Plant Life on the Surface of Emmons Glacier, Mount Rainier WA.

By Calie Rose and Claire Todd

Abstract

Mount Rainier is located in the southwest of Washington state and is protected along with 236,381 acres with national park status. For this research study we focused on Emmons Glacier, which is found on the northeast side of Mount Rainier. The goal for this study was to identify the conditions that are conducive to plant growth and to be able to identify where plant life could be based on characteristics like debris depth, composition, and how well sorted the debris is. To do this, 5 meter by 5 meter grids were made at different locations along the top of the debris cover. These grids were roped off to define a line of observation before the number of individual plants and the number of different species were determined and recorded. Data for the composition of the debris cover, debris thickness, and the debris sorting were used to make connections between the plant life and the environments in which they were found. 20 different species of plants and one fungi were found within 10 different sites on the debris cover. Two species, Vaccinium deliciosum and Juncus parryi were found in eight out of the 10 sites observed. While there was not a strong correlation between soil moisture content, the sorting of debris, and the plant species that were found, there was a small correlation between plant species and debris cover thickness. Four species, Antennaria lanata, Boechera lyallii, Phacelia hasta, and Achillea millefolium were all present at debris depths of at least 53 cm. These plants were also only present in debris within a 10 cm range in more than two sites. In conclusion, the data gathered does not support my hypothesis. The data gathered does however support the idea that the plant life atop Emmons glaciers debris cover has a correlation with the debris covers depth.

Research question

How does the debris cover on Emmons Glacier affect plant life on the glaciers surface?

Hypothesis

I hypothesize that there will be a correlation between where certain plant species are found and the soil moisture content and the degree to which the debris is sorted.

Introduction

To understand what soil characteristics are important for plant life you need to take samples of the soil found near surviving plants, but because of the fragile ecosystem atop Emmons Glaciers debris, this was something I was unable to do. Sampling soil in an area where plant life is scarce can be harmful to the ecosystem they have created. So instead I have been using rock composition data to create trends between composition and the plants found growing there. While studies like this one have not been popular on the United States glaciers, there have been a few done on a glacier found in the Italian Alps. Caccianiga et al. (2011) conducted a study like this and this study is what I based my methodology on. Vezzola et al. (2016) studied the correlation between glacier surface velocity and the abundance of tree life on debris covered glaciers. They found that when trees are present, the glacial surface velocity is low. Learning about plant life on Emmons Glacier can tell us many things about what is going on under the debris. It can also tell us what properties the debris itself holds like how moist, how thick, and possibly what the composition of the debris cover is.

