

**PLANT COMMUNITY DEVELOPMENT
IN HISTORIC FOREST STANDS AT
GETTYSBURG NATIONAL MILITARY PARK
AND EISENHOWER NATIONAL HISTORIC SITE**

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Summary

The species composition and structure of woody and herbaceous vegetation were described for six woodlots selected for long-term monitoring of plant community development at Gettysburg National Military Park (GETT) and Eisenhower National Historic Site (EISE). Fifteen or thirty 20- x 20-m plots per woodlot, each with nested 10- x 10-m and 2- x 2-m subplots, were randomly located. Measurements of trees, shrubs, seedlings, and ground cover were made during 1990-1992. A 3- x 3-m fence was erected at the center of 15 plots in each of Biesecker and Pitzer woodlots to exclude deer from the central 2- x 2-m subplot. Species composition and abundance of herbaceous plants and vines were determined in a total of 15 fenced and 75 unfenced 2- x 2-m subplots in four woodlots during 1992. The data acquired from this initial survey are intended to serve as the baseline for long-term monitoring of changes in plant communities with special reference to the regeneration of a variety of native woody species common to the mixed oak forests of south central Pennsylvania.

A pair of fenced and unfenced demonstration plots, each 10- x 10-m, were established in each of six woodlots during 1985-1986. These plots were intended to provide sites that could be viewed by the general public to observe differences in development of forest communities with and without the presence of deer. Measurements of the abundance of woody seedlings were obtained at the demonstration plots during 1986-1987, 1989, 1991, and 1994. Data from the demonstration plots provided the first view of regeneration of woody species in fenced and unfenced areas and insight to the kinds of changes to expect in the long-term monitoring plots in the Biesecker and Pitzer woodlots. The combined results of the surveys in the long-term monitoring and demonstration plots provided a profile of current conditions and background data for future monitoring to determine the effects of feeding by white-tailed deer on forest regeneration.

Long-term Monitoring Plots

The number of taxa in the six woodlots selected for long-term monitoring ranged from 10 to 18 for overstory trees, 12 to 17 for large saplings, three to nine for small saplings, and eight to 13 for seedlings. Oaks (*Quercus* spp.) and hickories (*Carya* spp.) were dominant species in the overstory, and ash spp. (*Fraxinus* spp.), hickory spp., wild black cherry (*Prunus serotina*), and red maple (*Acer rubrum*) were dominant species in the large sapling category. Cherry spp. (*Prunus* spp.), ash spp., and hickory spp. were the most common taxa in the small sapling category, whereas the small sapling oaks were much less abundant. The canopy in each of the six woodlots was generally closed and indicative of a mature forest.

Species of oaks and hickories were well represented in the seedling category in each of the six woodlots. However, $\leq 20\%$ of the oak seedlings attained a height of > 25 cm, which indicated a low potential for oaks to become small saplings.

The density of oak saplings (small and large combined) was lower than that of oaks in the overstory for each woodlot. Oaks in the overstory outnumbered oak saplings by a 3:1 ratio in four of the six woodlots.

A significant result of the present survey was the fact that the density of small saplings was lower [less than 200 per hectare (ha)] than the density of overstory trees in five of the six woodlots. The Herr Ridge woodlot, with 392 small saplings per ha, was the only one with more than 200 small saplings per ha. Herr Ridge was the only one of the six woodlots located north of Route 116 where the deer herd density was significantly lower than in the woodlots south of Route 116.

The fact that the number of seedlings per ha for all tree species combined was < 30,000 for four of the six woodlots indicates a serious deficiency for regenerating a diverse mixed oak forest at the Gettysburg parks. Related to this problem is the lack of oak seedlings. Except for the Bushman woodlot, less than 2,000 oak seedlings per ha were estimated in each of the woodlots. Furthermore, of the oak seedlings, white oaks were more abundant than either black oaks or northern red oaks in several of the woodlots.

Because of the low abundance of oak seedlings > 25 cm in height and low numbers of oaks in the small sapling stage, it appears that a new forest profile will develop once the current overstory is replaced.

Only 95 herbaceous species were found in the long-term monitoring plots. The crane-fly orchid (*Tipularia discolor*), a rare species in Pennsylvania, was located in one woodlot. Several species that are typically found in comparable areas were not found.

Demonstration Plots

There was a steady decline in the relative abundance of tree seedlings and an increase in the relative abundance of shrub seedlings in both the fenced and unfenced demonstration plots from 1986-1987 to 1994. The average number of tree seedlings decreased from 48,000 per ha in 1986-1987 to 21,000 per ha in 1994. In contrast, the average number of shrub seedlings increased from 2,000 per ha in 1986-87 to 15,000 per ha in 1994.

Ash spp., wild black cherry, and white oak (*Quercus alba*) were consistent in their dominance of the tree seedlings. Smooth black-haw (*Viburnum prunifolium*), spicebush (*Lindera benzoin*), *Rubus* spp., and *Rosa* spp. were dominant species among the shrubs.

The number of all tree and shrub seedlings per ha that were $\leq$ 25 cm in height declined from 1989 to 1994 in both fenced and unfenced plots. Conversely, the number of tree and shrub seedlings per ha that were > 25 cm in height increased during the same period in both fenced and unfenced plots. The increase was greater in fenced plots than in unfenced plots.

Acknowledgments

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Introduction

The development and evaluation of comprehensive inventory and monitoring programs continue to be important functions of the National Park Service for managing renewable natural resources. Long-term monitoring programs are essential to (1) determine trends in ecosystem development, (2) provide reference data for understanding interactions among ecosystem components, and (3) describe and understand ecological relationships at the landscape level (Porter 1991, Silsbee and Peterson 1991, Underwood and Porter 1991).

Monitoring of natural resources is essential to evaluate changes in forests due to factors such as aging and development of plants, weather events, insect defoliation, and feeding effects of large ungulates. The present survey at Gettysburg National Military Park (GETT) and Eisenhower National Historic Site (EISE) was conducted because of concern over the effects of white-tailed deer (*Odocoileus virginianus*) on forest regeneration. Park managers at GETT and EISE have frequently reported intensive feeding by deer on woody plants.

A management goal for GETT and EISE is to protect and perpetuate natural resources to reflect the local historical scenes appropriate to both areas (U.S. Dept. Inter. 1982, U. S. Dept. Inter. 1987). Thus, park managers need information to assess interactions between deer and other natural resources and to project future changes in plant and animal communities. The data acquired for the present study are expected to provide reference data by which future changes in plant communities can be assessed in woodlots at GETT and EISE.

The objectives of this study were to (1) describe the current status of forest plant communities based on the abundance and species composition of woody and herbaceous plants in permanent plots in six woodlots (Biesecker, Pitzer, Bushman, Herr Ridge, Powers Hill, and Spangler) selected for long-term monitoring at GETT and EISE, and to establish paired fenced plots (to exclude deer) in Biesecker and Pitzer woodlots for monitoring differences in plant community development between fenced and unfenced plots, (2) establish one pair of fenced and unfenced demonstration plots in Biesecker, Pitzer, Bushman, Spangler, Cobean (Butterfield Farm), and Slyder (Granite Farm) woodlots for evaluating the effect of feeding by deer on woody and herbaceous vegetation, and (3) determine the intensity of feeding (browsing) by white-tailed deer on woody vegetation in the Biesecker and Pitzer woodlots.

Study Area

The study area (Fig. 1) is located in Adams County, south central Pennsylvania. GETT comprised 1,551 ha (3,833 ac) and EISE comprised 279 ha (689 ac) of the study area during 1990-1993. The town of Gettysburg, which has a human population of about 7,000 residents, is surrounded by the study area.

The study area is in the Gettysburg Plain, which is part of the Piedmont Province (Keener and Park 1986). Rocks in the Gettysburg Plain are generally soft sandstone and shale of the Triassic Age (U.S. Dept. Agric. 1967). Three major soil associations are Penn-Reddington-Croton, Lehigh-Brecknock, and Mont Alto-Mount Lucas-Watchung. Soils are shallow to deep and medium acidity (see also Addendum I).

Cemetery Ridge and Seminary Ridge, oriented north-south and located approximately 1.6 km (1 mi) apart, traverse the area. Mean elevation of the study area is 168 m (551 ft) and the highest point (Big Round Top) is 240 m (787 ft). Three streams, Willoughby Run on the west, Plum Run (Bloody Run) through the center, and Rock Creek on the east, flow north and south through the area. Ten ponds and small wetlands also are within the study area.

Annual temperature averaged 11.7°C (53.1°F) from 1900-1983. Annual maximum and minimum temperatures averaged 36.6°C (97.9°F) and -17.8°C (-0.04°F), respectively, during 1900-1983. Mean annual precipitation averaged 104.2 cm (41.0 in) from 1900-1983 and 103.1 cm (40.6 in) from 1986-1992. A majority of precipitation occurs from April through September (U.S. Dept. Agric. 1967). An average of 78.4 cm (30.9 in) and 39.4 cm (15.5 in) of snowfall occurred annually from 1900-1983 and 1986-1992, respectively. The growing season is about 180 days and extends from mid-April to mid-October (U.S. Dept Agric. 1967).

In 1987, there were 756 ha (1,868 ac) of cropland and pasture and 547 ha (1,352 ac) of forest at GETT, and 232 ha (573 ac) of cropland and pasture and 9 ha (22 ac) of forest at EISE. Most of the wooded areas at the study area consisted of mature trees typical of Appalachian forest, including oaks (*Quercus* spp.), hickory (*Carya* spp.), and cherry (*Prunus* spp.) (Kuchler 1964). The woodlots surveyed for the present study ranged from 8 ha to 23 ha (20 - 57 ac) and were interspersed with agricultural land (Fig. 1). The location of each woodlot and the location and distribution of sample plots within each woodlot are presented in Appendix A.

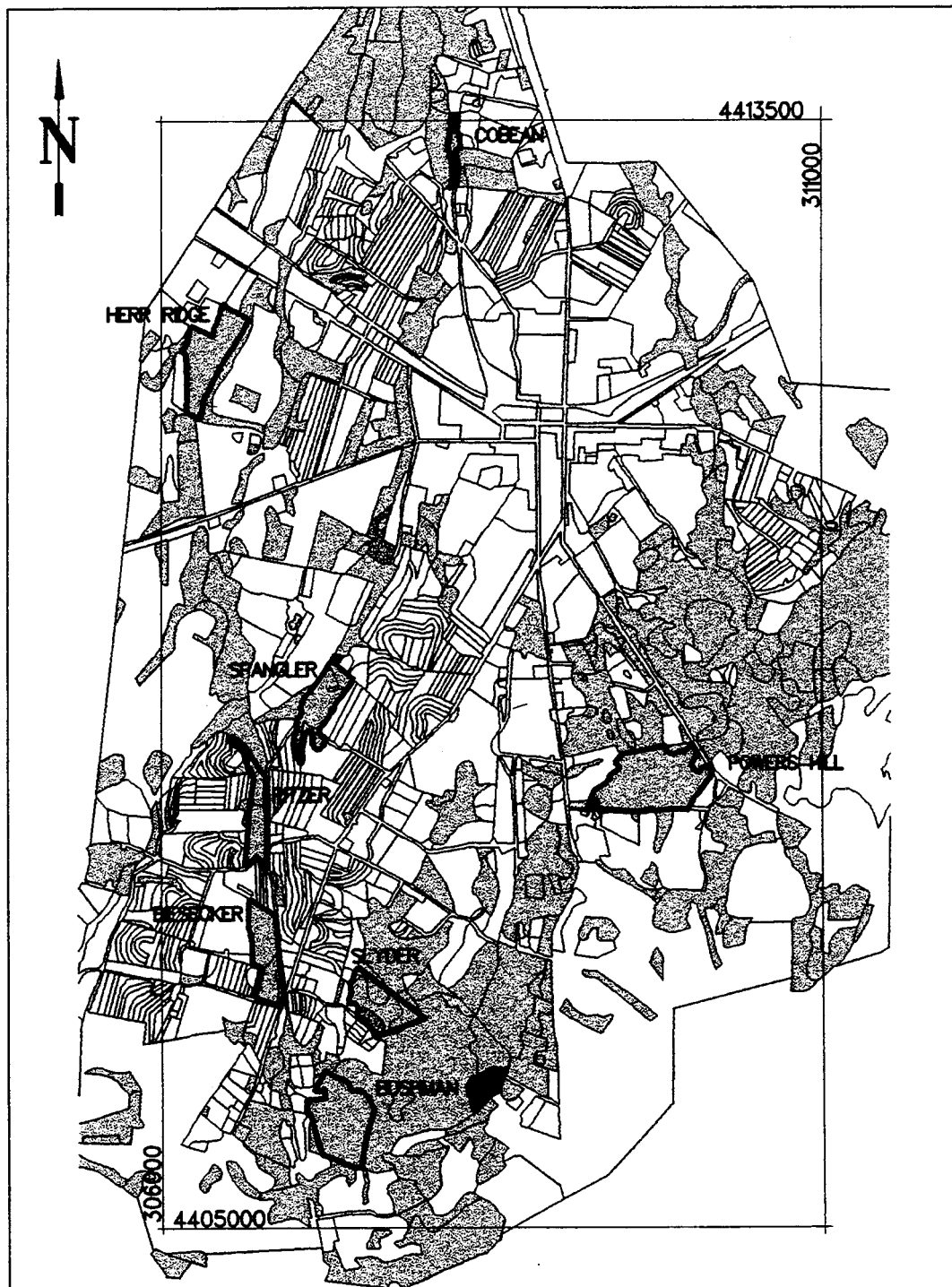


Fig. 1. Location of woodlots {Biesecker, Pitzer, Bushman, Herr Ridge, Powers Hill, Spangler, Cobean (Butterfield Farm), and Slyder (Granite Farm)} where plots were established to survey and monitor forest plant community development at the study area; numbers on the borderline represent UTM coordinates.

Previous Studies

Several short-term vegetative studies have been conducted at the study area. Bowersox and McCormick (1978) reported on restoration of historic vegetation at GETT. Smith and Mummert (1986) established transects at Culp's Hill, Little Round Top, Big Round Top, and Granite Farm to determine density, dominance, and frequency of trees > 6.4 cm diameter at breast height (dbh). Gibson (1987) described vegetation at Culp's Hill, Big Round Top, and Oak Ridge. Storm et al. (1989) reported on white-tailed deer at the study area and presented information on the effect of deer on forests and farm crops. Fairweather and Cavanaugh (1990) surveyed the current condition of historic woodlots at the study area and recommended future maintenance practices. Yahner et al. (1991) reported on a floral inventory and their report included a vegetative cover type map of the study area.

Methods

Long-term Monitoring Plots

A fixed plot monitoring system (Storm and Ross 1992) was implemented to survey tree, shrub, and herbaceous species and ground and vine cover at GETT and EISE. Each study plot consisted of a 20- x 20-m area that was subdivided into four 10- x 10-m subplots for measuring overstory and sapling trees and shrubs. A 2- x 2-m subplot nested in the center of the plot was subdivided into four 1- x 1-m subplots for measuring seedlings, herbaceous vegetation, and ground and vine cover (Fig. 2).

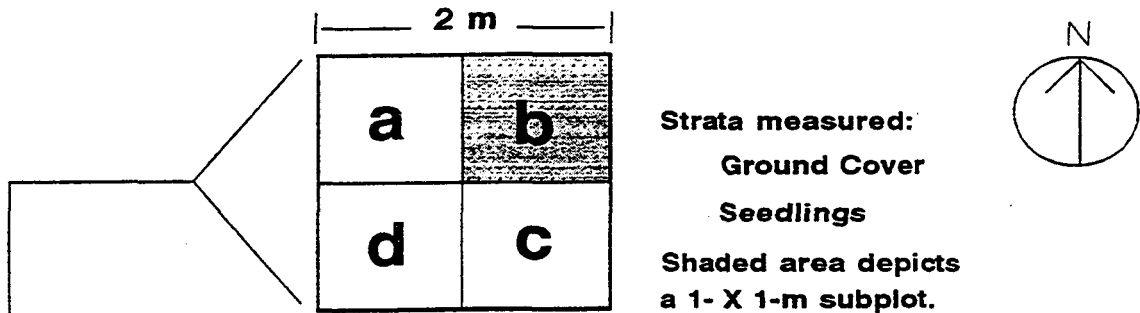
Six woodlots were selected as study sites. The name, size, and primary forest type associated with these six woodlots were as follows:

• Biesecker	11 ha	white oak-black oak-northern red oak
• Pitzer	16 ha	white oak-black oak-northern red oak
• Bushman	23 ha	white oak-black oak-northern red oak
• Herr Ridge	14 ha	white oak-black oak-northern red oak
• Powers Hill	19 ha	white oak-black oak-northern red oak
• Spangler	8 ha	white oak-black oak-northern red oak

Thirty 20- x 20-m plots were established and inventoried for woody vegetation and ground and vine cover in each of the Biesecker and Pitzer woodlots during 1990-1991 (Table 1). Fifteen plots with a fenced 2- x 2-m subplot in each of Biesecker and Pitzer woodlots were termed "fenced plots" and plots without fences were termed "unfenced plots" for this report. A 3- x 3-m wire-fence exclosure around the 2- x 2-m subplot provided a buffer area that would protect vegetation within the subplot from feeding by deer. Each exclosure in the Biesecker and Pitzer woodlots consisted of 14 gauge 7.5- x 10.0-cm mesh wire supported by 2.5-m steel t-posts driven approximately 0.5-m into the ground at each corner. Each exclosure was 1.8-m high. Fences were established in Biesecker during 1990 and in Pitzer during 1993 (Table 1). Fifteen plots, each with an unfenced 2- x 2-m subplot, were established and inventoried for woody vegetation and ground and vine cover in Spangler woodlot during 1991, and in each of Bushman, Herr Ridge, and Powers Hill woodlots during 1992 (Table 1). Herbaceous vegetation (including vines) surveys were conducted in the thirty plots in Biesecker during May 20 through May 29, 1992 and in the fifteen plots in Bushman, Herr Ridge, and Powers Hill during June 11 and 12, 1992, June 18 and July 7, 1992, and June 2, 8, and 18, 1992, respectively. A list of common and scientific names of plants identified during these surveys is presented in Appendix B.

For all woodlots, plot centers were randomly selected and then marked on a map. The distances and azimuths to conspicuous landmarks (e.g. woodlot corners) were recorded for each plot. The study plot locations were referenced to the Universal Transverse

I. Central 2- X 2- m subplot (0.0004 ha)



II. 20- x 20- m plot (0.04 ha)

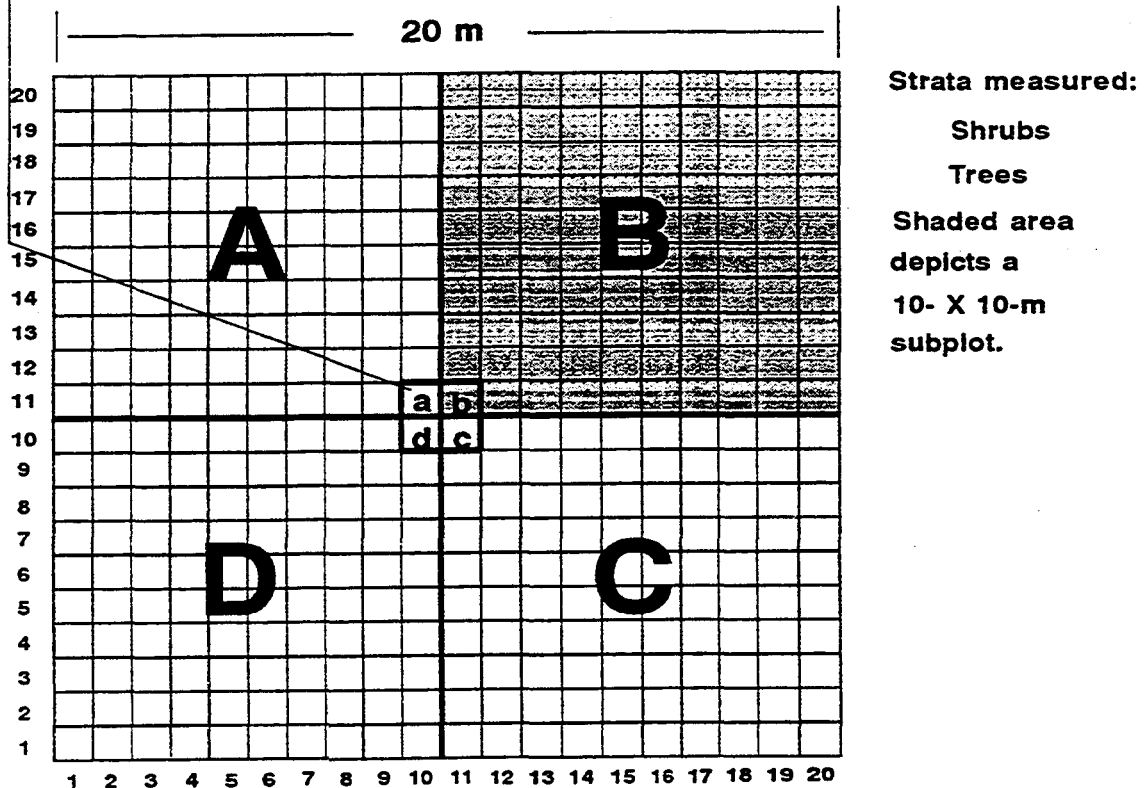


Fig. 2. Layout and orientation of 2- x 2-m and 10- x 10-m subplots located within the 20- x 20-m study plots used to inventory forest plant communities at Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1992; fiberglass pipe was established in the center of the central 2- x 2-m subplot.

Table 1. Woodlot and number of fenced and unfenced 20- x 20-m long-term monitoring plots^a for surveying woody and herbaceous vegetation and ground cover at Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1992.

Woodlot	Fenced ^b		Unfenced		Total plots
	Number of plots	Time of survey ^c	Number of plots	Time of survey ^c	
Biesecker ^d	15 ^e	May 1990	15 ^e	Oct 1991	30
Bushman	0	-	15 ^e	Jun 1992	15
Herr Ridge	0	-	15 ^e	Jun 1992	15
Pitzer ^f	15	May 90, Nov 91	15	May 90, Nov 91	30
Powers Hill	0	-	15 ^e	May 1992	15
Spangler	0	-	15	Dec 1991, Aug 92	15

^aSampling area was a 20- x 20-m plot with a 2- x 2-m subplot nested in the center.

^bEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of each plot.

^cWoody vegetation and ground and vine cover inventories for the 20- x 20-m sampling plots.

^dFences were established in 1990.

^eSeparate surveys of species composition of herbaceous and vine vegetation were conducted in 1992.

^fFences were established in 1993.

Mercator (UTM) system. The center of each 20- x 20-m plot was marked with an olive green fiberglass pipe (1 m in length, 1 cm in diameter) that was driven approximately 20 cm into the ground. Each pipe was marked with a polygon (woodlot) and plot number. Two overstory trees closest to the plot centers were selected as witness trees. Species, diameter at breast height [dbh; approximately 1.37 m (4.5 ft) above ground], and unique features (e.g. multiple stems) of the witness trees, and the azimuth and distance from each witness tree to the plot center were recorded on forms described in Storm and Ross (1992). An aluminum tag containing the polygon number, plot number, and year the plot was established was attached to the base of each witness tree.

The location and UTM coordinates of each woodlot and sampling plot are depicted in Appendix A. Plot design, location, direction to each study plot, and the descriptive data acquired from vegetation measurements are stored in original hard copy format and in dBase III + computer files. Copies of these files are available from the Pennsylvania Cooperative Fish and Wildlife Research Unit, The Pennsylvania State University, University Park, Pennsylvania and Gettysburg National Military Park, Gettysburg, Pennsylvania.

Attributes

The detailed methods and procedures used to measure overstory and sapling trees, shrubs, seedlings, and ground and vine cover are described in Storm and Ross (1992).

Overstory and Saplings - Tree Species: In each of the 10- x 10-m subplots, the species and diameter at breast height [dbh; 1.37 m (4.5 ft) above ground] were recorded for stems of all trees > 1.5 m (4.9 ft) in height. A tree was defined as a plant with a persistent woody stem usually with a single stem (Appendix B). Diameter (dbh) was measured to the nearest cm (e.g. stems $\leq$ 1.4 cm were recorded as 1 cm and those > 1.4 cm and $\leq$ 2.4 cm were recorded as 2 cm). Trees > 1.5 m in height and $\leq$ 1.4 cm dbh were classified as small saplings. Trees > 1.5 m in height and > 1.4 cm dbh and $\leq$ 11.4 cm dbh were considered large saplings and those > 1.5 m in height and > 11.4 cm dbh were considered overstory. Height and health status were recorded for five randomly selected sapling or overstory trees in each of the 10- x 10-m subplots. For subplots containing five or fewer sapling and overstory trees, the height, health status, species, and dbh were determined for each tree. A densiometer (Lemmon 1956) was used at the center of each 10- x 10-m subplot to estimate the amount of canopy closure.

Seedlings - Tree and Shrub Species: Counts of tree and shrub species seedlings (woody stems $\leq$ 1.5 m in height) were made in each 1-m² area of each central 2- x 2-m subplot. The species and height class (0-25, 26-50, 51-75, 76-100, 101-125, or 126-150 cm) were recorded for each tree and shrub species seedling.

Shrub Cover: A shrub was defined as a plant with a persistent woody stem with relatively low growth form (usually < 5 m in height) and usually with multiple basal stems as opposed to a single stem (Appendix B). Shrub coverage was estimated in two of the 10- x

10-m subplots (subplot A and subplot C) within each 20- x 20-m study plot using the line-intercept method (Hays et al. 1981). A total of four lines (two in each subplot, each 10 m in length) were surveyed at each plot. Random distances (selected from random numbers table) were used to locate points along the north-south line that divided the 10- x 10-m subplots, and the intercept lines were started at these points and run perpendicular to the outside edge of the subplot. The amount of each species of shrubs intersecting each 1,000 cm line was recorded to the nearest cm. Estimates of shrub coverage were based on all height classes of shrubs including shrub seedlings.

Ground and Vine Cover: Estimates of ground cover were made within two 1-m² areas (the a and c subplots) located in each central 2- x 2-m subplot. Ocular estimates (0, 1-4, 5-25, 26-50, 51-75, 76-95, or 96-100%) were used to determine horizontal coverage of herbaceous material (grasses, sedges, forbs, and moss-lichens), rock/mineral soil, litter, woody material, and non-woody (inorganic) material. The maximum height class (1-25, 26-50, 51-75, 76-100, 101-125, or 126-150 cm) of each attribute was also recorded.

During 1990 and 1991, woody material was recorded under the category 'other woody'. During 1992, woody material was separated into 'live-woody' and 'dead-woody' categories.

Horizontal vine coverage was ocularly estimated (0, 1-4, 5-25, 26-50, 51-75, 76-95, 96-100%) for each central 2- x 2-m subplot in two height zones; ≤ 2 m above ground and > 2 m above ground.

Herbaceous and Vine Species: In Biesecker, Bushman, Herr Ridge, and Powers Hill woodlots, species composition and abundance of herbaceous plants and vines were determined in approximately the same location as the 2- x 2-m central subplots in the unfenced 20- x 20-m plots and fenced (Biesecker only) 20- x 20-m plots during May through August, 1992. A 2- x 2-m (inside measurements) wooden frame, with wooden cross-pieces (3/4" wide) centered on the midpoint of each side of the frame, was used to delineate the sampling area and divide it into four ~ 1 -m² (0.9810407-m²) subplots (Fig. 3). The subplots were not exactly 1-m² because of the space occupied by the cross-pieces. The sides of the frame and cross-pieces were marked off in centimeters. At each plot the frame was positioned such that the frame sides were aligned along the north-south and east-west axes and the center stake of the 20- x 20-m plot rested against the two cross-pieces in the northwest corner of the southeast 1-m² subplot of the wooden frame.

At each of the 15 20- x 20-m fenced plots in Biesecker an additional 2- x 2-m subplot was measured for herbaceous plants and vines using the wooden frame. A subplot was established randomly in one of the four corners of a 40- x 40-m area centered on the 20- x 20-m plots such that two outside edges of the wooden frame were aligned with the two sides of the 40- x 40-m area. A 3/4" x 3/4" wooden stake was driven into the ground in the northwest corner of the southeast 1-m² subplot of the wooden frame. Thus, 45 2- x 2-m subplots were measured for herbaceous plants and vines in Biesecker woodlot; 15 were within the wire-fence exclosures and 30 were outside of the exclosures.

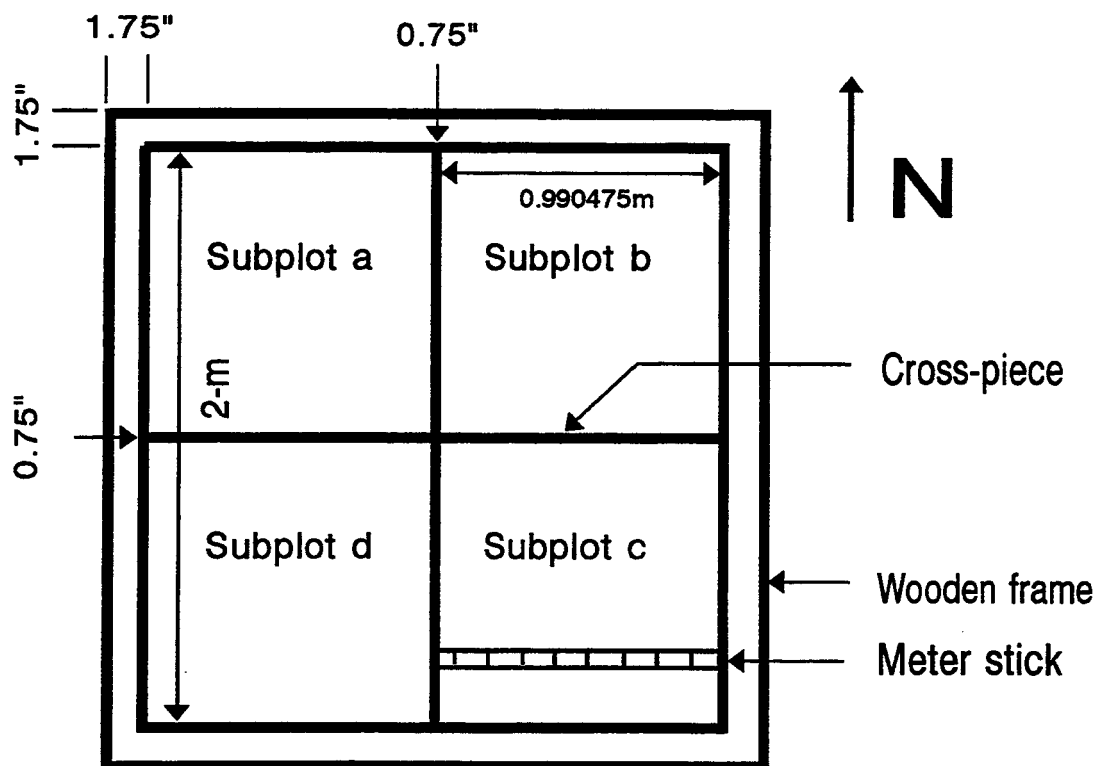


Figure 3. Illustration of wooden sampling frame and a meter stick when herbaceous line-transect was being conducted. The frame and cross-pieces were marked off in cm intervals. The two subplots used at each sample point were randomly chosen and the two positions of the meter stick in each of the two subplots were randomly determined using a random numbers table.

Two, 1-m line-transects running east-west were established in each of two of the four 1-m² subplots at each 2- x 2-m sampling subplot. The two 1- x 1-m subplots were randomly selected and two numbers between 1 and 99 were selected from a random numbers table to determine the position of the two line-transects. The position of the line-transect was determined by counting up from the southern edge of the 1-m² subplot. A meter stick was positioned between the frame side and a cross-piece such that the north side of the meter stick laid along the selected line-transect (Fig. 3). For each 10-cm interval of a line-transect, the length of the north edge of the meter stick that intercepted herbaceous plant tissue (for each species), litter, bare soil, rock, moss, and branch or log was recorded. The number of individuals of each species intercepting the north edge of the meter stick in each 10 cm interval and the number of intervals each species was present in along the line-transect were also recorded. All measurements were in centimeters. Values for the total of 40 intervals were totaled for each 2- x 2-m subplot. Specific procedures for sampling and vouchering herbaceous plants are described in Appendix C.

In addition, the total area within the two 1- x 1-m subplots sampled was searched for herbaceous and vine species that were not recorded along the four line-transects and the presence of these species was recorded.

The percent cover for each species and for litter, bare soil, rock, moss, and branch or log was also estimated within each of the two 1- x 1-m subplots by visualizing the number of square decimeters covered. Anything above one percent was estimated to the nearest percent, otherwise it was designated as < 1%. The percent cover values of the two 1- x 1-m subplots were averaged for each 2- x 2-m subplot.

Data Analysis

Overstory and Saplings - Tree Species: The dbh of each stem (saplings and overstory trees) was used to calculate an average dbh (nearest cm) for stems in all 20- x 20-m plots (0.6 ha for 15 plots or 1.2 ha for 30 plots) by species. Basal area (cm²) was determined for each small sapling, large sapling, and overstory stem. The basal area of all stems was summed for each plot by species and converted to m² per hectare to estimate basal area of saplings, overstory trees, and saplings and overstory trees combined. The number of stems (density) of small sapling, large saplings and overstory tree species was tallied within each of the four 10- x 10-m subplots. The total number of stems was summed for all plots (15 or 30) and then converted to stems per hectare for estimating density of saplings, overstory trees, and saplings and overstory trees combined.

For overstory and sapling trees, average dbh, basal area, density, frequency, and an importance value were calculated for each species in each woodlot. The importance value was based on measures of frequency, coverage, and density, which are defined as follows:

$$\text{Frequency} = \frac{\text{No. of subplots in which species A occurs}}{\text{Total no. of subplots examined}}$$

$$\text{Relative Frequency} = \frac{\text{Frequency of species A}}{\text{Sum of frequencies for all species}}$$

Relative frequency (RF) is the frequency of a given species as a proportion of the sum of the frequencies of all species.

$$\text{Coverage} = \text{Basal area of species A per unit area [Basal area per tree (cm}^2\text{) = 3.1416(dbh/2)}^2\text{]}$$

$$\text{Relative Coverage} = \frac{\text{Coverage of species A}}{\text{Sum of coverage values for all species}}$$

Relative coverage (RC) is the coverage of a species as a proportion of coverage for all species. Relative coverage as used in this report is equivalent to relative dominance as often used by plant ecologists (Mueller-Dombois and Ellenberg 1974).

$$\text{Density} = \frac{\text{Total number of individuals of species A}}{\text{Total area examined}}$$

$$\text{Relative Density} = \frac{\text{Density for species A}}{\text{Sum of densities for all species}}$$

Relative density (RD) is the proportion of a given species relative to the total number of individuals for all species.

RF, RC, and RD were summed for each species to obtain an importance value that could range from 0 to 3.00 (the higher the number, the more important the species). Dividing the importance value by 3 and multiplying by 100% results in an importance percentage that could range from 0 to 100% (Brower and Zar 1977).

Seedlings - Tree and Shrub Species: Tree and shrub species seedlings were counted by species in each 1- x 1-m sampling unit of the 2- x 2-m subplots in each woodlot. The number of seedlings were summed by species for each 2- x 2-m subplot and for all subplots in each woodlot. The total number of seedlings recorded for the plots were then converted to number of seedlings per 1-m² and estimated number of seedlings per hectare for each species.

Shrub Cover: Total centimeters of shrub coverage for the four intercept lines (two lines in each of two 10- x 10-m subplots) were summed for each shrub species in each plot. The total coverage of each species was divided by the total measured distance of the intercept lines to obtain a percent cover value.

Ground and Vine Cover: For ground cover, frequencies of occurrence were calculated by % cover class and maximum height class for each of the categories measured within the central subplots in each woodlot.

The data collected on tree and shrub species and ground and vine cover in the 30 plots in each of Biesecker and Pitzer woodlots were analyzed collectively and also separated into fenced and unfenced plot categories for analysis. Two-sample t-tests (Sokal and Rohlf 1969:220) were used to determine differences between fenced and unfenced plots in each woodlot. Variables compared included overstory and sapling tree dbh and density, canopy closure, coverage of shrubs, and total number of seedlings.

Herbaceous and Vine Species: Percent cover was summarized and density, frequency, coverage, relative density (RD), relative frequency (RF), relative coverage (RC), and importance values (IV) were calculated for each herbaceous species by woodlot (Brower et al. 1990).

A Shannon Index of diversity and an Evenness Index were calculated from the line-transect herbaceous data for each of the four woodlots (Brower et al. 1990). Coefficients of Similarity between the herbaceous communities in the four woodlots were calculated according to Brower et al. (1990) based on species presence within the 2- x 2-m subplots. Some inaccuracies occurred in the comparisons due to the change in species presence over the sampling period.

The importance values of the herbaceous species with the ten largest importance values in each group of fenced and unfenced plots at Biesecker were compared using a two-tailed t-test. An F-test was used to determine whether the variances of the two samples were statistically different (Ambrose and Ambrose 1987). The same tests were used to compare the number of species per plot between the fenced and unfenced plots at Biesecker.

Demonstration Plots

A pair of fenced (exclosure) and unfenced (control) demonstration plots was established in each of three woodlots [Slyder (Granite Farm), Pitzer, and Spangler] during 1985, and in each of three woodlots [Biesecker, Bushman, and Cobean (Butterfield)] during 1986 (Table 2). Exclosures were 10- x 10-m in size, constructed of 5- x 10-cm welded mesh wire, and supported by cedar posts and steel pipes. Each exclosure was 2.4-m in height. Distance and azimuth from the center of each exclosure to the center of the corresponding 10- x 10-m control plot were recorded. Fiberglass stakes, each 1.2 m in height, were placed at the center and corners of each control plot. The location of each exclosure and control plot was marked on 1987 aerial photographs (1:12,000) on file at the Pennsylvania Cooperative Fish and Wildlife Research Unit, University Park, PA 16802. These six pairs of fenced and unfenced plots were intended to provide demonstration sites that can be viewed by the general public to observe differences in development of forest communities with and without the presence of deer. The location of all demonstration plots are presented in Appendix A.

Attributes

Seedlings - Tree and Shrub Species: Surveys of tree and shrub seedlings in 1986, 1987, 1989, 1991, and 1994 were conducted in August and September. The 1986, 1987, and 1991 surveys were conducted on subplots within the 10- x 10-m plots. In 1986 and 1987 stems $\leq$

Table 2. The azimuth (corrected for magnetic declination) and distance (m) from the center of each of the six fenced 10- x 10-m plots to the center of an unfenced 10- x 10-m plot, Gettysburg National Military Park and Eisenhower National Historic Site, 1985-1986.

Woodlot	Year Established	Azimuth	Distance (m)
Biesecker	1986	160	26
Pitzer	1985	325	20
Bushman	1986	200	22
Spangler	1985	333	47
Cobean (Butterfield Farm)	1986	353	21
Slyder (Granite Farm)	1985	157	48

100 cm tall were recorded by species in four circular 2.0 m² subplots centered at points 3.25 m from the plot center towards each of the four plot corners. Total area sampled in each plot was 8.0 m². In 1991, the number of seedlings ($\leq$ 150 cm tall) were surveyed in four square 1.0 m² subplots in each of the four corners of each 10- x 10-m plot. The total area sampled per plot was 16 m².

During 1989 and 1994 the number of stems were counted in each of the entire 10- x 10-m (100 m²) plots. Height classes were $\leq$ 25, 26-50, 51-75, and 76-100 cm for 1989 and 1994, and height classes of 101-125 and 126-150 cm were also included during 1994.

Herbaceous and Vine Species: Herbaceous plants and vines were measured in a 2- x 2-m area in the center of the fenced demonstration plots in Biesecker and Bushman woodlots using the wooden frame used for the long-term monitoring plots. The center of each fenced demonstration plot was determined through triangulation and a 3/4" x 3/4" wooden stake was driven into the ground at that point. The sides of the wooden frame were aligned along the north-south and east-west axes and the frame was positioned such that the center stake fell in the northwest corner of the southeast 1-m² subplot of the wooden frame and touched the two cross-pieces. In each of the two woodlots a 2- x 2-m unfenced (control) subplot outside the exclosure was established by creating a 40- x 40-m area with its center being the center of the 10- x 10-m fenced plot and its sides parallel to the exclosure sides. One of the four corners of the 40- x 40-m area was randomly selected and the wooden frame was positioned within the 40- x 40-m area such that two outside edges of the frame were aligned along north-south and east-west sides of the 40- x 40-m area. A wooden stake was driven into the ground in the northwest corner of the southeast 1-m² subplot of the wooden frame.

Species composition and abundance of herbaceous plants and vines were measured in two randomly selected 1-m² subplots in each 2- x 2-m subplot according to the methods and procedures used for the long-term monitoring plots. The two 2- x 2-m subplots in each of the Biesecker and Bushman woodlots were sampled on May 21, 1992 and June 12, 1992, respectively.

Browse Availability and Use

To determine the relative use of twigs of shrub and tree taxa by white-tailed deer, 15 circular plots were established in each of the Biesecker and Pitzer woodlots in May, 1990. Plot centers were located by choosing a random azimuth and a random distance (1-25 m) from the center of the long-term monitoring plots established during 1990. A circular plot of 9.3 m² (98.5 ft²) with a 1.72 m (5.6 ft) radius was delineated for estimating the availability of twigs and use of twigs by deer. The number of unbrowsed and browsed twigs of each tree and shrub taxa was recorded as the available twigs, and the number of browsed twigs was recorded as twigs used by deer (Shafer 1963). A twig was defined as recent growth that when unbrowsed would have been $\geq$ 2.5 cm long (Stiteler and Shaw 1966). Single-stemmed seedlings and root sprouts with no twigs $\geq$ 2.5 cm long were counted as a single twig. Twigs were measured on stems, in a vertical stratum, extending from ground

level to 1.83 m high. Use was defined as the % of total available twigs browsed.

Twigs counted for each species present in each circular plot were summed for all plots. The percentage of browsed twigs was calculated for 15 plots in the Biesecker woodlot and 15 plots in the Pitzer woodlot.

Results

Long-term Monitoring Plots

The following section provides data to describe the current status of plant communities in six woodlots examined during 1990-1992. The Bushman, Herr Ridge, Powers Hill, and Spangler woodlots each contained 15 20- x 20-m plots whereas the Biesecker and Pitzer woodlots each had 30 20- x 20-m plots. The combined data for the 30 plots (fenced and unfenced) at each of the Biesecker and Pitzer woodlots and for the 15 plots at each of the other four woodlots were used to describe the vegetation and thus the descriptive data presented in this report serve as a reference for future monitoring. A comparison of vegetation in the fenced and unfenced plots in the Biesecker and Pitzer woodlots is also presented. These comparative data provide the background data for use in future evaluations of the effect of feeding by deer on forest regeneration. The location of each long-term monitoring plot within each woodlot is presented in Appendix A.

For this report we presented data on all taxa classified as seedlings of tree and shrub species, small saplings, large saplings, and overstory trees. In addition, we highlighted a separate profile of the abundance of the following selected taxa: black oak, pin oak, white oak, chestnut oak, northern red oak, scarlet oak, hickory spp., red maple, ash spp., eastern red cedar, black-gum, wild black cherry, sweet cherry, American elm, and yellow poplar. These selected taxa represent native hardwoods associated with mixed oak forests in Pennsylvania. In a few special cases scientific names of plants are included in the narrative (e.g. sedges). A complete list of common and scientific names of plants referenced in this report is presented in Appendix B.

Biesecker Woodlot (Combined Data)

Overstory - Tree Species: Twenty-three percent of the woody stems > 1.5 m in height were overstory trees (> 11.4 cm dbh) (Fig. 4). Hickory spp., white oak, northern red oak, and black oak were the dominant tree taxa recorded in the overstory category.

Overstory trees were estimated at 310 stems per hectare (ha) with an average dbh of 25 cm and basal area of 23 m² per ha (Table 3). The oak and hickory species accounted for 51% and 29%, respectively, of the overstory trees based on the estimated number of stems per ha (Table 4). Sweet cherry and wild black cherry accounted for 7% and 5%, respectively, and all others accounted for 8% of the total. The number of overstory trees and basal area values would place the woodlot in the 82% stocking level when compared to the standards developed for upland oaks (Dale and Lutz 1986). Mean canopy closure was 92% for the 30 plots.

