A Study on Altitude's Effects on Tree Diversity and Height

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ESP 126, Sarah Darhower

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Abstract

This study evaluated tree diversity and tree height at different altitudes. In this study, four different altitudes, 500 feet, 1000 feet, 1500 feet and 2000 feet were examined to determine if the difference in tree diversity and tree height at each altitude was statistically significant. Based on the data gathered, it was determined that there is a statistical difference between tree diversity and height and increasing altitude.

Key words: extremophiles, extremotolerant, altitude, conifers, deciduous, alpine timberline

Introduction

There are many species, known as extremophiles, that can survive in extreme environments that are intolerable for other species. These environments can be characterized by extreme temperatures, salinity, pressures or acidity. There are many species that grow only in extreme environments but there are others, known as extremotolerant, that can tolerate extreme environments, such as those at high altitudes, but grow optimally at normal environmental conditions (Rampelotto, 2013).

As altitude increases, temperature, and atmospheric pressure decrease while solar radiation and water loss increase. Certain species of trees are able to survive in these conditions while others are not able to survive. Conifers are better suited to survive in limiting environments, such as those at high altitudes, while deciduous trees are less suited to these environmental conditions. Conifers have adaptations that allow them to survive in areas with low precipitation and low temperatures (Canas & Canovas, 2016) while deciduous trees require higher temperatures and more precipitation to survive (Randin et al., 2013).

As altitude increases, tree size tends to decrease. There is a zone at a certain altitude, known as the alpine timberline where tree species can no longer grow and reproduce (Wardle, 1971). Up to this line, tree size decreases until the trees become stunted with more open canopies at high altitudes. On average, trees growing at higher altitudes are shorter than trees growing at lower altitudes (Coomes & Allen, 2007).

The null hypothesis is that there will be no difference in diversity or height of tree species as altitude increases. The alternative hypothesis is that as altitude increases, the diversity and height of tree species will decrease.

Materials

- 30-meter tape measure
- Garmin handheld GPS with altitude measurements
- Clinometer
- Forest Trees of Maine hand guide
- Data sheets
- Computer with Excel for spreadsheets and calculations

Methods

The research site was Pleasant Mountain in Bridgton, Maine (44.0270° N, 70.8220° W). The specific research area was the Firewarden's Trail. The total altitude of Pleasant Mountain is 2,006 feet, with an elevation gain of 1,500 feet on the Firewarden's Trail.

1. At altitude of 500 feet, mark out a 10 meter by 10-meter plot
2. Determine species and number of each species inside plot
3. Determine height of each tree inside plot
4. Repeat steps 1-4 at altitude of 1000 feet
5. Repeat steps 1-4 at altitude of 1500 feet
6. Repeat steps 1-4 at altitude of 2000 feet
7. Record in data table
8. Graph data in Excel
9. Analyze results for species diversity at each altitude by conducting a Shannon Diversity Index
10. Analyze results for height by calculating mean, and standard deviation at each altitude
11. Conduct a two-factor ANOVA test without replication to compare results

Results

As shown in Table 1 and Figure 1, the average tree height at the lowest altitude, 500 feet is 36.9 feet. At 1000 feet, the average tree height is 49.5 feet. At 1500 feet, the average tree height is 24.4 feet. The average tree height of the highest altitude, 2000 feet is 13.6 feet. As shown in Table 2 and Figure 2, the diversity of the lowest altitude is 1.655, the diversity at 1000 feet is 0.612, the diversity at 1500 feet is 0.90125 and the diversity at 2000 feet is 0.68, as determined by the Shannon Diversity Index. A two factor ANOVA without replication test was conducted to compare these results, giving a p-value of 0.0052.

