The Diversity and Species Composition of Woody Plant Species in a Managed Forest

A Study of Treatment Effects in Black Rock Forest after 65 Years

by Dan Farrell

Columbia University
Environmental Science

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Abstract

Woody plants were identified on 48 tenth-acre, sample plots in several sections of Black Rock Forest in order to assess and compare the species diversity and species composition of various sites. Sample plots were located on three kinds of forest treatment areas within the sections: one was clearcut in 1935, another was thinned in 1935, and a third received no treatment (control). Sample plots were also divided into several classes of local terrain: a stream valley, flat areas, hillsides, and hilltops. Woody species richness, the Margalef index for woody species, the Shannon diversity index for tree species, tree species evenness, and the relative abundance of individual tree species were compared. These comparisons were made between treatment areas within the same forest section, between treatment methods in combined forest sections, and between local terrain classes. Shrub coverage was compared between treatment areas within the same forest section and between treatment methods in combined forest sections. In addition, soils from thinned and control areas were tested for organic carbon content by the weight loss on ignition method. Differences in diversity, species composition, and soil organic content were statistically tested for significance.

Almost no significant difference in species diversity was found between treatments and local terrain classes. A deficiency in sample size, or greatly diminished treatment effects after 65 years, may have contributed to these results. Red Oak shows significantly higher relative abundances on clearcuts than on thinned or control areas, perhaps from a greater tendency than other species to sprout from living root systems. Relative abundances of Yellow Birch and Sugar Maple are significantly higher in the stream valley; Red Maples and Chestnut Oaks, on hillsides and flat areas. Such differences between terrain types might be explained by the

conventional understanding of the ecology of these species. Because local terrain and forest management practices affect the species composition of forests, future environmental changes which affect species in different ways, may, in turn, affect the future ecology of forest terrain types and forest treatments in critically different ways.

Introduction

This study attempts to answer the question: Does forest treatment or local terrain affect woody plant diversity or species composition? The study compares the amounts and abundances of woody species—*species diversity*—as well as the abundances of individual species—*species composition*—on various sites in Black Rock Forest, in order to assess the effects of certain anthropogenic and natural influences on woody plant diversity and species composition. The anthropogenic influences include three types of forest management practices: clearcutting, thinning, and no treatment (control). The effect of such forest practices on soil organic content was also assessed. The natural influences evaluated in this study were the effects of the local terrain: a stream valley, flat areas (without streams), hillsides, and hilltops.

The concept of biodiversity is intuitively related to ecosystem stability or health: it is conventionally assumed that the more biologically diverse an ecosystem, the more stable it is. For example, it seems logical that the more species there are in a given area, the more likely that some of those species will be resistant to a given environmental change, such as fire or disease. Such a concept of biodiversity is related to the *numbers* of species and the *numbers* of individuals of such species. However, the stability of forests is surely also related to the *types* of plant species present and their relationships to the local environment. In fact, it seems likely that a forest could show little change in quantitative diversity, while at the same time being affected detrimentally by qualitative changes—that is changes in species composition. Therefore, when assessing the stability or health of a forest, it seems logical to should take into account its qualitative as well as its quantitative aspects. Knowledge of quantitative differences in diversity between sites may indicate significant qualitative differences, which may, in turn, indicate differences in well-being. On the other hand, knowledge of qualitative differences between sites, when deemed unhealthy, may be used to design remedial procedures; to predict future species compositions of the forest; and, thus, predict its future well-being. In addition, knowledge of such differences may be helpful in predicting the effects of changes in soil acidity, climate and other ecological factors on managed forests. For example, one might ask: How do species encouraged by different management procedures fare under conditions of a sudden change in soil pH or climate? This study does not attempt to assess forest health. However, studies of this kind, in combination with present and future studies of the ecology of woody plants, may provide knowledge that can lead to the assessment of the present and future health of this and other forests of this type and, thus to the design of remedial methods.

The quantification of biodiversity requires some explanation. The concept of diversity has two aspects: the number of species and the relative abundance of species (relative number of individuals of each species). Quantitative approaches of interpreting biodiversity data use the first aspect separately or combine the two mathematically in various ways. The simplest measure of biodiversity, which uses only the first aspect, indicates the number of species in a given area, which is called species richness. Species diversity indices combine the two aspects together into one number for easy comparison; they incorporate the evenness or equitability of the abundances of species. High evenness or equitability—how equally abundant the different species are—is associated with high diversity. For example, a lake with 100 sunfish, 80 bass, and 60 trout is considered more diverse than a lake with 100 sunfish, 10 bass, and 5 trout even though both lakes have the same number of fish species.

Experimental Forest Sections

The study was done on several long term forest sections in the Black Rock Forest, which is located in the Hudson highlands proper (that is in the old Precambrian rocks) about a mile west of the Hudson River and immediately north of West Point (about 24.5° north and 74° west). It contains about 4000 acres. Its terrain consists of moderately rugged hills with peaks up to about 1400 feet. Sediment cores from ponds within the forest indicate that the region has been dominated by deciduous trees since times previous to European colonization. The entire region had been heavily logged in the 18^{th} and 19^{th} centuries. The species that make up the forest are roughly those found in the Oak-Hickory forest which extends from eastern Massachusetts to Ohio and south to the Carolinas. The region receives an average of 126 cm of precipitation per year (based on West Point precipitation data for the years 1980 - 1995).

We used a series of sixty year old forest treatments located in the Black Rock Forest. In the early 1930's, a large part of the forest was either clearcut, thinned, or received no treatment (control). The original purpose of the experiment was to find the treatment that maximized production of lumber, especially in the form of large straight trees. Out of this large experimental area, some sections remain uncut, three of which we used in this study. These sections will be referred to as Arthur's Brook, Bog Meadow, and Mount Misery (shown in figure 1). The Arthur's Brook and Bog Meadow sections

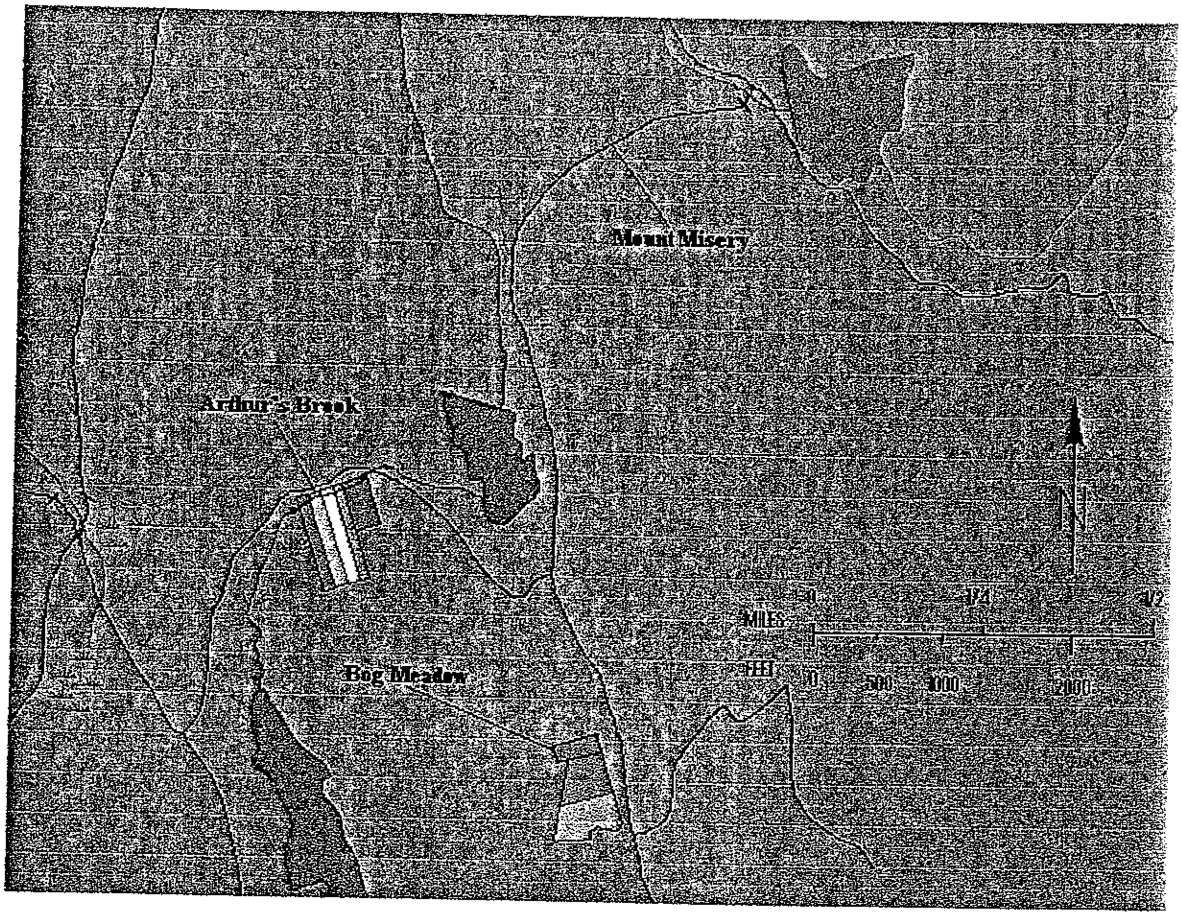

Figure 1: Locations of the Forest Sections within Black Rock Forest.

consist of clearcut, thinned, and control areas. However, Mount Misery contains only a thinned and a control area.

Here I give general descriptions of important non-biological aspects of the three experimental forest sections discussed in this study and the treatment areas on them. Detailed descriptions of their environmental aspects and plant community structure are given in the results section. The Arthur's Brook section is located on the southern hillside of a valley about 2.5 miles east-south-east of the Hudson. In the vicinity of the Arthur's Brook section, Arthur's Brook runs from approximately east-north-east (about 70°), through the center of the valley at about 1100 feet above sea level. White Oak Road runs along the north side of the brook, approximately parallel to it. The White Oak Trail runs along the south side of the section. The section's elevation ranges from about 1100 feet, at Arthur's Brook, to about 1250 feet, in the southern-most end of the section. The section was divided into six areas as shown in the map in figure 2.

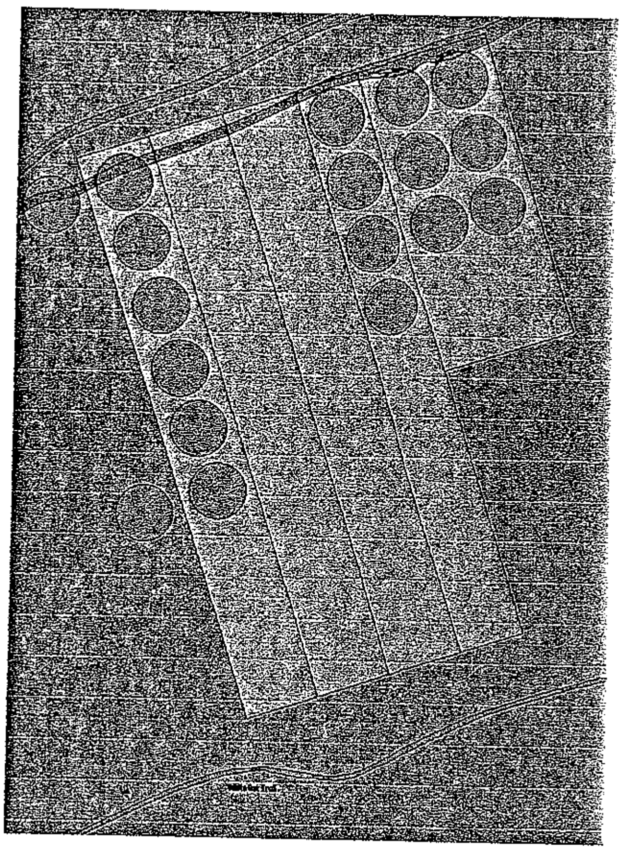

Figure 2. Arthur's Brook Forest Section.

From west to east, the treatments given to the areas are as follows: *thinning, control, thinning, thinning followed by under-planting with red pine and white spruce, thinning, and clearcutting*. The western-most thinned area is quite large; it extends indefinitely to the west of the control, and, therefore, the map shows no western boundary for it. The clearcut is about 200 feet by 400 feet. The other four areas are about 100 feet wide and 800 feet long. The long dimension of all the treatments runs approximately parallel to the slope of the hillside (342°). Arthur's Brook runs through the northern-most end of all the treatment areas.

The Bog Meadow section is located, for the most part, on a hillside that faces east-north-east (about 70°) about 2.3 miles east-south-east of the Hudson. As one moves from north to south along this "hillside," it becomes more of a rolling hillside. The section ranges in elevation from about 1200 feet, in the northwest corner to about 1300 feet, in the southeast corner. A forest road runs approximately north-south, to the east of the section. This section was divided into three treatment areas (figure 3).

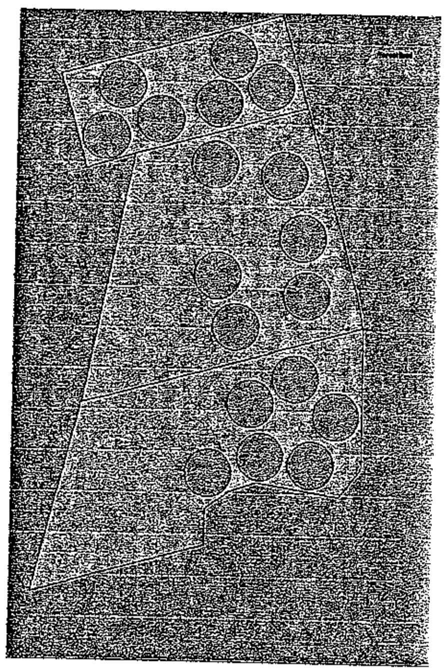

Figure 3. Bog Meadow Forest Section.

From north to south, the treatments are: *clearcutting, control, and thinning.* The clearcut area is the eastern-most portion of a 150-foot-wide, 1500-foot-long ,clearcut strip (not shown on map); however, we limited our study to only about 350 feet of it, so that the terrain would roughly match the control and clearcut areas. This treatment area is a relatively straight hillside that inclines from east to west. The control area is several times larger than that which is clearcut. It should be noted that much of the control area sits on top of a large slab of relatively shallow bedrock that may inhibit tree and shrub growth: this area is noticeably deficient in blueberries and huckleberries relative to the adjacent treatment areas. (This slab may explain the creation of a relatively large "control" area by people interested in lumber production). The thinned area is intermediate in size relative to the clearcut and the control. Although the elevation also generally increases from east to west, this treatment deviates most from a straight hillside—there are many local maxima and minima. In this respect, the control is intermediate to the clearcut and the thinned areas.

The Mount Misery section lies in a small valley between Honey Hill (1135 ft) and Mount Misery (1268 ft), about 2.0 miles from the Hudson. The thinned and control areas are separated by the White Oak Road that runs approximately northeast to southwest through the center of the valley (figure 4?). Thus, the control area lies southeast of the road partly on a hillside that faces northwest, and the thinned area lies partly on a hillside that faces southeast, northwest of the road. These hillsides are relatively straight. For the most part, however, the treatment areas lie in the flat center of the valley. The elevation of the road is approximately 1050 feet. The control and thinned areas in this section extend along either side of the road for a couple thousand feet and extend back from the road a few hundred feet.

Methods

Field Work

We first made preliminary visits to each of the forest sections to get a general idea of the treatment area boundaries and the types of vegetation we would encounter. We walked around the treatment areas and looked for types of plant growth that are symptomatic of the various treatments. For example: the areas that were thick with Mountain Laurel were most likely control areas, since Mountain Laurel takes a long time to reestablish such thick patches after cutting. Several tree stems growing from a single stump, on the other hand, are more likely to be found on a clearcut than on a thinned area, and more likely on a thinned area than on a control. These latter growth forms were once saplings which grew from the living stumps and root systems that persisted after a tree had been felled. We measured trees to estimate their age. We even cored several suspiciously large oak trees on the Arthur's Brook clearcut, but found that they were indeed under 60 years old. On these visits we also began to appreciate the variety of blueberry species that inhabit Black Rock. These species later proved to be the hardest to identify.

Our next task was to determine the exact position of the boundaries of the treatment areas in each forest section. In order to do this, we located the maps, records, and photographs made in the 1930's by the forest director at that time. These described the cutting methods used on the different areas of the forest and described the estimated position of these areas. (Thus, our project depended on the methods carried out by people in the 1930's, along with their descriptions, as well as our own methods). Some of the boundaries were marked by piles of rocks supporting painted posts, some of which had been replaced and repainted as needed over the years. These markers served as starting points for the delineation of the treatment areas.

Because the treatment areas in the Mount Misery section were so large (as described in the introduction), we decided to keep our sample plots well within these areas, precluding the need to delineate exact boundaries. Instead, we chose general, preexisting natural boundaries that enclosed similar types of terrain on each treatment area. On the thinned area, these included: an old logging road, for the southwestern boundary; the ridge of Honey Hill, for the northwestern boundary; a jutting out of the bedrock, for the northeastern boundary; and the road, for the southeastern boundary. On the control area, the southeastern boundary was about ¼ of the way up the slope of Mount Misery; the northwestern boundary was the road; while the southwestern and northeastern boundaries extended from points roughly across the road from the corresponding boundaries on the thinned area.

The Arthur's Brook and Bog Meadow treatment areas were first roughly delineated using tree marking tape and paint, on the basis of the differences in plant growth described above. We then used a compass and a bright, heavy duty, 250 ft measuring tape to delineate them more precisely. One of us held one end of the tape at a marker with a compass and directed the other on the appropriate heading. When the tape was obstructed by a tree, we tied sisal twine between the marker and the tree. We then continued in the same way from tree to tree until we reached the length of the side of the treatment noted on the old maps and then connected these sides in the same way.

We selected six one-tenth acre circles (37' radius) in each treatment area for a total of 48 sampling areas (Figures 2, 3, and 4?). We tried to distribute sample plots (circles) within similar elevation ranges on the different treatment areas in each forest section. Each sample plot was at least 10 feet from the treatment area boundary and other sample plots. We counted and identified the number of woody plant species and the number of individuals of each tree species within each of the sample plots. To do so, we drove a numbered stake into the center of each sample plot, attached a 37' cord to it, pulled it taut, and moved it around in a circular fashion, identifying all woody species in its path. Distinct tree stems growing from the same root system were counted as individual trees, even though such "trees" are not genetic individuals. After observing the plot in this way, we estimated the relative abundance of shrub species present, and several environmental factors of each circle: steepness, rockiness, and canopy coverage. We also took photographs of each site and its canopy for later reference[1]. We performed the field work during the summer of 1996: mapping and treatment area delineation in the early summer, data collection in the mid to late summer, and photography in the late summer.

Classification of Sample Plots

In order to analyze the differences in diversity and species composition between different treatments and local geography types, each circle was assigned to a class within

[1] Copies of these photos and photos of photos of some of the plant species present in the forest sections used in this study are available at the Black Rock Forest Headquarters.

four or five different comparison categories. For purposes of comparison, each was considered to belong to one of 8 treatment area classes, as well as a class that best described its local terrain (stream valley, dry flat area, hillside, or hilltop), and a forest section class (Arthur's Brook, Bog Meadow, or Mount Misery). In addition, because Mount Misery does not contain a clearcut, two treatment area comparison categories were considered: one includes clearcut, thinned, and control classes from Arthur's Brook and Bog Meadow, while the other includes only thinned and control classes from all three forest sections. Not all comparison categories were included in every analysis. Table 1 lists the various comparison categories and the corresponding classes to which each sample was assigned.

Table 1. List of classification categories and classes for analytical comparison of diversity and species composition. (AB=Arthur's Brook, BM=Bog Meadow, MM=Mount Misery, Ccut=clearcut, Thin=thinned area, and Cont=control).

Categories	Classes							
treatment area	ABCcut	ABThin	ABCont	BMCcut	BMThin	BMCont	MMThin	MMCont
treatment method	ABBMCcut	ABBMThin	ABBMCont	ABBMMM Thin	ABBMMM Cont			
forest section	AB	BM	MM					
local terrain type	stream valley	flat area	hillside	hilltop				

Each circle's treatment-method class(es) corresponds, simply, to the treatment method used on the treatment area in which it lies, and its forest section class corresponds simply to its forest section. Sample plot descriptions and photographs were used to assign circles to the various local terrain classes. The stream valley class includes sample plots that had at least part of their area on a stream. The flat area class consists of sample plots not located near streams in basins that were noted to have a grade of 0 - 5% and appeared flat in the photographs. Samples with grades above 10% and appeared sloped in photographs were included in the hillside class. Samples that had both hilly and flat areas were excluded from the analysis.

To enable the comparison of diversity measures and species compositions between local terrain classes, the various terrain classes had to be normalized to a standard number of sample plots: the numbers of tree and woody species, the abundances of each tree species, and the total number of trees expected to inhabit a standard number of circles in each local terrain class had to be estimated. The number 6 was chosen as the standard number of sample plots to enable the comparison of results between local terrain and treatment area classes. The expected abundance of each tree species, n_{exp}, on 6 sample plots was estimated as simply the abundance of the species in the sample plots in the given terrain class, n_{act}, multiplied by the standard number of 6 sample plots divided by the actual number of sample plots in the terrain class, $\#sp_{act}$:

$$n_{exp} = n_{act} \cdot 6 / \#sp_{act}$$

Similarly, the total number of trees expected to inhabit 6 sample plots, N_{exp}, was estimated to be the actual number of trees found on the sample plots in the given terrain class, N_{act}, multiplied by the standard number of sample plots, 6, and divided by the actual number of sample plots in the terrain class, $\#sp_{act}$:

$$N_{exp} = N_{act} \cdot 6 / \#sp_{act}$$

The estimation of the expected number of tree or woody species, S_{exp}, in terrain classes that had more than six sample plots differed from that for classes that had less than six sample plots. Sample plots from those that had more than six samples were arranged into as many independent combinations of 6 samples as was conveniently possible, and the number of species present in each combination was counted. The average number of species for all the combinations was used as the expected number of species for the standard number of 6 samples. This number was then used in the quantitative analyses of species diversity.

To estimate the expected number of species, S_{exp}, in 6 sample plots for terrain classes with less than 6 samples the average number of species was found for different numbers of sample plots. For example, if the actual number of sample plots is four (A,B,C&D), one would calculate the average number of species in each sample plot, in the 6 possible combinations of two sample plots (AB,AC,AD,BC,BD&CD), in the 4 possible combinations of 3 (ABC, ABD, ACD&BCD), and in the only possible combination of 4 sample plots (ABCD). The various average number of species were then plotted against the number of sample plots; a regression line was achieved and extrapolated to estimate the expected number of species in 6 sample plots. Since the mathematical function for such a regression line is unknown, the regression line function with the highest r value was chosen. If the r values of different regression line functions that give different values of S_{exp} are similar, the average of the two S_{exp}'s is used as the expected number of species.

Diversity Indices

The simplest species richness index used was the species richness itself: the number of woody species, S. The Margalef index (Magurran 1988), D_{mg}, was calculated for the tree species for each treatment area, treatment method, forest section, and local terrain class using the formula:

$$D_{mg} = (S - 1) / \ln N$$

where S is the tree species richness and N is the total number of trees for the given area, method, section or terrain class. We used the analysis of variance method (ANOVA) to test for significant differences in species richness and the Margalef index between treatment methods and forest sections[2]. Single factor Anovas without replication were used to test for significant differences between treatment methods, while two factor Anovas without replication were used to test differences between both treatment method classes and forest section classes.

Two species diversity indices were calculated for the tree species in each classification category. The Shannon Diversity Index (Magurran 1988) is calculated from the formula:

$$H' = -\Sigma\, p_i \ln p_i$$

[2] It should be noted that the Anova tests used in this study assume that the data are normally distributed. This may not be a good assumption, especially in tests with very limited data.

where p_i is estimated as the ratio of the number of individuals in the ith species, n_i, to the total number of individuals in the given class, N:

$$p_i \approx n_i / N \ \text{(estimate)}$$

Using n_i / N as an estimate for p_i gives a biased result that can be corrected by using the formula:

$$H' = -\Sigma\, p_i \ln p_i - (S-1)/N + (1 - \Sigma p_i^{-1})/12N^2 + \Sigma(p_i^{-1} - p_i^{-2})/12N^3$$

where S is the total number of species. However, the two formulas for H′ rarely produce results that are significantly different; the terms in the later formula become progressively less significant toward the right side.

Differences in H′ were tested for significance using the t-test. The variance, Var H′, degrees of freedom, df, and 't' are given by the following equations:

$$\text{Var } H' = \frac{\Sigma\, p_i (\ln p_i)^2 - (\Sigma\, p_i \ln p_i)^2}{N} + \frac{S - 1}{2N^2}$$

$$df = \frac{(\text{Var } H_1 + \text{Var } H_2)^2}{(\text{Var } H_1)^2/N_1 + (\text{Var } H_2)^2/N_2}$$

$$t = \frac{H_1' - H_2'}{(\text{Var } H_1' + \text{Var } H_2')^{1/2}}$$

S is the number of species in the class for which the index is being calculated. N_1 and N_2 represent the total number of individuals and H_1' and H_2' the Shannon diversity indices in the comparison categories 1 and 2. An H' was calculated for the tree species in each treatment area, treatment method, forest section, and local terrain class.

A further diversity index, evenness, E (Magurran 1988), can be simply calculated from H' and S. E is the ratio of the actual H' to the maximum H' possible, H_{max}, given the number of species present, S. H_{max} is the H' for a sample with S species, all of which have equal abundances. (It should be noted that this represents an unrealistic state of evenness). In this situation, since all species would be equally abundant:

$$N/S = n_i, \text{ for each species } i$$

$$\Rightarrow p_i \approx n_i / N = 1/S$$

$$\Rightarrow H_{max} = -\Sigma\, p_i \ln p_i = S\,(-1/S \ln 1/S) = \ln S$$

$$\Rightarrow E = H' / H_{max} = H'/\ln S \quad \text{(evenness)}$$

Evenness varies between 0 and 1. Evenness was calculated for each H' calculated. The analysis of variance method (ANOVA) was used to test for significant differences in evenness and the between classes in the same category. To test for significant differences in evenness between treatment methods, a single factor analysis of variance without replication was used. To test for possible significant differences between forest sections, a two-factor analysis of variance without replication was used.

Tree Species Composition

The relative abundances of the most abundant tree species in different classes of the comparison categories were compared. The relative abundance of the i^{th} species is simply p_i expressed as a percentage:

$$\text{relative abundance of species } i = 100\% \cdot p_i = 100\% \cdot n_i / N$$

where n_i is the abundance of the i^{th} tree species and N is the total number of trees in the given class.

Obvious differences in relative abundance between treatment method classes and local terrain classes were tested for significance using the analysis of variance method. Single and two-factor Anovas without replication and two-factor Anovas with replication were performed on potentially significant treatment method differences: treatment method was the first factor, forest section the second factor, and the sample plots within the various treatment areas were the replicates. Single factor Anovas were performed on potentially significant differences in tree species relative abundance between local terrain classes, where the single factor possibly affecting variation was the terrain class. The inputs to the analyses of treatment method variances without replication were the relative abundances of tree species on the various treatment areas. The abundances of tree species on each sample plot were used as the input values for the single factor analyses of variance without replication between terrain classes and for the two factor analyses of variance with replication between treatment methods and forest sections.

Shrub Coverage

The total coverage by shrubs on each sample plot (mostly heaths) was estimated using the Brown-Blanquet cover scale, which varies from 1 to 5: 1 represents 0 - 5%; 2 represents 6 - 25%; 3 represents 26 - 50%, 4 represents 51 - 75%, and 5 represents 76 - 100% total shrub coverage. The average shrub cover for each treatment area was estimated. For each sample plot, its cover scale value's percentage extremes were averaged such that 1 represented 2.5%, 2 represented 15.5%, 3 represented 38%, 4 represented 63%, and 5 represented 88%. The percentage of shrub cover for each sample plot attained in this way was averaged for each treatment area. The average shrub cover for each treatment method was calculated similarly. Differences in shrub cover between treatments areas and treatment methods were then compared.

Soil Organic Matter

Topsoil and subsoil samples were collected in August 1995 from thinned and control areas in the three forest sections used in this study as well as from the White Oak forest section, which is not used in this study. They were tested for their organic content by the loss on ignition method. They were sieved, and particles smaller than 2mm were analyzed for their organic content. The soils were crushed with a mortar and pestle and placed in an oven at 100°C for a couple of hours to drive off any moisture. Their dry weight was recorded as W_i. They were then placed in a furnace at 375°C overnight to combust all organic carbon present. They were cooled in a desiccator and then quickly weighed to find the dry weight W_f of the soils without their organic matter. The difference between the weights of the soils before and after combustion represents the amount of organic matter lost on ignition, LOI:

$$LOI = W_f - W_i$$

The fraction lost on ignition is assumed to represent organic matter only and twice the amount of organic carbon, C_{org}, in the soil:

$$\%OM = 2 \cdot \%C_{org} = \%LOI = 100\% \cdot LOI / W_i$$

Single factor Anova significance tests without replication were performed on apparent differences in organic carbon in the same soil horizon between treatment areas in individual forest sections and between treatment methods—the average of each treatment method for all forest sections.

Results[3]

Woody Species Data

The abundances of tree species found in each sample plot are arranged by treatment area in appendix A. Tables A1 to A3 show data for Arthur's Brook clearcut, thinned, and control areas respectively. Tables A5 to A7 and tables A9 and A10 show analogous data for the Bog Meadow and Mount Misery sections respectively. These tables show the total tree species abundances for the given treatment area, the average sample plot abundances, its standard deviation, and the relative abundances expressed as p_i and as a percentage. Also shown (bottom row) are the total number of trees on each sample plot and the treatment area as a whole. Tables A4, A8, and A12 summarize the total, average, and relative abundances of tree species for the treatment areas in the Arthur's Brook, Bog Meadow, and Mount Misery forest sections respectively. It should be noted that some Black and Scarlet Oaks are listed under Red Oak. The three species are difficult to distinguish from one another and it was thought that some bias due to misidentification would be eliminated in this way.

Tables A13 through A20 show the presence or absence of shrub species and the Brown-Blanquet shrub coverage for each sample plot. These tables are arranged primarily by forest section (AB,BM&MM) and then by treatment (Ccut, Thin, & Cont). They also show the total number of shrub species on each sample plot and on the treatment area as a whole. The last column shows the average number of shrub species per sample and the

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[3] Because the results include such a large number of calculations and tables, most of these, though referred to in the text, are located in the appendices. In general, significance tests with P-values greater than 0.05 are included in the appendices, as are most calculations.

standard deviation from this average Table A21 summarizes the shrubs species data for the various treatment areas. The shrub species names listed are working names and many may not be correct. However, this did not affect our quantitative analyses.

