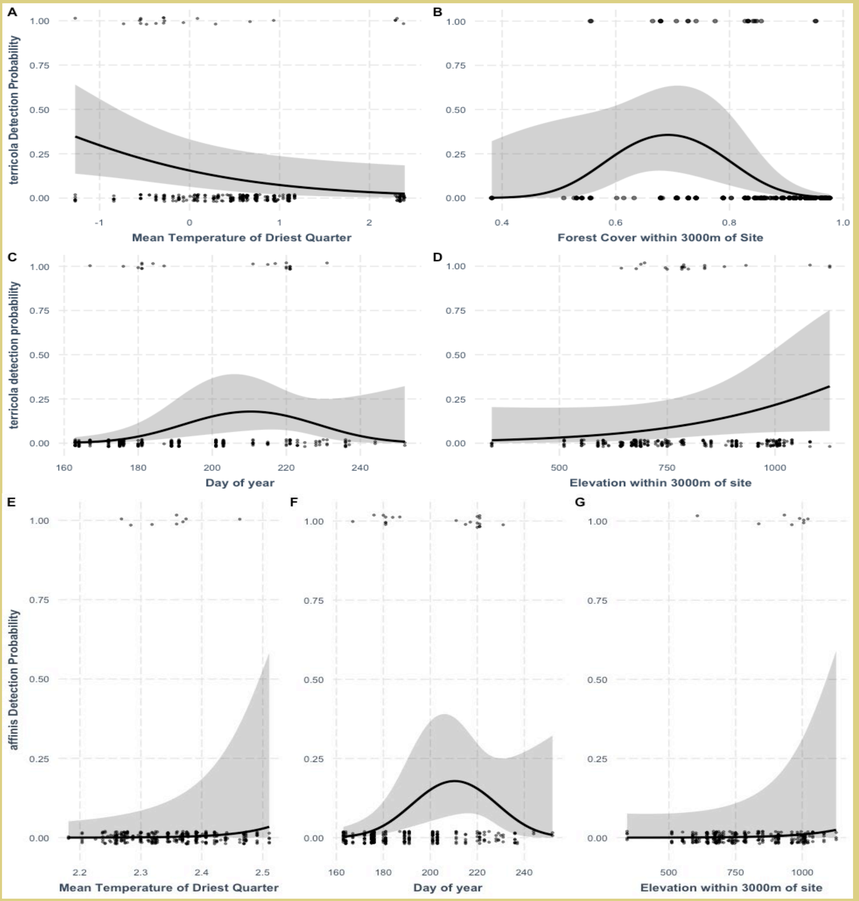

Figure 6: GLMs modeling the relationship between *Bombus affinis* and *Bombus terricola* detections against various bioclimatic variables.

DISCUSSION

- Mountains serve as a refuge for bumble bee species like *Bombus terricola* and *Bombus affinis*. With their cooler temperatures, they offer protection against the more extreme consequences of global warming, such as heat stress and phenological mismatches.
- Rare bumble bee detection probabilities generally exhibit an upward trend in high elevation mountains. Although we currently lack sufficient data to precisely determine the true detection probabilities, our efforts are effectively pinpointing the specific locations where these species continue to exist with greater accuracy.

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