Large Saplings - Tree Species: Large saplings were estimated at 986 stems per ha with an average dbh of 6 cm and basal area of 3 m² per ha (Table 3). Hickory spp., sweet cherry, wild black cherry, and white oak were the most abundant taxa in the large

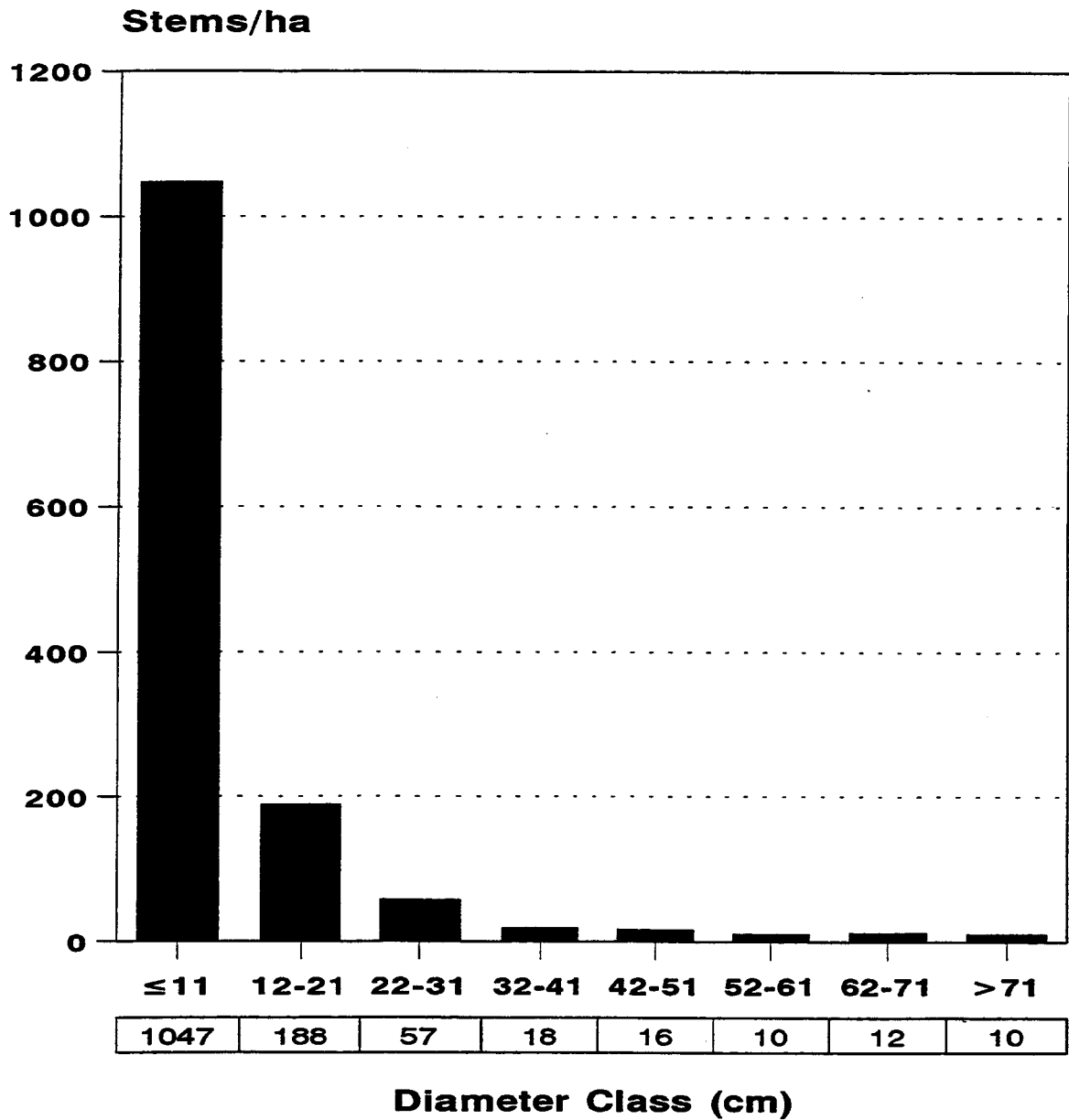


Figure 4. Estimated number of stems per hectare by diameter class (cm) of small and large sapling (≤ 11.4 cm dbh) and overstory (> 11.4 cm dbh) trees in 30 20- x 20-m plots measured in the Biesecker woodlot, Gettysburg National Military Park, and Eisenhower National Historic Site, 1990-1991; in this figure saplings ≤ 11.4 cm dbh were included in the ≤ 11 cm diameter class and overstory > 11.4 cm dbh were included in the appropriate larger (≥ 12 cm) diameter classes.

Table 3. Density, average diameter at breast height (dbh), and basal area for small sapling, large sapling, and overstory trees in 30 20- x 20-m plots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Unit	Small Saplings^b	Large Saplings^b	Overstory^b
Density			
stems/ha	61	986	310
(stems/ac)	(25)	(399)	(125)
DBH			
cm	1	6	25
(in)	(0.4)	(2.4)	(9.8)
Basal Area			
m ² /ha	0.004	3	23
(ft ² /ac)	(0.017)	(13)	(100)

^aTotal area of 30 plots was 1.2 ha.

^bSmall saplings were stems > 1.5 m in height and ≤ 1.4 cm dbh, large saplings were stems > 1.5 m in height and > 1.4 cm dbh and ≤ 11.4 cm dbh, overstory were stems > 1.5 m in height and > 11.4 cm dbh.

Table 4. Average diameter at breast height (dbh), basal area, and density for 17 overstory tree taxa in 30 20- x 20-m plots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	19	0.13	4
Catalpa, northern	13	0.03	3
Cedar, eastern red	17	0.11	5
Cherry, wild black	16	0.48	16
Cherry, sweet	14	0.33	22
Elm, American	22	0.35	8
Elm, slippery	43	0.12	1
Hickory, spp.	19	2.24	89
Maple, red	16	0.07	3
Oak, black	27	1.69	27
Oak, northern red	25	3.28	53
Oak, pin	25	0.13	3
Oak, scarlet	28	0.21	3
Oak, white	41	12.99	71
Pine, eastern white	24	0.04	1
Pine, pitch	31	0.06	1
Walnut, black	17	0.04	2

^aTotal area of 30 plots was 1.2 ha.

sapling stage and together comprised 90% of the total number of stems per ha (Table 5). These taxa also had high importance values (Appendix D). Northern red oak, ash spp., and eastern redcedar in the large sapling stage also ranked high based on importance values (Appendix D).

Small Saplings - Tree Species: Small sapling trees comprised a significant component of the woody profile between seedlings and large saplings in the Biesecker woodlot. The density of small saplings was 61 stems per ha (Table 3). Wild black cherry (59%) and white oak (23%) were the dominant small saplings based on the estimated total number of stems per ha in the 30 plots, whereas oaks and hickories combined accounted for 34% of the total (Appendix E).

The density of large and small saplings combined was 1,047 stems per ha (Table 3). Oaks had a much lower representation in the number of saplings per ha than was present in the overstory; oaks comprised 13% of the sapling group and 51% of the overstory group for all taxa, and 14% of the sapling group and 53% of the overstory group for selected taxa (Fig. 5).

Seedlings - Tree Species: Nine taxa of tree seedlings were counted in the Biesecker woodlot. The estimated number of seedlings was 25,250 stems per ha (Table 6). Wild black cherry comprised 40%, oak and hickory spp. combined comprised 47%, and ash spp. comprised 11% of the total tree taxa seedlings recorded. There were 10,167 oak spp. seedlings per ha (Table 6).

Seedlings - Shrub Species: Four taxa of shrub seedlings were recorded in the 2- x 2-m subplots in the Biesecker woodlot (Table 7). Smooth black-haw was estimated at 3,583 stems per ha and *Rubus* spp. at 4,000 stems per ha, whereas 167 downy serviceberry and 83 Japanese barberry seedlings per ha were estimated.

Shrub Cover: Eight shrub taxa were recorded in the 10- x 10-m subplots in the Biesecker woodlot. Dominant species included smooth black-haw, flowering dogwood, and downy serviceberry. Average total shrub coverage for all taxa was estimated at 6% in the 10-x 10-m subplots.

Ground and Vine cover: Litter occupied more than 50% of the ground surface at the forest floor in 55 of the 60 1- x 1-m subplots sampled in the Biesecker woodlot. Leaves were a major component of the litter layer in the 1-25 cm height category, whereas fallen branches and other unrooted woody material contributed to most of the upper height classes. Fifty-four of 60 1- x 1-m subplots had less than 26% of the ground cover in herbaceous material. Eleven of 60 1- x 1-m subplots had herbaceous material > 25 cm in height.

Coverage of vines $\leq$ 2 m in height was < 5% in 25 of the 30 subplots surveyed in the Biesecker woodlot.

Table 5. Average diameter at breast height (dbh), basal area, and density for 17 large sapling tree taxa in 30 20- x 20-m plots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	6	0.04	15
Black-gum	6	0.02	6
Catalpa, northern	5	0.02	7
Cedar, eastern red	7	0.06	17
Cherry, wild black	6	0.29	113
Cherry, pin	5	^b	1
Cherry, sweet	7	0.53	123
Elm, American	7	0.05	13
Elm, slippery	9	0.01	2
Hickory spp.	5	1.45	558
Maple, red	9	0.03	4
Oak, black	8	0.06	14
Oak, northern red	7	0.09	20
Oak, white	7	0.33	89
Sassafras	8	0.02	3
Unknown	8	^b	1
Walnut, black	5	0.01	3

^aTotal area of 30 plots was 1.2 ha.

^bBasal area < 0.01.

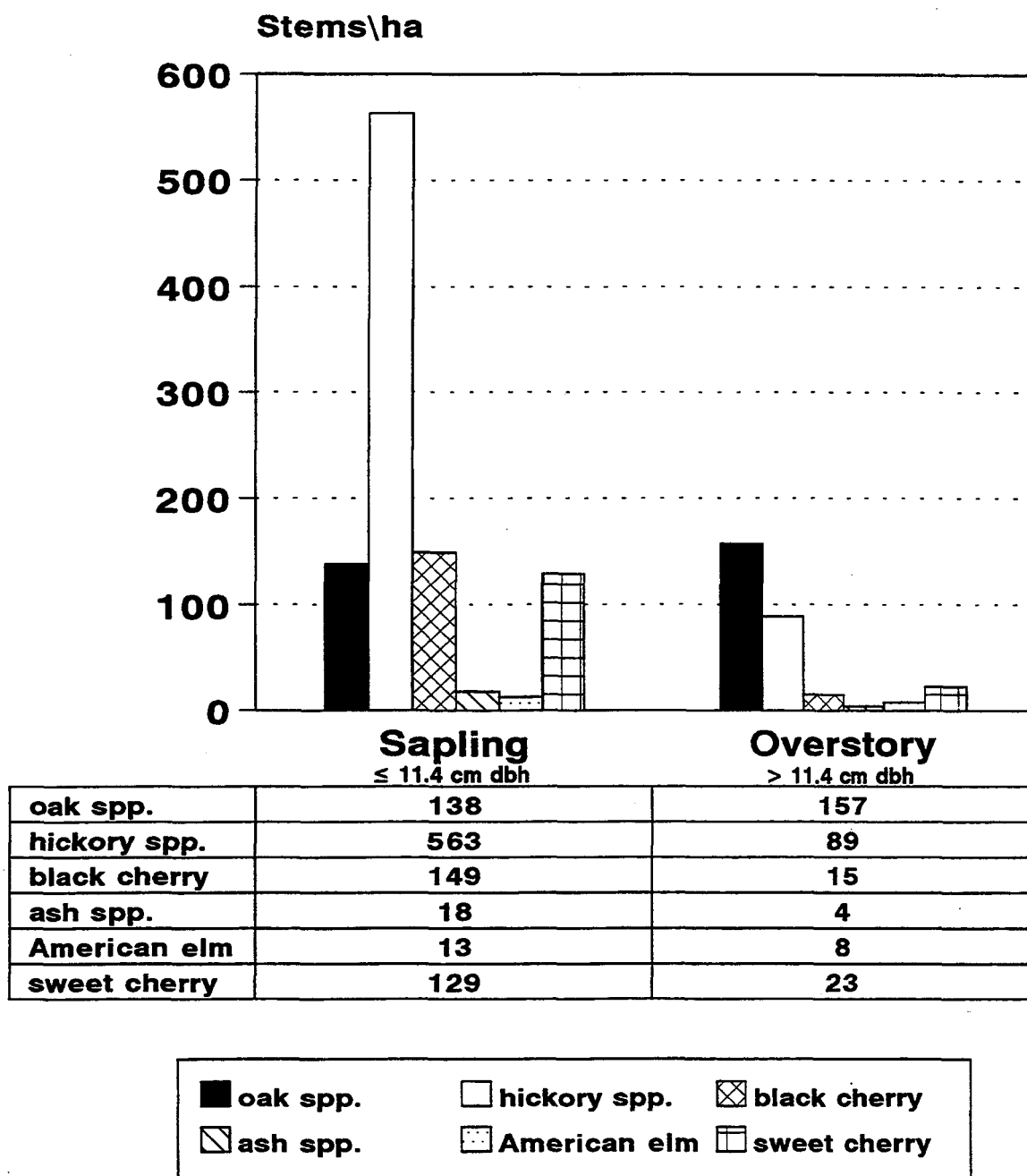


Figure 5. Estimated number of sapling and overstory stems per hectare of selected taxa present in 30 20- x 20-m plots measured in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Table 6. Number of tree seedlings (≤ 1.5 m in height) per 0.012 hectare^a and estimated number per hectare for nine taxa in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Number per 0.012 ha	Estimated Number per ha
Ash spp.	34	2,833
Cedar, eastern red	4	333
Cherry, wild black	120	10,000
Elm, American	1	83
Hickory spp.	20	1,667
Maple, red	2	167
Oak, black	2	167
Oak, northern red	5	417
Oak, white	115	9,583
Total	303	25,250

^aSeedlings were counted in the four 1-m² subplots of each of the 30 2- x 2-m central subplots; the total area sampled for the 30 plots was 0.012 ha.

Table 7. Number of shrub seedlings (≤ 1.5 m in height) per 0.012 hectare^a and estimated number per hectare for four taxa in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Number per 0.012 ha	Estimated Number per ha
Barberry, Japanese	1	83
Black-haw, smooth	43	3,583
<i>Rubus</i> spp.	48	4,000
Serviceberry, downy	2	167
Total	94	7,833

^aSeedlings were counted in the four 1-m² subplots of each of the 30 2- x 2-m central subplots; the total area sampled for the 30 plots was 0.012 ha.

Herbaceous and Vine Species: The importance values of Japanese honeysuckle (65.4) and spring-beauty (62.7) were more than 2.5 times larger than that of cinquefoil (24.4) (Table 8). Coverage contributed almost half of the importance value of Japanese honeysuckle while frequency and density were the major contributors to the spring-beauty importance value.

For all 45 2- x 2-m subplots measured in Biesecker woodlot, 32 herbaceous and vine species were encountered along the line-transects and a total of 42 species were present within the subplots. The Shannon Diversity and Evenness indices were 1.10 and 0.73, respectively, for the line-transect data (Table 9).

Biesecker Woodlot (Fenced and Unfenced Plots)

Overstory - Tree Species: Hickory spp., white oak, northern red oak, and black oak were dominant taxa in the overstory (Table 10) in both fenced and unfenced plots in the Biesecker woodlot. Based on importance values, wild black cherry and sweet cherry also ranked high in the overstory (Appendix D). Ash spp., northern catalpa, pin oak, eastern white pine, and black walnut overstory taxa were present in the fenced plots but absent in the unfenced plots (Table 10). Mean canopy closure was 94% for the fenced plots and 90% for the unfenced plots.

Large Saplings - Tree Species: Hickory spp., sweet cherry, wild black cherry, and white oak were dominant large sapling taxa (Table 11) in both fenced and unfenced plots. Based on importance values, black oak, northern red oak, and ash spp. also ranked high in the large sapling stage (Appendix D). Pin cherry and slippery elm large sapling taxa were present in the unfenced plots but absent in the fenced plots (Table 11).

Average dbh and basal area for overstory and large sapling trees combined were not different ($P > 0.05$) between fenced and unfenced plots (Figs. 6, 7). Average dbh was 10.2 cm for fenced plots and 10.5 cm for unfenced plots. Average density of 50.5 stems per fenced plot was not different ($P > 0.05$) from an average density of 53.2 stems per unfenced plot.

Small Saplings - Tree Species: Ten of 15 fenced plots and one of 15 unfenced plots in Biesecker woodlot contained small saplings. Wild black cherry and white oak comprised 84% of the total small saplings counted. The average density of 4.8 small saplings per fenced plot was significantly different ($P < 0.05$) from an average density of 0.1 small saplings per unfenced plot. Densities ranged from zero to 32 small saplings per plot in the fenced plots and from zero to one small sapling per plot in the unfenced plots.

Seedlings - Tree Species: Nine taxa of tree seedlings were recorded in the 15 fenced plots and 15 unfenced plots in Biesecker woodlot (Table 12). White oak and wild black cherry were the most abundant species recorded in the fenced plots, whereas wild black cherry and ash spp. were the most abundant taxa in the unfenced plots. A total of 122

Table 8. A listing of the relative density (RD), relative coverage (RC), relative frequency (RF) and importance values (IV) for the 10 herbaceous taxa with the greatest importance values for the Biesecker woodlot at Gettysburg National Military Park and Eisenhower National Historic Site. Values were calculated from line-transect data collected during May to August, 1992. Due to rounding of numbers, some of the importance values do not agree with the sum of the relative density, relative coverage, and relative frequency values.

Taxa^a	IV	RD	RC	RF
Japanese honeysuckle	65.4	15.6	31.8	18.0
Spring-beauty	62.7	24.3	10.6	27.8
Cinquefoil	24.4	6.8	10.5	7.1
Graminae spp.	23.4	10.6	4.6	8.3
Sedge (<i>C. complanata</i>)	15.9	9.6	2.7	3.6
Compositae sp. #1	14.2	3.5	6.9	3.9
Sedge (<i>C. spp.</i>)	14.1	6.8	2.4	5.0
Enchanter's-nightshade	11.0	3.1	4.4	3.6
Wild licorice	9.5	3.2	2.0	4.3
<i>Polygonum</i> spp.	8.0	2.8	2.9	2.4

^aCover and abundance of herbaceous and vine species were estimated along two line-transects in each of two 1-m² subplots in each of the 45 2- x 2-m subplots.

Table 9. Shannon Diversity and Evenness Index values for herbaceous species in 2- x 2-m subplots in Biesecker, Bushman, Herr Ridge, and Powers Hill woodlots at Gettysburg National Military Park and Eisenhower National Historic Site. Values were calculated from line-transect data collected May-August, 1992.

	Shannon Diversity Index	Evenness Index
Biesecker		
fenced ^a	1.02	0.76
unfenced ^a	0.93	0.79
all ^b	1.10	0.73
Bushman		
unfenced ^a	1.12	0.74
Herr Ridge		
unfenced ^a	0.91	0.77
Powers Hill		
unfenced ^a	0.97	0.77

^a Fifteen 2- x 2-m subplots centered in 20- x 20-m plots used for sampling woody species.

^b Forty-five total plots, including 15 unfenced 2- x 2-m subplots located inside the corners of the 40- x 40-m areas centered on the fenced areas.

Table 10. Average diameter at breast height (dbh), basal area, and density for 17 overstory tree taxa in 15 20- x 20-m fenced plots and 15 20- x 20-m unfenced plots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Fenced ^a			Unfenced		
	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)
Ash spp.	19	0.26	8	0	0	0
Catalpa, northern	13	0.06	5	0	0	0
Cedar, eastern red	17	0.19	8	16	0.03	2
Cherry, wild black	13	0.22	15	19	0.74	15
Cherry, sweet	13	0.15	12	14	0.51	33
Elm, American	19	0.16	5	24	0.54	10
Elm, slippery	0	0	0	43	0.24	2
Hickory spp.	19	2.77	82	18	2.73	97
Maple, red	0	0	0	16	0.14	7
Oak, black	25	1.03	18	27	2.36	35
Oak, northern red	20	1.50	40	28	5.04	67
Oak, pin	25	0.26	5	0	0	0
Oak, scarlet	26	0.17	3	31	0.24	3
Oak, white	49	16.69	72	33	9.29	70
Pine, eastern white	24	0.08	2	0	0	0
Pine, pitch	0	0	0	31	0.13	2

Table 10. (continued)

Taxa	Fenced ^a			Unfenced		
	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)
Walnut, black	17	0.08	3	0	0	0

^aEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of each plot.

Table 11. Average diameter at breast height (dbh), basal area, and density for 16 large sapling taxa in 15 20- x 20-m fenced plots and 15 20- x 20-m unfenced plots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historical Site, 1990-1993.

Taxa	Fenced ^a			Unfenced		
	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)
Ash spp.	5	0.05	18	6	0.04	13
Black-gum	6	0.04	12	0	0	0
Catalpa, northern	5	0.03	12	0	0	0
Cedar, eastern red	6	0.08	25	7	0.03	8
Cherry, wild black	5	0.32	140	6	0.27	85
Cherry, pin	0	0	0	5	^b	2
Cherry, sweet	7	0.40	87	7	0.67	158
Elm, American	6	0.02	8	7	0.07	17
Elm, slippery	0	0	0	9	0.02	3
Hickory spp.	5	1.40	530	5	1.47	583
Maple, red	9	0.02	3	9	0.03	5
Oak, black	8	0.03	7	7	0.09	22
Oak, northern red	7	0.11	27	7	0.06	13
Oak, white	6	0.33	102	7	0.34	77
Sassafras	8	0.03	5	7	^b	2
Walnut, black	5	0.01	7	0	0	0

^aEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of each plot.

^bBasal area < 0.01.

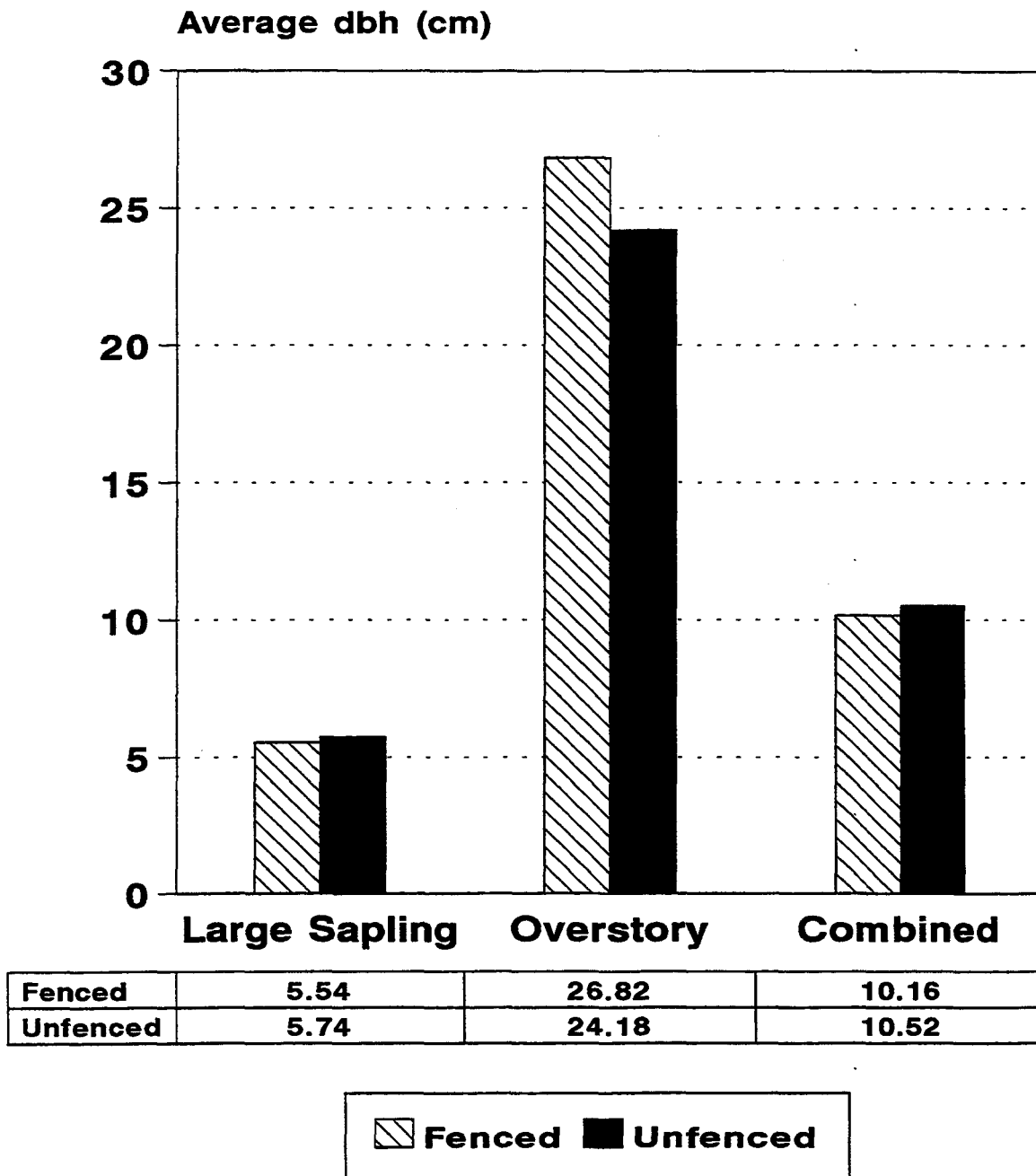


Figure 6. Average diameter at breast height (dbh) of large saplings, overstory trees, and large sapling and overstory trees combined for 15 20- x 20-m fenced plots and 15 20- x 20-m unfenced plots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

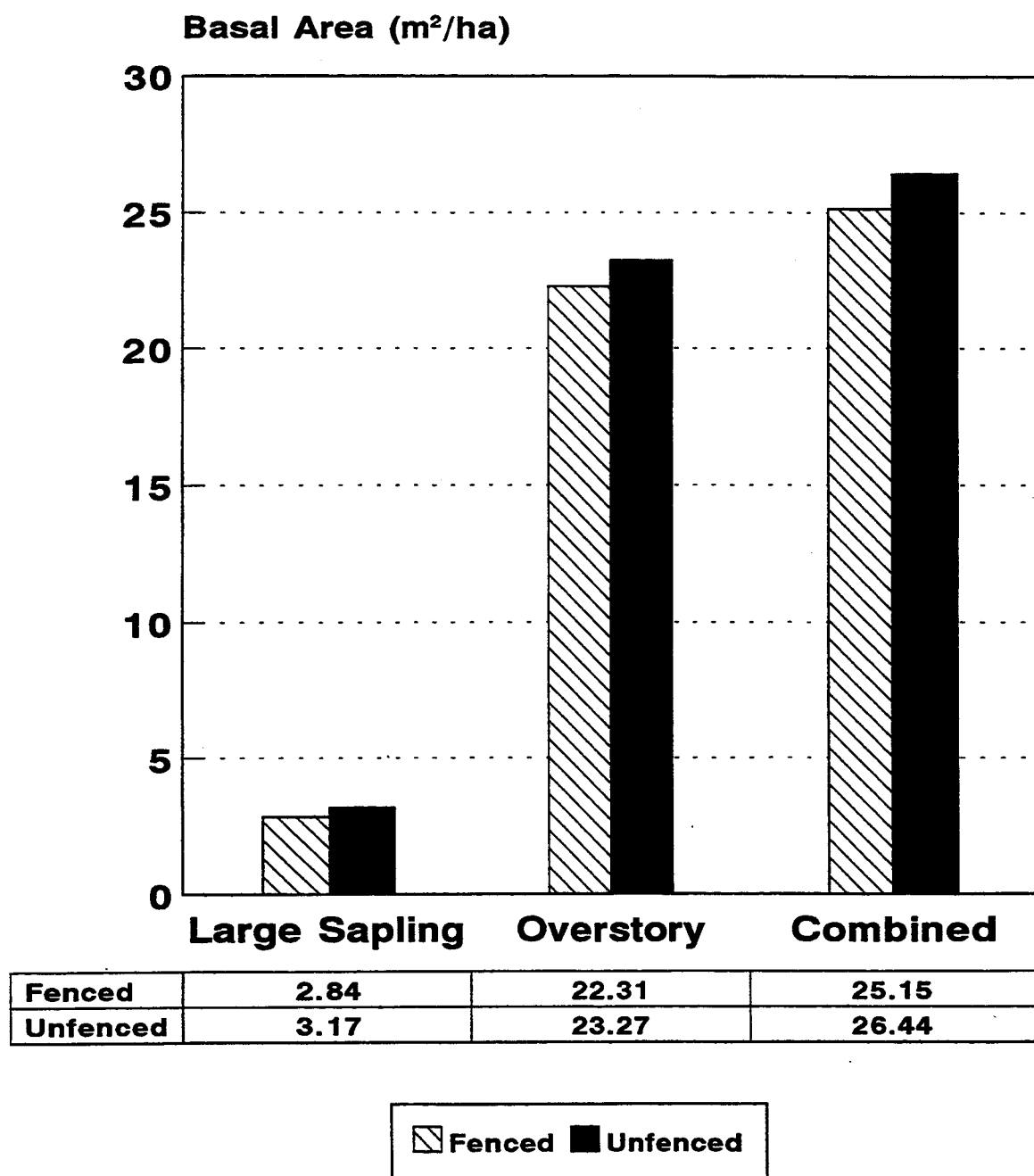


Figure 7. Basal area (m²/ha) of large saplings, overstory trees, and large sapling and overstory trees combined for 15 20- x 20-m fenced plots and 15 20- x 20-m unfenced plots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Table 12. Frequency, number per 0.006 hectare, and estimated number per hectare of tree seedlings (≤ 1.5 m in height) for nine taxa in 15 fenced and 15 unfenced 2- x 2-m central subplots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Fenced ^a			Unfenced		
	Frequency ^b	Number per 0.006 ha ^c	Estimated Number per ha	Frequency	Number per 0.006 ha	Estimated Number per ha
Ash spp.	7	28	4,667	3	6	1,000
Cedar, eastern red	1	4	667	0	0	0
Cherry, wild black	9	95	15,833	4	25	4,167
Elm, American	0	0	0	1	1	167
Hickory spp.	9	17	2,833	3	3	500
Maple, red	1	1	167	1	1	167
Oak, black	1	1	167	1	1	167
Oak, northern red	4	4	667	1	1	167
Oak, white	9	111	18,500	2	4	667
Total		261	43,501		42	7,000

^aEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of each plot.

^bThe number of subplots, each 1 m², which contained the taxa; there were four subplots for each of the 15 central subplots, for a total of 60 subplots for each of the fenced and unfenced plots.

^cTotal number of woody stems in 60 1-m² subplots.

oak seedlings were recorded, and 116 of these were in the fenced plots.

Seedlings - Shrub Species: Four taxa of shrub seedlings were recorded in the 15 fenced plots and no shrub seedlings were recorded in the 15 unfenced plots in Biesecker woodlot (Table 13). *Rubus* spp. was estimated at 8,000 per ha and smooth black-haw at 7,167 per ha, whereas 333 downy serviceberry and 167 Japanese barberry seedlings per ha were estimated in the fenced plots.

Shrub Cover: Eight shrub taxa were recorded in the fenced and unfenced plots in the Biesecker woodlot. Dominant species included smooth black-haw, flowering dogwood, and downy serviceberry (Table 14). Average total shrub coverage per plot for all taxa was 4.5% and 7.2% in the unfenced and fenced plots, respectively.

Ground and Vine Cover: Litter occupied more than 50% of the ground surface at the forest floor in 25 of the 30 1- x 1-m subplots sampled in the fenced plots and in 30 of the 30 unfenced plots in Biesecker woodlot (Tables 15, 16). Leaves were a major component of the litter layer in the 1-25 cm height category, whereas fallen branches and other unrooted woody material contributed to most of the upper height classes. Fifty-four of 60 1- x 1-m subplots had less than 26% of the ground cover in herbaceous material. Eleven of 60 1- x 1-m subplots had herbaceous material > 25 cm in height.

Vine coverage ≤ 2 m high was < 5% in 11 of 15 fenced plots surveyed in Biesecker woodlot (Table 15). In unfenced plots, vine coverage ≤ 2 m high was < 1% in 14 of 15 plots (Table 16). Vine coverage > 2 m high was < 1% in 29 of 30 of the plots.

Herbaceous and Vine Species: Within the 15 2- x 2-m central subplots of the fenced plots of the Biesecker woodlot, Japanese honeysuckle and spring-beauty had the largest importance values, 67.5 and 58.7, respectively (Table 17). The next largest importance value (32.2) was that of cinquefoil. A large coverage value was the major contributor to the importance value of Japanese honeysuckle whereas frequency and density were the major contributors to the spring-beauty importance value. The Shannon Diversity and Evenness indices were 1.02 and 0.76, respectively, for the line-transect data.

The dominant species in the 15 2- x 2-m central subplots of the unfenced plots was a sedge, *C. complanata*, which had an importance value of 64.0 (Table 18). Over half of its importance value was due to the density component. Cinquefoil had the next largest importance value (44.6) with coverage contributing the most to its importance value. Spring-beauty had the third largest importance value (30.9). The Shannon Diversity and Evenness indices were 0.93 and 0.79, respectively, for the line-transect data.

Spring-beauty had the largest importance value (89.6) in the set of unfenced 2- x 2-m subplots located within the corner of the 40- x 40-m area centered on the 20- x 20-m plots with the 3- x 3-m fence (Table 19). Japanese honeysuckle had an importance value of 86.5 which was significantly greater than the next largest importance value of 38.3 for Graminae spp. Density and frequency were the main contributors to the importance

Table 13. Frequency, number per 0.006 hectare, and estimated number per hectare of shrub seedlings (≤ 1.5 m in height) for four taxa in 15 fenced and 15 unfenced 2- x 2-m central subplots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Fenced ^a			Unfenced		
	Frequency ^b	Number per 0.006 ha ^c	Estimated Number per ha	Frequency	Number per 0.006 ha	Estimated Number per ha
Barberry, Japanese	1	1	167	0	0	0
Black-haw, smooth	5	43	7,167	0	0	0
<i>Rubus</i> spp.	9	48	3,000	0	0	0
Serviceberry, downy	2	2	333	0	0	0
Total		94	15,667		0	0

^aEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of each plot.

^bThe number of subplots, each 1 m², which contained the taxa; there were four subplots for each of the 15 central subplots, for a total of 60 subplots for each of the fenced and unfenced plots.

^cTotal number of woody stems in 60 1-m² subplots.

Table 14. Average percent cover for eight shrub taxa in 15 20- x 20-m fenced plots and 15 20- x 20-m unfenced plots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Taxa	Percent cover	
	Fenced ^b	Unfenced
Barberry, Japanese	c	c
Black-haw, smooth	4.2	1.6
Dogwood, flowering	1.5	c
Pinxter-flower	c	c
Privet	c	c
<i>Rosa</i> spp.	c	c
<i>Rubus</i> spp.	c	c
Serviceberry, downy	c	1.0
Total	7.2	4.5

^aShrub cover was estimated within two 10- x 10-m subplots in each of 30 20 x 20-m plots.

^bEach fence, 3- x 3-m square and 1.8-m high, enclosed the 2- x 2-m central subplot.

^cPresent but < 1% coverage.

Table 15. Number of subplots classified into seven categories of ground cover percent, seven ground cover height categories, and percent cover of vines in 15 fenced^a 2- x 2-m central subplots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^b

Class	Percent							Maximum height (cm)						
	1- 0 ^c	4 4	5- 25	26- 50	51- 75	76- 95	96- 100	1- 0	25 25	26- 50	51- 75	76- 100	101- 125	126- 150
Herbaceous	4	8	13	3	1	1	0	3	18	8	1	0	0	0
Rock/mineral soil	13	16	1	0	0	0	0	13	17	0	0	0	0	0
Litter ^d	0	0	1	4	2	9	14	0	27	3	0	0	0	0
Other woody (live and dead)	7	4	10	7	2	0	0	6	6	5	9	2	0	2
Non-woody	30	0	0	0	0	0	0	30	0	0	0	0	0	0
Vines $\leq$ 2 m high	10	1	2	2	0	0	0							
Vines > 2 m high	14	1	0	0	0	0	0							

^aEach fence, 3- x 3-m square and 1.8 high, enclosed the 2- x 2-m subplot at the center of each plot.

^bHerbaceous, rock/mineral soil, litter, other woody, and non-woody cover percentages and maximum height were calculated for 30 1-m² subplots (two for each of the 15 2- x 2-m central subplots). Vine coverage was estimated for the entire 2- x 2-m central subplot for each of the 15 plots.

^cIf the material was present but covered < 1% it was counted in cover class 0 and assigned to its respective height class; This was done for all materials except vines; For vines the cover class 0 represents the absence of vines.

^dLitter includes leaves and other unrooted woody material (e.g. branches) in contact with the forest floor.

Table 16. Number of subplots classified into seven categories of ground cover percent, seven ground cover height categories, and percent cover of vines in 15 unfenced 2- x 2-m central subplots in the Biesecker woodland, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Class	Percent							Maximum height (cm)						
	0 ^b	1-4	5-25	26-50	51-75	76-95	96-100	0	25	26-50	51-75	76-100	101-125	126-150
Herbaceous	23	2	4	1	0	0	0	9	19	2	0	0	0	0
Rock/mineral soil	20	9	1	0	0	0	0	20	10	0	0	0	0	0
Litter ^c	0	0	0	0	1	3	26	0	21	7	2	0	0	0
Other woody (live and dead)	22	6	0	1	1	0	0	16	6	2	3	1	0	2
Non-woody	30	0	0	0	0	0	0	30	0	0	0	0	0	0
Vines ≤ 2 m high	14	0	1	0	0	0	0							
Vines > 2 m high	15	0	0	0	0	0	0							

^aHerbaceous, rock/mineral soil, litter, other woody, and non-woody cover percentages and maximum height were calculated for 30 1-m² subplots (two for each of the 15 2- x 2-m central subplots). Vine coverage was estimated for the entire 2- x 2-m central subplot for each of the 15 plots.

^bIf the material was present but covered < 1% it was counted in cover class 0 and assigned to its respective height class; This was done for all materials except vines; For vines the cover class 0 represents the absence of vines.

^cLitter includes leaves and other unrooted woody material (e.g. branches) in contact with the forest floor.

Table 17. A listing of the relative density (RD), relative coverage (RC), relative frequency (RF), and importance values (IV) for the 10 herbaceous taxa with the greatest importance values for the 15 fenced^a 2- x 2-m central subplots in the Biesecker woodlot at Gettysburg National Military Park. Values were calculated from line-transect data collected during May to August, 1992. Due to rounding of numbers, some of the importance values do not agree with the sum of the relative density, relative coverage, and relative frequency values.

Taxa^b	IV	RD	RC	RF
Japanese honeysuckle	67.5	19.0	29.4	19.0
Spring-beauty	58.7	23.0	8.7	27.0
Cinquefoil	32.2	9.6	13.4	9.1
Sedge (<i>C. spp.</i>)	31.4	16.1	4.8	10.5
Compositae sp. #1	22.3	5.4	11.8	5.1
Spotted touch-me-not	14.0	3.4	6.3	4.3
Virginia-creeper	13.7	3.1	6.9	3.7
Graminae spp.	11.4	4.6	2.2	4.6
<i>Allium</i> spp.	7.9	4.0	0.8	3.1
Garlic mustard	6.9	1.3	4.0	1.7

^aEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of the plot.

^bCover and abundance of herbaceous and vine species were estimated along two line-transects in each of two 1-m² subplots in each of the 15 2- x 2-m central subplots.

Table 18. A listing of the relative density (RD), relative coverage (RC), relative frequency (RF), and importance values (IV) for the 10 herbaceous taxa with the greatest importance values for the 15 unfenced 2- x 2-m central subplots in the Biesecker woodlot at Gettysburg National Military Park and Eisenhower National Historic Site. Values were calculated from line-transect data collected during May to August, 1992. Due to rounding of numbers, some of the importance values do not agree with the sum of the relative density, relative coverage, and relative frequency values.

Taxa^a	IV	RD	RC	RF
Sedge (<i>C. complanata</i>)	64.0	33.7	14.0	16.3
Cinquefoil	44.6	9.9	21.0	13.6
Spring-beauty	30.9	11.3	3.8	15.8
Japanese honeysuckle	29.7	5.1	15.4	9.2
Enchanter's-nightshade	26.2	5.7	11.9	8.7
Graminae spp.	22.2	11.3	3.8	7.1
<i>Polygonum</i> spp.	19.8	6.2	7.6	6.0
Compositae sp. #2	18.8	4.5	7.8	6.5
Wild licorice	15.7	4.5	3.5	7.6
Wood sorrel	15.3	5.1	5.8	4.4

^aCover and abundance of herbaceous and vine species were estimated along two line-transects in each of two 1-m² subplots in each of the 15 2- x 2-m central subplots.

Table 19. A listing of the relative density (RD), relative coverage (RC), relative frequency (RF), and importance values (IV) for the 10 herbaceous taxa with the greatest importance values for the 15 2- x 2-m subplots located on an outside corner of a 40- x 40-m area surrounding the 15 20- x 20-m fenced plots in the Biesecker woodlot at Gettysburg National Military Park and Eisenhower National Historic Site. Values were calculated from line-transect data collected during May to August, 1992. Due to rounding of numbers, some of the importance values do not agree with the sum of the relative density, relative coverage, and relative frequency values.

Taxa^a	IV	RD	RC	RF
Spring-beauty	89.6	37.0	16.7	35.8
Japanese honeysuckle	86.5	20.7	43.8	21.9
Graminae spp.	38.3	17.0	8.0	13.2
Composite sp. #1	13.3	4.2	4.3	4.8
Enchanter's-nightshade	9.9	3.2	3.5	3.2
Wild licorice	9.1	3.2	2.3	3.6
False nettle	8.9	1.7	5.0	2.3
<i>Polygonum</i> spp.	7.6	2.2	3.2	2.3
<i>Galium</i> spp.	7.5	2.2	2.7	2.6
Composite sp. #2	5.8	1.7	1.8	2.3

^aCover and abundance of herbaceous and vine species were estimated along two line-transects in each of two 1-m² subplots in each of the 15 2- x 2-m subplots.

value of spring-beauty, whereas coverage was the main component of the importance value of Japanese honeysuckle.

Pitzer Woodlot (Combined Data)

Overstory - Tree Species: Nineteen percent of the woody stems > 1.5 m in height were overstory trees (> 11.4 cm dbh) (Fig. 8). White oak, northern red oak, and hickory spp. were the dominant tree taxa recorded in the overstory category. Black-gum and red maple also ranked high in the overstory category based on importance value (Appendix D).

Overstory trees were estimated at 304 stems per hectare (ha) with an average dbh of 27 cm and basal area of 25 m² per ha (Table 20). The oak and hickory taxa accounted for 38% and 22%, respectively of the overstory trees based on the number of stems per ha (Table 21). Red maple and black-gum accounted for 12% and 8%, respectively and all others accounted for 20% of the total. The number of overstory trees and basal area values would place the woodlot in the 89% stocking level when compared to the standards developed for upland oaks (Dale and Lutz 1986). Mean canopy closure was 92% for the 30 plots.

Large Saplings - Tree Species: Large saplings were estimated at 1,143 stems per ha with an average dbh of 5 cm and basal area of 3 m² per ha (Table 20). Hickory spp., ash spp., red maple, and wild black cherry were the most abundant taxa in the large sapling stage with 33%, 19%, 13%, and 13%, respectively of the total stems per ha (Table 22). Sweet cherry, black-gum, black oak, and white oak in the large sapling stage also were common species in the Pitzer woodlot (Appendix D).

Small Saplings - Tree Species: Small sapling trees comprised a significant component of the woody profile between seedlings and large saplings in the Pitzer woodlot. The density of small saplings was 169 stems per ha (Table 20). Ash spp. was the most dominant small sapling species counted in the 15 plots, whereas oaks and hickories combined accounted for only 4% of the number of small sapling taxa (Appendix E).

The density of large and small saplings combined was 1,312 stems per ha (Table 20). Oaks had a much lower representation in the number of saplings per ha than was present in the overstory; oaks comprised 6% of the sapling group and 38% of the overstory group for all taxa, and 8% of the sapling group and 43% of the overstory group for selected taxa (Fig. 9).

Seedlings - Tree Species: Ten taxa of tree seedlings were counted in the Pitzer woodlot. The estimated number of seedlings was 11,501 per ha (Table 23). Ash spp. comprised 45%, oak and hickory spp. combined comprised 20%, and red maple comprised 17% of the total tree taxa seedlings recorded. There were 1,667 oak seedlings per ha (Table 23).