Local Terrain Classification

Table 2 shows the distribution of sample plots from the various treatment areas among the different local terrain classes.

Table 2. Distribution of sample plots classified by local environment type between treatment areas.
Listed are sample plot numbers on the various treatment areas.

site classification	ABCCut	ABThin	ABCont	BMCCut	BMThin	BMCont	MMThin	MMCont
stream valley	1 & 2	1 & 5	1					
flat	4 & 5		6		1 & 2	1, 3 & 5	1, 2 & 6	1, 3 & 4
hillside	3 & 6	2, 3 & 4	2, 3 & 4	1,2,3,4& 6	3 & 4	2, 4 & 6	3, 4 & 5	2, 5 & 6
hilltop				5	5 & 6			
hilly and flat		6	5					

	#on CCuts	#on Thins	#on Conts	total
stream valley	2	2	1	5
flat	2	5	7	14
hillside	7	8	9	24
hilltop	1	2	0	3
hilly and flat	0	1	1	2
totals	12	18	18	48

It also shows the number of sample plots on each terrain class that were also clearcuts, thinned areas, and controls. The last column shows the total number of sample plots in each terrain class: 5 are in the stream valley at Arthur's Brook, 14 are on flat areas, 24 are on hillsides, and 3 are on hilltops. (The two that had both hilly and flat areas were not assigned to a terrain class). Tables B1, B3, B5, and B7 in appendix B arrange the tree species abundance data from appendix A into the various terrain classes (stream valley, flat area, hillside, and hilltop respectively). Totals, averages, relative abundances, and standard deviations are arranged similarly to those in appendix A. The fourth from the last column in these tables shows the calculation of the expected tree species abundances, n_{exp}, and the expected total number of trees in the given class, N_{exp}. Tables B2, B4, B6, and B8 show the presence or absence of shrub species for the sample plots on the various terrain classes. Tables B1 through B8 also show the total number of tree, shrub and woody species on each sample plot (bottom 3 rows).

The stream valley and hilltop classes contain less than 6 sample plots each. Therefore, the expected numbers of woody and tree species had to be estimated using regression analysis described in the methods section. Table 3 shows the calculation of the expected number of tree species, S_{exp}, on six sample plots in a stream valley, as described in the methods section.

The actual number of stream valley samples is 5. Therefore, the average number of tree species in the combinations of 1, 2, 3, 4, and 5 sample plots, shown in the table 3, are plotted in figure 4 against the number of sample plots. A linear regression line is fitted to the data and its formula is used to extrapolate the expected number of tree species in six samples which is then rounded to the nearest integer: 13. The same procedure is shown in table 4 and figure 5 on the following page for the total number of woody species. A logarithmic regression line is used, and the expected number of woody species is 29. There are actually 3 sample plots located on hilltops. Figures 6 and 7 and tables 5 and 6 show similar calculations of the expected numbers of tree species and total number of woody species on six samples located on hilltops. In both cases, however, significant r values were attained for both linear and logarithmic regression lines. Therefore, the

Table 3. Calculation of total expected number of tree species on six tenth acre circles. The average number of tree species expected on 1, 2, 3, 4, and 5 circles are calculated from the average number of species found on independant combinations of 1, 2, 3, 4, and 5 circles, respectively.

#sample circles	avg# tree species	trendline y = 1.32x + 5.4	
1	6.6	R2 = 0.9837	if x=6 y=13.32
2	8.4		
3	9.0		=> expected # of tree species = Sexp = 13
4	10.8		
5	12		

Figure 4. Average Number of Tree Species Found in a Stream Valley vs. Sample size

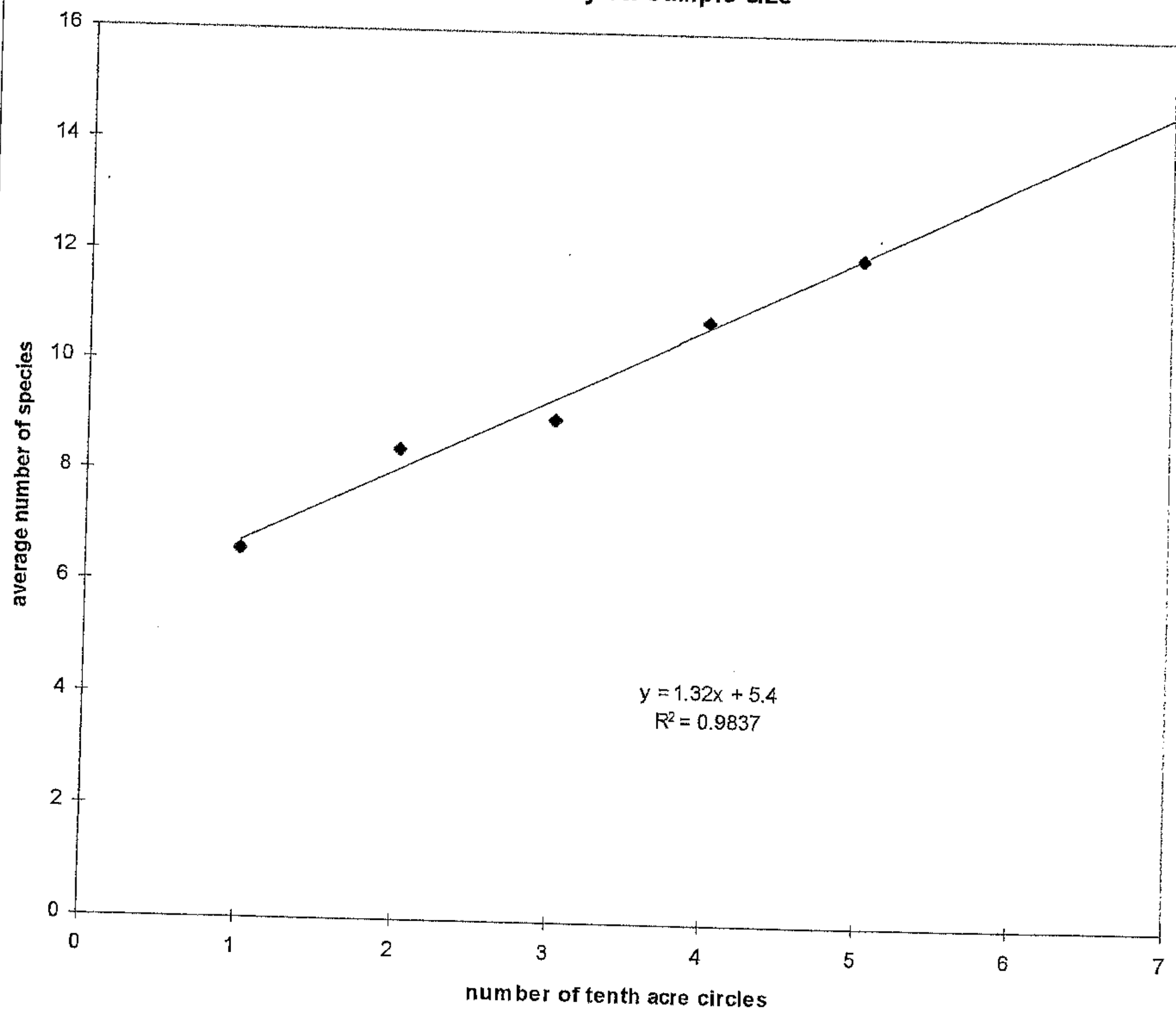


Table 4. Calculation of total expected number of woody species on six tenth acre circles. The average number of woody species expected on 1, 2, 3, 4, and 5 circles are calculated from the average number of species found on independant combinations of 1, 2, 3, 4, and 5 circles, respectively. Letters correspond to columns in table B1.

		combinations							
1	# of sp	2	# of sp	3	# of sp	4	# of sp	5	# of sp
A	10	AB	14	ABC	19	BCDE	28	ABCDE	28
B	14	AC	17	ABD	21	ACDE	28		
C	17	AD	18	ABE	17	ABDE	23		
D	16	AE	14	ACD	24	ABCE	23		
E	12	BC	19	ACE	21	ABCD	25		
		BD	20	ADE	22				
		BE	17	BCD	25				
		CD	24	BCE	22				
		CE	21	BDE	23				
		DE	22	CDE	28				
avg	13.8		18.6		22.2		25.4		28

#sample circles	avg total# species	trendline (from figure #)
1	13.8	y = 8.7577Ln(x) + 13.214
2	18.6	R2 = 0.9865
3	22.2	if X=6, Y=29 => expected number of species
4	25.4	on six tenth acre circles = S = 29
5	28	

Figure 5. Average Number of Woody Species Found in a Stream Valley vs. Sample size

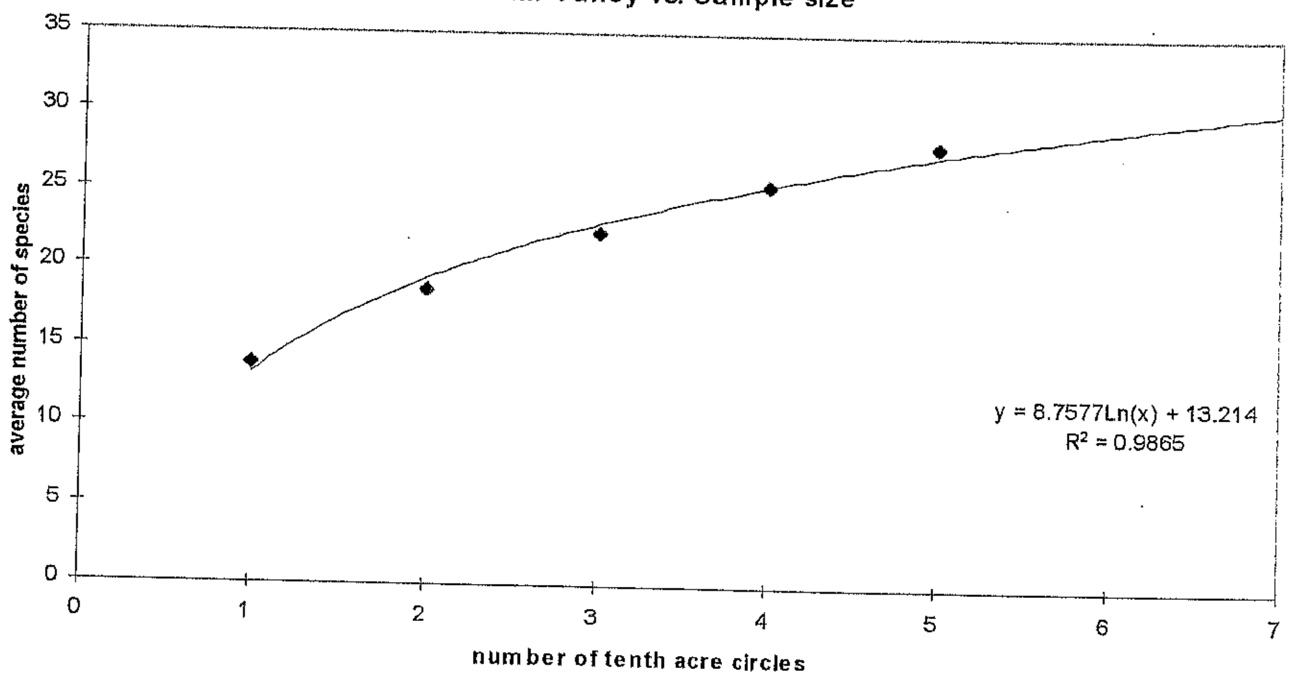


Table 5. Calculation of total expected number of tree species on six tenth acre circles. The average number of woody species expected on 1, 2, and 3 circles are calculated from the average number of species found on independant combinations of 1, 2, and 3 circles, respectively. Letters correspond to columns in table B5.

	combinations					
	1	# of sp	2	# of sp	3	# of sp
	A	6	AB	9	ABC	9
	B	7	AC	8		
	C	6	BC	8		
average		6.3		8.3		9
standard deviation						

#sample circles	avg# tree species	trendlines	if x=6 y=
1	6.333	y = 1.3335x + 5.2207 R2 = 0.9238	13.2217
2	8.33		
3	9	y = 2.4764Ln(x) + 6.4086 R2 = 0.9833	10.846

if X=6, Y=12 => expected number of species on six tenth acre circles = S = 12

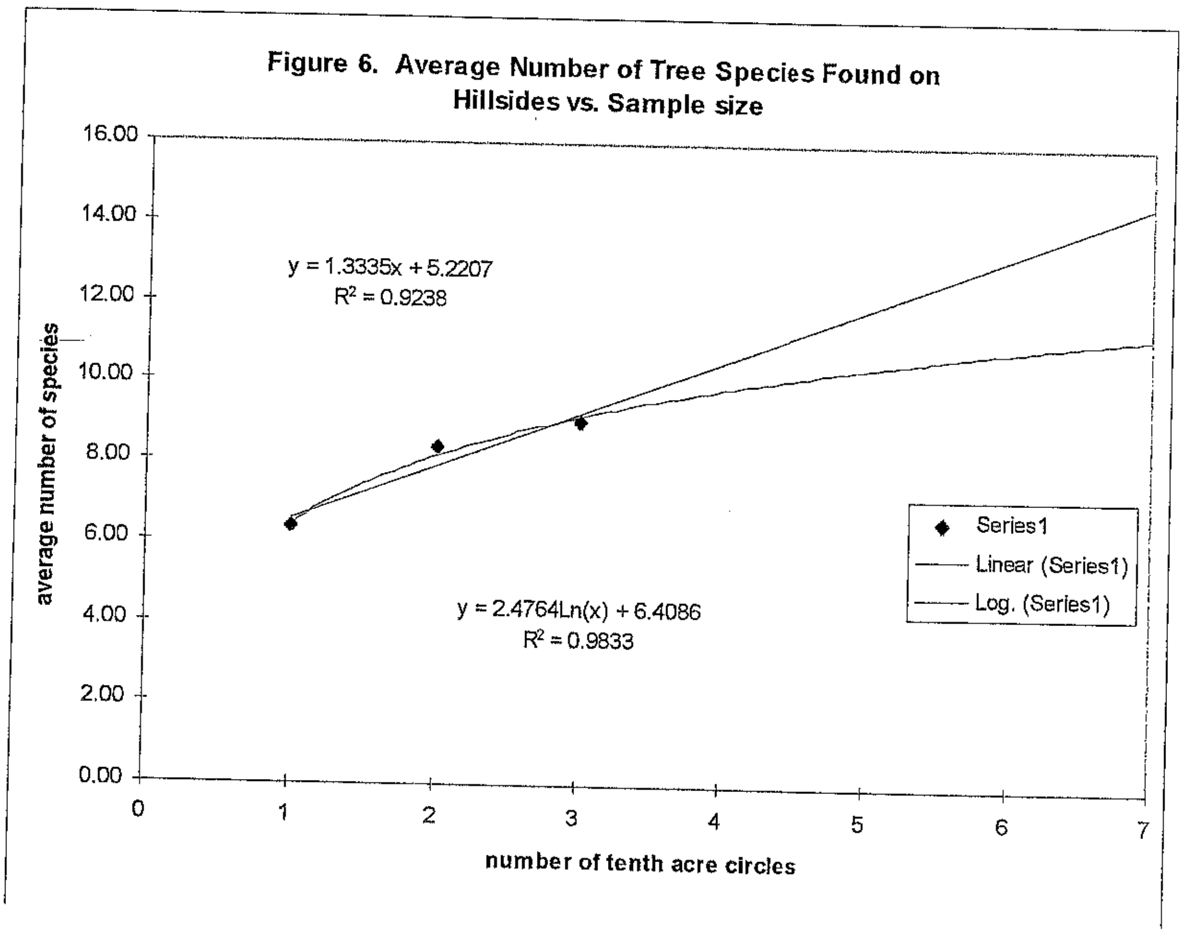


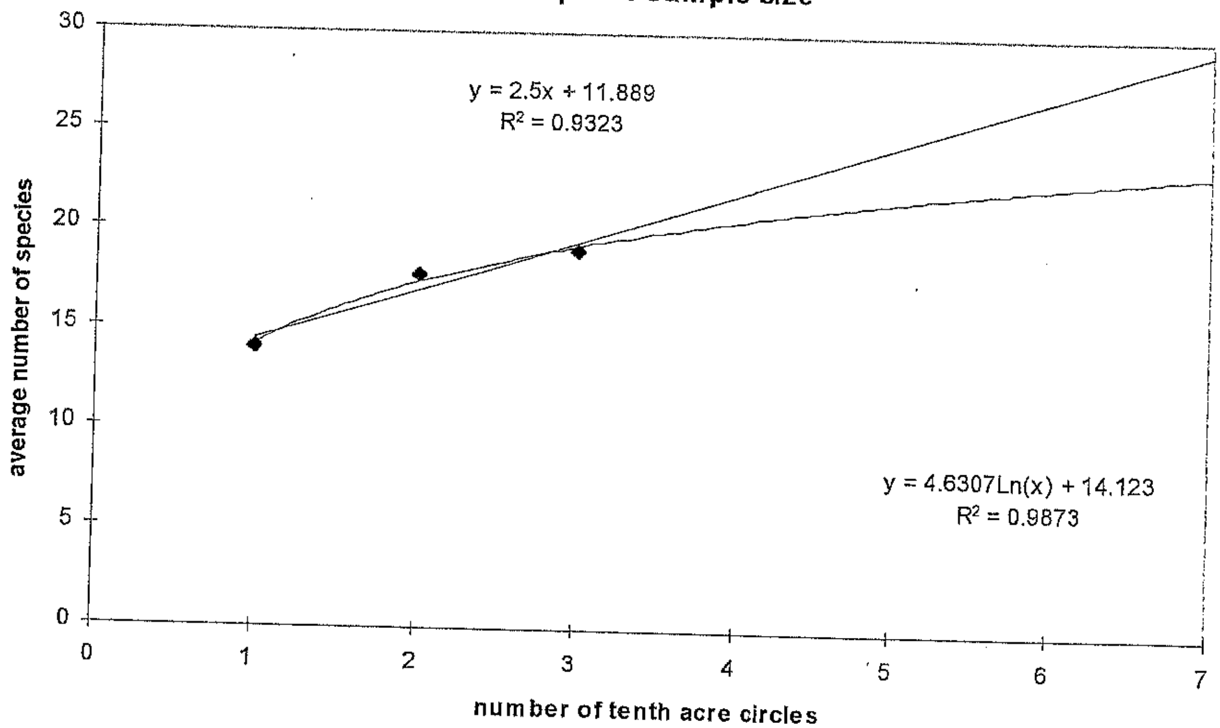
Table 6. Calculation of total expected number of woody species on six tenth acre circles. The average number of woody species expected on 1, 2, and 3 circles are calculated from the average number of species found on independant combinations of 1, 2, and 3 circles, respectively. Letters correspond to columns in table B6

	combinations					
		1 # of sp		2 # of sp		3 # of sp
	A	11	AB	18	ABC	19
	B	16	AC	17		
	C	15	BC	18		
average		14.0		17.7		19
standard deviation		2.6		0.6		

#sample circles	avg total# species	trendline	if x=6 y=	average y
1	14	y = 4.6307Ln(x) + 14.123	22.4201	
2	17.66667	R2 = 0.9873		24.655
3	19			
		y = 2.5x + 11.889	26.889	
		R2 = 0.9323		

if X=6, Y=25 => expected number of species on six tenth acre circles = Sexp = 25

Figure 7. Average Number of Woody Species Found on Hilltops vs. Sample size



extrapolated values from each regression line was averaged and rounded to the nearest integer to estimate the expected numbers of tree and woody species on 6 hilltop samples.

The flat area and hillside classes each contain more than 6 sample plots—14 and 24 respectively. Therefore, the expected numbers of species present in 6 hypothetical sample plots in each class were estimated by averaging the number of species present in as many independent combinations of 6 actual sample plots as was conveniently possible, as described in the methods section. Tables 7 and 8 on the following page show the relevant calculations for tree and total woody species on flat areas and hillsides respectively. The average values were then rounded to the nearest integer before use in diversity calculations. Table 9 summarizes the estimated expected total number of trees, tree species, and total woody species present on the standard number of 6 plots for each class in the local terrain comparison category.

Table 9. Estimation of expected number of species if six samples had been collected. Standard number of individuals is six times the actual number of individuals of all species divided by the number of samples actual.
samples had been collected

site class	actual #of samples	std # of samples	a std#/act# samples	b actual #of individuals	= a x b std#of ind	woody Sexp	tree Sexp
Stream	5	6	1.2	139	166.8	29	13
Flat Area	14	6	0.428571	614	263.1429	24	12
Hillside	24	6	0.25	1103	275.75	23	11
Hilltop	3	6	2	145	290	22	11

Species Richness and Species Diversity Indices

Table 10 lists the species richness (S), the Margalef index (D_{mg}), the Shannon Diversity index (H'), and the Evenness (E) for each treatment area, treatment method and local terrain class. The single and two-factor analyses of variance without replication,

Table 7. Calculation of total expected number of trees and woody species on six tenth acre circles. The average number of trees and woody species found on 14 independent combinations of six tenth acre plots are averaged to arrive at this number.

ABCDEF	1	11	24
BCDEFG	2	10	25
CDEFGH	3	9	23
DEFGHI	4	10	24
EFGHIJ	5	9	24
FGHIJK	6	9	23
GHIJKL	7	13	26
HIJKLM	8	13	27
IJKLMN	9	14	23
JKLMNA	10	13	25
KLMNAB	11	13	23
LMNABC	12	13	21
MNABCD	13	13	24
NABCDE	14	13	26
average		11.6	24.1
standard deviation		1.9	1.6

Table 8. Calculation of total expected number of tree species and woody species on six, tenth acre hillside circles. The average number of trees and woody species found on 24 independant combinations of six tenth acre circles are averaged to arrive at this number. Letters correspond to columns in table B5.

combinatio	combo#	# of tree species	total # of woody sp
ABCEDF	1	11	21
BCDEFG	2	10	20
CDEFGE	3	10	20
DEFGHI	4	11	21
EFGHIJ	5	12	22
FGHIJK	6	12	24
GHIJKL	7	12	24
HIJKLM	8	12	25
IJKLMN	9	10	22
JKLMNO	10	10	22
KLMNOP	11	9	22
LMNOPQ	12	9	22
MNOPQR	13	9	21
NOPQRS	14	10	22
OPQRST	15	11	23
PQRSTU	16	11	24
QRSTUV	17	13	26
RSTUVW	18	13	25
STUVWX	19	14	25
TUVWXA	20	15	28
UVWXAB	21	14	26
VWXABC	22	11	23
WXABCD	23	11	23
XABCDE	24	11	23
average		11.3	23.1
standard deviation		1.6	2.0

Table 10. Species richness and species diversity indices for all categories.

Treatment Area

Category:	**ABCcut**	**ABThin**	**ABCont**	**BMCcut**	**BMThin**	**BMCont**	**MMThin**	**MMCont**
# of **tree** species St	13	13	12	10	10	7	11	12
# of **shrub** species Ss	11	16	9	11	12	12	10	10
Total Number of species	24	29	21	21	22	19	21	22
Margalef Index **Dmg**	4.13	5.20	3.64	3.75	3.74	3.56	3.45	3.48
Shannon Diversity: **H'**	1.927	2.011	1.872	1.664	1.661	1.581	1.624	1.816
Evenness E = H'/ln S =	0.751	0.784	0.753	0.723	0.721	0.813	0.677	0.731

Treatment Method

Category:	**ABBMCC**	**ABBMTh**	**ABBMCo**	**ABBMMM Thin**	**ABBMMM Cont**
# of **tree** species St	15	14	12	17	15
# of **shrub** species Ss	14	17	13	19	14
Total Number of species	29	31	25	36	29
Margalef Index **Dmg**	4.56	4.84	4.00	5.22	4.18
Shannon Diversity: **H'**	1.919	1.946	1.839	1.963	1.917
Evenness E = H'/ln S =	0.709	0.737	0.740	0.693	0.708

Local Terrain

Category:	**stream**	**flat area**	**hillside**	**hilltop**	
# of **tree** species St	<13>	<12>	<11>	<11>	(estimated)
# of **shrub** species Ss	<>	<>	<>	<>	
Total Number of species	<29>	<24>	<23>	<22>	(estimated)
Margalef Index **Dmg**	5.47	4.13	3.91	3.70	
Shannon Diversity: **H'**	1.797	1.765	1.810	1.656	
Evenness E = H'/ln S =	0.700	0.710	0.755	0.691	

which test for significant differences in species richness, where the first factor is treatment and the second is forest section, produced no significant P-values. The two-factor Anova for species richness with replication, where the same factors are used and the sample plots within the forest sections are the replicates, also produced no significant P-values. Similarly, the single factor Anova test for significant differences in D_{mg} between treatment areas produced an insignificant P-value. Appendix C includes the results of the analyses of variance tests for significant differences in S and D_{mg} between treatment areas tables (C1 through C11).

The calculations of H′s for the various treatment areas are shown in tables C12 through C19 in appendix C. Similar calculations for the various treatment methods are shown in tables C20 through C24. Table C26 shows t-tests for significant differences in H′ between treatment areas in the same forest section, between the 3 treatment methods on Arthur's Brook and Bog Meadow combined, and between thinned and control treatments on all three forest sections combined. Only one such comparison provided a significant P-value (<0.05): the Mount Misery control area H′ is significantly higher than the H′ for the Mount Misery thinned area ($0.01<P<0.001$). The calculations of H′s for the various terrain classes are shown in tables C27 through C30 in appendix C. Table C32 shows t-tests for significant differences in H′ between various pairs of local terrain classes. No such tests provide P-values less than 0.05. Tables C34 through C36 show single and two-factor analyses of variance without replication that test for significant differences in E. Neither of the tests provided significant P-values.

Tree Species Composition

Figure 8 shows the relative abundances ($100\% \cdot n_i / N$) of all tree species found on all three forest sections in order of decreasing abundance. This sequence of species is used as the standard sequence of tree species for all tables and graphs in this paper. Figure 9 shows the relative abundances of tree species present on the Arthur's Brook clearcut, thinned, and control areas. Figure 10 shows an analogous bar graph for the treatment areas in the Bog Meadow section. Figure 11 shows the thinned and control area tree species abundances for the Mount Misery forest section. Figures 12 and 13 show the relative abundances of tree species for the two treatment method comparison categories; the former shows the relative abundances for the clearcut, thinned, and control areas on Arthur's Brook and Bog Meadow sections only and the latter shows them for only the thinned and control areas on all three sections. Figure 14 shows the tree species abundances for the entire Arthur's Brook and Bog Meadow sections, and figure 15 shows the tree species abundances for the combined thinned and control area on Arthur's Brook, Bog Meadow and Mount Misery. Tree species abundances for the local terrain classes are shown in figure 16.

