

Comparative study on pollinator visits to high elevation plant communities in Virginia Basin, Gothic, Colorado

Drake Gascon

Abstract

Plant-pollinator networks are intricate systems that can give insight on a location's biodiversity and response to environmental changes. By studying pollination networks at different elevations, researchers can evaluate how varying environmental conditions influence how plant and pollinator species interact with one another. In this project, I assessed two plant-pollinator communities in the Virginia Basin at 3500m and at 3350m. Plant-pollinator interactions were recorded by sampling 20x1m transects at each site while censusing flower abundance for five weeks during the summer of 2021. When looking at the overall abundance of flowers at both sites there was no difference between sites abundance or mean visitation per abundance. However, when analyzing the plant species found at both site there was a significant difference between the mean visitation, with plants at the mid site receiving more visits. This difference may be due to harsh conditions at the higher site or the greater plant diversity there, which results in the dilution of visits to each plant species. Further studies could look into how other factors like weather variables and climate change affect these plant-pollinator communities.

Introduction

Plant-pollinator communities are centered on mutualist interactions where both the plant and pollinator benefit from an interaction (Waser and Ollerton 2006). These communities are intricate systems that involve specialized and generalized pollinators. These plant-pollinator interaction networks are a valuable tool for assessing biodiversity and landscape response (Heink and Kowarik 2010). Plant-pollinator communities are affected by several outside factors that alter the relationship and distribution of life

in these communities to different degrees (Merriam 1890). One outside factor is the sensitivity to elevation change; as elevation increases, natural ecosystems change and have different characteristics in terms of plant and pollinator life (Devoto et al. 2005). Even over a short range, elevation gradients can greatly affect abiotic and biotic variables (Korner 2007). Abiotic factors like temperature and humidity decrease as elevation increases. Pollinator species also vary as elevation increases, at lower elevation bees are more dominant while flies are more common at higher elevations (Adedaja et al. 2018).

At higher elevations climate change is likely to alter snow melt which affects plant pollinator interactions. Current climate change trends already have detrimental effects on a plants phenological response to snowmelt, with varying responses between each species (Inouye 2008). Pollinators can respond to challenges brought about by climate change in a multitude of ways. Responses could involve a change in altitude, or it could involve evolutionary change with enough time (Inouye 2020). By taking a network approach when studying community-level interaction, information regarding patterns can more easily be discerned.

For this project, I studied the network interaction of the plant-pollinator community in Virginia Basin, near Gothic, Colorado. This high elevation sub-alpine meadow is located at 3,500m elevation. I studied the plant pollinator interactions at two sites: a mid-elevation-site and a high site above the tree line (Figure 1). The purpose of this study is to document how elevation affects plant abundance and visitation of pollinators in Virginia Basin. This is important because plant and pollinator species may not respond similarly to climate change, thereby changing species interaction patterns and potentially plant reproduction. I hypothesize that elevation affects the frequency of visits, with plants at the high site receiving more visitations because the high site is on a southeast facing slope, and receives more direct sunlight, compared with the mid site which is on an east facing slope.

Methods

Location

Data was collected at the Virginia Basin which is a sub-alpine meadow located at 3350m elevation and three kilometers northeast of Gothic, Colorado. A high site and mid site were set up in Virginia Basin, based off previous sites that were used by Alarcon (2004). The high site is located at 3500m, above the tree line on a southeast facing slope near a willow infested stream bed. The mid site is located at 3350m, below the tree line on an east facing slope. Of the two locations, the high site has a steeper slope gradient than the mid site.

Experimental design

Eight transects were established in Virginia Basin. Each transect was twenty meters long and one meter wide. A spacing of one meter was also placed between each transect to allow for traversal between areas. Each transect was divided into two-meter segments for a total of ten segments in each transect. The Virginia Basin mid site was set up by the Brosi lab following similar protocol.