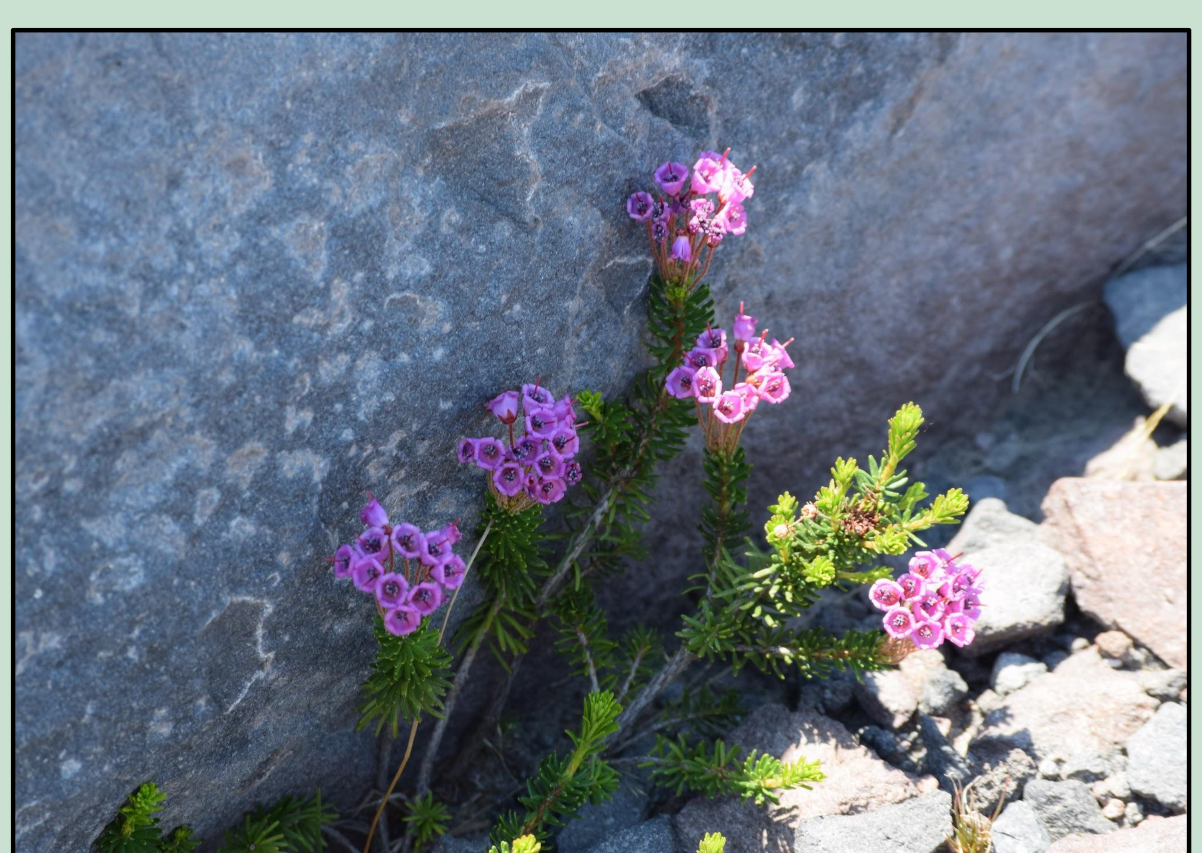

Photo of Phyllodoce empetriformis from Site 3. Plants are most 6 inches tall.

Why is this important?

Recording data for plant life atop Emmons Glacier is important because it can tell us a lot about the glacier and the environment around the glacier.The areas that are viable for plant life can tell us how thick the debris cover is, how well or poorly sorted the debris is, and what sort of rock compositions are present. The addition of plant life can also show the different rates of velocity of the glacier. This data is useful because if there is a relationship between plant life and glacier characteristics, we could be able to make assumptions about what is happening to the glacier where certain plants are found.

Study Area

Within Mount Rainier National Park, there are 28 different glaciers and snowfields (Sisson et al. 2011) that descend from the sides of the stratovolcano known as Mount Rainier. Of these 28 glaciers and snowfields, my study area is focused on Emmons Glacier, Figure 1. Emmons Glacier has the largest surface area out of all of the glaciers found in the United States. While this glacier has been retreating for many years, the thick cover of debris that you find on top has slowed the rate of glacier melt. Allstadt et al. (2015) used terrestrial radar interferometry to monitor the seasonal changes of Emmons Glaciers surface velocity. Figure 2 shows a map that Allstadt produced mapping out the rate of velocity change during the month of July. The purple shown in the upper right hand corner of the image is the area of Emmons Glacier that I studied. During the month of July, this area of the glacier showed zero meters of velocity per day.

