Compromise between clear skies and the forested landscape: Assessing the diversity and size of trees in the proposed Astronomy clearing site at the MacLeish Field Station

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Abstract

Smith College gained ownership of 180 acres of forested land in West Whately, Massachusetts in 1962. This land is part of one of the longest tracts of undeveloped land in the entire state. In 1964, an observatory was built for Five College Astronomy research but the inaccessibility of the site resulted in it to remain unused since 1994. Recently, the Astronomy department at Smith has expressed renewed interest in the usefulness of the site and would require the cutting of the regrowth trees to the Eastern Horizon. The aim of this study was to survey the species diversity of the site, their size in diameter-breast-height, and create recommendations on how and where future tree cutting should occur. In our area of study we surveyed a total of 220 trees from 15 different species and only 16 individual trees were found with a diameter-breast-height greater than 40 cm from 5 different species signifying how most trees are young. Additionally, a vernal pool was found with Wood Frog and Spotted salamander eggs. From these results we recommend selective cutting or trimming of trees that obscure the most sky, no cutting within 10 m of the vernal pool and 5 m within the stream, and the stream could be dammed to ensure the survivability of the vernal pool.

Introduction

The forested area in West Whately is part of one of the longest tracts of undeveloped land in Massachusetts. It borders protected land of the Franklin Land Trust and Fish & Wildlife on its Eastern side and protected land of the watershed for the Northampton reservoir on its Western side (Bertone-Johnson 2009). Historically, parts of this land have been used for cattle farming, lead mining, and logging since the 1800’s. In 1962, Smith College purchased 180 acres of this forested area in West Whately (Smith College 1962). This property was intended for the construction of a new Astronomy observatory to replace the old observatory that was torn down to make way for the building of Wright Hall. Due to the site’s distance from the city lights of Northampton, it was viewed to be an ideal location for viewing both faint and bright objects in the sky. Two years later in 1964, the construction of the observatory which included a circular brick building, revolving dome, and adjacent cement structure was completed (Daily Hampshire Gazette 1963). The total cost of the project was $70,000 while the 16-inch Cassegrain reflecting telescope alone constituted for nearly half of the cost at $34,000 (Daily Hampshire Gazette

1964). The telescope was the best in current design and at the time was the only modern instrument available in the valley.

This observatory at the MacLeish Field Station was actively used by the Astronomy department of the Five college consortium; Smith college, UMass Amherst, Amherst college, Hampshire college, and Mount Holyoke college. Due to the popularity of the site use, the forested area on the Eastern side of the fence was believed to have been completely cleared of its trees in order to improve the visibility of the sky. Unfortunately, the remoteness of the observatory from the Five Colleges began to make it inaccessible for student use. In the time it would take to reach the site, the visibility of the sky would often change making the trip unproductive. Additionally, the development of the McConnell Roof Observatory overshadowed the MacLeish site more since it is in walking distance for Smith College students. For these reasons, the observatory has remained unused as an undergraduate tool since 1994 (Gross 2001).

Recently, the appeal of the observatory at MacLeish has reemerged since the property's potential for scientific research has been newly recognized by a number of different disciplines at Smith College (Neurath 2009). Unfortunately, since the site has been out of use its condition has not been maintained resulting in a regrowth of the forested area that had once been cut. At present, this renewed interest by the Astronomy department has resulted in the desire for an area of the forest around the observatory to be cut. The highest priority area to be cut is the forested region towards the Eastern horizon since this would allow for the viewing objects in the sky rising such as the moon or stars (Lowenthal 2009). The next priority areas would be cutting in the Southern and then the Northern Horizons. The department's hope is that this cutting would help the site to once again become an actively used space for hands-on experience for its majors.

This desire by the Astronomy department to cut portions of the forested area has led to a number of concerns from other departments at Smith. Firstly, a member of the Geology department has expressed concern of the potential for soil erosion and the release of nitrogen and other cations such as phosphrous into the nearby stream (Rhodes 2009). Secondly, there is worry in the Biology department of the loss of tree diversity since it is currently unknown what species are on the property. Furthermore, there is concern over the potential loss of an accessible area of study by its majors since it is located so closely to the property's entrance. Thirdly, there is concern in the Environmental Studies and Policy department that the cutting would lead to further loss of natural land and habitat area as well as alter its present condition through the emergence of edge effects. Edge effects are a result of alterations of a forested area causing changes in sunlight penetration, temperature, and species structure and composition (Fox 1997). Fourthly, there is worry in the Landscape Studies department that cutting could lead to a loss of the aesthetic value of the site since the potential cutting area is close to the entrance of the property (Bertone-Johnson 2009). Finally, potential cutting must address the potential loss of forested view by the neighboring land owners whom the college has an agreement with not to alter their view. It is important that all of these concerns be taking into consideration when planning the prospective cutting of the property to ensure that the site's future use not be compromised.