To collect data for plant-pollinator interactions, flower counts were taken each week along each transect. Following this, each transect segment was surveyed for a total of three minutes for pollinators. An interaction is defined as anytime a pollinator, such as a fly, bee, and moth, or wasp, lands on or touches a flowered plant. When a pollinator interacted with a flowered plant, it was netted and placed into a vial for containment. The vial was then labeled and the interaction that corresponds to the vial was recorded separately. The exception to this is bumble bees and *Osmia* bees which were caught, identified, and immediately released. The order in which each transect was surveyed was randomly selected prior to arrival. Data was collected for five weeks from June 18th to July 23rd, 2021.

Data Analysis

Data was analyzed by calculating the mean number of visits per open flower for each plant species and the overall abundance of that plant throughout the five weeks. A paired t-tests assuming unequal variance was used to compare the mean abundance for each plant species. While a paired t-test assuming equal variance was used to compare the mean visits/abundance for each plant species. Paired t-tests were used, to compare the mean visits/abundance for plant species found at both sites and the abundance for each plant species found at both sites.

Results

The high site had 25 different plant species with a total of 249 pollinator interactions. The mid site had 14 different plant species with a total of 246 pollinator interactions. Flower abundance had a mean of 379.32 (SE= 88.584) at Virginia Basin high site, and 595.14 (SE= 300.015) at Virginia Basin mid site (Figure 2). T-test assuming equal variances suggests no difference in mean flower abundance between sites ($t = -0.86$, $df=37$, $p=0.40$). Mean visits per flower was 0.13 (SE= 0.054) at high site, and 0.08 (SE= 0.021) at mid site (Figure 3). T-test assuming unequal variances suggests no difference in mean visitation between sites ($t = 0.90$, $df= 30$, $p= 0.38$).

There were nine plant species that were found at both sites. Mean flower abundance for these species was 698.78 (SE= 172.941) at the high site, and 873.89 (SE= 447.172) at the mid site (Figure 4). Two paired t-test for means suggests no difference in mean flower abundance between sites ($t = -0.38$, $df= 8$, $p= 0.71$). Mean visits per flower had a mean of 0.03 (SE= 0.008) at the high site, and 0.07 (SE= 0.025) at the mid site (Figure 5). Two paired t-test for mean visitation between sites resulted in a p value of 0.053 which is not quite significant but shows a trend that there were more visitations at the mid site ($t = -2.27$, $df=8$, $p= 0.053$).

Discussion

The purpose of this study was to determine if elevation influences pollinator visits. When analyzing the data for all plant species there is not a significant difference between plant abundance or the number of interactions that occur between the sites. However, when analyzing only the plant species that are found at both sites there is a trend that shows there were more visitations at the mid site even though there was no difference between plant abundance. This did not align with my prediction, but it does show that there is a difference between the sites. The potential reason for this difference could have to do with the variety of plant species found at these sites. The high site had more plant species than the mid site. This could have led to the pollinator interactions being more spread out at the high and occurring with plants that were not found at the mid site. Pollinators tend to prefer large populations of plants as they yield more rewards, compared to more sparse populations of plants (Sih and Baltus 1987). However, in a study done by Mustajärvi et al. (2001), sparse plant populations had higher mean visits per plant species. This could be because sparse plant populations have a larger inflorescence (Mustajärvi et al. 2001). Another potential factor could be the harsher environment due to elevation gain. As elevation increases it is possible that certain species of plants pollinators drop out or their blooming period may decrease or increase. With the increasing severity and frequency of climate change, ecosystem stability and survival of species are at greater risk, especially at higher elevation where ecosystems are more susceptible to climate change (Tylianakis et al. 2008). With plant-pollinator communities being intricate systems that offer valuable insight on biodiversity and landscape response, it is important to continue studying them to see how climate change may affect and shift these interactions. This can be done by assessing first appearance date of pollinators and the onset of flowering in plants (Hegland et al. 2009). Further studies on plant-pollinator communities can look at factors like weather and temperature to include other outside variables for study. Plots in other elevations

could also be set up to have a larger sample size. By continuing study into plant-pollinator communities, data can be continued to be gathered that can help predict and understand the changes and responses of an ecological community.