The apparent differences in Red Oak relative abundances between treatment methods were tested for significance. Tables D1 through D3 in appendix D show single and two factor analyses of variance of Red Oak relative abundances without replication, where treatment is the first and forest section the second. Neither of these tests provided significant P-values. The calculation of relative Red Oak abundances for each sample in each treatment area is represented in table 11. Table 12 shows these relative abundances in the form of inputs for two factor Anovas with replication, where the same factors are

Figure 8. Tree Species Abundances for All Forest Sections Combined

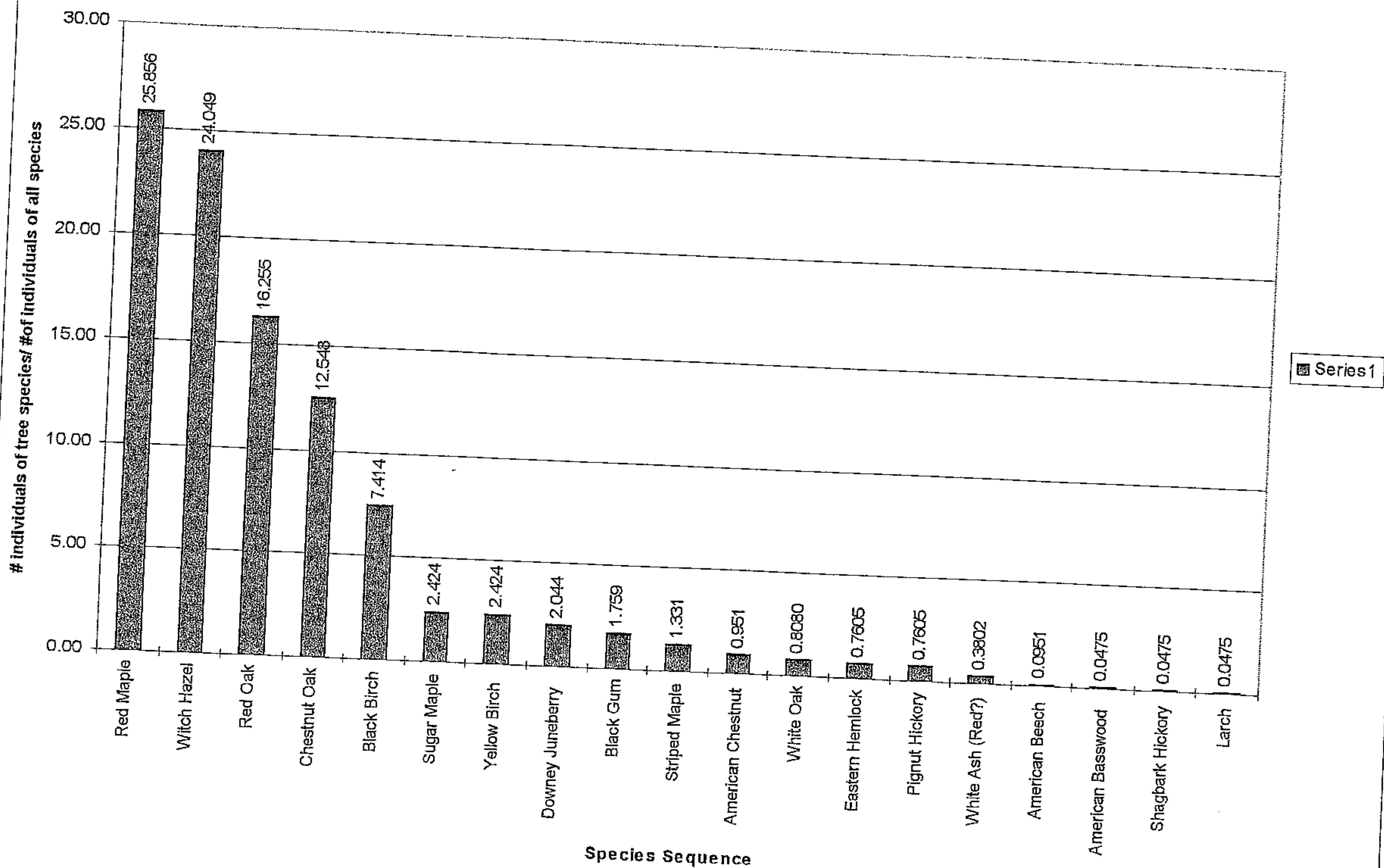
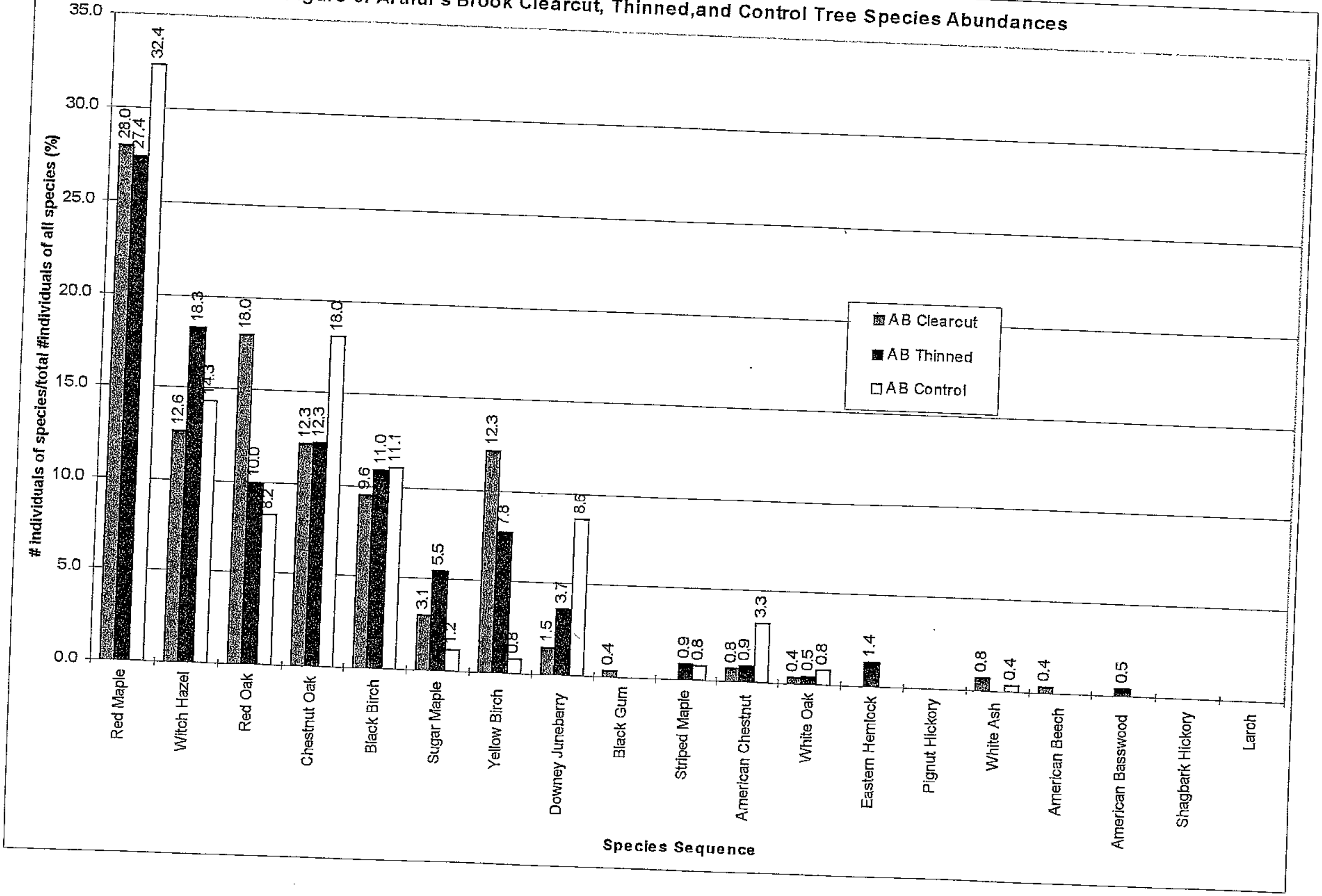


Figure 9. Arthur's Brook Clearcut, Thinned,and Control Tree Species Abundances



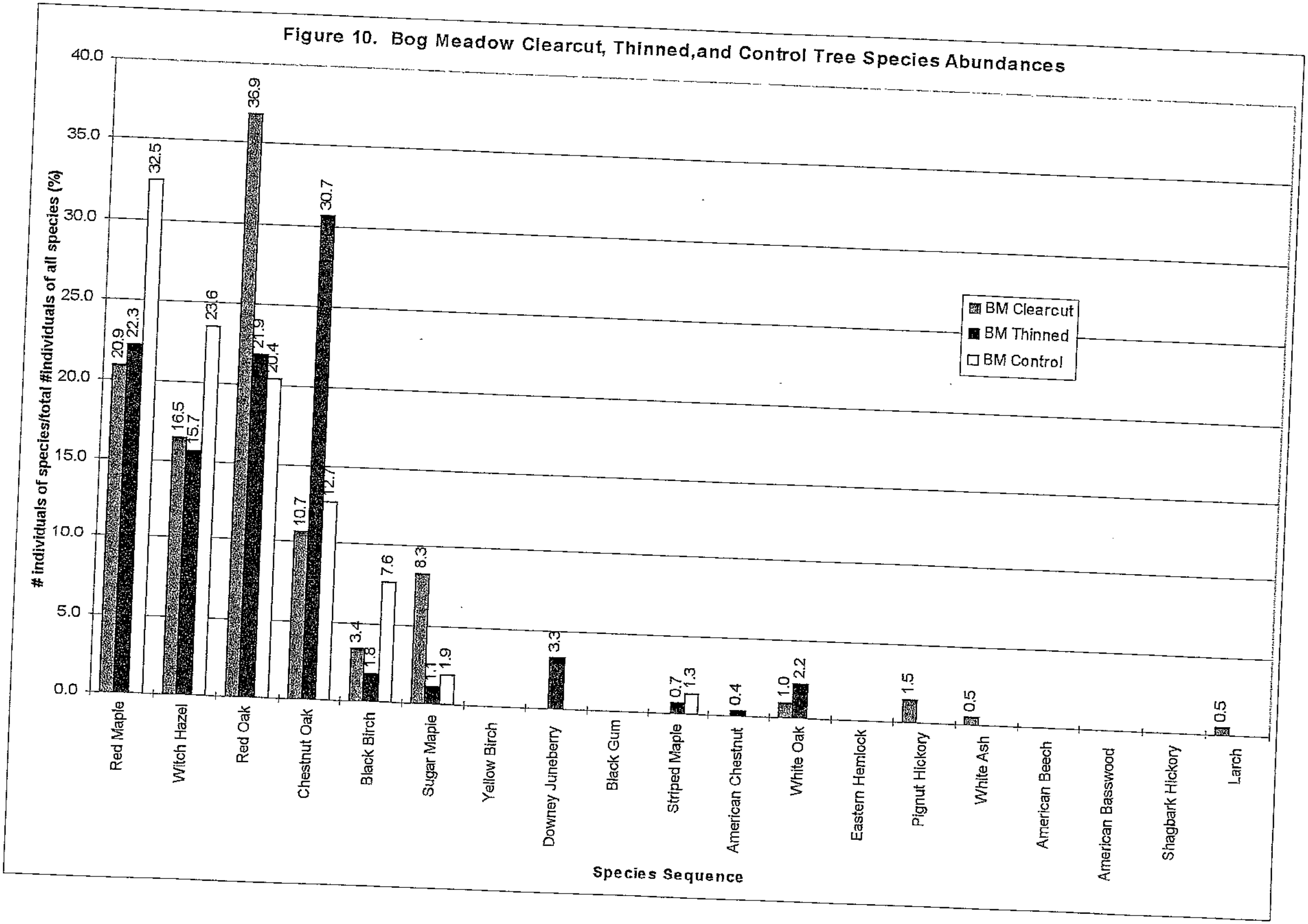


Figure 10. Bog Meadow Clearcut, Thinned,and Control Tree Species Abundances

Figure 11. Mount Misery Thinned and Control Tree Species Abundances

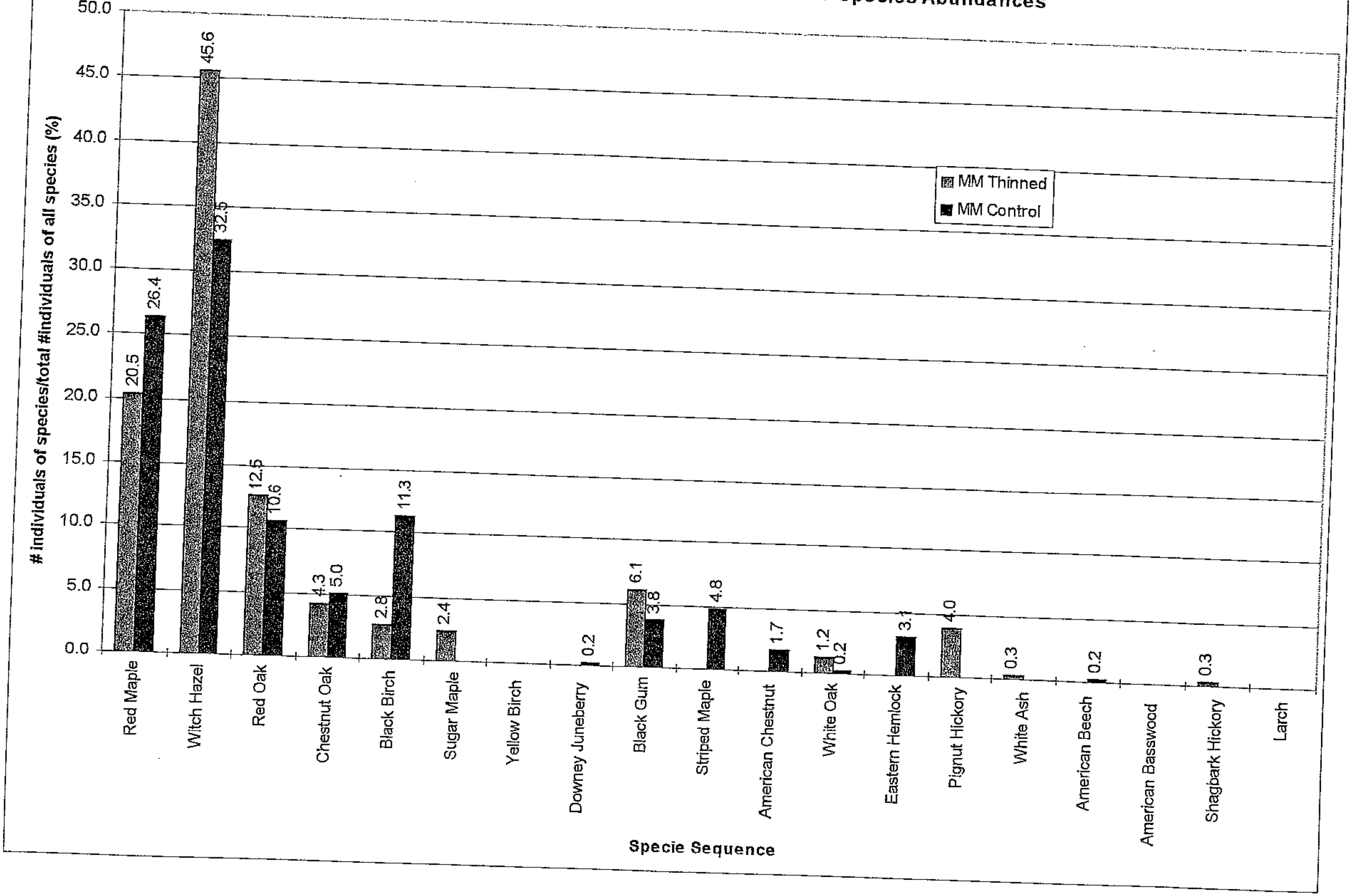


Figure 12. Tree Species Abundances by Treatment Method: Arthur's Brook and Bog Meadow Sections Combined

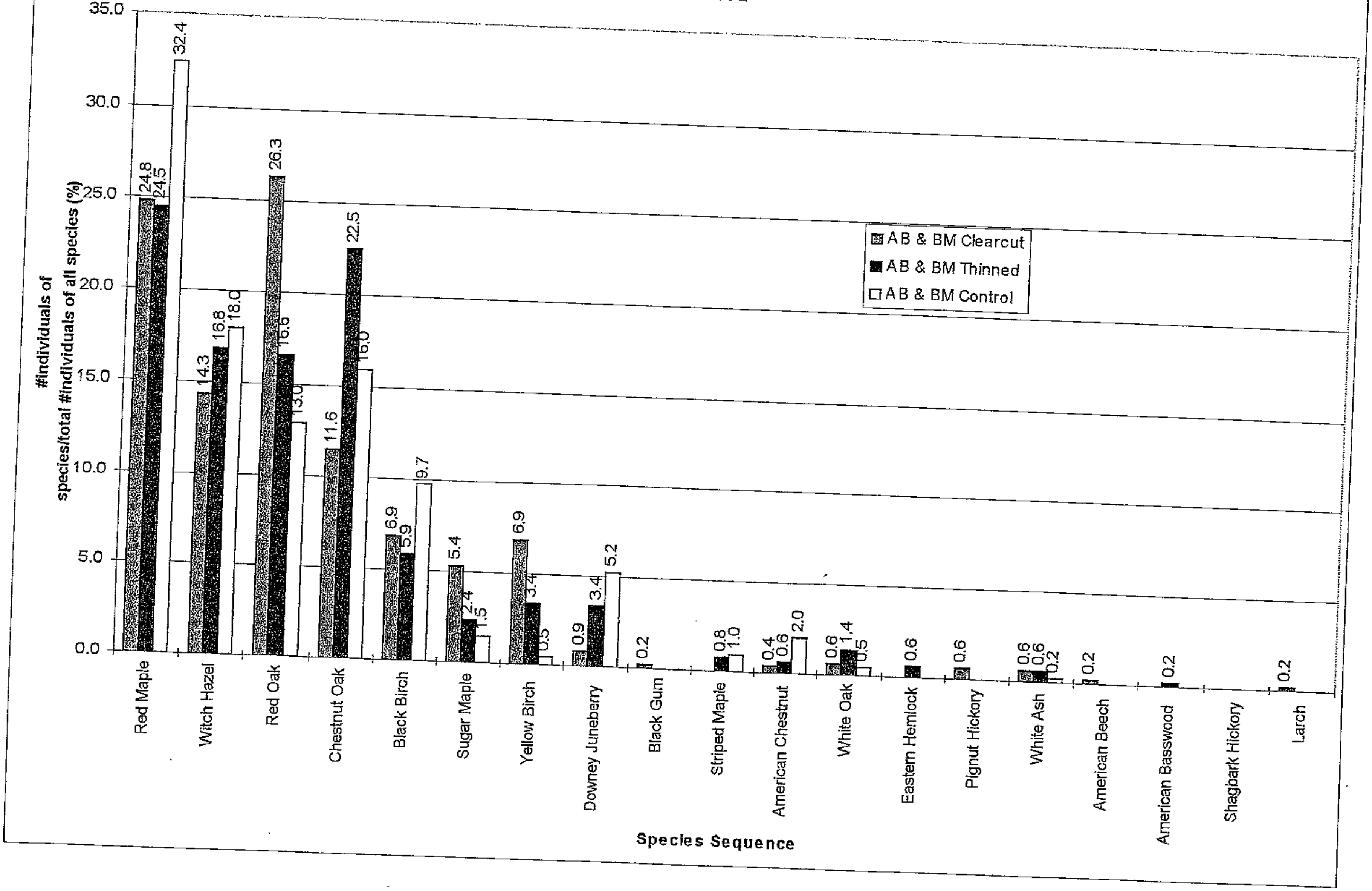


Figure 13.Tree Species Abundances of Thinned and Control Treatments for all Three Sections Combined

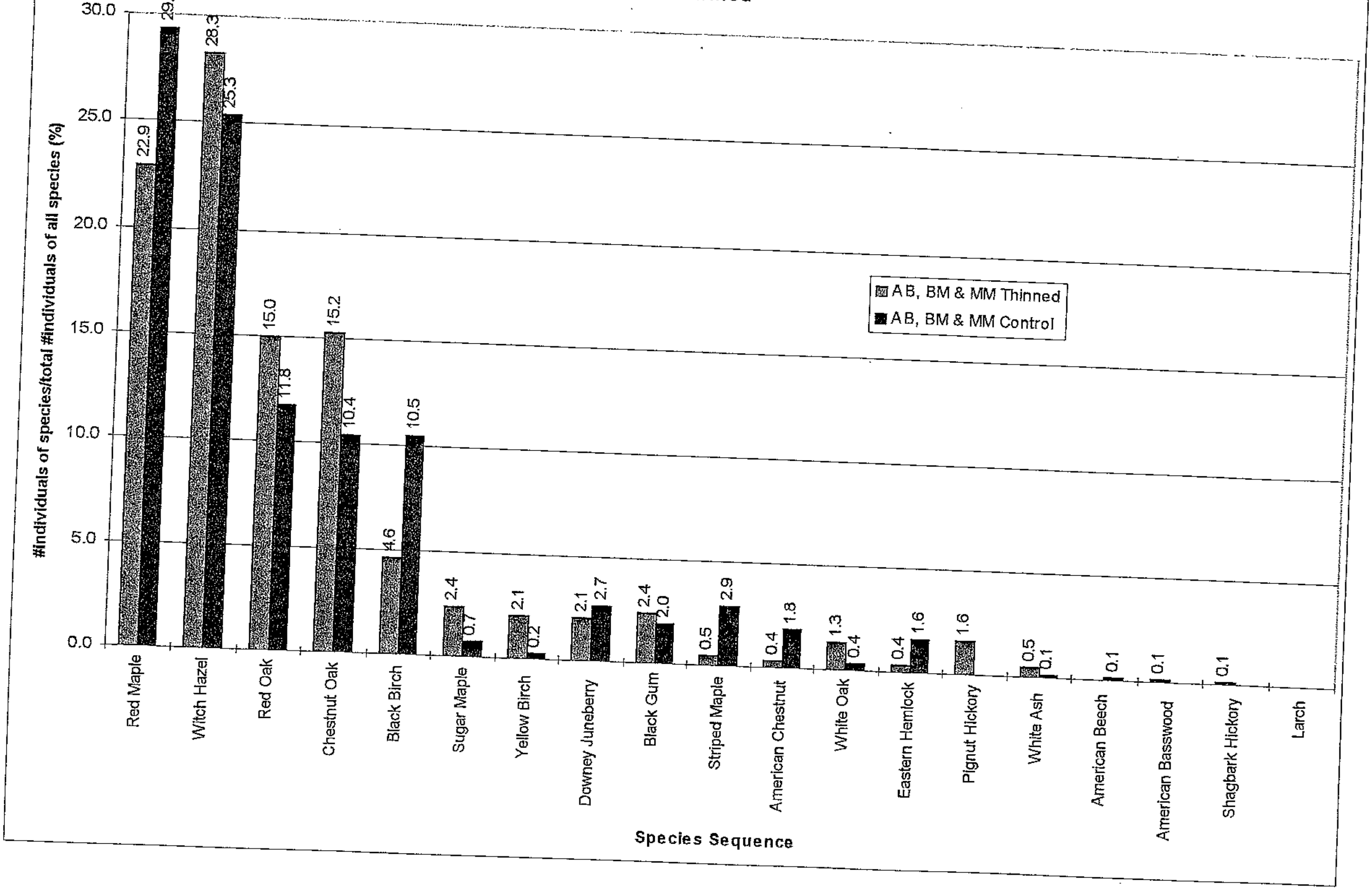


Figure 14. Tree Species Abundances of Combined Treatments for Arthur's Brook and Bog Meadow Sections

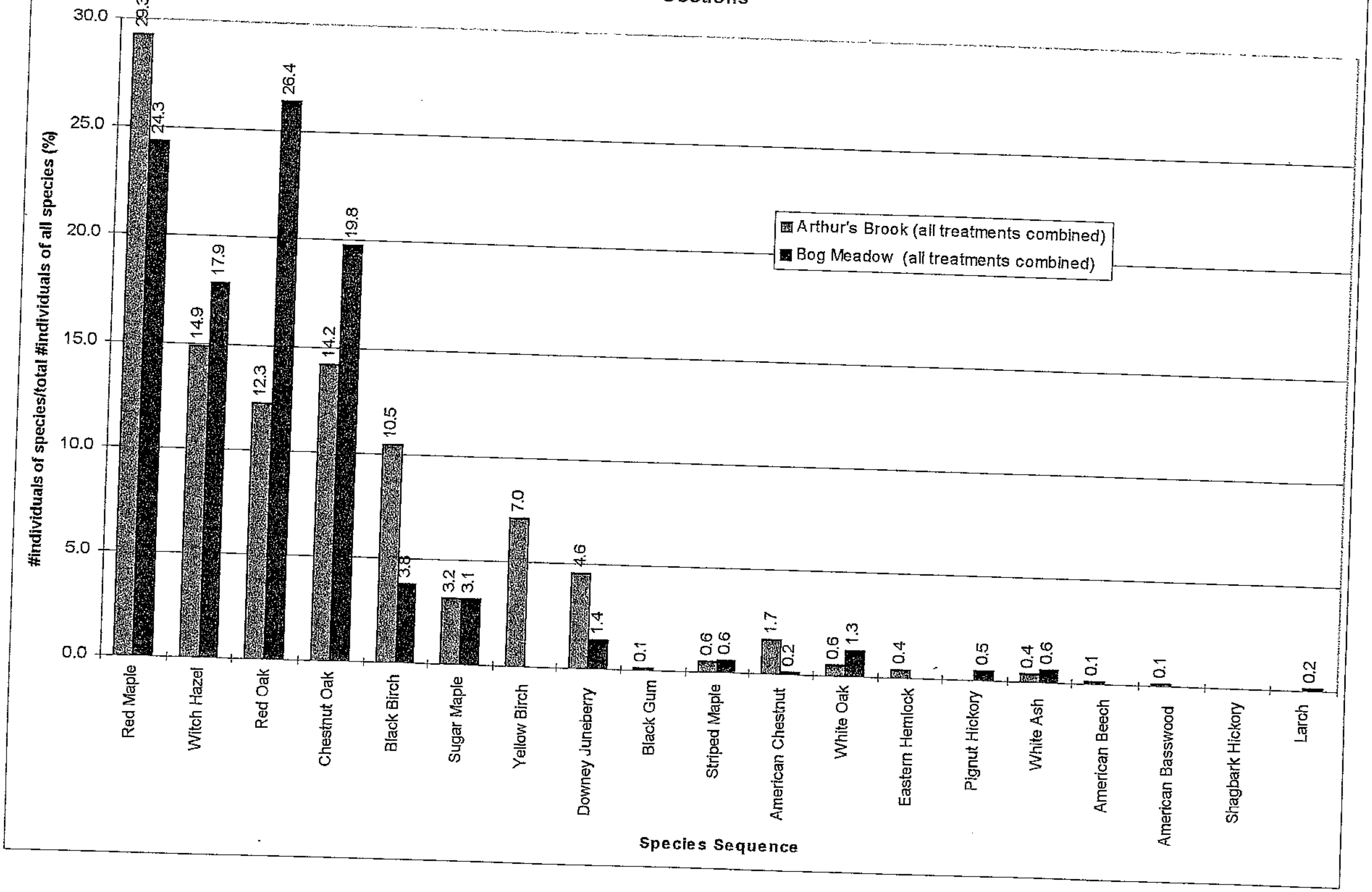


Figure 15. Tree Species Abundances of Thinned and Control Treatments for all Forest Sections

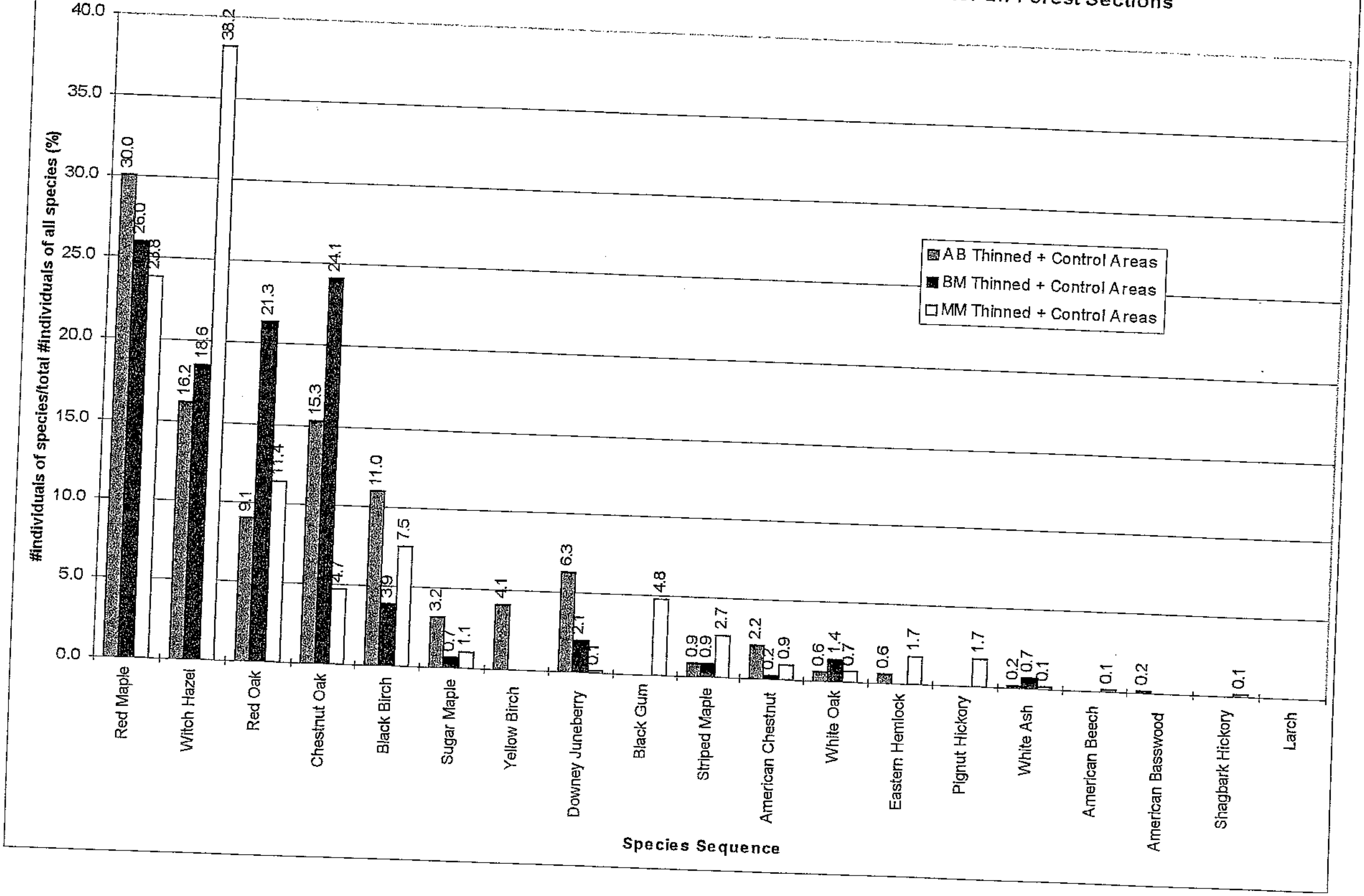


Figure 16. Tree Species Abundances by Site Classification

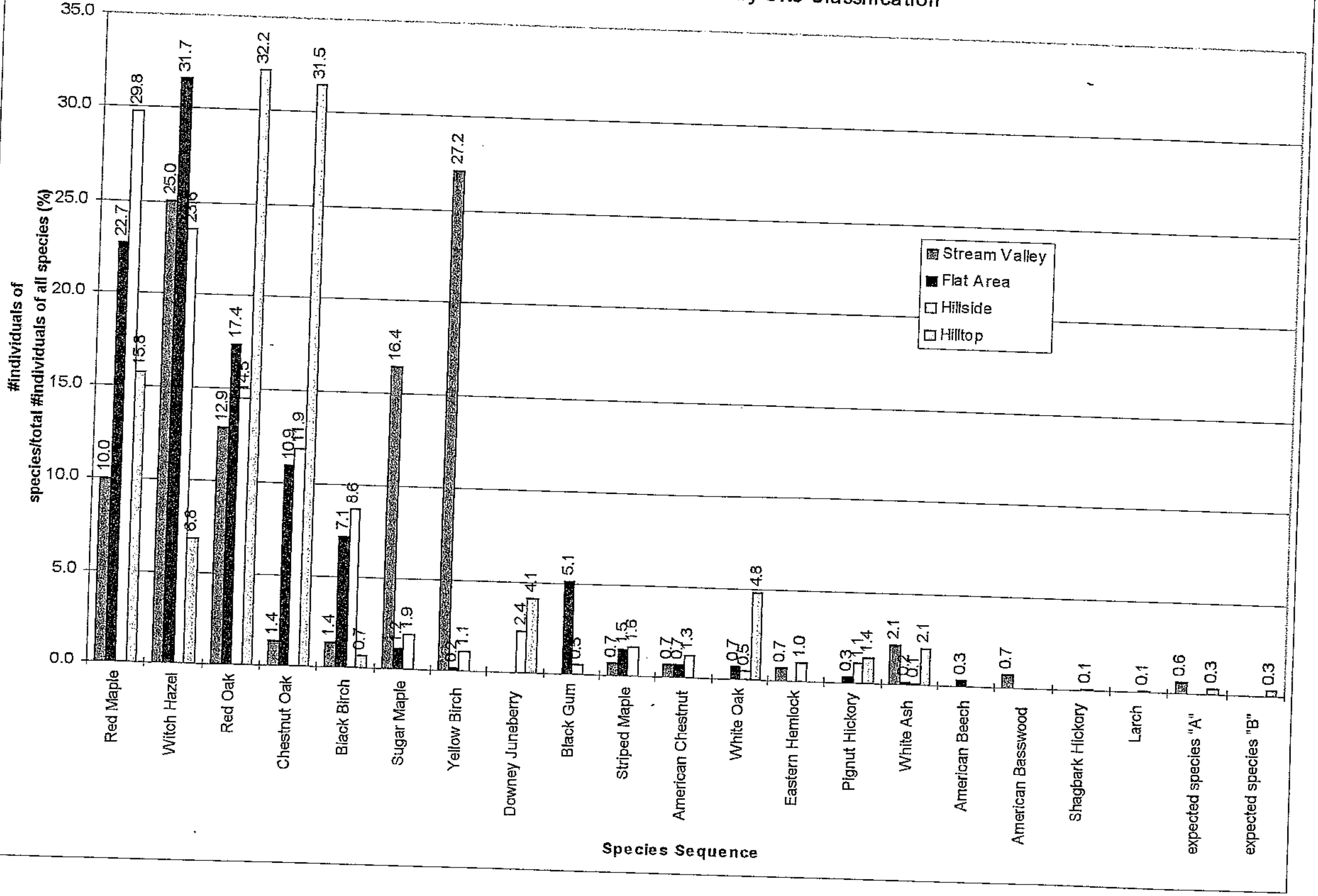


Table11. Calculation of % Red Oak abundances for each circle (=100% x #Red Oaks/total #trees) for two factor analyses of varience with replication.

