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Miles Berkey Bryophyte Research

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COLLEGE OF THE ENVIRONMENT

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DATE: 11/7/2022

To fulfill ESCI 498B, I assisted in mapping bryophyte flora in Mount Baker-Snoqualmie National Park, along LGM (last glacial maximum) spatial boundaries determined by GIS (see Figure 1). The aim of this research has been to determine the likelihood of an ice age refugium in Barlow Pass, by comparing the proportion of disjunct species to the known ice age refugium, Brooks Peninsula (Figure 2), and the known non-refugial area Cascade Pass (Figure 3). Bryophytes are a group of non-vascular plants, divided into mosses, liverworts, and hornworts. They are amongst the oldest extant lineage of terrestrial plants. Due to this evolutionary history and how they persisted before and during the Pleistocene, we are able to evaluate the likelihood of a refugium in a given area. Thus far, we have collected several species of moss and liverworts, but only one has been an indicator of a refugium. This specimen is the moss species *Oedipodium griffithianum.*

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Commented [MH2]: Which one? Is that one you studied?

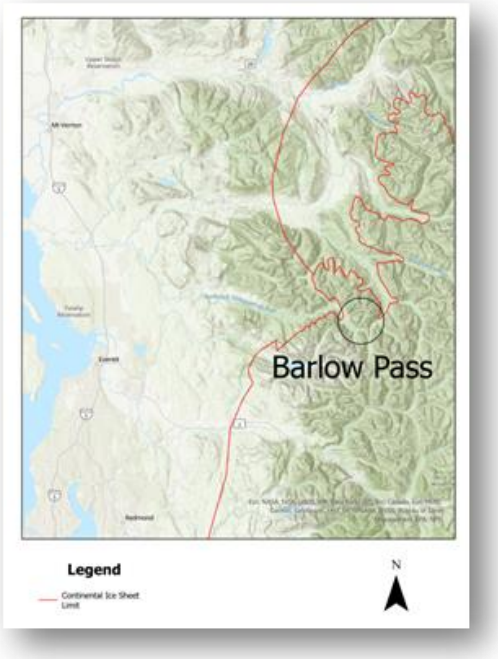

Figure 1. Research site in Mount Baker-Snoqualmie National Park (Barlow Pass region) in comparison to LGM boundaries (Reidel, 2017)

Figure 2. Comparing known refugial site, Brooks Peninsula (red triangle) to Barlow Pass study site (black triangle).

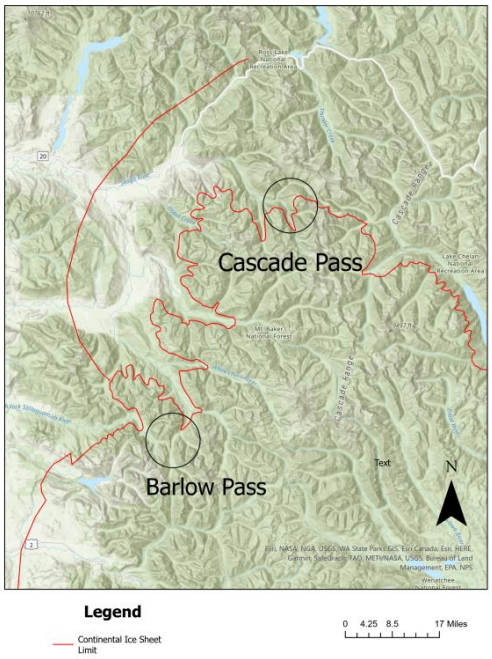

Figure 3. Showing non-refugial study site (Cascade Pass) compared to experimental study site (Barlow Pass)

Behind an ice sheet on a ridge in Barlow Pass, Washington at the Big Four Ice Caves, we identified *Oedipodium griffithianum,* which is extremely rare in North America and a strong indicator of a glacial refugia. This is because *Oedipodium* has a major disjunct distribution and expansion and is found commonly in Greenland at lower elevations (Belland & Brassard, 1981). Due to the drastic difference in geography where this species is found and the nature in which it normally flourishes, it is likely that *Oedipodium* dispersed and was able to survive in North America, in a microhabitat uncovered by the continental ice sheet.

The broader context of this work gives us not only a deeper understanding of the flora in the Pacific Northwest, but also an explanation for how these species have persisted and changed

Commented [MH3]: Where is that? I would think about including a map and methods section as well

Commented [MH4]: You discovered a new species? Or the first record in this location? Or was it identified, be clear

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over time. Gaining insight to this knowledge can help us map the history of flora dispersal, adaptation, and resistance as a result of changing climate. We will continue our survey through the end of the summer, where I will assist in collections and keying out species. Once our field work comes to a close, I will assist in organizing the species classifications into data points to be analyzed using a PCA analysis and a chi-squared goodness of fitness test. From here, we will develop correlation coefficients to determine the degree of similarity between Barlow Pass, Cascade Pass, and Brooks Peninsula.