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Appendix



Figure 1. Locations of High site (Elevation: 3500m) and Mid Site (Elevation: 3350) in Virginia Basin, CO

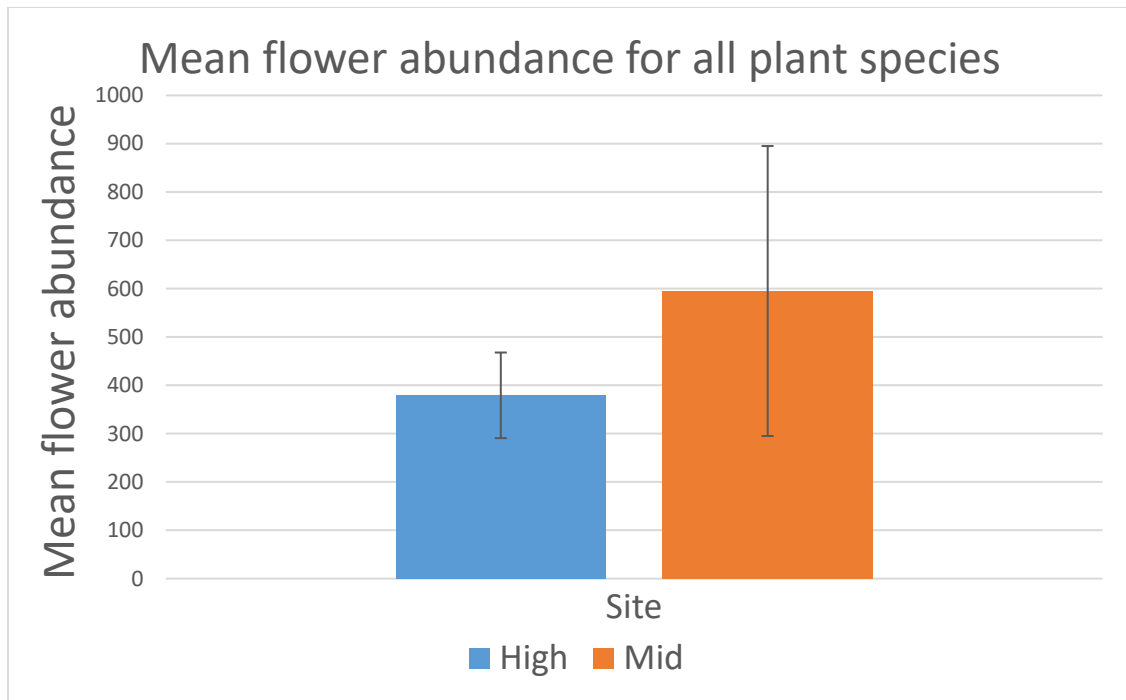


Figure 2. Mean flower abundance for all plant species at the high and mid sites.