	Clearcut			Thinned			Control		
circle#	# of Red oaks/circle	total # of trees/circle	%RO abundance	# of Red oaks/circle	total # of trees/circle	%RO abundance	# of Red oaks/circle	total # of trees/circle	%RO abundance
AB1	7	28	25.0	2	27	7.4	4	17	23.5
AB2	4	36	11.1	1	34	2.9	3	33	9.1
AB3	8	51	15.7	4	44	9.1	2	53	3.8
AB4	13	44	29.5	6	28	21.4	2	36	5.6
AB5	5	43	11.6	1	31	3.2	4	48	8.3
AB6	10	59	16.9	8	55	14.5	5	57	8.8
BM1	7	40	17.5	6	44	13.6	4	17	23.5
BM2	16	41	39.0	12	44	27.3	6	50	12.0
BM3	10	21	47.6	8	35	22.9	9	21	42.9
BM4	8	42	19.0	6	44	13.6	7	26	26.9
BM5	19	38	50.0	12	48	25.0	3	17	17.6
BM6	16	24	66.7	16	59	27.1	3	26	11.5
MM1				5	36	13.9	4	75	5.3
MM2				6	41	14.6	4	78	5.1
MM3				11	73	15.1	11	59	18.6
MM4				3	54	5.6	13	60	21.7
MM5				7	67	10.4	7	89	7.9
MM6				9	56	16.1	5	55	9.1
avg	10.3	38.9	29.1	6.8	45.6	14.7	5.3	45.4	14.5
std dev	4.8	10.8	17.8	4.1	13.1	7.6	3.0	22.4	10.2

Table12. Inputs for two factor analyses of varience of Red Oak abundances with replication (ANOVA). Values represent % Red Oak abundances for each circle (=100% x #Red Oaks/total #trees).

Input 1.

	Clearcut	Thinned	Control
Arthur's Brook	25.0	7.4	23.5
	11.1	2.9	9.1
	15.7	9.1	3.8
	29.5	21.4	5.6
	11.6	3.2	8.3
	16.9	14.5	8.8
BogMeadow	17.5	13.6	23.5
	39.0	27.3	12.0
	47.6	22.9	42.9
	19.0	13.6	26.9
	50.0	25.0	17.6
	66.7	27.1	11.5
average	29.1	15.7	16.1
std dev	17.8	8.9	11.3
std error	5.1	2.6	3.3

Input 2.

	Thinned	Control
Arthur's Brook	7.4	23.5
	2.9	9.1
	9.1	3.8
	21.4	5.6
	3.2	8.3
	14.5	8.8
BogMeadow	13.6	23.5
	27.3	12.0
	22.9	42.9
	13.6	26.9
	25.0	17.6
	27.1	11.5
Mount Misery	13.9	5.3
	14.6	5.1
	15.1	18.6
	5.6	21.7
	10.4	7.9
	16.1	9.1
average	14.7	14.5
std dev	7.6	10.2
std error	1.8	2.4

used and the replicates are the sample plots within each forest section. The first Anova tests for significant differences in Red Oak relative abundances between clearcut, thinned, and control methods on Arthur's Brook and Bog Meadow as well as for differences between these forest sections. The second one tests differences in such abundances between thinned and clearcut methods on all forest sections as well as differences between these sections. The results of these tests are shown in tables 13 and 14. Red Oaks are significantly more abundant on clearcuts than on thinned or control areas in Arthur's Brook and Bog Meadow ($P<0.01$). Additionally, they are significantly more abundant in Bog Meadow and Mount Misery thinned and control areas than they are in such areas at Arthur's Brook ($P<0.001$). There is no significant difference in Red Oak abundance between thinned and control treatment methods. However, there are significantly more Red Oaks on Bog Meadow thinned and control areas than there are on such areas in Arthur's Brook or Mount Misery ($P<0.001$).

Analogous significance tests to those described above for Red Oak were performed on the relative abundances of Red Maple. None of these tests showed significant differences in Red Maple relative abundances between treatment methods or forest sections. The results of these tests are presented in tables D4 through D10 in appendix D.

Apparent differences in Yellow Birch relative abundances between local terrain classes were tested for significance using a single factor analysis of variance.[4] Table 15 shows the calculation of Yellow Birch relative abundances for each sample plot in the

[4] The hilltop class is excluded from all species composition analyses for local terrain due to a deficiency of sample plots.

Table13. Two Factor Analysis of Varience of Red Oak Abundances with replication ("Anova: Two-Factor With Replication"). The factors are treatment (clearcut, thinned, and control) and forest section (Arthur's Brook and Bog Meadow only). Data from Input 2. Alpha = 0.05.

SUMMARY	Clearcut	Thinned	Control	Total
Arthur's Brook				
Count	6	6	6	18
Sum	109.9	58.6	59.1	227.6
Average	18.3	9.8	9.8	12.6
Variance	55.2	50.8	49.3	62.8
Bog Meadow				
Count	6	6	6	18
Sum	239.9	129.5	134.5	503.9
Average	40.0	21.6	22.4	28.0
Variance	363.1	40.5	137.8	235.4
Total				
Count	12	12	12	
Sum	349.8	188.2	193.5	
Average	29.1	15.7	16.1	
Variance	318.0	79.6	128.2	

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	2119.99	1	2119.99	18.26	0.0002	4.17
Columns	1404.34	2	702.17	6.05	0.0062	3.32
Interaction	179.95	2	89.98	0.77	0.47	3.32
Within	3483.89	30	116.13			
Total	7188.171	35				

Table14. Two Factor Analysis of Varience of Red Oak Abundances with replication ("Anova: Two-Factor With Replication"). The factors are treatment (thinned and control) and forest section (all sections). Data from Input 3. Alpha = 0.05.

SUMMARY	Thinned	Control	Total
Arthur's Brook			
	6	6	12
Sum	58.6	59.1	117.7
Average	9.8	9.8	9.8
Variance	50.8	49.3	45.5
Bog Meadow			
Count	6	6	12
Sum	129.5	134.5	264.0
Average	21.6	22.4	22.0
Variance	40.5	137.8	81.2
Mount Misery			
Count	6	6	12
Sum	75.7	67.7	143.4
Average	12.6	11.3	11.9
Variance	15.6	50.4	30.5
Total			
Count	18	18	
Sum	263.8	261.3	
Average	14.7	14.5	
Variance	58.3	103.3	

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	1017.23	2	508.616	8.859	0.0009	3.316
Columns	0.18	1	0.180	0.003	0.956	4.171
Interaction	7.15	2	3.573	0.062	0.940	3.316
Within	1722.29	30	57.410			
Total	2746.854	35				

Table15. Calculation of %Yellow Birch (YB) abundances for each circle (=100% x #YB/total #trees) for single factor analyses of varience without replication. Site class is the factor.

Stream			Flat Area			Hillside		
# of YB per circle	total # of trees/circl	%YB abundanc	# of YB per circle	total # of trees/circle	%YB abundanc	# of YB per circle	total # of trees/circle	%YB abundance
7	28	25.0	0	44	0.0	5	51	9.8
19	36	52.8	1	43	2.3	0	59	0.0
6	27	22.2	0	57	0.0	7	34	20.6
4	31	12.9	0	44	0.0	0	44	0.0
2	17	11.8	0	44	0.0	0	28	0.0
			0	17	0.0	0	33	0.0
			0	21	0.0	0	53	0.0
			0	17	0.0	0	36	0.0
			0	36	0.0	0	40	0.0
			0	41	0.0	0	41	0.0
			0	56	0.0	0	21	0.0
			0	75	0.0	0	42	0.0
			0	59	0.0	0	24	0.0
			0	60	0.0	0	35	0.0
						0	44	0.0
						0	50	0.0
						0	26	0.0
						0	26	0.0
						0	73	0.0
						0	54	0.0
						0	67	0.0
						0	78	0.0
						0	89	0.0
						0	55	0.0

various local terrain classes. These values are represented in table 16 as the input for the single factor Anova without replication. Table 17 shows this analysis. Yellow Birch is significantly more abundant in the stream valley class than in the flat area or hillside classes ($P \ll 0.0001$).

Analogous to the Yellow Birch test, single factor analyses of variance without replication were performed on apparent differences in Black Birch, Red Maple, Sugar maple, and Chestnut Oak relative abundances between local terrain classes. The Black Birch test did not provide a significant P-value. This test is represented in tables D11 through D13 in appendix D. Red Maple relative abundances, however, are significantly greater in flat area and hillside classes than they are in the stream valley class ($P<0.02$). The calculation of the Red Maple relative abundances for each circle in each terrain class is shown in table 18. These values appear in table 19 as the input for the single factor Anova, and the actual Anova test is shown in table 20. The relative abundances of Sugar Maples are significantly higher in the stream valley class than either the flat area or hillside class($P<0.0001$). The analysis process, similar to that for Yellow and Black Birch and for Sugar Maple, is shown in tables 21 through 23. Finally, the relative abundances of Chestnut Oak proved to be significantly greater in the flat area and hillside than in the stream valley class ($P<0.02$). Tables 24 to 26 present the analysis process in the same way as it was for the above terrain class analyses.

Shrub Coverage

The calculation of the average shrub cover for each treatment area appears in table 27, and the calculation of the average shrub cover for each treatment method appears in

Table16. Input for analyses of varience of Yellow Birch abundances without replication (ANOVA). Values represent %Yellow Birch abundances for each circle in stream, flat, and hillside classes (=100% x #Yellow Birch/total #trees).

Input 3	Stream	Flat Area	Hillside
	25.0	2.3	9.8
	52.8	0	20.6
	22.2	0	0
	12.9	0	0
	11.8	0	0
		0	0
		0	0
		0	0
		0	0
		0	0
		0	0
		0	0
		0	0
		0	0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
			0
average	24.9	0.2	1.2
standard dev	16.6	0.6	4.5
standard error	7.4	0.2	0.9

Table17. Single factor analysis of varience of Yellow Birch abundances without replication ("Anova: Single Factor"). Site class is the factor. Data from input 3. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Stream	5	124.67	24.93	275.20
Flat Area	14	2.33	0.17	0.39
Hillside	25	30.39	1.22	20.13

ANOVA

Source of Variatioi	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2582.792	2	1291.396	33.32	0.00000	3.23
Within Groups	1588.871	41	38.75295			
Total	4171.663	43				

Table18. Calculation of %Red Maple (RM) abundances for each circle (=100% x #RM/total #trees) for single factor analyses of varience without replication. Site class is the factor.

	Stream			Flat Area			Hillside	
# of RM per circle	total # of trees/circle	%RM abundance	# of RM per circle	total # of trees/circle	%RM abundance	# of RM per circle	total # of trees/circle	%RM abundance
3	28	10.7	14	44	31.8	15	51	29.4
1	36	2.8	18	43	41.9	22	59	37.3
6	27	22.2	24	57	42.1	5	34	14.7
4	31	12.9	18	44	40.9	12	44	27.3
0	17	0.0	5	44	11.4	11	28	39.3
			9	17	52.9	8	33	24.2
			7	21	33.3	15	53	28.3
			6	17	35.3	13	36	36.1
			7	36	19.4	6	40	15.0
			3	41	7.3	15	41	36.6
			5	56	8.9	3	21	14.3
			11	75	14.7	9	42	21.4
			7	59	11.9	3	24	12.5
			3	60	5.0	14	35	40.0
						8	44	18.2
						11	50	22.0
						13	26	50.0
						5	26	19.2
						16	73	21.9
						11	54	20.4
						25	67	37.3
						26	78	33.3
						40	89	44.9
						23	55	41.8

Table19. Input for analyses of varience of Red Maple abundances without replication (ANOVA). Values represent %Red Maple abundances for each circle in stream, flat, and hillside classes (=100% x #Red Maple/total #trees).

Input 4	Stream	Flat Area	Hillside
	10.7	31.8	29.4
	2.8	41.9	37.3
	22.2	42.1	14.7
	12.9	40.9	27.3
	0.0	11.4	39.3
		52.9	24.2
		33.3	28.3
		35.3	36.1
		19.4	15.0
		7.3	36.6
		8.9	14.3
		14.7	21.4
		11.9	12.5
		5.0	40.0
			18.2
			22.0
			50.0
			19.2
			21.9
			20.4
			37.3
			33.3
			44.9
			41.8
average	9.7	25.5	28.6
std dev	8.8	15.9	10.8
std error	3.9	4.3	2.2

Table 20. Single factor analysis of varience of Red Maple abundances without replication ("Anova: Single Factor"). Site class is the factor. Data from input 4. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Stream	5	48.62	9.72	77.52
Flat Area	14	356.85	25.49	253.56
Hillside	24	685.53	28.56	117.62

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1469.056	2	734.53	4.66	0.02	3.23
Within Groups	6311.65	40	157.79			
Total	7780.706	42				

Table 21. Calculation of %Sugar Maple (SM) abundances for each circle (=100% x #SM/total #trees) for single factor analyses of varience without replication. Site class is the factor.

	Stream			Flat Area			Hillside	
# of SM per circle	total # of trees/circle	%SM abundance	# of SM per circle	total # of trees/circle	%SM abundance	# of SM per circle	total # of trees/circle	%SM abundance
5	28	17.9	0	44	0.0	0	51	0.0
3	36	8.3	0	43	0.0	0	59	0.0
5	27	18.5	0	57	0.0	0	34	0.0
7	31	22.6	0	44	0.0	0	44	0.0
3	17	17.6	0	44	0.0	0	28	0.0
			0	17	0.0	0	33	0.0
			0	21	0.0	0	53	0.0
			0	17	0.0	0	36	0.0
			1	36	2.8	14	40	35.0
			3	41	7.3	0	41	0.0
			3	56	5.4	0	21	0.0
			0	75	0.0	3	42	7.1
			0	59	0.0	0	24	0.0
			0	60	0.0	0	35	0.0
						0	44	0.0
						0	50	0.0
						0	26	0.0
						3	26	11.5
						0	73	0.0
						1	54	1.9
						0	67	0.0
						0	78	0.0
						0	89	0.0
						0	55	0.0

Table 22. Input for analyses of varience of Sugar Maple abundances without replication (ANOVA). Values represent %Sugar Maple abundances for each circle in stream, flat, and hillside classes (=100% x #Sugar Maple/total #trees).

Input 5	Stream	Flat Area	Hillside
	17.9	0.0	0.0
	8.3	0.0	0.0
	18.5	0.0	0.0
	22.6	0.0	0.0
	17.6	0.0	0.0
		0.0	0.0
		0.0	0.0
		0.0	0.0
		2.8	35.0
		7.3	0.0
		5.4	0.0
		0.0	7.1
		0.0	0.0
		0.0	0.0
			0.0
			0.0
			0.0
			11.5
			0.0
			1.9
			0.0
			0.0
			0.0
			0.0
average	17.0	1.1	2.3
std dev	5.2	2.4	7.5
std error	2.3	0.6	1.5

Table 23. Single factor analysis of varience of Sugar Maple abundances without replication ("Anova: Single Factor"). Site class is the factor. Data from input 1. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Stream	5	84.94	16.99	27.43
Flat Area	14	15.45	1.10	5.61
Hillside	24	55.53	2.31	55.83

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1023.014	2	511.51	13.95	0.00003	3.23
Within Groups	1466.702	40	36.67			
Total	2489.716	42				

Table24. Calculation of %Chestnut Oak(CO) abundances for each circle (=100% x #SM/total #trees) for single factor analyses of varience without replication. Site class is the factor.

Stream			Flat Area			Hillside		
# of CO per circle	total # of trees/circle	%CO abundance	# of CO per circle	total # of trees/circle	%CO abundance	# of CO per circle	total # of trees/circle	%CO abundance
0	28	0.0	7	44	15.9	6	51	11.8
1	36	2.8	10	43	23.3	8	59	13.6
1	27	3.7	12	57	21.1	4	34	11.8
0	31	0.0	13	44	29.5	10	44	22.7
0	17	0.0	12	44	27.3	4	28	14.3
			1	17	5.9	6	33	18.2
			2	21	9.5	11	53	20.8
			4	17	23.5	4	36	11.1
			2	36	5.6	3	40	7.5
			0	41	0.0	3	41	7.3
			1	56	1.8	3	21	14.3
			2	75	2.7	8	42	19.0
			0	59	0.0	2	24	8.3
			0	60	0.0	7	35	20.0
						9	44	20.5
						9	50	18.0
						3	26	11.5
						1	26	3.8
						5	73	6.8
						3	54	5.6
						3	67	4.5
						6	78	7.7
						7	89	7.9
						6	55	10.9

Table 25. Input for analyses of varience of Chestnut Oak abundances without replication (ANOVA). Values represent %CO abundances for each circle in stream, flat, and hillside classes (=100% x #CO/total #trees).

Input 6	Stream	Flat Area	Hillside
	0.0	15.9	11.8
	2.8	23.3	13.6
	3.7	21.1	11.8
	0.0	29.5	22.7
	0.0	27.3	14.3
		5.9	18.2
		9.5	20.8
		23.5	11.1
		5.6	7.5
		0.0	7.3
		1.8	14.3
		2.7	19.0
		0.0	8.3
		0.0	20.0
			20.5
			18.0
			11.5
			3.8
			6.8
			5.6
			4.5
			7.7
			7.9
			10.9
average	1.3	11.9	12.4
std dev	1.8	11.1	5.7
std error	0.8	5.0	2.5

Table 26. Single factor analysis of varience of Chestnut Oak abundances without replication ("Anova: Single Factor"). Site class is the factor. Data from input 6. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Stream	5	6.5	1.3	3.3
Flat Area	14	166.0	11.9	123.6
Hillside	24	297.8	12.4	32.4

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	528.5494	2	264.275	4.472	0.018	3.232
Within Groups	2363.879	40	59.097			
Total	2892.428	42				

Table 27. Estimated coverage by shrubs. Values are percentages of circle area converted from the Bown-Blanquet cover scale values listed in tables A13-A20. (0-5%=2.5%, 6-25%=15.5%, 26-50%=38%, 51-75%=63%, and 76-100%=88%.

circle #	ABCCut%	ABThin %	ABCont %	BMCCut%	BMThin %	BMCont%	MMThin%	MMCont%
1	2.5	2.5	15.5	2.5	88	63	2.5	88
2	2.5	38	88	38	88	63	2.5	88
3	38	38	88	38	88	38	2.5	88
4	88	15.5	88	2.5	88	2.5	2.5	88
5	88	88	88	38	88	15.5	2.5	88
6	88	88	88	38	88	2.5	2.5	63
average	51.2	45.0	75.9	26.2	88.0	30.8	2.5	83.8
std dev	42.4	36.0	29.6	18.3	0.0	28.1	0.0	10.2
std error	17.3	14.7	12.1	7.5	0.0	11.5	0.0	4.2

Table 28. Calculation of average estimated percent shrub coverage for clearcut, thinned, and control treatments for all forest sections. (See Table 27 for origin of values)

Circle	Clearcut%	Thinned%	Control %
AB1	2.5	2.5	15.5
AB2	2.5	38	88
AB3	38	38	88
AB4	88	15.5	88
AB5	88	88	88
AB6	88	88	88
BM1	2.5	88	63
BM2	38	88	63
BM3	38	88	38
BM4	2.5	88	2.5
BM5	38	88	15.5
BM6	38	88	2.5
MM1		2.5	88
MM2		2.5	88
MM3		2.5	88
MM4		2.5	88
MM5		2.5	88
MM6		2.5	63
average	38.7	45.2	63.5
standard deviation	33.8	40.9	33.2
standard error	9.7	11.8	9.6

table 28. The average shrub cover for each treatment area and treatment method are shown graphically in figure 17. Although there appears to be more shrub cover on the control treatment method than on the clearcut method, this may not prove to be significant given the relatively large standard errors involved. The difference between the average thinned and clearcut treatment shrub cover appears even less significant.[5]

Soil Organic Content

The results of the loss on ignition tests for organic matter in top and subsoils appear in tables 29 to 31. The raw data for the tests are provided in tables E1 to E3 in appendix E. Table 29 shows the percentage of organic carbon values for each replicate, the mean value of these replicates, the standard deviation from the mean, and the standard error for each soil sample. Table 30 calculates average top and subsoil organic carbon contents for all plots. Table 31 compares the average organic carbon contents in the various treatment areas and methods (average of the treatments) by top and subsoil.

Given the relatively large standard errors in the average top and subsoils for thinned and control methods, there does not seem to be a significant difference in these values—except in that there is far more organic matter in the topsoil than in the subsoil. Single factor Anova significance tests without replication were performed on possible significant differences in organic carbon in the same soil horizon between treatment areas in individual forest sections. Apparent differences for Arthur's Brook topsoil and subsoil and White Oak topsoil provided no significant P-values. These significance tests are

[5] I have not found a good method to test for significant differences between shrub cover values given their methods of estimation and calculation.

Figure 17. Shrub Coverage

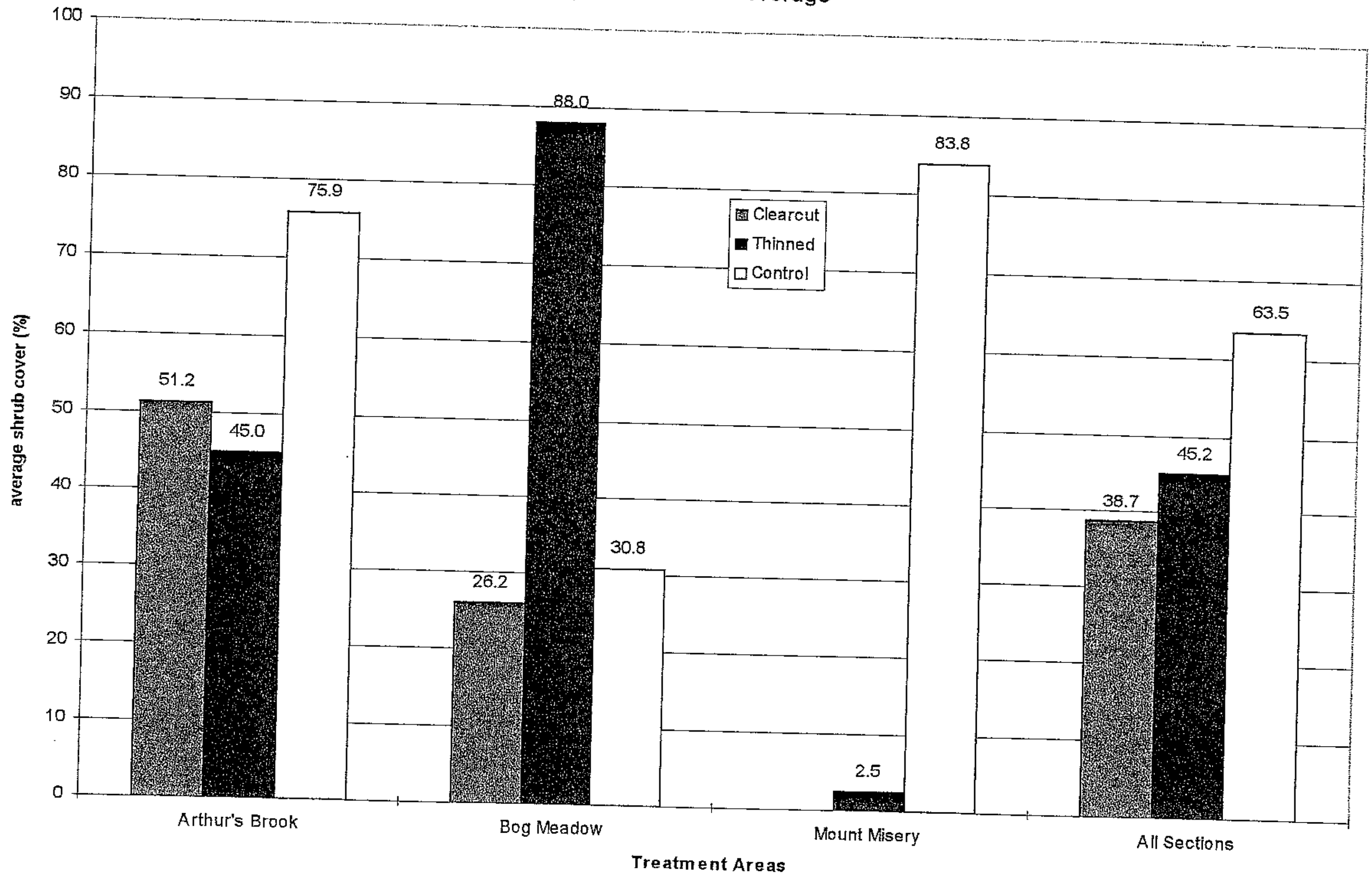


Table 29. Percent organic carbon for soil samples. Boxed values deviate significantly from the mean and are not included in the average %organic matter, the standard deviation, or the standard error.

	sample#	Run#1 %organic carbon	Run#2 %organic carbon	Run#3 %organic carbon	average %organic carbon	std dev	std error
MMThin topsoil	1	9.6	10.0	9.6	9.7	0.24	0.14
MMThin subsoil	2	[35.1]	4.7	4.6	4.6	0.07	0.05
MMCont topsoil	3	10.3	8.9	[0.8]	9.6	1.03	0.73
MMCont subsoil	4	4.2	3.9	4.0	4.0	0.13	0.08
BMThin topsoil	5	22.8	21.8	23.2	22.6	0.71	0.41
BMThin subsoil	6	6.2	5.8	6.1	6.0	0.22	0.13
BMCont topsoil	7	17.8	15.2	17.1	16.7	1.33	0.77
BMCont subsoil	8	4.9	5.0	5.4	5.1	0.23	0.13
WOThin topsoil	9	18.2	18.0	17.2	17.8	0.54	0.31
WOThin subsoil	10	7.5	7.1	8.4	7.6	0.67	0.39
WOCont topsoil	11	20.3	18.2	20.0	19.5	1.17	0.67
WOCont subsoil	12	7.6	7.6	8.2	7.8	0.36	0.21
ABThin topsoil	13	19.7	21.9	19.5	20.4	1.32	0.76
ABThin subsoil	14	7.6	7.5	7.4	7.5	0.14	0.08
ABCont topsoil	15	22.1	21.9	22.1	22.1	0.13	0.07
ABCont subsoil	16	6.5	[broke]	7.3	6.9	0.56	0.40
Slosh III int. std.	17	3.4	3.1	3.6	3.4	0.25	0.15

Table 30. Organic carbon and associated standard errors for topsoil and subsoil samples.

sample#	site	topsoil % carbon	std error	sample#	site	subsoil % carbon	std error
1	MMThin	9.7	0.14	2	MMThin	4.6	0.05
3	MMCont	9.6	0.73	4	MMCont	4.0	0.08
5	BMThin	22.6	0.41	6	BMThin	6.0	0.13
7	BMCont	16.7	0.77	8	BMCont	5.1	0.13
9	WOThin	17.8	0.31	10	WOThin	7.6	0.39
11	WOCont	19.5	0.67	12	WOCont	7.8	0.21
13	ABThin	20.4	0.76	14	ABThin	7.5	0.08
15	ABCont	22.1	0.07	16	ABCont	6.9	0.40
	average ts	17.3			average ss	6.2	

Table 31. Comparison of soil organic carbon between thinned and control areas for topsoil and subsoil.

	% organic carbon	
topsoil	Thinned%	Control %
Arthur's Brook	20.4	22.1
Bog Meadow	[22.6]	[16.7]
Mount Misery	9.7	9.6
White Oak	17.8	19.5
average	17.6	17.0
std dev	5.6	5.4
std error	2.8	2.7

	% organic carbon	
subsoil	Thinned%	Control %
Arthur's Brook	7.5	6.9
Bog Meadow	[6.0]	[5.1]
Mount Misery	[4.6]	[4.0]
White Oak	7.6	7.8
average	6.5	6.0
std dev	1.4	1.7
std error	0.7	0.9

provided in appendix E in tables E4 through E6. There is, however, significantly more organic carbon in the Bog Meadow thinned area topsoil sample than in that for the control area ($P<0.01$). The Arthur's Brook thinned area subsoil has significantly more organic carbon than the control sample ($P<0.01$). The Mount Misery control subsoil sample has significantly more organic carbon than the thinned area sample ($P<0.01$). The relevant significant tests are provided here in tables 32 through 34.

Table 32. Bog Meadow test for significant difference in organic carbon content in top soil between thinned and control areas: single factor analysis of variance without replication, where treatment is the factor.

Bog Meadow topsoil organic carbon content
Input 7.

run #	thinned	control
1	22.8	17.8
2	21.8	15.2
3	23.2	17.1

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
thinned	3	67.76	22.59	0.51
control	3	50.08	16.69	1.77

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	52.0675	1	52.07	45.72	0.0025	7.71
Within Groups	4.55553	4	1.14			
Total	56.62303	5				

Table 33. Arthur's Brook test for significant difference in organic carbon content in subsoil between thinned and control areas: single factor analysis of variance without replication, where treatment is the factor.

Bog Meadow subsoil organic carbon content.
Input 8.

run #	thinned	control
1	6.2	4.9
2	5.8	5.0
3	6.1	5.4

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
thinned	3	18.06	6.02	0.050
control	3	15.26	5.09	0.053

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.304333	1	1.30	25.28	0.007	7.71
Within Groups	0.206345	4	0.05			
Total	1.510678	5				

Table 34. Mount Misery test for significant difference in organic carbon content in subsoil between thinned and control areas: single factor analysis of variance without replication, where treatment is the factor.

Mount Misery subsoil organic carbon content
Input 9.

run #	thinned	control
1	4.7	4.2
2	4.6	3.9
3		4.0

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
thinned	2	9.29	4.65	0.0043
control	3	12.09	4.03	0.0173

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.456407	1	0.456	35.207	0.0096	10.128
Within Groups	0.03889	3	0.013			
Total	0.495297	4				

Discussion

Species Richness and Species Diversity Indices

All calculated values of H′ for trees vary between about 1.6 and 2. In nature, H′ usually varies between 1.5 and 3.5 and rarely exceeds a value of 4.5 (Magurran 1988). This may indicate that the diversity of tree species communities, at least in second growth woodlands, are relatively less diverse than most biological communities. Theoretically, E can vary only between 0 and 1. Our values vary between 0.68 and 0.81.