Based on these considerations, we developed a study that would both address the wants of the Astronomy department while exploring some solutions to these various concerns. The aim of this study was to evaluate the species and size of the trees on the site and where cutting should take place.

Methodology

Study Area and Data Collection:

The study area was in the West Whately property in Massachusetts and was measured from the Eastern side of the fence, which surrounds the Astronomy tower and the adjacent building, to the nearby cleared field. Data was collected on four afternoons in April 2009. A small area from the Southern side of the fence was also included in our study area. We surveyed the study area by establishing three transects from one edge of the perimeter to another. The first transect was positioned 180° South and was 28 meters long. The second transect was positioned 150° Southeast and was 60 meters long. The third transect was positioned 85° East and was 62 meters long. The location of these transects were determined through the use of a compass in order to divide the study area in three separate parts. The length of transect two and three would indicate that the nearby cleared field is about 60-62 meters away from the Eastern side of the fence. The total area of our study plot was approximately 3,500 square meters. These distances were measured using a standard meter tape.

Trees along each of these transects were then sampled. The sampled trees had to be within 5 meters of either side of transects and be taller than 1.6 meters off the ground or the height of our chests. The diameter breast height (dbh) of each tree was then measured using a diameter-breast-height tape in centimeters. The dbh of trees with multiple trunks were measured separately and then added together to signify one tree. Following these measurements, the species of each tree was identified using tree guides by Watts & Watts (1970) and Little (1980). We examined the trees bark and twigs for identification since most did not yet have leaves. Each tree was given an identification tag with the number of tree it was on which transect. For example, T1-20, would mean the 20^{th} tree along transect 1. Additionally, trees with a dbh greater than 40 cm. were surveyed over the entire study area and their species were also identified.

GPS pointed were gathered on various aspects of this study area. This included the perimeter of the study area, the perimeter of the vernal pool, the location of each transect, the location of the stream, and the location of each tree with a dbh greater than 40 cm. These points were gathered using a Trimble GeoExplorer XM (2001 series) with a 2-5 meter accuracy.

Data Analysis:

The data on tree species and dbh was analyzed by using Microsoft Excel. We compared the number of individuals of each species and the average dbh of each species to one another. We then focused our analysis on the three most abundant species in the study area and examined the distribution of their dbh to differentiate which sizes are most common. Furthermore, the measurements and GPS points collected were analyzed through the ArcMap program to create a map of our study area.

Results

GPS map:

The map of the study area shows the location of the Astronomy tower, each transect, the vernal pool, stream, trees with a dbh greater than 40 cm, and the perimeter of the study plot (Figure 1). Due to technical difficulties, the GPS points of the large trees, except the point for the White Ash, are the only points that are accurate in this map. Therefore, all of the other features were estimated based on memory and measurements taken manually.