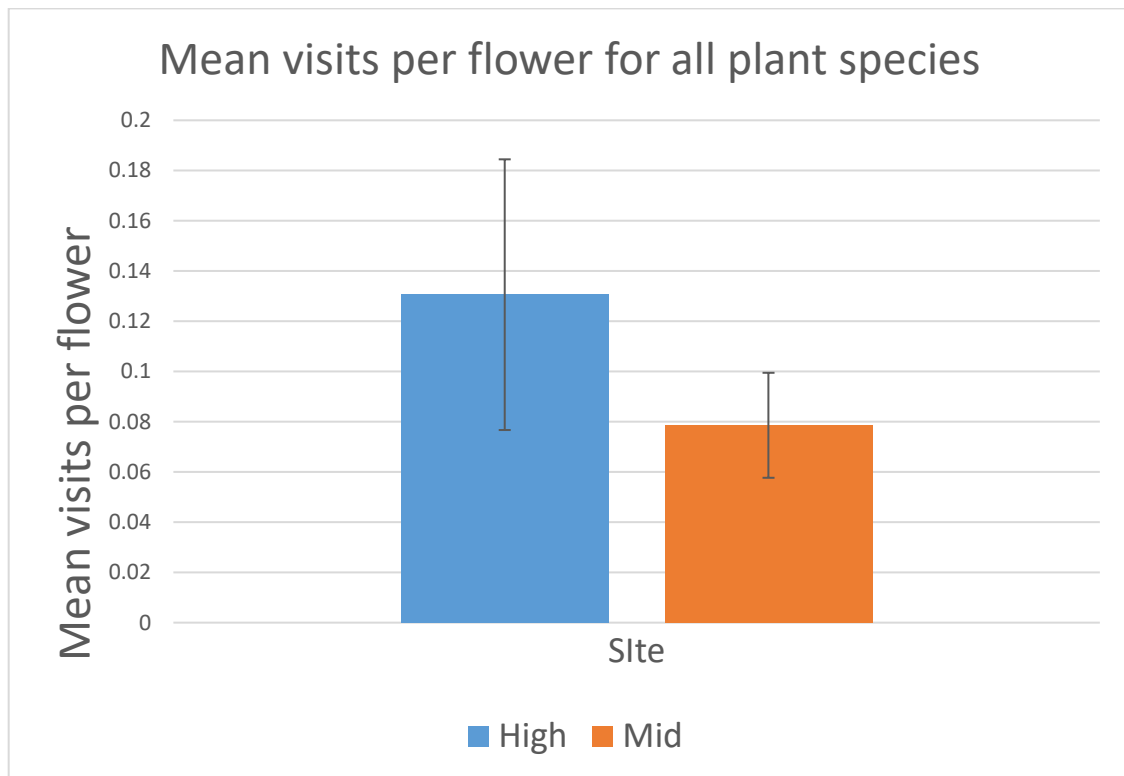


Figure 3. Mean visits per flower abundance for all plant species found at high and mid site

