
EFFECT OF ELEVATION ON THE ABUNDANCE OF NORTHERN RED OAK TREES

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ABSTRACT

Elevation plays an important role in the distribution of a species as some species can not survive at higher elevations. Some species are capable of living in a variety of environments across a range of elevations. The Northern red oak tree (*Quercus rubra* L.) is a species which is able to grow in a wide range of elevations. This study tested if the abundance of Northern red oak trees changes with elevation in order to determine the effects of elevation on tree abundance. The abundance of Northern red oak trees was measured at three different elevations in the same local area. This was done by counting the number of Northern red oak trees in four different areas at a lowest, middle, and highest elevation ranging in about 600 ft. There was found to be no significant difference in the abundance of these trees across the three elevations. These results indicate that there must be other abiotic factors such as soil composition, sun exposure or moisture which have a more profound affect on the abundance of Northern red oak trees. More research must be done to determine the relationship between elevation and site characteristics to understand which factor is more dominant in affecting various species abundance.

Keywords: Elevation, forest ecology, Northern red oak (Quercus rubra L.), population abundance

INTRODUCTION

Habitat characteristics are important in determining the growth and abundance of many plant species. These characteristics can include both abiotic factors such as soil composition, moisture, light availability, and weather like wind, snow or rain. Elevation can also have an impact on the growth and abundance of species. Some species of trees for example thrive at higher elevations while others will only ever be found at lower elevations. Though an area may seem similar, even a slight elevation gradient can differ in abiotic factors and may affect the local abundances of a tree species along the gradient. The Northern red oak tree (*Quercus rubra* L.) is a common tree found in forests throughout the United States. It has a wide range in which covers a variety of habitats differing in their mean precipitation and temperature. This range also includes a variety of topographic

differences. Northern red oak trees can grow in a range of elevations up to 5,500 ft. (Sander, 1990).

Although the Northern red oak can survive in a range of elevations, it grows better at lower and middle elevations (Sander, 1990). A study found that Northern red oak seedlings when compared to another tree species had increased growth when either light or soil moisture was limited (Kolb et al., 1990). This indicates that Northern red oaks may be capable of living in a variety of habitats which differ in site characteristics. In another study, the abundance of Northern red oak saplings was found to be correlated to site characteristics rather than elevation in West Virginia (Collins and Carson, 2004). This indicates that the abundance of Northern red oak trees should be more dependent on the site characteristics such as soil composition, moisture, and light availability than elevation. These studies show that Northern red oaks

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can grow at various elevations but does not show at which point elevation becomes the dominant factor in determining abundance. To do this the abundances of Northern red oak trees should be studied at sites closer in elevation with little differences in site characteristics. Through this study, I hope to examine the effects of elevation on the local abundance of adult Northern red oak trees. The null hypothesis of this study is that there will be no significant difference between the abundances of Northern red oak trees at each elevation. The results of this study can be used to examine additional relationships between elevation and the abundance of different plant species.

FIELD SITE

Data was collected at various points throughout King’s Gap Environmental Education Center in Cumberland County, Pennsylvania. The state park straddles South mountain and ranges in elevation from 600-1400 ft. The lower elevations of the park are characterized by being wet due to the abundance of streams. Higher elevation in the park are

characterized as dry (Wildlife Watching at Kings Gap Environmental Education Center, n.d.). Data was collected in areas surrounding various hiking trails within the park. The field sites at 1300 ft and 770 ft elevations were dry, forested areas, but the field site at elevation 1050 ft was wet and a small stream running through the area.

METHODS AND MATERIALS

To test this hypothesis, data was collected at three different elevation points: 770 ft., 1050 ft., and 1300 ft. At each elevation four areas were randomly selected to collect data. Each area was the same size of 15 ft. x 15 ft. Since there was no foliage, Northern red oak trees were identified by their bark. The number of Northern red oak trees and total number of trees in each area was recorded. Only adult Northern red oak trees and other adult trees were counted and included in the data.