During this period, my job has been to collect specimens and key them out in the WWU herbarium laboratory. I have learned how to key out species of mosses and liverworts using various taxonomic keys. These are the online data base, Flora of North America (FNA, 1993), the Guide to Oregon Liverworts (Wagner, 2006), and the physical key book, Moss Flora of the Pacific Northwest by Elva Lawton (Lawton, 1999). In the field, I gather specimens and place them in a packet where we fill out information about the ecology of where the collection was found. This includes the elevation, aspect, sunlight levels, substrate type, rock type, and degree of rotting wood if found on a tree. This allows us to compare the microhabitats between the specimens in Barlow Pass and the specimens in a known ice age refugium. We also label each collection based on the coordinate and habitat where the specimen is found, which allows us to convert them into data points (see methods for detailed procedure).

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Much of my time spent in lab is learning the terms that describe the anatomy of bryophytes. Bryophytes differ greatly from vascular plants, so understanding the different terms is important when keying out specimens. This includes terms, such as the “costa”, which is analogous to the “mid-rib” of a vascular plant. It’s also important to know the terms for shapes and textures of the cells, such as “sinuous” or “papillose”, which describes the outer shape of the cell wall and the texture of the cell itself. Liverworts and mosses are distinguished by the shape of their leaves and

their intercellular features, which I have had to familiarize myself with. The main differing features are that mosses do not have leaf lobes, while liverworts do. Liverworts also uniquely have oil bodies, which function is still poorly understood, however it is likely that it prevents desiccation and aids in cellular metabolism.

After I key out specimens, I set them aside in a compartment where they will be confirmed by my supervisor. If they are correct, they are placed in a tray where we will store them and convert their information into data points in excel. Once our collections come to an end, we will finish keying them out and run tests in R-studio to determine whether there is a significance between our control and experimental sites.

This work has allowed me to understand the relationship between ecology and the anatomy of plants, as well as their level of persistence during changing weather patterns. My future goals consist of working in conservation and research regarding climate change, so understanding how these are intertwined gives me insight on how a habitat should be restored and what the future of geographical flora will look like within changing temperatures. Analyzing the microclimates in which bryophytes flourish will help me get a better understanding of larger scale climate conditions. I am also very interested in plant research in the future, so learning these terms and understanding how to identify specimens will help me greatly.

My coursework in biology, ecology, and biostatistics at Western has given me the necessary background knowledge for this project. The units on bryology and vascular plant anatomy in Biology 204 and 206 have helped me relate the anatomical terms I learned about vascular plants to the analogous structures of non-vascular plants. Learning about the history of bryophytes in these classes gave me an understanding of how we can map and analyze the ecology of an area based on the type of bryophyte flourishing there. Taking ecology at Western also helped me understand how species disperse and how they behave under various conditions and

microhabitats. This has helped me see how disjunct species of bryophytes occur and how it explains the possibility of refugia during the Pleistocene glacier. Finally, taking biostatistics and learning how to run statistical tests through R-studio has helped me understand what makes data significant and what type of test to use. As stated previously, we will be using a chi-squared goodness of fitness test to determine the degree of similarity between our testing groups. We will also run regression and correlation analyses to find a correlation coefficient.

This experience has been difficult and frustrating, but extremely rewarding at the same time. Learning the terms that taxonomic keys ask for has taken months, and many failed identifications, but I now feel I have developed strong skills in microscopy and in my ability to key out specimens. Being a part of this research has shown me how fascinating plants and the information they can provide are and I plan to take more courses on them, such as botany and more ecology courses. Doing this work has gotten me closer to my professional goals by giving me experience with field work and data analysis relating to ecology and climate. I want to participate in more research such as this in the future and I feel confident now to do so. It has also helped me to use statistical analysis in a place other than the classroom and has strengthened my understanding of the programs used to do so. This has also satisfied personal goals of mine, which is being able to spend time outside and to take the information I have learned and see it in real time. The field work has been exhausting, but being able to learn beneficial and valuable information and doing so in a beautiful place truly pays off. I have learned the importance of taking notes on everything you see and find in the field, because every piece of information regarding the ecology of where we collect provides us with essential knowledge for our studies. Due to this, I have become more intuitive and have been able to spot relationships between species type and behavior to its surrounding environment. Overall, I feel confident in my ability to one day set up my own project or be a part of something similar to this that I am passionate about. I am looking

forward to finishing our collections and making conclusions about our findings, and am grateful that I am able to be a part of this experience.

Methods

Our methods for collecting data were to gather specimens along various microhabitats, such as cliff bases, ridges, and talus fields in Barlow and Cascade Pass. We did this by collecting specimens into packets where we included information regarding UTM's, topography, habitat, rock type, levels of sun exposure, elevation, aspect, substrate, and details about surrounding flora and fauna. The specimens would then be taken to the lab to be identified with the taxonomic keys Flora of North America, Guide to the Liverworts of Oregon, and Moss Flora of the Pacific Northwest (see references below). After identification, specimens were assigned ID numbers and inputted into excel under a category relating to where they were collected (ex: Barlow Pass Ice Caves). However, we are still finishing up our species identifications and will not be able to analyze the data until they are complete. Once every species is keyed out, we will input the data into R-studio to determine a correlation coefficient and whether or not the data is significant.

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Time sheet

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