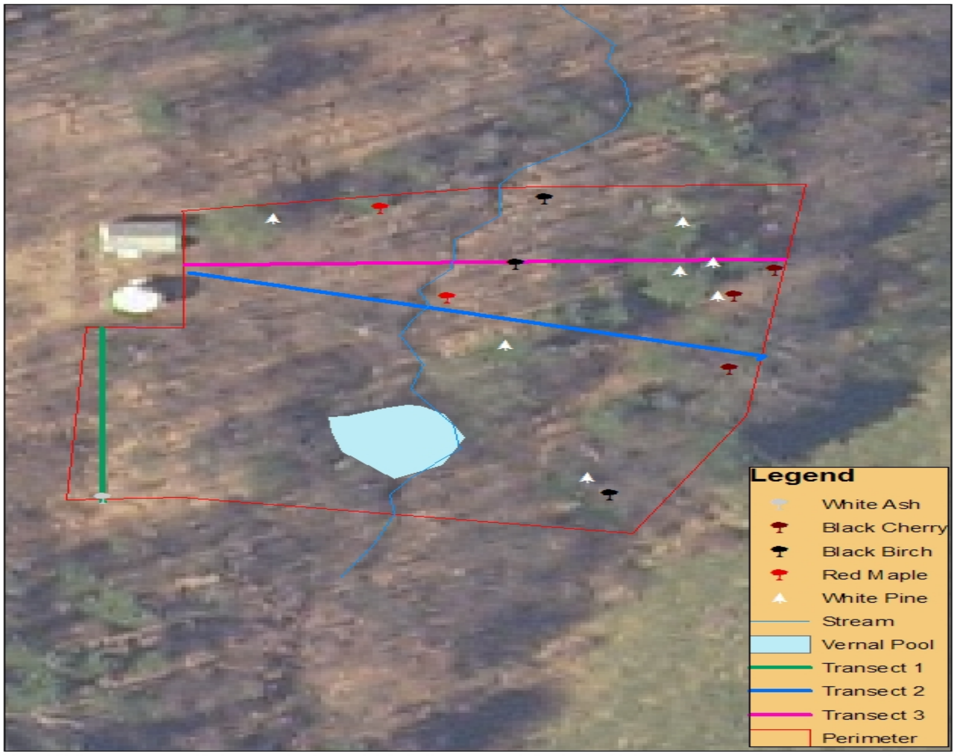

Figure 1: Map of study area with distinctive features. The points of different tree species were trees with a diameter breast height greater than 40 cm.

Tree data:

A total of 220 trees were surveyed from 15 different species. These species included the Alternate leafed dogwood, *Cornus alternifolia*, American Beech, *Fagus grandifolia*, Black Birch, *Betula lenta*, Black Cherry, *Prunus serotina*, Common apple, *Malus sylvstris*, Eastern Hemlock, *Tsuga canadensis*, Grey Birch, *Betula populifolia*, Red Maple, *Acer rubrum*, Red Oak, *Quercus rubra*, Striped Maple, *Acer pensylvanicum*, Sugar Maple, *Acer saccaharum*, White Ash, *Fraxinus americana*, White Birch, *Betula papyrifera*, White Pine, *Pinus strobes*, and Yellow Birch, *Betula alleghaniensis*. From this distribution, it was found that the three tree species with the highest percentage of individuals in the study area was the Sugar Maple at 47%, White Pine at 20%, and Black Birch at 13% (Figure 2).

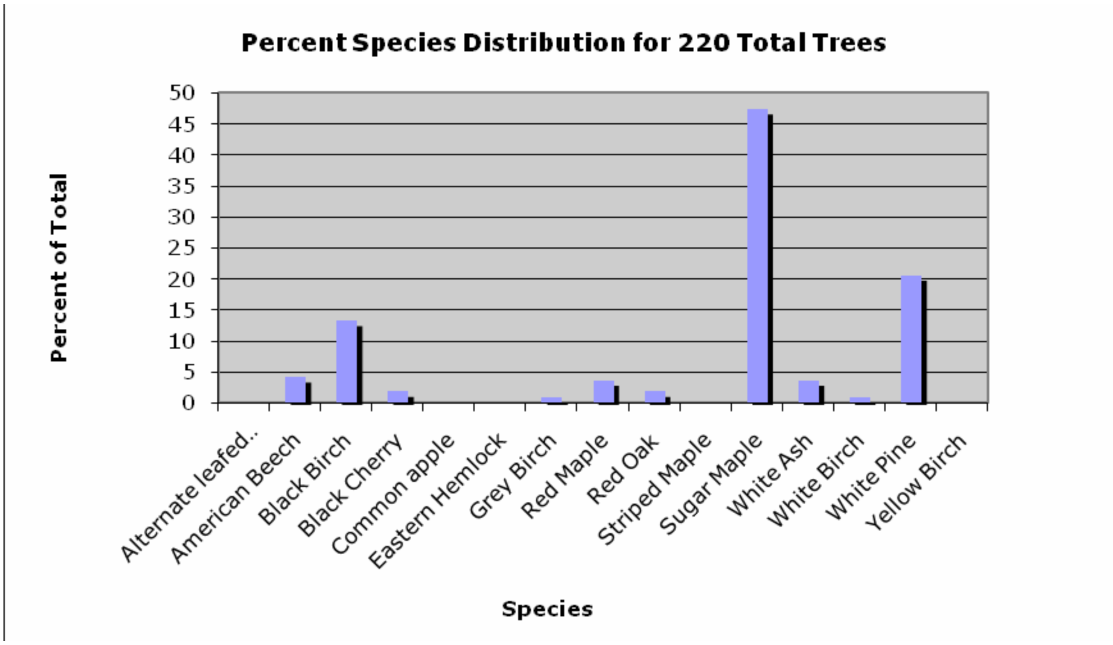

Figure 2: Composition of species of study site along Transect 1, 2, and 3 in percentage.

