

Bumble bee populations at lower elevations are shifting in geographic range and latitude due to effects of climate change.

## History of Bumble bees and Climate Change

- In 1974, Graham Pyke conducted a study that examined *Bombus* spp. distributions along five transects around the Rocky Mountain Biological Laboratory area in Crested Butte, CO.
- The study was repeated in 2007 and within the intervening 33-year period, it showed that certain species of bumble bees had shifted higher in elevation due to climate change.
- The study has been repeated every five to seven years since 2007 with the most recent re-survey carried out in 2014.
- These studies are intended to use bumble bees as an ideal indicator of climate change due to their rapid life cycle.
- In 2019, I repeated the study using only low to mid-elevation sites to determine whether there was an increase or decrease in relative abundance compared to 2014.

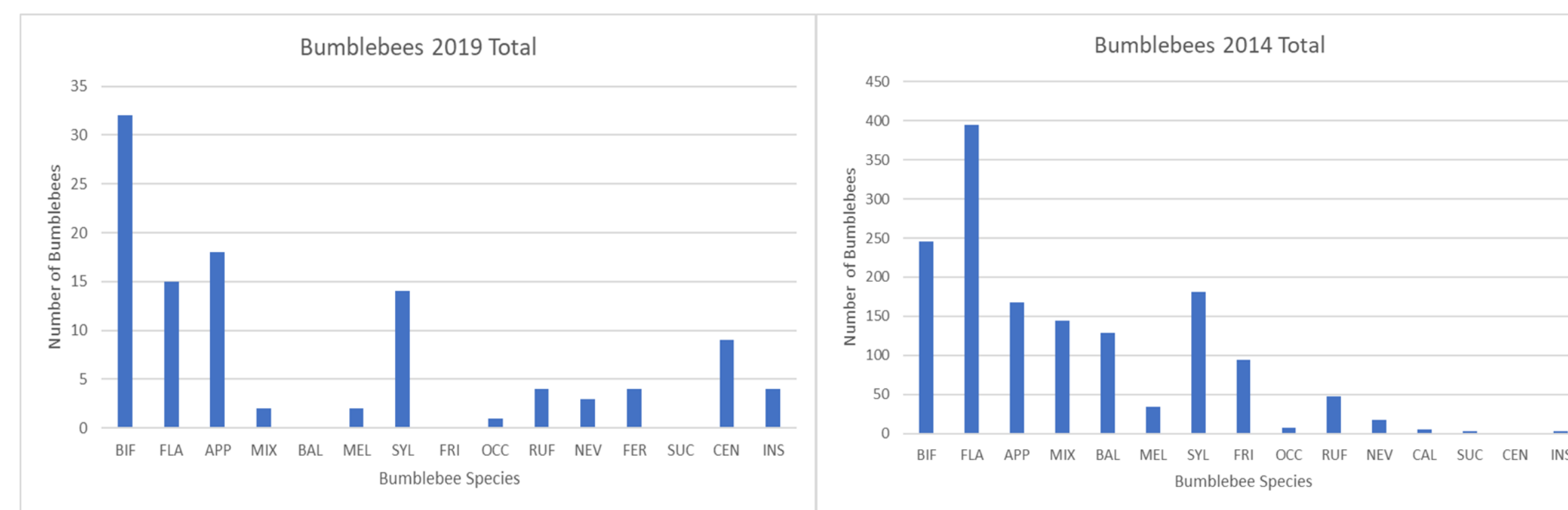


Bumble bee foraging on *Delphinium barbeyi*

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Overall in 2019, there were an increase in relative abundance in the following species compared to 2014:

- B. bifarius*
- B. nevadensis*
- B. fervidus*
- B. insularis*
- B. centralis*

The following bumble bee species remained the same relatively:

- B. appositus*
- B. melanopygus*
- B. occidentalis*
- B. rufocinctus*
- B. sylvicola*

These species experienced an overall decrease in relative abundance in 2019:

- B. flavifrons*
- B. balteatus*
- B. mixtus*
- B. frigidus*
- B. suckleyi*

| Year | Time     | Total     | Bees Per Minute |
|------|----------|-----------|-----------------|
| 2014 | 5664 min | 1474 bees | 3               |
| 2019 | 2137 min | 108 bees  | 0.050538        |



*B. insularis* caught on *Veratrum* leaves



*B. bifarius* caught on *Potentilla pulcherrima*



*B. appositus* caught on *Delphinium barbeyi*

Table 3. Proportions and p Values of Dominant Species and Site. Significant p-values are bolded at the P < 0.05 level.