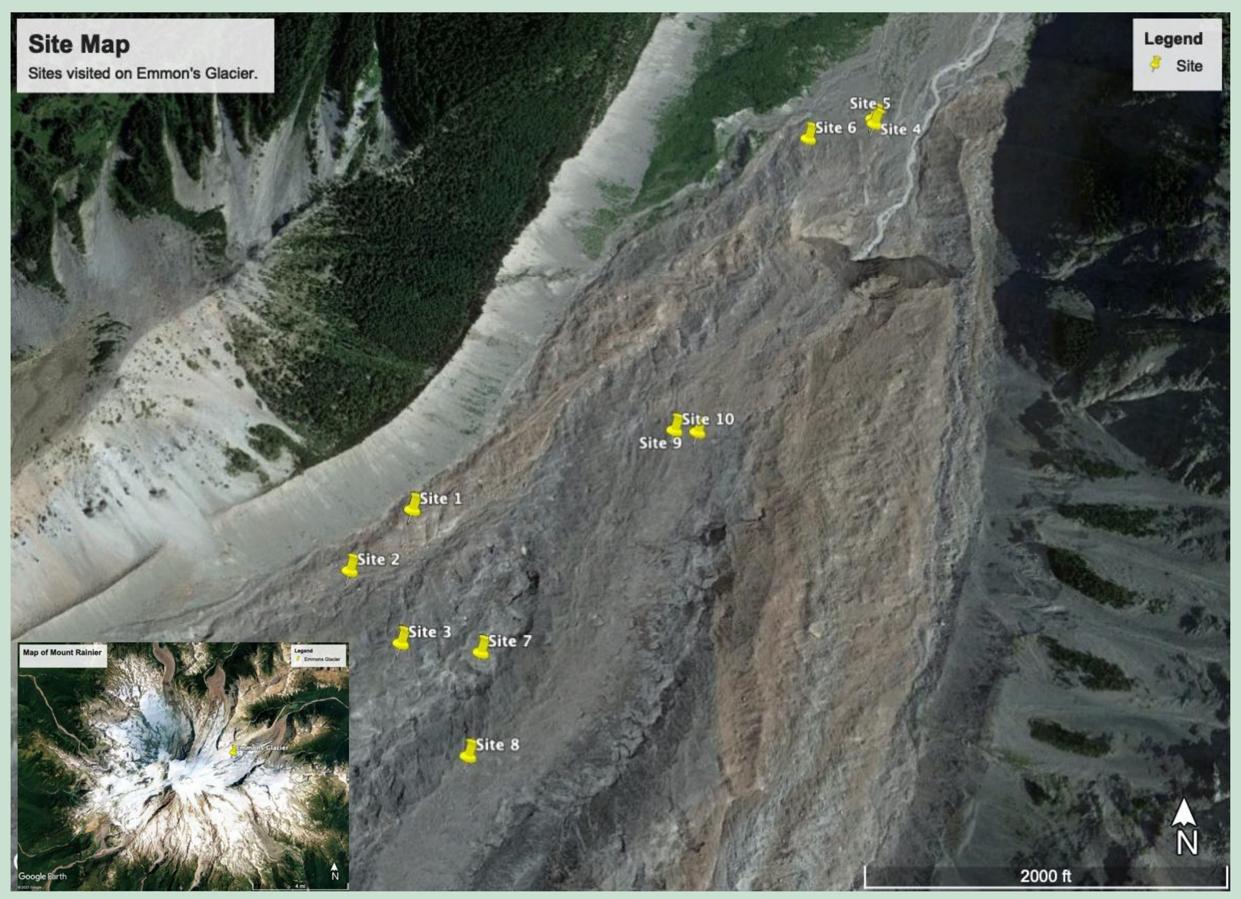

Figure 1. Map of Mount Rainier and Emmons Glacier. Yellow push pins are sites where samples were collected.

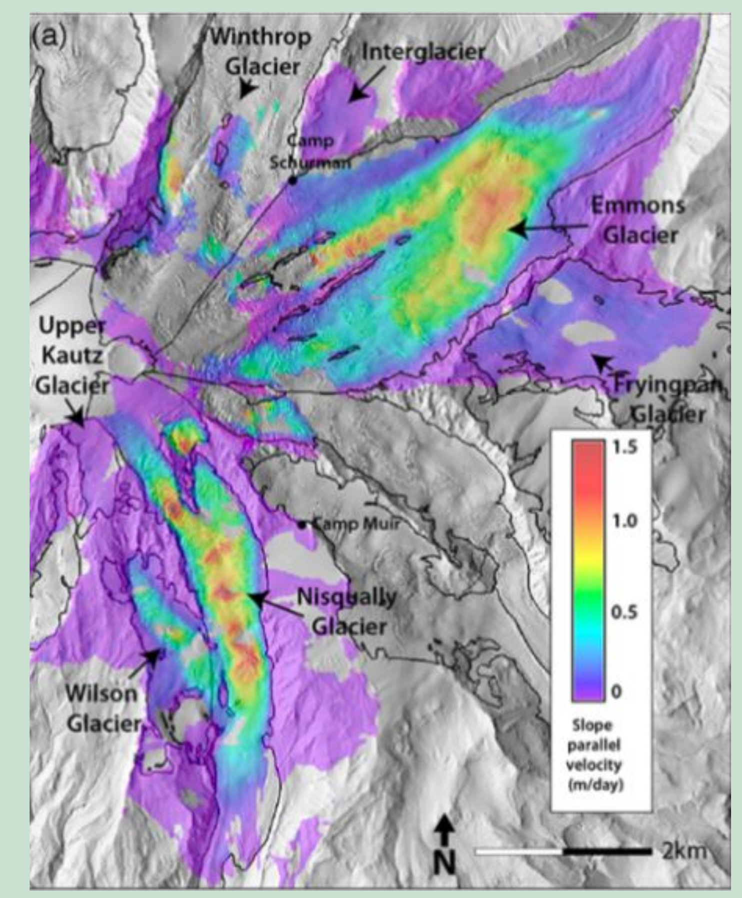

Figure 2. Allstadt etal 2015, Map showing parallel slope velocity in meters per day.

