

Does Bumble Bee Diet Breadth Vary With the Floral  
Abundance in a Meadow?

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Independent Research and Short Course

Summer 2015

## ***Abstract***

Years of early snowmelt tend to have a decrease in floral abundance throughout the year. This causes flowers to be more susceptible to frost and drought stress. Based on which flowers are successful this can affect bumble bee diet breadth due to the direct correlation between bumble bee proboscis length and flower corolla length. It was found that there is no relation between *Bombus appositus* diet breadth and floral abundance. Other factors such as floral richness, and overall bumble bee abundance also proved to not have an influence on diet breadth. The relationship between *Delphinium barbeyi* abundance and the proportion of flowers visited also did not have any significance.

## ***Introduction***

As our climate continues to change it is difficult to predict how different species will react and adapt to the environment. In recent years the Rocky Mountain Biological Laboratory has been affected by early snow melt, which appears to be becoming more frequent. With early snow melt, plants grow earlier and their flower buds are more susceptible to frost (Inouye 2008). Also, in early snow melt years, plants might be more prone to drought stress. Together this suggests that community floral abundance may be lower in early snow melt years. Indeed, some abundant wildflowers produce fewer flowers in in early snow melt years (Inouye 2002, Saavedra 2003, Inouye 2008, Miller-Rushing and Inouye 2009).

Early snow melt provides less water to flowers overtime, causing flower abundance to decline. Based on which flowers are more successful during years of early snow melt this may affect bumble bees with certain proboscis lengths. This is because there is a

correlation between a bee's tongue length and the corolla length of flowers that it visits (Inouye 1980, Pyke 1982). Bumble bees with certain proboscis lengths are more successful at foraging from flowers with corresponding corolla lengths (short, medium, and long).

Within the means of proboscis length, different species of bumble bees choose to forage from different flowers. This is due to the different nutrition requirements of the bumble bees and the fact that the nectars and pollens of different flowers are not chemically identical (Inouye 1978). Due to the amount of skill that a bumble bee needs in order to become an efficient forager, it is common for bumble bees to have a specialized diet breadth (the number of flower types or species that a bee visits) and to choose a major flower and a minor flower that they forage from. Specialization promotes foraging efficiency due to different features and rewards that are offered from different plants (Heinrich 1976). The specialization of bumble bees due to the correlation between corolla length and bumble bee proboscis length may allow different species of bumble bees to coexist (Inouye 1980, Pyke 1982). However, with decreased flower abundance bumble bees may need to become more generalized in order to obtain sufficient resources.

Does bumble bee diet breadth vary with floral abundance in a meadow? This question is important for the response of bumble bees to climate change due to fewer flowers during early snow melt years. My hypothesis was that bumble bee diet breadth decreased with an increase in the floral abundance of a meadow. If there was a large floral abundance in a meadow then bumble bees would specialize in which flowers they choose to forage from, while bumble bees in meadows with low flower abundance would be more