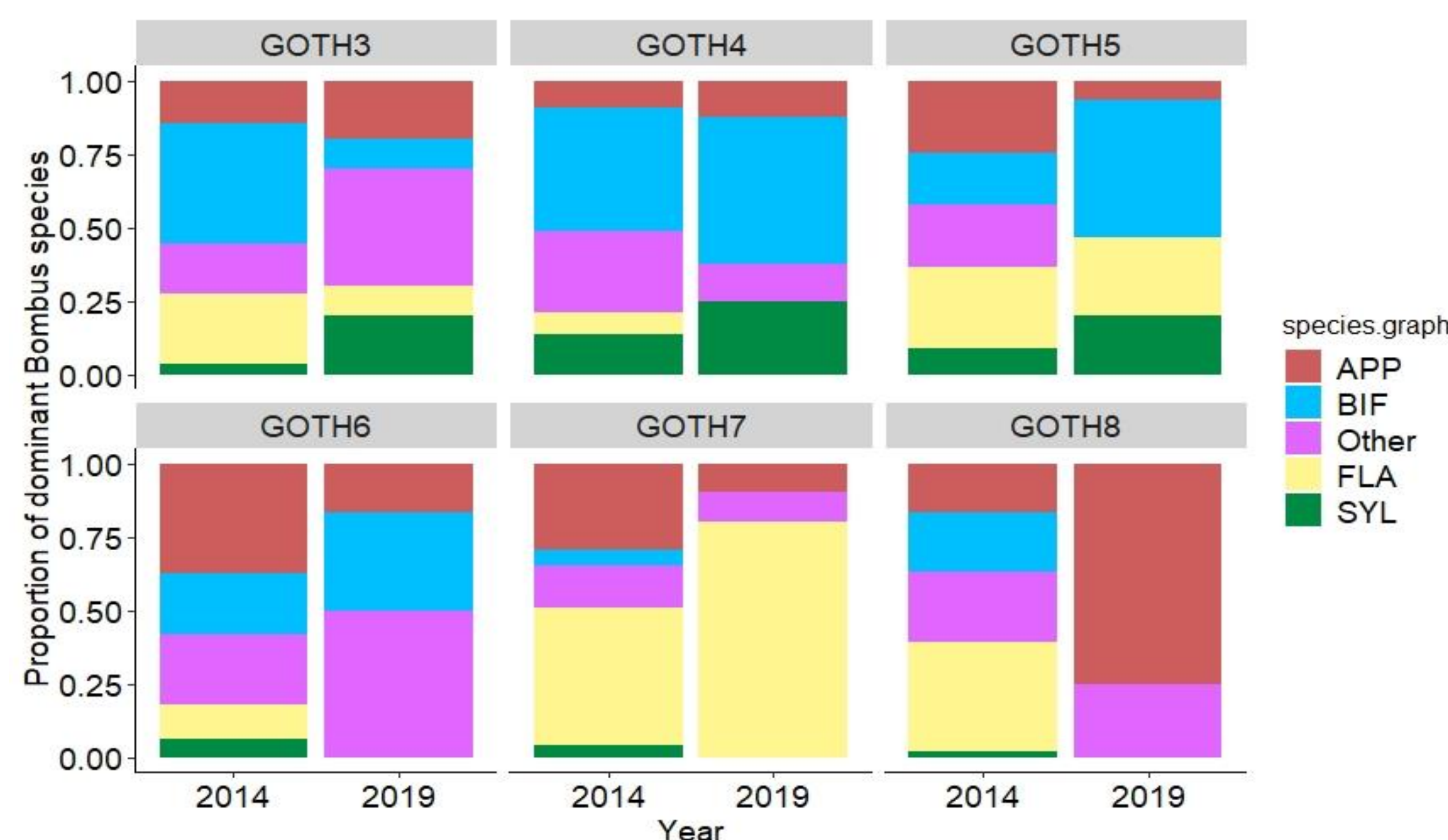
| Species | Site   | Proportion 2014 | Proportion 2019 | P              |
|---------|--------|-----------------|-----------------|----------------|
| BIF     | GOTH 3 | 0.4096386       | 0.1000000       | 0.1178         |
| BIF     | GOTH 4 | 0.4186047       | 0.5000000       | 0.9696         |
| BIF     | GOTH 5 | 0.1754386       | 0.4666667       | <b>0.04324</b> |
| BIF     | GOTH 6 | 0.2089552       | 0.3333333       | 0.8489         |
| BIF     | GOTH 7 | 0.0533333       | 0               | No data        |
| BIF     | GOTH 8 | 0.2037037       | 0               | No data        |
| APP     | GOTH 3 | 0.1445783       | 0.2000000       | 1              |
| APP     | GOTH 4 | 0.09302326      | 0.1250000       | 1              |
| APP     | GOTH 5 | 0.24561404      | 0.0666667       | 0.2456         |
| APP     | GOTH 6 | 0.3731343       | 0.1666667       | 0.5708         |
| APP     | GOTH 7 | 0.2933333       | 0.1000000       | 0.3608         |
| APP     | GOTH 8 | 0.1666667       | 0.7500000       | <b>0.0324</b>  |
| FLA     | GOTH 3 | 0.2409639       | 0.1000000       | 0.5439         |
| FLA     | GOTH 4 | 0.06976744      | 0               | No data        |
| FLA     | GOTH 5 | 0.2807018       | 0.2666667       | 1              |
| FLA     | GOTH 6 | 0.119403        | 0               | No data        |
| FLA     | GOTH 7 | 0.4666667       | 0.8000000       | 0.1002         |
| FLA     | GOTH 8 | 0.3703704       | 0               | 0.07688        |
| SYL     | GOTH 3 | 0.03614458      | 0.2000000       | 0.1532         |
| SYL     | GOTH 4 | 0.1395349       | 0.2500000       | 0.7952         |

