Study of the North-facing Slope

of the Grand Valley State University Ravines

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I. INTRODUCTION

The beech-maple climax forest, found in North America, grows only in environments that meet certain basic requirements. Among these requirements are specific tolerance levels of light intensity, precipitation, temperature, and soil texture. In our nine week study of a beech-maple forest we were able to come up with data that paint a good picture of what each of these limits may be. We propose that the tolerance levels for each of the above mentioned factors are as follows: light intensity levels play a very minimal role in the stable climax forest; precipitation levels must be fairly high; temperature must be moderate; and soil texture should be made up of clay, sand, silt, and a high amount of organic matter.

The Study Site

The site studied in this experiment is the north-facing slope of the ravines on the campus of Grand Valley State University. Grand Valley State University is located in Ottawa County, Michigan, in the Township of Allendale. The study site starts approximately 680 feet above sea level at the crest, and ends at approximately 600 feet above sea level at the foot. The ravines are located at 42°58´ North, 85°53´ West (fig.1).

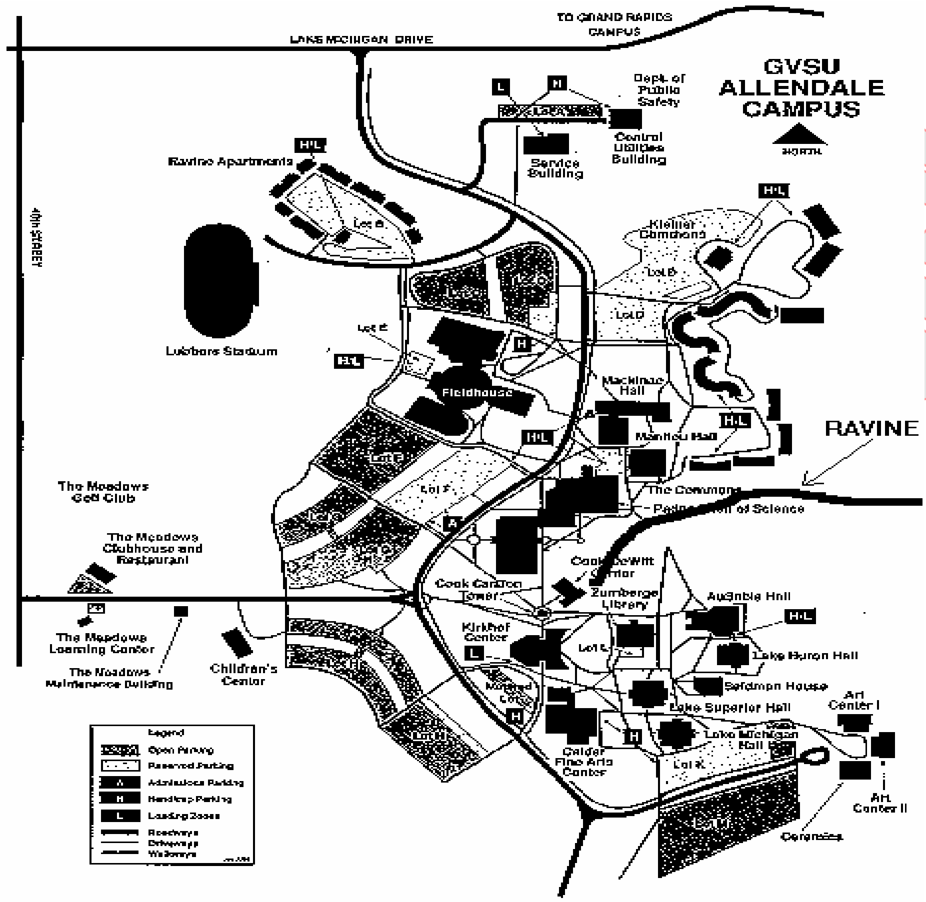

Figure 1. Map of the Grand Valley Campus, with the ravine labeled.