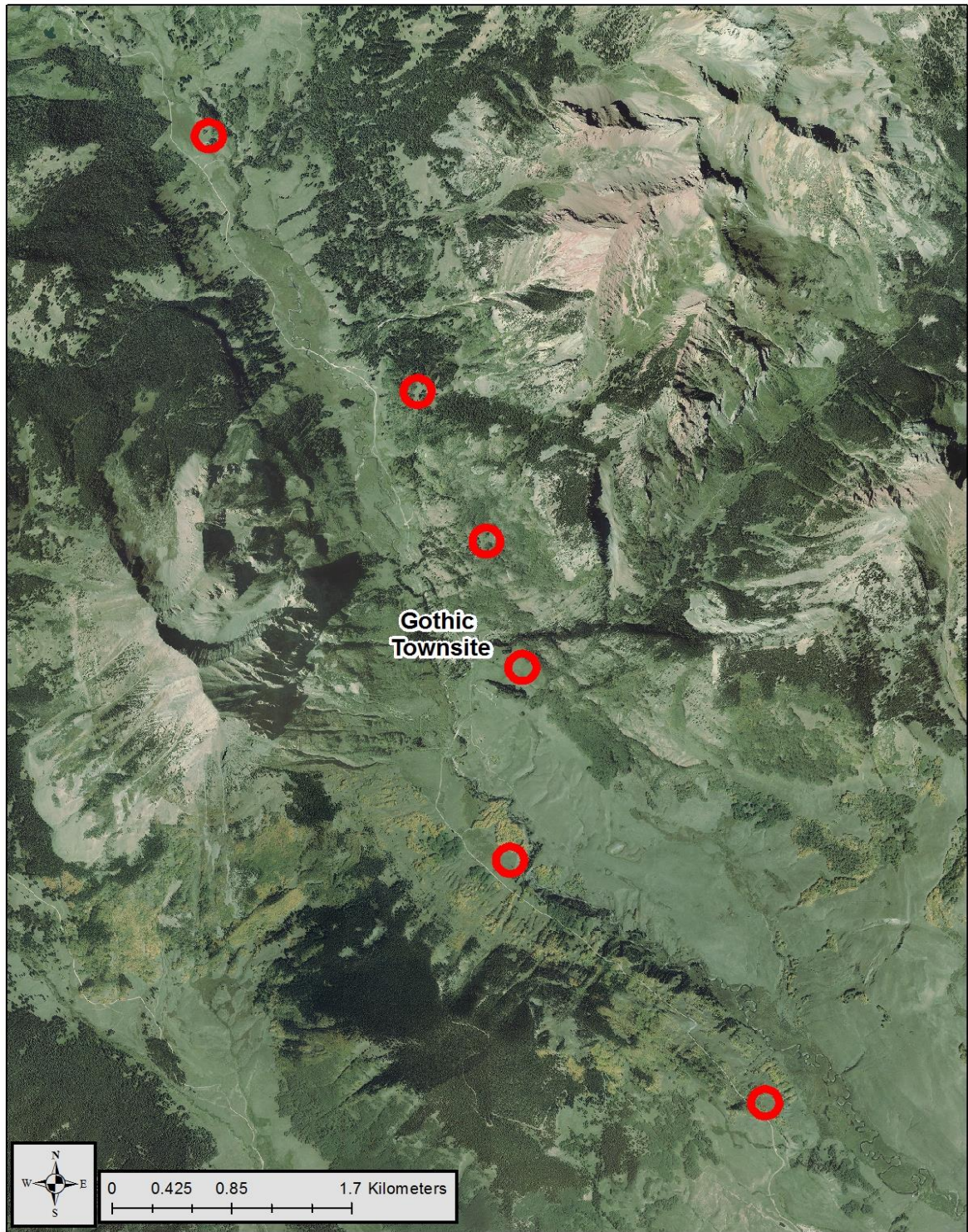
generalized and would need to visit more flower types to obtain the food resources they needed.

## ***Methods***

### *Study system*

*Does bumble bee diet breadth vary with floral abundance in a meadow?* The independent variable for my experiment was the flower abundance of the meadow while the dependent variable was the bumble bee's diet breadth. I tested for the prediction of my hypothesis by focusing on the specific long-tongue bumble bee species, *Bombus appositus*. Due to the fact that bumble bee queens are long lived and are less flower-constant (Heinrich 1976), I decided to focus on the worker bees. I was interested in the relationship between *Bombus appositus* diet breadth and floral abundance and performed work at 6 different meadows in the East River Valley, each about 1 km away from each other. My 6 sites can be seen in figure 1. At these 6 meadows I tested bumble bee diet breadth in two different ways. I tested diet breadth at a species level as well as at an individual level.

Figure 1: 2015 Sites



### *Species bumble bee diet breadth*

At a species level my team and I performed bee observations and flower counts. We visited each meadow once a week and would perform bumble bee observations for one hour. When performing bumble bee observations we counted all the bumble bees that we saw and the flowers that they visited. This allowed us to get a measure of bumble bee abundance and what flowers each species visited. From this data we were able to see the diet breadth of *Bombus appositus* workers at each meadow.

We measured the independent variable of flower abundance at each meadow we visited by performing flower counts on Jane Ogilvie's 120 m by 50 cm transects that are spread out between wet, dry, and an aspen forest habitat. We counted the flower species in each transect on the day of our observations so we could determine a general understanding of the floral abundance of each meadow. All observations and flower counts were recorded. For our measures of bee abundance and floral abundance at a site we chose to use the data from each peak day of floral abundance and bumble bee abundance rather than using the average. Using the peak abundances for each meadow instead of the averages seemed to be the most appropriate way to address floral abundance due to floral abundances varying over time (they rise and fall). In addition, I chose to use a *Delphinium barbeyi* rank instead of averages as a result of our flower transects not producing an accurate representation of the actual *Delphinium barbeyi* abundance for each meadow.

### *Individual bumble bee diet breadth*

I tested the dependent variable of bumble bee diet breadth at the individual level by visiting the same 6 meadows mentioned earlier. I conducted a manipulative experiment by presenting an “interview stick” to any *Bombus appositus* worker that was found foraging on the flower, *Delphinium barbeyi*, which is the species of flower that the *Bombus appositus* tends to prefer (its major). Attached to the interview stick there were 3 species of flowers. *Delphinium barbeyi* and then two other flower species that the *Bombus appositus* does not normally visit but is still able to visit. The other flowers used were *Vicia americana* and *Aconitum columbianum*. At each site I would randomize the position of the flowers on the interview stick. My replicates were the 6 meadows that I visited. I visited each one of the 6 sites multiple times a week for 2 weeks until I received 20 interviews from *Bombus appositus* workers that decided to visit a flower.