RESULTS

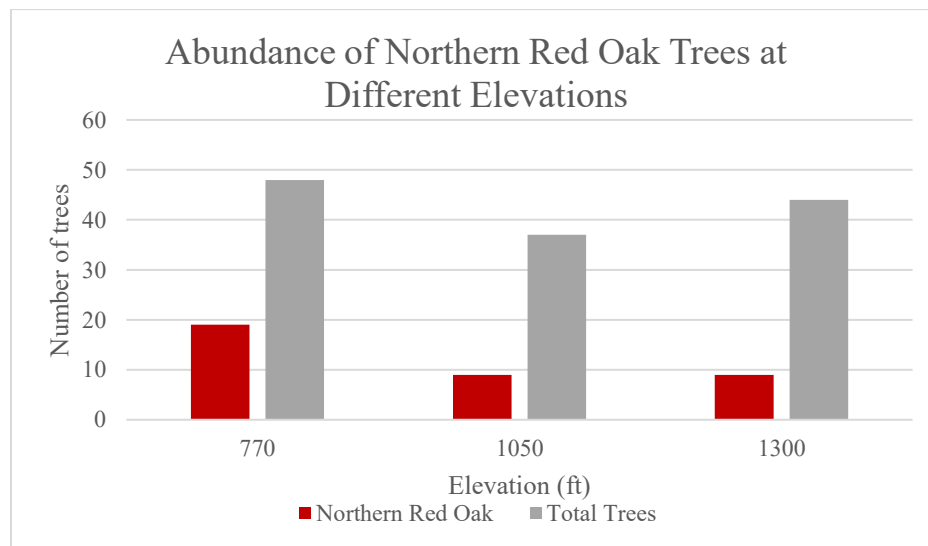


Figure 1. A graphical representation of the data comparing the difference between the total number of trees and the number of Northern red oak trees found at each elevation. ~~Table of the number of Northern red oak trees found at each elevation.~~ four sites at three elevations. This data was used in the ANOVA test.

ELEVATION (ft):	770	1050	1300
AREA 1	3	0	0

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AREA 2	5	2	0
AREA 3	4	3	7
AREA 4	7	4	2

Table 2. A summary of the ANOVA test results testing the significance between the abundance of Northern red oak trees counted in each area at each elevation.

SUMMARY							
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>			
770 ft	4	19	4.75	2.916667			
1050 ft	4	9	2.25	2.916667			
1300 ft	4	9	2.25	10.91667			
ANOVA							
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>	
Between Groups	16.66667	2	8.333333	1.492537	0.275555	4.256495	
Within Groups	50.25	9	5.583333				
Total	66.91667	11					

As seen in figure 1, there were the most Northern red oak trees at the lowest elevation (770 ft) and there was no difference in the number of Northern red oak trees at the two higher elevations (1050 ft and 1300 ft). This data was then tested for statistically significant using an ANOVA test. The data used in the ANOVA test was the number of Northern red oak trees counted in each of the four areas at each elevation (table 1). As seen in table 2, the p-value of this data is 0.275. Since this value is greater than 0.05, this indicates that there is no significant difference between the data collect. The results of this study accept the null hypothesis that there is no significant difference between abundance of Northern red oak trees at different elevations.

DISCUSSION

By studying an elevation gradient with similar abiotic factors across the gradient, the results of this study can determine the effect of elevation on Northern red oak abundance. The results of this study concluded that elevation does not significantly affect the abundance of Northern red oak trees. This is supported by the study mentioned previously in which

Northern red oak sapling abundance was not correlated with elevation but was more correlated to site characteristics (Collins and Carson, 2004). However, previous studies have shown that Northern red oak trees can grow in environments lacking an essential abiotic factor such as light or moisture (Kolb et al., 1990).

The data seen in figure 1 does show that there were nearly twice as many Northern red oak trees at the lowest elevation than at both of the higher elevations. This is interesting because the lowest elevation had similar site characteristics to the highest elevation but had the same amount of Northern red oak trees as the middle elevation which was wet and therefore had different site characteristics. This observation shows that there may be a point at which elevation is more dominant in determining the growth and abundance of a species rather than other site characteristics (light, moisture, etc.). This is because it would be predicted that if there were to be a difference in abundance due to elevation then the 1050 ft and 1300 ft elevations should have had different abundances of Northern red oak trees. Since the area at 1050 ft was a wet environment which is more favorable, it could also be predicted that the abundance would be greater at 1050 ft than 1300 ft as well.

Due to there being no significant difference, this indicates that there are other factors more likely to affect abundance of trees than elevation. A follow up study could be done in which soil samples are taken at each elevation in addition to measurements of the abundance of Northern red oak trees. Soil samples can be used to determine site characteristics such as soil type, moisture, and nutrient availability. This information could allow for a clearer understanding between different abiotic factors that occur at different elevations and how these factors may affect abundance at various elevations. Another follow up study possibility could examine the physical characteristics (height, circumference) of the Northern red oak trees at the two elevations that had the same abundance. Larger trees could be an indication of better soil composition, sunlight availability, etc. which can better explain if a factor other than elevation effects abundance.

LITERATURE CITED

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