The ravine's slope is home to a beech-maple forest. From the preliminary data collected we found that the dominate tree species are the American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharinum*). The beech and maple trees totaled seventy in number out of a sum of one hundred seventeen, thus proving their dominance.

Objectives of the Study

The objective of our study was to prove our proposal that the beech-maple forest has certain criteria that must be met for it to exist.

II. METHODS AND MATERIALS

Our study of the north facing slope of the ravines was conducted over a nine week period. This nine week period began on August 29 and concluded on November 7. The physical environment readings were taken at regular intervals throughout the duration of the study, starting on September 12. The physical environment readings consisted of the maximum temperature, minimum temperature, temperature at 1.5, 0, -.005, and -.012 meters, light intensity, and the amount of precipitation. The soil samples were taken destructively on September 12. The plant sampling was done on August 29. Each soil sample was approximately one half cubic meter in volume. This sample was then allowed to air dry over the next seven weeks before any analysis took place.

In our study of the soil, five samples were taken mid-way down the slope, approximately twenty meters apart. In the plant sampling study, a total of 19 quadrats were sampled. For the tree data the quadrats were 100 square meters, while for the saplings and seedlings the sizes were twenty-five and one square meters respectively. From the plant sampling we calculated a series of data consisting of the relative density, frequency, relative frequency, percent basal area, importance index, and total number per hectare.

For specific instructions please see “Study of a Terrestrial Ecosystem (1-4)” (Shontz,1996)

III. RESULTS

This forest is a beech-maple forest. The beech-maple forest is commonly found to have beech, maple, red oak, and basswood as the canopy species (Brewer 1994). Our forest has high occurrences of these species in the canopy (table 1,2).

Table 1. Number of each species of tree found in the “ravine forest”. To be classified as a tree the DBH must be >5cm.

Species	Number
Beech	40
Sugar Maple	30
Red Maple	10
Red Oak	10
Basswood	6
Bigtooth Aspen	6
American Elm	6
White Oak	3
White Ash	2
Juneberry	1
Musclewood	1
Black Cherry	1
Thornapple	1

Table 2. Number of each species of saplings found in the “ravine forest”. To be classified as a sapling the DBH must be greater than 1cm. but less than 5cm.

Species	Number
Sugar Maple	8
Quaking Aspen	2
White Ash	2
Red Oak	2
Red Maple	6
Musclewood	6
Black Cherry	1
Beech	14
Hop Hornbean	1
Juneberry	1
Bigtooth Aspen	2
Basswood	2
Which Hazel	3
Mapleleaf Vibernum	1

The light intensity readings were varied. They ranged from 32.5 to 300 foot-candles. These data show a fluctuation that tend toward a low intensity. Our data points are graphed below on figure 2. It should be noted that the light intensity reading for Friday, 19 September is thought to be a misreading. All of the data surrounding this point are significantly lower and more consistent.

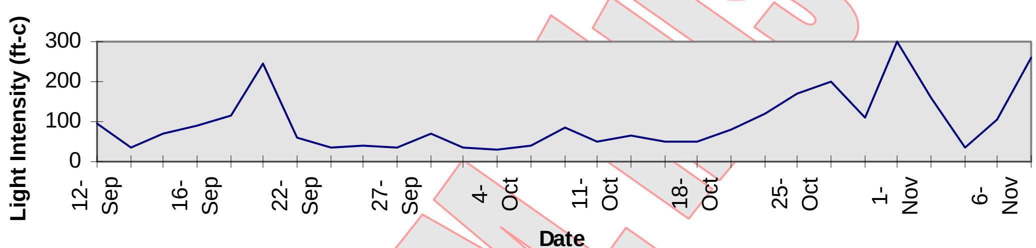

Figure 2. This figure shows the light intensity found in the forest at approximately 1.5 meters above the ground.

The levels of precipitation in our forest were substantial, and also varied. Below, in Table 3, is listed the amount of precipitation received for each day that measurements were taken and the total amount of precipitation received during our eight week study.