The average dbh of each species was then compared (Figure 3). From this comparison, it could be concluded that the Common Apple and Eastern Hemlock have the highest average dbh. However, it is important to note that these two species as well as the Alternate leafed dogwood, Striped Maple, and Yellow Birch only had one individual tree in the study area so their averages are not accurate. Furthermore, the average dbh does not give an indication of the differences in sizes for a number of tree species. Therefore, we decided to examine the size distribution of the three most abundant tree species Sugar Maple, White Pine, and Black Birch (Figure 4-6).

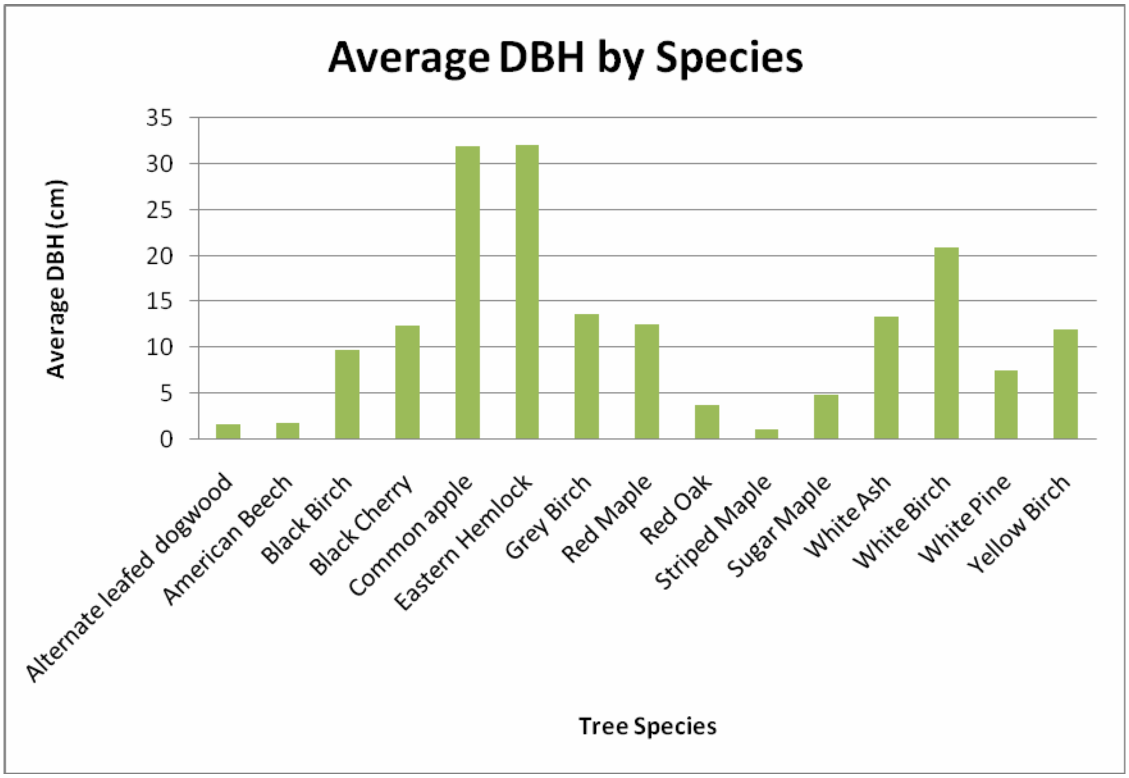

Figure 3: Average diameter breast height (dbh) of the 15 different tree species.