Methods

In the Field

- Observe the debris cover surface and find an area that appears to have more than one plant species in it.
- Mark off a 5 meter by 5 meter grid with rope on the debris cover surface, Figure 3 (*Caccianiga et al. 2011*).
- Record grid location with a handheld GPS, Figure 1.
- Count and record number of different species and individual plants found.
  - If plant abundance is too high, section off a one meter grid to record plant density (Fig.4).

In the Lab

- Using Pojar and MacKinnon et al. (1994) begin to identify plant species.
- Enter number of individual plants found into data spreadsheet. In a plant identification spreadsheet, record each species found in each site.
- Add new species to data set and record ecology to compare to moisture content data.
- Compare plant species data to soil moisture content and debris thickness for the area the grid is located in.
- Create grain size analysis graphs using sieve data and compare plant life found in grids sampled.

Figure 3. Photo of me setting up Site 1.

Figure 4. Image of one meter by one meter box inside of the original grid, so plant density can be calculated.

Results

While my results are final, this is not a comprehensive list of plants found on top of Emmons Glacier. 20 different plant species belonging to 10 different plant families and one fungi were observed on the debris cover. All of the plants and fungi found are native to Washington state and are all found in mountainous areas. Of the plants found, three belong to the aster family, three belong to the rush family, and five belong to the shrub family. An evening primrose, rose, plox, stonecrop, waterleaf, brassicaceae, and a tree species were also observed in this area. Within the ten site I surveyed, there were eight different debris thicknesses found, and nine different average soil moistures. The plant species that appeared the most throughout the study was Vaccinium deliciosum, Figure 6. It was found in eight out of the ten grids observed, Figure 5. Out of 28 grain size analysis compiled, only one site, site 7, produced a well sorted graph, Figure 7. Site 7 ended up producing the second highest plant density.