The general lack of significant differences for all diversity indices between the classes within the various comparison categories may be due, at least in part, to the number of areas sampled for each treatment area: perhaps more samples in each treatment area would have produced significant differences. However, it may be that these results signify that the affects of these forest management practices on woody plant diversity after 65 years has greatly diminished. Reiners (1992) studied all plant species in an experimentally deforested area in Hubbard Brook Experimental Forest in the White Mountains for twenty years after deforestation. He found that plant species richness started out relatively low and increased until it leveled off after about 4 years. The Shannon diversity index and Equitability, J′ (an index similar to E), for all plants, on the other hand, started out relatively high and decreased until they leveled off after about 6 or 7 years. This may indicate that most of the big differences in quantitative diversity between treatments is only noticeable soon after the treatment has taken place. However, it may be that the quantitative diversity of woody species are not as affected by forest treatment as is the diversity of the various groups of herbaceous species. Perhaps separate studies of such groups would produce a wide variety of results.

The only significant difference in a diversity index between the classes in the comparison categories was for the comparison between the thinned and control areas in the Mount Misery section: the control area had a significantly higher (12%) Shannon diversity index (1.82) than the thinned area (1.62). Besides treatment, this difference might be explained by the fact that the Mount Misery thinned area is on the north side and the control on the south side of an east-west running valley. It should also be noted that the direction of this difference does not obviously indicate that the control area is healthier than the thinned area. If we had included the number of individual shrub stems in this treatment area in our calculations of H′ and E, as we did for trees, the values of these indices would, most likely, have been greater on the thinned than on the control areas. This is due to the much greater presence of shrub species on the control area and to the tendency of the presence of a few highly abundant species to decrease the H′ and E values, by decreasing the equitability of relative abundances of species. (This can be proven by calculating H′ and E for hypothetical treatment areas that are identical in terms of their tree species abundances, but differ in that only one contains an extra highly abundant shrub). In such a case, S may be a better indicator of forest health than either H′ or E. However, it may not even be true that a larger value of S indicates greater well-being. For example, a large S value may represent the invasion of species alien to the forest community—two woody species, European Larch and Japanese Barberry, found in the study areas are aliens. Such an invasion may be the source of unhealthy competition for native species.

It is interesting to note that there was no significant difference found between the local terrain classes. One might expect that such an important factor as the relative steepness or the presence of a stream would affect the species diversity indices more than forest treatment. However, the t-test for significant differences between H′ values, for example, produces quite similar P-values (compare tables C26 and C32).

Tree Species Composition[6]

The significantly greater relative abundance of Red Oaks on clearcuts than on control or thinned (factor of two) areas might be explained by a greater tendency by these trees than others to sprout stems from the living root systems that remain after cutting. Our methods involved the counting of tree stems growing from the same root system as distinct trees. The records from the 1930's indicated that trimming and weeding was performed on some of the treatment areas several years after the initial cuttings. It is uncertain, however, whether these actions encouraged Red Oak saplings. Additionally, Red Oaks have about twice the relative abundance on the Bog Meadow thinned and control areas than they do for such areas on Mount Misery or Arthur's Brook. This might be due to any number of local environmental factors not covered in this study. The obvious difference between these areas is that Bog Meadow is on a east facing slope, whereas the all the other slopes in this study face either north or south.

Yellow Birches are about more than 20 times more abundant near streams than they are on hillsides or drier flat areas in the study area. Yellow Birches are known to do

[6] Appendix F describes some basic ecology of the species that are mentioned in the discussion section.

well in moist forests (Petrides, 1972), which may explain their distribution in the study area. Sugar Maples are about 10 times more abundant near streams than they are on hillsides of drier flat areas in these forest sections. This species is renowned for its ability slowly, but surely, take over the forest canopy(Krichner and Morrison, 1988). It does so by growing well in the shade and then sprouting quickly when gaps open in the canopy. It may be that such gaps are periodically available as Arthur's Brook periodically meander's back and forth. It is interesting to note that these two species, Yellow Birch and Sugar Maple, are two of the most abundant species in the Northern Hardwood Forest to the north; perhaps this stream valley represents a microclimate suitable for species normally associated with higher latitudes.

Chestnut Oaks are about 10 times as abundant on hillsides and relatively dry flat areas in the study area than they are near Arthur's Brook. They are known to be an upland tree(Petrides, 1972). This may explain the distribution between terrain classes shown in table 13 (or 14?). Red Maples have a 30% higher relative abundance on hillsides than they do on relatively dry flat areas and about 230% higher relative abundance on these flat areas than they do near Arthur's Brook. This distribution would seem to contradict the primary description of this species as a "water loving species" (Krichner and Morrison, 1988). However, it is also known that these species are very adaptable and can also do well in drier soils. Perhaps the closely related Sugar Maples out compete the Red Maples in the stream valley. Since there was little systematic difference in relative abundances of Yellow Birch, Sugar Maple, Red Maple or Chestnut Oak between treatments, it seems unlikely that the species composition differences between terrain classes was affected by the distribution of sample plots among the various treatment areas (see table 2).

Shrub Coverage

Most of the shrub cover present in the study area is represented by Heaths (see appendix F): mostly Mountain Laurel, various Blueberries, and Black Huckleberries; and, to a lesser extent, pink azalea, *Gautheria procumbens*, and spotted pipsissewa ('holly'in the tables). This family of plants prefers acidic dry soils in cool climates.

It may be that there is a general trend in shrub cover values to increase from clearcut to thinned areas and from thinned areas to controls. However, the large scatter of the data make such a conclusion impossible. The main deviation from this trend seems to stem from the large amount of shrub cover present on the Bog Meadow thinned area relative to the Bog Meadow control area. It has been suggested that this situation may be due to a large slab of shallow bedrock present beneath the control area, which prevents the growth of the shrubs. If such bedrock were limestone or some other type of calcareous rock, it might raise the soil pH enough to exclude the acid loving shrubs from this area.

Soil Organic Content

In general topsoils contained about 2 to 4 times as much organic carbon than subsoils. Topsoils appear dark and loamy with some clumps and undecomposed plant material, whereas subsoils mostly light yellow-brown and had a fine texture. No consistent relationship between overall soil organic content and forest treatment was found. Bog Meadow thinned area top and subsoils were significantly higher in organic carbon than were those for the Bog Meadow control—35% and 18% higher respectively. The Mount Misery control area had significantly more organic carbon—15%—than the

Mount Misery thinned area. These results are consistent with the relative amounts of shrub cover on these treatment areas. A greater amount of shrub cover should produce a greater amount of leaf litter in the O horizon (plant litter layer), which, in turn, should produce a greater amount of soil humus in the A horizon (topsoil), and, perhaps, a greater trace amount of organic carbon in the B horizon (subsoil).

Recommendations

It might be interesting to count the number genetically individual trees on the sample plots. These may produce quite different results than those of this study. For example, if the relative abundances of Red Oaks on clearcuts did not greatly exceed those on control or thinned areas, then it might be concluded that the greater relative abundance of Red Oak stems is indeed caused by a greater tendency than other species to sprout from stumps. Hilltops show potentially significant differences in species composition that were not investigated in this study due to a deficiency of sample plots; therefore it may prove interesting to investigate additional hilltop sample plots. Additionally, one might find a better way to estimate the coverage by or abundance of individual shrubs species, and, thus, be able to accurately assess the effect of forest treatment on the understorey. Soil samples for each sample plot might tested in order to test the hypothesis that organic carbon content is positively related to shrub cover, and, perhaps, therefore, to forest treatment.

It seems that these sections of forest have great potential for similar but more comprehensive biodiversity studies. They might include surveys of: prokaryotic and eukaryotic unicellular organisms, fungi, non-woody plant species, amphibians, and mammals. Ferns and mosses, for example, are much more site specific than woody species and would thus be expected to have greater differences in diversity under different conditions. They may prove to be good indicators of local site conditions like soil pH and moisture (Cobb 1984). With the information achieved from such studies and knowledge of the interrelationships between the studied organisms and between the organisms and non-living elements, one might be in a position to hypothesize causal relationships between any differences in the abundances of species between treatment areas and terrain classes.

Finally, a future study might be performed in an area that has not yet been treated. An inventory of abundances and coverage of organisms could be taken before the treatment and at various intervals after the treatment. In this way, the effects of local terrain might be eliminated, because one would be comparing indices and abundances for the same terrain.

Conclusion

It is apparent that local terrain and forest management affect the species composition of the area studied at Black Rock Forest. Yellow Birch dominates the Arthur's Brook stream valley area, where it is noticeably absent from hillside and drier flat areas. Likewise, Sugar Maple is much more abundant in the Arthur's Brook stream valley than on the hillsides or drier flat areas of the study area. Red Maples and Chestnut Oaks are affected by terrain in an opposite way; these species are noticeably deficient in the stream valley, while being more abundant on the drier flat areas and hillsides. The forest management practice of clear cutting has increased the relative number of Red Oaks relative to thinned and untreated areas. Additionally, it is highly likely that the shrub cover of an area is positively related to the soil organic content.

These substantial differences in qualitative species composition are not reflected in quantitative diversity measures: differences in woody plant diversity are minimal between clearcut, thinned, and control areas and between the local terrain classes of stream valley, flat area, and hillside. Thus, it seems that critical factors that affect the ecology of forests—like the identity of important species—might not be reflected in quantitative measures of diversity.

Arthur's Brook Data (CC, Thin, and Con)
Number of individuals of each species or indication of presense or absence of species.

Notes: BM thinned (plot 1),BM control (plot 5), and MM thinned (plot 3) contain black oaks; however, blacknot distinguished from red oaks on many plots and are included with and scarlet oaks were them in the tables.

Table A1. Arthur's Brook clearcut trees. Values in the first six columns represent the number of each tree species found on each tenth acre circle. pi, %species abundance, and its standard deviation are also listed.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	total/sp.	average	std dev	pi = total/sp. / tot ind/CC	%total/sp. / tot ind/CC	%std dev
Red Maple	3	1	15	14	18	22	73	12.2	8.4	0.280	28.0	19.3
Witch Hazel	6	6	3	2	4	12	33	5.5	3.6	0.126	12.6	8.2
Red Oak	7	4	8	13	5	10	47	7.8	3.3	0.180	18.0	7.6
Chestnut Oak		1	6	7	10	8	32	5.3	4.0	0.123	12.3	9.2
Black Birch			11	6	5	3	25	10.0	7.6	0.096	9.6	17.5
Sugar Maple	5	3					8	1.3	2.2	0.031	3.1	5.0
Yellow Birch	7	19	5		1		32	5.3	7.3	0.123	12.3	16.7
Downey Juneberry			1			3	4	0.7	1.2	0.015	1.5	2.8
Black Gum			1				1	0.2	0.4	0.004	0.4	0.9
Striped Maple												
American Chestnut			1			1	2	0.3	0.5	0.008	0.8	1.2
White Oak				1			1	0.2	0.4	0.004	0.4	0.9
Eastern Hemlock												
Pignut Hickory												
White Ash		2					2	0.3	0.8	0.008	0.8	1.9
American Beech				1			1	0.2	0.4	0.004	0.4	0.9
American Basswood												
Shagbark Hickory												
Larch												
total # individuals (all sp)	28	36	51	44	43	59	261	43.5	10.9	1	100	

Table A2. Arthur's Brook thinned area trees. Values in the first six columns represent the number of each tree species found on each tenth acre circle. pi, %species abundance, and its standard deviation are also listed.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	total/sp.	average	std dev	pi= total/sp. tot ind/Th	%total/sp. tot ind/Th	%std dev
Red Maple	6	5	12	11	4	22	60	10.0	6.7	0.274	27.4	18.4
Witch Hazel	6	8	7	1	13	5	40	6.7	3.9	0.183	18.3	10.8
Red Oak	2	1	4	6	1	8	22	3.7	2.9	0.100	10.0	7.9
Chestnut Oak	1	4	10	4		8	27	4.5	3.9	0.123	12.3	10.6
Black Birch		5	9	3		7	24	4.0	3.7	0.110	11.0	10.1
Sugar Maple	5				7		12	2.0	3.2	0.055	5.5	8.7
Yellow Birch	6	7			4		17	2.8	3.3	0.078	7.8	8.9
Downey Juneberry		2	1	2		3	8	1.3	1.2	0.037	3.7	3.3
Black Gum												
Striped Maple			1		1		2	0.3	0.5	0.009	0.9	1.4
American Chestnut				1		1	2	0.3	0.5	0.009	0.9	1.4
White Oak						1	1	0.2	0.4	0.005	0.5	1.1
Eastern Hemlock	1	2					3	0.5	0.8	0.014	1.4	2.3
Pignut Hickory												
White Ash												
American Beech												
American Basswood					1		1	0.2	0.4	0.005	0.5	1.1
Shagbark Hickory												
Larch												
total # individuals (all sp)	27	34	44	28	31	55	219	36.5	10.9	1	100.0	

Table A3. Arthur's Brook control trees. Values in the first six columns represent the number of each tree species found on each tenth acre circle. pi, %species abundance, and its standard deviation are also listed.

AB Control: Trees										pi=		
										total/sp.	%total/sp.	
Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	total/sp.	average	std dev	tot ind/Co	tot ind/Co	%std dev
Red Maple		8	15	13	19	24	79	13.2	8.4	0.324	32.4	20.7
Witch Hazel	4	7	9	5	5	5	35	5.8	1.8	0.143	14.3	4.5
Red Oak	4	3	2	2	4	5	20	3.3	1.2	0.082	8.2	3.0
Chestnut Oak		6	11	4	11	12	44	7.3	4.8	0.180	18.0	11.8
Black Birch	2	1	7	6	8	3	27	4.5	2.9	0.111	11.1	7.1
Sugar Maple	3						3	0.5	1.2	0.012	1.2	3.0
Yellow Birch	2						2	0.3	0.8	0.008	0.8	2.0
Downey Juneberry		4	7	4	1	5	21	3.5	2.6	0.086	8.6	6.4
Black Gum												
Striped Maple		2					2	0.3	0.8	0.008	0.8	2.0
American Chestnut	1	2	2	2		1	8	1.3	0.8	0.033	3.3	2.0
White Oak						2	2	0.3	0.8	0.008	0.8	2.0
Eastern Hemlock												
Pignut Hickory												
White Ash	1						1	0.2	0.4	0.004	0.4	1.0
American Beech												
American Basswood												
Shagbark Hickory												
Larch												
total # individuals (all sp)	17	33	53	36	48	57	244	40.7	14.9	1.00	100.0	

Table A4. Summary of Arthur's Brook tree species: total number of individuals, average number of individuals per circle, and % abundance of each species for each treatment.

Species	ABCCut total/sp.	ABCcut average	%total/sp. tot ind/CC	ABThin total/sp.	ABThin average	%total/sp. tot ind/Th	ABCont total/sp.	ABCont average	total/sp. ot ind/Co
Red Maple	73	12.2	28.0	60	10.0	27.397	79	13.2	32.4
Witch Hazel	33	5.5	12.6	40	6.7	18.265	35	5.8	14.3
Red Oak	47	7.8	18.0	22	3.7	10.046	20	3.3	8.2
Chestnut Oak	32	5.3	12.3	27	4.5	12.329	44	7.3	18.0
Black Birch			9.6	24	4.0	10.959	27	4.5	11.1
Sugar Maple	8	1.3	3.1	12	2.0	5.479	3	0.5	1.2
Yellow Birch	32	5.3	12.3	17	2.8	7.763	2	0.3	0.8
Downey Juneberry	4	0.7	1.5	8	1.3	3.653	21	3.5	8.6
Black Gum	1	0.2	0.4						
Striped Maple				2	0.3	0.913	2	0.3	0.8
American Chestnut	2	0.3	0.8	2	0.3	0.913	8	1.3	3.3
White Oak	1	0.2	0.4	1	0.2	0.457	2	0.3	0.8
Eastern Hemlock				3	0.5	1.370			
Pignut Hickory									
White Ash	2	0.3	0.8				1	0.2	0.4
American Beech	1	0.2	0.4						
American Basswood						0.46			
Shagbark Hickory									
Larch									
total # individuals (all sp)	261	43.5	100.0	219	36.5	100.0	244	40.7	100.0

Bog Meadow Data (CC, Thin, and Con)
Number of individuals of each species.

Table A5. Bog Meadow clearcut trees. Values in the first six columns represent the number of each tree species found on each tenth acre circle. pi, %species abundance, and its standard deviation are also listed.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	total/sp.	average	std dev	pi= total/sp. / tot ind/CC	%total/sp. / tot ind/CC	%std dev
Red Maple	6	15	3	9	7	3	43	7.2	4.5	0.209	20.9	13.1
Witch Hazel	4	6	4	11	6	3	34	5.7	2.9	0.165	16.5	8.4
Red Oak	7	16	10	8	19	16	76	12.7	5.0	0.369	36.9	14.5
Chestnut Oak	3	3	3	8	3	2	22	3.7	2.2	0.107	10.7	6.3
Black Birch	4		1	2			7	1.2	1.6	0.034	3.4	4.7
Sugar Maple	14			3			17	2.8	5.6	0.083	8.3	16.3
Yellow Birch												
Downey Juneberry												
Black Gum												
Striped Maple												
American Chestnut												
White Oak				1	1		2	0.3	0.5	0.010	1.0	1.5
Eastern Hemlock												
Hickory		1			2		3	0.5	0.8	0.015	1.5	2.4
White Ash	1						1	0.2	0.4	0.005	0.5	1.2
American Beech												
American Basswood												
Shagbark Hickory												
Larch	1						1	0.2	0.4	0.005	0.5	1.2
total # individuals (all sp)	40	41	21	42	38	24	206	34.3	9.3	1.000	100.0	

Table A6. Bog Meadow thinned area trees. Values in the first six columns represent the number of each tree species found on each tenth acre circle. pi, %species abundance, and its standard deviation are also listed.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	total/sp.	average	std dev	pi= total/sp. tot ind/Th	%total/sp. tot ind/Th	%std dev
Red Maple	18	5	14	8	9	7	61	10.2	4.9	0.223	22.3	10.7
Witch Hazel	5	11	4	19	4		43	7.2	6.8	0.157	15.7	14.9
Red Oak	6	12	8	6	12	16	60	10.0	4.0	0.219	21.9	8.8
Chestnut Oak	13	12	7	9	16	27	84	14.0	7.1	0.307	30.7	15.5
Black Birch		2	2		1		5	0.8	1.0	0.018	1.8	2.2
White Ash					1	2	3	0.5	0.8	0.011	1.1	1.8
Yellow Birch												
Downey Juneberry		2		1	5	1	9	1.5	1.9	0.033	3.3	4.1
Black Gum												
Striped Maple	2						2	0.3	0.8	0.007	0.7	1.8
American Chestnut				1			1	0.2	0.4	0.004	0.4	0.9
White Oak						6	6	1.0	2.4	0.022	2.2	5.4
Eastern Hemlock												
Pignut Hickory												
White Ash												
American Beech												
American Basswood												
Shagbark Hickory												
Larch												
total # individuals (all sp)	44	44	35	44	48	59	274	45.6667	7.8	1.000	100.0	17.1

Table A7. Bog Meadow control trees. Values in the first six columns represent the number of each tree species found on each tenth acre circle. pi, %species abundance, and its standard deviation are also listed.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	total/sp.	average	std dev	pi= total/sp. tot ind/Co	%total/sp. tot ind/Co	%std dev
Red Maple	9	11	7	13	6	5	51	8.5	3.1	0.325	32.5	11.8
Witch Hazel	2	17	3	3	2	10	37	6.2	6.1	0.236	23.6	23.4
Red Oak	4	6	9	7	3	3	32	5.3	2.4	0.204	20.4	9.3
Chestnut Oak	1	9	2	3	4	1	20	3.3	3.0	0.127	12.7	11.5
Black Birch	1	7			2	2	12	2.0	2.6	0.076	7.6	10.0
Sugar Maple						3	3	0.5	1.2	0.019	1.9	4.7
Yellow Birch												
Downey Juneberry												
Black Gum												
Striped Maple												
American Chestnut						2	2	0.3	0.8	0.013	1.3	3.1
White Oak												
Eastern Hemlock												
Hickory												
White Ash												
American Beech												
American Basswood												
Shagbark Hickory												
Larch												
total # individuals (all sp)	17	50	21	26	17	26	157	26.2	12.4	1.000	100.0	47.2

Table A8. Summary of Bog Meadow tree species: total number of individuals, average number of individuals per circle, and % abundance of each species for each treatment.

Species	BMCCut total/sp.	BMCcut average	%total/sp. tot ind/CC	BMThin total/sp.	BMThin average	%total/sp. tot ind/Th	BMCont total/sp.	BMCont average	%total/sp. tot ind/Co
Red Maple	43	7.2	20.9	61	10.2	22.3	51	8.5	32.5
Witch Hazel	34	5.7	16.5	43	7.2	15.7	37	6.2	23.6
Red Oak	76	12.7	36.9	60	10.0	21.9	32	5.3	20.4
Chestnut Oak	22	3.7	10.7	84	14.0	30.7	20	3.3	12.7
Black Birch	7	1.2	3.4	5	0.8	1.8	12	2.0	7.6
Sugar Maple	17	2.8	8.3	3	0.5	1.1	3	0.5	1.9
Yellow Birch									
Downey Juneberry				9	1.5	3.3			
Black Gum									
Striped Maple				2	0.3	0.7	2	0.3	1.3
American Chestnut				1	0.2	0.4			
White Oak	2	0.3	1.0	6	1.0	2.2			
Eastern Hemlock									
Pignut Hickory	3	0.5	1.5						
White Ash	1	0.2	0.5						
American Beech									
American Basswood									
Shagbark Hickory									
Larch	1	0.2	0.5						
total # individuals (all sp)	206	34.3	100.0	274	45.7	100.0	157	26.2	100.0

Mount Misery Data (CC, Thin, and Con)
Number of individuals of each species.

Table A9. Mount Misery thinned area trees. Values in the first six columns represent the number of each tree species found on each tenth acre circle. pi, %species abundance, and its standard deviation are also listed.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	total/sp.	average	std dev	pi= total/sp. / tot ind/Th	%total/sp. / tot ind/Th	%std dev
Red Maple	7	3	16	11	25	5	67	11.2	8.2	0.205	20.5	15.1
Witch Hazel	10	17	40	32	17	33	149	24.8	11.8	0.456	45.6	21.6
Red Oak	5	6	11	3	7	9	41	6.8	2.9	0.125	12.5	5.2
Chestnut Oak	2		5	3	3	1	14	2.3	1.8	0.043	4.3	3.2
Black Birch	3	2		3		1	9	1.5	1.4	0.028	2.8	2.5
Sugar Maple	1	3		1		3	8	1.3	1.4	0.024	2.4	2.5
Yellow Birch												
Downey Juneberry												
Black Gum	6	10	1			3	20	3.3	4.0	0.061	6.1	7.3
Striped Maple												
American Chestnut												
White Oak				1	3		4	0.7	1.2	0.012	1.2	2.2
Eastern Hemlock												
Pignut Hickory	2				11		13	2.2	4.4	0.040	4.0	8.1
White Ash						1	1	0.2	0.4	0.003	0.3	0.7
American Beech												
American Basswood												
Shagbark Hickory					1		1	0.2	0.4	0.003	0.3	0.7
Larch												
total # individuals (all sp)	36	41	73	54	67	56	327	54.5	14.3	1.000	100.0	

Table A10. Mount Misery control area trees. Values in the first six columns represent the number of each tree species found on each tenth acre circle. pi, %species abundance, and its standard deviation are also listed.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	total/sp.	average	std dev	pi= total/sp. tot ind/Co	%total/sp. tot ind/Co	%std dev
Red Maple	11	26	7	3	40	23	110	18.3	13.9	0.264	26.4	20.1
Witch Hazel	32	18	28	37	14	6	135	22.5	11.8	0.325	32.5	17.0
Red Oak	4	4	11	13	7	5	44	7.3	3.8	0.106	10.6	5.5
Chestnut Oak	2	6			7	6	21	3.5	3.2	0.050	5.0	4.6
Black Birch	4	17	10	4	5	7	47	7.8	5.0	0.113	11.3	7.3
Sugar Maple												
Yellow Birch												
Downey Juneberry						1	1	0.2	0.4	0.002	0.2	0.6
Black Gum	11	4		1			16	2.7	4.4	0.038	3.8	6.3
Striped Maple	5		2		11	2	20	3.3	4.2	0.048	4.8	6.0
American Chestnut	3	2			1	1	7	1.2	1.2	0.017	1.7	1.7
White Oak				1			1	0.2	0.4	0.002	0.2	0.6
Eastern Hemlock	2	1	1	1	4	4	13	2.2	1.5	0.031	3.1	2.1
Pignut Hickory												
White Ash												
American Beech	1						1	0.2	0.4	0.002	0.2	0.6
American Basswood												
Shagbark Hickory												
Larch												
total # individuals (all sp)	75	78	59	60	89	55	416	69.3	13.4	1.000	100.0	

Table A11. Summary of Mount Misery tree species: total number of individuals, average number of individuals per circle, and % abundance of each species for each treatment.

Species	MMThin total/sp.	MMThin average	%total/sp. tot ind/Th	MMCont total/sp.	MMCont average	%total/sp. tot ind/Co
Red Maple	67	11.2	20.5	110	18.3	26.4
Witch Hazel	149	24.8	45.6	135	22.5	32.5
Red Oak	41	6.8	12.5	44	7.3	10.6
Chestnut Oak	14	2.3	4.3	21	3.5	5.0
Black Birch	9	1.5	2.8	47	7.8	11.3
Sugar Maple	8	1.3	2.4			
Yellow Birch						
Downey Juneberry				1	0.2	0.2
Black Gum	20	3.3	6.1	16	2.7	3.8
Striped Maple				20	3.3	4.8
American Chestnut				7	1.2	1.7
White Oak	4	0.7	1.2	1	0.2	0.2
Eastern Hemlock				13	2.2	3.1
Pignut Hickory	13	2.2	4.0			
White Ash	1	0.2	0.3			
American Beech				1	0.2	0.2
American Basswood						
Shagbark Hickory	1	0.2	0.3			
Larch						
total # individuals (all sp)	327	54.5	100.0	416	69.3	100.0

Table A12. Summary of the total number of each tree species on each treatment area.

seq#	Species	code	ABCCut total/sp.	ABThin total/sp.	ABCont total/sp.	BMCCut total/sp.	BMThin total/sp.	BMCont total/sp.	MMThin total/sp.	MMCont total/sp.	totals	total pi =%totsp/tot
1	Red Maple	RM	73	60	79	43	61	51	67	110	544	25.86
2	Witch Hazel	WH	33	40	35	34	43	37	149	135	506	24.05
3	Red Oak	RO	47	22	20	76	60	32	41	44	342	16.25
4	Chestnut Oak	CO	32	27	44	22	84	20	14	21	264	12.55
5	Black Birch	BB	25	24	27	7	5	12	9	47	156	7.41
6	Sugar Maple	SuM	8	12	3	17		3	8		51	2.42
7	Yellow Birch	YB	32	17	2						51	2.42
8	Downey Juneberry	DJ	4	8	21		9			1	43	2.04
9	Black Gum	BG	1						20	16	37	1.76
10	Striped Maple	StM		2	2		2	2		20	28	1.33
11	American Chestnut	AC	2	2	8		1			7	20	0.95
12	White Oak	WO	1	1	2	2	6		4	1	17	0.81
13	Eastern Hemlock	EH		3						13	16	0.76
14	Pignut Hickory	PH				3			13		16	0.76
15	White Ash (Red?)	WA	2		1	1	3		1		8	0.38
16	American Beech	Be	1							1	2	0.10
17	American Basswood	AB		1							1	0.05
18	Shagbark Hickory	SH							1		1	0.05
19	Larch	La				1					1	0.05
	total # individuals (all sp)		261	219	244	206	274	157	327	416	2104	

Table A13. Arthur's Brook clearcut shrub species. The bottom row indicates the total number of shrub species for each circle, for the treatment area as a whole, and the average number of shrub species per circle. Shrub coverage is estimated with the Brown-Blanquet cover scale: 1= 0-5%, 2=6-25%, 3=26-50%, 4=51-75%, and 5=76-100%.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	ABCCut all plots	average	std dev
Shrub Cover:	1	1	3	5	5	5			
Mountain Laurel	present	present	present	present	present	present	present		
Pink Azalea		present		present		present	present		
Japanese Barberry									
Virginia Creeper									
Sample #ABthin1a									
Sample #ABthin1b									
Sample #ABthin1c									
"*Vaccinium palidum*"	present	present	present	present	present	present	present		
"*V. angustifolium*"		present	present	present		present	present		
"*V. corymbosum*"	present	present	present		present	present	present		
"*V. vacillans*"	present	present	present	present	present	present	present		
"*V*. big *ang.* #1"				present	present	present	present		
"*V.* hairy *corymbosum*"			present				present		
Poison ivy									
Southern Arrowwood									
Sample #ABthin5a									
Black Huckleberry	present	present	present	present	present	present	present		
Gautheria Procumbens			present	present	present	present	present		
Maple Leaf Viburnum				present			present		
total number of shrub sp	5	7	8	9	7	9	11	7.5	1.5

Table 14. Arthur's Brook thinned area shrub species. The bottom row indicates the total number of shrub species for each circle, for the treatment area as a whole, and the average number of shrub species per circle. Shrub coverage is estimated with the Brown-Blanquet cover scale: 1= 0-5%, 2=6-25%, 3=26-50%, 4=51-75%, and 5=76-100%.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	ABThin all plots	avg # sp.	std dev
Shrub Cover:	1	3	3	2	5	5			
Mountain Laurel	present	present	present	present	present	present	present		
Pink Azalea		present	present	present	present		present		
Japanese Barberry									
Virginia Creeper									
Sample #ABthin1a	present						present		
Sample #ABthin1b	present						present		
Sample #ABthin1c	present						present		
"*Vaccinium palidum*"	present	present	present	present	present	present	present		
"*V. angustifolium*"	present	present	present	present	present	present	present		
"*V. corymbosum*"	present		present	present	present		present		
"*V. vacillans*"	present	present	present	present		present	present		
"*V*. big *ang. #1*"		present			present	present	present		
"*V.* hairy *corymbosum*"	present						present		
Poison ivy					present		present		
Southern Arrowwood					present		present		
Sample #ABthin5a					present		present		
Black Huckleberry	present	present	present	present		present	present		
Gautheria Procumbens		present	present			present	present		
Maple Leaf Viburnum									0.0
total number of shrub sp	10	8	8	7	9	7	16	8.2	1.2