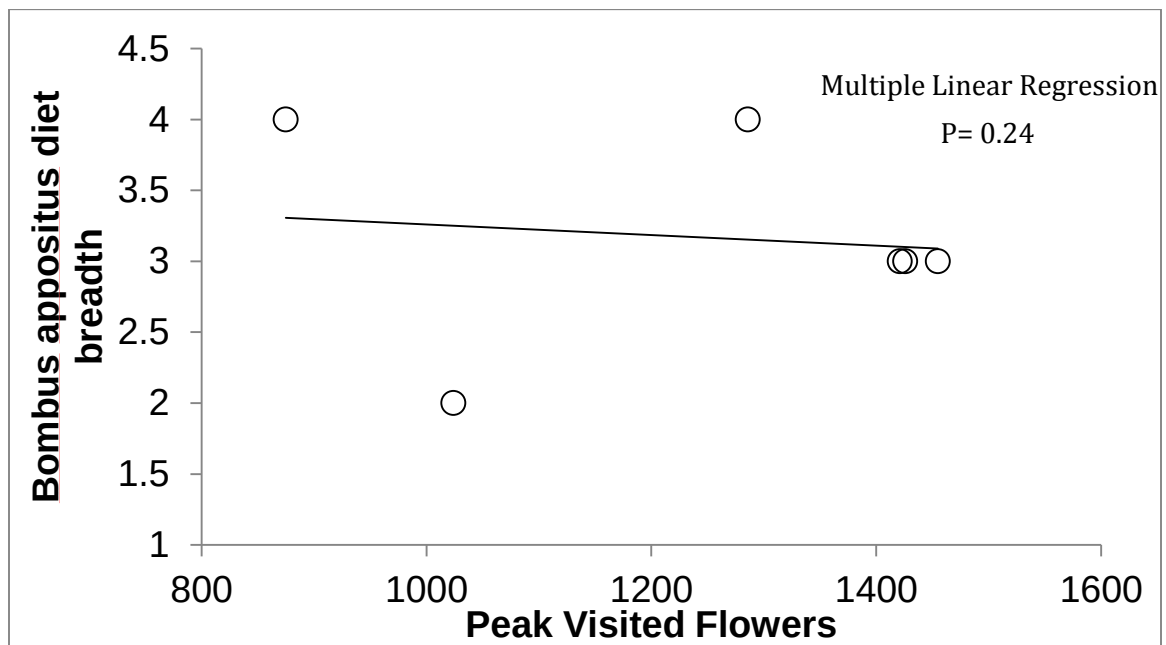
### *Statistical Analysis*

For population *Bombus appositus* worker diet breadth the relationships between Peak flower counts for floral abundance, floral richness, bee abundance, and *Bombus appositus* diet breadth were analyzed using a multiple linear regression with the program, R. For individual *Bombus appositus* worker diet breadth I closely looked at the behavior of bumble bees that were “interviewed” and if they approached, avoided, or visited any of the three flowers that resided on the interview stick that was presented to them. Using R once more, I used a Binomial generalized linear model to analyze the relationship between *Delphinium barbeyi* rank and the proportion of flowers that were visited (*Delphinium barbeyi* and other flowers).

## Results

We did not see any patterns between peak visited flowers (the flower species that the *Bombus appositus* workers visited) and *Bombus appositus* diet breadth. This can be seen in figure 1. The relationship for figure 1 had a p value of 0.24 and was not significant.

