THOMPSON RIVERS UNIVERSITY

UREAP REPORT
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Assessing the Interior British Columbia Grasslands using the BIODESERT Survey

Report by

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CONTENTS

1. Summary

The BIODESERT survey is a global cooperative study coordinated by Dr. Fernando Maestre, and assigned to me by Dr. Lauchlan Fraser. It was developed in order to study drylands worldwide to assess their proper functioning under the dry conditions caused by climate change, and damage caused by grazing. Many challenges arose leading to modification of the original methods, and the extension of my project to complete analysis and shipping of samples. In the Lac du Bois grasslands of Kamloops, I completed vegetation, grazing, and soil/IEM surveys to gather data and characteristics of plants species, grazers, and soil present. Furthermore, the tea-bag index was completed to assess general ecosystem activity. This work experience revealed much to me about this career path, and I highly recommend students try research through the UREAP or equivalent award. This project required much time and work to complete, but was very fulfilling and taught me many lessons that I will use moving forward.

2. Introduction

The BIODESERT survey was developed by Dr. Fernando Maestre, at Rey Juan Carlos University in Spain, to gather information from drylands worldwide. Dr. Lauchlan Fraser assigned me to complete this study for the Kamloops area grasslands, thus representing the drylands of the BC Interior. Drylands are areas dominated by grasses and/or shrubs that have a low amount of yearly precipitation, making these areas quite arid (lacking moisture). Climate change has been steadily increasing the aridity of these areas worldwide (Feng & Fu 2013, Delgado-Baquerizo et al. 2013, Huang et al. 2015, IPCC 2016). The drier these areas are, the more prone they are to becoming deserts(Feng & Fu 2013, Huang et al. 2015). Desertification of drylands results in the loss of valuable species and ecosystem processes. Another factor contributing to desertification is grazing, which can increase the likelihood of desertification if areas are overgrazed beyond the normal amount (Asner et al. 2004, Xu et al. 2011). The BIODESERT project aims to determine how the pressures from increased aridity caused by climate change, and those caused by grazing, alters dryland ecosystem structure, functionality and processes. This information will be used to answer previously unanswered questions about drylands at both local and global scales. Thus, the BIODESERT survey is filling a void in the knowledge of dryland ecology, which has limited our ability to manage and care for these valuable areas in the past. This report details my experiences with each section of the BIODESERT survey: a description of what was done and why, any issues present when sampling and/or what was learned. A list of changes to my project is also covered. For reasons detailed below, analysis of data is yet to be completed, and as a result it will not be discussed.

3. The BIODESERT survey

3.0 Changes and adjustments

Problems arise in all research projects as they are carried out. My project was no different. Initially, I had established two study sites: one in Merritt, and the other at the Lac du Bois grasslands in Kamloops. Both of which had 4 plots (described later). Additionally, I had planned to complete every part of the BIODESERT survey in full.

As the summer progressed, I begun working more than Lauchlan or I had expected, committing long hours every day for a couple weeks. I was exhausted. Lauchlan and I met to discuss modifying my project to make it fairer on myself. To do so, I contacted the coordinators in Spain to discuss alterations to my project. We had agreed on the following changes to my sampling protocol:

1. Remove the facilitation survey from my project (an optional section).
2. Remove one plot from each site, for a total of three plots each.
3. Decrease the number of quadrats and plants sampled for section 3.2.2.
4. If necessary, remove the Merritt site entirely from the study.

With these adjustments, I was working regular hours and was taking weekends off again. I had recovered from the strenuous weeks, and my project was back on schedule.

Another issue arose later in July: the numerous wildfires across BC produced immense amounts of smoke that covered the Kamloops area. Being field researchers working outside, it was unavoidable that we would be working in the smoke. However, it was important to me that we did so whilst minimizing possible health risks. I made two important decisions to keep my team and I safe: first, I had purchased n95 masks, those recommended by the BC Center for Disease Control, to limit the inhalation of smoke particulates. The second decision was to start spending half days in the field, which decreased our daily smoke exposure further. The unfortunate result was that my project schedule was pushed back. Because of this, I have not yet completed the analysis of my data and the Merritt site had to be removed due to time constraints. As a result, I cannot discuss any findings associated with my project as of now.