Seedlings - Shrub Species: Three taxa of shrub seedlings were recorded in the

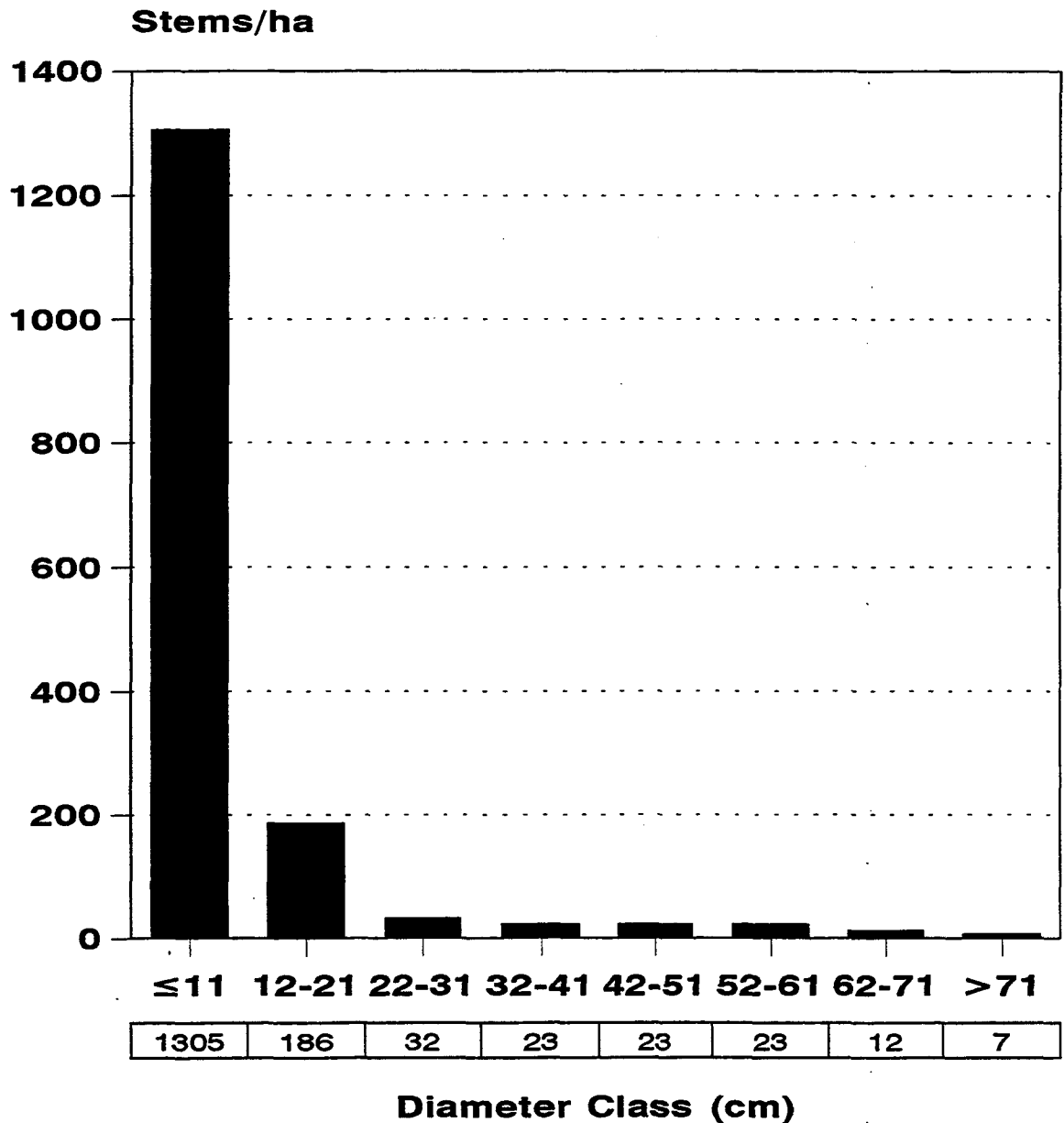


Figure 8. Estimated number of stems per hectare by diameter class (cm) of small and large sapling (≤ 11.4 cm dbh) and overstory (> 11.4 cm dbh) trees in 30 20- x 20-m plots measured in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991; in this figure saplings ≤ 11.4 cm dbh were included in the ≤ 11 cm diameter class and overstory > 11.4 cm dbh were included in the appropriate larger (≥ 12 cm) diameter classes.

Table 20. Density, average diameter at breast height (dbh), and basal area for small sapling, large sapling, and overstory trees in 30 20- x 20-m plots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Unit	Small Saplings^b	Large Saplings^b	Overstory^b
Density			
stems/ha	169	1,143	304
(stems/ac)	(68)	(463)	(123)
DBH			
cm	1	5	27
(in)	(0.4)	(2)	(10.6)
Basal Area			
m ² /ha	0.013	3	25
(ft ² /ac)	(0.056)	(13)	(108)

^aTotal area of 30 plots was 1.2 ha.

^bSmall saplings were stems > 1.5 m in height and ≤ 1.4 cm dbh, large saplings were stems > 1.5 m in height and > 1.4 cm dbh and ≤ 11.4 cm dbh, overstory were stems > 1.5 m in height and > 11.4 cm dbh.

Table 21. Average diameter at breast height (dbh), basal area, and density for 18 overstory tree taxa in 30 20- x 20-m plots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	16	0.31	15
Black-gum	23	1.12	23
Cedar, eastern red	12	^b	1
Cherry, wild black	15	0.18	10
Cherry, sweet	14	0.28	17
Elm, American	32	0.07	1
Elm, slippery	15	0.07	4
Hemlock, eastern	26	0.04	1
Hickory spp.	20	2.47	67
Maple, red	16	0.88	37
Oak, black	26	1.81	21
Oak, northern red	29	2.85	31
Oak, pin	23	0.03	1
Oak, white	50	14.48	64
Pine, scots	29	0.11	2
Sassafras	13	0.06	5
Sycamore, American	34	0.08	1
Walnut, black	18	0.12	4

^aTotal area of 30 plots was 1.2 ha.

^bBasal area < 0.01.

Table 22. Average diameter at breast height (dbh), basal area, and density for 17 large sapling tree taxa in 30 20- x 20-m plots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	4	0.30	211
Black-gum	6	0.25	72
Cedar, eastern red	6	0.03	11
Cherry, wild black	5	0.33	147
Cherry, sweet	7	0.22	53
Elm, American	7	0.03	8
Elm, slippery	6	0.03	9
Hackberry	5	^b	4
Hickory spp.	6	0.94	376
Maple, Norway	9	^b	1
Maple, red	6	0.47	153
Oak, black	7	0.17	34
Oak, northern red	8	0.08	14
Oak, scarlet	9	^b	1
Oak, white	6	0.11	33
Sassafras	7	0.06	15
Walnut, black	11	^b	1

^aTotal area of 30 plots was 1.2 ha.

^bBasal area < 0.01.

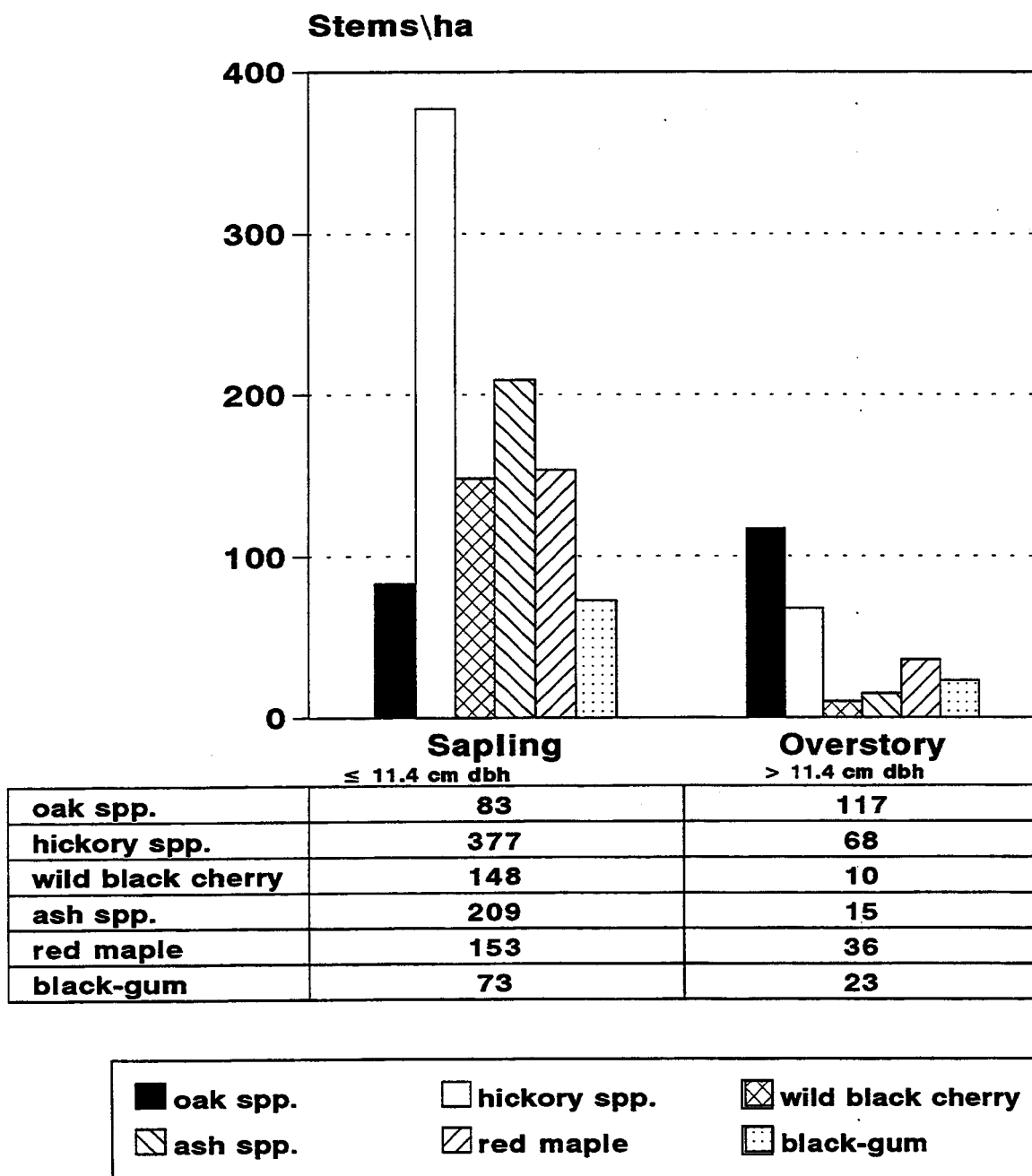


Figure 9. Estimated number of sapling and overstory stems per hectare of selected taxa present in 30 20- x 20-m plots measured in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Table 23. Number of tree seedlings (≤ 1.5 m in height) per 0.012 hectare^a and estimated number per hectare for 10 taxa in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Number per 0.012 ha	Estimated Number per ha
Ash spp.	62	5,167
Cherry, wild black	15	1,250
Cherry, sweet	3	250
Elm, American	2	167
Hackberry	3	250
Hickory spp.	8	667
Maple, red	24	2,000
Oak, northern red	2	167
Oak, white	18	1,500
Sassafras	1	83
Total	138	11,501

^aSeedlings were counted in the four 1-m² subplots of each of the 30 2- x 2-m central subplots; the total area sampled for the 30 plots was 0.012 ha.

2- x 2-m subplots in the Pitzer woodlot (Table 24). Smooth black-haw was estimated at 3,167 stems per ha, whereas 1,750 flowering dogwood and 1,000 *Rubus* spp. seedlings per ha were estimated.

Shrub Cover: Eight shrub taxa were recorded in the 10- x 10-m subplots at plots in the Pitzer woodlot. Dominant species included flowering dogwood, smooth black-haw, and downy serviceberry. Average total shrub coverage per plot for all taxa was estimated at 15%.

Ground and Vine Cover: Litter occupied more than 50% of the ground surface at the forest floor in 56 of the 60 1- x 1-m subplots sampled in the Pitzer woodlot. Leaves were a major component of the litter layer in the 1-25 cm height category, whereas fallen branches and other unrooted woody material contributed to most of the upper height classes. Forty-one of 60 1- x 1-m subplots had less than 26% of the ground cover in herbaceous material. Three of the 60 1- x 1-m subplots had herbaceous material > 25 cm in height.

Coverage of vines $\leq$ 2 m high was < 5% in 25 of the 30 subplots surveyed in the Pitzer woodlot.

Herbaceous and Vine Species: No data were collected in the Pitzer woodlot.

Pitzer Woodlot (Fenced And Unfenced Plots)

Overstory - Tree Species: Hickory spp., white oak, and red maple were dominant taxa in the overstory (Table 25) in both fenced and unfenced plots in the Pitzer woodlot. Based on importance values, black-gum and red maple also ranked high in the overstory (Appendix D). Pin oak and scots pine overstory species were present in the fenced plots but absent in the unfenced plots. American sycamore, eastern red cedar, American elm, and eastern hemlock overstory species were present in the unfenced plots but absent in the fenced plots (Table 25).

Large Saplings - Tree Species: Hickory spp., ash spp., red maple, and wild black cherry were dominant large sapling taxa (Table 26) in both fenced and unfenced plots. Based on importance values, black-gum and sweet cherry ranked high in the large sapling stage (Appendix D). Norway maple and black walnut large sapling species were present in the unfenced plots but absent in the fenced plots (Table 26).

Average dbh and basal area for overstory and large sapling trees combined were not different ($P > 0.05$) between fenced and unfenced plots (Figs. 10, 11). Average dbh was 9.6 cm for fenced plots and 9.8 cm for unfenced plots. Average density of 56 stems per fenced plot was not different ($P > 0.05$) from an average density of 60 stems per unfenced plot. Mean canopy closure was 92% for both fenced and unfenced plots.

Small Saplings - Tree Species: Eleven of 15 fenced plots and 10 of 15 unfenced plots in Pitzer woodlot contained small saplings. Ash spp. and wild black cherry comprised 82%

Table 24. Number of shrub seedlings (≤ 1.5 m in height) per 0.012 hectare^a and estimated number per hectare for three taxa in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Number per 0.012 ha	Estimated Number per ha
Black-haw, smooth	38	3,167
Dogwood, flowering	21	1,750
<i>Rubus</i> spp.	12	1,000
Total	71	5,917

^aSeedlings were counted in the four 1-m² subplots of each of the 30 2- x 2-m central subplots; the total area sampled for the 30 plots was 0.012 ha.

Table 25. Average diameter at breast height (dbh), basal area, and density for 18 overstory tree taxa in 15 20- x 20-m fenced plots and 15 20- x 20-m unfenced plots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Fenced ^a			Unfenced		
	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)
Ash spp.	16	0.17	8	16	0.44	22
Black-gum	22	0.56	12	23	1.67	35
Cedar, eastern red	0	0	0	12	0.02	2
Cherry, wild black	15	0.15	8	15	0.21	12
Cherry, sweet	14	0.25	17	15	0.30	17
Elm, American	0	0	0	32	0.13	2
Elm, slippery	14	0.08	7	19	0.05	2
Hemlock, eastern	0	0	0	26	0.09	2
Hickory spp.	19	1.78	52	20	3.17	83
Maple, red	16	0.82	38	17	0.87	35
Oak, black	21	0.96	20	31	2.66	22
Oak, northern red	33	4.42	37	23	1.27	25
Oak, pin	23	0.07	2	0	0	0
Oak, white	57	15.26	57	46	13.69	72
Pine, scots	29	0.22	3	0	0	0
Sassafras	12	0.02	2	13	0.11	8

Table 25. (Continued).

Taxa	Fenced ^a			Unfenced		
	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)	Average dbh (cm)	Basal area (m ² /ha)	Density (stems/ha)
Sycamore, American	0	0	0	34	0.15	2
Walnut, black	20	0.11	3	17	0.12	5

^aEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of each plot.

Table 26. Average diameter at breast height (dbh), basal area, and density for 17 large sapling taxa in 15 20- x 20-m fenced plots and 15 20- x 20-m unfenced plots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Fenced ^a			Unfenced		
	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)
Ash spp.	4	0.22	123	3	0.37	300
Black-gum	6	0.14	40	6	0.37	103
Cedar, eastern red	5	0.03	12	7	0.04	10
Cherry, wild black	5	0.35	140	5	0.31	145
Cherry, sweet	7	0.22	45	6	0.22	62
Elm, American	3	^b	2	7	0.06	13
Elm, slippery	10	0.04	5	4	0.02	13
Hackberry	5	^b	3	6	0.01	3
Hickory spp.	5	0.70	504	6	0.78	250
Maple, Norway	0	0	0	9	0.01	2
Maple, red	6	0.48	155	6	0.46	152
Oak, black	7	0.19	38	7	0.14	30
Oak, northern red	8	0.11	20	9	0.05	8
Oak, scarlet	9	0.01	2	0	0	0
Oak, white	6	0.13	37	5	0.08	30

Table 26. (Continued).

Taxa	Fenced ^a			Unfenced		
	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)	DBH (cm)	Basal area (m ² /ha)	Density (stems/ha)
Sassafras	5	0.02	7	7	0.10	23
Walnut, black	0	0	0	11	0.2	2

^aEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of each plot.

^bBasal area < 0.01.

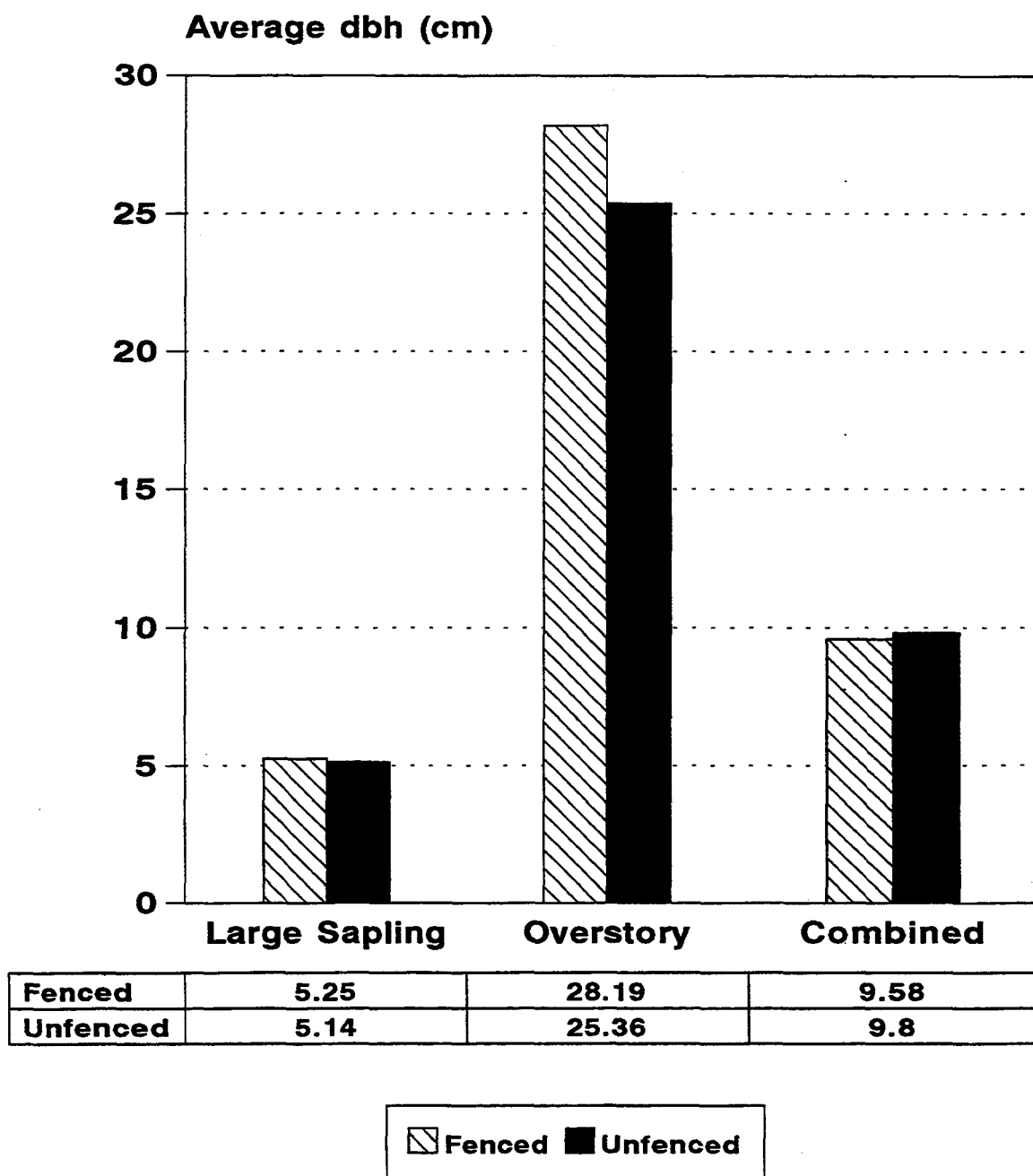


Figure 10. Average diameter at breast height (dbh) of large saplings, overstory trees, and large sapling and overstory trees combined for 15 20- x 20-m fenced plots and 15 20- x 20-m unfenced plots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

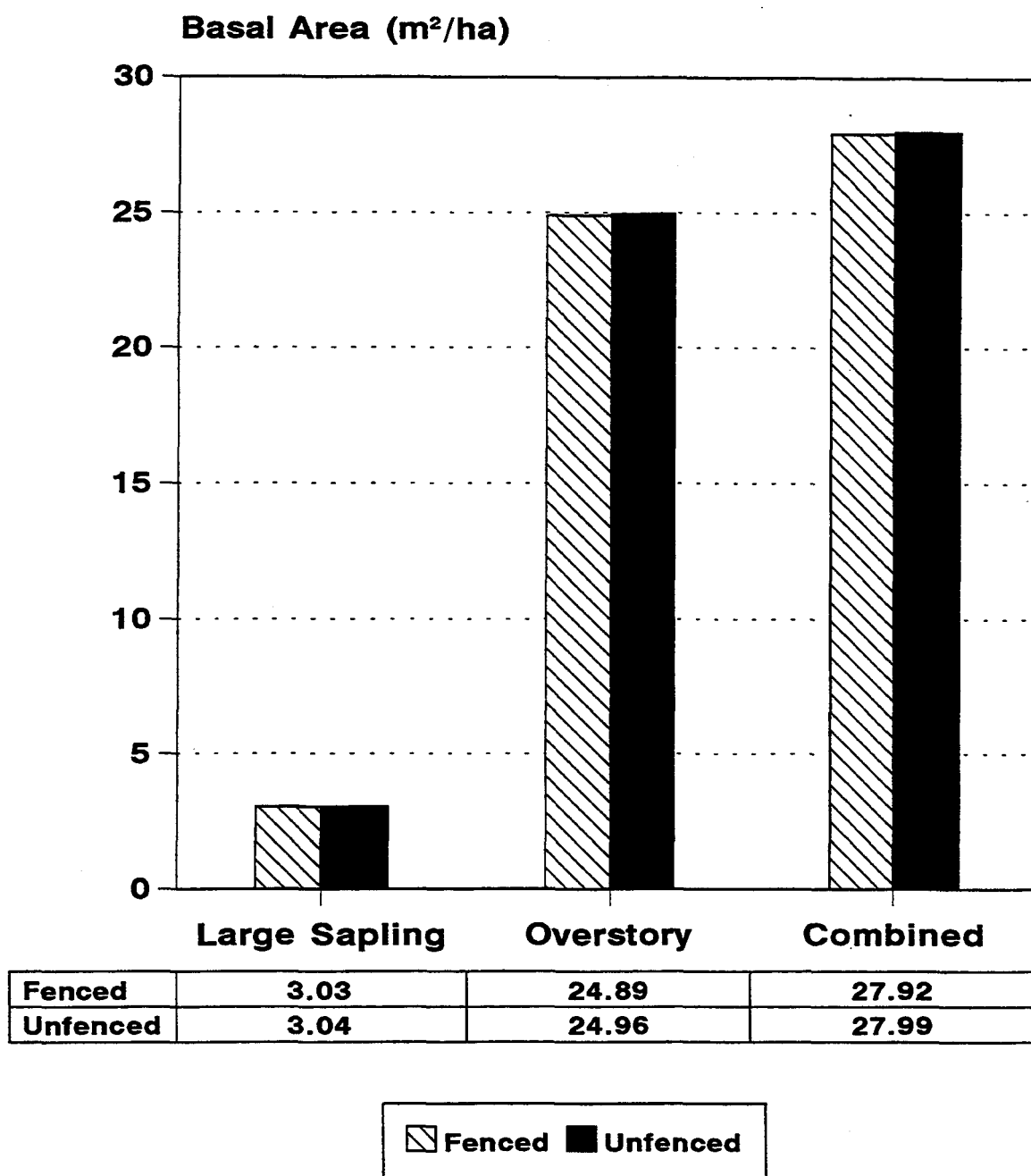


Figure 11. Basal area (m²/ha) of large saplings, overstory trees, and large sapling and overstory trees combined for 15 20- x 20-m fenced plots and 15 20- x 20-m unfenced plots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

of the total small saplings counted. Average density of 5.7 small saplings per fenced plot was not different ($P > 0.05$) from an average density of 7.3 small saplings per unfenced plot. Densities ranged from zero to 39 small saplings per plot in the fenced plots and from zero to 50 small saplings per plot in the unfenced plots.

Seedlings - Tree Species: Ten taxa of tree seedlings were recorded in the 15 fenced plots and seven taxa were recorded in the 15 unfenced plots in Pitzer woodlot (Table 27). Ash spp. was the most abundant taxa recorded in the fenced and unfenced plots. A total of 20 oak seedlings were recorded.

Seedlings - Shrub Species: Two taxa of shrub seedlings were recorded in the 15 fenced plots and three taxa were recorded in the 15 unfenced plots in Pitzer woodlot (Table 28). Smooth black-haw was estimated at 1,833 stems per ha and *Rubus* spp. was estimated at 1,333 stems per ha in the fenced plots. Densities of 4,500 smooth black-haw seedlings, 3,500 flowering dogwood seedlings, and 667 *Rubus* spp. seedlings per ha occurred in the unfenced plots.

Shrub Cover: Eight shrub taxa were recorded in the fenced and unfenced plots in the Pitzer woodlot. Dominant species included flowering dogwood, smooth black-haw, and downy serviceberry (Table 29). Average total shrub coverage per plot for all taxa was 14% and 16% in the fenced and unfenced plots.

Ground and Vine Cover: Litter occupied more than 50% of the ground surface at the forest floor in 28 of the 30 1- x 1-m subplots sampled in each of the fenced and unfenced plots in Pitzer woodlot (Tables 30, 31). Leaves were a major component of the litter layer in the 1-25 cm height category, whereas fallen branches and other unrooted woody material contributed to most of the upper height classes. Fifty-seven of 60 1- x 1-m subplots had less than 26% of the ground cover in herbaceous material. Three of 60 1- x 1-m subplots had herbaceous material > 25 cm in height.

Vine coverage ≤ 2 m high was < 5% in 12 of 15 fenced plots surveyed in Pitzer woodlot (Table 30). In unfenced plots, vine coverage ≤ 2 m high was < 5% in 13 of 15 unfenced plots surveyed (Table 31).

Herbaceous and Vine Species: No data were collected in Pitzer woodlot.

Bushman Woodlot

Overstory - Tree Species: Fifty-two percent of the woody stems > 1.5 m in height were overstory trees (> 11.4 cm dbh) (Fig. 12). White oak, black oak, northern red oak, hickory spp., and ash spp. were dominant tree taxa recorded in the overstory category. Black-gum, yellow-poplar, and eastern red cedar also ranked high in the overstory category based on importance value (Appendix D).

Overstory trees were estimated at 317 stems per hectare (ha) with an average dbh of 29 cm and basal area of 27 m² per ha (Table 32). The oak and hickory species accounted

Table 27. Frequency, number per 0.006 hectare, and estimated number per hectare of tree seedlings (≤ 1.5 m in height) for 10 taxa in 15 fenced and 15 unfenced 2- x 2-m central subplots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Fenced ^a			Unfenced		
	Frequency ^b	Number per 0.006 ha ^c	Estimated Number per ha	Frequency	Number per 0.006 ha	Estimated Number per ha
Ash spp.	7	37	6,167	9	25	4,167
Cherry, wild black	4	5	833	5	10	1,667
Cherry, sweet	0	0	0	1	3	500
Elm, American	1	2	333	0	0	0
Hackberry	2	2	333	1	1	167
Hickory spp.	2	3	500	3	5	833
Maple, red	0	0	0	3	24	4,000
Oak, northern red	1	2	333	0	0	0
Oak, white	3	8	1,333	5	10	1,667
Sassafras	1	1	167	0	0	0
Total		60	9,999		78	13,001

^aEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of each plot.

^bThe number of subplots, each 1 m², which contained the taxa; there were four subplots for each of the 15 central subplots, for a total of 60 subplots for each of the fenced and unfenced plots.

^cTotal number of woody stems in 60 1-m² subplots.

Table 28. Frequency, number per 0.006 hectare, and estimated number per hectare of shrub seedlings (≤ 1.5 m in height) for three taxa in 15 fenced and 15 unfenced 2- x 2-m central subplots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Fenced ^a			Unfenced		
	Frequency ^b	Number per 0.006 ha ^c	Estimated Number per ha	Frequency	Number per 0.006 ha	Estimated Number per ha
Black-haw, smooth	5	11	1,833	7	27	4,500
Dogwood, flowering	0	0	0	3	21	3,500
<i>Rubus</i> spp.	1	8	1,333	2	4	667
Total		19	3,167		52	8,667

^aEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of each plot.

^bThe number of subplots, each 1 m², which contained the taxa; there were four subplots for each of the 15 central subplots, for a total of 60 subplots for each of the fenced and unfenced plots.

^cTotal number of woody stems in 60 1-m² subplots.

Table 29. Average percent cover for eight shrub taxa in 15 20- x 20-m fenced plots and 15 20- x 20-m unfenced plots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Taxa	Percent cover	
	Fenced ^b	Unfenced
Barberry, Japanese	c	c
Black-haw, smooth	5.7	2.8
Dogwood, flowering	8.2	6.3
Honeysuckle, tartarian	0.0	c
<i>Ribes</i> spp.	0.0	c
<i>Rubus</i> spp.	c	c
Serviceberry, downy	1.3	4.2
Witch hazel	0.0	c
Total	15.8	14.0

^aShrub cover was estimated within two 10- x 10-m subplots in each of 30 20- x 20-m plots.

^bEach fence, 3- x 3-m square and 1.8-m high, enclosed the 2- x 2-m central subplot.

^cPresent but < 1% coverage.

Table 30. Number of subplots classified into seven categories of ground cover percent, seven ground cover height categories, and percent cover of vines in 15 fenced^a 2- x 2-m central subplots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^b

Class	Percent										Maximum height (cm)						
	1- 0 ^c	4	5- 25	26- 50	51- 75	76- 95	96- 100	0	25	1- 18	26- 50	51- 75	76- 100	101- 125	126- 150		
Herbaceous	17	7	3	3	0	0	0	9	18	2	1	0	0	0	0		
Rock/mineral soil	16	9	5	0	0	0	0	14	16	0	0	0	0	0	0		
Litter ^d	0	0	1	1	4	3	21	0	25	3	1	1	1	0	0		
Other woody (live and dead)	17	8	5	0	0	0	0	11	9	4	1	0	0	1	4		
Non-woody	30	0	0	0	0	0	0	30	0	0	0	0	0	0	0		
Vines $\leq$ 2 m high	10	2	3	0	0	0	0										
Vines > 2 m high	15	0	0	0	0	0	0										

^aEach fence, 3- x 3-m square and 1.8 m high, enclosed the 2- x 2-m subplot at the center of each plot.

^bHerbaceous, rock/mineral soil, litter, other woody, and non-woody cover percentages and maximum height were calculated for 30 1-m² subplots (two for each of the 15 2- x 2-m central subplots). Vine coverage was estimated for the entire 2- x 2-m central subplot for each of the 15 plots.

^cIf the material was present but covered < 1% it was counted in cover class 0 and assigned to its respective height class; This was done for all materials except vines; For vines the cover class 0 represents the absence of vines.

^dLitter includes leaves and other unrooted woody material (e.g. branches) in contact with the forest floor.

Table 31. Number of subplots classified into seven categories of ground cover percent, seven ground cover height categories, and percent cover of vines in 15 unfenced 2- x 2-m central subplots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Class	Percent							Maximum height (cm)						
	0 ^b	1-4	5-25	26-50	51-75	76-95	96-100	0	1-25	26-50	51-75	76-100	101-125	126-150
Herbaceous	14	13	3	0	0	0	0	7	17	4	2	0	0	0
Rock/mineral soil	15	12	2	1	0	0	0	14	16	0	0	0	0	0
Litter ^c	0	0	2	0	1	6	21	0	22	5	2	0	0	1
Other woody (live and dead)	9	14	5	2	0	0	0	5	14	3	0	2	1	5
Non-woody	30	0	0	0	0	0	0	29	1	0	0	0	0	0
Vines $\leq$ 2 m high	10	3	1	1	0	0	0							
Vines > 2 m high	14	1	0	0	0	0	0							

^aHerbaceous, rock/mineral soil, litter, other woody, and non-woody cover percentages and maximum height were calculated for 30 1-m² subplots (two for each of the 15 2- x 2-m central subplots). Vine coverage was estimated for the entire 2- x 2-m central subplot for each of the 15 plots.

^bIf the material was present but covered < 1% it was counted in cover class 0 and assigned to its respective height class; This was done for all materials except vines; For vines the cover class 0 represents the absence of vines.

^cLitter includes leaves and other unrooted woody material (e.g. branches) in contact with the forest floor.

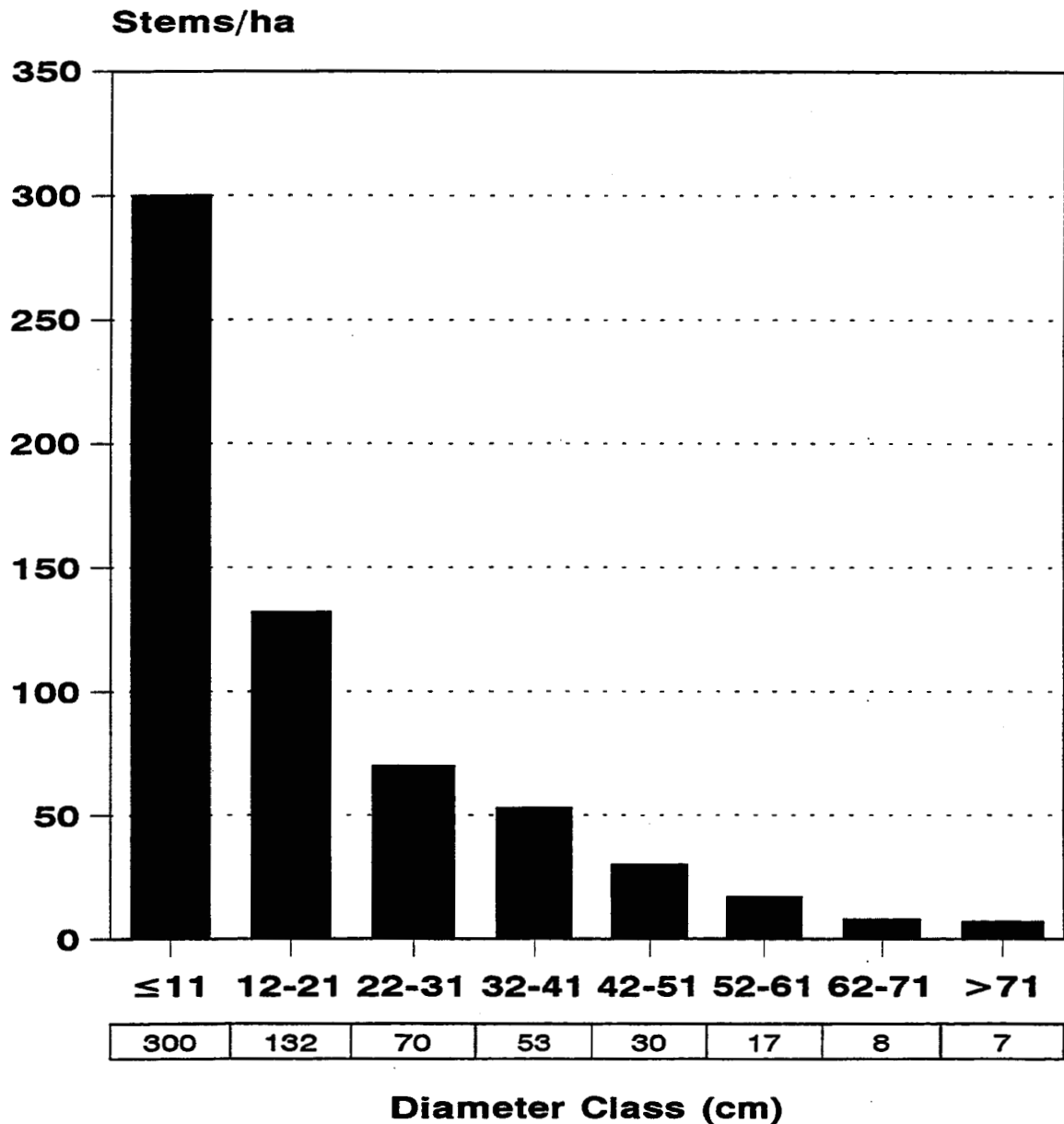


Figure 12. Estimated number of stems per hectare by diameter class (cm) of small and large sapling (≤ 11.4 cm dbh) and overstory (> 11.4 cm dbh) trees in 15 20- x 20-m plots measured in the Bushman woodlot, Gettysburg National Military Park, June 1992; in this figure saplings ≤ 11.4 cm dbh were included in the ≤ 11 cm diameter class and overstory > 11.4 cm dbh were included in the appropriate larger (≥ 12 cm) diameter classes.

Table 32. Density, average diameter at breast height (dbh), and basal area for small sapling, large sapling, and overstory trees in 15 20- x 20-m plots in the Bushman woodlot, Gettysburg National Military Park, June 1992.^a

Unit	Small Saplings^b	Large Saplings^b	Overstory^b
Density			
stems/ha	8	292	317
(stems/ac)	(3)	(118)	(128)
DBH			
cm	1	7	29
(in)	(0.4)	(2.8)	(11.4)
Basal Area			
m ² /ha	0.0007	1.2	27
(ft ² /ac)	(0.003)	(5.2)	(118)

^aTotal area of 15 plots was 0.6 ha.

^bSmall saplings were stems > 1.5 m in height and ≤ 1.4 cm dbh, large saplings were stems > 1.5 m in height and > 1.4 cm dbh and ≤ 11.4 cm dbh, overstory were stems > 1.5 m in height and > 11.4 cm dbh.

for 53% and 12%, respectively of the overstory trees based on the number of stems per ha (Table 33). Ash spp. and black-gum accounted for 11% and 6%, respectively and all others accounted for 18% of the total. The number of overstory trees and basal area values would place the woodlot in the 94% stocking level when compared to the standards developed for upland oaks (Dale and Lutz 1986). Mean canopy closure was 96% for the 15 plots.

Large Saplings - Tree Species: Large saplings were estimated at 292 stems per ha with an average dbh of 7 cm and basal area of 1.2 m² per ha (Table 32). Hickory spp., ash spp., and red maple were the most abundant taxa in the large sapling stage with a combined 69% of the total number of stems per ha (Table 34). These three taxa also had the highest importance values (Appendix D). American elm, eastern red cedar, and sweet cherry in the large sapling stage also were common species in the Bushman woodlot (Appendix D).

Small Saplings - Tree Species: Small sapling trees comprised a very minor component of the woody profile between seedlings and large saplings in the Bushman woodlot. Four of the 15 plots in Bushman woodlot contained small saplings. The density of small saplings was 8 per ha (Table 32). Three wild black cherry, one white ash, and one sassafras were the only small saplings counted in the 15 plots, at the Bushman woodlot (Appendix E).

The density of large and small saplings combined was 300 stems per ha (Table 32). Oaks had a much lower representation in the number of saplings per ha than was present in the overstory; oaks comprised 8% of the sapling group and 58% of the overstory group for all taxa, and 8% of the sapling group and 58% of the overstory group for selected taxa (Fig. 13).

Seedlings - Tree Species: Eleven taxa of tree seedlings were counted in the Bushman woodlot. The estimated number of seedlings was 43,832 stems per ha (Table 35). Ash spp. comprised 39% of the total tree taxa seedlings recorded. Oak and hickory species combined and wild black cherry comprised 44% and 5%, respectively of the total. There were approximately 17,333 oak spp. seedlings per ha (Table 35).

Seedlings - Shrub Species: Nine taxa of shrub seedlings were recorded in the 2- x 2-m subplots in the Bushman woodlot (Table 36). Eastern redbud was estimated at 13,167 stems per ha and *Rubus* spp. at 9,667 stems per ha, whereas 5,667 spicebush and 2,833 smooth black-haw seedlings per ha were estimated.

Shrub Cover: Ten shrub taxa were recorded at plots in the Bushman woodlot. Dominant species included flowering dogwood, eastern redbud, and smooth black-haw (Table 37). Total average shrub coverage per plot for all taxa was estimated at 45%.

Ground and Vine Cover: Litter occupied more than 50% of the ground surface at the forest floor in 23 of the 30 1- x 1-m subplots sampled in the Bushman woodlot (Table 38). Leaves were a major component of the litter layer in the 1-25 cm height category,

Table 33. Average diameter at breast height (dbh), basal area, and density for 16 overstory tree taxa in 15 20- x 20-m plots in the Bushman woodlot, Gettysburg National Military Park, June 1992.^a

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	19	1.12	35
Black-gum	28	1.23	18
Cedar, eastern red	18	0.44	17
Cherry, wild black	15	0.06	3
Cherry, sweet	21	0.12	3
Elm, American	17	0.04	2
Elm, slippery	16	0.03	2
Hickory spp.	27	2.61	37
Maple, red	15	0.25	13
Oak, black	36	3.37	30
Oak, chestnut	20	0.56	17
Oak, northern red	29	2.97	40
Oak, scarlet	28	0.46	7
Oak, white	40	11.32	75
Poplar, yellow	38	2.10	15
Sassafras	13	0.04	3

^aTotal area of 15 plots was 0.6 ha.

Table 34. Average diameter at breast height (dbh), basal area, and density for 15 large sapling tree taxa in 15 20- x 20-m plots in the Bushman woodlot, Gettysburg National Military Park, June 1992.^a

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	8	0.41	83
Black-gum	6	0.03	8
Cedar, eastern red	7	0.06	13
Cherry, wild black	3	^b	7
Cherry, sweet	6	0.05	13
Elm, American	6	0.04	15
Elm, slippery	8	0.02	5
Hickory spp.	6	0.29	85
Maple, red	7	0.13	33
Oak, black	7	0.01	3
Oak, chestnut	9	0.03	5
Oak, northern red	11	0.02	2
Oak, scarlet	5	^b	2
Oak, white	8	0.05	8
Sassafras	7	0.04	8

^aTotal area of 15 plots was 0.6 ha.

^bBasal area < 0.01.