Table A15. Arthur's Brook control shrub species. The bottom row indicates the total number of shrub species for each circle, for the treatment area as a whole, and the average number of shrub species per circle. Shrub coverage is estimated with the Brown-Blanquet cover scale: 1=0-5%, 2=6-25%, 3=26-50%, 4=51-75%, and 5=76-100%.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	ABCont all plots	avg # sp.	std dev
Shrub Cover:	2	5	5	5	5	5			
Mountain Laurel	present	present	present	present	present	present	present		
Pink Azalea		present		present		present	present		
Japanese Barberry									
Virginia Creeper									
Sample #ABthin1a									
Sample #ABthin1b									
Sample #ABthin1c									
"*Vaccinium palidum*"	present	present	present	present	present	present	present		
"*V. angustifolium*"		present	present	present		present	present		
"*V. corymbosum*"	present	present	present		present	present	present		
"*V. vacillans*"	present	present	present	present	present	present	present		
"*V*. big *ang.* #1"									
"*V*. big *ang*. #2"									
"*V.* hairy *corymbosum*"			present				present		
Poison ivy									
Southern Arrowwood									
Sample #ABthin5a									
Black Huckleberry	present	present	present	present	present	present	present		
Gautheria Procumbens			present	present	present	present	present		
Maple Leaf Viburnum									
total #shrub sp	5	7	8	7	6	8	9	6.8	1.2

Table A16. Bog Meadow clearcut shrub species. The bottom row indicates the total number of shrub species for each circle, for the treatment area as a whole, and the average number of shrub species per circle. Shrub coverage is estimated with the Brown-Blanquet cover scale: 1= 0-5%, 2=6-25%, 3=26-50%, 4=51-75%, and 5=76-100%.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	BMCCut all plots	avg# shrub sp/circle	std dev
Shrub Cover:	1	3	3	1	3	3			
Mountain Laurel	present			present			present		
Pink Azalea									
Japanese Barberry									
Virginia Creeper									
Sample #ABthin1a									
Sample #ABthin1b			present				present		
Sample #ABthin1c									
"*Vaccinium palidum*"	present	present	present	present	present	present	present		
"*V. angustifolium*"	present	present	present	present	present	present	present		
"*V. corymbosum*"	present	present	present	present	present	present	present		
"*V. vacillans*"	present	present	present	present	present	present	present		
"*V*. big *ang. #1*"	present	present	present	present		present	present		
"*V.* hairy *corymbosum*"		present	present				present		
Poison ivy									
Southern Arrowwood									
Sample #ABthin5a									
Black Huckleberry	present	present	present	present	present	present	present		
Gautheria Procumbens									
Maple Leaf Viburnum									
"heart leaf"			present	present			present		
Sample #BMCC4a				present			present		
total # shrub sp	7	7	9	9	5	6	11	7.2	1.6

Table 17. Bog Meadow thinned area shrub species. The bottom row indicates the total number of shrub species for each circle, for the treatment area as a whole, and the average number of shrub species per circle. Shrub coverage is estimated with the Brown-Blanquet cover scale: 1= 0-5%, 2=6-25%, 3=26-50%, 4=51-75%, and 5=76-100%.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	BMThin all plots	avg# shrub sp/circle	std dev
Shrub Cover:	5	5	5	5	5	5			
Mountain Laurel	present	present	present	present	present		present		
Pink Azalea	present	present	present	present			present		
Japanese Barberry									
Virginia Creeper									
Sample #ABthin1a									
Sample #ABthin1b									
Sample #ABthin1c					present	present	present		
"*Vaccinium palidum*"	present	present	present	present	present	present	present		
"*V. angustifolium*"	present	present	present	present	present	present	present		
"*V. corymbosum*"	present	present	present	present	present	present	present		
"*V. vacillans*"	present	present	present	present	present	present	present		
"*V*. big *ang.* #1"	present	present	present	present	present	present	present		
"*V.* hairy *corymbosum*"			present				present		
Poison ivy									
Southern Arrowwood									
Sample #ABthin5a									
Black Huckleberry	present	present	present	present	present	present	present		
Gautheria Procumbens					present	present	present		
Maple Leaf Viburnum									
"Deerberry"						present	present		
total # shrub sp	8	8	9	8	9	9	12	8.5	0.5

Table A18. Bog Meadow control shrub species. The bottom row indicates the total number of shrub species for each circle, for the treatment area as a whole, and the average number of shrub species per circle. Shrub coverage is estimated with the Brown-Blanquet cover scale: 1= 0-5%, 2=6-25%, 3=26-50%, 4=51-75%, and 5=76-100%.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	BMCont all plots	avg# shrub sp/circle	std dev
Shrub Cover:	4	4	3	1	2	1			
Mountain Laurel	present	present	present		present		present		
Pink Azalea	present	present	present	present	present		present		
Japanese Barberry									
Virginia Creeper									
Sample #ABthin1a		present	present		present	present	present		
Sample #ABthin1b									
Sample #ABthin1c									
"*Vaccinium palidum*"	present	present	present	present	present	present	present		
"*V. angustifolium*"	present	present	present	present	present		present		
"*V. corymbosum*"	present	present	present	present	present		present		
"*V. vacillans*"	present	present	present	present	present		present		
"*V*. big *ang.* #1"	present	present	present	present	present		present		
"*V.* hairy *corymbosum*"	present				present				
"*V.* narrow *corymbosum*"									
Poison ivy									
Southern Arrowwood									
Sample #ABthin5a									
Black Huckleberry	present	present	present	present	present		present		
Gautheria Procumbens									
Maple Leaf Viburnum			present	present			present		
"heart leaf"						present	present		
total # shrub sp	9	9	10	8	10	3	12	8.2	2.6

Table A19. Mount Misery thinned area shrub species. The bottom row indicates the total number of shrub species for each circle, for the treatment area as a whole, and the average number of shrub species per circle. Shrub coverage is estimated with the Brown-Blanquet cover scale: 1= 0-5%, 2=6-25%, 3=26-50%, 4=51-75%, and 5=76-100%.

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	MMThin all plots	avg#shrub sp/circle	std dev
Shrub Cover:	1	1	1	1	1	1			
Mountain Laurel		present	present		present	present	present		
Pink Azalea						present	present		
Japanese Barberry									
Virginia Creeper									
Sample #ABthin1a									
Sample #ABthin1b									
Sample #ABthin1c									
"*Vaccinium palidum*"	present	present		present	present	present	present		
"*V. angustifolium*"	present		present			present	present		
"*V. corymbosum*"	present	present	present		present	present	present		
"*V. vacillans*"	present		present	present	present	present	present		
"*V*. big *ang.* #1"									
"*V.* hairy *corymbosum*"									
Poison ivy									
Southern Arrowwood									
Sample #ABthin5a									
Black Huckleberry	present						present		
Gautheria Procumbens									
Maple Leaf Viburnum									
"holly"	present	present		present			present		
Sample #MMthin2a		present					present		
"heart leaf" (MM thin2b)		present			present		present		
total #shrub sp	6	6	4	3	5	6	10	5.0	1.3

Table A20. Mount Misery control area shrub species. The bottom row indicates the total number of shrub species for each circle, for the treatment area as a whole, and the average number of shrub species per circle. Shrub coverage is estimated with the Brown-Blanquet cover scale: 1= 0-5%, 2=6-25%, 3=26-50%, 4=51-75%, and 5=76-100%.

MMCont avg#shrub

Species	plot 1	plot 2	plot 3	plot 4	plot 5	plot 6	all plots	sp/circle	std dev
Shrub Cover:	5	5	5	5	5	4			
Mountain Laurel	present	present	present	present	present	present	present		
Pink Azalea	present	present	present	present		present	present		
Japanese Barberry									
Virginia Creeper									
Sample #ABthin1a									
Sample #ABthin1b									
Sample #ABthin1c									
"*Vaccinium palidum*"	present	present	present	present	present	present	present		
"*V. angustifolium*"	present	present		present		present	present		
"*V. corymbosum*"	present		present	present		present	present		
"*V. vacillans*"	present	present	present	present	present	present	present		
"*V*. big *ang.* #1"						present	present		
"*V.* hairy *corymbosum*"									
Poison ivy									
Southern Arrowwood									
Sample #ABthin5a									
Black Huckleberry	present	present	present	present	present	present	present		
Gautheria Procumbens									
Maple Leaf Viburnum		present	present	present		present	present		
"heart leaf"									
Sample #BMCC4a									
"Partridge Berry"						present	present		
total #shrub sp	7	7	7	8	4	10	10	7.2	1.9

Table A21. Summary of shrub species presence or absence for all treatment areas. The last row shows the number of shrub species present on each treatment area.

Species	ABCCut all plots	ABThin all plots	ABCont all plots	BMCCut all plots	BMThin all plots	BMCont all plots	MMThin all plots	MMCont all plots
Mountain Laurel	present	present	present	present	present	present	present	present
Pink Azalea	present	present	present		present	present	present	present
Japanese Barberry								
Virginia Creeper								
Sample #ABthin1a		present				present		
Sample #ABthin1b		present		present				
Sample #ABthin1c		present			present			
"*Vaccinium palidum*"	present	present	present	present	present	present	present	present
"*V. angustifolium*"	present	present	present	present	present	present	present	present
"*V. corymbosum*"	present	present	present	present	present	present	present	present
"*V. vacillans*"	present	present	present	present	present	present	present	present
"*V*. big *ang.* #1"	present	present		present	present	present		present
"*V.* hairy *corymbosum*"	present	present		present	present			
Poison ivy		present	present					
Southern Arrowwood		present						
Sample #ABthin5a		present						
Black Huckleberry	present	present		present	present		present	present
Gautheria Procumbens	present	present	present		present	present		
Maple Leaf Viburnum	present		present					present
Sample #MMthin2a							present	
"heart leaf"				present	present	present	present	
Sample #BMCC4a				present		present	present	present
total number of shrub sp	11	16	9	11	12	12	10	10

Table B1. Stream valley species abundances.

Trees on sample plots that have streams on or near them. Values in columns labeled A through E represent the number of each tree species found on each tenth acre circle. The total number of individuals on all five circles is multiplied by 6/5 to approximate the expected number of individuals that would be found on 6 circles. pi, %species abundance, and its standard deviation (=std dev x6x100%/tot # of trees) are also listed.

species	A ABCCut1	B ABCCut2	C ABThin'	D ABThin5	E ABCont1	average	std dev	nact total/sp.	nexp & Nexp total/sp. X 6/5	'elative abundances pi= total/sp. tot ind/s	%total/sp. tot ind/sv	%std dev
Red Maple	3	1	6	4		2.8	1.9	14	16.8	0.100	10.0	6.8
Witch Hazel	6	6	6	13	4	7	1.6	35	42	0.250	25.0	5.7
Red Oak	7	4	2	1	4	3.6	1.6	18	21.6	0.129	12.9	5.7
Chestnut Oak		1	1			0.4	0.6	2	2.4	0.014	1.4	2.0
Black Birch					2	0.4	0.8	2	2.4	0.014	1.4	2.8
Sugar Maple	5	3	5	7	3	4.6	1.2	23	27.6	0.164	16.4	4.3
Yellow Birch	7	19	6	4	2	7.6	6.3	38	45.6	0.272	27.2	22.6
Downey Juneberry												
Black Gum												
Striped Maple				1		0.2	0.4	1	1.2	0.007	0.7	1.4
American Chestnut					1	0.2	0.4	1	1.2	0.007	0.7	1.3
White Oak												
Eastern Hemlock			1			0.2	0.5	1	1.2	0.007	0.7	1.7
Pignut Hickory												
White Ash		2			1	0.6	0.7	3	3.6	0.021	2.1	2.5
American Beech												
American Basswood				1		0.2	0.4	1	1.2	0.007	0.7	1.4
Shagbark Hickory												
Larch												
expected species "A"									1	0.006	0.6	
total # individuals (all sp)	28	36	27	31	17	27.8	6.8	139	167.8	1	100.0	24.2
# of tree species	5	7	7	7	7	6.6	0.9	12	13			
#shrub species	5	7	10	9	5							
total # woody sp	10	14	17	16	12							

Table B2. Stream valley shrub species.

shrub species	ABCCut1	ABCCut2	ABThin1	ABThin5	ABCont1
Mountain Laurel	present	present	present	present	present
Pink Azalea		present		present	
Japanese Barberry					
Virginia Creeper					
Sample #ABthin1a			present		
Sample #ABthin1b			present		
Sample #ABthin1c			present		
"*Vaccinium palidum*"	present	present	present	present	present
"*V. angustifolium*"		present	present	present	
"*V. corymbosum*"	present	present	present	present	present
"*V. vacillans*"	present	present	present		present
"*V*. big *ang.* #1"				present	
"*V.* hairy *corymbosum*"			present		
Poison ivy				present	
Southern Arrowwood				present	
Sample #ABthin5a				present	
Black Huckleberry	present	present	present		
Gautheria Procumbens					present
Maple Leaf Viburnum					
# of shrub species	5	7	10	9	5
total# of woody species	10	14	17	16	12

Table B3. Trees on flat sample plots. Values in columns labeled A through N represent the number of each tree species found on each tenth acre circle. The total number of individuals on all 14 circles is multiplied by 6/14 to approximate the expected number of individuals that would be found on 6 circles. pi, %species abundance, and its standard deviation (=std dev x6x100%/tot # of trees) are also listed.

flat sample code:	A	B	C	D	E	F	G	H	I	J	K	L	M	N
species	ABCC4	ABCC5	ABCo6	BMTh1	BMTh2	BMCo1	BMCo:	BMCo5	MMTh1	MMTh2	MMTh6	MMCo1	MMCo3	MMCo4
Red Maple	14	18	24	18	5	9	7	6	7	3	5	11	7	3
Witch Hazel	2	4	5	5	11	2	3	2	10	17	33	32	28	37
Red Oak	13	5	5	6	12	4	9	3	5	6	9	4	11	13
Chestnut Oak	7	10	12	13	12	1	2	4	2		1	2		
Black Birch	6	5	3		2	1		2	3	2	1	4	10	4
Sugar Maple									1	3	3			
Yellow Birch		1												
Downey Juneberry														
Black Gum									6	10	3	11		1
Striped Maple				2								5	2	
American Chestnut			1									3		
White Oak	1		2											1
Eastern Hemlock														
Pignut Hickory									2					
White Ash											1			
American Beech	1											1		
American Basswood														
Shagbark Hickory														
Larch														
total # individuals (all sp)	44	43	57	44	44	17	21	17	36	41	56	75	59	60
# of tree species	7	6	7	5	5	5	4	5	8	6	8	9	5	6
# of shrub species	9	7	8	4	5	9	10	10	6	6	6	7	7	8
total# of woody species	16	13	15	9	10	14	14	15	14	12	14	16	12	14

			nexp	relative abundances		
			&Nexp			
	std		total/sp.	total/sp.	%ttl/sp.	
avg	dev	total/sp.	X 6/14	tot ind/fl	tot ind/fl	%std dev
9.8	6.3	137	58.7	0.227	22.7	14.7
13.6	12.6	191	81.9	0.317	31.7	29.3
7.5	3.5	105	45.0	0.174	17.4	8.1
4.7	4.8	66	28.3	0.109	10.9	11.1
3.1	2.0	43	18.4	0.071	7.1	4.6
0.5	1.1	7	3.00	0.012	1.2	2.5
0.1	0.3	1	0.429	0.002	0.2	0.6
2.2	3.8	31	13.3	0.051	5.1	8.9
0.6	1.4	9	3.86	0.015	1.5	3.3
0.3	0.8	4	1.71	0.007	0.7	1.9
0.3	0.6	4	1.71	0.007	0.7	1.4
0.1	0.5	2	0.857	0.003	0.3	1.2
0.1	0.3	1	0.429	0.002	0.2	0.6
0.1	0.3	2	0.857	0.003	0.3	0.8
43.9	16.6	614	258.43	1.00000	100.0	38.6

Table B4. Flat area shrub species

flat sample code:	A	B	C	D	E	F	G	H	I	J	K	L	M	N
shrub species	ABCC4	ABCC5	ABCo6	BMTh1	BMTh2	BMCo1	BMCo:	BMCo5	MMTh1	MMTh2	MMTh6	MMCo1	MMCo3	MMCo4
Mountain Laurel	present	present	present	present	present	present	presen	present		present	present	present	present	present
Pink Azalea	present		present			present	presen	present			present	present	present	present
Japanese Barberry				present	present									
Virginia Creeper				present	present									
Sample #ABthin1a							presen	present						
Sample #ABthin1b														
Sample #ABthin1c				present	present									
"*Vaccinium palidum*"	present	present	present			present	presen	present	present	present	present	present	present	present
"*V. angustifolium*"	present		present			present	presen	present	present		present	present		present
"*V. corymbosum*"		present	present			present	presen	present	present	present	present	present	present	present
"*V. vacillans*"	present	present	present			present	presen	present	present		present	present	present	present
"*V*. big *ang.* #1"	present	present				present	presen	present						
"*V.* hairy *corymbosum*"					present	present		present						
Poison ivy														
Southern Arrowwood														
Sample #ABthin5a														
Black Huckleberry	present	present							present			present	present	present
Gautheria Procumbens	present	present	present			present	presen	present						
Maple Leaf Viburnum	present		present										present	present
"holly"							present		present	present				
Sample #MMthin2a										present				
"heart leaf" (MM thin2b)										present				
# of shrub species	9	7	8	4	5	9	10	10	6	6	6	7	7	8
total# of woody species	16	13	15	9	10	14	14	15	14	12	14	16	12	14

Table B5. Trees on hillside sample plots. Values in columns labeled A through X represent the number of each tree species found on each tenth acre circle. The total number of individuals on all 24 circles is multiplied by 6/24 to approximate the expected number of individuals that would be found on 6 circles. pi, %species abundance, and its standard deviation (=std dev x6x100%/tot # of trees) are also listed.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Species	ABCC3	ABCC6	ABTh2	ABTh3	ABTh4	ABCo2	ABCo3	ABCo4	BMCC1	BMCC2	BMCC3	BMCC4	BMCC6	BMTh3
Red Maple	15	22	5	12	11	8	15	13	6	15	3	9	3	14
Witch Hazel	3	12	8	7	1	7	9	5	4	6	4	11	3	4
Red Oak	8	10	1	4	6	3	2	2	7	16	10	8	16	8
Chestnut Oak	6	8	4	10	4	6	11	4	3	3	3	8	2	7
Black Birch	11	3	5	9	3	1	7	6	4		1	2		2
Sugar Maple									14			3		
Yellow Birch	5		7											
Downey Juneberry	1	3	2	1	2	4	7	4						
Black Gum	1													
Striped Maple				1		2								
American Chestnut	1	1			1	2	2	2						
White Oak												1		
Eastern Hemlock			2											
Pignut Hickory										1				
White Ash									1					
American Beech														
American Basswood														
Shagbark Hickory														
Larch									1					
total # individuals (all sp)	51	59	34	44	28	33	53	36	40	41	21	42	24	35
# tree species	9	7	8	7	7	8	7	7	8	5	5	7	4	5
# shrub species	8	9	8	8	7	7	8	7	6	7	9	9	6	9
total # woody sp	17	16	16	15	14	15	15	14	14	12	14	16	10	14

O BMTh4	P BMCo2	Q BMCo4	R BMCo6	S MMTh3	T MMTh4	U MMTh5	V MMCo2	W MMCo5	X MMCo6	avg	standard deviation	total/sp.	total/sp. X 6/24	total/sp. / tot ind/side	%total/sp. / tot ind/side	%std dev
8	11	13	5	16	11	25	26	40	23	13.7	8.6	329	82.25	0.298	29.8	18.6
19	17	3	10	40	32	17	18	14	6	10.8	9.4	260	65	0.236	23.6	20.5
6	6	7	3	11	3	7	4	7	5	6.7	3.9	160	40	0.145	14.5	8.6
9	9	3	1	5	3	3	6	7	6	5.5	2.7	131	32.75	0.119	11.9	5.9
	7		2		3		17	5	7	4.0	4.2	95	23.75	0.086	8.6	9.1
			3		1					0.9	2.9	21	5.25	0.019	1.9	6.4
										0.5	1.7	12	3	0.011	1.1	3.7
1									1	1.1	1.8	26	6.5	0.024	2.4	3.9
				1			4			0.3	0.8	6	1.5	0.005	0.5	1.8
			2					11	2	0.8	2.3	18	4.5	0.016	1.6	5.0
1							2	1	1	0.6	0.8	14	3.5	0.013	1.3	1.7
					1	3				0.2	0.7	5	1.25	0.005	0.5	1.4
							1	4	4	0.5	1.2	11	2.75	0.010	1.0	2.6
						11				0.5	2.2	12	3	0.011	1.1	4.9
										0.0	0.2	1	0.25	0.001	0.1	0.4
										0.0	0.0					
										0.0	0.0					
						1				0.0	0.2	1	0.25	0.001	0.1	0.4
										0.0	0.2	1	0.25	0.001	0.1	0.4
44	50	26	26	73	54	67	78	89	55	46.0	17.8	1103	275.75			38.8
6	5	4	7	5	7	7	8	8	9							
8	9	8	3	4	3	5	7	4	10							
14	14	12	10	9	10	12	15	12	19							

Table B6. Hillside shrub species.

shrub species	ABCC3	ABCC6	ABTh2	ABTh3	ABTh4	ABCo2	ABCo3	ABCo4	BMCC1	BMCC2	BMCC3	BMCC4	BMCC6	BMTh3
Mountain Laurel	present	present	present	present	present	present	presen	present	present			present		present
Pink Azalea		present	present	present	present	present		present						present
Japanese Barberry														
Virginia Creeper														
Sample #ABthin1a														
Sample #ABthin1b											present			
Sample #ABthin1c														
"*Vaccinium palidum*"	present	present	present	present	present	present	presen	present	present	present	present	present	present	present
"*V. angustifolium*"	present	present	present	present	present	present	presen	present	present	present	present	present	present	present
"*V. corymbosum*"	present	present		present	present	present	present		present	present	present	present	present	present
"*V. vacillans*"	present	present	present	present	present	present	presen	present	present	present	present	present	present	present
"*V*. big *ang.* #1"		present	present						present	present	present	present	present	present
"*V.* hairy *corymbosum*"	present						present			present	present			present
Poison ivy														
Southern Arrowwood														
Sample #ABthin5a														
Black Huckleberry	present	present	present	present	present		presen	present	present	present	present	present	present	present
Gautheria Procumbens	present	present	present	present		present	presen	present						
Maple Leaf Viburnum														
"holly"											present	present		
Sample #MMthin2a												present		
"heart leaf" (MM thin2b)														
# of shrub species	8	9	8	8	7	7	8	7	6	7	9	9	6	9
total# of woody species	17	16	16	15	14	15	15	14	14	12	14	16	10	14

BMTh4	BMCo2	BMCo4	BMCo6	MMTh3	MMTh4	MMTh5	MMCo2	MMCo5	MMCo6
present	present			present		present	present	present	present
present	present	present					present		present
	present		present						
present	present	present	present		present	present	present	present	present
present	present	present		present			present		present
present	present	present		present		present			present
present	present	present		present	present	present	present	present	present
present	present	present							present
present	present	present					present	present	present
		present					present		present
					present				
			present						
						present			present
8	9	8	3	4	3	5	7	4	10
14	14	12	10	9	10	12	15	12	19

Table B7. Trees on sample plots on a hilltop. Values in columns labeled A through C represent the number of each tree species found on each tenth acre circle. The total number of individuals on all three circles is multiplied by 6/3 to approximate the expected number of individuals that would be found on 6 circles. pi, %species abundance, and its standard deviation (=std dev x6x100%/tot # of trees) are also listed.

	A	B	C		standard		expect	relative abundance		
							total/sp	total/sp.	%total/sp.	
Species	BMCCut5	BMThin5	BMTh6	average	deviation	total/sp.	X 6/3	tot ind/t	tot ind/tc	%std dev
Red Maple	7	9	7	7.7	0.9	23	46	0.158	15.8	1.8
Witch Hazel	6	4		3.3	1.5	10	20	0.068	6.8	3.0
Red Oak	19	12	16	15.7	3.5	47	94	0.322	32.2	7.2
Chestnut Oak	3	16	27	15.3	9.1	46	92	0.315	31.5	18.6
Black Birch		1		0.3	0.3	1	2	0.007	0.7	0.7
Sugar Maple										
Yellow Birch										
Downey Juneberry		5	1	2.0	2.4	6	12	0.041	4.1	5.0
Black Gum										
Striped Maple										
American Chestnut										
White Oak	1		6	2.3	2.3	7	14	0.048	4.8	4.8
Eastern Hemlock										
Pignut Hickory	2			0.7	0.9	2	4	0.014	1.4	1.8
White Ash		1	2	1.0	1.0	3	6	0.021	2.1	2.1
American Beech										
American Basswood										
Shagbark Hickory										
Larch										
expected species "A"							1	0.003	0.3	
expected species "B"							1	0.003	0.3	
total # individuals (all sp)	38	48	59	48.3	10.5	145	292	1.000	100.0	21.6
# of tree species	6	7	6	6.3	0.6	9	11		0.0	1.2

Table B8. Hilltop shrub species.

shrub species	plot 5	plot 5	plot 6
Mountain Laurel		present	
Pink Azalea			
Japanese Barberry			
Virginia Creeper			
Sample #ABthin1a			
Sample #ABthin1b			
Sample #ABthin1c		present	present
"*Vaccinium palidum*"	present	present	present
"*V. angustifolium*"	present	present	present
"*V. corymbosum*"	present	present	present
"*V. vacillans*"	present	present	present
"*V*. big *ang.* #1"		present	present
"*V.* hairy *corymbosum*"			
"*V.* narrow *corymbosum*"			
Poison ivy			
Southern Arrowwood			
Sample #ABthin5a	present	present	present
Black Huckleberry		present	present
Gautheria Procumbens			
Maple Leaf Viburnum			present
"heart leaf"			
# of shrub species	5	9	9
total# of woody species	11	16	15

TableC1. Input for analyses of varience species richness without replication (ANOVA). Values represent the number of woody species for each treatment area.

Input C1	Clearcut	Thinned	Control
Arthur's Brook	29	30	22
Bog Meadow	26	25	23
Mount Misery		24	22
average	27.5	26.3	22.3
standard dev.	2.1	3.2	0.6

Table C2. Single factor analysis of varience of species richness without replication ("Anova: Single Factor"). Treatment is the factor. Data from input 7. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Clearcut	2	55	27.5	4.5
Thinned	3	79	26.3	10.3
Control	3	67	22.3	0.3

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	39.0	2	19.5	3.8	0.100	5.8
Within Groups	25.8	5	5.2			
Total	64.875	7				

Table C3. Two Factor Analysis of Varience of species richness without replication ("Anova: Two-Factor Without Replication"). The factors are treatment (all) and forest section (all). Data from Input c1. Alpha = 0.05.

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Arthur's Brook	3	81	27.0	19.0
Bog Meadow	3	74	24.7	2.3
Mount Misery	2	46	23.0	2.0
Clearcut	2	55	27.5	4.5
Thinned	3	79	26.3	10.3
Control	3	67	22.3	0.3

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	228.67	2	114.33	1.52	0.32	6.94
Columns	96	2	48.00	0.64	0.58	6.94
Error	301.33	4	75.33			
Total	626	8				

Table C4. Inputs for two factor analyses of varience of species richness with replication (ANOVA). Values represent the number of woody species in each circle.

Input C2.	Clearcut	Thinned	Control
Arthur's Brook	13	17	13
	18	16	16
	16	15	16
	18	14	14
	14	17	12
	15	16	16
Bog Meadow	16	15	15
	14	14	16
	15	16	17
	18	14	14
	14	16	18
	12	15	11

Input C3.	Thinned	Control
Arthur's Brook	17	13
	16	16
	15	16
	14	14
	17	12
	16	16
Bog Meadow	15	15
	14	16
	16	17
	14	14
	16	18
	15	11
Mount Misery	14	17
	12	16
	10	13
	12	15
	15	12
	16	19

Table C5. Two Factor Analysis of species richness with replication ("Anova: Two-Factor With Replication"). The factors are treatment (clearcut, thinned, and control) and forest section (Arthur's Brook and Bog Meadow only). Data from Input C2. Alpha = 0.05.

SUMMARY	Clearcut	Thinned	Control	Total
Arthur's Brook				
Count	6	6	6	18
Sum	94	95	87	276
Average	15.7	15.8	14.5	15.3
Variance	4.3	1.4	3.1	2.9
Bog Meadow				
Count	6	6	6	18
Sum	89	90	91	270
Average	14.8	15.0	15.2	15.0
Variance	4.2	0.8	6.2	3.3
Total				
Count	12	12	12	
Sum	183	185	178	
Average	15.3	15.4	14.8	
Variance	4.0	1.2	4.3	

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	1	1	1	0.302	0.587	4.171
Columns	2.17	2	1.08	0.327	0.723	3.316
Interaction	4.5	2	2.25	0.680	0.514	3.316
Within	99.33	30	3.31			
Total	107	35				

Table C6. Two Factor Analysis of Varience of species richness with replication ("Anova: Two-Factor With Replication"). The factors are treatment (thinned and control) and forest section (all sections). Data from Input C3. Alpha = 0.05.

SUMMARY	Thinned	Control	Total
Arthur's Brook			
Count	6	6	12
Sum	95	87	182
Average	15.8	14.5	15.2
Variance	1.4	3.1	2.5
Bog Meadow			
Count	6	6	12
Sum	90	91	181
Average	15	15.2	15.1
Variance	0.8	6.2	3.2
Mount Misery			
Count	6	6	12
Sum	79	92	171
Average	13.2	15.3	14.3
Variance	5.0	6.7	6.6
Total			
Count	18	18	
Sum	264	270	
Average	14.7	15	
Variance	3.4	4.8	

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	6.17	2	3.08	0.802	0.458	3.316
Columns	1	1	1	0.260	0.614	4.171
Interaction	18.5	2	9.25	2.406	0.107	3.316
Within	115.33	30	3.84			
Total	141	35				

Table C7. Input for analysis of varience of the Margalef index, Dmg, without replication. Values represent Dmg for each treatment area.

Input C4.	Clearcut	Thinned	Control
Arthur's Brook	4.13	5.2	3.64
Bog Meadow	3.75	3.74	3.56
Mount Misery		3.45	3.48

Table C8. Single factor analysis of varience of Dmg without replication ("Anova: Single Factor"). Treatment is the factor. Data from input #. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Clearcut	2	7.88	3.94	0.0722
Thinned	3	12.39	4.13	0.8797
Control	3	10.68	3.56	0.0064

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.500888	2	0.250444	0.67893	0.548463	5.786148
Within Groups	1.8444	5	0.36888			
Total	2.345288	7				

Table C9. Input for analyses of varience of Margalef indices with treatment and forest section.