Table 1: Tree Height by Altitude

Altitude Above Sea Level (ft.)	Average Tree Height (ft.)	Standard Deviation
500	36.9	21.42
1000	49.5	11.72
1500	24.4	7.26
2000	13.6	3.50

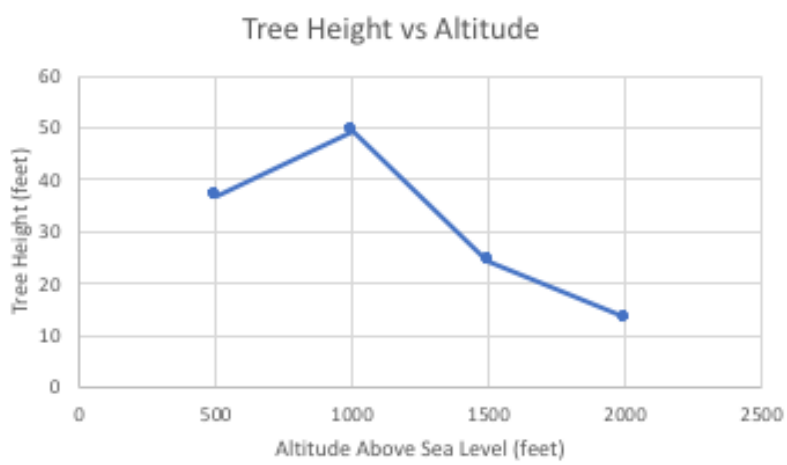

Figure 1: Tree Height by Altitude

Table 2: Tree Diversity by Altitude

Altitude Above Sea Level (ft.)	Diversity
500	1.655
1000	0.612
1500	0.90125
2000	0.68

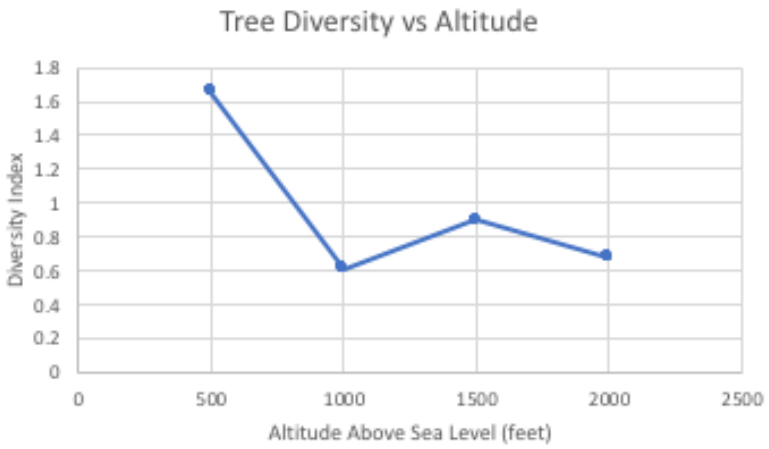

Figure 2: Tree Diversity by Altitude

Discussion

The hypothesis was that tree height and diversity would decrease as altitude increases. The null hypothesis was that there would be no statistical significance between tree height or diversity and altitude. Based on the data gathered, and a two factor ANOVA without replication test, a p-value of 0.0052 was obtained. In statistics, a

t-test of less than 0.05 is determined to be statistically significant. Based on this, it is determined that there is a statistical difference between altitude and tree height and diversity and we accept the alternative hypothesis.

One possible error in this experiment comes from improper tree identification. This experiment was conducted in April, before leaves appear on deciduous trees. Tree identification is mostly based on leaves and identification is made more difficult, although possible, without leaves, creating more room for error in identification. Another possible error in this experiment comes from inaccurate use of the equipment. Inaccurate use of the clinometer and inaccurate use of the altitudinal readings from the GPS could give inaccurate data and skew the results.

If this experiment were to be done again, extra care would be given to ensure accurate readings and use of the equipment. Another way this experiment could be done more accurately is if the data was gathered in summer or early fall months, when leaves are on deciduous trees. This would make tree identification easier and more accurate. The results gathered in this experiment could be expanded by measuring tree height and diversity at other locations, including those at higher altitudes. The highest altitude measured in this experiment was 2000 feet above sea level. Expanding this to include higher altitudes could lead to an expansion of the information gathered in this lab as well as offering insight into what altitude trees are no longer able to survive and if and how this differs among locations.

References

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