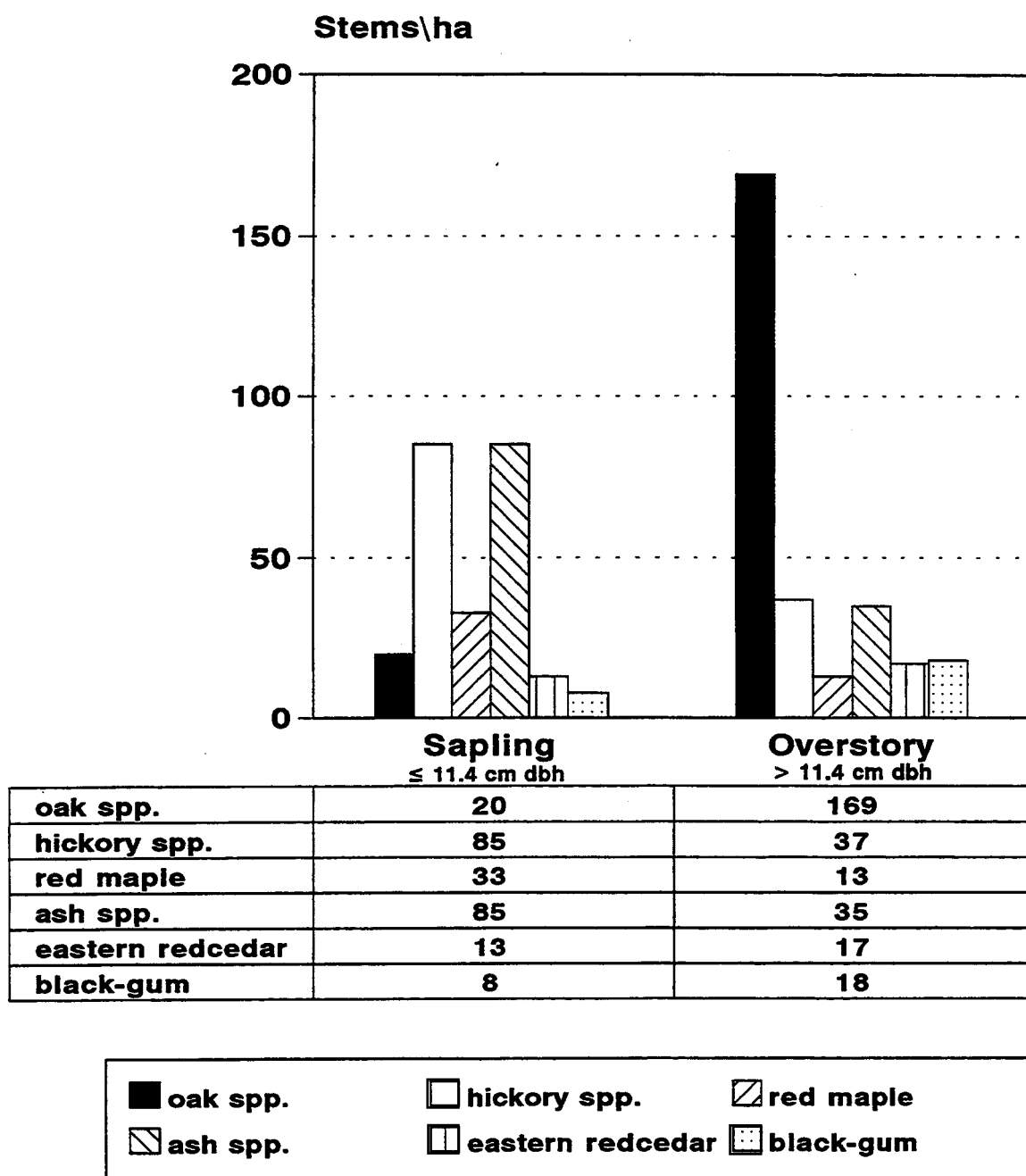


Figure 13. Estimated number of sapling and overstory stems per hectare of selected taxa present in 15 20- x 20-m plots measured in the Bushman woodlot, Gettysburg National Military Park, June 1992.

Table 35. Number of tree seedlings (≤ 1.5 m in height) per 0.006 hectare^a and estimated number per hectare for 11 taxa in the Bushman woodlot, Gettysburg National Military Park, June 1992.

Taxa	Number per 0.006 ha	Estimated Number per ha
Ash spp.	103	17,167
Black-gum	7	1,167
Cherry, wild black	14	2,333
Elm, American	11	1,833
Elm, slippery	2	333
Hickory spp.	12	2,000
Maple, red	8	1,333
Oak, black	14	2,333
Oak, northern red	1	167
Oak, white	89	14,833
Sassafras	2	333
Total	263	43,832

^aSeedlings were counted in the four 1-m² subplots of each of the 15 2- x 2-m central subplots; the total area sampled for the 15 plots was 0.006 ha.

Table 36. Number of shrub seedlings (≤ 1.5 m in height) per 0.006 hectare^a and estimated number per hectare for nine taxa in the Bushman woodlot, Gettysburg National Military Park, June 1992.

Taxa	Number per 0.006 ha	Estimated Number per ha
Barberry, Japanese	3	500
Black-haw, smooth	17	2,833
Dogwood, flowering	6	1,000
Redbud, eastern	79	13,167
<i>Rubus</i> spp.	58	9,667
Serviceberry, downy	7	1,167
Spicebush	34	5,667
<i>Vaccinium</i> spp.	16	2,667
Viburnum, maple-leaved	3	500
Total	223	37,167

^aSeedlings were counted in the four 1-m² subplots of each of the 15 2- x 2-m central subplots; the total area sampled for the 15 plots was 0.006 ha.

Table 37. Average percent cover for 10 shrub taxa in 15 20- x 20-m plots in the Bushman woodlot, Gettysburg National Military Park, June 1992.^a

Taxa	Percent Cover
Barberry, Japanese	1.8
Black-haw, smooth	4.9
Dogwood, flowering	19.3
Redbud, eastern	9.9
<i>Rubus</i> spp.	1.8
Serviceberry, downy	2.7
Spicebush	2.4
<i>Vaccinium</i> spp.	^b
Viburnum, maple leaved	^b
Witch hazel	1.8
Total	44.7

^aShrub cover was estimated within two 10- x 10-m subplots in each of 15 20- x 20-m plots.

^bPresent but < 1% coverage.

Table 38. Number of subplots classified into seven categories of ground cover percent, seven ground cover height categories, and percent cover of vines in 15 2- x 2-m central subplots in the Bushman woodland, Gettysburg National Military Park, June 1992.^a

Ground Cover Class	Percent							Maximum height (cm)						
	0 ^b	1-4	5-25	26-50	51-75	76-95	96-100	0	1-25	26-50	51-75	76-100	101-125	126-150
Herbaceous	2	8	15	3	1	1	0	0	15	12	3	0	0	0
Rock/mineral soil	14	8	5	2	1	0	0	13	14	3	0	0	0	0
Litter ^c	0	0	1	6	13	10	0	0	27	3	0	0	0	0
Combination ^d	30	0	0	0	0	0	0	30	0	0	0	0	0	0
Woody-Live	3	7	15	5	0	0	0	2	8	12	5	1	0	2
Woody-Dead	29	1	0	0	0	0	0	29	0	0	1	0	0	0
Non-woody	30	0	0	0	0	0	0	30	0	0	0	0	0	0
Vines ≤ 2 m high	5	7	2	0	1	0	0							
Vines > 2 m high	15	0	0	0	0	0	0							

^aHerbaceous, rock/mineral soil, litter, combination, woody-live, woody-dead, and non-woody cover percentages and maximum height were calculated for 30 1-m² subplots (two for each of the 15 2- x 2-m central subplots). Vine coverage was estimated for the entire 2- x 2-m central subplot for each of the 15 plots.

^bIf the material was present but covered < 1% it was counted in cover class 0 and assigned to its respective height class; This was done for all materials except vines; For vines the cover class 0 represents the absence of vines.

^cLitter includes leaves and other unrooted material (e.g. branches) in contact with the forest floor.

^dThe category "combination" was included in 1992 to account for cases where litter was on top of exposed rock.

whereas fallen branches and other unrooted woody material contributed to most of the upper height classes. Twenty-five of 30 1- x 1-m subplots had less than 26% of the ground cover in herbaceous material. Fifteen of 30 1- x 1-m subplots had herbaceous material greater than 25 cm in height. Coverage of vines ≤ 2 m in height was $< 5\%$ in 12 of 15 subplots surveyed in the Bushman woodlot (Table 38). Vines > 2 m high were not present in any of the 15 subplots.

Herbaceous and Vine Species: The plots in the Bushman woodlot were dominated by *Galium* spp. and Japanese honeysuckle which had importance values of 58.7 and 43.7, respectively (Table 39). Enchanter's-nightshade and naked-flowered tick-trefoil, with importance values of 21.0 and 20.8, respectively, were nearly tied for the third largest importance value at less than half the importance value of the top two species. Density was the major component of the importance value of *Galium* spp. whereas density, frequency, and coverage contributed fairly uniformly to the importance value of Japanese honeysuckle.

Thirty-two herbaceous and vine species were encountered along the line-transects in the 2- x 2-m subplots whereas 47 species were present within the subplots. The Shannon Diversity and Evenness indices were 1.12 and 0.74, respectively, for the line-transect data (Table 9).

Herr Ridge Woodlot

Overstory - Tree Species: Fifteen percent of the woody stems > 1.5 m in height were overstory trees (> 11.4 cm dbh) (Fig. 14). White oak, black oak, northern red oak, and hickory spp. were dominant tree taxa recorded in the overstory category. Ash spp. and sweet cherry also ranked high in the overstory category based on importance value (Appendix D).

Overstory trees were estimated at 240 stems per hectare (ha) with an average dbh of 29 cm and basal area of 21 m² per ha (Table 40). The oak and hickory taxa accounted for 44% and 33%, respectively of the overstory stems based on the number of stems per ha (Table 41). Ash spp. and sweet cherry accounted for 10% and 5%, respectively and all others accounted for 8% of the total. The number of overstory trees and basal area values would place the woodlot in the 74% stocking level when compared to the standards developed for upland oaks (Dale and Lutz 1986). Mean canopy closure was 94% for the 15 plots.

Large Saplings - Tree Species: Large saplings were estimated at 1,025 stems per ha with an average dbh of 5 cm and basal area of 2 m² per ha (Table 40). Hickory spp., wild black cherry, and ash spp. were the most abundant taxa in the large sapling stage with a combined 89% of the total number of stems per ha (Table 42). These taxa also had the highest importance values (Appendix D). Sweet cherry and American elm in the large sapling stage also were common species in the Herr Ridge woodlot (Appendix D).

Table 39. A listing of the relative density (RD), relative coverage (RC), relative frequency (RF), and importance values (IV) for the 10 herbaceous taxa with the greatest importance values for the Bushman woodlot at Gettysburg National Military Park. Values were calculated from line-transect data collected during May to August, 1992. Due to rounding of numbers, some of the importance values do not agree with the sum of the relative density, relative coverage, and relative frequency values.

Taxa^a	IV	RD	RC	RF
<i>Galium</i> spp.	58.7	27.2	11.6	19.4
Japanese honeysuckle	43.7	15.2	17.3	11.2
Enchanter's-nightshade	21.0	5.4	7.3	8.2
Naked-flowered tick-trefoil	20.8	4.8	8.2	7.8
Hog-peanut	17.1	4.3	6.8	5.9
Agrimony	17.0	4.2	6.6	6.1
Virginia-creeper	15.5	3.7	6.0	5.7
Cinquefoil	14.6	4.2	4.5	5.9
Sedge (<i>C. laxiflora</i>)	14.3	9.2	1.8	3.2
Small white-snake root	12.2	2.3	6.4	3.6

^aCover and abundance of herbaceous and vine species were estimated along two line-transects in each of two 1-m² subplots in each of the 15 2- x 2-m central subplots.

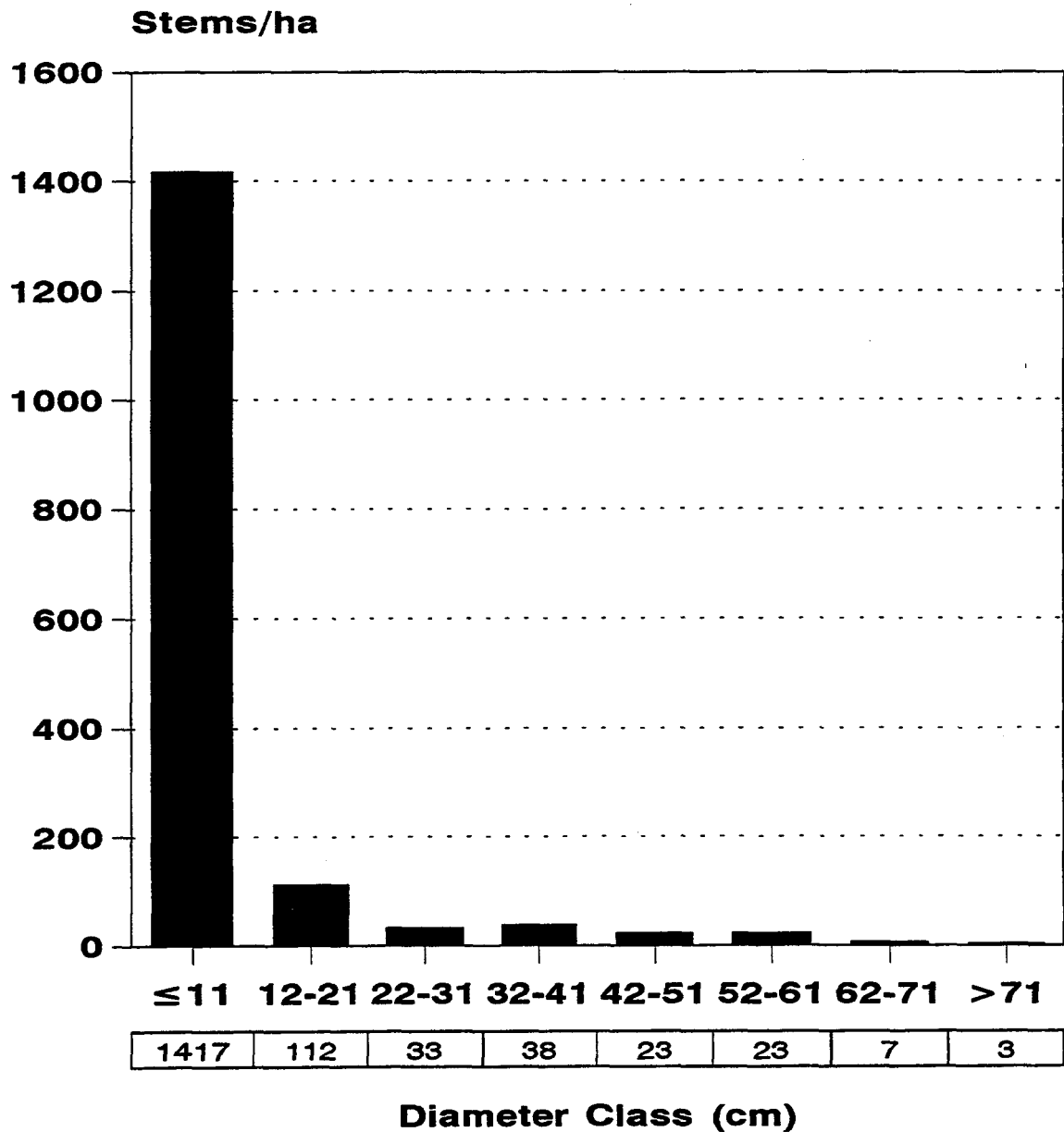


Figure 14. Estimated number of stems per hectare by diameter class (cm) of small and large sapling (≤ 11.4 cm dbh) and overstory (> 11.4 cm dbh) trees in 15 20- x 20-m plots measured in the Herr Ridge woodlot, Gettysburg National Military Park, June 1992; in this figure saplings ≤ 11.4 cm dbh were included in the ≤ 11 cm diameter class and overstory > 11.4 cm dbh were included in the appropriate larger (≥ 12 cm) diameter classes.

Table 40. Density, average diameter at breast height (dbh), and basal area for small sapling, large sapling, and overstory trees in 15 20- x 20-m plots in the Herr Ridge woodlot, Gettysburg National Military Park, June 1992.^a

Unit	Small Saplings^b	Large Saplings^b	Overstory^b
Density			
stems/ha	392	1,025	240
(stems/ac)	(159)	(415)	(97)
DBH			
cm	1	5	29
(in)	(0.4)	(2)	(11.4)
Basal Area			
m ² /ha	0.03	2	21
(ft ² /ac)	(0.13)	(8.7)	(91.5)

^aTotal area of 15 plots was 0.6 ha.

^bSmall saplings were stems > 1.5 m in height and ≤ 1.4 cm dbh, large saplings were stems > 1.5 m in height and > 1.4 cm dbh and ≤ 11.4 cm dbh, overstory were stems > 1.5 m in height and > 11.4 cm dbh.

Table 41. Average diameter at breast height (dbh), basal area, and density for 10 overstory tree taxa in 15 20- x 20-m plots in the Herr Ridge woodlot, Gettysburg National Military Park, June 1992 ^a.

Taxa	DBH (cm)	Basal area (m²/ha)	Density (Stems/ha)
Ash spp.	21	1.01	25
Cherry, wild black	14	0.13	8
Cherry, sweet	14	0.20	13
Elm, slippery	24	0.08	2
Hickory spp.	19	2.57	80
Maple, sugar	23	0.07	2
Oak, black	47	5.34	28
Oak, northern red	34	2.61	25
Oak, white	45	9.24	53
Walnut, black	15	0.06	3

^aTotal area of 15 plots was 0.6 ha.

Table 42. Average diameter at breast height (dbh), basal area, and density for 15 large sapling tree taxa in 15 20- x 20-m plots in the Herr Ridge woodlot, Gettysburg National Military Park, June 1992.^a

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	4	0.18	115
Black-gum	6	0.04	13
Cedar, eastern red	10	0.01	2
Cherry, wild black	4	0.47	313
Cherry, sweet	5	0.07	27
Elm, American	5	0.03	15
Elm, slippery	6	0.03	8
Hickory spp.	5	1.25	505
Maple, Norway	6	0.02	5
Maple, red	8	0.02	3
Maple, sugar	2	^b	2
Oak, black	5	0.02	7
Oak, northern red	5	0.02	7
Oak, white	7	0.01	2
Sassafras	7	0.01	2

^aTotal area of 15 plots was 0.6 ha.

^bBasal area < 0.01.

Small Saplings - Tree Species: Small sapling trees comprised a significant component of the woody profile between seedlings and large saplings in the Herr Ridge woodlot. All 15 of the 15 plots in Herr Ridge woodlot contained small saplings. The density of small saplings was 392 stems per ha (Table 40). Wild black cherry (70%), hickory spp. (14%), and ash spp. (12%) were the dominant small saplings counted in the 15 plots, whereas oaks accounted for 17% of the small sapling taxa (Appendix E).

The density of large and small saplings combined was 1,417 stems per ha (Table 40). Oaks had a much lower representation in the number of saplings per ha than was present in the overstory; oaks comprised 2% of the sapling group and 44% of the overstory group for all taxa, and 2% of the sapling group and 46% of the overstory group for selected taxa (Fig. 15).

Seedlings - Tree species: Eleven taxa of tree seedlings were counted in Herr Ridge woodlot. The estimated number of seedlings was 22,833 stems per ha (Table 43). Ash spp. comprised 47%, and oak and hickory spp. comprised 10%, and wild black cherry comprised 37% of the total tree taxa seedlings recorded. There were 1,333 oak seedlings per ha (Table 43).

Seedlings - Shrub Species: Eight taxa of shrub seedlings were recorded in the 2- x 2-m subplots in the Herr Ridge woodlot (Table 44). *Rubus* spp. was estimated at 34,500 stems per ha and smooth black-haw at 6,000 stems per ha, whereas 1,667 *Ribes* spp. and 1,167 flowering dogwood seedlings per ha were estimated.

Shrub Cover: Eight shrub taxa were recorded at the 10- x 10-m subplots in the Herr Ridge woodlot. Dominant species included smooth black-haw, *Rubus* spp., and eastern redbud (Table 45). Average total shrub coverage per plot for all taxa was estimated at 33%.

Ground and Vine Cover: Litter occupied more than 50% of the ground surface at the forest floor in 25 of 30 1- x 1-m subplots sampled in the Herr Ridge woodlot (Table 46). Leaves were a major component of the litter layer in the 1-25 cm height category, whereas fallen branches and other unrooted woody material contributed to most of the upper height classes. Twenty-five of the 30 1- x 1-m subplots had less than 26% of the ground cover in rock and mineral soil. Thirteen of the 30 1- x 1-m subplots had herbaceous material > 25 cm in height.

Coverage of vines $\leq$ 2 m in height was present in nine of 15 subplots surveyed in the Herr Ridge and was > 5% in four of the 15 plots. Only one subplot had vines $\geq$ 2 m high and the percent vine coverage was < 5% (Table 46).

Herbaceous and Vine Species: Enchanter's-nightshade had a slightly larger importance value (86.2) than Japanese honeysuckle (84.2) at the Herr Ridge woodlot (Table 47). Virginia-creeper (44.5) had the next largest importance value at slightly more than half

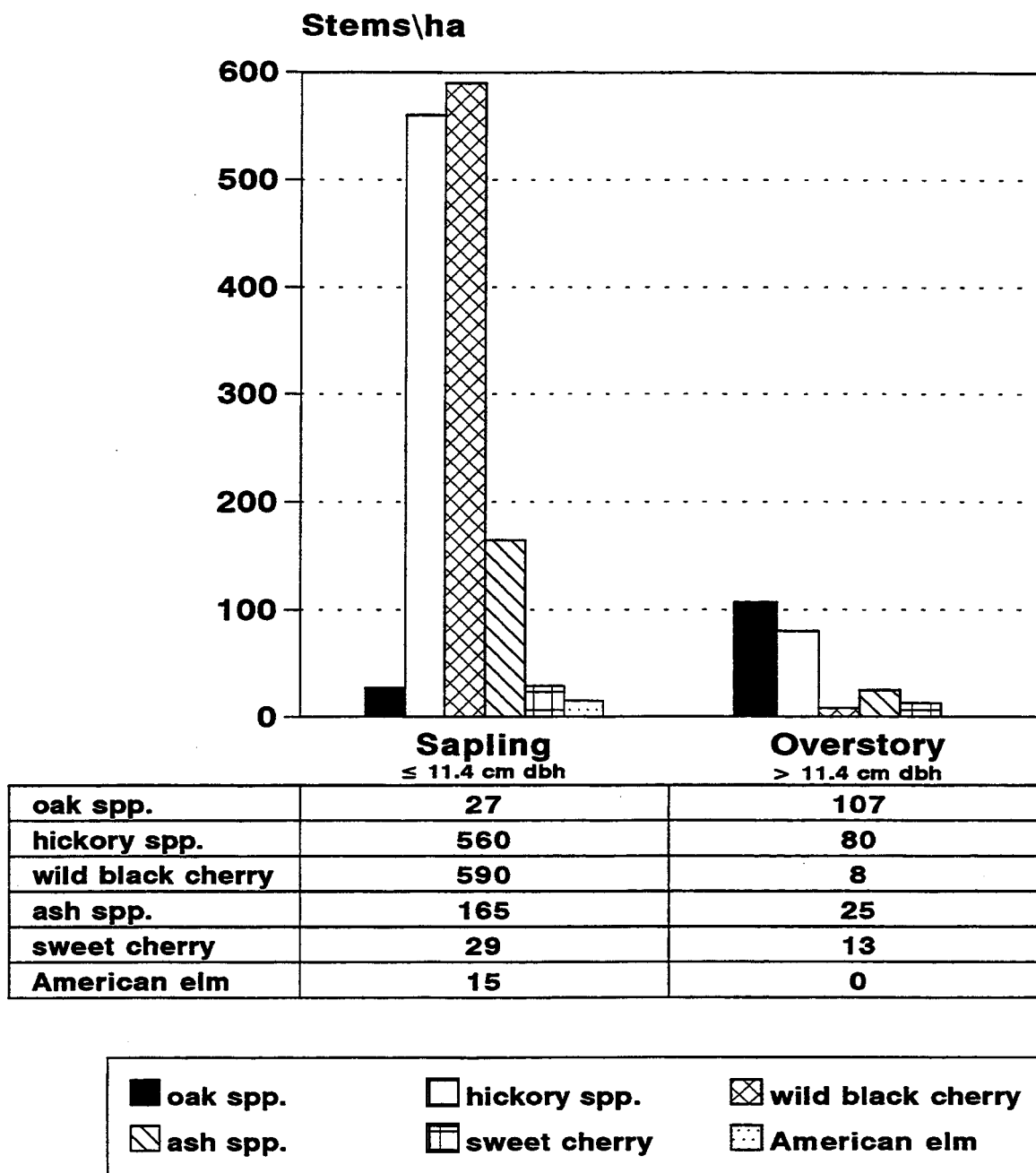


Figure 15. Estimated number of sapling and overstory stems per hectare of selected taxa present in 15 20- x 20-m plots measured in the Herr Ridge woodlot, Gettysburg National Military Park, June 1992.

Table 43. Number of tree seedlings (≤ 1.5 m in height) per 0.006 hectare^a and estimated number per hectare for 11 taxa in the Herr Ridge woodlot, Gettysburg National Military Park, June 1992.

Taxa	Number per 0.006 ha	Estimated Number per ha
Ash spp.	61	10,167
Black-gum	1	167
Cherry, wild black	49	8,167
Hickory spp.	5	833
Maple, Norway	1	167
Maple, red	3	500
Maple, sugar	2	333
Oak, black	1	167
Oak, northern red	2	333
Oak, white	5	833
Sassafras	1	167
Total	131	22,833

^aSeedlings were counted in the four 1-m² subplots of each of the 15 2- x 2-m central subplots; the total area sampled for the 15 plots was 0.006 ha.

Table 44. Number of shrub seedlings (≤ 1.5 m in height) per 0.006 hectare^a and estimated number per hectare for eight taxa in the Herr Ridge woodlot, Gettysburg National Military Park, June 1992.

Taxa	Number per 0.006 ha	Estimated Number per ha
Arrowwood	6	1,000
Azalea	3	500
Black-haw, smooth	36	6,000
Dogwood, flowering	7	1,167
Redbud, eastern	4	667
<i>Ribes</i> spp.	10	1,667
<i>Rubus</i> spp.	207	34,500
Viburnum, maple-leaved	1	167
Total	274	45,667

^aSeedlings were counted in the four 1-m² subplots of each of the 15 2- x 2-m central subplots; the total area sampled for the 15 plots was 0.006 ha.

Table 45. Average percent cover for eight shrub taxa in 15 20- x 20-m plots in the Herr Ridge woodlot, Gettysburg National Military Park, June 1992.^a

Taxa	Percent Cover
Black-haw, smooth	10.4
Dogwood, flowering	1.8
Redbud, eastern	7.4
<i>Ribes</i> spp.	^b
<i>Rubus</i> spp.	9.3
Serviceberry, downy	3.3
<i>Vaccinium</i> spp.	^b
Viburnum, maple leaved	^b
Total	32.6

^aShrub cover was estimated within two 10- x 10-m subplots in each of 15 20- x 20-m plots.

^bPresent but < 1% coverage.

Table 46. Number of subplots classified into seven categories of ground cover percent, seven ground cover height categories, and percent cover of vines in 15 2- x 2-m central subplots in the Herr Ridge woodland, Gettysburg National Military Park, June 1992.^a

Ground Cover Class	Percent							Maximum height (cm)						
	1-4	5-25	26-50	51-75	76-95	96-100		0	1-25	26-50	51-75	76-100	101-125	126-150
Herbaceous	4	12	14	0	0	0	0	0	17	13	0	0	0	0
Rock/mineral soil	20	8	0	2	0	0	0	13	17	0	0	0	0	0
Litter ^c	0	0	0	5	9	16	0	0	28	2	0	0	0	0
Combination ^d	30	0	0	0	0	0	0	30	0	0	0	0	0	0
Woody-live	4	6	12	5	2	1	0	4	4	5	4	6	2	5
Woody-dead	28	2	0	0	0	0	0	30	0	0	0	0	0	0
Non-woody	30	0	0	0	0	0	0	30	0	0	0	0	0	0
Vines ≤ 2 m high	6	5	2	2	0	0	0							
Vines > 2 m high	14	1	0	0	0	0	0							

^aHerbaceous, rock/mineral soil, litter, combination, woody-live, woody-dead, and non-woody cover percentages and maximum height were calculated for 30 1-m² subplots (two for each of the 15 2- x 2-m central subplots). Vine coverage was estimated for the entire 2- x 2-m central subplot for each of the 15 plots.

^bIf the material was present but covered < 1% it was counted in cover class 0 and assigned to its respective height class; This was done for all materials except vines; For vines the cover class 0 represents the absence of vines.

^cLitter includes leaves and other unrooted material (e.g. branches) in contact with the forest floor.

^dThe category "combination" was included in 1992 to account for cases where litter was on top of exposed rock.

Table 47. A listing of the relative density (RD), relative coverage (RC), relative frequency (RF), and importance values (IV) for the 10 herbaceous species with the greatest importance values for Herr Ridge woodlot at Gettysburg National Military Park. Values were calculated from line-transect data collected during May to August, 1992. Due to rounding of numbers, some of the importance values do not agree with the sum of the relative density, relative coverage, and relative frequency values.

Taxa^a	IV	RD	RC	RF
Enchanter's-nightshade	86.2	24.9	33.2	28.0
Japanese honeysuckle	84.2	32.1	26.6	25.4
Virginia-creeper	44.5	11.9	17.2	15.4
Wild licorice	20.4	7.6	4.3	8.5
Poison-ivy	18.4	4.7	8.5	5.3
Sedge (<i>C. rosea</i>)	12.2	7.6	1.3	6.4
Sedge (<i>C. laxiflora</i>)	6.9	4.3	0.4	2.1
Greenbrier	6.3	1.4	3.3	1.6
Cinquefoil	5.1	1.4	1.6	2.1
May-apple	3.4	1.4	0.3	1.6

^aCover and abundance of herbaceous and vine species were estimated along two line-transects in each of two 1-m² subplots in each of the 15 2- x 2-m central subplots.

the value of the dominant species. The contributions of density, frequency, and coverage to the importance values were fairly evenly divided for the two dominant species with coverage contributing slightly more to the importance value of enchanter's-nightshade and density contributing slightly more to Japanese honeysuckle's importance value.

Fifteen herbaceous and vine species were encountered along the line-transects in the 2- x 2-m subplots whereas 22 species were present within the subplots. The Shannon Diversity and Evenness indices were 0.91 and 0.77, respectively, for the line-transect data (Table 9).

Powers Hill Woodlot

Overstory - Tree species: Fifty-two percent of the woody stems > 1.5 m in height were overstory trees (> 11.4 cm dbh) (Fig. 16). White oak, northern red oak, black oak, and hickory spp. were dominant tree taxa recorded in the overstory category. Ash spp. and yellow poplar also ranked high in the overstory category based on importance value (Appendix D).

Overstory trees were estimated at 320 stems per hectare (ha) with an average dbh of 27 cm and basal area of 24 m² per ha (Table 48). The oak and hickory taxa accounted for 39% and 20%, respectively of the overstory trees based on the number of stems per ha (Table 49). Ash spp. and yellow poplar accounted for 9% each and all others accounted for 23% of the total. The number of overstory trees and basal area values would place the woodlot in the 85% stocking level when compared to the standards developed for upland oaks (Dale and Lutz 1986). Mean canopy closure was 95% for the 15 plots.

Large Saplings - Tree Species: Large saplings were estimated at 275 stems per ha with an average dbh of 7 cm and basal area of 1 m² per ha (Table 48). Ash spp., hickory spp., and black-gum were the most abundant taxa in the large sapling stage with a combined 60% of the total number of stems per ha (Table 50). These species also had the highest importance values (Appendix D). American elm and red maple in the large sapling stage also were common taxa in the Powers Hill woodlot (Appendix D).

Small Saplings - Tree Species: Small sapling trees ($\leq$ 1.4 cm dbh) comprised a very minor component of the woody profile between seedlings and large saplings in the Powers Hill woodlot (Table 48). Six of the 15 plots in Powers Hill woodlot contained small saplings. The density of small saplings was 25 per ha (Table 48). Wild black cherry (47%) and ash spp. (27%) were the dominant small saplings counted in the 15 plots, whereas oak and hickory species combined accounted for 20% of the number of small sapling stems per ha.

The density of large and small saplings combined was 300 stems per ha (Table 48). Oaks had a much lower representation in the number of saplings per ha than was

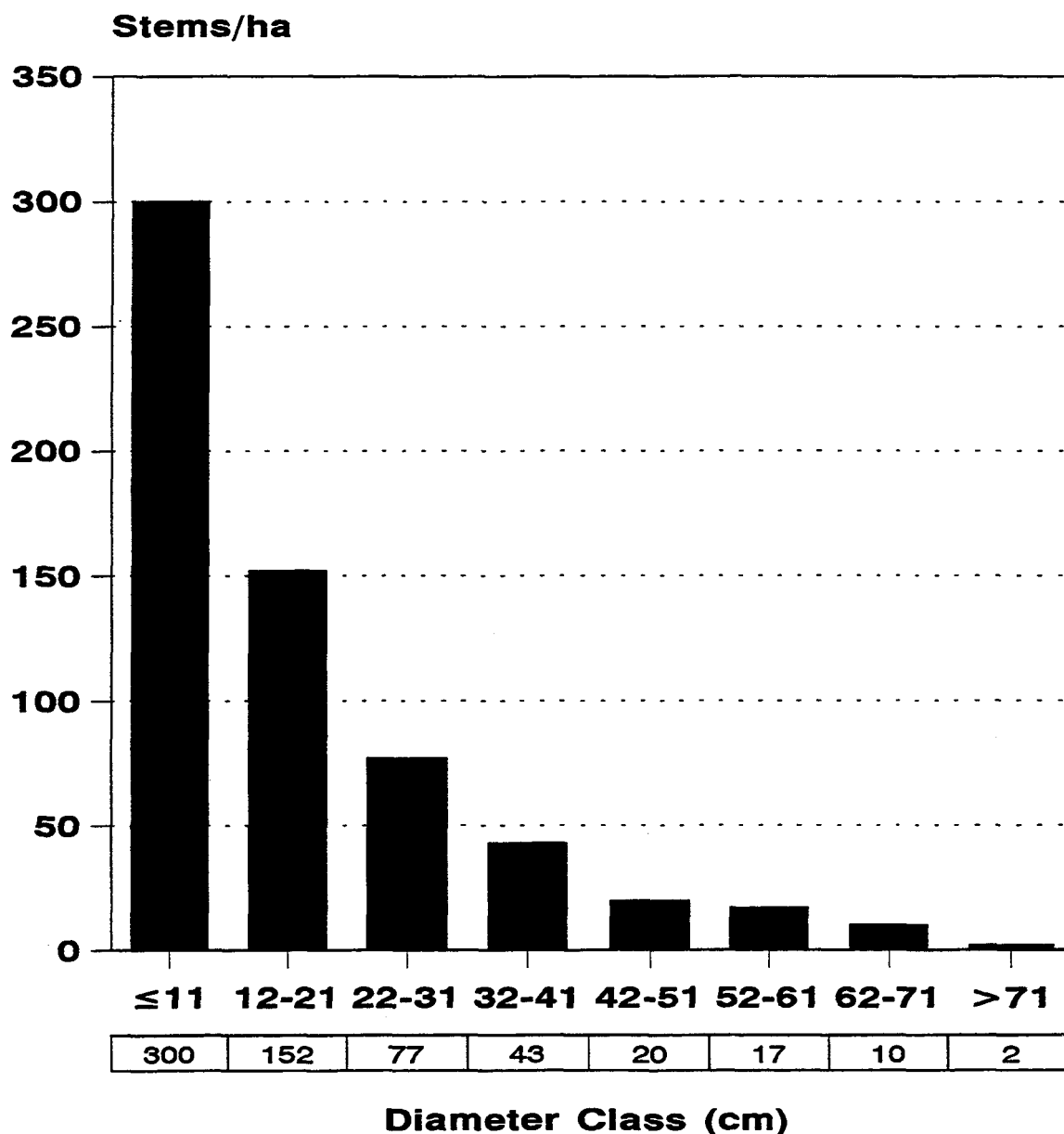


Figure 16. Estimated number of stems per hectare by diameter class (cm) of small and large sapling (≤ 11.4 cm dbh) and overstory (> 11.4 cm dbh) trees in 15 20- x 20-m plots measured in the Powers Hill woodlot, Gettysburg National Military Park, June 1992; in this figure saplings ≤ 11.4 cm dbh were included in the ≤ 11 cm diameter class and overstory > 11.4 cm dbh were included in the appropriate larger (≥ 12 cm) diameter classes.

Table 48. Density, average diameter at breast height (dbh), and basal area for small sapling, large sapling, and overstory trees in 15 20- x 20-m plots in the Powers Hill woodlot, Gettysburg National Military Park, June 1992.^a

Unit	Small Saplings^b	Large Saplings^b	Overstory^b
Density			
stems/ha	25	275	320
(stems/ac)	(10)	(111)	(130)
DBH			
cm	1	7	27
(in)	(0.4)	(2.8)	(10.6)
Basal Area			
m ² /ha	0.002	1	24
(ft ² /ac)	(0.009)	(4.3)	(103)

^aTotal area of 15 plots was 0.6 ha.

^bSmall saplings were stems > 1.5 m in height and ≤ 1.4 cm dbh, large saplings were stems > 1.5 m in height and > 1.4 cm dbh and ≤ 11.4 cm dbh, overstory were stems > 1.5 m in height and > 11.4 cm dbh.

Table 49. Average diameter at breast height (dbh), basal area, and density for 18 overstory tree taxa in 15 20- x 20-m plots in the Powers Hill woodlot, Gettysburg National Military Park, June 1992.^a

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	24	1.85	28
Black-gum	20	0.37	12
Cedar, eastern red	21	0.50	13
Cherry, wild black	12	0.02	2
Cherry, sweet	15	0.09	5
Elm, American	29	4.30	12
Hickory spp.	23	3.04	65
Maple, Norway	16	0.03	2
Maple, red	15	0.33	18
Oak, black	31	3.68	42
Oak, chestnut	23	0.27	5
Oak, northern red	37	4.14	33
Oak, scarlet	50	0.33	2
Oak, white	34	5.07	43
Pine, pitch	55	0.40	2
Poplar, yellow	30	2.40	30
Sassafras	14	0.03	2
Walnut, black	30	0.37	5

^aTotal area of 15 plots was 0.6 ha.

Table 50. Average diameter at breast height (dbh), basal area, and density for 12 large sapling tree taxa in 15 20- x 20-m plots in the Powers Hill woodlot, Gettysburg National Military Park, June 1992.^a

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	7	0.43	93
Black-gum	7	0.09	25
Cedar, eastern red	7	0.02	7
Cherry, wild black	4	0.01	10
Cherry, sweet	11	0.02	2
Elm, American	8	0.10	18
Hickory spp.	6	0.25	72
Maple, red	6	0.08	23
Oak, black	9	0.02	3
Oak, chestnut	11	0.02	2
Oak, white	10	0.08	10
Poplar, yellow	8	0.06	10

^aTotal area of 15 plots was 0.6 ha.

present in the overstory; oaks comprised 5% of the sapling group and 39% of the overstory group for all taxa, and 7% of the sapling group and 45% of the overstory group for selected taxa (Fig. 17).

Seedlings - Tree Species: Thirteen taxa of tree seedlings were counted in the Powers Hill woodlot. The estimated number of seedlings averaged 32,502 stems per ha (Table 51). Ash spp. comprised 41%, oak and hickory spp. combined comprised 12%, and wild black cherry comprised 33% of the total tree taxa seedlings recorded. There were 1,833 oak seedlings per ha (Table 51).

Seedlings - Shrub Species: Six taxa of shrub seedlings were recorded in the 2- x 2-m subplots in the Powers Hill woodlot (Table 52). Spicebush was estimated at 13,667 stems per ha and Japanese barberry at 5,833 stems per ha, whereas 4,167 flowering dogwood and 3,333 eastern redbud seedlings per ha were estimated.

Shrub Cover: Eight shrub species were recorded in the 10- x 10-m subplots in the Powers Hill woodlot. Dominant species included flowering dogwood, spicebush, and eastern redbud (Table 53). Average total shrub coverage per plot for all taxa was estimated at 45%.

Ground and Vine Cover: Litter occupied more than 50% of the ground surface at the forest floor in 28 of 30 1- x 1-m subplots sampled in the Powers Hill woodlot (Table 54). Leaves were a major component of the litter layer in the 1-25 cm height category, whereas fallen branches and other unrooted woody material contributed to the 26-50 cm height class. Twenty-eight of 30 1- x 1-m subplots had less than 26% of the ground cover in herbaceous material. Six of the 30 1- x 1-m subplots had herbaceous material greater than 25 cm in height.

Coverage of vines $\leq$ 2 m in height was present in 10 of 15 subplots surveyed in the Powers Hill woodlot (Table 54). None of the 15 subplots had vines $>$ 2 m in height (Table 54).

Herbaceous and Vine Species: Japanese honeysuckle had the greatest importance value (98.7) in the Powers Hill woodlot (Table 55). The importance value was more than double that of wild licorice which had the next largest importance value (42.9). All other importance values were significantly less than these two species. Density and frequency each contributed nearly a third to the importance value of Japanese honeysuckle whereas coverage contributed slightly more than a third. The main contributors to the importance value of wild licorice were density and frequency.

Eighteen herbaceous and vine species were encountered along the line-transects in the 2- x 2-m subplots whereas 32 species were present within the subplots. The Shannon Diversity and Evenness indices were 0.97 and 0.77, respectively, for the line-transect data (Table 9).

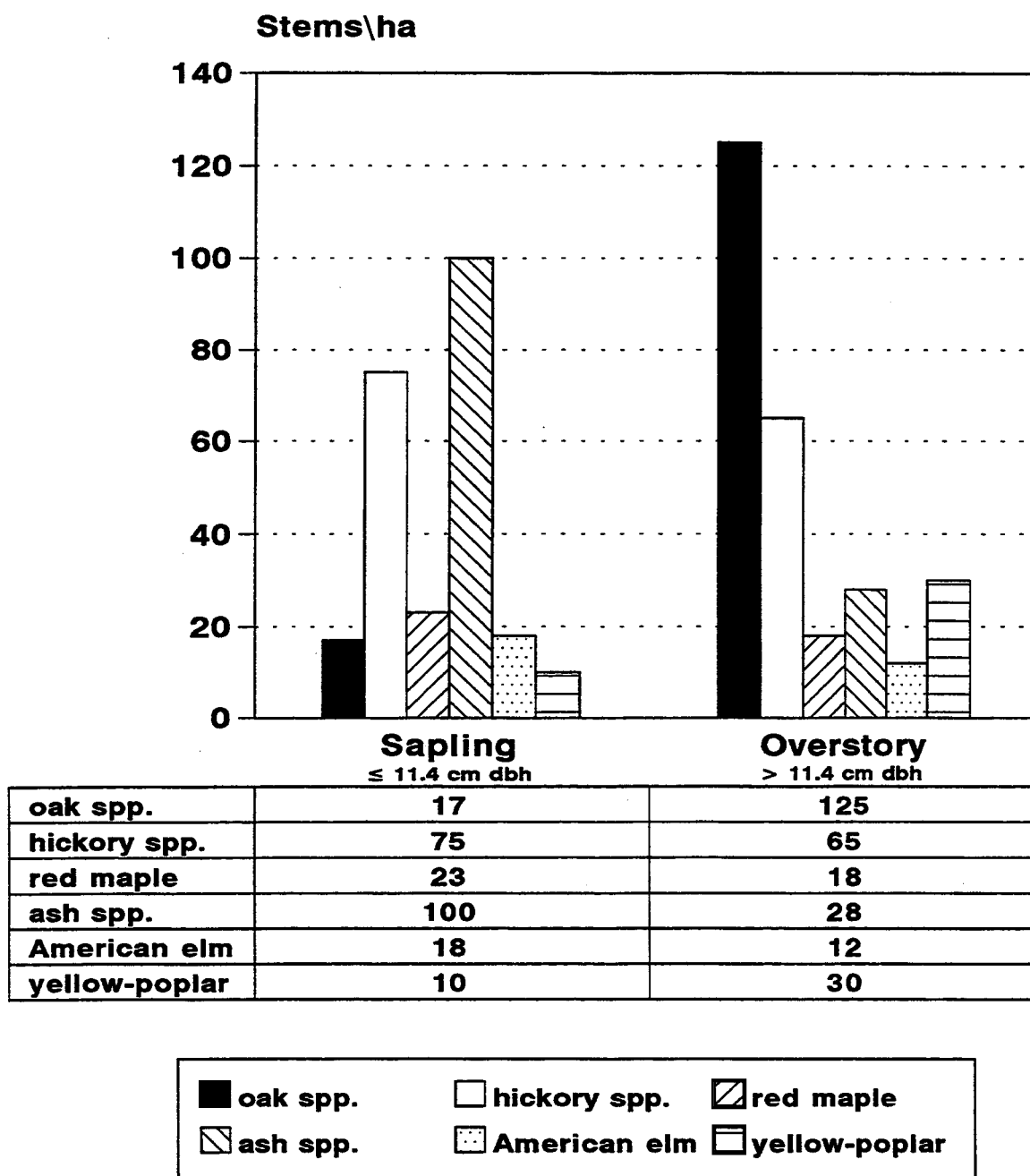


Figure 17. Estimated number of sapling and overstory stems per hectare of selected taxa present in 15 20- x 20-m plots measured in the Powers Hill woodlot, Gettysburg National Military Park, June 1992.