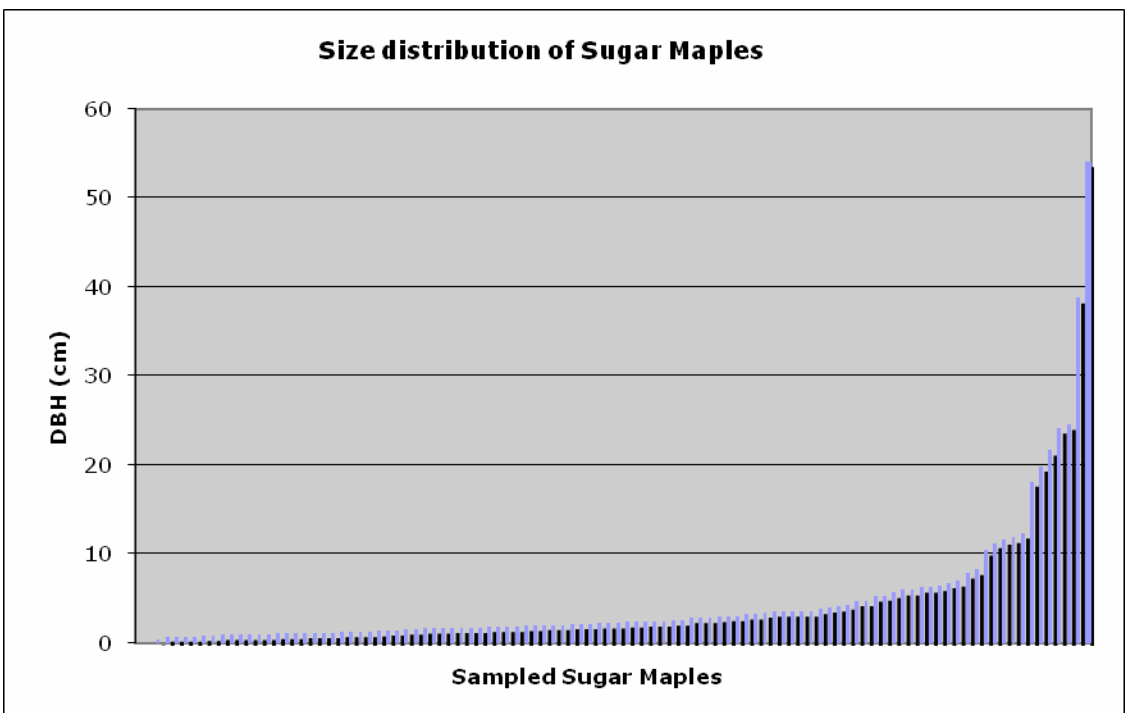

Figure 4: Distribution of diameter breast height sizes of Sugar Maple, *Acer saccharum*.