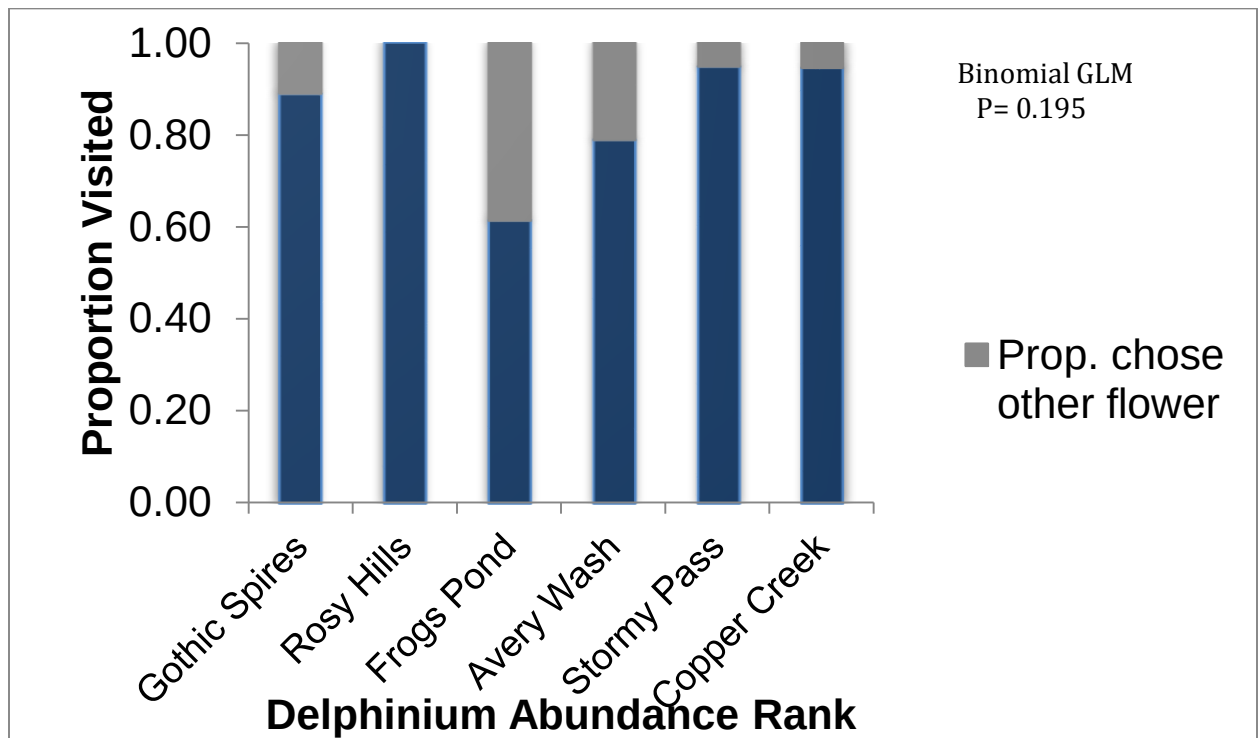
Figure 2: Peak Visited Flowers vs. Diet Breadth



When looking at an individual level and bee interviews we also did not see any kind of trend. The relationship between *Delphinium barbeyi* rank and the proportion of flowers that the *Bombus appositus* workers visited had a p value of 0.195 and was not significant. The *Bombus appositus* workers did not increase their diet breadth in meadows with a lower floral abundance. They had a narrow diet breadth and only visited 2 to 4 different

flower species per site. Across all 6 sites the *Bombus appositus* workers only visited 9 different flower species.

Figure 3: Delphinium Abundance Rank vs. Proportion Visited



## Discussion

There was not any significance that shows that the floral abundance of a meadow effects bumble bee diet breadth. Possible reasons why the *Bombus appositus* workers did not visit more flowers in meadows with lower floral abundance could be due to the fact that there was not enough variation of floral abundance between the 6 sites. Years of early snow melt have a tendency to have floral abundance decrease through time. However, due to all of the rain that the East River Valley received this summer the flowers were successful at all of our 6 meadows. It has been said that a decrease in available resources

leads to an increase in individual diet breadth (Fontaine 2008). Instead of a decrease in resources there was an increase in available resources at all 6 of our meadow meadows. This may be another potential reason why the *Bombus appositus* workers did not increase their diet breadth at meadows that had less flowers than others. Even though certain meadows had less flowers in comparison to other meadows, there was still a large floral abundance overall. Also, although all of our 6 meadows had a successful floral abundance there still seemed to be variation in the proportion of flower species visited (*Delphinium barbeyi* vs. *Vicia americana* and *Aconitum columbianum*). Unfortunately, this variation was not due to *Delphinium barbeyi* rank (figure 3). Something that could also be considered about this study could be the possibility that there is not any significance between bumble bee diet breadth and the floral abundance of a meadow. This topic has not been closely studied before but is an important relationship that is unknown and should be examined.

Things that could have been done differently about this study are if I had more time to perform extra interviews or visit additional sites. These changes would have given me a larger sample size and may have changed the outcome of my statistical analyses. In addition, this project may produce more significant results if repeated during a year with fewer flowers. This would provide more harsh conditions and could potentially have a greater influence on floral abundance and bumble bee diet breadth. Finally, I would like to thank the Rocky Mountain Biological Laboratory for their funding and support, as well as Jane Ogilvie, for mentoring me this summer.

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