Table 51. Number of tree seedlings (≤ 1.5 m in height) per 0.006 hectare^a and estimated number per hectare for 13 taxa in the Powers Hill woodlot, Gettysburg National Military Park, June 1992.

Taxa	Number per 0.006 ha	Estimated Number per ha
Ash spp.	79	13,167
Black-gum	1	167
Cedar, eastern red	1	167
Cherry, wild black	64	10,667
Cherry, sweet	1	167
Elm, American	9	1,500
Hickory spp.	13	2,167
Maple, red	7	1,167
Oak, black	2	333
Oak, northern red	4	667
Oak, white	5	833
Poplar, yellow	3	500
Unknown	6	1,000
Total	195	32,502

^aSeedlings were counted in the four 1-m² subplots of each of the 15 2- x 2-m central subplots; the total area sampled for the 15 plots was 0.006 ha.

Table 52. Number of shrub seedlings (≤ 1.5 m in height) per 0.006 hectare^a and estimated number per hectare for six taxa in the Powers Hill woodlot, Gettysburg National Military Park, June 1992.

Taxa	Number per 0.006 ha	Estimated Number per ha
Barberry, Japanese	35	5,833
Black-haw, smooth	6	1,000
Dogwood, flowering	25	4,167
Redbud, eastern	20	3,333
<i>Rubus</i> spp.	16	2,667
Spicebush	82	13,667
Total	184	30,667

^aSeedlings were counted in the four 1-m² subplots of each of the 15 2- x 2-m central subplots; the total area sampled for the 15 plots was 0.006 ha.

Table 53. Average percent cover for eight shrub species in 15 20- x 20-m plots in the Powers Hill woodlot, Gettysburg National Military Park, June 1992.^a

Species	Percent Cover
Barberry, Japanese	1.5
Black-haw, smooth	^b
Dogwood, alternate-leaved	^b
Dogwood, flowering	22.1
Redbud, eastern	4.0
Serviceberry, downy	2.6
Spicebush	12.8
Witch hazel	^b
Total	45.4

^aShrub cover was estimated within two 10- x 10-m subplots in each of 15 20- x 20-m plots.

^bPresent but < 1% coverage.

Table 54. Number of subplots classified into seven categories of ground cover percent, seven ground cover height categories, and percent cover of vines in 15 2- x 2-m central subplots in the Powers Hill woodlot, Gettysburg National Military Park, June 1992.^a

Ground Cover Class	Percent							Maximum height (cm)						
	0 ^b	1-4	5-25	26-50	51-75	76-95	96-100	0	25	26-50	51-75	76-100	101-125	126-150
Herbaceous	1	10	17	1	1	0	0	1	23	6	0	0	0	0
Rock/mineral soil	17	5	7	1	0	0	0	9	21	0	0	0	0	0
Litter ^c	0	0	2	5	4	15	4	0	22	8	0	0	0	0
Combination ^d	30	0	0	0	0	0	0	30	0	0	0	0	0	0
Woody-Live	1	10	13	5	1	0	0	1	8	3	10	3	1	4
Woody-Dead	24	1	5	0	0	0	0	23	0	1	0	0	2	4
Non-woody	30	0	0	0	0	0	0	30	0	0	0	0	0	0
Vines ≤ 2 m high	5	9	1	0	0	0	0							
Vines > 2 m high	15	0	0	0	0	0	0							

^aHerbaceous, rock/mineral soil, litter, combination, woody-live, woody-dead, and non-woody cover percentages and maximum height were calculated for 30 1-m² subplots (two for each of the 15 2- x 2-m central subplots). Vine coverage was estimated for the entire 2- x 2-m central subplot for each of the 15 plots.

^bIf the material was present but covered < 1% it was counted in cover class 0 and assigned to its respective height class; This was done for all materials except vines; For vines the cover class 0 represents the absence of vines.

^cLitter includes leaves and other unrooted material (e.g. branches) in contact with the forest floor.

^dThe category "combination" was included in 1992 to account for cases where litter was on top of exposed rock.

Table 55. A listing of the relative density (RD), relative coverage (RC), relative frequency (RF), and importance values (IV) for the 10 herbaceous taxa with the greatest importance values for Powers Hill woodlot at Gettysburg National Military Park. Values were calculated from line-transect data collected during May to August, 1992. Due to rounding of numbers, some of the importance values do not agree with the sum of the relative density, relative coverage, and relative frequency values.

Taxa ^a	IV	RD	RC	RF
Japanese honeysuckle	98.7	30.9	37.2	30.6
Wild licorice	42.9	14.1	10.2	18.5
<i>Galium</i> spp.	25.8	9.5	6.4	9.9
Spotted touch-me-not	20.6	4.9	10.2	5.6
Club-rush	19.2	13.5	1.8	3.9
Enchanter's-nightshade	18.4	5.2	7.2	6.0
Lady's-thumb	16.1	4.9	5.2	6.0
Sedge (<i>C. laxiflora</i>)	13.3	6.1	2.0	5.2
Small white-snake root	11.1	1.8	6.7	2.6
Rue anemone	7.9	2.4	2.4	3.0

^aCover and abundance of herbaceous and vine species were estimated along two line-transects in each of two 1-m² subplots in each of the 15 2- x 2-m central subplots.

Spangler Woodlot

Overstory - Tree Species: Twenty-nine percent of the woody stems > 1.5 m in height were overstory trees (> 11.4 cm dbh) (Fig. 18). White oak, wild black cherry, hickory spp., black oak, and ash spp. were dominant tree taxa recorded in the overstory category. Sweet cherry and northern red oak also ranked high in the overstory category based on importance value (Appendix D).

Overstory trees were estimated at 365 stems per hectare (ha) with an average dbh of 25 cm and basal area of 26 m² per ha (Table 56). The oak and hickory taxa accounted for 35% and 10%, respectively of the overstory trees based on the number of stems per ha (Table 57). Ash spp., wild black cherry, and sweet cherry accounted for 13%, 18%, and 13%, respectively and all others accounted for 11% of the total. The number of overstory trees and basal area values would place the woodlot in the 93% stocking level when compared to the standards developed for upland oaks (Dale and Lutz 1986). Mean canopy closure was 79% for the 15 plots.

Large Saplings - Tree Species: Large saplings were estimated at 868 stems per ha with an average dbh of 6 cm and basal area of 3 m² per ha (Table 56). Hickory spp., ash spp., wild black cherry, and sweet cherry were the most abundant taxa in the large sapling stage with a combined 86% of the total number of stems per ha (Table 58). These taxa also had the highest importance values (Appendix D). Black-gum, red maple, and sassafras in the large sapling stage also were common species in the Spangler woodlot (Appendix D).

Small Saplings - Tree Species: Small sapling trees comprised a very minor component of the woody profile between seedlings and large saplings in the Spangler woodlot (Table 56). Five of the 15 plots in Spangler woodlot contained small saplings. The density of small saplings was 42 stems per ha (Table 56). Ash spp. (88%) was the most abundant of the small saplings counted in the 15 plots, whereas oaks and hickories combined accounted for 4% of the number of small sapling stems per ha.

The density of large and small saplings was 910 stems per ha (Table 56). Oaks had a much lower representation in the number of saplings per ha than was present in the overstory; oaks comprised 3% of the sapling group and 38% of the overstory group for all taxa, and 3% of the sapling group and 37% of the overstory group for selected taxa (Fig. 19).

Seedlings - Tree Species: Eight taxa of tree seedlings were counted in Spangler woodlot. The estimated number of seedlings averaged 6,333 stems per ha (Table 59). Hackberry comprised 45%, oak and hickory spp. combined comprised 16%, and ash spp. comprised 13% of the total tree taxa seedlings recorded. There were 333 white oak seedlings per ha (Table 59).

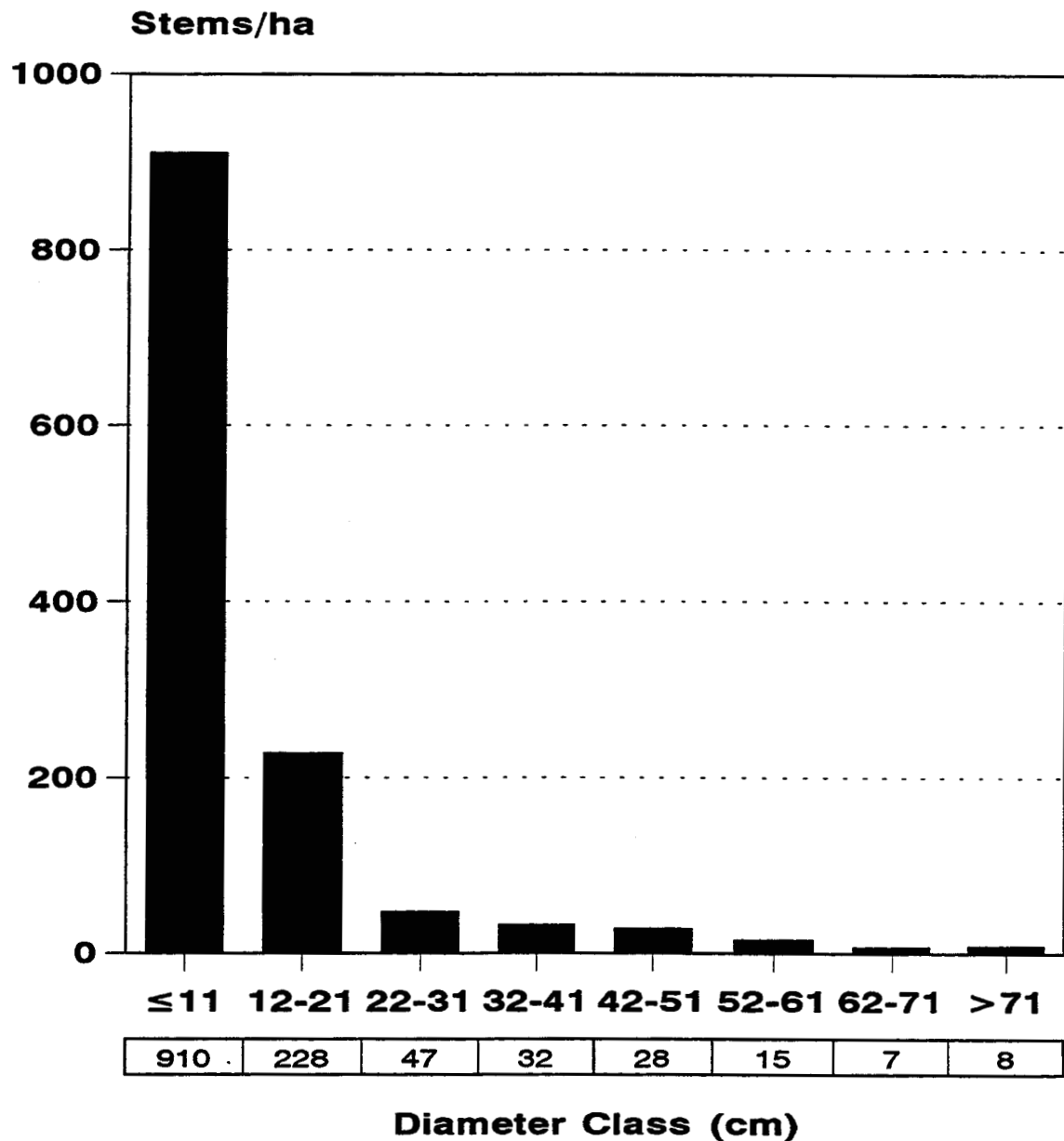


Figure 18. Estimated number of stems per hectare by diameter class (cm) of small and large sapling (≤ 11.4 cm dbh) and overstory (> 11.4 cm dbh) trees in 15 20- x 20-m plots measured in the Spangler woodlot, Gettysburg National Military Park, 1991-1992; in this figure saplings ≤ 11.4 cm dbh were included in the ≤ 11 cm diameter class and overstory > 11.4 cm dbh were included in the appropriate larger (≥ 12 cm) diameter classes.

Table 56. Density, average diameter at breast height (dbh), and basal area for small sapling, large sapling, and overstory trees in 15 20- x 20-m plots in the Spangler woodlot, Gettysburg National Military Park, 1991-1992.^a

Unit	Small Saplings^b	Large Saplings^b	Overstory^b
Density			
stems/ha	42	868	365
(stems/ac)	(17)	(351)	(148)
DBH			
cm	1	6	25
(in)	(0.4)	(2.4)	(9.8)
Basal Area			
m ² /ha	0.003	3	26
(ft ² /ac)	(0.013)	(13)	(113)

^aTotal area of 15 plots was 0.6 ha.

^bSmall saplings were stems > 1.5 m in height and ≤ 1.4 cm dbh, large saplings were stems > 1.5 m in height and > 1.4 cm dbh and ≤ 11.4 cm dbh, overstory were stems > 1.5 m in height and > 11.4 cm dbh.

Table 57. Average diameter at breast height (dbh), basal area, and density for 12 overstory tree taxa in 15 20- x 20-m plots in the Spangler woodlot, Gettysburg National Military Park, 1991-1992.^a

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	20	2.29	47
Black-gum	21	0.38	10
Cherry, wild black	16	1.30	65
Cherry, sweet	15	0.91	48
Elm, American	13	0.07	5
Elm, slippery	21	0.06	2
Hickory spp.	33	4.15	38
Maple, red	17	0.46	17
Oak, black	24	2.65	42
Oak, northern red	26	2.04	33
Oak, white	48	11.30	53
Sassafras	14	0.05	3

^aTotal area of 15 plots was 0.6 ha.

Table 58. Average diameter at breast height (dbh), basal area, and density for 13 large sapling tree taxa in 15 20- x 20-m plots in the Spangler woodlot, Gettysburg National Military Park, 1991-1992.*

Taxa	DBH (cm)	Basal area (m²/ha)	Density (stems/ha)
Ash spp.	5	0.54	235
Black-gum	7	0.11	30
Cherry, wild black	6	0.56	160
Cherry, sweet	7	0.52	112
Elm, American	6	0.04	12
Elm, slippery	8	0.03	5
Hickory spp.	5	0.64	243
Maple, Norway	10	0.01	2
Maple, red	5	0.06	25
Oak, black	7	0.06	13
Oak, northern red	7	0.04	8
Oak, white	10	0.01	2
Sassafras	7	0.10	22

*Total area of 15 plots was 0.6 ha.

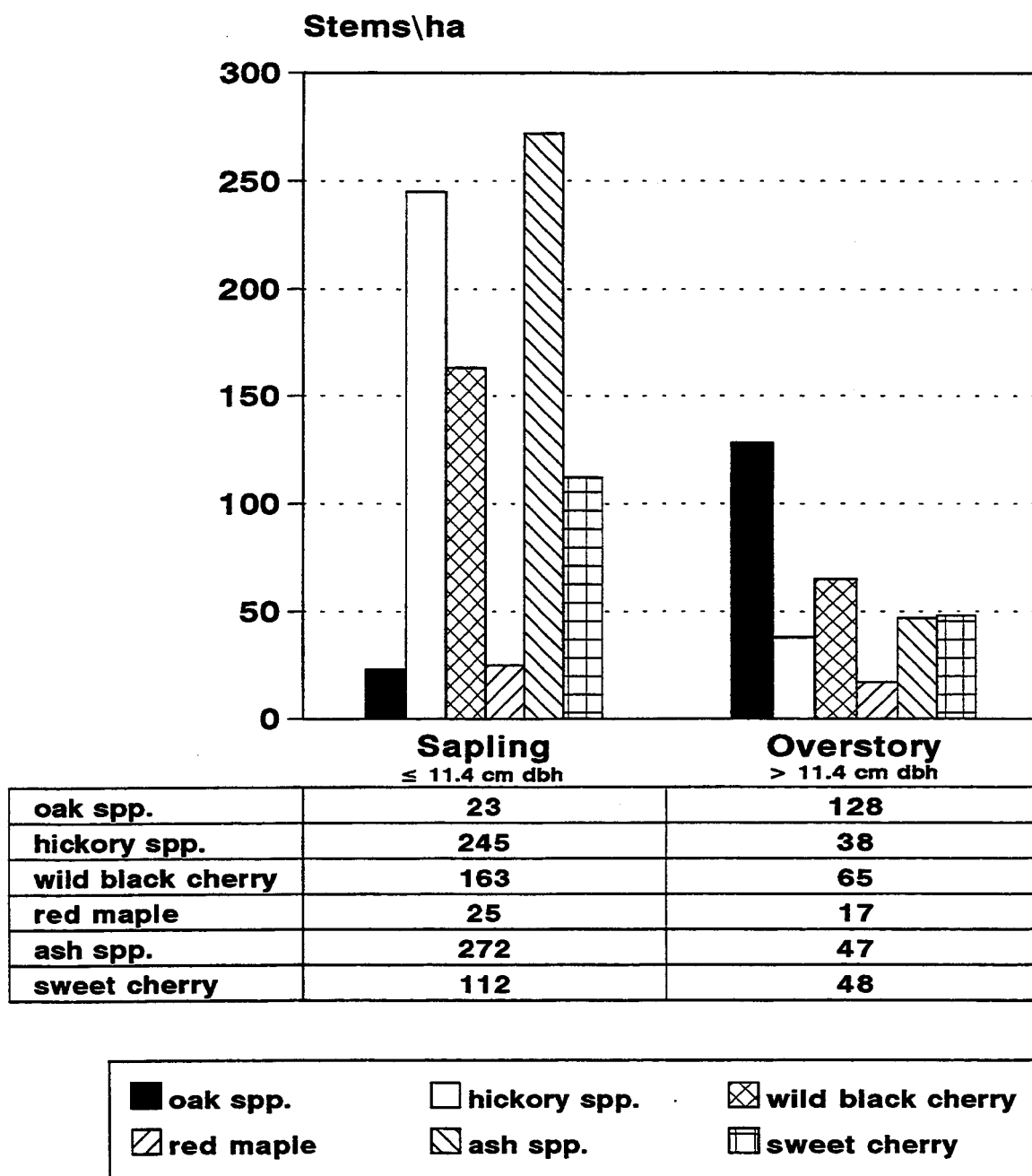


Figure 19. Estimated number of sapling and overstory stems per hectare of selected taxa present in 15 20- x 20-m plots measured in the Spangler woodlot, Gettysburg National Military Park, 1991-1992.

Table 59. Number of tree seedlings (≤ 1.5 m in height) per 0.006 hectare^a and estimated number per hectare for eight taxa in the Spangler woodlot, Gettysburg National Military Park, 1991-1992.

Taxa	Number per 0.006 ha	Estimated Number per ha
Ash spp.	5	833
Cedar, eastern red	1	167
Cherry, wild black	4	667
Hackberry	17	2,833
Hickory spp.	4	667
Maple, red	3	500
Oak, white	2	333
Sassafras	2	333
Total	38	6,333

^aSeedlings were counted in the four 1-m² subplots of each of the 15 2- x 2-m central subplots; the total area sampled for the 15 plots was 0.006 ha.

Seedlings - Shrub Species: Four taxa of shrub seedlings were recorded in the 2- x 2-m subplots at plots in Spangler woodlot (Table 60). Flowering dogwood was estimated at 1,667 stems per ha and *Rubus* spp. at 1,333 stems per ha, whereas 333 smooth black-haw and 333 maple-leaved viburnum seedlings per ha were estimated.

Shrub Cover: Seven shrub taxa were recorded in the 10- x 10-m subplots in Spangler woodlot. Dominant species included flowering dogwood, smooth black-haw, and downy serviceberry (Table 61). Average total shrub coverage per plot for all taxa was estimated at 14%.

Ground and Vine Cover: Litter occupied more than 50% of the ground surface at the forest floor in all 30 of the 1- x 1-m subplots sampled in the plots in Spangler woodlot (Table 62). Leaves were a major component of the litter layer in the 1-25 cm height category, whereas fallen branches and other unrooted woody material contributed to the higher height classes. Twenty-eight of 30 1- x 1-m subplots had less than 26% of the ground cover in herbaceous material. Only one of 30 1- x 1-m subplots had herbaceous material greater than 25 cm in height.

Coverage of vines ≤ 2 m in height were present in two of 15 subplots surveyed in the Spangler woodlot (Table 62). Vines > 2 m in height were not present in the 15 subplots (Table 62).

Herbaceous and Vine Species: No data were collected from Spangler woodlot.

Demonstration Plots

The fenced and unfenced 10- x 10-m demonstration plots located in Biesecker, Pitzer, Bushman, Spanger, Cobean (Butterfield Farm), and Slyder (Granite Farm) woodlots were surveyed for tree and shrub species seedlings in 1986, 1987, 1989, 1991 and 1994. Data from initial surveys in 1986 and 1987 were averaged to become the 1986-87 survey. The 1986-87 and 1991 surveys were conducted on subplots within the 10- x 10-m plots. The 1989 and 1994 surveys were conducted on the entire area within the 10- x 10-m plots. The 1986-1987, and 1989 surveys measured seedlings ≤ 100 cm in height whereas the 1991 and 1994 surveys measured seedlings ≤ 150 cm in height. Seedlings were recorded by height in the 1989, 1991, and 1994 surveys but not in the 1986-1987 surveys. The 1989 survey recorded seedlings in four height classes. These were ≤ 25 , 26-50, 51-75, and 76-100 cm. The 1991 and 1994 surveys recorded the seedlings in two additional height classes, 101-125 and 126-150 cm.

We present comparative data among years for the four sampling periods (1986-87, 1989, 1991, and 1994), but recognize that differences among years may be due to sampling methods (partial counts in subplots versus complete counts in the entire 10- x 10-m plots). Furthermore, the figures concerning seedling abundance were available for stems with heights ≤ 100 cm for 1989 and ≤ 150 cm for year 1991 and 1994. Consequently,

Table 60. Number of shrub seedlings (≤ 1.5 m in height) per 0.006 hectare^a and estimated number per hectare for four taxa in the Spangler woodlot, Gettysburg National Military Park, 1991-1992.

Taxa	Number per 0.006 ha	Estimated Number per ha
Black-haw, smooth	2	333
Dogwood, flowering	10	1,667
<i>Rubus</i> spp.	8	1,333
Viburnum, maple-leaved	2	333
Total	22	3,666

^aSeedlings were counted in the four 1-m² subplots of each of the 15 2- x 2-m central subplots; the total area sampled for the 15 plots was 0.006 ha.

Table 61. Average percent cover for seven shrub taxa in 15 20- x 20-m plots in the Spangler woodlot, Gettysburg National Military Park, 1991-1992.^a

Taxa	Percent Cover
Barberry, Japanese	^b
Black-haw, smooth	1.2
Dogwood, flowering	7.8
Hop-hornbeam, eastern	^b
Redbud, eastern	^b
<i>Rubus</i> spp.	^b
Serviceberry, downy	3.4
Total	14.0

^aShrub cover was estimated within two 10- x 10-m subplots in each of 15 20- x 20-m plots.

^bPresent but < 1% coverage.

Table 62. Number of subplots classified into seven categories of ground cover percent, seven ground cover height categories, and percent cover of vines in 15 2- x 2-m central subplots in the Spangler woodlot, Gettysburg National Military Park, 1991-1992.^a

Ground Cover Class		Percent							Maximum height (cm)						
		1- 4	5- 25	26- 50	51- 75	76- 95	96- 100		1- 0	25 25	26- 50	51- 75	76- 100	101- 125	126- 150
Herbaceous	21	6	1	2	0	0	0		9	20	1	0	0	0	0
Rock/mineral soil	18	10	2	0	0	0	0		12	18	0	0	0	0	0
Litter ^c	0	0	0	0	3	9	18		0	25	2	1	2	0	0
Other woody (live and dead)	22	5	2	1	0	0	0		19	6	1	2	0	0	2
Non-woody	30	0	0	0	0	0	0		30	0	0	0	0	0	0
Vines $\leq$ 2 m high	13	1	1	0	0	0	0								
Vines > 2 m high	15	0	0	0	0	0	0								

^aHerbaceous, rock/mineral soil, litter, other woody, and non-woody cover percentages and maximum height were estimated for 30 1-m² plots (two for each of the 15 2- x 2-m central subplots). Vine coverage was estimated for the entire 2- x 2-m central subplot for each of the 15 plots.

^bIf the material was present but covered < 1% it was counted in cover class 0 and assigned to its respective height class; This was done for all materials except vines; For vines the cover class 0 represents the absence of vines.

^cLitter includes leaves and other unrooted material (e.g. branches) in contact with the forest floor.

comparisons among years 1989, 1991, and 1994 may be relevant only to height classes $\leq$ 100 cm. We caution the reader about the interpretation and conclusions of the data derived from the demonstration plots.

Biesecker and Bushman woodlots were the only woodlots that were sampled for herbaceous and vine species within and outside the fenced demonstration plots.

Biesecker Woodlot

The number of tree seedling taxa recorded (fenced and unfenced combined) was 10 in 1986-87, nine in 1989, eight in 1991, and 11 in 1994, indicating species richness was similar during the sampling period. The estimated number of tree seedlings declined from 102,000 stems per ha in 1986-87 to 29,000 stems per ha in 1994 in the fenced plot, and from 49,000 stems per ha in 1986-87 to 31,000 stems per ha in 1994 in the unfenced plot (Table 63). Wild black cherry and sweet cherry were the most abundant tree seedlings in the fenced plot, whereas ash spp. was the most abundant tree seedling taxa in the unfenced plot during 1986-87 through 1994. The density of wild black cherry and sweet cherry seedlings declined in the fenced plot, whereas the density of ash spp. in the unfenced plot did not change significantly from 1986-87 to 1994 (Table 63).

The number of shrub seedling taxa recorded (fenced and unfenced combined) was two in 1986-87, five in 1989, three in 1991, and nine in 1994, indicating an increase in shrub species richness during the sampling period. The estimated total number of shrub seedlings increased from 1,000 stems per ha in 1986-87 to 13,000 stems per ha in 1994 in the fenced plot, whereas there was no significant change in the unfenced plot (Table 63). *Rubus* spp. and serviceberry were dominant shrub seedling taxa in both the fenced and the unfenced plot during 1986-87 through 1994 (Table 63).

The estimated number of tree seedlings > 25 cm in height in the fenced plot decreased from 17,000 stems per ha in 1989 to 10,000 stems per ha in 1994 (Fig. 20). The estimated number of tree seedlings in the 26-50 cm height class decreased slightly in the unfenced plot during 1989 through 1994. No tree seedlings > 51 cm in height were recorded in the unfenced plot in 1989, 1991, and 1994 (Fig. 20).

The total number of shrub seedlings in the fenced plot increased during 1989 through 1994 (Fig. 20). No shrub seedlings > 25 cm in height were present in the unfenced plot in 1989 and 1994, and no shrub seedlings > 50 cm in height were recorded in the unfenced plot in 1991 (Fig. 20).

Four herbaceous and vine species were found along the line-transects in the fenced subplot and none were found in the unfenced subplot. For the line-transect data in the fenced subplot, the Shannon Diversity and Evenness indices were 0.561 and 0.932, respectively.

Table 63. Estimated number of tree and shrub seedlings per hectare by taxa and survey year in fenced and unfenced 10- x 10-m demonstration plots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site.^a

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Ash spp.	6	28	2	24	2	19	3	28
Black-gum							b	
Cedar, eastern red			b				b	
Cherry, sweet	14	2	3	b	9		4	1
Cherry, wild black	73	6	26	3	44	6	12	1
Elm spp.	1		1		1		1	
Hickory, mockernut		1			1	1	2	1
Hickory, pignut	1		1	1			b	
Hickory, shagbark	1		b	b	1			
Maple, red	2						b	
Oak, black					1			
Oak, chestnut	1							
Oak, northern red			b		1		b	

Table 63. (continued)

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Oak, white	8	14	3	2			2	
Total Tree	102	49	37	29	60	26	29	31
Barberry, Japanese			2	b				b
Black-haw, smooth			b	1			b	b
Dogwood, flowering			b				b	
Grape spp.							b	
Rosa spp.					2			
Rubus spp.					13	4	6	b
Sassafras	1	1					1	
Serviceberry	1		2	b		2	5	1
Spicebush				b				b
Total Shrub	1	1	4	2	14	6	13	1
Total Tree and Shrub	103	50	41	31	74	32	42	32

^aValues for the 1986-87 survey were averages from four circular 2.0 m² subplots in each 10- x 10-m plot in 1986 and 1987 (16 m²); 1989 and 1994 survey values were from the entire 10- x 10-m plot (100 m²); and 1991 survey values were averages from four square 1.0 m² subplots at each of 4 locations in each 10- x 10-m plot (16 m²). Values within columns may not add up to the value for Total Tree, Total Shrub or Total Tree and Shrub due to rounding.

^bPresent but < 1.

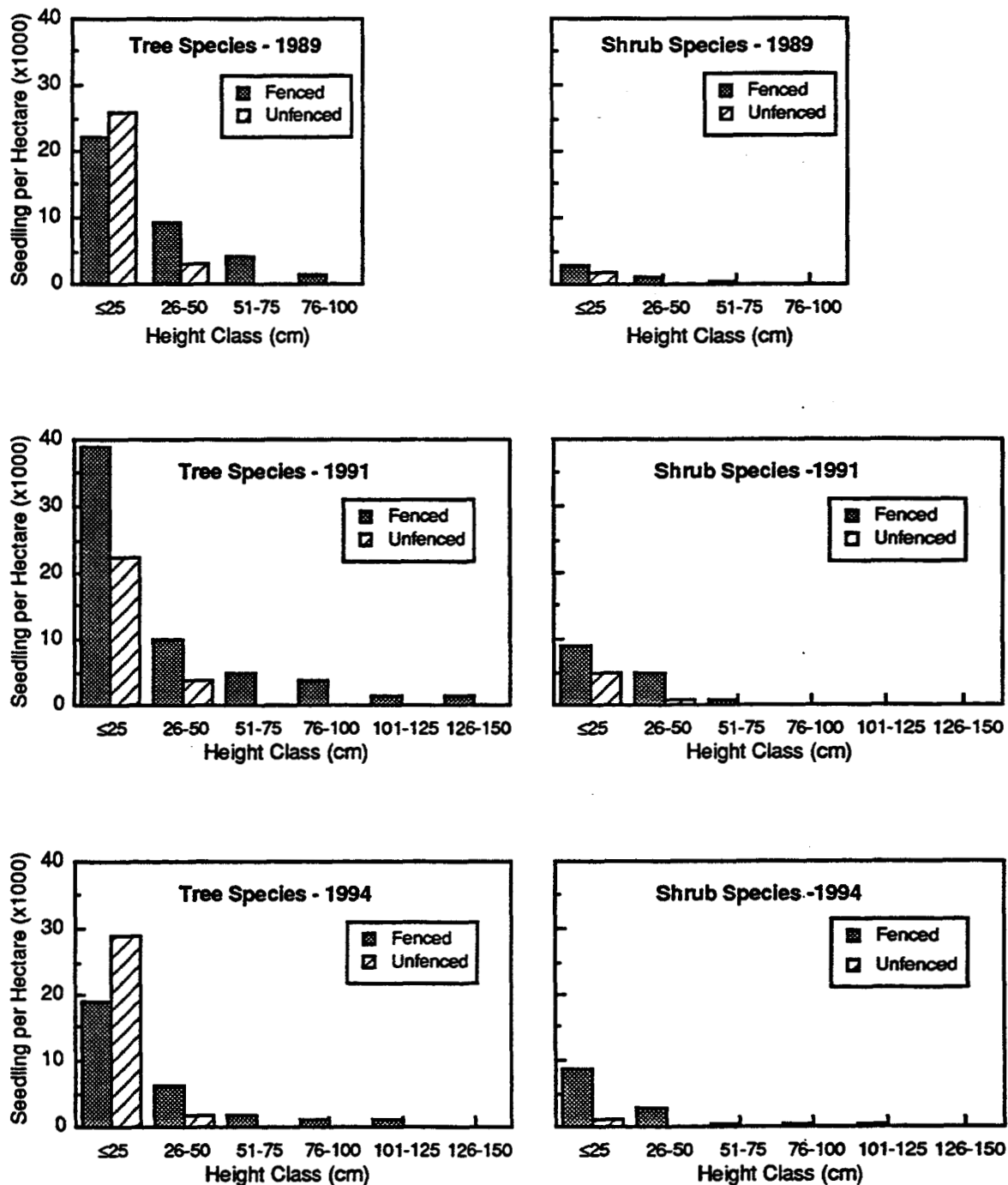


Figure 20. Estimated number of seedlings per hectare for tree and shrub species in the fenced and unfenced 10- x 10-m demonstration plots, by height class, for the 1989, 1991, and 1994 surveys of the Biesecker woodlot at Gettysburg National Military Park and Eisenhower National Historic Site.

Five herbaceous and vine species were found in the fenced subplot and two herbaceous species were found in the unfenced subplot, based on the line-transect data and a complete search of the two subplots. Spring-beauty was the only species common to both subplots.

Pitzer Woodlot

The number of tree seedling taxa recorded (fenced and unfenced combined) was seven in 1986-87, 10 in 1989, five in 1991, and nine in 1994, indicating no consistent change in tree species richness during the sampling period. The estimated total number of tree seedlings per ha did not change significantly from 1986-87 to 1994 in the fenced and unfenced plots (Table 64). White oak and wild black cherry were the most abundant tree seedling taxa in the fenced and unfenced plots. The density of white oak and ash spp. seedlings was higher in the fenced plot compared to the unfenced plot during 1986-87 to 1994 (Table 64).

The number of shrub seedling taxa recorded (fenced and unfenced combined) was three in 1986-87, two in 1989, one in 1991, and seven in 1994, indicating an increase in shrub species richness during the sampling period. The estimated total number of shrub seedlings increased from 1,000 stems per ha in 1986-87 to 9,000 stems per ha in 1994 in the fenced plot, whereas there was no significant change in the unfenced plot (Table 64). *Rubus* spp. and smooth black-haw were dominant shrub seedling taxa in both the fenced and unfenced plots during 1989 through 1994 (Table 64).

The estimated number of tree seedlings > 25 cm in height increased in the fenced plot from 1,000 stems per ha in 1989 to 5,000 stems per ha in 1994 (Fig. 21). Conversely, the estimated number of tree seedlings > 25 cm in height decreased slightly in the unfenced plot during 1989 through 1994. A small number of tree seedlings > 51 cm in height were present in the unfenced plot in 1989 and 1991 (Fig. 21).

The estimated number of shrub seedlings in the fenced plot increased in all height classes during 1989 through 1994, with the greatest increase in the 26-50 cm height class (Fig. 21).

Bushman Woodlot

The number of tree seedling taxa recorded (fenced and unfenced combined) was six in 1986-87, nine in 1989, nine in 1991, and 10 in 1994, indicating an increase in species richness of tree seedlings during the sampling period. The estimated total number of tree seedlings declined from 115,000 stems per ha in 1986-87 to 62,000 stems per ha in 1994 in the fenced plot and from 98,000 stems per ha in 1986-87 to 30,000 stems per ha in the unfenced plot (Table 65). White oak and ash spp. were the most abundant tree seedling taxa in both the fenced and unfenced plots during 1986-87 through 1994. The density of white oak seedlings declined in the fenced and unfenced plots, whereas the density of ash spp. did not change significantly from 1986-87 to 1994 (Table 65).

Table 64. Estimated number of tree and shrub seedlings per hectare by taxa and survey year in fenced and unfenced 10- x 10-m demonstration plots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site.^a

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Ash spp.	8		1	^b	1		1	1
Cedar, eastern red	1		2	^b	1	1	1	^b
Cherry, sweet		1	^b	^b			2	1
Cherry, wild black	3	4	4	2	14	4	5	5
Elm spp.			^b					
Hickory, mockernut					2	2	1	^b
Hickory, shagbark		1	1	1			1	3
Locust, black				^b				
Oak, black			1	^b			1	
Oak, chestnut		1						
Oak, northern red				^b			1	1
Oak, white	19	3	11	3	11	3	10	1
Total Tree	23	16	19	7	28	9	21	12

Table 64. (continued)

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Black-haw, smooth	1	1	2	1			2	^b
Dogwood, flowering							^b	
Grape spp.		1					^b	
Honeysuckle, tartarian								
Redbud, eastern		1					^b	
<i>Rosa</i> spp.								
<i>Rubus</i> spp.					3	7	5	2
Serviceberry				^b			1	^b
Total shrub	1	3	2	1	3	7	9	3
Total Tree and Shrub	24	18	21	8	31	16	30	15

^aValues for the 1986-87 survey were averages from four circular 2.0 m² subplots in each 10- x 10-m plot in 1986 and 1987 (16 m²); 1989 and 1994 survey values were from the entire 10- x 10-m plot (100 m²); and 1991 survey values were averages from four square 1.0 m² subplots at each of 4 locations in each 10- x 10-m plot (16 m²). Values within columns may not add up to the value for Total Tree, Total Shrub or Total Tree and Shrub due to rounding.

^bPresent but < 1.

The number of shrub seedling taxa recorded (fenced and unfenced combined) was three in 1986-87, seven in 1989, seven in 1991, and ten in 1994, indicating an increase in shrub species richness during the sampling period. The estimated total number of shrub seedlings increased from 8,000 stems per ha in 1986-87 to 32,000 stems per ha in 1994 in the fenced plot and from 2,000 stems per ha in 1986-87 to 38,000 stems per ha in 1994 in the unfenced plot (Table 65). Spicebush, smooth black-haw, and eastern redbud were dominant shrub seedling taxa in both the fenced and unfenced plots during 1986-87 through 1994 (Table 65).

The estimated number of tree seedlings > 25 cm in height increased in the fenced plot from 1989 to 1994 (Fig. 22). Conversely, the number of tree seedlings > 25 cm in height decreased in the unfenced plot during 1989 through 1994. No tree seedlings > 51 cm in height were present in the unfenced plot in 1989, 1991, and 1994 (Fig. 22).

The estimated total number of shrub seedlings in the fenced and unfenced plots increased during 1989 through 1994 (Fig. 22). Shrub seedlings > 50 cm height were higher in the fenced plots than in the unfenced plots in 1991 and 1994.

Six herbaceous and vine species were found in the fenced subplot and 12 species were found in the unfenced subplot, based on the line-transect data and a complete search of the 1-m² subplots sampled. Only three common species were found in both subplots. Four species were found along the line-transects in the fenced subplot and eight were found in the unfenced subplot. For the fenced subplot line-transect data, the Shannon Diversity and Evenness indices were 0.565 and 0.938, respectively. The Shannon Diversity and Evenness indices were 0.829 and 0.918, respectively, for the unfenced subplot based on line-transect data.

Spangler Woodlot

The number of tree seedling taxa recorded (fenced and unfenced combined) was seven in 1986-87, 10 in 1989, six in 1991, and 11 in 1994, indicating there was no consistent change in the species richness of tree seedlings over the sampling period. The estimated total number of tree seedlings declined from 57,000 stems per ha in 1986-87 to 46,000 stems per ha in 1994 in the fenced plot and from 55,000 stems per ha in 1986-87 to 4,000 stems per ha in 1994 in the unfenced plot (Table 66). White oak, ash spp., and wild black cherry were the most abundant tree seedling taxa in both the fenced and unfenced plots during 1986-87 through 1994. The density of white oak seedlings declined in the fenced and unfenced plots, whereas the density of ash spp. and wild black cherry did not change significantly from 1986-87 to 1994 (Table 66).

The number of shrub seedling taxa recorded (fenced and unfenced combined) was two in 1986-87, five in 1989, four in 1991, and seven in 1994, indicating an increase in shrub species richness during the sampling period. The estimated total number of shrub seedlings increased from 4,000 stems per ha in 1986-87 to 12,000 stems per ha in 1994 in

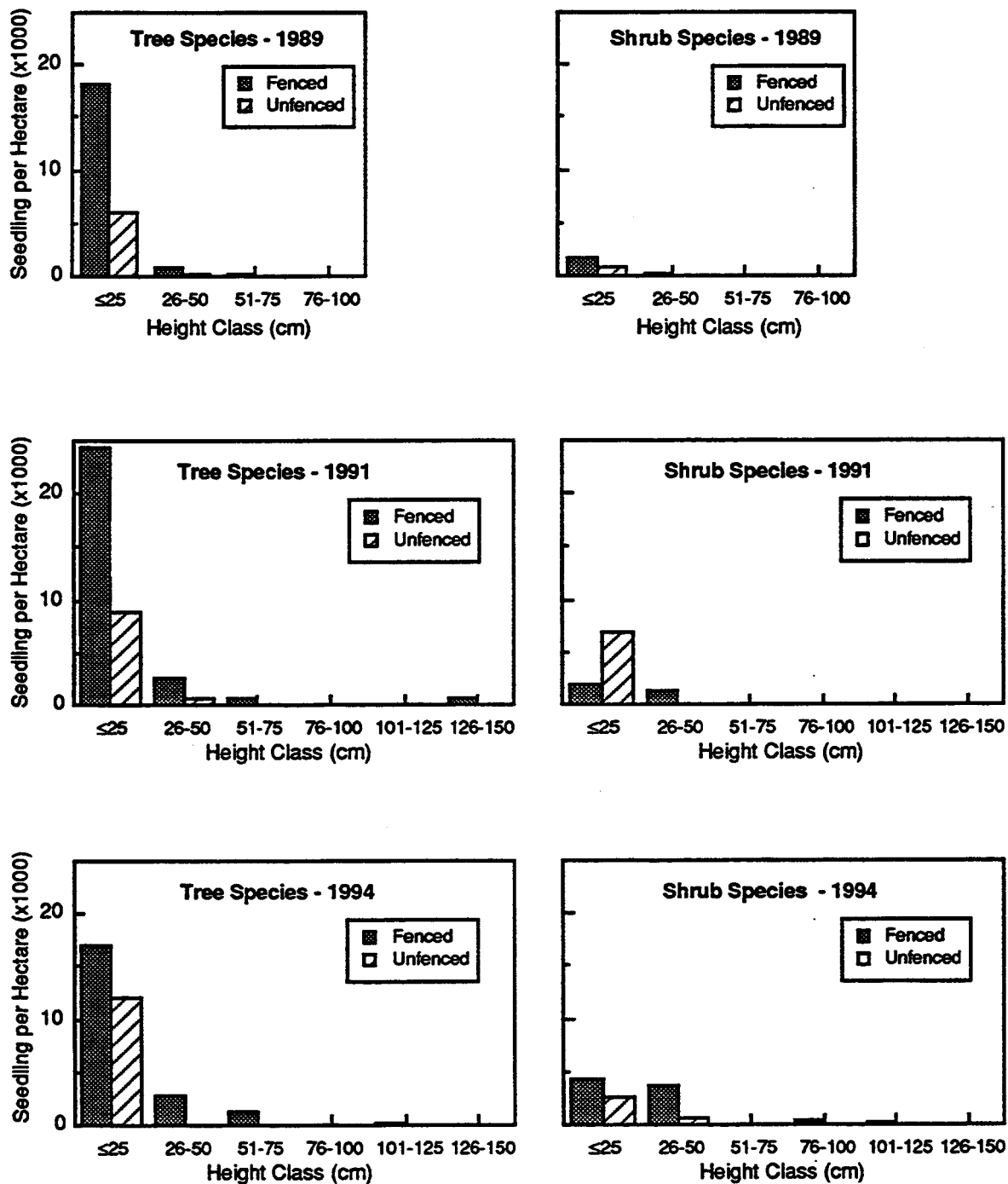


Figure 21. Estimated number of seedlings per hectare for tree and shrub species in the fenced and unfenced 10- x 10-m demonstration plots, by height class, for the 1989, 1991, and 1994 surveys of the Pitzer woodlot at Gettysburg National Military Park and Eisenhower National Historic Site.

Table 65. Estimated number of tree and shrub seedlings per hectare by taxa and survey year in fenced and unfenced 10- x 10-m demonstration plots in the Bushman woodlot, Gettysburg National Military Park.^a

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Ailanthus							b	
Ash spp.	28	23	26	33	20	37	25	14
Cherry, sweet			b	6			b	
Cherry, wild black	6	5	2	1	2		2	2
Elm spp.	15	1	11	b	19	1	17	1
Hickory, mockernut					2		3	1
Hickory, pignut	1	1	3	1	2			
Hickory, shagbark					2			
Maple, red	1	1	b		1		1	b
Oak, black			b	b	1			
Oak, northern red			b	b			1	1
Oak, white	81	68	24	35	25	22	12	9
Yellow-poplar								b

Table 65. (continued)

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Total Tree	133	98	66	73	74	62	62	30
Black-haw, smooth	2	2	7	2	3	5	10	3
Dogwood, flowering			b	1			b	b
Grape spp.							3	10
Redbud, eastern	2		7	3		1	1	4
Rosa spp.					6	1	4	
Rubus spp.					28	8		b
Sassafras				b		1	b	b
Serviceberry			b				1	1
Spicebush	4		8	5	4	8	9	14
Total Shrub	8	2	21	11	41	23	32	38
Total Tree and Shrub	140	99	93	48	116	84	94	69

^aValues for the 1986-87 survey were averages from four circular 2.0 m² subplots in each 10- x 10-m plot in 1986 and 1987 (16 m²); 1989 and 1994 survey values were from the entire 10- x 10-m plot (100 m²); and 1991 survey values were averages from four square 1.0 m² subplots at each of 4 locations in each 10- x 10-m plot (16 m²). Values within columns may not add up to the value for Total Tree, Total Shrub or Total Tree and Shrub due to rounding.