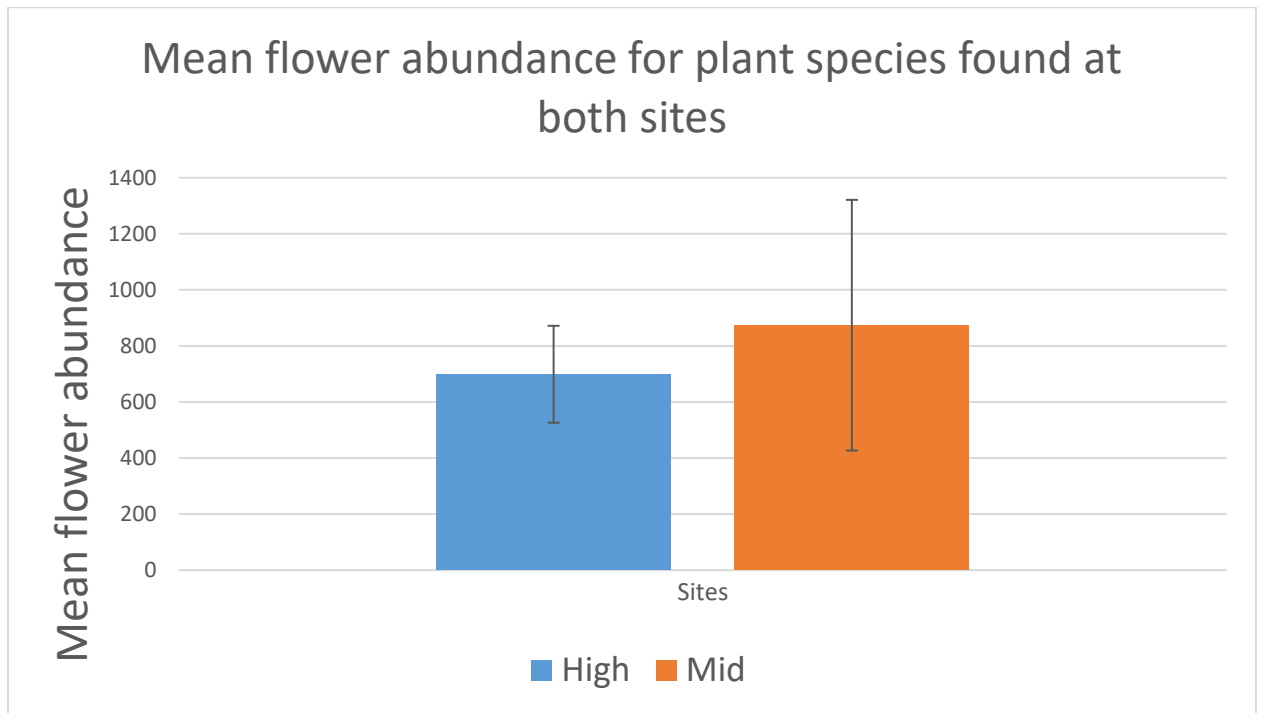


Figure 4. Mean flower abundance for plant species that were found at both sites

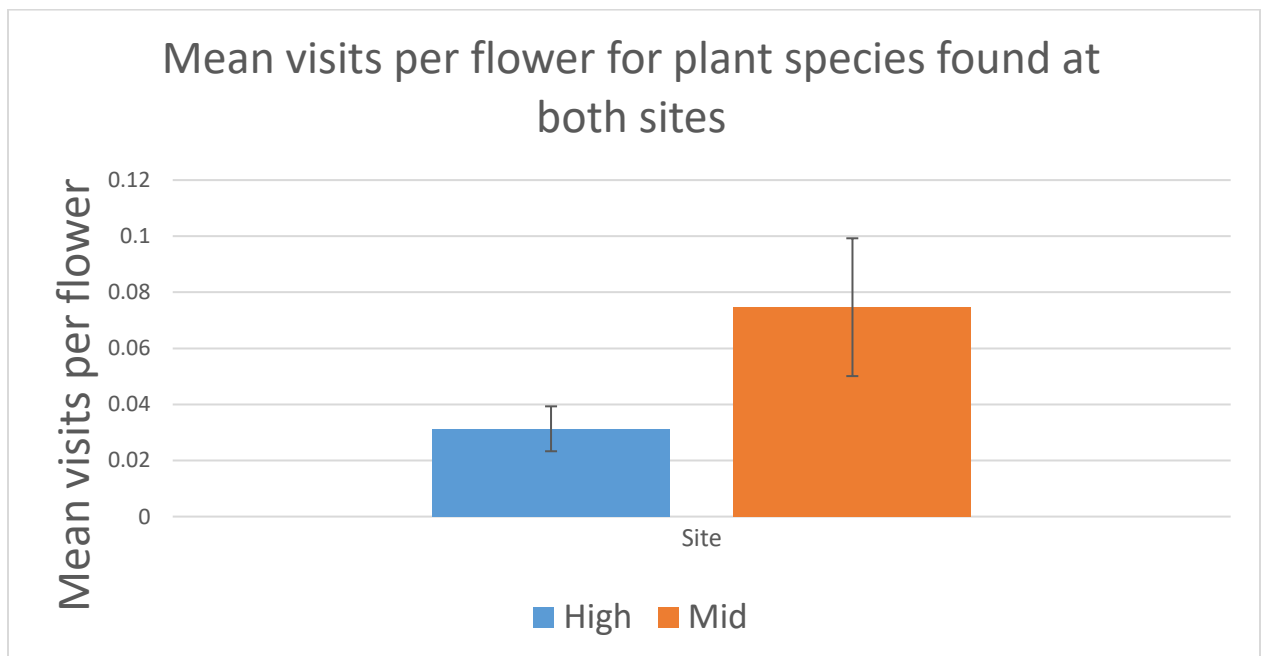


Figure 5. Mean visits per flower for plant species that were found at both sites

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