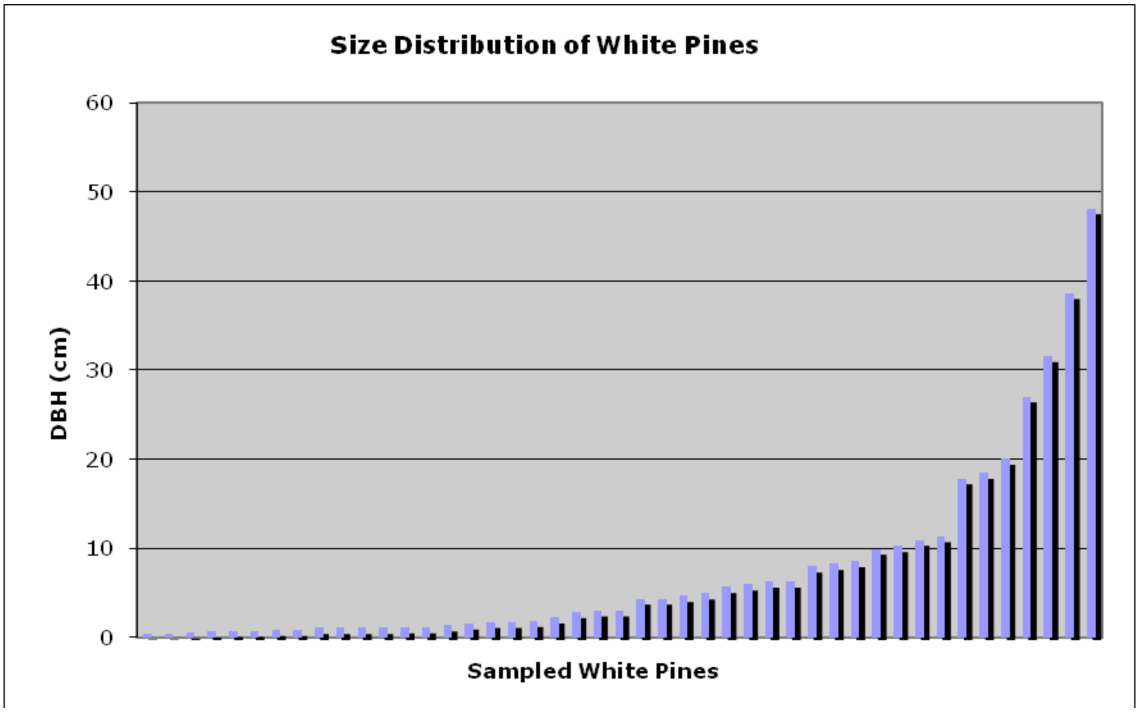

Figure 5: Distribution of diameter breast height sizes of White Pine, *Pinus strobes.*

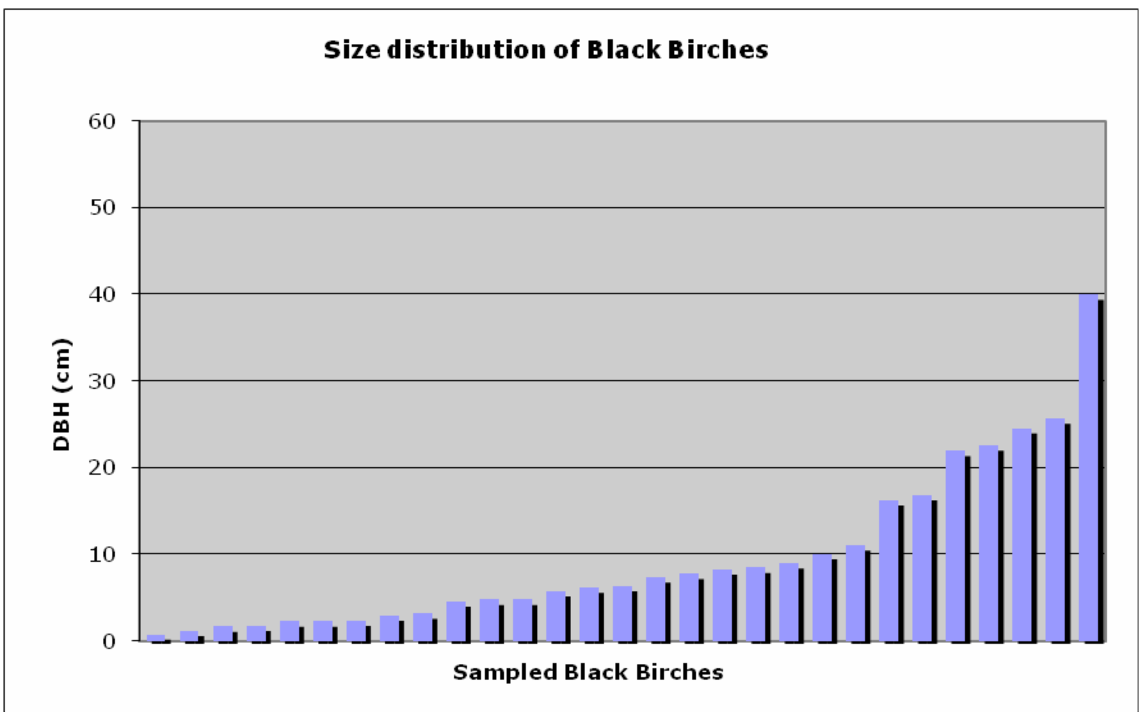

Figure 6: Distribution of diameter breast height sizes of Black Birch, *Betula lenta.*

The distribution of dbh of these tree species illustrates a pattern in the sizes that would have been lost by only examining the dbh average. Each of these species had a high number of trees with a low dbh, a few trees with a medium dbh, and only one or two trees with a high dbh. This indicates that the majority of these three species are young trees.

A total of 16 individual trees from 5 different species were found in the study area. The large trees with a dbh greater than 40 cm are somewhat spaced sporadically in the study area with a cluster of them located along the boundary of the study area and the cleared field. (Appendix, Figure 1). The dbh of these larger trees shows major fluctuations in the sizes that were found at the site (Figure 7). It appears that there is no pattern in one species of trees being larger than the individuals of another.