^bPresent but < 1.

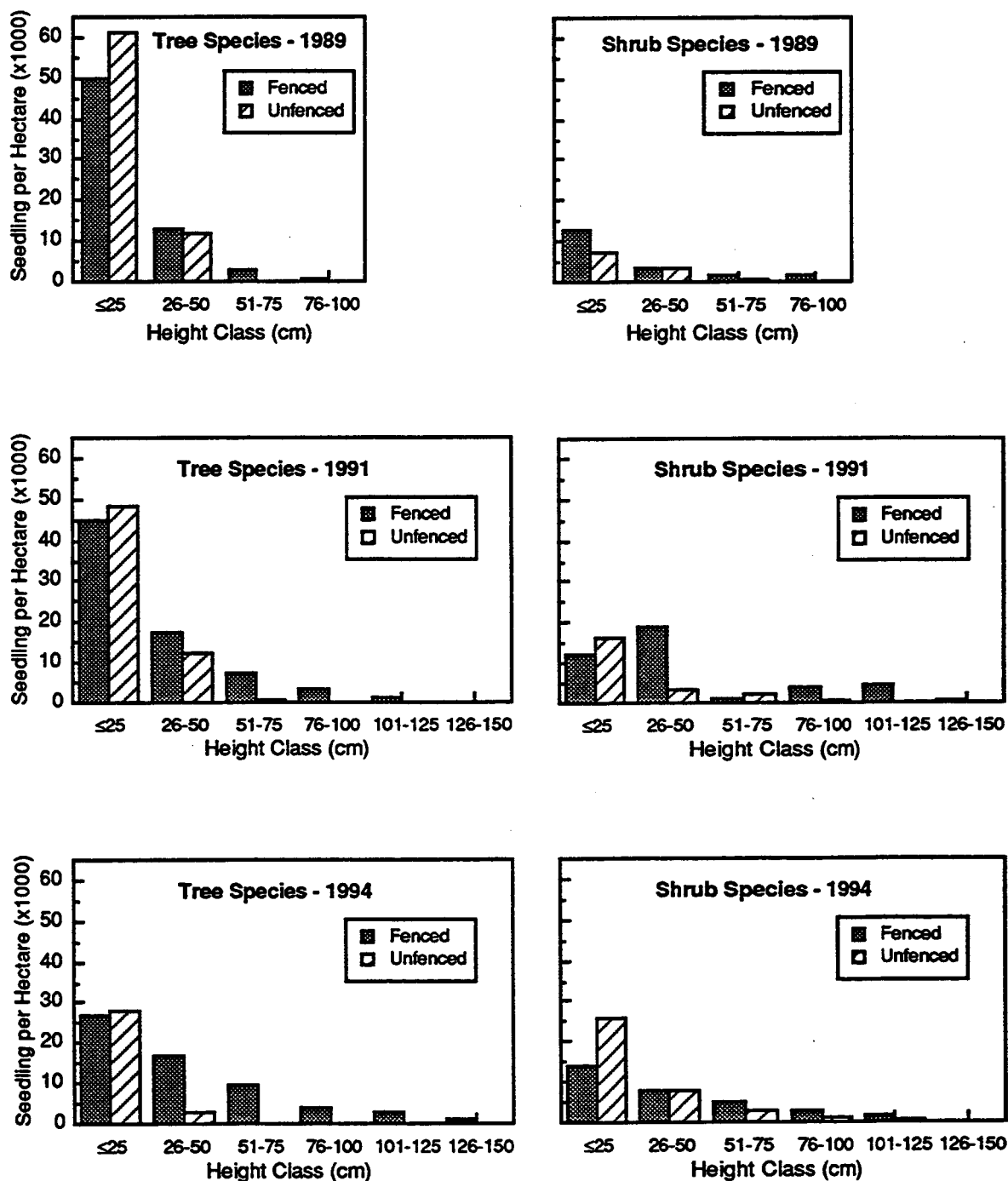


Figure 22. Estimated number of seedlings per hectare for tree and shrub species in the fenced and unfenced 10- x 10-m demonstration plots, by height class, for the 1989, 1991, and 1994 surveys of the Bushman woodlot at Gettysburg National Military Park.

the fenced plot and from less than 1,000 stems per ha in 1986-87 to 4,000 stems per ha in 1994 in the unfenced plot (Table 66). Smooth black-haw and *Rubus* spp. were dominant shrub seedling taxa in both the fenced and unfenced plots during 1986-87 through 1994 (Table 66).

The estimated number of tree seedlings > 25 cm in height increased in the fenced plot from 10,000 stems per ha in 1989 to 17,000 stems per ha in 1994 (Fig. 23). No tree seedlings > 25 cm in height were present in the unfenced plot in 1989, 1991, and 1994 (Fig. 23).

The estimated total number of shrub seedlings in the fenced and unfenced plots increased during 1989 through 1994 (Fig. 23). The abundance of shrub seedlings > 25 cm in height was higher in the fenced plot compared to the unfenced plot in 1989, 1991, and 1994 (Fig. 23).

Cobean (Butterfield Farm) Woodlot

The number of tree seedling taxa recorded (fenced and unfenced combined) was six in 1986-87, seven in 1989, zero in 1991, and seven in 1994, indicating there was no consistent change in the species richness of tree seedlings over the sampling period. The estimated total number of tree seedlings per ha was quite variable from 1986-87 to 1994 in both the fenced and unfenced plots (Table 67). Ash spp., wild black cherry, and shagbark hickory were the most abundant tree seedling taxa in both the fenced and unfenced plots during 1986-87 through 1994. Ash spp. seedling densities of 87,000 stems per ha or greater were recorded in 1989, decreased to zero in 1991, and were 2,000 stems per ha in 1994. The density of wild black cherry seedlings declined, whereas the density of shagbark hickory did not change significantly from 1986-87 to 1994 (Table 67).

The number of shrub seedling taxa recorded (fenced and unfenced combined) was zero in 1986-87, three in 1989, two in 1991, and five in 1994, indicating an increase in shrub species richness during the sampling period. Although no shrub seedlings were recorded in the fenced plot in 1986-87, a density of 24,000 stems per ha was recorded in 1994 (Table 67). The estimated total number of shrub seedlings in the unfenced plot increased from 1,000 stems per ha in 1986-87 to 9,000 stems per ha in 1994 (Table 67). *Rubus* spp. and *Rosa* spp. were dominant shrub seedling taxa in both the fenced and the unfenced plot during 1986-87 through 1994 (Table 67).

The estimated number of tree seedlings 26-50 cm and 51-75 cm in height increased in the fenced plot from 1989 to 1994 (Fig. 24). Except for a greater number of tree seedlings 26-50 cm height in the fenced plot compared to the unfenced plot, tree seedling abundance was not different between the fenced and unfenced plots in 1991 and 1994 (Fig. 24).

The estimated total number of shrub seedlings increased in both the fenced and unfenced plots during 1989 through 1994 (Fig. 24). However, shrub seedling abundance was greater

Table 66. Estimated number of tree and shrub seedlings per hectare by taxa and survey year in fenced and unfenced 10- x 10-m demonstration plots in the Spangler woodlot, Gettysburg National Military Park.^a

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Ash spp.	23	18	82	20	41	11	36	b
Cedar, eastern red	b			b				
Cherry, sweet	1		6	1	4	1	4	1
Cherry, wild black	4	13	1	1	1	3	13	2
Elm spp.				b			b	
Hickory, mockernut		1			2	1	1	
Hickory, shagbark		1	b	1			b	b
Maple, Norway							b	
Maple, red			1	b	1		1	3
Oak, black				b				b
Oak, northern red			b	b			b	b
Oak, white	20	20	4	1	3		1	
Total Tree	57	55	96	23	54	15	46	4

Table 66. (continued)

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
	-----Seedlings (x1000) per hectare-----							
Barberry, Japanese			b	b			1	
Black-haw, smooth	1		3	2	1	1	7	1
Dogwood, flowering								1
Greenbrier	3				1	1	b	b
<i>Rubus</i> spp.			b	b	6	1	3	b
Sassafras			b			1	b	
Serviceberry			b				b	b
Spicebush							b	b
Total Shrub	4	b	4	2	9	4	12	4
Total Tree and Shrub	61	55	100	25	63	19	58	8

^aValues for the 1986-87 survey were averages from four circular 2.0 m² subplots in each 10- x 10-m plot in 1986 and 1987 (16 m²); 1989 and 1994 survey values were from the entire 10- x 10-m plot (100 m²); and 1991 survey values were averages from four square 1.0 m² subplots at each of 4 locations in each 10- x 10-m plot (16 m²). Values within columns may not add up to the value for Total Tree, Total Shrub or Total Tree and Shrub due to rounding.

^bPresent but < 1.

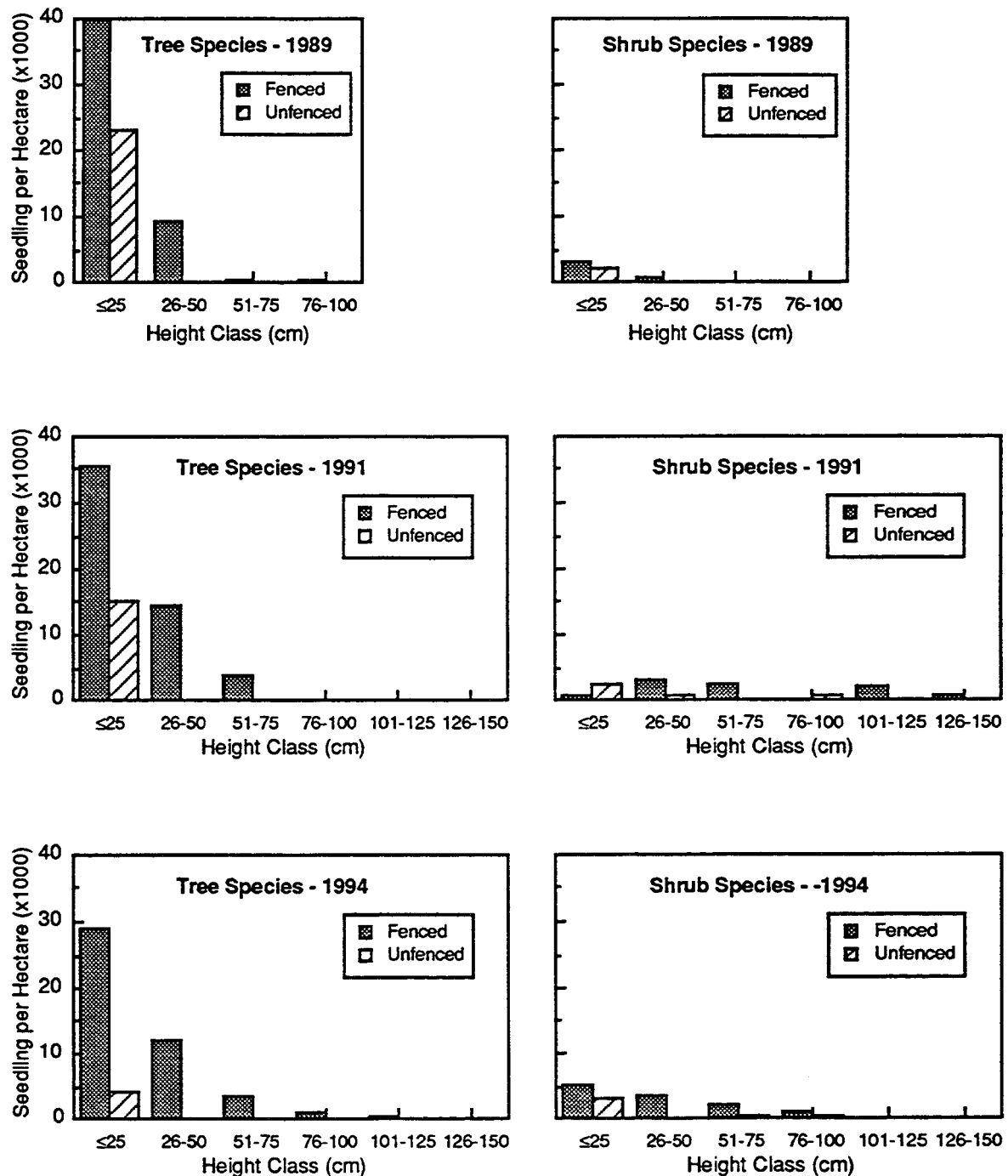


Figure 23. Estimated number of seedlings per hectare for tree and shrub species in the fenced and unfenced 10- x 10-m demonstration plots, by height class, for the 1989, 1991, and 1994 surveys of the Spangler woodlot at Gettysburg National Military Park. Average number of tree seedling species ≤ 25 cm in height in 1989 was 86,000 per hectare for the fenced plot.

Table 67. Estimated number of tree and shrub seedlings per hectare by taxa and survey year in fenced and unfenced demonstration plots in the Cobean woodlot, Gettysburg National Military Park.^a

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Ash spp.	9	3	87	95	2			b
Cherry, wild black	6		1	4				
Elm spp.	1		b	1	b			
Hickory, mockernut					1			
Hickory, pignut	1	1						
Hickory, shagbark	3		1	b	2		b	2
Locust, black								
Oak, black	2		b		b		b	b
Oak, chestnut			b					
Oak, northern red			b				b	
Total Tree	21	3	90	100	6			2

Table 67. (continued)

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Barberry, Japanese			2					
Black-haw, smooth			1	b				
Honeysuckle, tartarian							1	2
Redbud, eastern				b			3	b
<i>Rosa</i> spp.					16		5	2
<i>Rubus</i> spp.		1			1		14	3
Sassafras							1	
Serviceberry								
Total Shrub		1	3	b	17		24	9
Total Tree and Shrub	21	4	93	100	17		30	14

^aValues for the 1986-87 survey were averages from four circular 2.0 m² subplots in each 10- x 10-m plot in 1986 and 1987 (16 m²); 1989 and 1994 survey values were from the entire 10- x 10-m plot (100 m²); and 1991 survey values were averages from four square 1.0 m² subplots at each of 4 locations in each 10- x 10-m plot (16 m²). Values within columns may not add up to the value for Total Tree, Total Shrub or Total Tree and Shrub due to rounding.

^bPresent but < 1.

in the fenced plot compared to the unfenced plot in 1989, 1991, and 1994 for all height classes (Fig. 24).

Slyder (Granite Farm) Woodlot

The number of tree seedling taxa recorded (fenced and unfenced combined) was four in each of 1986-87, 1989, and 1991, and seven in 1994, indicating a steady to slightly increasing change in the species richness of tree seedlings over the sampling period. The total number of tree seedlings per ha did not change significantly from 1986-87 to 1994 in both the fenced and unfenced plots (Table 68). Northern red oak was the most abundant tree seedling taxa in the fenced plot, whereas ash spp. was the most abundant tree seedling taxa in the unfenced plot during 1986-87 through 1994. The density of northern red oak seedlings did not change significantly in the fenced plot from 1986-87 to 1994.

Ash spp. seedlings increased in the unfenced plot from 1986-87 to 1991, but were not present in 1994 (Table 68).

The number of shrub seedling taxa recorded (fenced and unfenced combined) was four in 1986-87, four in 1989, five in 1991, and eight in 1994, indicating an increase in shrub species richness during the sampling period. The estimated total number of shrub seedlings increased from 2,000 stems per ha in 1986-87 to 25,000 stems per ha in 1994 in the fenced plot and from 4,000 stems per ha in 1986-87 to 13,000 stems per ha in 1994 in the unfenced plot (Table 68). *Rubus* spp. and *Rosa* spp. were dominant shrub seedling taxa in the fenced plot, whereas *Rubus* spp. and smooth black-haw were dominant in the unfenced plot during 1986-87 through 1994 (Table 68).

Tree seedlings > 25 cm in height declined or remained the same in the unfenced areas from 1989 through 1994, whereas tree seedling abundance increased in the fenced plots (Fig. 25). Shrub seedlings increased and the greatest increase was in the fenced plots during 1989 through 1994.

Browse Availability and Use

Biesecker Woodlot

Over 70% of the available twigs were browsed by deer on six of 11 tree and shrub taxa in the Biesecker woodlot browse plots (Table 69). Smooth black-haw and rose spp. had browse rates of 100%. Juneberry had the lowest browse rate (0%) in the Biesecker woodlot.

Pitzer Woodlot

Eleven of 12 tree and shrub taxa recorded in the Pitzer woodlot browse plots had twig browse rates > 70% (Table 70). Smooth black-haw, *Carya* spp., sweet cherry, slippery

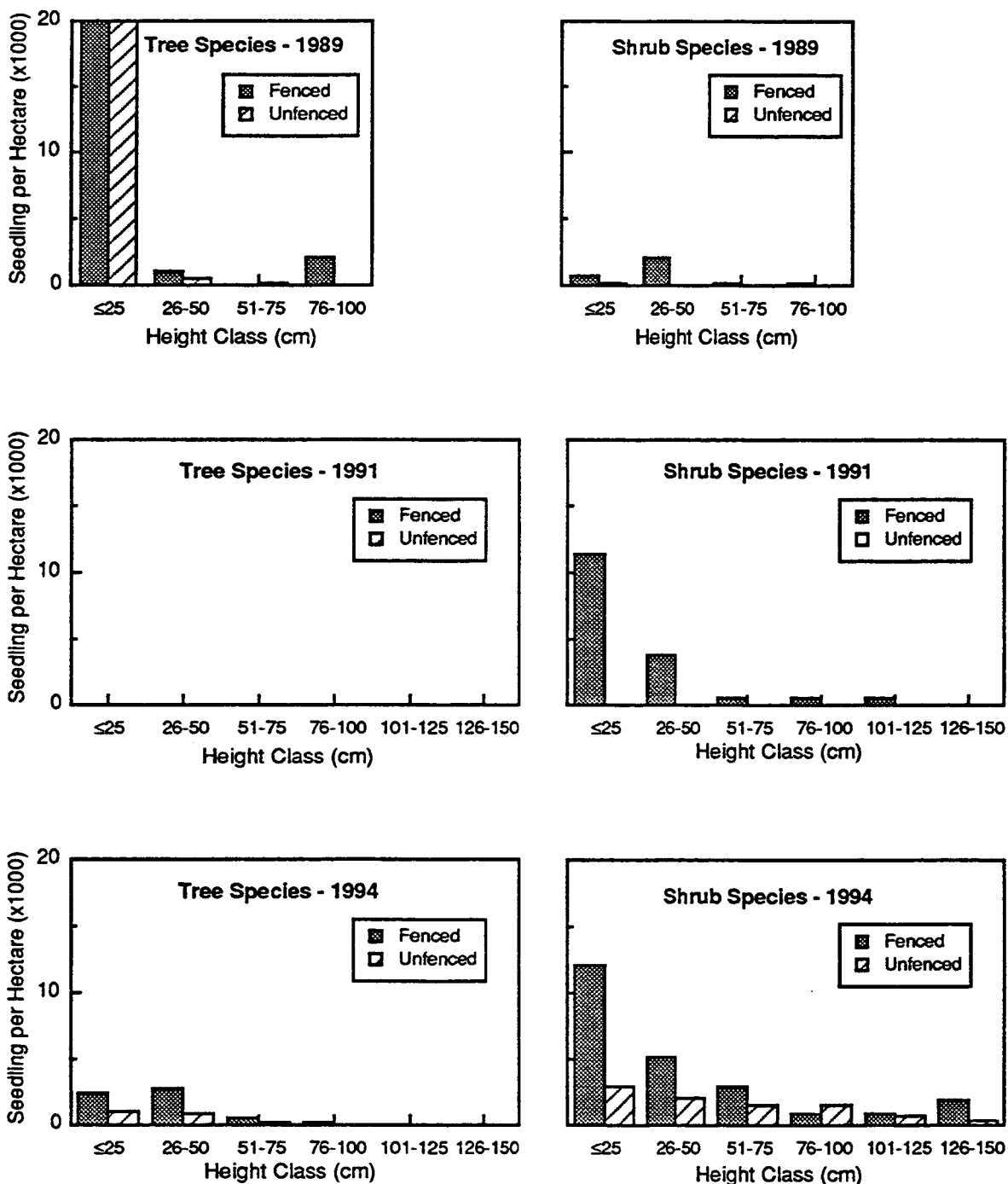


Figure 24. Estimated number of seedlings per hectare for tree and shrub species in the fenced and unfenced 10- x 10-m demonstration plots, by height class, for the 1989, 1991, and 1994 surveys of the Cobean woodlot at Gettysburg National Military Park. Average number of tree seedling species ≤ 25 cm in height in 1989 was 99,000 and 88,000 per hectare for the unfenced and fenced plot, respectively.

Table 68. Estimated number of tree and shrub seedlings per hectare by taxa and survey year in fenced and unfenced 10- x 10-m demonstration plots in the Snyder woodlot, Gettysburg National Military Park.^a

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Ash spp.		13		2		34	b	
Black-gum							b	
Cedar, eastern red							b	
Cherry, sweet								
Cherry, wild black	1		b		b		b	1
Hickory, mockernut					b		1	
Hickory, pignut		1	b	b				
Hickory, shagbark	1	1						
Maple, Norway							b	
Oak, northern red			1	b	2		2	b
Total Tree	1	14	2	3	3	34	4	1

Table 68. (continued)

Taxa	Survey Year							
	1986-87		1989		1991		1994	
	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced	Fenced	Unfenced
-----Seedlings (x1000) per hectare-----								
Barberry, Japanese							5	b
Black-haw, smooth		1	b			5	1	
Dogwood, flowering			1	4				
Grape spp.		1					3	b
Greenbrier								3
Redbud, eastern	1	1		b		1		b
<i>Rosa</i> spp.					8		7	2
<i>Rubus</i> spp.					35	17	13	3
Sassafras						1		
Serviceberry	1							
Spicebush			1	b			2	b
Total Shrub	2	4	2	4	43	23	25	13
Total Tree and Shrub	3	16	4	6	46	56	29	14

^aValues for the 1986-87 survey were averages from four circular 2.0 m² subplots in each 10- x 10-m plot in 1986 and 1987 (16 m²); 1989 and 1994 survey values were from the entire 10- x 10-m plot (100 m²); and 1991 survey values were averages from four square 1.0 m² subplots at each of 4 locations in each 10- x 10-m plot (16 m²). Values within columns may not add up to the value for Total Tree, Total Shrub or Total Tree and Shrub due to rounding.

^bPresent but < 1.

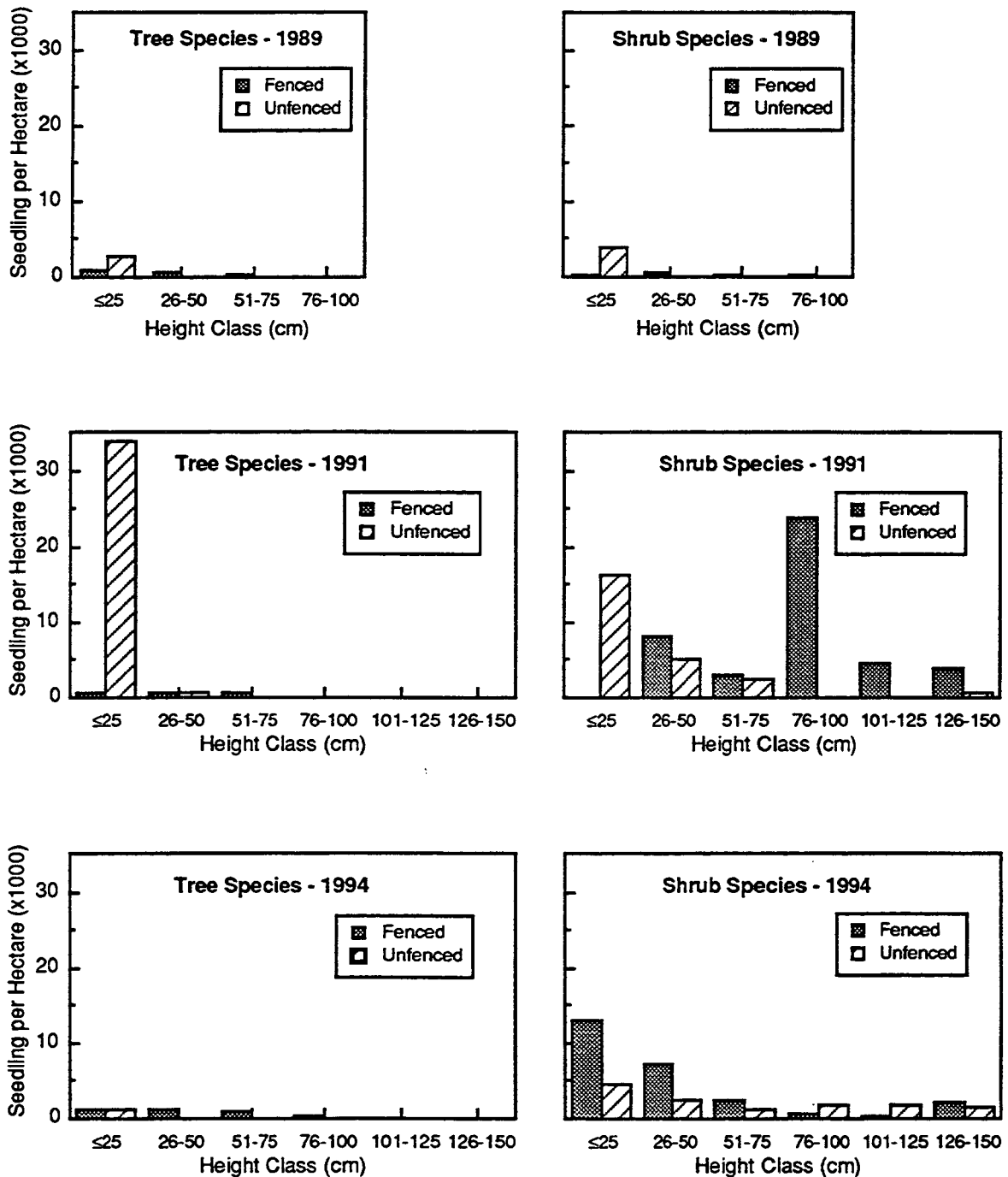


Figure 25. Estimated number of seedlings per hectare for tree and shrub species in the fenced and unfenced 10- x 10-m demonstration plots, by height class, for the 1989, 1991, and 1994 surveys of the Slyder woodlot at Gettysburg National Military Park.

Table 69. Number of twigs of tree and shrub taxa available and the percent of woody twigs browsed at 15 browse plots in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Taxa	Number available	Percent Browsed
Ash spp.	141	72
Black-haw, smooth	256	100
<i>Carya</i> spp.	27	44
Cherry, wild black	552	83
Dogwood, flowering	4	75
Juneberry	2	0
Oak, northern red	5	60
Oak, white	299	54
<i>Rosa</i> spp.	5	100
<i>Rubus</i> spp.	55	85
Serviceberry, downy	4	50

^aTwigs were counted in 15 circular plots, each 9.3 m² in size with a radius of 1.72 m.

Table 70. Number of twigs of tree and shrub taxa available and the percent of woody twigs browsed at 15 browse plots in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.^a

Taxa	Number available	Percent browsed
Ash spp.	124	92
Barberry, Japanese	6	33
Black-haw, smooth	276	100
Cedar, eastern red	16	81
<i>Carya</i> spp.	3	100
Cherry, wild black	95	81
Cherry, sweet	5	100
Dogwood, flowering	20	80
Elm, slippery	4	100
Hackberry	13	100
Oak, white	19	74
<i>Rubus</i> spp.	39	95

^aTwigs were counted in 15 circular plots, each 9.3 m² in size with a radius of 1.72 m.

elm, and hackberry had browse rates of 100%. Japanese barberry had the lowest browse rate (33%) in Pitzer woodlot.

Future Projections

Present species composition, number, and size distribution of the overstory stems should enable Biesecker, Pitzer, Bushman, Herr Ridge, Powers Hill, and Spangler woodlots to meet the requirements of the Category B woodlots for the next 25 years, given normal mortality rates. Category B woodlots are historic woodlots used to screen army movements and positions during the Civil War, and important factors in their perpetuation are overstory canopy height, native species composition, and a mix of deciduous and coniferous species. There is concern for the long term perpetuation of these woodlots. This concern is due to the changing species composition and number of stems in the smaller size classes. Species composition was shifting from long-lived oak and hickory spp. to short-lived ash spp. and wild black cherry in all woodlots surveyed. Oak and hickory spp. combined accounted for 64, 42, 16, and 28% of the total tree species stems in the overstory, large sapling, small sapling, and seedling components of the woodlots, respectively. In contrast, ash spp. and wild black cherry combined accounted for 13, 33, 63, and 54% of the total tree species stems in the overstory, large sapling, small sapling, and seedling components, respectively. Optimum and woodlot average numbers of stems per hectare, by diameter class, are given in Table 71. Compared to the Fairweather and Cavanaugh (1990) projected structure at the 100% stocking level (optimum), there should have been 485 stems per hectare with diameters ≥ 12 cm. Our surveys recorded an average of 309 stems per hectare with diameters ≥ 12 cm. Compared to the optimum numbers, there were surpluses in the number of stems in the ≥ 32 cm diameter classes and substantial shortfalls in number of stems in the diameter classes < 32 cm (Table 71). Shortages were particularly acute in the small sapling class even though there appears to be sufficient numbers of seedlings becoming established within the woodlots. Possible reasons for, but not limited to, the changing species composition and low number of stems growing from the seedling to the small sapling component are: (1) competition from the overstory trees, (2) competition from shrub species, and (3) foraging by white-tailed deer.

Table 71. Optimum and woodlot average number of tree species seedlings, small saplings, large saplings, and overstory stems per hectare, by diameter class, for balanced unevenaged woodlots at Gettysburg National Military Park and Eisenhower National Historic Site.

Component	Diameter Class (cm)	Optimum at 100% Stocking	Woodlot Average^a
---Number of Stems per Hectare---			
Seedling	< 0.1	26,712^b	23,709
Small Sapling	0.1-1.9	4,452^c	116
Large Sapling	2-11	1,484^d	765
Tree	12-21	366^d	166
	22-31	90^d	53
	32-41	22^d	34
	42-51	5.5^d	23
	52-61	1.4^d	18
	62-71	0.3^d	9.3
	> 71	0.1^d	6.1
	All Trees	485	309

^aAverage for Biesecker, Pitzer, Bushman, Herr Ridge, Powers Hill, and Spangler woodlots.

^b Assumed that six seedlings were needed to achieve one small sapling.

^c Assumed that three small saplings were needed to achieve one large sapling.

^d Determined by the equation developed by Fairweather and Cavanaugh (1990).

Discussion

Long-term Monitoring Plots

The long-term monitoring plots for the present studies were randomly established in six woodlots (Biesecker, Pitzer, Bushman, Herr Ridge, Powers Hill, Spangler) that were considered relatively mature with closed canopies ($> 90\%$ closed for each woodlot). Thus, the reduced light entering the forest floor was considered a key factor affecting the development and growth of young woody stems. Furthermore, the combined effects of reduced light and intensive feeding by white-tailed deer may reduce or eliminate the regeneration of at least some species of trees, shrubs, and herbaceous plants.

Large saplings outnumbered overstory trees in Biesecker, Pitzer, Herr Ridge, and Spangler woodlots. However, in Bushman and Powers Hill woodlots, the number of overstory trees was higher than the number of large and small saplings combined.

One of the most significant results of the present survey was the fact that the density of small saplings was less than 200 per ha (range 8-169) in five of the six woodlots. Thus, the density of small saplings was lower than the density of overstory trees for these five woodlots. The Herr Ridge woodlot, with an estimated 392 small saplings per ha, was the only one with more than 200 small saplings per ha. Herr Ridge was the only woodlot located north of Route 116 where the deer herd density is significantly lower than in the five woodlots south of Route 116 (Storm et al. 1989).

Another important finding from the present survey was the low number of oak saplings in all six woodlots. The density of oak saplings (small and large combined) was lower than that of oaks in the overstory for each woodlot. Oaks in the overstory outnumbered oak saplings by a 3:1 ratio in four of the six woodlots. The overstory:sapling ratio for hickories was in sharp contrast to that for oaks. For the hickory species, saplings were more abundant than overstory stems in all six woodlots.

Ash spp. and cherry spp. represented a significant component of the large saplings in five of the six woodlots. The density of ash spp. exceeded 80 stems per ha in five of the six woodlots, whereas cherry spp. exceeded 130 stems per ha in three of the six woodlots. Thus, ash spp., cherry spp., and hickory spp. were a significant component of the large sapling profile in the woodlots surveyed.

The fact that the estimated number of seedlings per ha for all tree species combined was $< 30,000$ for four of the six woodlots indicates a serious deficiency for regenerating a mixed oak forest at the Gettysburg parks with high species diversity. Related to this problem is the lack of oak seedlings. Except for the Bushman woodlot, less than 2,000 oak seedlings per ha were estimated in the woodlots. Furthermore, of oak seedlings the majority were white oaks and significantly less were black oak and northern red oak.

Another important finding concerning seedlings was that over 60% of all tree seedlings were ≤ 25 cm in height. For species of oaks, 80 percent of the seedlings were ≤ 25 cm in height. The lack of seedlings > 25 cm in height was also noted in our estimate of ground cover in the long-term monitoring plots. Ground cover included a live woody component that included tree and shrub seedlings. These data indicated that tree and shrub seedlings were ≤ 25 cm in height in 75% of the plots. In addition, our data for the demonstration plots indicated that over 75% of the seedlings recorded in the paired 10- x 10-m plots were ≤ 25 cm in height in the unfenced plots.

The average dbh and basal area for large saplings and overstory trees were not significantly different between fenced and unfenced plots established for long-term monitoring. Such a similarity at the onset of monitoring was desirable because the presence of a similar overstory structure among plots helped to eliminate the influence of light as a factor, and thereby facilitate an evaluation of the presence or absence of white-tailed deer on forest regeneration.

The species composition and abundance of herbaceous and vine species in the long-term monitoring plots were determined in four woodlots, Biesecker, Bushman, Herr Ridge, and Powers Hill. At each of a total of 90 sampling sites in the four woodlots, data were recorded within two 1- x 1-m subplots along line-transects and by a search of the complete area of the subplots. Other areas of the parks were also searched to locate additional species. The sampling period extended over much of the summer so that some of the early appearing species had disappeared by the time the last sites were sampled and some of the later developing species were not visible or identifiable early in the sampling period.

A total of 248 herbaceous and vine species representing 55 families were identified from specimens collected within the boundaries of Gettysburg National Military Park and Eisenhower National Historic Site. At the 90 sampling sites in the four woodlots, 95 species were found within the 1- x 1-m subplots and 71 species were intercepted by the line-transects. A collection of mounted specimens of these species are housed in the Biology Department at Elizabethtown College. The crane fly orchid, which is recorded as "Pennsylvania Rare" on the Pennsylvania Natural Diversity Inventory (PNDI) list (DER 1992, Weigman 1986) of plants of special concern, was located along the line-transects in Herr Ridge woodlot. No other species on the PNDI list were found.

Several species found within the area by Yahner et al. (1991), including white and yellow violets, virginia bluebells, and true solomon's seal, were not found. Earlier studies (Darrah 1973, Gibson 1987, and Greenlee 1977) in the same general area as Biesecker and Bushman woodlots also recorded species that were not encountered at our herbaceous sampling sites. Whether the absence of expected species at the sampling sites was related to patchy distribution due a variety of factors or a result of stress, such as deer browse was not determined. A study in Missouri found that deer consumed solomon's seal, white and yellow violets, and several other species in significant

quantities in April and May (Korschgen et al. 1980).

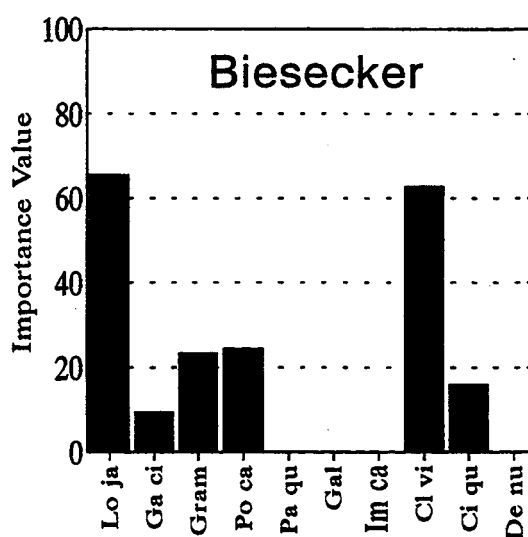
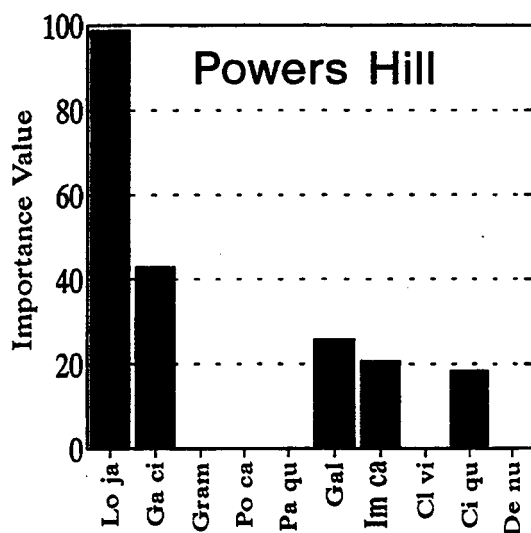
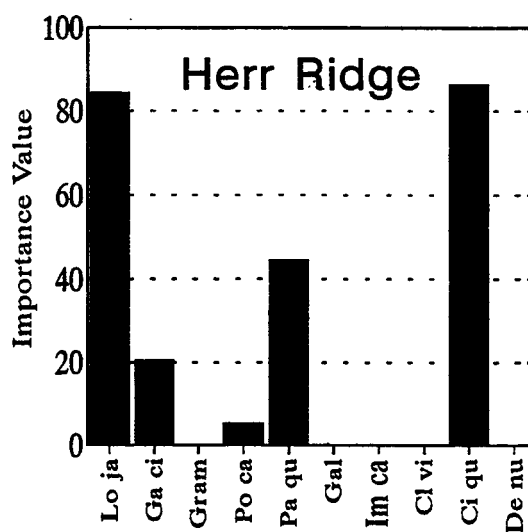
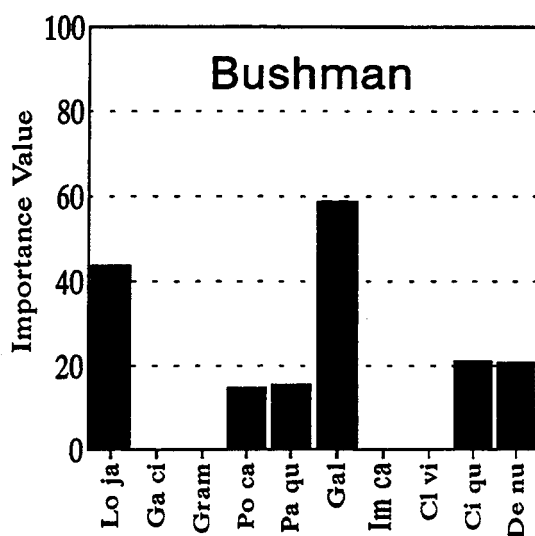
Jack-in-the-pulpit was reported to be more common in areas with low deer densities in the Allegheny National Forest (David S. deCalesta, pers. commun.). During the present study at Gettysburg, Jack-in-the-pulpit were common even in high deer density areas. Whether the differences in use of this species between the Allegheny and Gettysburg was due to differences in food preferences by deer, or due to differences in land cover (mainly forest in the Allegheny versus farm and forest mixed at Gettysburg) is unclear.

In the 15 fenced Biesecker sampling sites, the importance value of Japanese honeysuckle was greatest with spring-beauty and cinquefoil next in order (Fig. 26). In the 15 unfenced central plots, the importance values for a sedge, *Carex complanatum*, was greatest, followed by cinquefoil, spring-beauty, and Japanese honeysuckle. Within the unfenced plots, the greatest importance value was for spring-beauty. Japanese honeysuckle and a Graminae spp. ranked second and third. A t-test of the importance values and number of species present in the fenced, random unfenced, and unfenced reference plots of Biesecker showed no significant difference ($P > 0.05$) among the sites.

The families represented by more than one species whose importance values ranked in the top ten within the four woodlots were the sedge (Cyperaceae), madder (Rubiaceae), rose (Rosaceae), and bean family (Fabaceae). Bushman and Powers Hill both had two of these families, each of which was represented by two species in the top ten ranking. No one family dominated the flora in any of the woodlots by the presence of large numbers of several species.

For all herbaceous species found within the 1-m² subplots, the coefficient of community similarity was greatest between the Herr Ridge and Powers Hill woodlots (0.50) (Table 72). The coefficients between Biesecker and Bushman, Biesecker and Herr Ridge, Biesecker and Powers Hill, Bushman and Herr Ridge, and Bushman and Powers Hill woodlots were 0.30, 0.23, 0.21, 0.30, and 0.44, respectively (Table 72). The greatest coefficient of community similarity between the line-transect data occurred between Bushman and Powers Hill and between Herr Ridge and Powers Hill woodlots (0.43) (Table 72). The coefficients between Biesecker and Bushman, Biesecker and Herr Ridge, Biesecker and Powers Hill, and Bushman and Herr Ridge woodlots were 0.28, 0.24, 0.18, and 0.34, respectively.

Even though the Bushman woodlot, with the largest area (23 hectares) of the four woodlots, contained the greatest number of herbaceous species (47), there was not a correlation between size of woodlot and number of species across the four woodlots. This was possibly due to varying degrees of disturbance within the woodlots.



Japanese Honeysuckle Lo ja
Wild Licorice Ga ci
Gramineae spp. Gram
Cinquefoil Po ca
Virginia Creeper Pa qu

***Galium* spp.** Gal
Spotted touch-me-not Im ca
Spring-beauty Cl vi
Enchanter's nightshade Ci qu
Naked-flowered tick-trefoil De nu

Figure 26. Importance values of ten herbaceous species collected along line-transects in 2- x 2-m subplots in four woodlots at Gettysburg National Military Park and Eisenhower National Historic Site, May to August, 1992.

Table 72. Number of herbaceous and vine species encountered within the 2- x 2-m subplots and along four transects inside the 2- x 2-m subplots in Biesecker, Bushman, Herr Ridge, and Powers Hill woodlots at Gettysburg National Military Park and Eisenhower National Historic Site and the coefficients of community similarity between the *within subplots* and *along transect* data, May to August, 1992.

	<i>within subplots</i> ^a		<i>along transects</i> ^b	
	# of species encountered	# of species in common between two woodlots	# of species encountered	# of species in common between two woodlots
		(coefficient of community similarity) ^c		(coefficient of community similarity)
		Bushman	Herr Ridge	Powers Hill
Biesecker	42	21(0.30)	12(0.23)	13(0.21)
Bushman	47		16(0.30)	24(0.44)
Herr Ridge	22			18(0.50)
Powers Hill	32			
				18

^aData collected along line-transects inside the 1- x 1-m subplots within each 2- x 2-m subplot and by searching the entire area of the 1-m² subplots.

^bData collected only along line-transects.

^cCoefficient of Community Similarity = $\frac{c}{S_1 + S_2 - c}$ where S_1 = species in community 1 and S_2 = species in community 2 and c = the number of species in common between the two communities.

Demonstration Plots

Eighteen tree seedling taxa were recorded at least once in the fenced and unfenced demonstration plots during the 1986-87, 1989, 1991 and 1994 surveys. Ash spp., wild black cherry, black locust, black oak, elm spp., sweet cherry, mockernut hickory, pignut hickory, shagbark hickory, eastern red cedar, red maple, northern red oak, and white oak were tree taxa recorded in all surveys. Ailanthus, black-gum, Norway maple, and yellow-poplar seedlings were first recorded in 1994.