Table 3. Amount of precipitation received at ground level on the specified day, and the total amount received during the study.

Date	Ppt. (in.)
12-Sep	
13-Sep	0
15-Sep	0
16-Sep	0
18-Sep	0
20-Sep	0
22-Sep	0.13

23-Sep	0.036
25-Sep	0.04
27-Sep	0.41
29-Sep	0.05
2-Oct	0
4-Oct	0
6-Oct	0
9-Oct	0.38
11-Oct	0.4
14-Oct	0
16-Oct	0.24
18-Oct	0.54
20-Oct	0
21-Oct	0
25-Oct	0.27
28-Oct	0
30-Oct	0.9
1-Nov	0.05
3-Nov	0
4-Nov	0.04
6-Nov	0.02
7-Nov	0.17
Total:	**3.676**

Another one of the abiotic factors we kept record of was the temperature. We have graphed below in figure 3 some of our data. This graph shows the minimum, maximum, and average temperature for each day that data was collected. This graph shows a trend of the temperature to decrease as it gets later in the year, as would be expected.

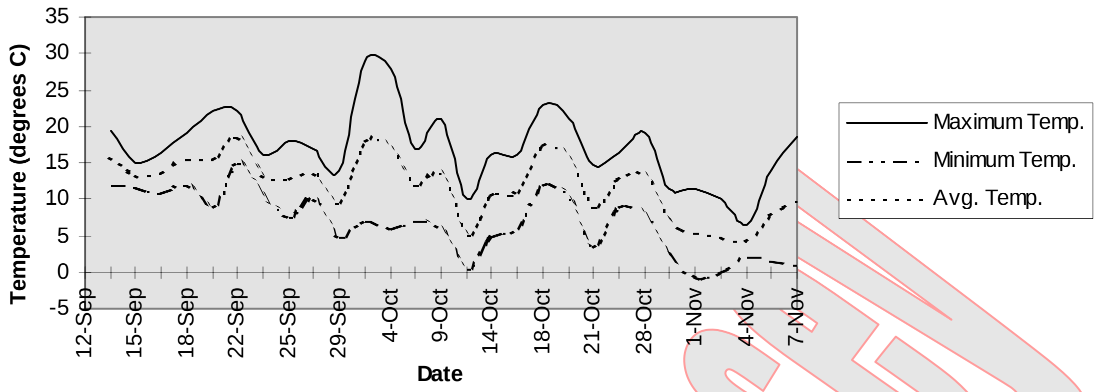

Figure 3. The maximum, minimum, and average temperature over our eight week study. This graph shows a decreasing temperature trend.

The last variable that we studied in this experiment is the soil texture. From the samples taken on August 29 we were able to determine the percent composition of sand, silt, and clay (Figure 4). We were also able to find the amount of organic matter in the soil, which was found to be 65.6% of the total soil.

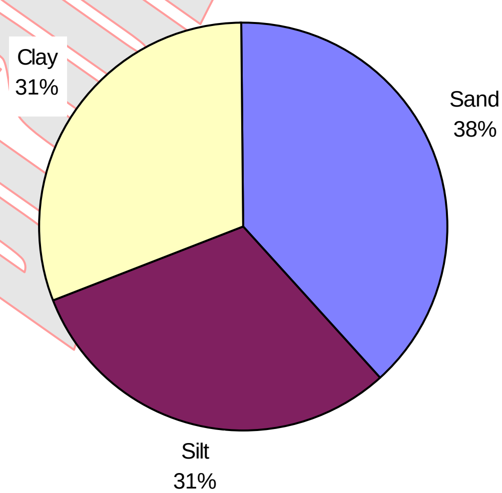

Figure 4. This pie chart shows the approximate percentages of sand, silt, and clay in the soil of our study area.

