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A comparison of soil quality between UBC Farm and UBC Botanical Gardens using invertebrates as bioindicators

Abstract

This experiment was conducted with the aim of answering the question: Does the UBC Farm or UBC Botanical Gardens have a higher soil quality using invertebrates as bioindicators? Data was collected from the UBC Farm in late November, 2020 at 3 different time points on the first day. The following day data was collected from the UBC Botanical Gardens at 3 identical times as the previous day. The hypothesis of this experiment is that the UBC Farm will have a higher number of invertebrates and a higher soil quality. The data collected in this experiment found a mean number of 9.44 invertebrates found at the UBC Farm and a mean number of 7.11 at the UBC Botanical Gardens.The data was analyzed through a one-way ANOVA test, which indicated that there was no statistically significant difference between the two locations. Therefore, the null hypothesis failed to be rejected.

Introduction

soil is one of the most complicated and profound habitat systems in the world, however it is still poorly understood. soil plays an integral role in the life cycle of many living animals, fungi, bacteria, and plants, residing in different habitats and inhabiting different niches. Conversely many organisms such as invertebrates can also play an important role in maintaining healthy soil, which indirectly have an impact on the development of major industries such as agriculture and forestry (Stork & Eggleton, 1992). Good

Along with a wide range of various organisms, soil quality plays a particular importance in human health. Soil is an important source of nutrients in our food supply as it plays an integral role in crop production and feeding nearly 8 billion mouths across our planet. Additionally, soil is an absolutely necessary part of growing trees which through the process of photosynthesis, helps to convert carbon dioxide into oxygen (Steffan et al., 2018).

The goal of this paper is to determine which location (UBC Farm or UBC Botanical Gardens) has superior soil quality using the presence of invertebrates as a bioindicator. In this paper, there is an assumption that the presence of invertebrates is a direct indicator of soil quality. This assumption is based on several different reasons. For one, the presence of earthworms

(*Lumbricus terrestris)* indicate moist, well hydrated soil that contains sufficient organic matter, since these are essential living conditions for earthworms. Earthworms have several important functions that play a role in soil health. Earthworms increase soil aeration, infiltration, nutrient cycling, and water movement, which all have a positive impact on the soil health (Pankhurst et al., 1995).

This study aimed to determine whether the UBC Farm or UBC Botanical Gardens had superior soil quality. It is hypothesized that the UBC Farm will have superior soil quality based on the number of invertebrates. This is based on the fact that in order for crops and plants to grow, there will have to be sufficient nutrients and water present in the soil.

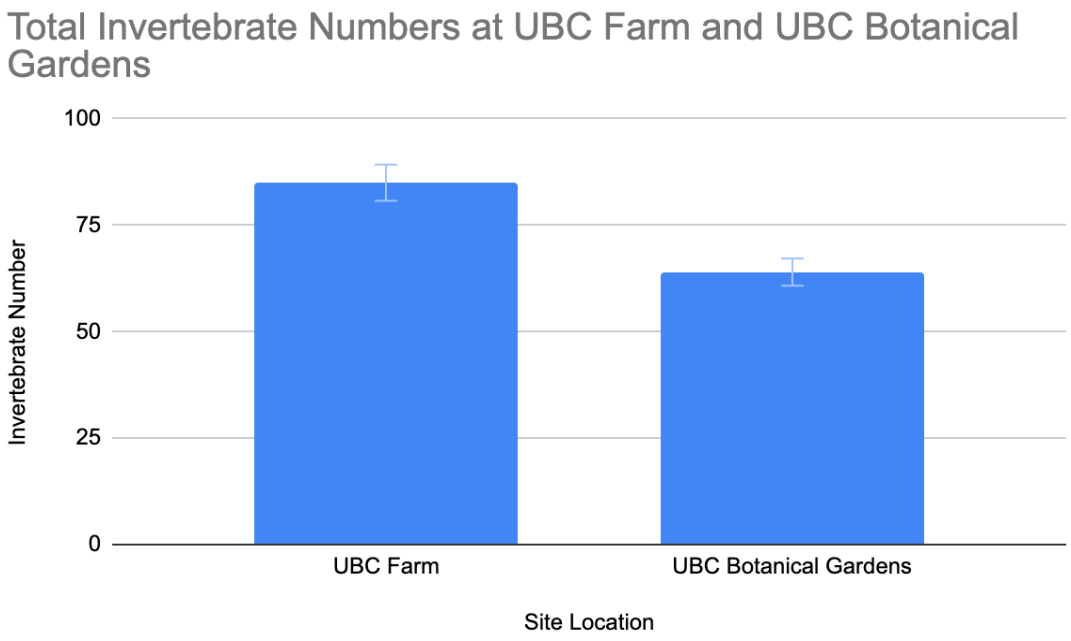
Methods

Identify 2 suitable locations to be dug up over 2 consecutive days. On both days, 3 trials were collected at 3 different times during the day (morning, noon and afternoon). Suitable plots of land were identified to be dug up with string used to outline the parameters of the plot. A hole was dug to a depth of 0.2 meters and the soil was dumped into a bucket. A strainer was used to sift through the dirt and identify all invertebrates found in the soil. Pictures and the Streamkeepers handbook were used in order to properly identify the correct species of invertebrates. A total of 18 trials were collected over the span of 2 days. Data was transferred to a computer and an ANOVA test was run on the data to determine whether or not there is a statistical difference between the locations.