Ash spp., wild black cherry, and white oak consistently dominated, accounting for 76 to 91% of all tree seedlings recorded in each of the surveys. In 1986-87, white oak was the most abundant species with 42% of all tree seedlings, followed by ash spp. (28%) and wild black cherry (19%). By 1994, ash spp. increased to 42% of the total, followed by wild black cherry (17%) and white oak (14%).

The estimated number of tree seedlings per ha decreased from 1986-87 to 1994 in both the fenced and unfenced plots, and the rate of decrease was the same for the fenced and unfenced plots (Fig. 27). The estimated number of tree seedlings decreased from 56,000 per ha in 1986-87 to 28,000 per ha in 1994 in the fenced plots and from 39,000 per ha in 1986-87 to 13,000 per ha in 1994 in the unfenced plots.

The estimated number of tree seedlings ≤ 25 cm in height decreased from 40,000 per ha in 1989 to 14,000 per ha in 1994. In both years, the average number of tree seedlings per hectare in the fenced plots were slightly greater than the average number in the unfenced plots (Fig. 28). This difference was probably due to the location of the fence treatments in 1986-87.

Fencing had a greater effect on the number of tree seedlings > 25 cm in height. In 1989, there was an estimated 3,000 seedlings > 25 cm in height per ha in the unfenced plots and 6,000 seedlings > 25 cm in height per ha in the fenced plots. By 1994, the estimated number of seedlings > 25 cm decreased to 1,000 per ha in the unfenced plots and increased to 12,000 per ha in the fenced plots.

The decline in the estimated number of tree seedlings per ha in the unfenced plots and the increase in the estimated number of tree seedlings per ha in the > 25 cm height class for the fenced plots suggest that deer were influencing the height growth of tree species seedlings. It is important to note that there was a decline in the estimated number of tree seedlings ≤ 25 cm in height in both the fenced and unfenced plots. The estimated number of tree seedlings ≤ 25 cm in height surveyed in the fenced plots in 1994 (17,000 per ha) was 27,000 per ha lower than the 44,000 per ha surveyed in 1989. There was a corresponding increase of 4,000 per ha in the > 25 cm height class between 1989 and 1994. This leaves 24,000 per ha tree seedlings that were lost from the ≤ 25 cm height class. These losses could be due to factors influencing the establishment of new recruits or survival of the existing seedlings.

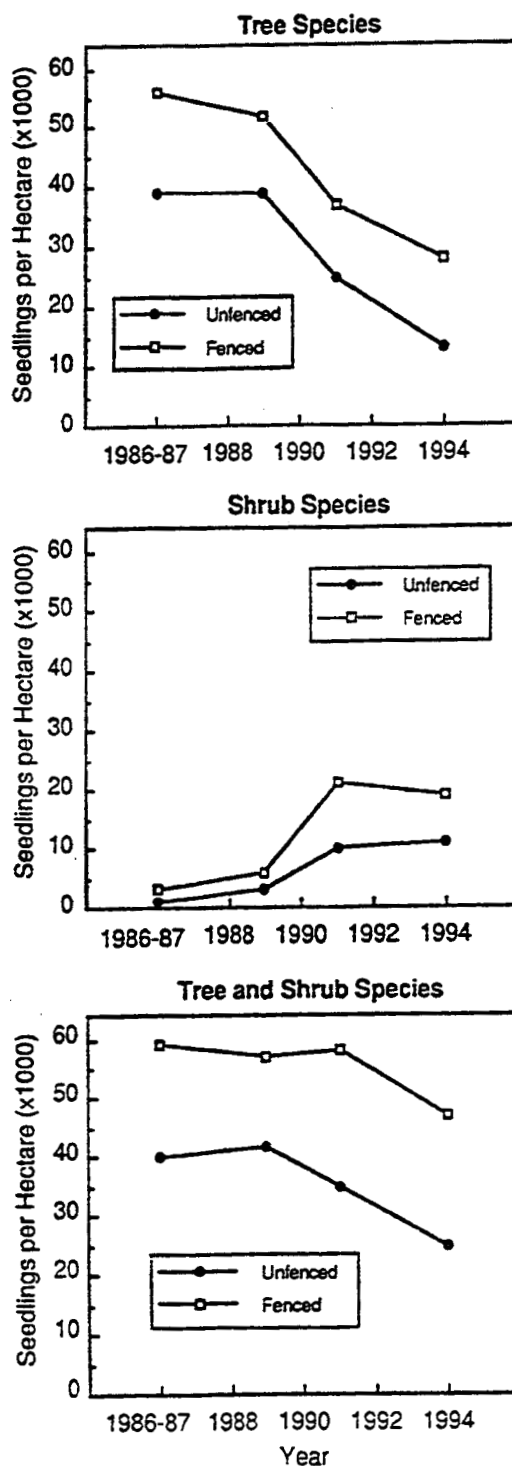


Figure 27. Average number of seedlings per hectare for tree, shrub, and tree and shrub species in the fenced and unfenced 10- x 10-m demonstration plots for the 1986-87 to 1994 surveys in six woodlots at Gettysburg National Military Park and Eisenhower National Historic Site.

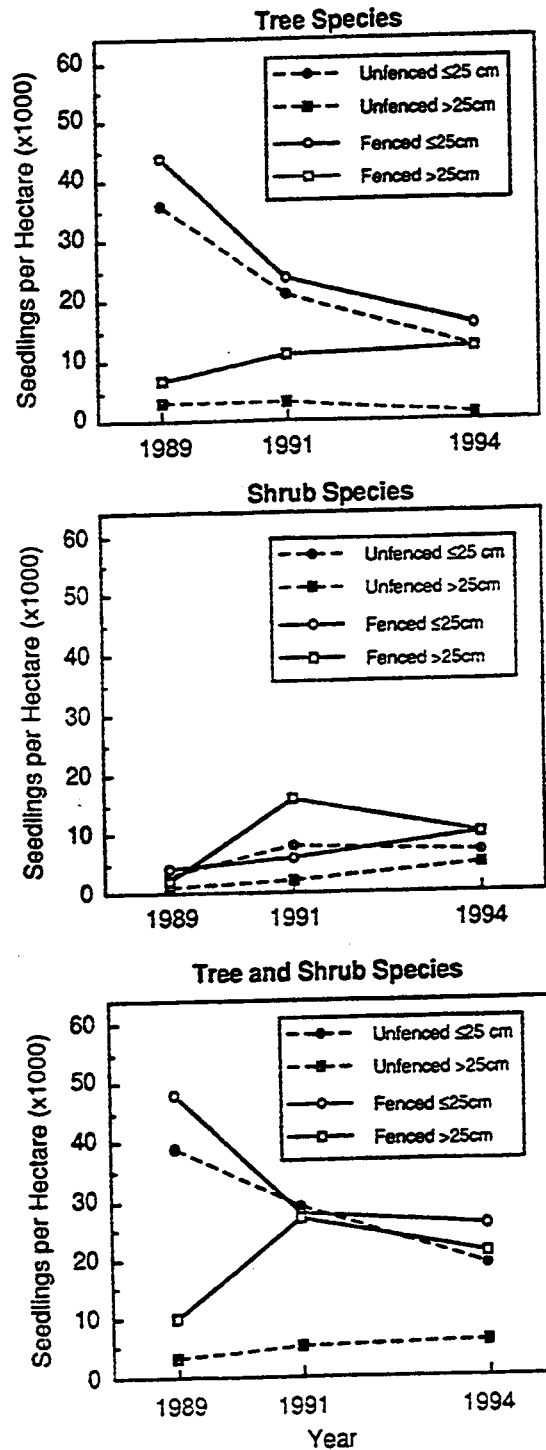


Figure 28. Average number of seedlings per hectare for tree, shrub, and tree and shrub species in the fenced and unfenced 10- x 10-m demonstration plots, by height class of ≤ 25 and > 25 cm, for the 1989, 1991, and 1994 surveys in six woodlots at Gettysburg National Military Park and Eisenhower National Historic Site.

Thirteen shrub seedling taxa were recorded at least once in the fenced and unfenced demonstration plots during the 1986-87, 1989, 1991 and 1994 surveys. Smooth black-haw, greenbrier, eastern redbud, *Rosa* spp., sassafras, serviceberry, and spicebush were the shrub taxa usually present in the surveys. Flowering dogwood, grape spp., and tartarian honeysuckle were recorded in 1994 only. Smooth black-haw was consistently a dominating species among the shrubs. Spicebush was a dominating species in 1989 and 1994. *Rubus* spp. and *Rosa* spp. became the two most dominating shrub taxa in 1991 and continued their importance in 1994.

From 1986-87 to 1994, the estimated number of shrub seedlings increased from 1,000 to 11,000 per ha in the unfenced plots and from 3,000 to 19,000 per ha in the fenced plots (Fig. 27). The estimated number of shrub seedlings in the fenced and unfenced combined increased from 2,000 per ha in 1986-87 to 15,000 per ha in 1994.

The estimated number of shrub seedlings per hectare generally increased in the ≤ 25 and > 25 cm height classes in the fenced and unfenced plots from 1989 to 1994 (Fig. 28). The most pronounced increase was in the fenced plots for the shrub seedlings > 25 cm in height. These data suggest that the conditions were favorable for the establishment of new shrub seedlings, and, once established, the seedlings were able to grow in height. Although presence and growth of seedlings for individual species may have been affected by deer browsing, the influence of deer on shrub species as a group does not appear as strong as on tree species.

The number of tree and shrub seedling species combined recorded in the woodlots increased between the 1986-87 and 1994 surveys. There was an average of nine tree and shrub seedling species per plot in 1986-87 and 17 species per plot in 1994. The number of tree and shrub seedling species surveyed ranged from 7 at the Cobean woodlot to 12 at the Biesecker woodlot in 1986-87, and from 13 at the Cobean woodlot to 21 at the Bushman woodlot in 1994.

Over all six woodlots and all surveys, there was an average of 37,000 seedlings per ha for the tree species and 9,000 seedlings per ha for the shrub species. In general, the number of tree and shrub seedlings were lower in Cobean, Slyder, and Pitzer woodlots and higher in Biesecker, Bushman, and Spangler woodlots. The net effect of decreasing tree seedlings and increasing shrub seedlings resulted in an average of 50,000, 50,000, 46,000, and 36,000 tree and shrub combined seedlings per ha for 1986-87, 1989, 1991, and 1994, respectively.

There was a steady decline in the relative abundance of tree seedlings and an increase in the relative abundance of shrub seedlings from 1986-87 to 1994. The dominance of tree seedlings decreased from 96% in 1986-87 to 91% in 1989, 66% in 1991, and 58% in 1994.

In 1986-87, average number of tree and shrub species with seedlings per plot was six

and seven in the unfenced and fenced plots, respectively. Average number of tree and shrub species had increased to 12 per plot in the unfenced plots and 16 per plot in the fenced plots by 1994. The difference was due to the higher frequency of elm spp., oak spp., hickory spp., and sassafras seedlings in the fenced plots than was recorded in the unfenced plots. In 1986-87, there was an estimated 39,000 tree and 1,000 shrub seedlings per ha in the unfenced plots and an estimated 56,000 tree and 3,000 shrub seedlings per ha in the fenced plots. By 1994 there was an estimated 11,000 shrub and 14,000 tree seedlings per ha in the unfenced areas and an estimated 19,000 shrub and 30,000 tree seedlings per ha in the fenced plots (Fig. 27). The differences in the estimates (17,000 trees and 2,000 shrub seedlings per ha) between the fenced and unfenced plots in 1986-87 were due to the selection of plots to be fenced and remain unfenced and not due to the one to two years of protection from deer. Therefore, to properly evaluate the effect of fencing on the seedlings, it is necessary to account for these initial differences or examine the changes that occurred in the fenced and unfenced areas over time and not the actual differences between the fenced and unfenced plots at any particular survey.

The estimated number of all tree and shrub seedlings per ha that were ≤ 25 cm in height declined from 1989 to 1994, regardless of whether or not they were fenced (Fig. 28). In contrast, the estimated number of tree and shrub seedlings per ha that were > 25 cm in height increased, and the increase was greater for the fenced plots than those in the unfenced plots.

The general trends in the tree and shrub seedlings in both the fenced and unfenced plots for the individual woodlots between 1986-87 and 1994 were (a) the number of species increased, (b) the estimated number of shrub seedlings per ha remained stable or slightly increased, and (c) the estimated number of tree seedlings per ha decreased. There were substantially more tree seedlings than shrub seedlings in 1986-87. By 1994, the differences in number of tree over shrub seedlings had decreased or was reversed in Bushman, Cobean, and Slyder woodlots. The change in the shrub:tree ratio was more pronounced in the unfenced plots than in the fenced plots.

Except for shrub species at Bushman, Cobean, and Slyder, the number of seedlings in the > 25 cm height classes were strongly influenced by the placement or presence of the fence for all surveys. The unfenced plots occasionally had seedlings in the > 25 cm classes and rarely had seedlings in the > 50 cm classes. In contrast, fenced plots consistently had seedlings in the > 25 cm classes and frequently had seedlings in the > 50 cm classes.

The species composition and abundance of herbaceous and vine species was determined within a 2- x 2-m subplot both inside and outside the fenced demonstration plot at the Biesecker and Bushman woodlots. Based on line-transect data, *Galium* spp. had the greatest importance value within the fenced demonstration subplot, whereas cinquefoil had the greatest importance value in the nearby unfenced control subplot at the

Bushman woodlot. Four species were present in the fenced demonstration subplot and eight in the control subplot, with only two in common between them. Virginia-creeper dominated the Biesecker fenced demonstration subplot with an importance value 50% greater than that of the next species, spring-beauty. However, in the control subplot, spring-beauty was the only species encountered along the line-transects.

The coefficient of community similarity values are low, as few herbaceous and vine species were in common among or between woodlots. The coefficient values for the line-transect data were 0.143 and 0.182 between the fenced Biesecker and fenced Bushman subplots and the fenced Biesecker and unfenced Bushman subplots, respectively. For the line-transect plus the complete subplot search data, the coefficient values were 0.10 and 0.214 between the fenced Biesecker and fenced Bushman subplots and the fenced Biesecker and unfenced Bushman subplots, respectively.

Conclusions

Based on the results of the present survey we concluded that:

- 1. The most significant deficiency in the profile of the Gettysburg woodlots was the absence of a viable population of small saplings and the low numbers of tree seedlings, especially those > 25 cm in height.**
- 2. It is very likely that the combination of a high population of white-tailed deer and the closed forest canopy are major influences impeding the successful regeneration of a diverse forest. However, more data from repeated measures over time are needed to fully elucidate any cause and effect relationships.**
- 3. Overall, the composition of woody species in the woodlots sampled appears to be shifting from long-lived oak spp. and hickory spp. to short-lived ash spp. and wild black cherry.**
- 4. Japanese honeysuckle dominated the herbaceous layer throughout the woodlots sampled.**
- 5. At present, data are insufficient to evaluate the effect of exclosures on the herbaceous and vine species; species composition is sensitive to time of sampling, indicating the need for multiple samples per year.**
- 6. The data provided by our survey represents the background and initial reference points for use in evaluating future changes in plant communities as new data are collected at established sampling plots in each of the woodlots. The sampling plots at Biesecker and Pitzer woodlots are especially valuable because of the presence of fenced and unfenced plots. These 30 plots in each of Biesecker and Pitzer woodlots and the six paired fenced and unfenced 10- x 10-m demonstration plots provide adequate facilities for studies of the effects of white-tailed deer on forest regeneration at Gettysburg.**
- 7. A challenge for future studies is the need for a data management plan that truly embodies the scope of long-term (> 50 years) monitoring and assessment of plant communities. To address this challenge, the data collected for this initial phase have been organized and entered into a series of files via the dBase III+ program. This computer-based data set, along with the necessary documentation, will be transferred to the resource management personnel at the Gettysburg National Military Park. The data will also be on file and available from the Pennsylvania Cooperative Fish and Wildlife Research Unit, School of Forest Resources, The Pennsylvania State University, University Park.**

Maintenance and Monitoring Actions

An annual inventory of all plots should be conducted to insure that stakes and aluminum tags remain intact to allow future identification of the study plots. Exclosures can be damaged from falling trees and deer could enter the study plots. Damage to the exclosures could adversely affect the design of the study. Maintenance of the exclosures should be conducted as soon as possible after any damage is detected.

Relocating plots and obtaining repeated measures of vegetative conditions is essential to monitor long-term ecological changes. Russell (1989) provided guidelines for repeating measurements as follows:

- 1. All measurements made during the original survey should be repeated if possible, and checking the condition of witness trees, corner stakes, and condition of exclosures is mandatory.**
- 2. Original measurements and remeasurements should be made during the same season of the year; May and June are preferred months in deciduous forests of eastern United States.**
- 3. A sampling interval of no more than five years is recommended, but measurements taken over a longer interval are still worthwhile for long-term monitoring.**
- 4. Frequent (annual and semi-annual) measurements are recommended for plant communities in early successional stages.**

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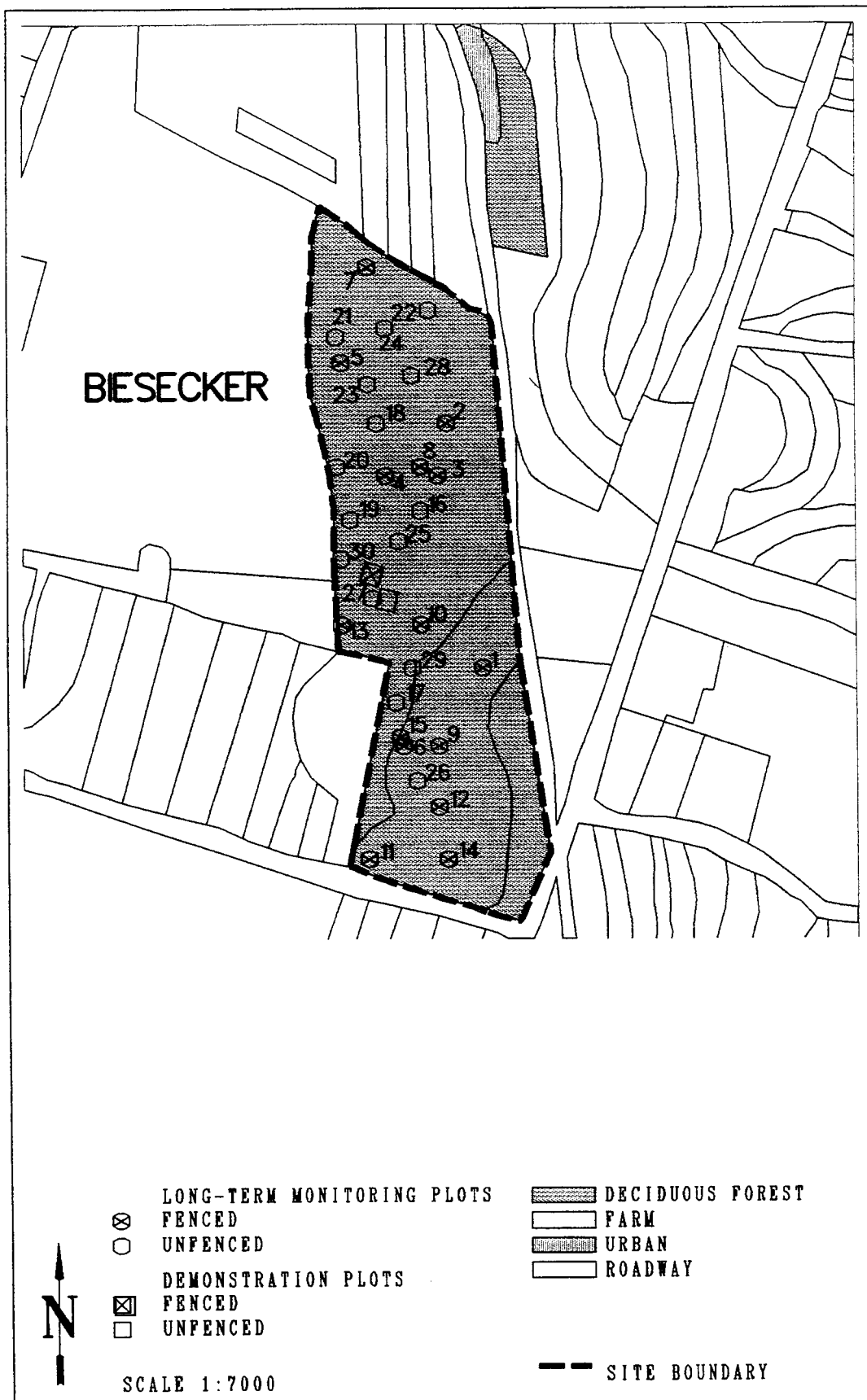
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Appendix A. Maps (scale 1:7000) of each woodlot and the distribution of sample plots with reference to long-term monitoring plots and demonstration plots (fenced and unfenced) and to UTM coordinates.

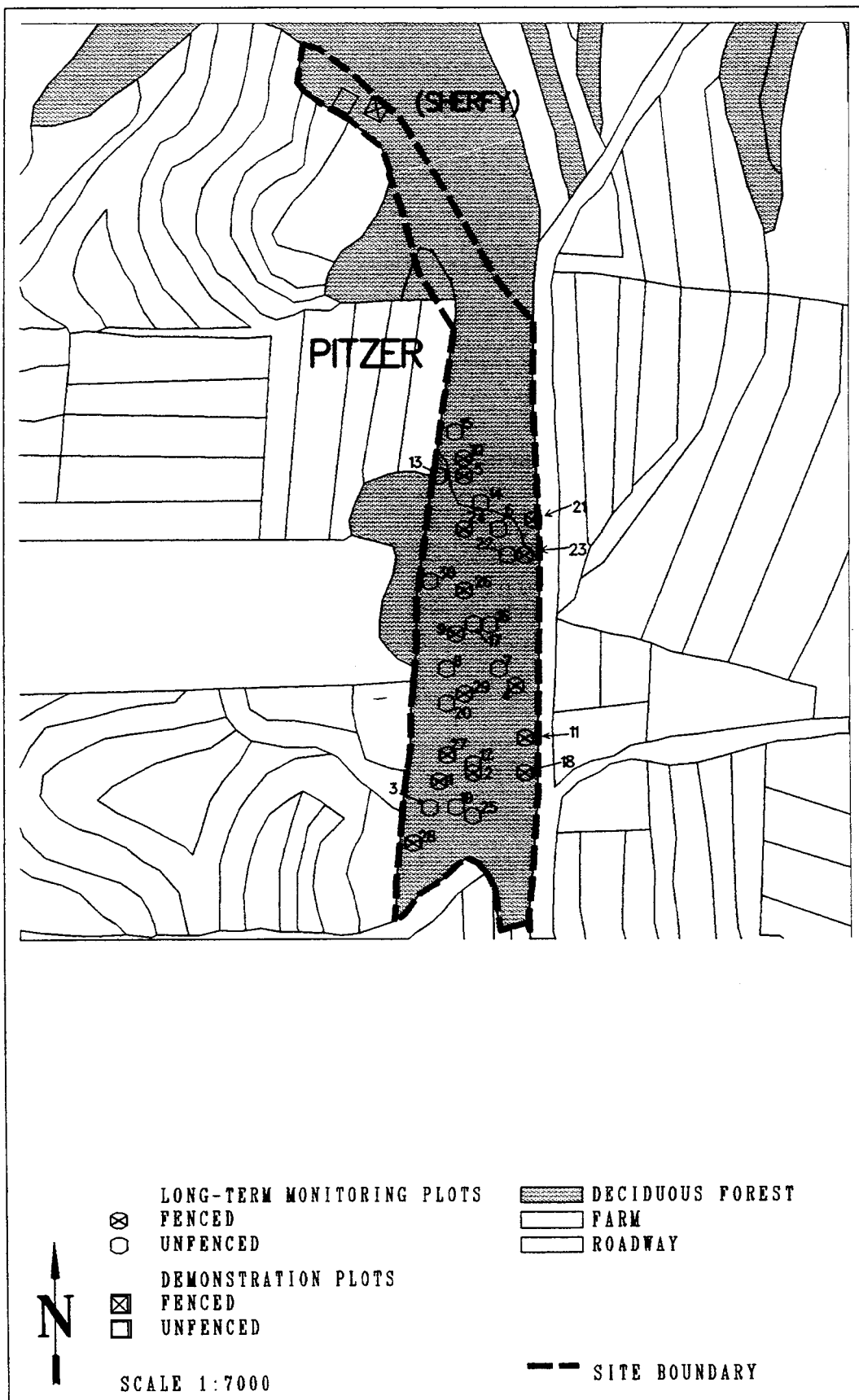
UTM Coordinates for plots located in the Biesecker woodlot:

		<u>X-Coordinate</u>	<u>Y-Coordinate</u>
Long-term Monitoring Plot #:			
Fenced	1	306860	4407000
	2	306820	4407280
	3	306810	4407220
	4	306750	4407220
	5	306700	4407350
	6	306770	4406910
	7	306730	4407460
	8	306790	4407230
	9	306810	4406910
	10	306790	4407050
	11	306730	4406780
	12	306810	4406840
	13	306700	4407050
	14	306820	4406780
	15	306720	4406920
Unfenced	16	306790	4407180
	17	306720	4406960
	18	306740	4407280
	19	306710	4407170
	20	306680	4407230
	21	306690	4407380
	22	306800	4407410
	23	306730	4407080
	24	306750	4407390
	25	306765	4407390
	26	306785	4406870
	27	306735	4407080
	28	306780	4407335
	29	306780	4407000
	30	306685	4407125
Demonstration Plots:			
Fenced		306735	4407107
Unfenced		306751	4407077



UTM Coordinates for plots located in the Pitzer woodlot:

		<u>X-Coordinate</u>	<u>Y-Coordinate</u>
Long-term Monitoring Plot #:			
Fenced	1	306690	4407940
	2	306730	4407949
	4	306780	4408050
	5	306720	4408290
	9	306710	4408109
	10	306719	4408309
	11	306790	4407989
	18	306790	4407949
	21	306800	4408239
	23	306791	4408199
	24	306720	4408229
	26	306720	4408159
	27	306700	4407970
	28	306660	4407869
	29	306720	4408040
Unfenced	3	306680	4407910
	6	306760	4408229
	7	306760	4408069
	8	306699	4408069
	12	306730	4407959
	13	306690	4408290
	14	306739	4408259
	15	306709	4408340
	16	306750	4408120
	17	306730	4408121
	19	306710	4407910
	20	306699	4408029
	22	306771	4408199
	25	306729	4407900
	30	306680	4408170
Demonstration Plots:			
Fenced		306619	4408709
Unfenced		306582	4408718

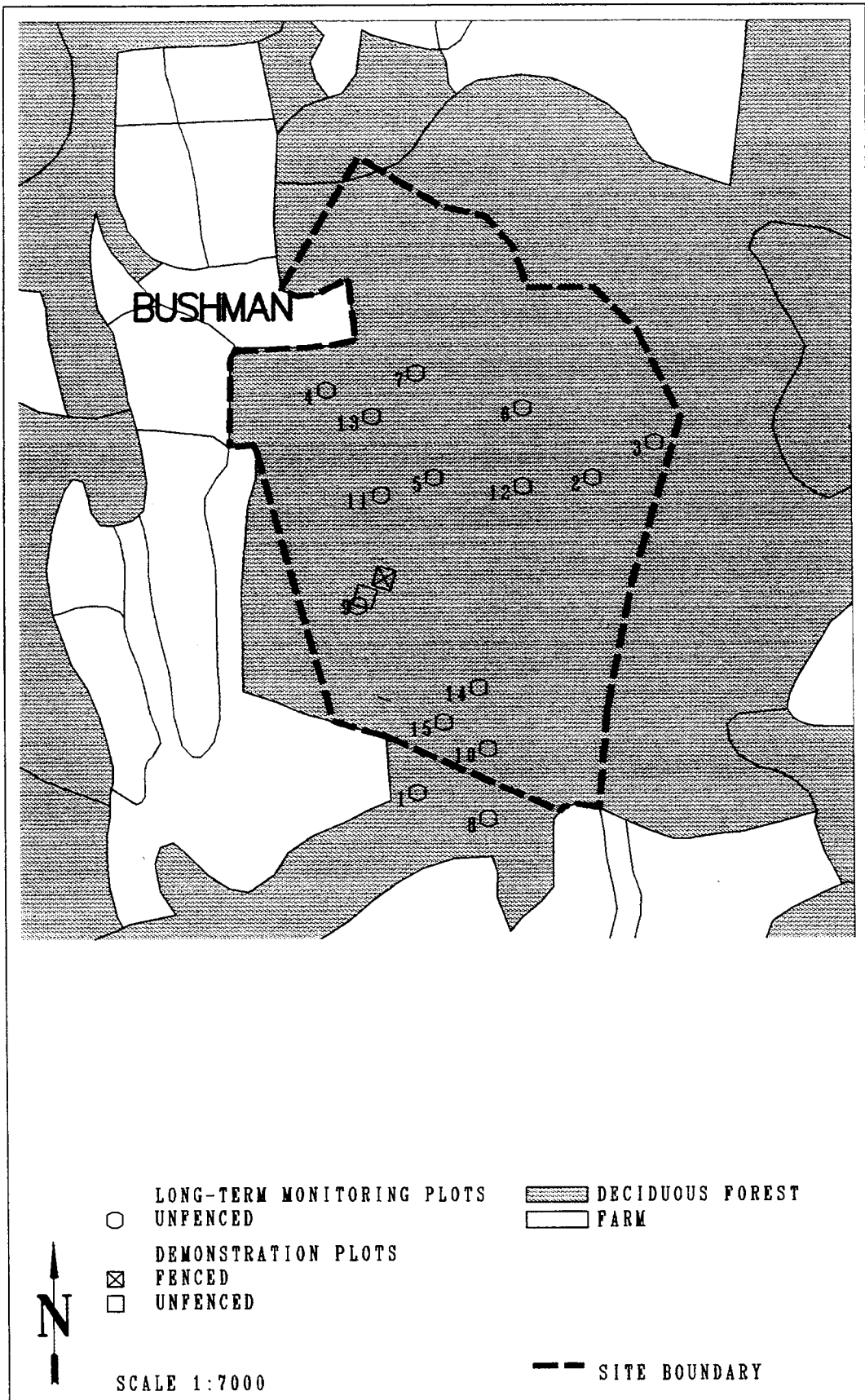


UTM Coordinates for plots located in the Bushman woodlot:

	<u>X-Coordinate</u>	<u>Y-Coordinate</u>
Long-term Monitoring Plot #:		
1	307310	4405480
2	307510	4405840
3	307580	4405880
4	307210	4405940
5	307330	4405840
6	307430	4405920
7	307310	4405960
8	307390	4405450
9	307250	4405700
10	307390	4405530
11	307270	4405820
12	307430	4405830
13	307260	4405910
14	307380	4405600
15	307340	4405560

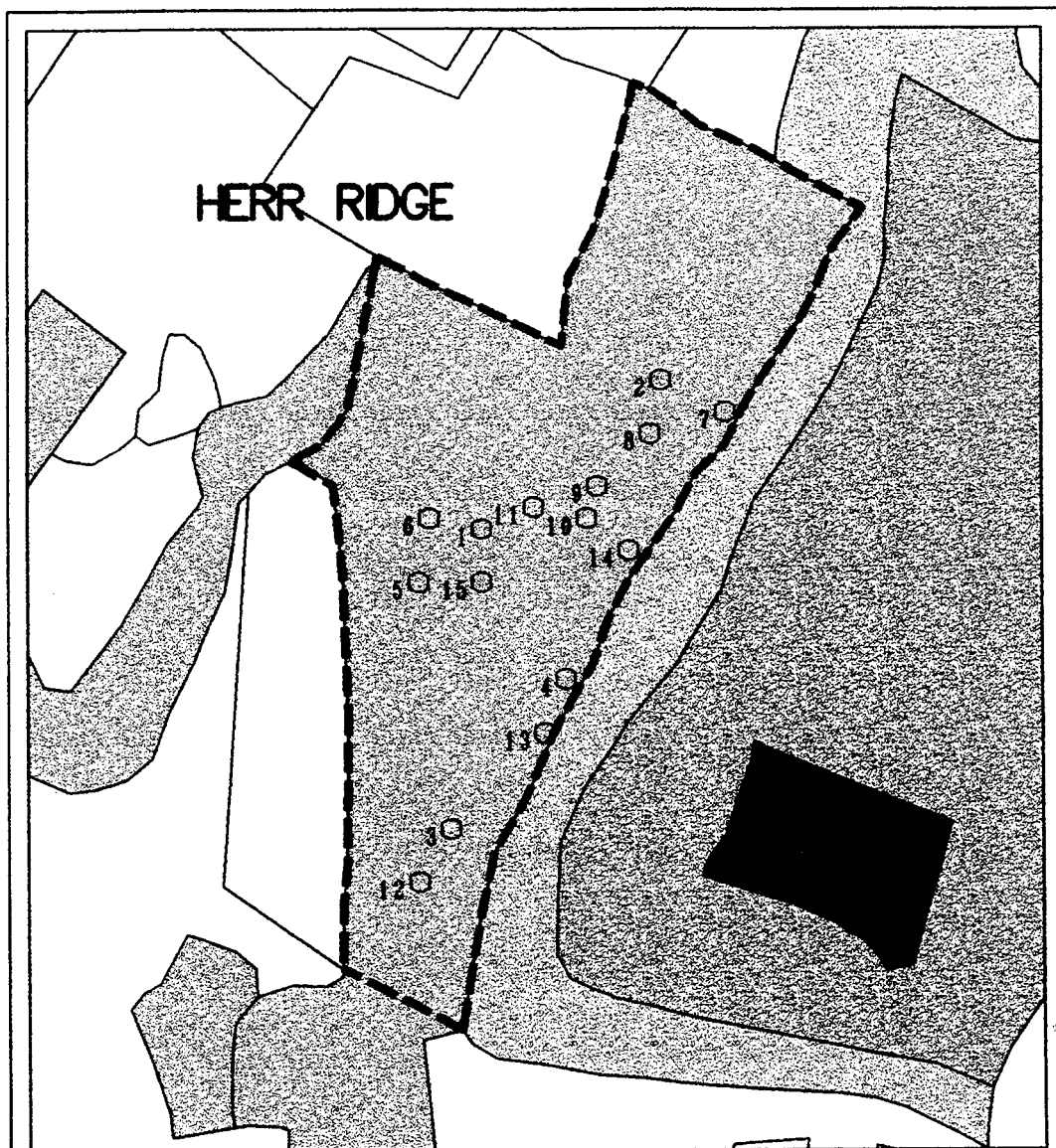
Demonstration Plots:

Fenced	307273	4405725
Unfenced	307251	4405703



UTM Coordinates for plots located in the Herr Ridge woodlot:

	<u>X-Coordinate</u>	<u>Y-Coordinate</u>
Long-term Monitoring Plot #:		
1	306320	4411680
2	306490	4411820
3	306290	4411400
4	306400	4411540
5	306260	4411630
6	306270	4411690
7	306550	4411790
8	306480	4411770
9	306430	4411720
10	306420	4411690
11	306370	4411700
12	306260	4411350
13	306380	4411490
14	306460	4411660
15	306320	4411630



○ LONG-TERM MONITORING PLOTS
○ UNFENCED



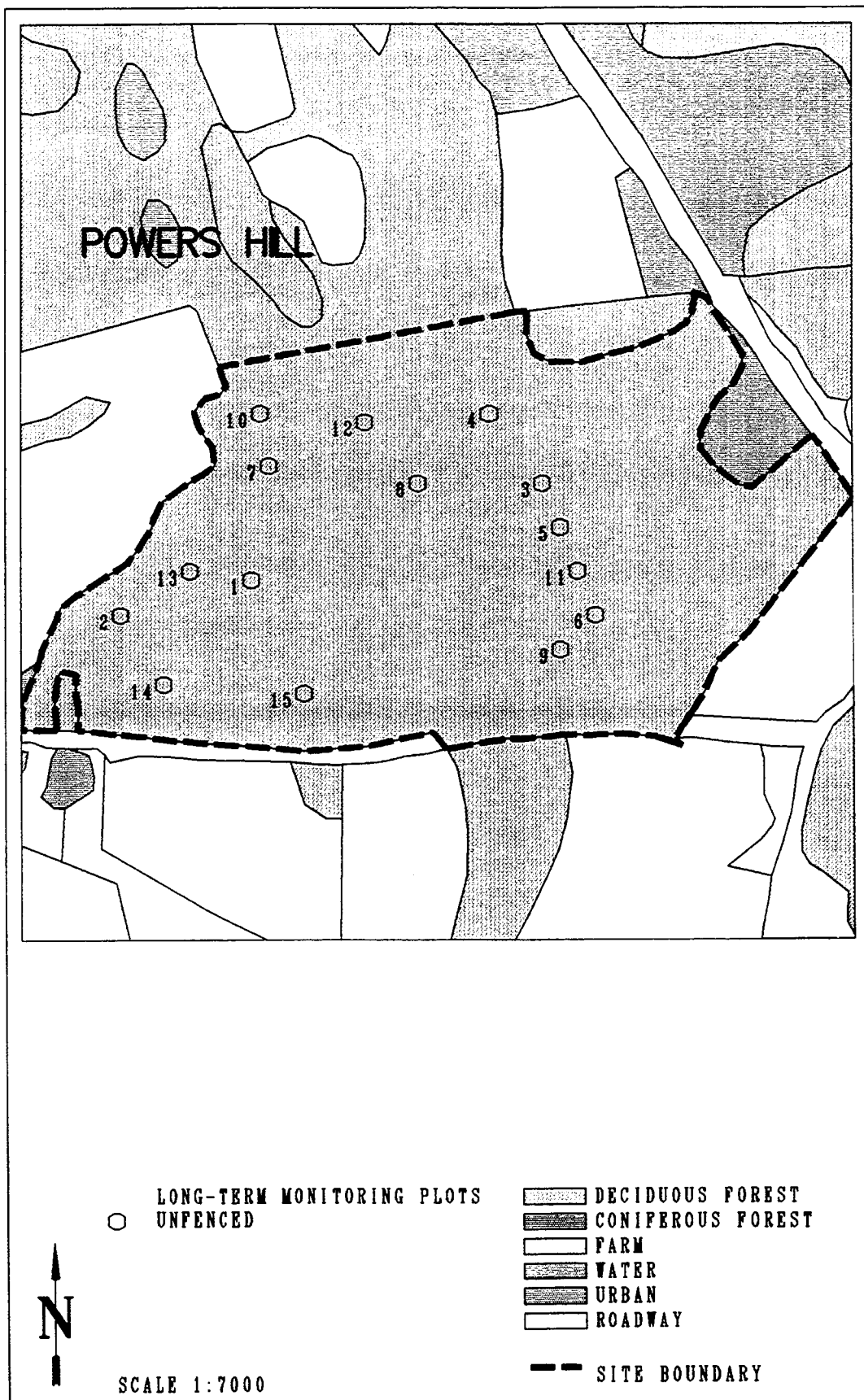
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DECIDUOUS FOREST
CONIFEROUS FOREST
FARM
URBAN
ROADWAY
GOLF COURSE

--- SITE BOUNDARY

UTM Coordinates for plots located in the Powers Hill woodlot:

	<u>X-Coordinate</u>	<u>Y-Coordinate</u>
Long-term Monitoring Plot #:		
1	309470	4408390
2	309320	4408350
3	309800	4408500
4	309740	4408580
5	309820	4408450
6	309860	4408350
7	309490	4408520
8	309660	4408500
9	309820	4408310
10	309480	4408580
11	309840	4408400
12	309600	4408570
13	309400	4408400
14	309370	4408270
15	309530	4408260

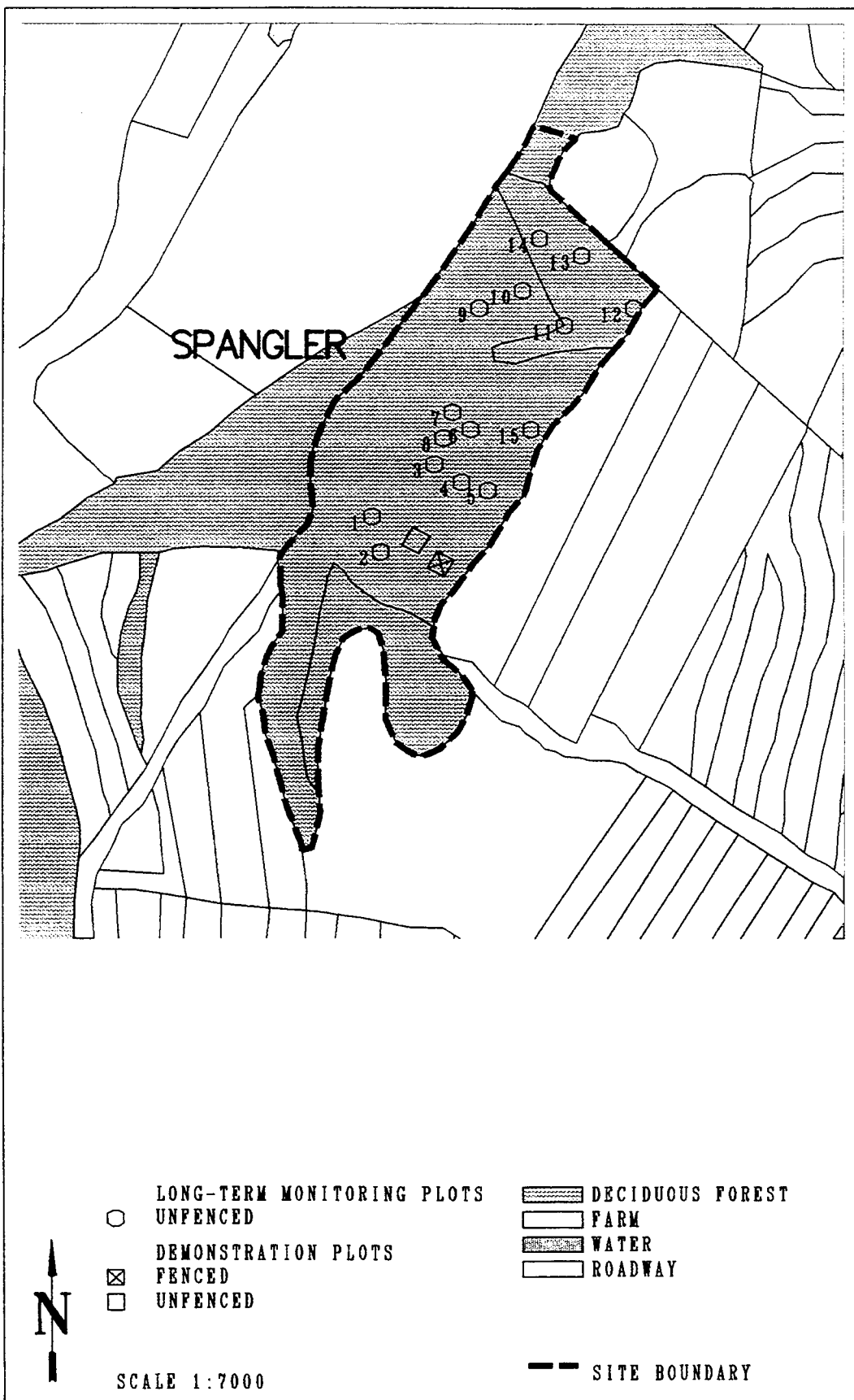


UTM Coordinates for plots located in the Spangler woodlot:

	<u>X-Coordinate</u>	<u>Y-Coordinate</u>
Long-term Monitoring Plot #:		
1	307140	4408950
2	307150	4408910
3	307210	4409010
4	307240	4408990
5	307270	4408980
6	307250	4409050
7	307230	4409070
8	307220	4409040
9	307260	4409190
10	307310	4409210
11	307360	4409170
12	307440	4409190
13	307380	4409250
14	307330	4409270
15	307320	4409050