IV. DISCUSSION

Light intensity does not play all that great of a role in the development of the beech and maple trees. The beech and maple trees are both shade tolerant species (Hunt 1996). This allows them to do well in our low light environment. These species can survive under the canopy in the beech-maple forest, assuring them a greater chance at a spot in the top when they finally grow up. Already existing as a large sapling, they have a greater chance of filling in an opening in the canopy than a seedling of a faster growing, shade intolerant species (Canham 1989). This advantage is doubled in the sugar maple by experiencing it's greatest growth when an opening in the canopy occurs(Poulson & Platt 1996). A gap in the canopy that lets in 1 to 2 percent of the total sunlight is enough to release a big response by the shade-tolerant species' seeds, such as the sugar maple and the beech(Canham 1989). This is one of the reasons there is a greater occurrence of sugar maple and beech tree saplings in our area (table 2). Other species of trees may be present here, but their numbers are impeded because they are not a shade-tolerant species. This retardation in their numbers is the reason they will not become the dominant species. Although beech and maple trees are only minimally affected by light intensity, the trees have a large impact on light intensity. When the canopy is lost going into the fall, the light intensity increases on the forest floor because there is no foliage to obstruct the light's path.

Our area study was progressing from a dry summer into the fall season while our research was being conducted. This is why the precipitation was gradually increasing as time progressed. A study conducted over the course of an entire year would show a substantially higher amount of precipitation for the same area. Beech-maple forests are found in high precipitation areas (Brewer 1994), and as the seasons progress from summer to fall, the precipitation starts to rise as seen in Table 4. The loss of the foliage in the canopy is also a major contributor to the increased amount of rain that reaches the forest floor. Leaves have a tendency to collect water that is then evaporated from their surface before it can reach the forest floor.

The beech-maple forest grows in a climate where the summers are mild, and winters are pretty mild (Brewer 1994). The temperatures measured by our group showed the transition from the summer to the fall. These temperatures were mild (Figure 3), not hot or cold from a relative standpoint.

A beech-maple forest is not unlike any other forest in its need for a specific soil type. A climax community thrives the most with a 30:40:30 ratio of clay, silt, and sand(Brewer 1994). Our data showed clay at 31 percent of the soil, sand at 38 percent, and silt at 31 percent of the total composition. This mixture provides an optimal balance between sand particles (light soil), which allow roots to grow easily and also trap air and other gasses, and the silt and clay particles (heavy soil) which hold water. This provides us with a field capacity of 9.0 percent.

The forest floor provided soil with a very high amount of organic matter. This weighed in at 64 percent of the total amount of the soil sample. This high amount of organic matter means that many successional steps have already occurred, leaving a climax forest.

V. CONCLUSION

The north facing slope of the ravines of Grand Valley State University is a prime example of the tolerable conditions for a climax forest of beech and maple trees. As shown earlier, the data we collected shows a lot about the tolerance levels of many environmental factors. Even though our study was only nine weeks in duration, from this data we can assume that these patterns of change occur every year with roughly the same results. By looking at our sample data it is easily concluded that:

1. Beech and maple trees do not need high levels of sunlight. Throughout the majority of the trees' growing time the light intensity is below 100 foot-candles. Only after the growing season is over and the leaves fall off of all the trees does the light intensity really climb.
2. Precipitation levels must be high. Our data shows that a great deal of precipitation reached the forest floor during the nine week study. There is no reason to believe that this is not the case the whole year round, and thus we conclude that beech and maple trees need a high amount of water in order for them to grow.
3. Temperature levels must be moderate. From the data we have collected, it is easy to see that there were no extreme temperatures reported. The temperatures showed a steady decline as it got later in the fall, however, the temperature never dropped to an "arctic cold" level. Also there are no heat waves where the temperature was above 100 degrees. It is assumed that this is the case for the whole year. We do know from our own experience living in Michigan for the past 20 years that the temperatures here are very moderate the whole year, which correlates with our data.
4. Soil texture should have a ratio of approximately 3:3:4 silt, clay, sand. This is the soil texture of the forest

we sampled. This type of a mixture holds enough water for the beech and maple trees while also allowing for proper aeration.

VI. WORKS CITED

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