Results

The mean number of invertebrates found at UBC farm was 9.44 and the mean number of invertebrates found at the UBC botanical gardens was 7.11. There were a total of 18 trials conducted. A one-way ANOVA test was conducted to determine whether the variation within and between groups was statistically significant. The test resulted in a p-value greater than 0.05 ($p = 0.1579$). Therefore, the invertebrate numbers between the two locations are not statistically significant.

Graph 1: Bar Graph of Total Invertebrate Numbers at UBC Farm and UBC Botanical Gardens. Vertical bars represent a 5% error. The one-way ANOVA test determined that the invertebrate numbers were not statistically significantly different between the two locations (F=24.39, p = 0.1579).



Discussion

The statistical analysis performed returned a p-value of 0.1579 which is greater than 0.05, therefore we fail to reject the null hypothesis, and conclude that there is no significant difference between the number of invertebrates found at the UBC Farm and UBC Botanical Gardens.

Although the raw data showed that the UBC Farm had more invertebrates, the ANOVA test showed that the data was statistically insignificant and could not support the original hypothesis of this paper which was that the UBC Farm would have a higher number of invertebrates found in the soil and thus, based on the assumptions made in this paper, a higher soil quality.

There are several potential reasons that there is no statistically significant difference. For one, the two site locations are within 2 kilometers radius of each other. Therefore, many characteristics such as rainfall levels and temperature which can impact soil quality would be the same.

Sources of Error

There are numerous sources of error that can occur while collected data from the soil. For one, there is a certain level of uncertainty with how accurately the 3 trials of digging up a 30cm x 30cm plot of soil can be representative of the entire area as a whole. There is a chance that the data collected could be over or under representative of the number of invertebrates in the soil overall. Since this experiment is working with biological creatures that are constantly moving in unpredictable manners, there will always be a level of uncertainty.

Another potential source of error is that the individual collecting the data may have dug up the soil but inaccurately recorded/identified the number of invertebrates in the soil. There is a chance that the data collector may have simply missed or not seen an invertebrate, which would lead to the data being under representative of the actual area.

Future Experiments

To reduce the number of errors in future experiments, there should be multiple researchers that go to collect the data instead of one individual. This would hopefully reduce the number of invertebrates missed/unidentified in the soil. Additionally, in a future experiment, more trials could be conducted instead of only 3. Having 5 or even 10 trials at each time and each location would give a more accurate representation of the area as a whole and would reduce the impact of anomalies.

Conclusion

After running a one-way ANOVA test on the data collected during this experiment, it was concluded that the difference in invertebrate numbers between the UBC Farm and UBC Botanical Gardens was not statistically significant. The one-way ANOVA test returned a p-value of 0.1579. Since this value is greater than 0.05, it can be concluded that the results are not statistically significant. Because the results of the ANOVA were not statistically significant, no further statistical analysis is needed. In conclusion, we failed to reject the null hypothesis and found that there was no statistically significant difference in the number of invertebrates found in the soil at the UBC Farm and the UBC Botanical Gardens.

References

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Appendix

Table 1: Raw data collected from UBC Farm.

UBC Farm	Species					
	Earthworms	Pill Bugs	Beetles	Spider	Total Number of Invertebrates:	Sum of Trials
Morning Trial 1	6	11	0	0	17	
Morning Trial 2	3	4	0	1	8	
Morning Trial 3	5	8	0	0	13	38
Noon Trial 1	5	1	0	0	6	
Noon Trial 2	1	3	0	0	4	
Noon Trial 3	2	6	0	0	8	18
Evening Trial 1	6	7	0	0	13	
Evening Trial 2	4	4	0	0	8	
Evening Trial 3	7	0	1	0	8	29
						Overall Total = 85

Table 2: Raw data collected from UBC Botanical Gardens.

UBC Botanical Gardens	Species					
	Earth worms	Pill Bugs	Beetles	Spider	Total Number of Invertebrates:	Sum of Trials
Morning Trial 1	5	2	0	0	7	
Morning Trial 2	4	0	0	0	4	

Morning Trial 3	4	1	0	1	6	17
Noon Trial 1	3	5	0	0	8	
Noon Trial 2	0	2	1	0	3	
Noon Trial 3	4	6	0	0	10	21
Evening Trial 1	6	3	0	0	9	
Evening Trial 2	3	2	0	0	5	
Evening Trial 3	6	6	0	0	12	26
						Overall Total = 64

Figure 1: ANOVA Test Results.

ANOVA Test Results	
F	1.94
P-value	0.1579
P-value summary	Not significant
Significant diff. among means ($P < 0.05$)?	No