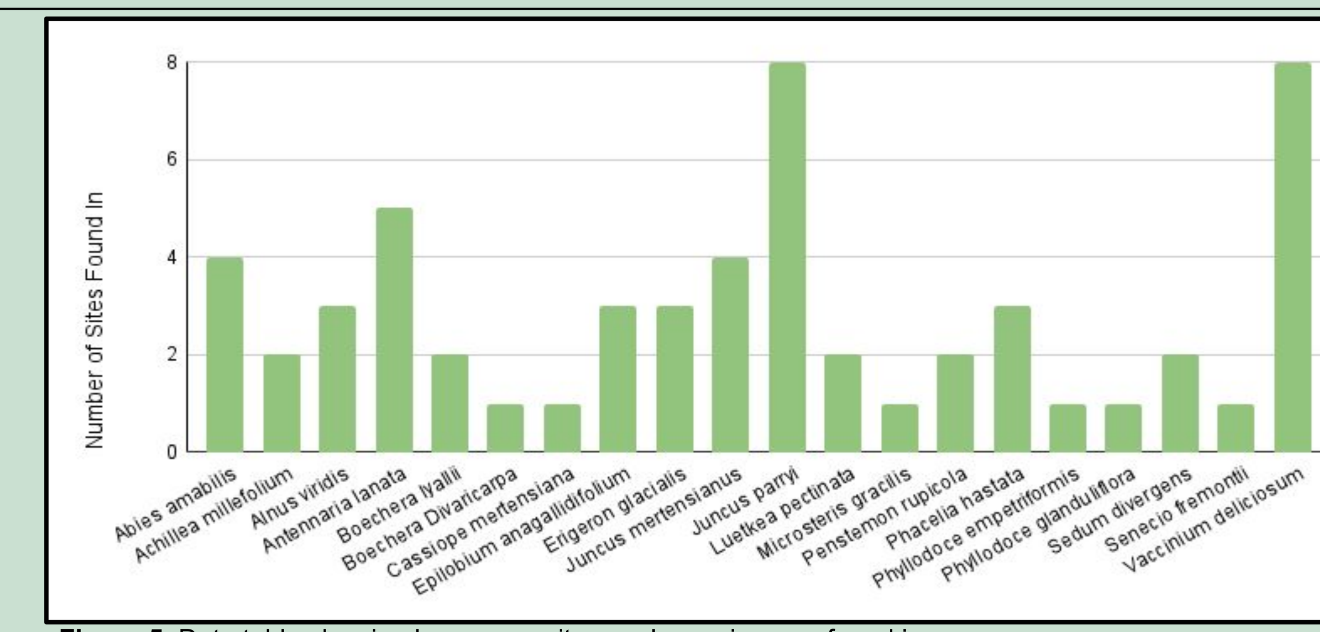

Figure 5. Data table showing how many sites each species was found in.

Discussion

While I was looking for a correlation between plant species and the average soil moisture content, the data does not support this. The soil moisture data turned out to not be useful due to the fact that there is no existing scale to base the percentages off of. The soil moisture content ranged from 0.326% to 10.794%. One correlation I found was between plant species and debris thickness. Four plant species were found within a 10cm range of debris thickness, with the shallowest debris depth being 53cm and the deepest being 65cm. This data leads me to believe that there is a correlation between plant life and debris depth. Vezzola et al. (2016) found the same correlation between trees and debris thickness, 90% of their plant life data was recorded in areas with a debris thickness of 32-55cm. While I was unable to draw overarching conclusions from the grain size analysis graphs, I was able to see a correlation between plant density and well sorted debris. But while site 7 had the best sorted debris, only three plant species were found in this site. Vaccinium deliciosum was the only species found at almost every debris thickness recoded, it was also found in Eight different moisture content percentages. From the seven possible rock units, plants were found in four out of these seven. Two rock units are composed of angular rocks from a rockfall event. The other two rock units were less angular and were sub glacially transported bedrock.

Figure 6. Image of Vaccinium deliciosum in site 3. Plants are a little taller than a foot.

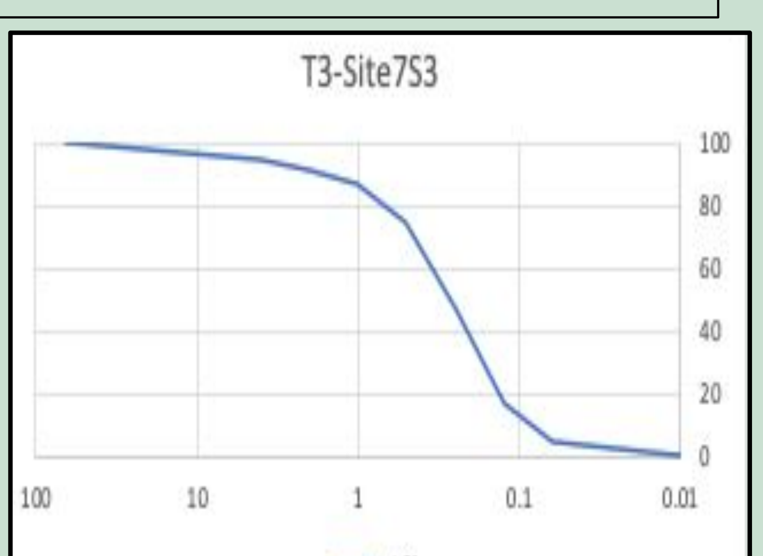

Figure 7. Grain size analysis graph from the third sample taken from site 7.

Conclusion

- There was no correlation between plant species and soil moisture content.
- With further research, a stronger correlation between debris thickness and plant species could be made.
- With further research, a stronger correlation between debris grading and plant density could be made.
- There are at least 10 different families of plants on the glaciers debris cover.
- More data needs to be collected.

Acknowledgments

To start, I would like to thank Dr. Haberle for her extensive plant knowledge and willingness to help me along with this project. I would also like to thank Dr. Michelle Koutnik, Dr. Carol Holder and Dr. John Mallinckrodt's Glacial Geology Research Fund and the NASA SSW award 80NSSC20K0747 for funding this summer's work, without their support this research would not be possible. To the PLU Natural Science Department and the National Parks Service, thank you for being a home for this research. Lastly I would like to thank the Debris and Water teams for keeping high spirits throughout the summer and making my job that much more enjoyable.