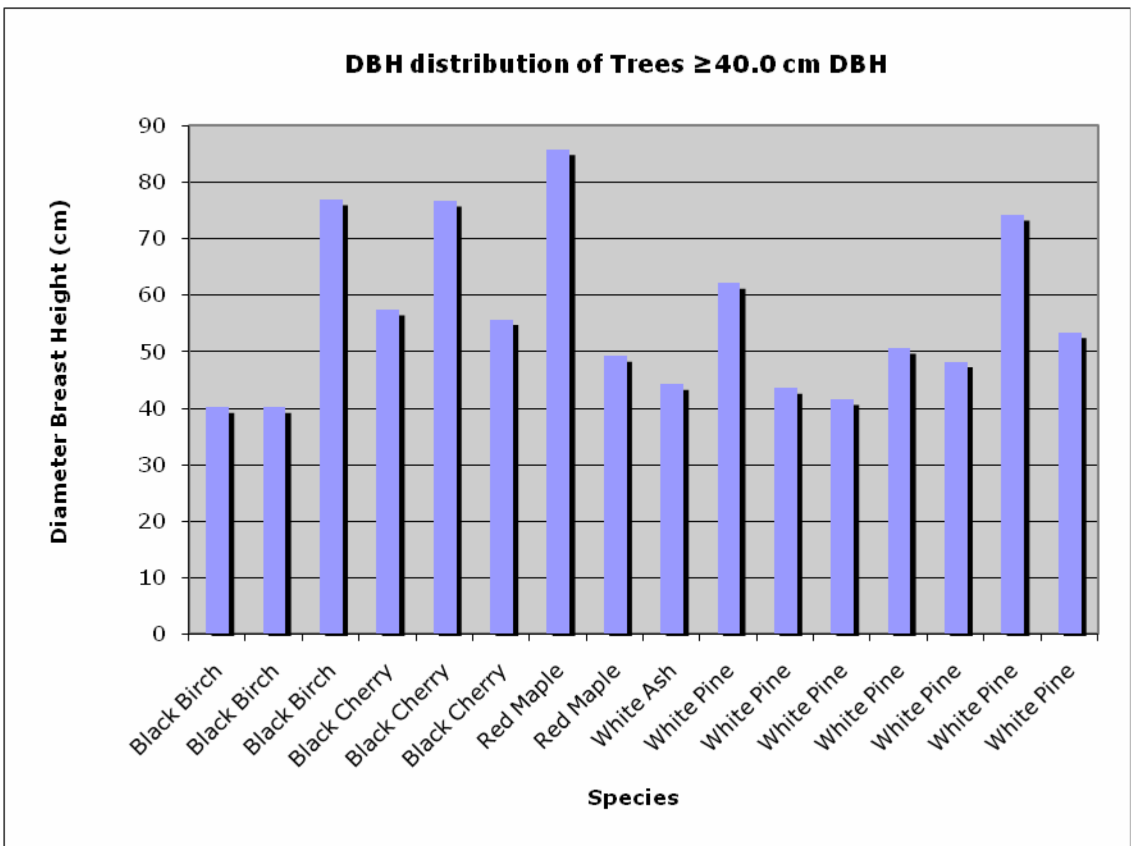

Figure 7: Distribution of sizes of diameter breast height of large trees with a DBH greater than 40 cm.

Vernal Pool:

A vernal pool was found along the stream in our study area (Figure 1). In the pool we found Spotted Salamander, *Ambystoma maculatum* and Wood Frog, *Rana sylvatica* eggs. Over the course of our field work, the vernal pool was observed to shrink in size.

Discussion

Trees:

The species distribution of this small area signifies its high diversity. With 15 different species over 10 genera, the studied plot would seem diverse however; no past studies have been completed on other parts of the property. If another area had been studied, in a different part of the property, than we would be able to determine if these results are normal, high, or low for tree species diversity in this region. Furthermore, the most common species of this site may be an indication of normal succession processes where the Sugar Maple, White Pine, and Black Birch are amongst the first species to colonize the area (Hibbs 1983). Therefore, it is possible for the composition of these species to change over time if the site were left untouched.

