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? Is there **differential risk** of climate-induced, ecologically disruptive **mismatches** in plant and pollinator phenology in **alpine** and **lowland** habitats?

"phenology" is the timing of life history events in organisms

plant-pollinator **interactions** depend on phenological alignment[1]

changes in **climatic cues** may advance or delay phenology[2]

alpine habitats are especially sensitive to changes in climate[3]

The Data

Collection dates of plant and insect specimens in herbaria and entomological museums can indicate changes in phenology over decades. Comparing long-term shifts in collection dates can reveal developing **mismatches**.[4]

Represented Range
- **Northern California**
- **Lowland: 0-1500m**
- **Alpine: 2700-3200+ m**
- Minimum alpine elevation limits vary by latitude

Plant Taxa:
- **154 years**
- **1302 records**
- **26 taxa of 7 genera**
- short flowering periods
- conspicuous flowers
- abundant records

Pollinator Taxa:
- **117 years**
- **3283 records**
- **7 Genera**
- Observed or documented relationships to the plants selected for study

Analyses: Modeling Changes in Phenology

→ **Random-intercept, mixed-effect models** explain how phenology of each taxon varies over time

→ Magnitude and direction of resulting slope values characterize **trends in changing phenology**

Field Work

→ Plant models used to **predict peak flowering** dates of selected populations of each taxon (with restrictions due to fire and COVID-19)