Input C5.	Clearcut	Thinned	Control
Arthur's Brook	4.13	5.20	3.64
Bog Meadow	3.75	3.74	3.56
Mount Misery		3.45	3.48
average	3.94	4.13	3.56
std dev	0.27	0.93	0.08
std error	0.19	0.54	0.05

Table C10. Single factor analysis of varience of Margalef indices without replication. ("Anova: Single Factor"). Data is from input C5. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Clearcut	2	7.89	3.94	0.07
Thinned	3	12.39	4.13	0.87
Control	3	10.68	3.56	0.01

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.502309	2	0.251	0.687	0.545	5.786
Within Groups	1.827671	5	0.366			
Total	2.32998	7				

Table C11. Two factor analysis of varience of Margalef indices without replication ('Anova: Two-Factor Without Replication"). The factors are treatment and forest section (all included). Data from input C5. Alpha = 0.05.

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Arthur's Brook	3	12.97	4.32	0.6332
Bog Meadow	3	11.06	3.69	0.0118
Mount Misery	2	6.94	3.47	0.0004
Clearcut	2	7.89	3.94	0.0720
Thinned	3	12.39	4.13	0.8717
Control	3	10.68	3.56	0.0061

ANOVA

Source of Variatioi	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	6.332	2	3.166	2.160	0.231	6.944
Columns	3.446	2	1.723	1.175	0.397	6.944
Error	5.863	4	1.466			
Total	15.642	8				

Table C12. Calculation of H' for the Arthur's Brook Clearcut. Total number of species, S, is 13.

AB Clearcut: Trees	total/sp.	pi = total/sp. / tot ind/CC	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
			for use in calculation of the four terms in H'				for var calc
Species							
Red Oak	47	0.180077	-0.30872	5.553191	30.83794	-25.2847442	0.5292586
White Oak	1	0.003831	-0.02132	261	68121	-67860	0.1186356
Chestnut Oak	32	0.122605	-0.25732	8.15625	66.52441	-58.3681641	0.5400639
Red Maple	73	0.279693	-0.35635	3.575342	12.78307	-9.20773128	0.4540072
Sugar Maple	8	0.030651	-0.10682	32.625	1064.391	-1031.76563	0.3722843
Black Birch	25	0.095785	-0.22468	10.44	108.9936	-98.5536	0.5270161
Yellow Birch	32	0.122605	-0.25732	8.15625	66.52441	-58.3681641	0.5400639
White Ash (Red?)	2	0.007663	-0.03733	130.5	17030.25	-16899.75	0.1818412
Downey Juneberry	4	0.015326	-0.06403	65.25	4257.563	-4192.3125	0.267549
Witch Hazel	33	0.126437	-0.26147	7.909091	62.55372	-54.6446281	0.5407293
American Chestnut	2	0.007663	-0.03733	130.5	17030.25	-16899.75	0.1818412
Black Gum	1	0.003831	-0.02132	261	68121	-67860	0.1186356
American Beech	1	0.003831	-0.02132	261	68121	-67860	0.1186356
total ni, pi, and pilnpi	261	1	-1.97533	1185.665	244093.7	-242908.005	4.4905615

-Sum pi ln pi	1.97533
- (S-1)/N	-0.045977
(1-Sum piE-1)/12NE2	-0.0014492
Sum [(piE-1)-(piE-2)]/12NE3	-0.0011385
H' for ABCCut=	1.926763
Varience in H' for ABCCut=	0.0023434

Table C13. Calculation of H' for the Arthur's Brook Thinned Area. Total number of species, S, is 13.

			for use in calculation of the four terms in H'				for var calc
AB Thinned: Trees	total/sp.	pi = total/sp. / tot ind/Th	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
Species							
Red Oak	22	0.100457	-0.23085	9.954545	99.09298	-89.1384298	0.5305052
White Oak	1	0.004566	-0.02461	219	47961	-47742	0.1326123
Chestnut Oak	27	0.123288	-0.25807	8.111111	65.79012	-57.6790123	0.5402012
Red Maple	60	0.273973	-0.35472	3.65	13.3225	-9.6725	0.4592653
Sugar Maple	12	0.054795	-0.15913	18.25	333.0625	-314.8125	0.4621466
Striped Maple	2	0.009132	-0.04289	109.5	11990.25	-11880.75	0.2013855
Black Birch	24	0.109589	-0.2423	9.125	83.26563	-74.140625	0.535737
Yellow Birch	17	0.077626	-0.1984	12.88235	165.955	-153.072664	0.5070822
Eastern Hemlock	3	0.013699	-0.05877	73	5329	-5256	0.252165
Downey Juneberry	8	0.03653	-0.1209	27.375	749.3906	-722.015625	0.4001334
Witch Hazel	40	0.182648	-0.31054	5.475	29.97563	-24.500625	0.5279733
American Chestnut	2	0.009132	-0.04289	109.5	11990.25	-11880.75	0.2013855
American Basswood	1	0.004566	-0.02461	219	47961	-47742	0.1326123
total # individuals (all sp)	219		-2.06867	824.823	126771.4	-125946.532	4.8832048

- Sum pi ln pi	2.06867
- (S-1)/N	-0.0547945
(1-Sum piE-1)/12NE2	-0.0014314
Sum [(piE-1)-(piE-2)]/12NE3	-0.00100
H' for ABThin=	2.0114448
Varience in H' for ABThin=	0.0028822

Table C14. Calculation of H' for the Arthur's Brook Control Area. Total number of species, S, is 12.

			for use in calculation of the four terms in H'				for var calc
AB Control: Trees Species	total/sp.	pi = total/sp. / tot ind/CC	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
Red Oak	20	0.081967	-0.20504	12.2	148.84	-136.64	0.5128838
White Oak	2	0.008197	-0.03938	122	14884	-14762	0.189169
Chestnut Oak	44	0.180328	-0.3089	5.545455	30.75207	-25.2066116	0.5291353
Red Maple	79	0.32377	-0.36512	3.088608	9.539497	-6.45088928	0.4117562
Sugar Maple	3	0.012295	-0.05408	81.33333	6615.111	-6533.77778	0.2378766
Striped Maple	2	0.008197	-0.03938	122	14884	-14762	0.189169
Black Birch	27	0.110656	-0.24359	9.037037	81.66804	-72.6310014	0.5362222
Yellow Birch	2	0.008197	-0.03938	122	14884	-14762	0.189169
White Ash (Red?)	1	0.004098	-0.02253	244	59536	-59292	0.1238478
Downey Juneberry	21	0.086066	-0.21109	11.61905	135.0023	-123.38322	0.517725
Witch Hazel	35	0.143443	-0.27854	6.971429	48.60082	-41.6293878	0.5408742
American Chestnut	8	0.032787	-0.11206	30.5	930.25	-899.75	0.3829789
total # individuals (all sp)	244	1	-1.91907	770.2949	112187.8	-111417.469	4.3608068

- Sum pi ln pi	1.91907
- (S-1)/N	-0.045082
(1-Sum piE-1)/12NE2	-0.0010768
Sum [(piE-1)-(piE-2)]/12NE3	-0.0006391
H' for ABCont=	1.8722721
Varience in H' for ABCont=	0.002871

Table C15. Calculation of H' for the Bog Meadow Clearcut. Total number of species, S, is 10.

BM Clearcut: Trees	total/sp.	pi = total/sp. / tot ind/CC	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
			for use in calculation of the four terms in H'				for var calc
Species							
Red Oak	76	0.368932	-0.36788	2.710526	7.346953	-4.63642659	0.3668268
White Oak	2	0.009709	-0.045	103	10609	-10506	0.2085506
Chestnut Oak	22	0.106796	-0.23889	9.363636	87.67769	-78.3140496	0.5343464
Red Maple	43	0.208738	-0.32702	4.790698	22.95078	-18.1600865	0.5123416
Sugar Maple	17	0.082524	-0.20587	12.11765	146.8374	-134.719723	0.5135768
Black Birch	7	0.033981	-0.11492	29.42857	866.0408	-836.612245	0.3886595
White Ash (Red?)	1	0.004854	-0.02586	206	42436	-42230	0.1377974
Witch Hazel	34	0.165049	-0.29734	6.058824	36.70934	-30.650519	0.5356582
Hickory	3	0.014563	-0.06159	68.66667	4715.111	-4646.44444	0.2604855
Larch	1	0.004854	-0.02586	206	42436	-42230	0.1377974
total # individuals (all sp)	206		-1.71023	648.1366	101363.7	-100715.537	3.5960403

- Sum pi ln pi	1.71023
- (S-1)/N	-0.0436893
(1-Sum piE-1)/12NE2	-0.0012708
Sum [(piE-1)-(piE-2)]/12NE3	-0.0009601
H' for BMCcut=	1.6643098
Varience in H' for BMCCut=	0.0033641

Table C16. Calculation of H' for the Bog Meadow Thinned Area. Total number of species, S, is 10.

BM Thinned: Trees		pi =	for use in calculation of the four terms in H'				for var calc
Species	total/sp.	total/sp. / tot ind/Th	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
Red Oak	60	0.218978	-0.33258	4.566667	20.85444	-16.2877778	0.5051175
White Oak	6	0.021898	-0.08368	45.66667	2085.444	-2039.77778	0.3197706
Chestnut Oak	84	0.306569	-0.36246	3.261905	10.64002	-7.37811791	0.428541
Red Maple	61	0.222628	-0.33444	4.491803	20.1763	-15.6844934	0.5024191
Striped Maple	2	0.007299	-0.03591	137	18769	-18632	0.1766877
Black Birch	5	0.018248	-0.07306	54.8	3003.04	-2948.24	0.2925098
White Ash (Red?)	3	0.010949	-0.04943	91.33333	8341.778	-8250.44444	0.223148
Downey Juneberry	9	0.032847	-0.1122	30.44444	926.8642	-896.419753	0.3832685
Witch Hazel	43	0.156934	-0.29063	6.372093	40.60357	-34.2314765	0.5382277
American Chestnut	1	0.00365	-0.02049	274	75076	-74802	0.1149898
total # individuals (all sp)	274		-1.69488	651.9369	108294.4	-107642.464	3.4846798

- Sum pi ln pi	1.69488
- (S-1)/N	-0.0328467
(1-Sum piE-1)/12NE2	-0.0007225
Sum [(piE-1)-(piE-2)]/12NE3	-0.0004361
H' for BMThin=	1.6608747
Varience in H' for BMThin=	0.0022937

Table C17. Calculation of H' for the Bog Meadow Control Area. Total number of species, S, is 7.

BM Control: Trees	total/sp.	pi = total/sp. / tot ind/Co	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
			for use in calculation of the four terms in H'				for var calc
Species							
Red Oak	32	0.203822	-0.32418	4.90625	24.07129	-19.1650391	0.5156121
Chestnut Oak	20	0.127389	-0.26249	7.85	61.6225	-53.7725	0.5408555
Red Maple	51	0.324841	-0.36526	3.078431	9.47674	-6.39830834	0.4107029
Sugar Maple	3	0.019108	-0.07562	52.33333	2738.778	-2686.44444	0.2992904
Striped Maple	2	0.012739	-0.05558	78.5	6162.25	-6083.75	0.2425048
Black Birch	12	0.076433	-0.19654	13.08333	171.1736	-158.090278	0.5053594
Witch Hazel	37	0.235669	-0.34062	4.243243	18.00511	-13.76187	0.4923057
total # individuals (all sp)	157	1	-1.62028	163.9946	9185.377	-9021.38244	3.0066308

- Sum pi ln pi	1.62028
- (S-1)/N	-0.0382166
(1-Sum piE-1)/12NE2	-0.0005511
Sum [(piE-1)-(piE-2)]/12NE3	-0.0001943
H' for BMCont=	1.5813181
Varience in H' for BMCont=	0.0025505

Table C18. Calculation of H' for the Mount Misery Thinned Area. Total number of species, S, is 11.

MM Thinned: Trees		pi =	for use in calculation of the four terms in H'				for var calc
Species	total/sp.	total/sp. / tot ind/Th	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
Red Oak	41	0.125382	-0.26034	7.97561	63.61035	-55.6347412	0.5405715
White Oak	4	0.012232	-0.05387	81.75	6683.063	-6601.3125	0.2372143
Chestnut Oak	14	0.042813	-0.1349	23.35714	545.5561	-522.19898	0.4250601
Red Maple	67	0.204893	-0.32481	4.880597	23.82023	-18.9396302	0.514911
Sugar Maple	8	0.024465	-0.09078	40.875	1670.766	-1629.89063	0.3368305
Black Birch	9	0.027523	-0.09888	36.33333	1320.111	-1283.77778	0.3552591
White Ash	1	0.003058	-0.01771	327	106929	-106602	0.1025188
Witch Hazel	149	0.455657	-0.35815	2.194631	4.816405	-2.62177379	0.2815133
Black Gum	20	0.061162	-0.1709	16.35	267.3225	-250.9725	0.4775358
Pignut Hickory	13	0.039755	-0.12821	25.15385	632.716	-607.56213	0.4134833
Shagbark Hickory	1	0.003058	-0.01771	327	106929	-106602	0.1025188
total # individuals (all sp)	327	1	-1.65626	892.8702	225069.8	-224176.911	3.7874165

1	- Sum pi ln pi	1.65626
2	- (S-1)/N	-0.030581
3	(1-Sum piE-1)/12NE2	-0.00070
4	Sum [(piE-1)-(piE-2)]/12NE3	-0.0005343
5	H' for MMThin=	1.6244496
6	Varience in H' for MMThin=	0.0032401

Table C21. Calculation of H' for the combined Arthur's Brook and Bog Meadow Thinnings. The number of species, S, is 14.

Species	total Thin AB & BM	pi= total/sp. tot ind/Th	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
			for use in calculation of the four terms in H'				for var calc
Red Oak	82	0.166329	-0.29836	6.012195	36.14649	-30.1342951	0.5351926
White Oak	7	0.014199	-0.06041	70.42857	4960.184	-4889.7551	0.2570209
Chestnut Oak	111	0.225152	-0.3357	4.441441	19.7264	-15.2849606	0.5005173
Red Maple	121	0.245436	-0.34477	4.07438	16.60057	-12.5261936	0.484303
Sugar Maple	12	0.024341	-0.09044	41.08333	1687.84	-1646.75694	0.3360414
Striped Maple	4	0.008114	-0.03906	123.25	15190.56	-15067.3125	0.188046
Black Birch	29	0.058824	-0.16666	17	289	-272	0.4721822
Yellow Birch	17	0.034483	-0.11611	29	841	-812	0.390989
Eastern Hemlock	3	0.006085	-0.03105	164.3333	27005.44	-26841.1111	0.1583936
White Ash (Red?)	3	0.006085	-0.03105	164.3333	27005.44	-26841.1111	0.1583936
Downey Juneberry	17	0.034483	-0.11611	29	841	-812	0.390989
Witch Hazel	83	0.168357	-0.29996	5.939759	35.28074	-29.3409784	0.5344228
American Chestnut	3	0.006085	-0.03105	164.3333	27005.44	-26841.1111	0.1583936
American Basswood	1	0.002028	-0.01258	493	243049	-242556	0.0779844
total # individuals (all sp)	493	1	-1.97329	1316.23	347982.7	-346666.444	4.6428695

1	- Sum pi ln pi	1.97329
2	- (S-1)/N	-0.0263692
3	(1-Sum piE-1)/12NE2	-0.0004509
4	Sum [(piE-1)-(piE-2)]/12NE3	-0.0002411
5	H' for AB & BM Thinnings=	1.9462288
6	Varience in H' for ABBMTh=	0.001546

Table C22. Calculation of H' for the combined Arthur's Brook and Bog Meadow Controls. The number of species, S, is 12.

Species	total Cont AB & BM	pi= total/sp. tot ind/Co	for use in calculation of the four terms in H' pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	for var calc pi(ln pi)^2
Red Oak	52	0.129676	-0.26489	7.711538	59.46783	-51.756287	0.5410977
White Oak	2	0.004988	-0.02644	200.5	40200.25	-39999.75	0.1401428
Chestnut Oak	64	0.159601	-0.29288	6.265625	39.25806	-32.9924316	0.5374584
Red Maple	130	0.32419	-0.36518	3.084615	9.514852	-6.43023669	0.4113439
Sugar Maple	6	0.014963	-0.06288	66.83333	4466.694	-4399.86111	0.264217
Striped Maple	4	0.009975	-0.04596	100.25	10050.06	-9949.8125	0.2117765
Black Birch	39	0.097257	-0.22665	10.28205	105.7206	-95.4385273	0.528179
Yellow Birch	2	0.004988	-0.02644	200.5	40200.25	-39999.75	0.1401428
White Ash (Red?)	1	0.002494	-0.01495	401	160801	-160400	0.0895949
Downey Juneberry	21	0.052369	-0.15446	19.09524	364.6281	-345.53288	0.4555686
Witch Hazel	72	0.179551	-0.30834	5.569444	31.01871	-25.449267	0.5295148
American Chestnut	8	0.01995	-0.0781	50.125	2512.516	-2462.39063	0.3057051
total # individuals (all sp)	401	1	-1.86715	1071.217	258840.4	-257769.164	4.1547414

1	- Sum pi ln pi	1.86715
2	- (S-1)/N	-0.0274314
3	(1-Sum piE-1)/12NE2	-0.0005546
4	Sum [(piE-1)-(piE-2)]/12NE3	-0.0003331
5	H' for AB & BM Control=	1.8388308
6	Varience in H' for ABBMCo=	0.0017013

Table C23. Calculation of H' for the combined Arthur's Brook, Bog Meadow and Mount Misery Thinnings. The number of species, S, is 17.

	total Thin	pi= total/sp.	for use in calculation of the four terms in H'				for var calc
Species	AB,BM,MM	tot ind/Th	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
Red Oak	123	0.15	-0.28457	6.666667	44.44444	-37.7777778	0.5398596
White Oak	11	0.013415	-0.05784	74.54545	5557.025	-5482.47934	0.2493545
Chestnut Oak	125	0.152439	-0.28674	6.56	43.0336	-36.4736	0.5393484
Red Maple	188	0.229268	-0.33768	4.361702	19.02445	-14.6627433	0.4973571
Sugar Maple	20	0.02439	-0.09057	41	1681	-1640	0.3363565
Striped Maple	4	0.004878	-0.02597	205	42025	-41820	0.1382168
Black Birch	38	0.046341	-0.14235	21.57895	465.651	-444.072022	0.4372527
Yellow Birch	17	0.020732	-0.08036	48.23529	2326.644	-2278.4083	0.3114749
Eastern Hemlock	3	0.003659	-0.02053	273.3333	74711.11	-74437.7778	0.1151702
White Ash (Red?)	4	0.004878	-0.02597	205	42025	-41820	0.1382168
Downey Juneberry	17	0.020732	-0.08036	48.23529	2326.644	-2278.4083	0.3114749
Witch Hazel	232	0.282927	-0.35721	3.534483	12.49257	-8.95808561	0.4510067
American Chestnut	3	0.003659	-0.02053	273.3333	74711.11	-74437.7778	0.1151702
American Basswood	1	0.00122	-0.00818	820	672400	-671580	0.0548961
Black Gum	20	0.02439	-0.09057	41	1681	-1640	0.3363565
Pignut Hickory	13	0.015854	-0.0657	63.07692	3978.698	-3915.6213	0.2722973
Shagbark Hickory	1	0.00122	-0.00818	820	672400	-671580	0.0548961
total # individuals (all sp)	820	1	-1.9833	2955.461	1596408	-1593452.42	4.8987053

1	- Sum pi ln pi	1.9833
2	- (S-1)/N	-0.0195122
3	(1-Sum piE-1)/12NE2	-0.0003662
4	Sum [(piE-1)-(piE-2)]/12NE3	-0.0002408
5	H' for AB,BM & MM Thinned=	1.9631808
6	Var in H' for ABBMMMThin=	0.001189

Table C24. Calculation of H' for the combined Arthur's Brook, Bog Meadow and Mount Misery Controls. The number of species, S, is 15.

	total Cont	pi= total/sp.	for use in calculation of the four terms in H'				for var calc
Species	AB,BM,MM	tot ind/Co	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
Red Oak	96	0.117503	-0.25161	8.510417	72.42719	-63.9167752	0.5387664
White Oak	3	0.003672	-0.02059	272.3333	74165.44	-73893.1111	0.1154422
Chestnut Oak	85	0.104039	-0.23544	9.611765	92.38602	-82.7742561	0.5327964
Red Maple	240	0.293758	-0.35985	3.404167	11.58835	-8.18418403	0.4408202
Sugar Maple	6	0.007344	-0.03609	136.1667	18541.36	-18405.1944	0.1773284
Striped Maple	24	0.029376	-0.10363	34.04167	1158.835	-1124.7934	0.3655478
Black Birch	86	0.105263	-0.23698	9.5	90.25	-80.75	0.5335068
Yellow Birch	2	0.002448	-0.01472	408.5	166872.3	-166463.75	0.0884946
Eastern Hemlock	13	0.015912	-0.06589	62.84615	3949.639	-3886.7929	0.272814
White Ash (Red?)	1	0.001224	-0.00821	817	667489	-666672	0.0550374
Downey Juneberry	22	0.026928	-0.09733	37.13636	1379.11	-1341.97314	0.3518198
Witch Hazel	207	0.253366	-0.34785	3.94686	15.5777	-11.6308432	0.4775721
American Chestnut	15	0.01836	-0.0734	54.46667	2966.618	-2912.15111	0.2934036
Black Gum	16	0.019584	-0.07702	51.0625	2607.379	-2556.31641	0.3029402
American Beech	1	0.001224	-0.00821	817	667489	-666672	0.0550374
total # individuals (all sp)	817	1	-1.9368	2725.527	1606901	-1604175.34	4.6013276

1	- Sum pi ln pi	1.9368
2	- (S-1)/N	-0.0195838
3	(1-Sum piE-1)/12NE2	-0.0003401
4	Sum [(piE-1)-(piE-2)]/12NE3	-0.0002451
5	H' for AB,BM & MM Control=	1.9166309
6	Var in H' for ABBMMMCont=	0.0010426

Table C25. Calculation of the Shannon Diversity Index, H', its varience, Var H' and evenness. Rows 1 - 4 list the four terms in H' for each treatment; row 5 shows their sum, H'; and row 6 shows the Var H'; and for each treatment areaand method.

		ABCcut	ABThin	ABCont	BMCcut	BMThin	BMCont	MMThin	MMCont	ABBMCCut
1	- Sum pi ln pi	1.97533	2.06867	1.91907	1.71023	1.69488	1.6203	1.65626	1.84342	1.95033
2	- (S-1)/N	-0.045977	-0.05479	-0.04508	-0.04369	-0.03285	-0.03822	-0.030581	-0.02644	-0.029979
3	(1-Sum piE-1)/12NE2	-0.0014492	-0.00143	-0.00108	-0.00127	-0.00072	-0.00055	-0.000695	-0.00069	-0.000874
4	Sum [(piE-1)-(piE-2)]/12NE3	-0.0011385	-0.001	-0.00064	-0.00096	-0.00044	-0.00019	-0.000534	-0.00061	-0.000649
5	H' for MMThin=	1.926763	2.011445	1.872272	1.66431	1.660875	1.58132	1.6244496	1.815682	1.9188275
6	Varience in H' for MMThin=	0.0023434	0.002882	0.002871	0.003364	0.002294	0.00895	0.0032401	0.001886	0.0015836
7	Number of species, S=	13	13	12	10	10	7	11	12	15
8	Hmax = ln S=	2.5649494	2.564949	2.484907	2.302585	2.302585	1.945910149	2.3978953	2.484907	2.7080502
9	Evenness E = H'/ln S =	0.751	0.784	0.753	0.723	0.721	0.813	0.677	0.731	0.709

Table C26. Values for Var, t, df, and P for tests of significant difference between treatment areas and methods.

Comparison (1 and 2)	Var 1	Var 2	H' 1	H' 2	N 1	N 2	t	df	P
ABCCut and ABThin	0.0023434	0.002882	1.926763	2.011445	261	219	1.171445	463.0457	P >.20
ABCCut and ABCont	0.0023434	0.002871	1.926763	1.872272	261	244	0.754612	495.9714	P >>.20
ABThin and ABCont	0.0028822	0.002871	2.011445	1.872272	219	244	1.834845	461.5509	.05<P<0.1
BMCCut and BMThin	0.0033641	0.002294	1.66431	1.660875	206	274	0.0456671	431.7857	P >>.20
BMCCut and BMCont	0.0033641	0.002551	1.66431	1.581318	206	157	1.0790823	362.9977	P >.20
BMThin and BMCont	0.002294	0.002251	1.660875	1.581318	274	157	1.1800736	401.2642	P >.20
MMThin and MMCont	0.0032401	0.001886	1.62445	1.815682	327	416	2.670981	646.332	.01<P<.001
ABBMCCut and ABBMThin	0.0015836	0.001546	1.918827	1.946229	467	493	0.489810	958.5341	P>>0.20
ABBMCCut and ABBMCont	0.0015836	0.001701	1.918827	1.838831	467	401	1.395771	857.2112	0.2>P>0.1
ABBMThin and ABBMCont	0.001546	0.001701	1.946229	1.838831	493	401	1.884677	873.9344	0.1>P>0.05
ABBMMM: Thin and Cont	0.001189	0.001043	1.963181	1.916631	820	817	0.985406	1630.365	P>0.20

Table C27. Calculation of H' for the stream valley class. The estimated total number of species, S, is 13.

			for use in calculation of the four terms in H'				for var calc
AB Clearcut: Trees	total/sp.	pi = total/sp.	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
Species	X 6/5	tot ind/sv					
Red Oak	21.6	0.129496	-0.2647	7.722222	59.63272	-51.9104938	0.5410818
Chestnut Oak	2.4	0.014388	-0.06103	69.5	4830.25	-4760.75	0.2588324
Red Maple	16.8	0.100719	-0.23119	9.928571	98.57653	-88.6479592	0.5306843
Sugar Maple	27.6	0.165468	-0.29767	6.043478	36.52363	-30.4801512	0.5355075
Striped Maple	1.2	0.007194	-0.0355	139	19321	-19182	0.1751729
Black Birch	2.4	0.014388	-0.06103	69.5	4830.25	-4760.75	0.2588324
Yellow Birch	45.6	0.273381	-0.35454	3.657895	13.38019	-9.72229917	0.4598049
White Ash (Red?)	3.6	0.021583	-0.08279	46.33333	2146.778	-2100.44444	0.3175648
Eastern Hemlock	1.2	0.007194	-0.0355	139	19321	-19182	0.1751729
Witch Hazel	42	0.251799	-0.34726	3.971429	15.77224	-11.8008163	0.4789179
American Chestnut	1.2	0.007194	-0.0355	139	19321	-19182	0.1751729
American Basswood	1.2	0.007194	-0.0355	139	19321	-19182	0.1751729
expected species A	1	0.005995	-0.03068	166.8	27822.24	-27655.44	0.156964
totals	167.8	1.005995	-1.87289	939.4569	117137.4	-116197.946	4.2388816

-Sum pi ln pi	1.87289
- (S-1)/N	-0.0715137
(1-Sum piE-1)/12NE2	-0.0027775
Sum [(piE-1)-(piE-2)]/12NE3	-0.0020495
H' for ABCCut=	1.7965494
Varience in H' for ABCCut=	0.0045705

ABBMThin	ABBMCont	ABBMMM Thin	ABBMMM Cont
1.97329	1.86715	1.9833	1.9368
-0.02637	-0.02743	-0.01951	-0.01958
-0.00045	-0.00055	-0.00037	-0.00034
-0.00024	-0.00033	-0.00024	-0.00025
1.946229	1.838831	1.963181	1.916631
0.001546	0.001701	0.001189	0.001043
14	12	17	15
2.639057	2.484907	2.833213	2.70805
0.737	0.740	0.693	0.708

Table C28. Calculation of H' for the flat area class. The estimated total number of species, S, is 12.

			for use in calculation of the four terms in H'				for var calc
AB Clearcut: Trees species	total/sp. X 6/14	pi = total/sp. tot ind/sv	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
Red Oak	45	0.174709	-0.3048	5.723809	32.76199	-27.0381793	0.5317699
White Oak	1.7142857	0.006656	-0.03336	150.25	22575.06	-22424.8075	0.167209
Chestnut Oak	28.285714	0.109817	-0.24258	9.10606	82.92032	-73.8142618	0.5358428
Red Maple	58.714286	0.227953	-0.33706	4.386861	19.24455	-14.8576871	0.4983744
Sugar Maple	3	0.011647	-0.05186	85.85713	7371.447	-7285.59021	0.2309232
Striped Maple	3.8571429	0.014975	-0.06292	66.77777	4459.271	-4392.49285	0.2643322
Black Birch	18.428571	0.071547	-0.1887	13.97674	195.3493	-181.372592	0.4976732
Witch Hazel	81.857143	0.317804	-0.36431	3.146597	9.90107	-6.75447308	0.4176108
American Chestnut	1.7142857	0.006656	-0.03336	150.25	22575.06	-22424.8075	0.167209
Black Gum	13.285714	0.051581	-0.15292	19.38709	375.8594	-356.472343	0.4533376
American Beech	0.8571429	0.003328	-0.01899	300.5	90300.23	-89999.73	0.1083266
Pignut Hickory	0.8571429	0.003328	-0.01899	300.5	90300.23	-89999.73	0.1083266
totals	257.57143	1	-1.80983	1109.862	238297.3	-237187.468	3.9809353

-Sum pi ln pi	1.80983
- (S-1)/N	-0.0427066
(1-Sum piE-1)/12NE2	-0.0013928
Sum [(piE-1)-(piE-2)]/12NE3	-0.0011567
H' for ABCCut=	1.7645739
Varience in H' for ABCCut=	0.0028218

Table C29. Calculation of H' for the hillside class. The estimated total number of species, S, is 11.

			for use in calculation of the four terms in H'				for var calc
AB Clearcut: Trees species	total/sp. X 6/24	pi = total/sp. tot ind/sv	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
Red Oak	40	0.148561	-0.28327	6.73125	45.30973	-38.5784766	0.5401281
Chestnut Oak	32.75	0.121634	-0.25625	8.221374	67.59099	-59.3696172	0.5398541
Red Maple	82.25	0.305478	-0.36226	3.273556	10.71617	-7.44261417	0.4295952
Sugar Maple	5.25	0.019499	-0.07677	51.28571	2630.224	-2578.93878	0.3022911
Striped Maple	4.5	0.016713	-0.06838	59.83333	3580.028	-3520.19444	0.279792
Black Birch	23.75	0.088208	-0.21417	11.33684	128.524	-117.187147	0.5200271
Yellow Birch	3	0.011142	-0.05011	89.75	8055.063	-7965.3125	0.2253288
Eastern Hemlock	2.75	0.010214	-0.04682	97.90909	9586.19	-9488.28099	0.2146217
Downey Juneberry	6.5	0.024141	-0.0899	41.42308	1715.871	-1674.44822	0.3347644
Witch Hazel	65	0.241411	-0.34311	4.142308	17.15871	-13.0164053	0.4876413
American Chestnut	3.5	0.012999	-0.05645	76.92857	5918.005	-5841.07653	0.2451701
totals	269.25	1	-1.84749	450.8351	31754.68	-31303.8457	4.1192137

-Sum pi ln pi	1.84749
- (S-1)/N	-0.0371402
(1-Sum piE-1)/12NE2	-0.0005171
Sum [(piE-1)-(piE-2)]/12NE3	-0.0001336
H' for ABCCut=	1.8096991
Varience in H' for ABCCut=	0.002691

Table C30. Calculation of H' for the hilltop class. The estimated total number of species, S, is 11.

			for use in calculation of the four terms in H'				for var calc
AB Clearcut: Trees	total/sp.	pi = total/sp.					
species	X 6/3	tot ind/sv	pi ln pi	piE-1	piE-2	(piE-1)-(piE-2)	pi(ln pi)^2
Red Oak	94	0.321918	-0.36488	3.106383	9.649615	-6.54323223	0.4135773
White Oak	14	0.047945	-0.14564	20.85714	435.0204	-414.163265	0.4424192
Chestnut Oak	92	0.315068	-0.36389	3.173913	10.07372	-6.89981096	0.4202839
Red Maple	46	0.157534	-0.29114	6.347826	40.2949	-33.9470699	0.5380613
Black Birch	2	0.006849	-0.03413	146	21316	-21170	0.1701119
White Ash (Red?)	6	0.020548	-0.07983	48.66667	2368.444	-2319.77778	0.3101339
Downey Juneberry	12	0.041096	-0.13117	24.33333	592.1111	-567.777778	0.4186803
Witch Hazel	20	0.068493	-0.18363	14.6	213.16	-198.56	0.4923203
Hickory	4	0.013699	-0.05877	73	5329	-5256	0.252165
expected species B	1	0.003425	-0.01944	292	85264	-84972	0.1103614
expected species C	1	0.003425	-0.01944	292	85264	-84972	0.1103614
totals	292	1	-1.69198	924.0853	200841.8	-199917.669	3.6784758

-Sum pi ln pi	1.69198
- (S-1)/N	-0.0342466
(1-Sum piE-1)/12NE2	-0.0009022
Sum [(piE-1)-(piE-2)]/12NE3	-0.0006691
H' for ABCCut=	1.6561621
Varience in H' for ABCCut=	0.0028521

Table C31. Calculation of the Shannon Diversity Index, H', and its varience, Var H'. Rows 1 - 4 list the four terms in H' for each circle *?* treatment; row 5 shows their sum, H'; and row 6 shows the Var H' for each treatment area*?* and method *?*.

		stream	flat area	hillside	hilltop
1	- Sum pi ln pi	1.8729	1.8098	1.8475	1.6920
2	- (S-1)/N	-0.0715	-0.0427	-0.0371	-0.0342
3	(1-Sum piE-1)/12NE2	-0.0028	-0.0014	-0.0005	-0.0009
4	Sum [(piE-1)-(piE-2)]/12NE3	-0.0020	-0.0012	-0.0001	-0.0007
5	H' for MMThin=	1.7965	1.7646	1.8097	1.6562
6	Varience in H' for MMThin=	0.0046	0.0028	0.0027	0.0029
7	Number of tree species, S=	13.0000	12.0000	11.0000	11.0000
8	Hmax = ln S=	2.5649	2.4849	2.3979	2.3979
9	Evenness E = H'/ln S =	0.7004	0.7101	0.7547	0.6907

Table C32. Values for Var, t, df, and P for tests of significant difference between treatment areas.