3.1 Establishing the study site

The Lac du Bois grassland of Kamloops is an ideal area to study due to its protected status, which helps it stay relatively pristine. In order to study various levels of grazing intensity, we set up three 45x45-meter-squared plot areas spaced in a gradient away from a large pond (=watering point). Past research has shown that animals tend to gather around watering points, and will spend relatively less time further from them (Manthey and Peper 2010, and reviewed by D´Odorico et al. 2013). The more time these animals spend in an area increases the amounts of grazing that occurs. Thus more grazing occurs close to the watering points, and less grazing occurs farther from them. As a result, our four plots spaced close to far from the watering point represent various levels of grazing intensity. By carrying out the survey at each plot, we will understand how ecosystem processes and functionality are different across grazing levels.

Plots were marked out with a GPS way point and flags. In each plot, four evenly spaced 45m “transect” lines were set up. These ran downslope, and were used as a physical guideline for where sampling should occur. Plot establishment was very straightforward, and no issues occurred with this. I learned the importance establishing accurate plot areas regarding scientific accuracy. The precision of where our transects are located dictate where we are sampling, and which samples are collected as a result. If we did not establish transects at the exact locations determined by the project coordinators, our collected data would not have represented the dryland accurately.

3.2 Vegetation survey

3.2.1 Patch-interpatch survey

Patches are defined as any obstacle able to prevent the flow of water, soil, and their nutrients across the soil surface. At our study site, patches were typically dense grasses, dead plant material, and wood stems of sagebrush. Working along each transect, we recorded the dimensions of patch and interpatch zones. This survey gives us an idea of how dense some of the species are; that is, how much physical area each species is taking up. Species density is an important measurement to collect as it gives an idea on which plants are dominant/abundant and which are less so.

Sometimes the patches seemed to be infinitely large, so I had contacted the coordinators to modify the protocol. We decided to identify a patch as “continuous” when it was over 6 meters wide. As the grassland is densely packed with grasses, it was challenging to decide when species were bundled in a patch or separated. The data entry for this section involved some rather complicated Excel equations, so I learned more about the statistics and formulas used to calculate species density. I was unaware of this sampling method previously, and although it is not widely used, I am happy to have learned it.

3.2.2 Vegetation cover with quadrats / Plant traits

Quadrats are small sampling squares that are placed to study the density of species within them. For each species, we estimated approximately how much area they covered in the sampling square. Thus, this was also used to measure species density. In total, 180 1.5x1.5-meter quadrats were sampled, giving information on more than 50 grassland species. Additionally, leaf samples were taken from the most prevalent species. The size and weights of the leaves were determined, and the samples will be sent to Spain to analyze their chemical composition. This information will be used to construct a data library of measurements for the species present in grasslands.

This section of the BIODESERT protocol was the most time consuming, and was the initiator of my substantial workweeks. Originally, the plan was to sample 1,200 quadrats at two sites. Thankfully, we reduced the number of quadrats needed to 180. This issue would have been problematic if it were not resolved; if I had continued attempting to survey all 1,200 quadrats, the project would not have been finished. I learned techniques to identify plants, plant anatomy, and can now identify many grassland plants species. Furthermore, I developed my professional communication by emailing and discussing sampling adjustments with the coordinators in Spain.

3.2.3 Vegetation cover with the line intercept method

This section required us to drop a long metal pin every 20cm down a transect line, and identify what it touched: bare soil, rocks, soil crusts (mosses, lichen, or bacteria on the soil surface), dead plant matter, or a plant species in which case it would be identified. This survey complemented the two previous sections by also measuring species density, giving us replication of our data (necessary for statistical significance) as well as allowing us to critically compare the three sampling methods used.

The problem with this survey was also one of time management. Having to drop a needle 3000 times and record data is not easy. This problem was solved by managing my volunteers and assistants by splitting them into teams. This increased the amount of transects we could survey in a week, and established the teams we would use for the patch-interpatch survey (3.2.1) started the week after. I learned how to manage people effectively, and yet another sampling technique previously unknown to me.