→ Populations were **visited** and open flowers **quantified** on given dates

→ Pollinators were **collected or photographed**

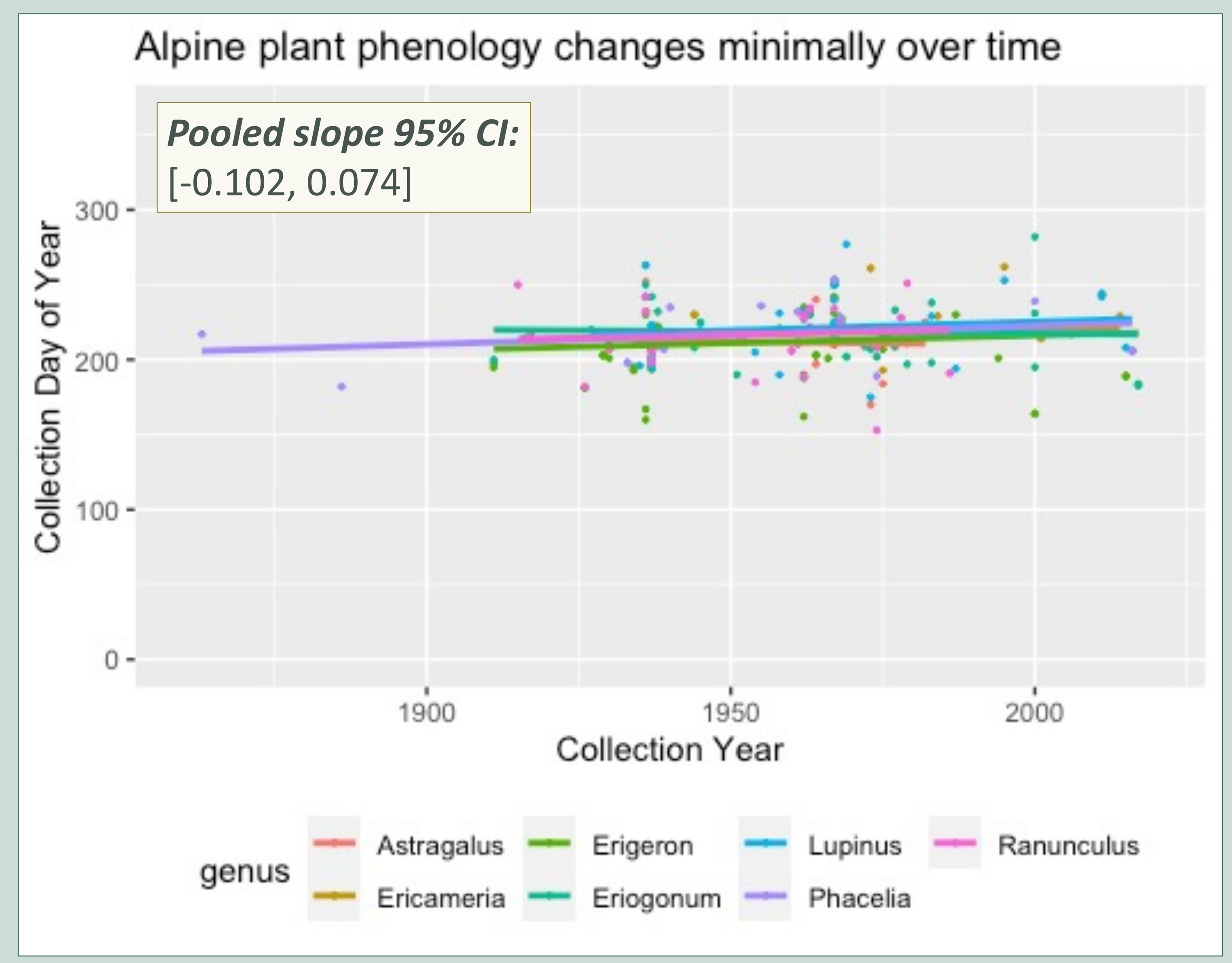
Impacts

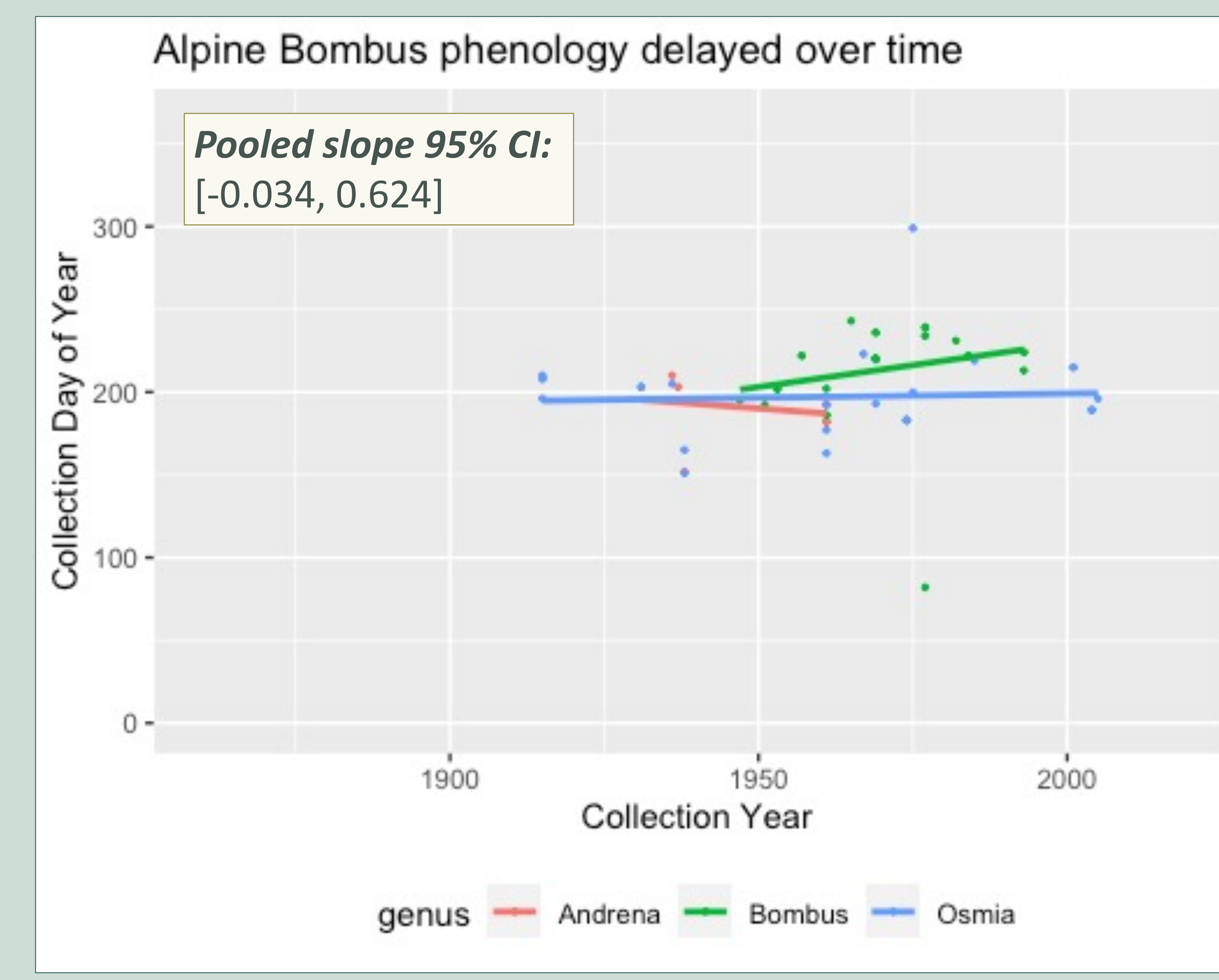
Understanding how important interactions between plants and pollinators may be changing in climate-sensitive habitats such as California's alpine may **aid climate-related conservation work** impacting both groups. Similar studies of such interactions would benefit from an increase in **alpine collection records**, which limited the scope and power of these comparisons.