## Methods

- Data was collected by capturing bumble bees, identifying them in the field, and also taking photos of bumble bees in a clear cylindrical PVC tube to confirm field identifications. Bees were then transferred to a bee squeezer and marked for identification.
- I also recorded the flower species the bumble bees were collected off of. Floral surveys were also conducted to assess whether floral distributions affected bumble bee distributions.



View of a Photo Booth, top view (left), top view (middle), view of a bee squeezer (right)



In our comparison in 2019, only the most dominant bee species were compared whereas every other species was denoted as "Other." The species compared between similar sites in 2014 and 2019 were *B. bifarius*, *B. appositus*, *B. sylvicola*, and *B. flavifrons*. We used a 2-tailed z-test to determine if relative abundance has had any significant changes in 2019 compared to 2014.

## Results

- We found a general increase in low-elevation species and a general decrease in high-elevation species over the elevation range that I studied, with the exception of one species.
- Comparison of floral phenology over a short period of time suggested that some plants were present in 2014 that were not present in 2019, which may be attributed to climate change or successional changes in the sites over time.
- The findings indicated that bumble bee species composition at each site has slightly shifted, but a larger sampling over the entire elevation range will help indicate whether these slight shifts are due to climate change or other unmeasured factors.

## Discussion

Reasons that may have attributed to the low bumblebee count of 2019:

- 2019 was a late snowmelt year in the Rocky Mountains which shifts the phenology of the plants and causes bees to react accordingly
- Bombus* workers did not emerge until mid July which would have normally emerged in late June or early July
- The floral abundance may have attracted different bees to pollinate at different times
- Of the original study, only two of the five original transects were sampled due to snowmelt in higher elevation transects

## Conclusion

- With the late emergence of bumble bees, it may be necessary to sample into the end of the bumble bee season to understand whether bumble bee distributions have shifted.
- Since there is a new generation of bumble bees every year, bumble bees are able to adapt to the rapidly shifting effects of climate change with equal speed in response.
- Overall, bumble bees are not necessarily declining in population size but could be shifting in terms of phenology and relative abundance.

## Acknowledgments

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