Comparison (1 and 2)	Var 1	Var 2	H' 1	H' 2	N 1	N 2	t	df	P
stream valley and flat area	0.0045705	0.002822	1.796549	1.764574	167.8	257.5714	0.3719034	351.64	P>>0.2
stream valley and hillside	0.0045705	0.002691	1.796549	1.809699	167.8	269.25	0.1543132	348.32	P>>0.2
stream valley and hilltop	0.0045705	0.002852	1.796549	1.656162	167.8	292	1.6294915	361.64	0.2>P>0.1
flat area and hillside	0.0028218	0.002691	1.764574	1.809699	257.5714	269.25	0.6077611	525.71	P>>0.2
flat area and hilltop	0.0028218	0.002852	1.764574	1.656162	257.5714	292	1.4392579	547.77	0.2>P>0.1
hillside and hilltop	0.002691	0.002852	1.809699	1.656162	269.25	292	2.0622252	561.18	.05>P>.02

Table C33. Calculation of Margalef's Diversity Index = Dmg = (S-1)/lnN.

	stream	flat area	hillside	hilltop
estimated total #of woody sp.=	29	24	23	22
total # of tree individuals = N	166.8	263.1429	275.75	290
Margalef Index = Dmg	5.47	4.13	3.91	3.70

Table C34. Input for analyses of varience of Evenness (E) with treatment and forest section.

Input C6.	Clearcut	Thinned	Control
Arthur's Brook	0.751	0.784	0.753
Bog Meadow	0.723	0.721	0.813
Mount Misery		0.677	0.731
average	0.737	0.728	0.766
std dev	0.020	0.054	0.042
std error	0.014	0.031	0.024

Table C35. Single factor analysis of varience of Evenness (E) without replication. ("Anova: Single Factor"). Data is from input C6. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Clearcut	2	1.474	0.737	0.00040
Thinned	3	2.183	0.728	0.00288
Control	3	2.297	0.766	0.00179

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.002298	2	0.0011	0.5898	0.5889	5.7861
Within Groups	0.009741	5	0.0019			
Total	0.012039	7				

Table C36. Two factor analysis of varience of Evenness (E) without replication ('Anova: Two-Factor Without Replication"). The factors are treatment and forest section (all included). Data from input C6. Alpha = 0.05.

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Arthur's Brook	3	2.289	0.763	0.00034
Bog Meadow	3	2.257	0.752	0.00274
Mount Misery	2	1.408	0.704	0.00142
Clearcut	2	1.474	0.737	0.00040
Thinned	3	2.183	0.728	0.00288
Control	3	2.297	0.766	0.00179

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.1663	2	0.083	1.618	0.306	6.944
Columns	0.1325	2	0.066	1.289	0.370	6.944
Error	0.2055	4	0.0514			
Total	0.5044	8				

TableD1. Input for analyses of varience of Red Oak abundances without replication (ANOVA). Values represent % Red Oak abundances for each treatment area (=100% x #Red Oaks/total #trees).

Input D1	Clearcut	Thinned	Control
Arthur's Brook	18.0	10.0	8.2
Bog Meadow	36.9	21.9	20.4
Mount Misery		12.5	10.6
average	27.5	14.8	13.1
standard dev.	13.4	6.2	6.5
standard error	9.4	3.6	3.7

TableD2. Single factor analysis of varience of Red Oak abundances without replication ("Anova: Single Factor"). Treatment is the factor. Data from input D1. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Clearcut	2	54.9	27.5	178.3
Thinned	3	44.5	14.8	39.0
Control	3	39.2	13.1	41.7

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	278.5419	2	139.27	2.05	0.22	5.79
Within Groups	339.859	5	67.97			
Total	618.4009	7				

Table D3. Two Factor Analysis of Varience of Red Oak Abundances without replication ("Anova: Two-Factor Without Replication"). The factors are treatment (all) and forest section (all). Data from Input D1. Alpha = 0.05

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Arthur's Brook	3	36.3	12.1	27.2
Bog Meadow	3	79.2	26.4	83.3
Mount Misery	2	23.1	11.6	1.9
Clearcut	2	54.9	27.5	178.3
Thinned	3	44.5	14.8	39.0
Control	3	39.2	13.1	41.7

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	573.0471	2	286.52	4.26	0.10	6.94
Columns	42.75895	2	21.38	0.32	0.74	6.94
Error	269.1626	4	67.29			
Total	884.9687	8				

TableD4. Input for analyses of varience of Red Maple abundances without replication (ANOVA). Values represent % Red Maple abundances for each treatment area (=100% x #RM/total #trees).

Input D2	Clearcut	Thinned	Control
Arthur's Brook	28.0	27.4	32.4
Bog Meadow	20.9	22.3	32.5
Mount Misery		20.5	26.4
average	24.5	23.4	30.4
standard dev.	5.0	3.6	3.5

Table D5. Single factor analysis of varience of Red Maple abundances without replication ("Anova: Single Factor"). Treatment is the factor. Data from input D2. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Clearcut	2	48.9	24.5	25.2
Thinned	3	70.2	23.4	12.8
Control	3	91.3	30.4	12.2

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	83.328	2.000	41.664	2.769	0.155	5.786
Within Groups	75.232	5.000	15.046			
Total	158.56	7				

Table D6. Two Factor Analysis of Varience of Red Oak Abundances without replication ("Anova: Two-Factor Without Replication"). The factors are treatment (all) and forest section (all). Data from Input D2. Alpha = 0.05.

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Arthur's Brook	3	87.8	29.3	7.5
Bog Meadow	3	75.7	25.2	40.1
Mount Misery	2	46.9	23.5	17.4
Clearcut	2	48.9	24.5	25.2
Thinned	3	70.2	23.4	12.8
Control	3	91.3	30.4	12.2

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	294.30	2	147.15	3.28	0.14	6.94
Columns	299.63	2	149.81	3.34	0.14	6.94
Error	179.47	4	44.87			
Total	773.40	8				

TableD7. Calculation of % Red Maple abundances for each circle (=100% x #Red Oaks/total #trees) for two factor analyses of varience with replication.

	Clearcut			Thinned			Control		
circle#	# of Red Map/circle	total # of trees/circle	%RM abundance	# of Red Map/circle	total # of trees/circle	%RM abundance	# of Red Map/circle	total # of trees/circle	%RM abundance
AB1	3	28	10.7	6	27	22.2	0	17	0.0
AB2	1	36	2.8	5	34	14.7	8	33	24.2
AB3	15	51	29.4	12	44	27.3	15	53	28.3
AB4	14	44	31.8	11	28	39.3	13	36	36.1
AB5	18	43	41.9	4	31	12.9	19	48	39.6
AB6	22	59	37.3	22	55	40.0	24	57	42.1
BM1	6	40	15.0	18	44	40.9	9	17	52.9
BM2	15	41	36.6	5	44	11.4	11	50	22.0
BM3	3	21	14.3	14	35	40.0	7	21	33.3
BM4	9	42	21.4	8	44	18.2	13	26	50.0
BM5	7	38	18.4	9	48	18.8	6	17	35.3
BM6	3	24	12.5	7	59	11.9	5	26	19.2
MM1				7	36	19.4	11	75	14.7
MM2				3	41	7.3	26	78	33.3
MM3				16	73	21.9	7	59	11.9
MM4				11	54	20.4	3	60	5.0
MM5				25	67	37.3	40	89	44.9
MM6				5	56	8.9	23	55	41.8
avg	9.7	38.9	22.7	10.4	45.6	22.9	13.3	45.4	29.7
std dev	6.9	10.8	12.4	6.4	13.1	11.7	9.9	22.4	15.2

Table D8. Inputs for two factor analyses of varience of Red Maple abundances with replication (ANOVA). Values represent % Red Maple abundances for each circle (=100% x #Red Maples/total #trees).

Input D3.	Clearcut	Thinned	Control
Arthur's Brook	10.7	22.2	0.0
	2.8	14.7	24.2
	29.4	27.3	28.3
	31.8	39.3	36.1
	41.9	12.9	39.6
	37.3	40.0	42.1
BogMeadow	15.0	40.9	52.9
	36.6	11.4	22.0
	14.3	40.0	33.3
	21.4	18.2	50.0
	18.4	18.8	35.3
	12.5	11.9	19.2
average	22.7	24.8	31.9
std dev	12.4	12.1	14.5
std error	3.6	3.5	4.2

Input D4.	Thinned	Control
Arthur's Brook	22.2	0.0
	14.7	24.2
	27.3	28.3
	39.3	36.1
	12.9	39.6
	40.0	42.1
BogMeadow	40.9	52.9
	11.4	22.0
	40.0	33.3
	18.2	50.0
	18.8	35.3
	11.9	19.2
Mount Misery	19.4	14.7
	7.3	33.3
	21.9	11.9
	20.4	5.0
	37.3	44.9
	8.9	41.8
average	22.9	29.7
std dev	11.7	15.2
std error	2.8	3.6

Table D9. Two Factor Analysis of Varience of Red Maple Abundances with replication ("Anova: Two-Factor With Replication"). The factors are treatment (clearcut, thinned, and control) and forest section (Arthur's Brook and Bog Meadow only). Data from Input D3. Alpha = 0.05.

SUMMARY	Clearcut	Thinned	Control	Total
Arthur's Brook				
Count	6	6	6	18
Sum	153.9	156.4	170.3	480.6
Average	25.6	26.1	28.4	26.7
Variance	239.3	137.5	239.2	182.7
Bog Meadow				
Count	6	6	6	18
Sum	118.2	141.1	212.8	472.1
Average	19.7	23.5	35.5	26.2
Variance	78.6	181.8	193.2	181.2
Total				
Count	12	12	12	
Sum	272.1	297.5	383.1	
Average	22.7	24.8	31.9	
Variance	154.1	146.9	210.2	

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	2.01	1	2.01	0.01	0.92	4.17
Columns	564.39	2	282.19	1.58	0.22	3.32
Interaction	273.66	2	136.83	0.77	0.47	3.32
Within	5348.26	30	178.28			
Total	6188.32	35				

Table D10. Two Factor Analysis of Varience of Red Maple Abundances with replication ("Anova: Two-Factor With Replication"). The factors are treatment (thinned and control) and forest section (all sections). Data from Input D4. Alpha = 0.05.

SUMMARY	Thinned	Control	Total
Count	6	6	12
Sum	156.4	170.3	326.7
Average	26.1	28.4	27.2
Variance	137.5	239.2	172.7
Count	6	6	12
Sum	141.1	212.8	353.9
Average	23.5	35.5	29.5
Variance	181.8	193.2	209.4
Count	6	6	12
Sum	115.3	151.6	266.9
Average	19.2	25.3	22.2
Variance	116.7	285.8	193.0
Total			
Count	18	18	
Sum	412.8	534.8	
Average	22.9	29.7	
Variance	136.7	230.5	

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	329.8	2	164.92	0.86	0.43	3.32
Columns	413.6	1	413.58	2.15	0.15	4.17
Interaction	141.4	2	70.72	0.37	0.70	3.32
Within	5771.2	30	192.37			
Total	6656.1	35				

Table D11. Calculation of %Black Birch (BB) abundances for each circle (=100% x #BB/total #trees) for single factor analyses of varience without replication. Site class is the factor.

Stream # of BB per circle	Stream total # of trees/circle	Stream %BB abundance	Flat Area # of BB per circle	Flat Area total # of trees/circle	Flat Area %BB abundance	Hillside # of BB per circle	Hillside total # of trees/circle	Hillside %BB abundance
0	28	0.0	6	44	13.6	11	51	21.6
0	36	0.0	5	43	11.6	3	59	5.1
0	27	0.0	3	57	5.3	5	34	14.7
0	31	0.0	0	44	0.0	9	44	20.5
2	17	11.8	2	44	4.5	3	28	10.7
			1	17	5.9	1	33	3.0
			0	21	0.0	7	53	13.2
			2	17	11.8	6	36	16.7
			3	36	8.3	4	40	10.0
			2	41	4.9	0	41	0.0
			1	56	1.8	1	21	4.8
			4	75	5.3	2	42	4.8
			10	59	16.9	0	24	0.0
			4	60	6.7	2	35	5.7
						0	44	0.0
						7	50	14.0
						0	26	0.0
						2	26	7.7
						0	73	0.0
						3	54	5.6
						0	67	0.0
						17	78	21.8
						5	89	5.6
						7	55	12.7

Table D12. Input for analyses of varience of Black Birch abundances without replication (ANOVA). Values represent %Black Birch abundances for each circle in stream, flat, and hillside classes (=100% x #Black Birch/total #trees).

Input D5	Stream	Flat Area	Hillside
	0.0	13.6	21.6
	0.0	11.6	5.1
	0.0	5.3	14.7
	0.0	0.0	20.5
	11.8	4.5	10.7
		5.9	3.0
		0.0	13.2
		11.8	16.7
		8.3	10.0
		4.9	0.0
		1.8	4.8
		5.3	4.8
		16.9	0.0
		6.7	5.7
			0.0
			14.0
			0.0
			7.7
			0.0
			5.6
			0.0
			21.8
			5.6
			12.7
average	2.4	6.9	8.3
std dev	5.3	5.1	7.2
std error	2.4	2.3	3.2

TableD13. Single factor analysis of varience of Black Birch abundances without replication ("Anova: Single Factor"). Site class is the factor. Data from input D5. Alpha = 0.05.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Stream	5	11.8	2.4	27.7
Flat Area	14	96.7	6.9	25.5
Hillside	24	198.1	8.3	52.2

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	145.0489	2	72.524	1.766	0.184	3.232
Within Groups	1642.436	40	41.061			
Total	1787.485	42				

Table E1. Raw data for soil test: first replicate. It was found that several crucibles lost some weight after heating to 375 degrees C. Thus, Wcrf represents the final weight of the crucibles.

Run#1

sample#	Wcri	Wcrf	W1	Wsoili= W1-Wcri	W2	Wsoilf= W2-Wcrf	LOI	%LOI	%organic carbon
1	15.668	15.668	16.954	1.286	16.708	1.040	0.246	19.1	9.6
2	17.100	17.100	19.282	2.182	17.749	0.649	1.533	70.3	35.1
3	42.957	42.937	44.530	1.573	44.185	1.248	0.325	20.7	10.3
4	42.759	42.720	44.943	2.184	44.722	2.002	0.182	8.3	4.2
5	42.850	42.818	43.810	0.960	43.340	0.522	0.438	45.6	22.8
6	43.196	43.174	45.161	1.965	44.895	1.721	0.244	12.4	6.2
7	43.664	43.635	44.585	0.921	44.228	0.593	0.328	35.6	17.8
8	17.499	17.499	19.764	2.265	19.540	2.041	0.224	9.9	4.9
9	15.505	15.505	16.512	1.007	16.145	0.640	0.367	36.4	18.2
10	13.851	13.851	16.062	2.211	15.732	1.881	0.330	14.9	7.5
11	16.727	16.727	17.747	1.020	17.332	0.605	0.415	40.7	20.3
12	14.799	14.799	17.015	2.216	16.678	1.879	0.337	15.2	7.6
13	17.102	17.102	18.244	1.142	17.794	0.692	0.450	39.4	19.7
14	16.181	16.181	18.057	1.876	17.770	1.589	0.287	15.3	7.6
15	10.769	10.769	11.703	0.934	11.290	0.521	0.413	44.2	22.1
16	15.580	15.580	17.619	2.039	17.355	1.775	0.264	12.9	6.5
17	43.381	43.356	45.420	2.039	45.257	1.901	0.138	6.8	3.4

Table E2. Raw data for soil test: second replicate. It was found that several crucibles lost some weight after heating to 375 degrees C. Thus, Wcrf represents the final weight of the crucibles.

Run#2

sample#	Wcri	Wcrf	W1	Wsoili= W1-Wcri	W2	Wsoilf= W2-Wcrf	LOI	%LOI	%organic carbon
1	15.668	15.668	16.908	1.240	16.660	0.992	0.248	20.0	10.0
2	17.100	17.100	19.167	2.067	18.973	1.873	0.194	9.4	4.7
3	42.937	42.928	44.039	1.102	43.834	0.906	0.196	17.8	8.9
4	42.720	42.713	44.689	1.969	44.528	1.815	0.154	7.8	3.9
5	42.818	42.806	43.866	1.048	43.397	0.591	0.457	43.6	21.8
6	43.174	43.167	45.162	1.988	44.925	1.758	0.230	11.5	5.8
7	43.635	43.616	44.706	1.071	44.361	0.745	0.326	30.4	15.2
8	17.499	17.499	19.535	2.036	19.333	1.834	0.202	9.9	5.0
9	15.505	15.505	16.727	1.222	16.288	0.783	0.439	35.9	18.0
10	13.851	13.851	15.818	1.967	15.540	1.689	0.278	14.1	7.1
11	16.727	16.727	17.844	1.117	17.438	0.711	0.406	36.3	18.2
12	14.799	14.799	16.920	2.121	16.596	1.797	0.324	15.3	7.6
13	17.102	17.102	18.173	1.071	17.704	0.602	0.469	43.8	21.9
14	16.181	16.181	18.001	1.820	17.729	1.548	0.272	14.9	7.5
15	10.769	10.769	11.771	1.002	11.332	0.563	0.439	43.8	21.9
16	15.580	15.580	17.587	2.007		broke crucible			0.0
17	43.356	43.347	45.335	1.979	45.203	1.856	0.123	6.2	3.1

Table E3. Raw data for soil test: third replicate. It was found that several crucibles lost some weight after heating to 375 degrees C. Thus, Wcrf represents the final weight of the crucibles.

Run#3

sample#	Wcri	Wcrf	W1	Wsoili= W1-Wcri	W2	Wsoilf= W2-Wcrf	LOI	%LOI	%organic carbon
1	15.668	15.668	16.718	1.050	16.516	0.848	0.202	19.2	9.6
2	17.100	17.100	19.165	2.065	18.975	1.875	0.190	9.2	4.6
3	42.928	42.923	43.993	1.070	43.976	1.053	0.017	1.6	0.8
4	42.713	42.706	44.821	2.115	44.651	1.945	0.170	8.0	4.0
5	42.806	42.799	43.859	1.060	43.368	0.569	0.491	46.3	23.2
6	43.167	43.161	45.507	2.346	45.222	2.061	0.285	12.1	6.1
7	43.616	43.605	44.675	1.070	44.310	0.705	0.365	34.1	17.1
8	17.499	17.499	19.582	2.083	19.359	1.860	0.223	10.7	5.4
9	15.505	15.505	16.608	1.103	16.229	0.724	0.379	34.4	17.2
10	13.851	13.851	16.031	2.180	15.666	1.815	0.365	16.7	8.4
11	16.727	16.727	17.927	1.200	17.447	0.720	0.480	40.0	20.0
12	14.799	14.799	16.884	2.085	16.540	1.741	0.344	16.5	8.2
13	17.102	17.102	18.311	1.209	17.839	0.737	0.472	39.0	19.5
14	16.181	16.181	18.274	2.093	17.965	1.784	0.309	14.8	7.4
15	10.769	10.769	11.747	0.978	11.314	0.545	0.433	44.3	22.1
16	43.015	42.969	45.286	2.317	44.949	1.980	0.337	14.5	7.3
17	43.347	43.340	44.824	1.484	44.717	1.377	0.107	7.2	3.6

Table E4. Arthur's Brook test for significant difference in organic carbon content in top soil between thinned and control areas: single factor analysis of variance without replication, where treatment is the factor.

Arthur's Brook topsoil organic carbon content
Input E1

run #	thinned	control
1	19.7	22.1
2	21.9	21.9
3	19.5	22.1

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
thinned	3	61.12	20.37	1.75
control	3	66.15	22.05	0.02

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4.22427	1	4.224	4.791	0.094	7.709
Within Groups	3.526561	4	0.882			
Total	7.750831	5				

Table E5. White Oak test for significant difference in organic carbon content in top soil between thinned and control areas: single factor analysis of variance without variation, where treatment is the factor.

White Oak topsoil organic carbon content
Input E2.

run #	thinned	control
1	18.2	20.3
2	18.0	18.2
3	17.2	20.0

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
thinned	3	53.37	17.79	0.29
control	3	58.52	19.51	1.36

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4.423164	1	4.423	5.348	0.082	7.709
Within Groups	3.30821	4	0.827			
Total	7.731374	5				

Table E6. Arthur's Brook test for significant difference in organic carbon content in subsoil between thinned and control areas: single factor analysis of variance without variation, where treatment is the factor.

Arthur's Brook subsoil organic carbon content
Input E3.

run #	thinned	control
1	7.6	6.5
2	7.5	7.3
3	7.4	

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
thinned	3	22.50	7.50	0.02
control	2	13.80	6.90	0.32

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.433696	1	0.43	3.64	0.15	10.13
Within Groups	0.357011	3	0.12			
Total	0.790707	4				

Basic Ecology of Important Woody Species

The following is a series of descriptions of some of the basic ecological aspects of the major species that showed differences in species composition between classes within the various comparison categories. This list was compiled from information found in *Ecology of Eastern Forests* (Kricher and Morrison, 1988) and *A Field Guide to Trees and Shrubs* (Petrides, 1972).

Oaks (genus: *Quercus*)

Slow growing, long lived; relatively disease and insect resistant; acorns eaten by nearly all, and twigs eaten by most, birds and mammals; southern affinity species—prefer south facing slopes; divided into two major groups: Red Oaks and White Oaks; differences in acorns between the groups affect mammals that feed on them: Red Oak acorns have both high fat and tannin content and sprout late; White Oak acorns have lower fat and tannin content and sprout early; leaves have relatively high C:N ratio, which cause them to decompose over a period of about 3 years; Oak galls are produced by the Cynipididae family of wasps; may have more myccorhizal relationships than any other angiosperm.

Red Oak (*Quercus Rubra*)

70' - 80' (max 100')[7]; found in woods; acorns bitter and usually inedible; somewhat shade tolerant, but less so than White Oak; disadvantaged on drier more exposed sites.

Chestnut Oak (*Quercus prinus*)

60' - 70' (max 100'); upland tree; belongs to a distinctive subdivision of the White Oak group; acorns are mostly inedible; requires rather open woodlots to become established; prolific sprouter; sometimes can be indicators of a xeric moisture regime.

White Oak (*Quercus alba*)

60' - 80' (max 150'); dry or moist woods; relatively shade tolerant; "masting" species: produces a large number of acorns every 4 - 10 years; mammal and bird populations may be affected by regional patterns of acorn production; good stump sprouter; thus, it recovers well after cutting; of intermediate shade tolerance: less so than Sugar Maple or Hemlock, but more so than Red Oak; damaged by gypsy moths in the Oak-Hickory Forest; disadvantaged on drier more exposed sites.

[7] Note: the average height of individual tree species and the average height of the canopy as a whole was not determined for the study area. The estimated average and maximum heights listed here are for entire ranges of the species and probably significantly exceed those for the Black Rock Forest.

Yellow Birch (*Betula lutea*)

70' - 80' (max 100'); moist forests; often associated with Black Birch and Hemlock; indicator species of the Northern Hardwood Forest (along with Sugar Maple and American Beech) where it inhabits both mature and disturbed sites; seeds do poorly in thick litter; grow best in forest gaps; grow well in boulder cracks and rotting logs; the most shade tolerant of Birch species; can remain almost indefinitely as a canopy species.

Black Birch (*Betula lenta*)

50' - 70' (max 80'); mature forests.

Red Maple (*Acer rubrum*)

20' - 40' (max 100'); wet woods and second growth; found many types of forests in the northeast; indicator species of Red Maple Swamp Forests of the northeastern U.S.; water loving species; important in forests along northeastern rivers and flood planes; highly adaptable species: does well in very moist or dry soils, but best in moist rich soils; successional tree of northern old fields; can grow on the woody mats of rocky outcrops; 'multilayered' tree: its leaves are usually small and arranged randomly on branches, shade intolerant, pattern useful in open areas—efficient in using large amounts of light; relatively high C:N ratio causes leaves to decompose over about 3 years.

Sugar Maple (*Acer Saccharum*)

40' - 60' (max 80'); mature upland forests; survive well in shade; persistent, slow growing shade tolerant tree; "monolayer species:" umbrella-like with a single dense layer of leaves, with the largest less lobed ones at the base; most effective with low light; can survive in the understory for long periods and then sprout quickly when gaps permit direct exposure to sunlight; can eventually replace less tolerant species; many times will have two suppression and release episodes before it reaches the canopy; will assume canopy status; slowly encroaching on Oaks and Hickories in the Oak-Hickory Forest; "northern affinity species:" it prefers north facing slopes; indicator of Northern Hardwood Forest in combination with Yellow Birch and American Beech; resistant to catastrophic wind damage; relatively fast decomposition of leaves affected by their low C:N ratio: 20:1.

Witch Hazel (*Hamamelis virginiana*)

10' - 25' (max 30'); shrub or small tree; woods; seeds eaten by several birds and mammals; an indicator of the Oak-Hickory Forest; tolerant of many soil types and moisture regimes; occurs in almost all forests of the northeast; aphids sometimes cause galls to appear on leaves (young aphids feed on Birches for six generations before returning to Witch Hazel, some cause leaf rolling of Birch leaves).

Heaths (Family: Ericaceae)

Found on acidic, sandy, dry soils in cool climates; many are found in bogs; most species are evergreen; often comprise the understorey of dry forests; include: rhododendrons, blueberries, huckleberries, cranberries, azaleas, Mountain Laurel, and *Gaultheria procumbens*; litter from blueberries and huckleberries may be slightly toxic to tree seedlings.

Mountain Laurel (*Kalmia latifolia*)

to 10' (rarely 35'); rocky woods and swamps; evergreen understorey shrub or small tree (under optimal conditions); an indicator of the Oak-Hickory Forest; tolerant of many soil types and moisture regimes; does not grow in old fields (unlike blueberries and huckleberries); deer eat leaves.

Black Huckleberry (*Gaylussacia baccata*)

to 3'; woodland shrub; closely related to blueberries; common in open areas and sandy acidic soils; spread asexually by root stocks; indicator of Northern Savanna Forest in Minnesota and Wisconsin.

Blueberries (genus: *Vaccinium*)

Complex series of acid soil loving heaths; common to old fields and forest understorey; fruit important to birds and mammals; may hybridize; "low" blueberries from the Northern Pine-Oak Forest north to the Boreal Forests.

Highbush Blueberry (*Vaccinium corymbosum*)

to 12'; tall shrub; swampy woodlands and dry open old fields; an indicator of the Oak-Hickory Forest; tetraploid which may form confusing hybrids.

Early Lowbush Blueberry (*Vaccinium vacillans*)

to 3'; low shrub; dry woods and thickets; an indicator of the Oak-Hickory Forest.

Late Low Blueberry (*Vaccinium angustifolium*)

to 2'; low shrub; tundras bogs and barrens; indicator of Northern Savanna Forest in Minnesota and Wisconsin.

Southern Low Blueberry (*Vaccinium pallidum*)

to 2'; low shrub.

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