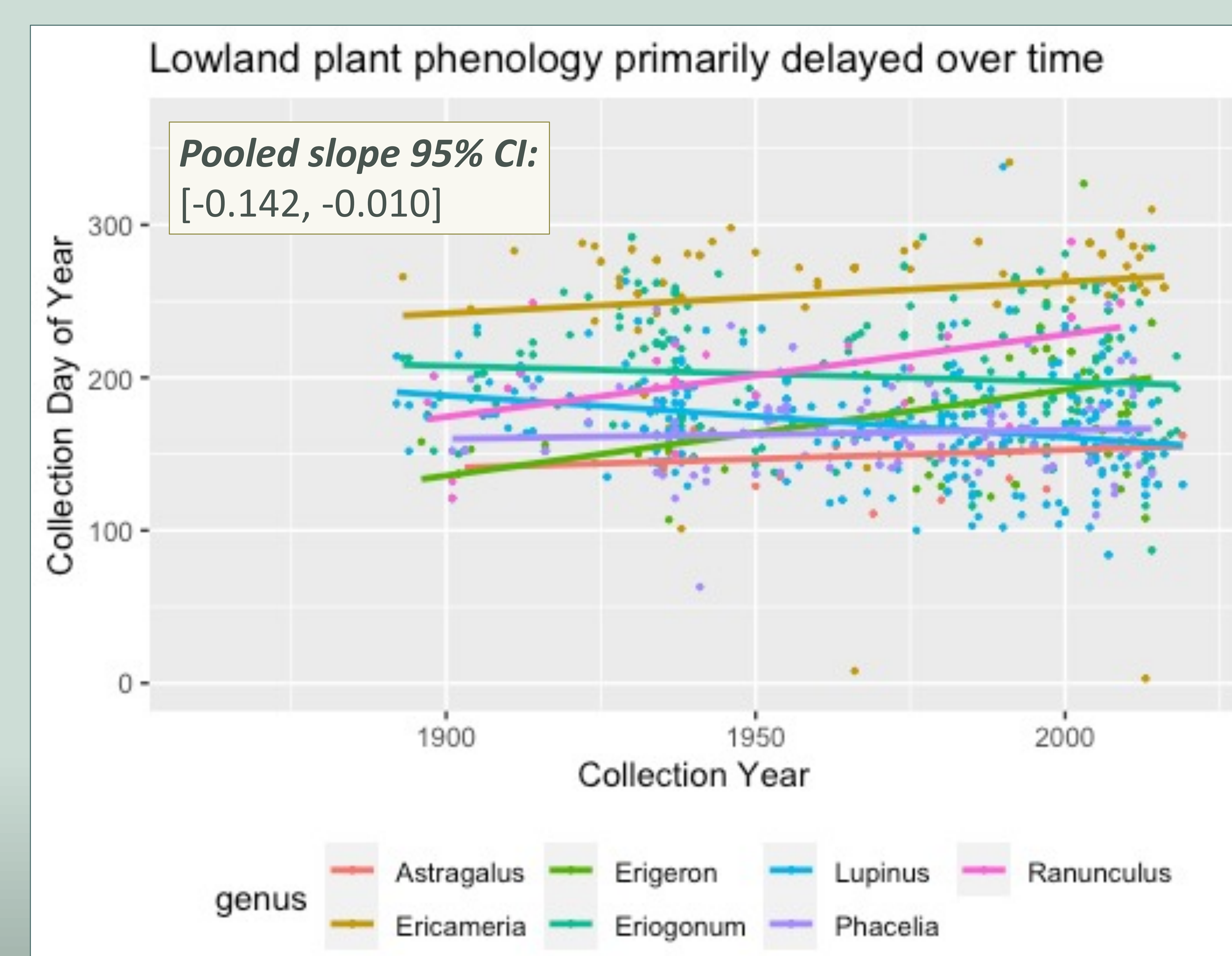
Results

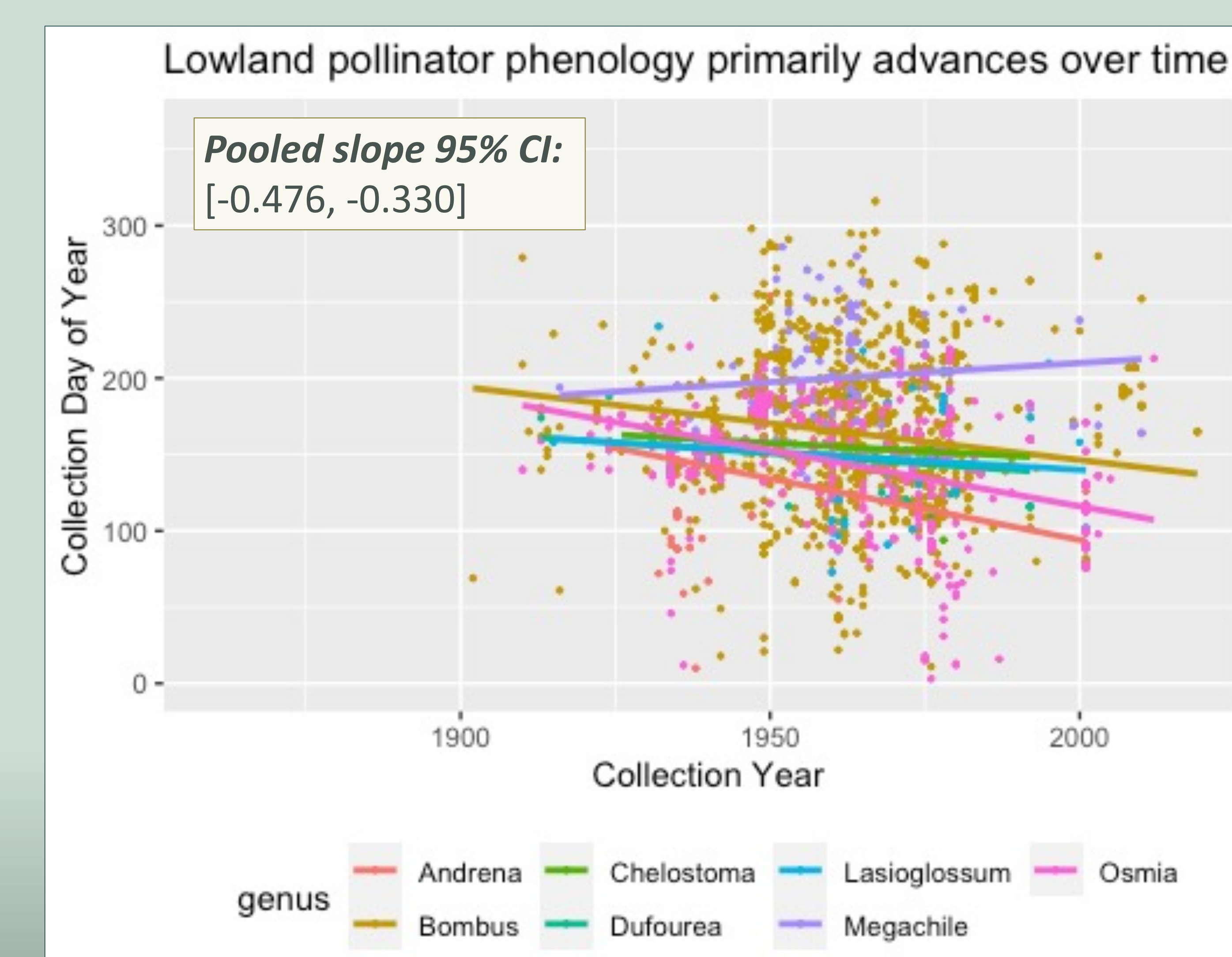
Phenological shifts of important pollinators are different than plants in both alpine and lowland habitats.

The magnitude and direction of differences in collection date trends (and therefore phenology) vary among individual plant-pollinator partners. Similarly, ecological implications differ in specialist and generalist relationships, as the availability of alternate partners may vary.









Acknowledgements & References

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