From the results, it is apparent that most of the trees in this area of study had a low dbh signifying that these trees are young. This finding would support the idea that there was extensice clearing of the site in the past but since there were trees found with a dbh greater than 40 cm we can disprove the claim that this area was once clear cut. We observed that a majority of the smaller and thus younger trees were concentrated within the first 15 meters away from the fence. This finding would lead us to believe that this area was probably where the most extensive cutting took place 15 years ago. Furthermore, the high occurrence of younger trees indicates that the area was successfully recruited after the previous cutting. This may be evidence of how the previous cutting was not detrimental on the regrowth of the area showing that the area could successfully recover if the site were to once again fall out of use.

Vernal pool:

The existence of a vernal pool in the area of study adds a number of considerations that need to be made in view of the proposed tree cutting. Since vernal pools are the breeding sites of many different species of amphibians any changes in their surrounding habitat may have detrimental effects on the survivability of the pool to eggs of amphibians. The vernal pool found was originally man made from an old cattle pond on the site for drinking water. Although eggs of the Wood frog and Spotted salamander were found it is still unknown whether the vernal pool is a viable breeding site for either species since the pool may possibly dry up before the eggs hatch and the tadpoles reach a juvenile state. However, if the site is viable to their survival than any tree cutting must consider the home ranges and movements of these species. In the case of the Spotted salamander, it has been established through past studies that this species requires 100.7 meters from the edge of the pool for its home range and 164 meters from the edge to encompass its' complete movements (Lannoo 2005). In relation to our study site, these distances would cover the entirety the area of our site and the proposed site for tree cutting.

Recommendations:

Based on the findings of our tree survey and the needs of the Astronomy department, we would recommend the selective cutting and/or trimming of trees. This cutting would focus on the trees that were found to obstruct the most sky. However, since most, if not all, of these trees would be the larger trees with a dbh greater than 40 we would recommend that these trees only be trimmed. Given that trees of this size are already so few in this area we believe that it would be a great loss to the diversity of the site if they were cut completely. The trunks of all trees that are selected to be cut should be left in order to limit any soil erosion that may result. Due to the size of our area of study we concluded that no selective cutting should occur within 10 meters of the stream and 5 meters within the vernal pool. These distances would help create a buffer for both of these sensitive areas and create a corridor for animal movement while still allowing for cutting to be done on this site. Although the home range and total movement of the Spotted salamander encompasses the total area of study it has been speculated that selective cutting would not have detrimental effects on the species. Furthermore, the presence of newly fallen trees may provide prime habitat for the species (Tilley 2009).

In relation to the survivability of the vernal pool we propose that a short dam be created on the stream to ensure that the pool does not dry up before the eggs hatch of either species. However, the issue may arise if it is reasonable to help protect a habitat that was originally man-made or if it's acceptable to destroy it since it is not natural.

Conclusion

This proposal of tree cutting by the Astronomy department is a classic example of a public policy issue where a number of different stakeholders have there any claims and concerns on its outcome. But in order to accurately predict the possible impacts of cutting a number of areas of interest should be studied before, during, or after cutting is complete. These would include the study of the hydro-period of the vernal pool to establish the survivability of the pool, the release of nitrogen and other cations into the stream, and the measuring of the height of trees in order to more efficiently determine which trees would obstruct the most view based on the angle of the viewscape the Astronomy department wishes to gain. The hopes and desires of this site by the Astronomy department should be heavily considered when assessing the future uses of this site since these wishes are both reasonable and warranted.

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Appendix

Coordinates of 15 large trees with a diameter breast height greater than 40 cm. Coordinates were taken with a Trimble GeoExplorer XM (2001 series) with a 2-5 meter accuracy.

Big tree points	Northing	Easting
B1 (white pine)	911547.739	102902.704
B2 (red maple)	911549.569	102913.691
B3 (red maple)	911533.142	102920.668
B4 (black birch)	911539.385	102927.839
B5 (black birch)	911551.239	102930.697
B6 (white pine)	911538.114	102.944.994
B7 (white pine)	911546.981	102945.26
B8 (white pine)	911533.497	102948.901
B9 (white pine)	911539.621	102948.442
B10 (black cherry)	911538.156	102954.729
B11 (black cherry)	911533.51	102950.429
B12 (black cherry)	911520.066	102950.013
B13 (white pine)	911500.115	102935.373
B14 (black birch)	911497.109	102937.539
B15 (white pine)	911524.415	102926.877
B16 (white ash)	N/A	N/A