3.2.4 Grazing exclusion survey

For this survey, I had to design and construct cages that would enclose a square meter. Five of these were required in each plot. This was done at the beginning of the season before any sites were removed, so I had to purchase enough material for 40 cages (initially two sites, each with four plots). By enclosing a square meter, grazers are unable to eat the area inside of the cage. Thus, we have 5 square meters of ungrazed area for each plot, that we can compare to sections that have been grazed. After a year, the plants inside the cage will be harvested and weighed, as well as plants outside of the cage. This will show the level of grazing intensity occurring at each plot, as well as the ecosystem productivity experienced under various levels of grazing intensity.

The biggest problem faced here was finding how to build 40 inexpensive cages able to withstand cattle from breaking them. After weeks spent researching ideas and price checking at stores, the best design I had would cost over $2000 for all the cages. Working under stress and necessity I decided to contact a supplier of material instead of the dealership/hardware stores. The result was a design involving pre-bent u-shaped rebar that would be hammered into the ground and wrapped in chicken wire. This design cost $550 for all 40 cages. With this section of the project, I learned many skills needed for project management, the importance of having a well-functioning and organized team in the field, and that I am capable of very strenuous physical work. It was certainly a challenge, and it required all the skills valued in a great field researcher.

3.3 Grazing intensity and characteristics

With this survey, animal tracks were measured and identified down each transect, and 5x5 meter sampling quadrats were used to collect animal dropping to be weighed. Both of which gave information on the amount of grazing occurring in each plot, and what species of animal was the primary grazer. This survey was used to provide evidence for our claim that higher grazing levels occurred closer to the watering point, and less were present at plots further from the watering point.

As the soil at the Lac du Bois grasslands is highly compacted it was very challenging to find complete animal tracks. This part of the survey was noted to be not suitable for our grasslands, but we identified and collected as much data as possible. The collection of animal droppings went well, and as expected, the primary grazers are cows. I learned that identifying animal tracks and dung was surprisingly much easier than identifying grass species. I am now able to identify some different grazers based off their droppings and tracks, which may be useful in future ecological studies I participate in.

3.4 Soil survey

15 sampling points were established in each plot. Five points in open areas, five underneath the dominant plant species (sagebrush), and five in areas where soils crusts (see 3.2.3 above) were present. At each sampling point, various soil samples were collected which will be used to analyze microbial organism communities, soil nutrients and chemicals present, and soil compaction. The microbial soil samples are being sent to Spain for analysis, while the other measurements will be determined here in October.

Because our grassland soils are highly compacted, hammering and drilling hollow “soil corers” into the ground was not easy. It resulted in blistered hands and many tired researchers. Frequent breaks were taken by implementing team rotation. This survey taught me how to perform the “bulk density” measurement; a widely used and useful technique in ecology studies. I also learned basic soil classification involved with the different soil samples being taken, and some theory on how they would be analyzed.

3.5 Ion exchange survey

Ion exchange membranes (IEMs) are small pieces of parchment that mimic the uptake of soil nutrients by roots. Two IEMs were placed at the same sampling points as section 3.4, and were left in the field for 4 weeks. These were collected, and will be sent to Spain for analysis. This survey provides us with the availability of important soil nutrients used by plants, such as nitrogen and phosphorus.

This section was intended to be completed in March, because rain is needed for the nutrient uptake process. Having a summer start to my UREAP, this could not be done. June was the next best month to place the IEMs based on precipitation patterns of previous years. This section was straightforward, and the likely problem to occur was losing the IEMs after their placement. We avoided this by mapping out the locations of the IEMs using compass directions and footsteps to each. Essentially, we made treasure maps for each plot indicating where our IEMs were located. This survey introduced IEMs to me, which are simple and can provide similar measurements of soil nutrient availability like that of a soil survey. This is a sampling method I will consider in future research if I pursue this field of study.

3.6 The Tea-bag index

Sounding very simple, but far from it, was the “tea-bag index” survey. Using two types of scientifically standardized and agreed upon tea bags, Lipton Green and Rooibos tea, we can quantify overall biological activity in an ecosystem. At the same sampling points used in 3.4 and 3.5, one pre-weighed tea bag of each kind/flavour was placed 8cm below the ground. These are left for 3 months underground, and are re-weighed afterwards. Because tea leaves are simply dead plant matter, we can measure how fast these leaves are being decomposed by the environment over time to give a general idea of ecosystem activity. Those ecosystems being able to recycle dead plant matter (tea leaves) faster have a higher biological activity. If the tea bag has lost substantial weight, the biological activity is higher than if the tea bag weight was unchanged. These will be collected in October and reweighed.

The placement of the tea-bags was not challenging, but obtaining them was unexpectedly difficult. We were told the tea was available at most grocery stores. After days spent searching in town, we started calling various locations outside of Kamloops. Nowhere in BC seemed to have the tea bags. We discovered that a company supplying scientific materials had purchased the entire stock of every store, to be the only source of them. They then increased the price to $20 a box. We needed to have the tea shipped from the team in Spain to save money. Something as simple as tea, needed to be imported for our study. It was an odd situation, and it reinforced my thoughts that anything in science costs more than normal goods. Placing teabags in the ground was the simplest part of the survey, and the most appreciated, as it was a break from the rest of the fieldwork. Here I learned that even if the materials and equipment used are relatively simple, sound science can be achieved if you are clever enough. In this case, assessing the health of an entire ecosystem with something as simple as a bag of leaves.

4. Recommendations

With this project, I understand the value of completing research before graduating. It increases employability, decreases stress with future projects, and gives students exposure to this path before committing to it. Research is time consuming, full of complications, and quite demanding of the mind; however, it is valuable, necessary, and fulfilling. Whether these benefits outweigh the negatives is up to the student. What is certain to me, is that the undergraduate research award is a useful tool to help students decide if they want to become a researcher, and if they do, it gives them relevant experience to use later. I would highly recommend the UREAP program, and undergraduate research, to be carried out by every student during their studies.

Dr. Lauchlan Fraser and the Fraser Lab team were an absolute pleasure to work with. They are outstanding researchers, supervisors and mentors, and truly respectable people. Being that Lauchlan is busy, I sometimes felt I was not receiving the supervision that was needed. I am understanding of that fact however, as he had faith that his researchers could complete any task given. In this case, a global comparative and cooperative study of the Lac du Bois, and worldwide, drylands.

5. Conclusions

The BIODESERT survey was an opportunity given to me that I am incredibly proud to have completed. Few students have the option to take part in a globally reaching scientific study before graduation. I am one of the few, and that is something I cannot express enough gratitude for. This summer was spent organizing, managing and completing the various sections of the survey. Each week was different, and most weeks were a lot of work. In any case, it was all incredibly valuable as I learned a great deal of information about dryland ecology theory, techniques, and about myself. Furthermore, the data collected here will complement that of over 50 labs studying drylands from around the world. The analysis will not be started until October and will be completed the following year. After which, many papers will be produced in the field of dryland ecology. Having contributed to this fact, I am very happy.

The most valuable aspect of this Summer were the important lessons I have learned. First, I learned that not every problem can be solved by rushing into it with a “chin kept up” attitude and the hope that working hard will get it done. By not initially taking the time to seriously analyze this project, and not doubting certain elements, I would find myself working an overwhelming amount. Working hard is important, but everyone has their limits. It is important to evaluate a project or problem and its components, in many regards, before working on it. It is important to understand the workload I am capable of, and that saying "yes" to everything results in less being completed if there is too much to do. Secondly, I learned a substantial amount of techniques, theory, and equipment used in the fields of Natural Resources and Ecology. I also learned more about who I am; an example being that I can work ludicrously long days and still wake up the next day to do it again. Finally, I learned how to manage people, projects, research, and problems more than I had expected. It was a tough project and work term, but it was one of the most valuable and unique experiences of my life.

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