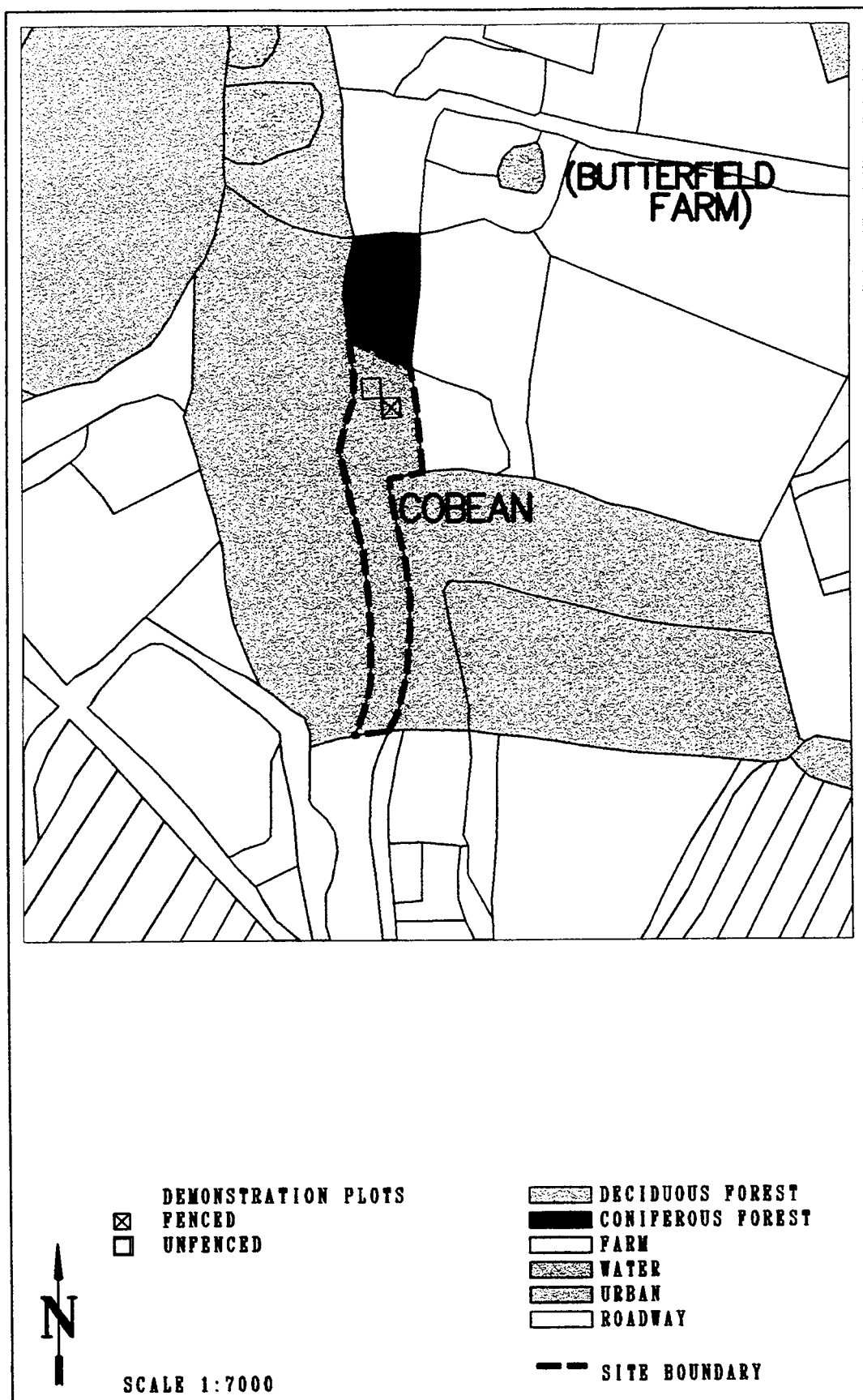
Demonstration Plots:

Fenced	307217	4408896
Unfenced	307190	4408923



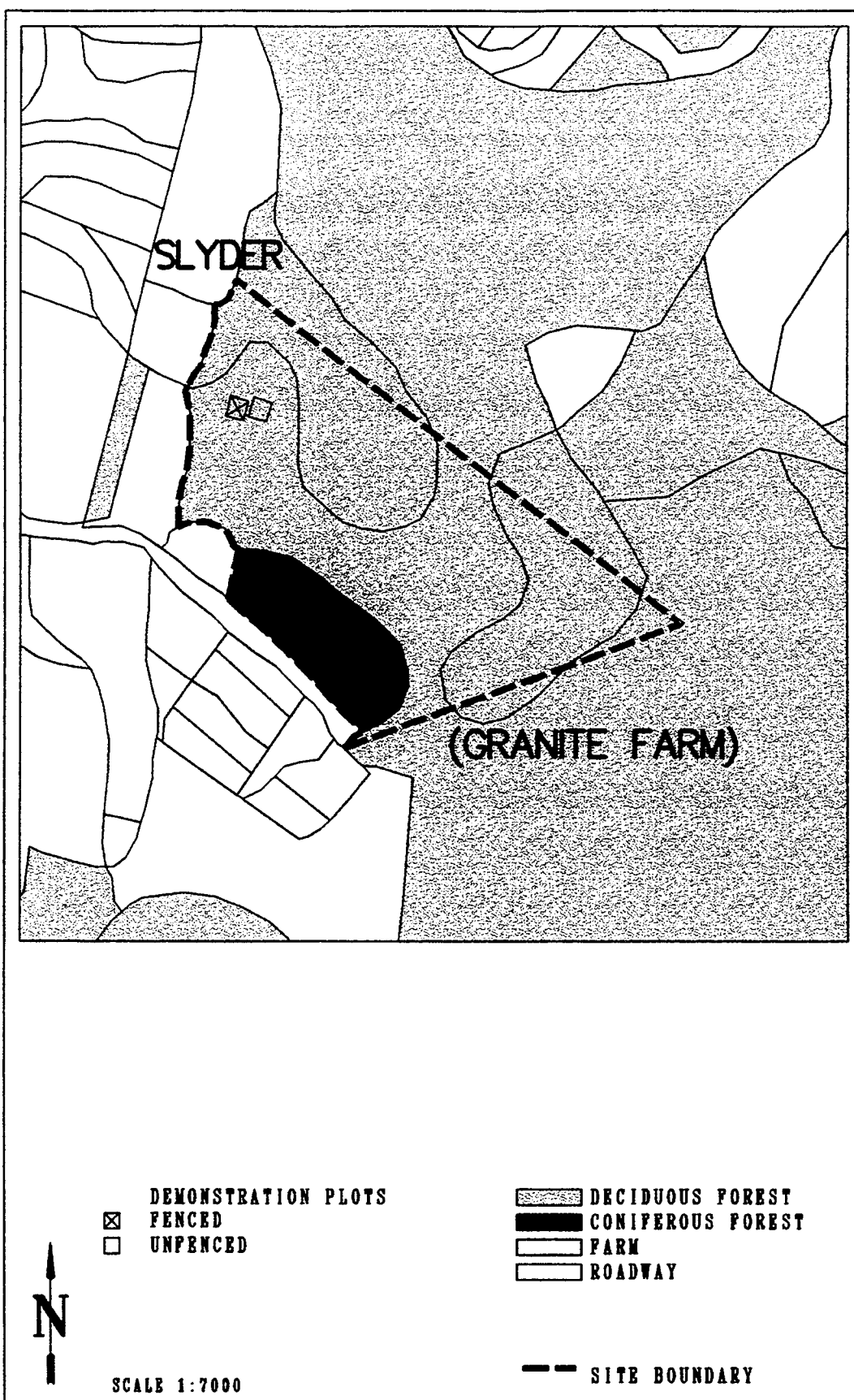
UTM Coordinates for plots located in the Cobean (Butterfield Farm) woodlot:

	<u>X-Coordinate</u>	<u>Y-Coordinate</u>
Demonstration Plots:		
Fenced	308221	4413368
Unfenced	308209	4413376



UTM Coordinates for plots located in the Slyder (Granite Farm) woodlot:

	<u>X-Coordinate</u>	<u>Y-Coordinate</u>
Demonstration Plots:		
Fenced	307490	4406854
Unfenced	307517	4406854



Appendix B. Common and scientific names of tree, shrub, herbaceous, and vine species identified during the study and in present report. A tree is defined as having a persistent woody stem, usually a single stem, and commonly classified into seedling, sapling, pole, and sawtimber categories based on height and diameter at breast height (1.37 m); a shrub is defined as having a persistent woody stem with relatively low growth form as compared to trees, and usually with multiple basal stems as opposed to a single stem (see Petrides 1958); and a herbaceous species is defined as annual, biennial, or perennial plants whose exposed parts die down at the end of growing season and include grasses, sedges, forbes, and moss-lichen. The herbaceous species were identified, mounted, and stored as a reference collection in a herbarium within the Biology Department at Elizabethtown College, Elizabethtown, PA. All species in this appendix are listed by family, scientific name, and common name where known. Taxonomy follows that of Rhoads and Klein (1993).

Aceraceae

- T *Acer plantanoides* L. - Norway maple
- T *Acer rubrum* L. - red maple
- T *Acer saccharum* Marshall - sugar maple

Alismataceae

- Alisama subcordatum* Raf. - southern water-plantain

Amaryllidaceae

- Hypoxis hirsuta* (L.) Cov. - yellow star-grass

Anacardiaceae

- Toxicodendron radicans* L. - poison-ivy

Apocynaceae

- Apocynum cannabinum* L. - Indian hemp
- Vinca minor* L. - common periwinkle

Araceae

- Arisaema triphyllum* - jack-in-the-pulpit (var. *triphyllum* which others name as species, *atrorubens*)
- Symplocarpus foetidus* (L.) Nutt. - skunk-cabbage

Aristolochiaceae

- Asarum canadense* L. - wild ginger

Asclepiadaceae

- Asclepias incarnata* L. - swamp-milkweed
- Asclepias quadrifolia* Jacq. - four-leaved milkweed
- Asclepias syriaca* L. - common milkweed
- Asclepias variegata* L. - white milkweed

Balsaminaceae

- Impatiens capensis* Meerb. - jewelweed; touch-me-not

Berberidaceae

- ‡ *Berberis thunbergii* DC. - Japanese barberry
- Podophyllum peltatum* L. - may-apple

Betulaceae

† *Ostrya virginiana* K. Koch - hop-hornbeam, eastern

Bignoniaceae

† *Catalpa speciosa* (Warder ex Barney) - northern catalpa

Boraginaceae

Cynoglossum virginianum L. - wild comfrey

Echium vulgare L. - blue-weed

Hackelia virginiana (L.) Johnst. - stickseed

Mertensia virginica (L.) Pers. ex Link - Virginia bluebells

Myosotis verna Nutt. - spring forget-me-not

Brassicaceae

Arabis canadensis L. - sicklepod

Hesperis matronalis L. - dame's - rocket

Caesalpiniaceae

† *Cercis canadensis* L. - eastern redbud

Senna marilandica Fern. - wild senna

Campanulaceae

Triodanis perfoliata (L.) Nieuwl. - venus's-looking-glass

Caprifoliaceae

‡,h *Lonicera japonica* Thunb. - Japanese honeysuckle

‡ *Lonicera tatarica* L. - tartarian honeysuckle

‡ *Viburnum acerifolium* L. - maple-leaved viburnum

† *Viburnum dentatum* L. - southern arrow-wood

† *Viburnum prunifolium* L. - smooth black-haw

Caryophyllaceae

Cerastium arvense L. - field chickweed

Cerastium fontanum L. - common mouse-ear chickweed

Dianthus armeria L. - deptford-pink

Paronychia canadensis L. - forked chickweed

Silene alba Mill. - white campion

Silene armeria L. - garden catchfly

Silene cucubalus Wibel. - bladder-campion

Stellaria graminea L. - lesser stitchwort

Stellaria media (L.) Cyrill. - common chickweed

Commelinaceae

Commelina communis L. - dayflower

Tradescantia virginiana L. - spiderwort

Compositae

Achillea millefolium L. - common yarrow

Ambrosia artemisiifolia L. - common ragweed

Ambrosia trifida L. - giant ragweed

Antennaria neglecta Greene. - field pussytoes

Antennaria plantaginifolia - plantain pussytoes

Anthemis cotula L. - stinking chamomile

Arctium minus Schk. - common burdock

Aster fragilis Lam. - small white aster

Aster lateriflorus (L.) Britt. - calico aster

Aster puniceus L. - purple-stemmed aster

Bidens vulgata Greene. - beggar-ticks

Chrysanthemum leucanthemum L. - ox-eye daisy

Cirsium arvense (L.) Scop. - Canada thistle

Cirsium discoor (Muhl.) Spreng. - field thistle

Cirsium vulgare (Savi.) Tenore. - bull-thistle

Erechtites hieraciifolia (L.) - pilewort

Erigeron annuus (L.) Pers. - daisy fleabane

Erigeron philadelphicus L. - common fleabane

Eupatorium aromaticum L. - smaller white-snakeroot

Eupatorium perfoliatum L. - boneset

Eupatorium purpureum L. - joe-pye weed
Eupatorium serotinum Michx. - late-eupatorium
Euthamia graminifolia (L.) Salisb. - grass-leaved goldenrod
Galinsoga ciliata (Raf.) Blake - quickweed
Hieracium pratense Tausch. - field hawkweed
Hieracium venosum L. - rattlesnake-weed
Rudbeckia hirta L. - black-eyed-susan
Senecio aureus L. - golden ragwort
Senecio pauperculus Michx. - balsam ragwort
Solidago altissima L. - tall goldenrod
Solidago bicolor L. - silver-rod
Solidago canadensis L. - canada goldenrod
Solidago juncea Ait. - early goldenrod
Taraxacum officinale Weber. - dandelion
Veronia noveboracensis (L.) Michx. - New York ironweed

Cornaceae

- ‡ *Cornus alternifolia* L.f. - alternate-leaved dogwood
- † *Cornus florida* L. - flowering dogwood

Cruciferae

Alliaria petiolata Andrz. - garlic-mustard
Barbarea vulgaris R.Br. - yellow rocket
Capsella bursa-pastoris (L.) Medic. - shepherd's-purse
Cardamine bulbosa (Schreb.) Bsp. - bitter-cress
Cardamine pensylvanica Muhl. - Pennsylvania bitter-cress
Dentaria lancinata Muhl. - cut-leaved toothwort
Draba verna - whitlow-grass
Lepidium campestre - field cress
Lunaria annua - money-plant
Nasturtium officinale - watercress

Cyperaceae

Carex aquarrosa - sedge

Carex complanata Torr. & Hook. (*hirsutella* by others) - sedge

Carex frankii - sedge

Carex glaucoidea - sedge

Carex laxiflora - sedge

Carex pennsylvanica - sedge

Carex rosea - sedge

Scirpus atrovirens - black bulrush

Scirpus cyperinus Kunth. - wool-grass

Scirpus verecundus - club-rush

Dioscoreaceae

Dioscorea villosa L. - wild yam

Dipsacaceae

Dipsacus sylvestris - teasel

Ebenaceae

† *Diospyros virginiana* L. - persimmon

Ericaceae

Chimaphila maculata Pursh. - spotted wintergreen

‡ *Rhododendron periclymenoides* (Michx.) Shinn. - pinxster-flower

‡ *Rhododendron* spp. - azalea spp.

‡ *Rhododendron* spp. - rhododendron

Euphorbiaceae

Acalypha rhomboidea - three-seeded mercury

Euphorbia corollata - flowering spurge

Fabaceae

Amphicarpaea bracteata Fern. - hog-peanut

Crotalaria sagittalis - rattlebox

Desmodium glutinosum - sticky tick-clover

Desmodium marilandicum - Maryland tick-clover
Desmodium nudiflorum - naked-flowered tick-trefoil
Desmodium paniculatum (L.) DC.- panicle tick-trefoil
Desmodium rotundifolium DC. - prostrate tick-trefoil
Lespedeza hirta (L.) Hornem. - bush-clover
Lespedeza virginica (L.) Britt. - Virginia bush-clover
Lotus corniculatus L. - bird's-foot trefoil
Melilotus officinalis (L.) Desr. - yellow sweet-clover
T *Robinia pseudoacacia* L. - black locust
Trifolium hybridum L. - alsike clover
Trifolium procumbens L. - low hop-clover
Trifolium repens L. - white clover

Fagaceae

T *Quercus alba* L. - white oak
T *Quercus coccinea* muenchh. - scarlet oak
T *Quercus montana* willd. - chestnut oak
T *Quercus palustris* muenchh. - pin oak
T *Quercus rubra* L. - northern red oak
T *Quercus* spp. - oak
T *Quercus velutina* Lam. - black oak

Fumariaceae

Dicentra cucullaria (L.) Bernh. - dutchman's-breeches

Geranieaceae

Geranium maculatum L. - wood geranium

Graminaceae

Andropogon scoparius Michx. - little bluestem
Anthoxanthum odoratum L. - sweet vernal grass
Bromus racemosus L. - soft chess
Echinochloa crusgalli (L.) Beauv. - barnyard grass

Elymus riparius Wieg. - riverbank wild-rye
Festuca elatior L. - fescue
Glyceria striata (Lam.) Hitchc. - fowl mannagrass
Hystrix patula Moench. - bottlebrush grass
Leersia virginica Willd. - cutgrass
Panicum boscii Poir. - panic-grass
Paspalum laeve Michx. - field beadgrass
Phalaris arundinacea L. - reed canary-grass
Phleum pratense L. - timothy
Setaria glauca (L.) Beauv. - yellow foxtail
Sorghastrum nutans (L.) Nash. - Indian grass
Triodia flava (L.) Smyth. - purple-top

Grossulariaceae

‡ *Ribes* spp. - prickly gooseberry, wild gooseberry, and species of currant
 (see Yahner et al. 1991)

Hamamelidaceae

‡ *Hamamelis virginiana* L. - witch-hazel

Hypericaceae

Hypericum perforatum L. - St.-John's-wort
Hypericum punctatum Lam. - spotted St.-John's-wort

Iridaceae

Sisyrinchium montanum Greene. - blue-eyed grass
Sisyrinchium mucronatum - blue-eyed-grass

Juglandaceae

T *Juglans nigra* L.- black walnut
 T *Carya glabra* sweet - pignut hickory
 T *Carya laciniosa* Loud. - shellbark hickory
 T *Carya ovata* K. Koch - shagbark hickory
 T *Carya* spp. - hickory

T *Carya tomentosa* Nutt. - mockernut hickory

Juncaceae

Juncus acuminatus Michx. - sharp-fruited rush

Luzula bulbosa - wood-rush

Luzula campestris (L.) DC. - common wood-rush

Labiataceae

Collinsonia canadensis L. - horse-balm

Cunila organoides (L.) Britt. - common dittany

Glechoma hederacea L. - ground-ivy

Hedeoma pulegioides (L.) Pers. - American pennyroyal

Lamium amplexicaule L. - henbit

Lamium purpureum L. - purple dead-nettle

Melissa officinalis L. - lemon-balm

Mentha gentilis L. - red mint

Mentha rotundifolia (L.) Huds. - apple mint

Prunella vulgaris L. - heal-all

Pycnanthemum flexuosum (Walt.) Bsp. - mountain-mint

Satureja vulgaris (L.) Fritsch. - wild basil

Scutellaria elliptica Muhl. - hairy skullcap

Scutellaria integrifolia L. - hyssop skullcap

Scutellaria lateriflora L. - mad-dog skullcap

Lamiaceae

Perilla frutescens - perilla

Lauraceae

‡ *Lindera benzoin*(L.) Blume - spicebush

T *Sassafras albidum* (Nutt.) Nees - sassafras

Liliaceae

Allium canadense L. - wild onion

Allium vineale L. - field garlic

Muscari botryoides (L.) Mill. - grape-hyacinth

Ornithogalum umbellatum L. - star-of-Bethlehem

Polygonatum biflorum (Walt.) Ell. - true solomon's seal

Smilacina racemosa (L.) Desf. - false solomon's-seal

Smilax herbacea L. - carrion-flower

‡,h *Smilax rotundifolia* L. - greenbrier

Uvularia perfoliata L. - bellwort

Uvularia sessilifolia L. - bellwort

Lobeliaceae

Lobelia inflata L. - Indian-tobacco

Lobelia siphilitica L. - great lobelia

Lobelia spicata Lam. - spiked lobelia

Magnoliaceae

T *Liriodendron tulipifera* L. - yellow poplar

Monotropaceae

Monotropa uniflora L. - Indian-pipe

Nyssaceae

T *Nyssa sylvatica* (marshall) - black-gum

Oleaceae

T *Fraxinus* spp. - ash spp.

Ligustrum obtusifolium Sieb. & Zucc. - privet

Onagraceae

Circaea quadrisulcata (Maxim.) Franch. & Sav. - enchanter's-nightshade

Oenothera fruticosa L. - sundrops

Ophioglossaceae

Botrychium virginianum (L.) Sw. - rattlesnake fern

Orchidaceae

Goodyera pubescens (Willd.) R.Br. - downy rattlesnake-plantain

Orchis spectabilis - showy orchis

Sprianthes gracilis (Bigel.) Beck. - southern slender ladies'-tresses

Tipularia discolor (Pursh.) Nutt. - cranefly orchid (PA rare)

Orobanchaceae

Orobanche uniflora L. - cancerroot

Oxalidaceae

Oxalis europaea - common yellow wood - sorrel

Oxalis stricta L. - common yellow wood - sorrel

Oxalis violacea - violet wood - sorrel

Phrymaceae

Phryma leptostachya L. - lopseed

Phytolaccaceae

Phytolacca americana L. - pokeweed

Pinaceae

† *Pinus rigida* P. Mill. - pitch pine

† *Pinus* spp. - pine

† *Pinus strobus* L. - eastern white pine

† *Pinus sylvestris* L. - scots pine

† *Tsuga canadensis* (L.) Carr. - Canada hemlock

Plantaginaceae

Plantago lanceolata L. - English plantain

Plantago major L. - broadleaf plantain

Polygonaceae

Polygonum aviculare L. - knotweed

Polygonum coccineum Muhl. - water smartweed

Polygonum hydropiper L. - common smartweed

Polygonum persicaria L. - lady's-thumb

Polygonum sagittatum L. - arrow-leaved tearthumb

Polygonum virginianum L. - sagittatum jumpseed

Rumex acetosella L. - sheep sorrel

Rumex crispus L. - curly dock

Tovara virginiana - jumpseed

Polypodiaceae

Adiantum pedatum L. - maidenhair fern

Asplenium platyneuron (L.) Oakes - ebony spleenwort

Dryopteris austriaca (Jacq.) Woynar - spinulose woodfern

Onoclea sensibilis L. - sensitive fern

Portulacaceae

Claytonia virginica L. - spring-beauty

Primulaceae

Anagallis arvensis L. - scarlet pimpernel

Lysimachia ciliata L. - fringed loosestrife

Lysimachia nummularia L. - moneywort

Ranunculaceae

Anemonella thalictroides (L.) Spach. - rue anemone

Hepatica americana (DC.) Ker. - liverleaf

Ranunculus abortivus L. - small-flowered crowfoot

Ranunculus bulbosus L. - bulbous buttercup

Ranunculus hispidus Michx. - hairy buttercup

Ranunculus recurvatus Poir. - hooked crowfoot

Ranunculus septentrionalis Poir. - swamp buttercup

Rosaceae

Agrimonia gryposepala Wallr. - agrimony

Agrimonia parviflora Ait. - southern agrimony

† *Amelanchier arborea* (Michx.f.) Fern. - serviceberry

† *Crataegus* spp. - hawthorn

Geum canadense Jacq. - white avens

Geum macrophyllum Willd. - large-leaved avens

- Geum virginianum* L. - cream-colored avens
Potentilla canadensis L. - cinquefoil
T *Prunus avium* (L.) - sweet cherry
T *Prunus pensylvanica* L.f. - pin cherry
T *Prunus serotina* Ehrh. - wild black cherry
Rosa spp. - mainly multiflora rose (see Yahner et al. 1991)
Rubus spp. - commonly blackberry, dewberry, black raspberry, and several other species (see Yahner et al. 1991)

Rubiaceae

- Galium aparine* L. - cleavers
Galium circaezans Michx. - wild licorice
Galium concinnum T. & G. - shining bedstraw
Galium mollugo L. - wild madder
Galium palustre L. - marsh bedstraw
Houstonia caerulea L. - bluets

Saxifragaceae

- Saxifraga virginensis* Michx. - early saxifrage

Scrophulariaceae

- Chaenorrhinum minus* (L.) Lange. - dwarf snapdragon
Chelone glabra L. - turtlehead
Gerardia tenuifolia Vahl. - false-foxglove
Linaria vulgaris Hill. - butter-and-eggs
Mimulus ringens L. - allegheny monkey-flower
Penstemon digitalis Nutt. - beard-tongue
Penstemon hirsutus (L.) Willd. - beard-tongue
Verbascum blattaria L. - moth mullein
Verbascum thapsus L. - common mullein
Veronica officinalis L. - common speedwell
Veronica persica Poir. - bird's-eye speedwell

Veronica serpyllifolia L. - thyme-leaved speedwell

Solanaceae

Physalis subglabrata Nutt. - ground cherry

Solanum carolinense L. - horse-nettle

Solanum dulcamara L. - trailing nightshade

Solanum nigrum L. - black nightshade

Ulmaceae

† *Celtis* spp. - hackberry

† *Ulmus americana* - American elm

† *Ulmus rubra* - slippery elm

Umbelliferae

Circuta bulbifera L. - water-hemlock

Cryptotaenia canadensis (L.) DC. - honewort

Daucus carota L. - Queen-Anne's-lace

Osmorhiza claytonii (Michx.) Clarke - sweet-cicely

Sanicula canadensis L. - snake-root

Sanicula gregaria Bickn. - fragrant snake-root

Sanicula marilandica L. - black sanicle

Zizia aptera (Gray) Fern. - golden-alexanders

Urticaceae

Boehmeria cylindrica (L.) Sw. - false nettle

Parietaria pensylvanica Muhl. - pellitory

Pilea pumila (L.) Gray. - clearweed

Verbenaceae

Verbena hastata L. - blue vervain

Verbena urticifolia L. - white vervain

Violaceae

Viola spp. - yellow violets

Viola palata L. - violet

Viola papilionacea Pursh. - common blue violet

Viola sagittata Ait. - arrow-leaved violet

Viola triloba Schw. - early blue violet

Vitaceae

Parthenocissus quinquefolia (L.) Planch. - virginia-creeper

Vitis aestivalis Michx. - summer grape

*Nomenclature follows that of Rhoads and Klein (1993).

T = Tree.

† = Growth form may be typical of small tree but classified as shrub for this report.

‡ = Shrub.

‡,h = Included in shrub and herbaceous and vine categories.

Appendix C. Procedure for sampling and vouchering herbaceous plants and vines.

Sampling Procedures

The following guidelines were used to determine abundance of herbaceous and vine species based on the line-intercept method. If a plant extended over two 10-cm intervals, the portion in each interval was counted separately. If two leaves were at the same node, as in honeysuckle, the length including both leaves was used. If there were two overlapping plants, only the interception of the upper one was counted so that the total interception for an interval did not exceed 10 cm. Each leaf or stem of grasses and sedges was counted as an individual rather than counting the clump as one individual. For trailing plants with narrow stems, length of stem was counted to the first set of leaves encountered if only the stem intercepted the north edge of the meter stick; otherwise the interval intercepted by the leaves was counted.

Voucher Specimen Collection and Management

Voucher specimens were primarily collected from the woodlots where quantitative studies were being conducted, but specimens in some of the surrounding fields and along the roadways were also collected. No effort was made in this study to collect from all areas of Gettysburg National Military Park. Specimens were primarily collected between May 2 and September 10, 1992; however, some were collected in October, 1992 and a few were collected in April, 1993.

Specimens were collected using a digging tool to obtain a complete root system. Where possible, specimens in flower were collected for preservation because in most cases identification depends upon flower structure. Some specimens in fruit were also collected.

Although most of the specimens were pressed in the field, some were brought back to the laboratory in plastic bags for identification prior to pressing. The specimens were pressed between blotters and corrugated cardboard until they were dry. They were then stored in a dry incubator with moth balls to prevent mildew and insect damage until mounting could be accomplished.

While a variety of sources were used to verify identifications (Newcomb 1977, Braun 1967, Britton and Brown 1970, in addition to Gleason and Cronquist's *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* 1963), the taxonomy used followed that of Rhodes and Klein (1993).

The specimens were mounted on herbarium sheets and labeled according to name, location, habitat type, and date of collection. Specimens are housed in a herbarium case within the Biology Department at Elizabethtown College, Elizabethtown, PA.

Appendix D. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for overstory and large sapling taxa in six woodlots: Biesecker (fenced and unfenced), Pitzer (fenced and unfenced), Bushman, Herr Ridge, Powers Hill, and Spangler.

Table D1. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 14 overstory tree taxa based on the combined data for 15 20- x 20-m plots^a (with fenced 2- x 2-m central subplots) in the Biesecker woodland, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (m ²)	Number of trees ^c	RF	RC	RD	IV
Oak, white	33	49	100136	43	0.27	0.71	0.26	1.24
Hickory spp.	29	19	16571	49	0.23	0.12	0.29	0.64
Oak, northern red	19	20	8994	24	0.15	0.06	0.14	0.35
Oak, black	8	25	6151	11	0.06	0.04	0.07	0.17
Cherry, wild black	7	13	1295	9	0.06	0.01	0.05	0.15
Cherry, sweet	7	13	899	7	0.06	^d	0.04	0.11
Ash, spp.	4	19	1539	5	0.03	0.01	0.03	0.07
Cedar, eastern red	4	17	1137	5	0.03	^d	0.03	0.07
Elm, American	2	19	933	3	0.02	^d	0.02	0.05
Oak, pin	3	25	1544	3	0.02	0.01	0.02	0.05
Catalpa, northern	3	13	380	3	0.02	^d	0.02	0.04
Oak, scarlet	2	26	1022	2	0.02	^d	0.01	0.04
Walnut, black	2	17	460	2	0.02	^d	0.01	0.03
Pine, eastern white	1	24	452	1	0.01	^d	^d	0.02

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D2. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 12 overstory tree taxa based on combined data for 15 20- x 20-m plots^a (with unfenced 2- x 2-m central subplots) in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Oak, white	27	33	55741	42	0.21	0.42	0.20	0.83
Oak, northern red	26	28	30237	40	0.20	0.23	0.20	0.63
Hickory spp.	27	18	16396	58	0.21	0.12	0.28	0.61
Oak, black	17	27	14143	21	0.13	0.11	0.10	0.34
Cherry, sweet	12	14	3523	20	0.09	0.03	0.10	0.22
Cherry, wild black	8	19	3986	9	0.06	0.03	0.04	0.13
Elm, American	5	24	3270	6	0.04	0.02	0.03	0.09
Maple, red	4	16	828	4	0.03	^d	0.02	0.06
Elm, slippery	1	43	1452	1	^d	0.01	^d	0.03
Oak, scarlet	2	31	1465	2	0.02	0.01	^d	0.03
Cedar, eastern red	1	16	201	1	^d	^d	^d	0.02
Pine, pitch	1	31	755	1	^d	^d	^d	0.02

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D3. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 14 large sapling tree taxa based on the combined data for 15 20- x 20-m plots^a (with fenced 2- x 2-m central subplots) in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Hickory spp.	52	5	8246	318	0.28	0.48	0.54	1.30
Cherry, wild black	36	5	1934	84	0.20	0.11	0.14	0.45
Cherry, sweet	25	7	2382	52	0.14	0.14	0.08	0.36
Oak, white	22	6	1977	61	0.12	0.12	0.10	0.34
Oak, northern red	10	7	686	16	0.05	0.04	0.03	0.12
Ash spp.	10	5	307	11	0.05	0.02	0.02	0.09
Cedar, eastern red	7	6	492	15	0.04	0.03	0.03	0.10
Elm, American	5	6	135	5	0.03	^d	^d	0.05
Catalpa, northern	4	5	188	7	0.02	0.01	0.01	0.04
Oak, black	3	8	206	4	0.02	0.01	^d	0.04
Sassafras	3	8	174	3	0.02	0.01	^d	0.04
Black-gum	2	6	218	7	0.01	0.01	0.01	0.03
Maple, red	2	9	134	2	0.01	^d	^d	0.02
Walnut, black	2	5	86	4	0.01	^d	^d	0.02

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D4. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 13 large sapling tree taxa based on combined data for 15 20- x 20-m plots^a (with unfenced 2- x 2-m central subplots) in the Biesecker woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Hickory spp.	58	5	8876	351	0.36	0.47	0.59	1.42
Cherry, sweet	27	7	4353	104	0.17	0.23	0.17	0.57
Oak, white	18	7	2057	47	0.11	0.11	0.08	0.30
Cherry, wild black	21	6	1349	44	0.13	0.07	0.07	0.27
Oak, black	10	7	514	13	0.06	0.03	0.02	0.11
Elm, American	6	7	449	10	0.04	0.02	0.02	0.08
Oak, northern red	6	7	353	8	0.04	0.02	0.01	0.07
Ash spp.	6	6	229	7	0.04	0.01	0.01	0.06
Cedar, eastern red	4	7	200	5	0.02	0.01	^d	0.04
Maple, red	3	9	209	3	0.02	0.01	^d	0.03
Elm, slippery	2	9	129	2	0.01	^d	^d	0.02
Cherry, pin	1	5	20	1	^d	^d	^d	0.01
Sassafras	1	7	39	1	^d	^d	^d	0.01

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D5. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 14 overstory tree taxa based on the combined data for 15 20- x 20-m plots^a (with fenced 2- x 2-m central subplots) in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (m ²)	Number of trees ^c	RF	RC	RD	IV
Oak, white	26	57	91574	34	0.24	0.61	0.22	1.07
Oak, northern red	15	33	26530	22	0.14	0.18	0.14	0.46
Hickory spp.	21	19	10696	31	0.19	0.07	0.20	0.46
Maple, red	12	16	4939	23	0.11	0.03	0.15	0.29
Oak, black	8	21	5770	12	0.07	0.04	0.08	0.19
Cherry, sweet	5	14	1528	10	0.05	0.01	0.06	0.12
Black-gum	5	22	3351	7	0.05	0.02	0.04	0.11
Ash spp.	5	16	1048	5	0.05	0.01	0.03	0.09
Cherry, wild black	5	15	899	5	0.05	^d	0.03	0.09
Elm, slippery	2	14	486	3	0.02	^d	0.02	0.04
Pine, scots	2	29	1342	2	0.02	0.01	0.01	0.04
Oak, pin	1	23	416	1	0.01	^d	^d	0.02
Sassafras	1	12	113	1	0.01	^d	^d	0.02
Walnut, black	1	20	645	2	0.01	^d	0.01	0.02

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D6. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 16 overstory tree taxa based on the combined data for 15 20- x 20-m plots^a (with unfenced 2- x 2-m central subplots) in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Oak, white	29	46	82130	43	0.21	0.54	0.21	0.96
Hickory spp.	25	20	19022	50	0.18	0.12	0.24	0.54
Black-gum	13	23	10047	21	0.09	0.07	0.10	0.26
Oak, black	10	31	15940	13	0.07	0.10	0.06	0.23
Maple, red	13	17	5214	20	0.09	0.03	0.10	0.22
Oak, red	12	23	7637	15	0.09	0.05	0.07	0.21
Ash spp.	8	16	2642	13	0.06	0.02	0.06	0.14
Cherry, sweet	9	15	1793	10	0.07	0.01	0.05	0.13
Cherry, wild black	6	15	1262	7	0.04	^d	0.03	0.08
Sassafras	5	13	646	5	0.04	^d	0.02	0.06
Walnut, black	2	17	737	3	0.01	^d	0.01	0.04
Cedar, eastern red	1	12	113	1	^d	^d	^d	0.02
Elm, American	1	32	804	1	^d	^d	^d	0.02
Elm, slippery	1	19	284	1	^d	^d	^d	0.02
Hemlock, eastern	1	26	531	1	^d	^d	^d	0.02
Sycamore, American	1	34	908	1	^d	^d	^d	0.02

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D7. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 15 large sapling tree taxa based on combined data for 15 20- x 20-m plots^a (with fenced 2- x 2-m central subplots) in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Hickory spp.	52	5	6602	301	0.24	0.36	0.44	1.04
Cherry, wild black	41	5	2096	89	0.19	0.12	0.13	0.44
Maple, red	17	6	2855	93	0.08	0.16	0.14	0.38
Ash spp.	27	4	1339	74	0.13	0.07	0.11	0.31
Cherry, sweet	16	7	1309	27	0.07	0.07	0.04	0.18
Oak, black	16	7	1122	23	0.07	0.06	0.03	0.16
Oak, white	12	6	780	22	0.06	0.04	0.03	0.13
Black-gum	8	6	823	25	0.04	0.05	0.03	0.12
Oak, red	9	8	653	12	0.04	0.04	0.02	0.10
Cedar, eastern red	6	5	178	7	0.03	0.01	d	0.05
Sassafras	4	5	99	4	0.02	d	d	0.03
Elm, slippery	3	10	224	3	0.01	0.01	d	0.02
Oak, scarlet	1	9	64	1	d	d	d	0.01
Hackberry	1	5	20	1	d	d	d	d
Elm, American	1	3	7	1	d	d	d	d

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D8. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 16 large sapling tree taxa based on the combined data for 15 20- x 20-m plots^a (with unfenced 2- x 2-m central subplots) in the Pitzer woodlot, Gettysburg National Military Park and Eisenhower National Historic Site, 1990-1991.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Hickory spp.	44	6	4677	151	0.20	0.26	0.22	0.68
Ash spp.	27	3	2177	177	0.12	0.12	0.26	0.50
Cherry, wild black	35	5	1878	88	0.16	0.10	0.13	0.39
Maple, red	23	6	2736	91	0.11	0.15	0.13	0.39
Black-gum	23	6	2204	62	0.11	0.12	0.09	0.32
Cherry, sweet	16	6	1335	37	0.07	0.07	0.05	0.19
Oak, black	12	7	859	18	0.06	0.05	0.03	0.14
Sassafras	8	7	630	14	0.04	0.03	0.02	0.09
Oak, white	8	5	488	18	0.04	0.03	0.03	0.10
Elm, American	6	7	346	8	0.03	0.02	0.01	0.06
Cedar, eastern red	6	7	238	6	0.03	0.01	^d	0.05
Oak, northern red	4	9	316	5	0.02	0.02	^d	0.05
Elm, slippery	3	4	140	8	0.01	^d	0.01	0.03
Hackberry	2	6	51	2	^d	^d	^d	0.01
Maple, Norway	1	9	64	1	^d	^d	^d	0.01
Walnut, black	1	11	95	1	^d	^d	^d	0.01

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D9. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 16 overstory tree taxa based on the combined data for 15 20- x 20-m plots^a in the Bushman woodlot, Gettysburg National Military Park, June 1992.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Oak, white	27	40	67891	45	0.21	0.42	0.24	0.87
Hickory spp.	19	27	15681	22	0.15	0.10	0.12	0.37
Oak, black	15	36	20243	18	0.12	0.13	0.09	0.34
Oak, northern red	14	29	17840	24	0.11	0.11	0.13	0.35
Ash spp.	12	19	6736	21	0.09	0.04	0.11	0.24
Black-gum	9	28	7354	11	0.07	0.05	0.06	0.18
Poplar, yellow	4	38	12608	9	0.03	0.08	0.05	0.16
Cedar, eastern red	8	18	2618	10	0.06	0.02	0.05	0.13
Oak, chestnut	5	20	3358	10	0.04	0.02	0.05	0.11
Maple, red	6	15	1523	8	0.05	0.01	0.04	0.10
Oak, scarlet	1	28	2787	4	^d	0.02	0.02	0.05
Cherry, wild black	2	15	334	2	0.02	^d	^d	0.04
Cherry, sweet	2	21	708	2	0.02	^d	0.01	0.04
Elm, American	1	17	227	1	^d	^d	0.01	0.02
Elm, slippery	1	16	201	1	^d	^d	^d	0.02
Sassafras	2	13	267	2	0.02	^d	0.01	0.04

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D10. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 15 large sapling tree taxa based on the combined data for 15 20- x 20-m plots^a in the Bushman woodlot, Gettysburg National Military Park, June 1992.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Ash spp.	23	8	2469	50	0.22	0.34	0.29	0.85
Hickory spp.	28	6	1736	51	0.27	0.24	0.29	0.80
Maple, red	12	7	802	20	0.11	0.11	0.11	0.33
Elm, American	6	6	251	9	0.06	0.03	0.05	0.14
Cedar, eastern red	6	7	372	8	0.06	0.05	0.05	0.16
Cherry, sweet	5	7	302	8	0.05	0.04	0.05	0.14
Oak, white	5	8	277	5	0.05	0.04	0.03	0.12
Black-gum	5	7	178	5	0.05	0.02	0.03	0.10
Sassafras	5	7	236	5	0.05	0.03	0.03	0.11
Oak, chestnut	2	9	181	3	0.02	0.03	0.02	0.07
Elm, slippery	3	8	139	3	0.03	0.02	0.02	0.07
Cherry, wild black	3	3	48	4	0.03	^d	0.02	0.06
Oak, black	2	7	70	2	0.02	0.01	0.01	0.04
Oak, northern red	1	11	95	1	0.01	0.01	^d	0.03
Oak, scarlet	1	5	20	1	0.01	^d	^d	0.02

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D11. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 10 overstory tree taxa based on the combined data for 15 20- x 20-m plots^a in the Herr Ridge woodland, Gettysburg National Military Park, June 1992.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Oak, white	24	45	55463	32	0.21	0.43	0.22	0.84
Hickory spp.	35	19	15477	48	0.30	0.12	0.33	0.75
Oak, black	16	47	32043	17	0.14	0.25	0.12	0.51
Oak, northern red	12	34	15634	15	0.10	0.12	0.10	0.32
Ash spp.	14	21	6062	15	0.12	0.05	0.10	0.27
Cherry, sweet	7	14	1225	8	0.06	0.01	0.06	0.13
Cherry, wild black	5	14	778	5	0.04	^d	0.03	0.08
Elm, slippery	1	24	452	1	0.01	^d	^d	0.02
Maple, sugar	1	23	416	1	0.01	^d	^d	0.02
Walnut, black	1	15	353	2	0.01	^d	0.01	0.02

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D12. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 17 large sapling tree taxa based on the combined data for 15 20- x 20-m plots^a in the Herr Ridge woodlot, Gettysburg National Military Park, June 1992.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Hickory spp.	56	5	7516	303	0.33	0.58	0.49	1.38
Cherry, wild black	44	4	2832	188	0.26	0.22	0.31	0.79
Ash spp.	33	4	1084	70	0.19	0.08	0.11	0.38
Cherry, sweet	6	5	391	16	0.03	0.03	0.03	0.09
Elm, American	8	5	207	9	0.05	0.02	0.01	0.08
Black-gum	3	6	258	8	0.02	0.02	0.01	0.05
Elm, slippery	5	6	162	5	0.03	0.01	0.01	0.05
Oak, black	4	5	105	4	0.02	0.01	0.01	0.04
Oak, northern red	4	5	116	4	0.02	^d	^d	0.04
Maple, Norway	3	6	95	3	0.02	^d	^d	0.03
Cedar, eastern red	1	10	79	1	^d	^d	^d	0.02
Maple, red	2	8	89	2	0.01	^d	^d	0.02
Oak, white	1	7	39	1	^d	^d	^d	0.01
Sassafras	1	7	39	1	^d	^d	^d	0.01
Maple, sugar	1	2	3	1	^d	^d	^d	^d

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D13. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 18 overstory tree taxa based on the combined data for 15 20- x 20-m plots^a in the Powers Hill woodlot, Gettysburg National Military Park, June 1992.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Oak, white	21	34	32234	27	0.15	0.24	0.14	0.53
Hickory spp.	24	23	18227	39	0.17	0.14	0.20	0.51
Oak, black	16	31	22052	25	0.12	0.17	0.13	0.42
Oak, northern red	14	37	24812	20	0.10	0.19	0.10	0.39
Ash spp.	14	24	11092	17	0.10	0.08	0.09	0.27
Poplar, yellow	10	30	14400	18	0.07	0.11	0.09	0.27
Maple, red	8	15	1981	11	0.06	0.02	0.06	0.14
Black-gum	7	20	2208	7	0.05	0.02	0.04	0.11
Cedar, eastern red	7	21	2973	8	0.05	0.02	0.04	0.11
Elm, American	6	29	3612	7	0.04	0.03	0.04	0.11
Walnut, black	2	30	2209	3	0.01	0.02	0.02	0.05
Cherry, sweet	3	15	514	3	0.02	^d	0.02	0.04
Oak, chestnut	2	23	1590	3	0.01	0.01	0.02	0.04
Pine, pitch	1	55	2376	1	^d	0.02	^d	0.04
Oak, scarlet	1	50	1964	1	^d	0.01	^d	0.03
Cherry, wild black	1	12	113	1	^d	^d	^d	0.02
Maple, Norway	1	16	201	1	^d	^d	^d	0.02
Sassafras	1	14	154	1	^d	^d	^d	0.02

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D14. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 12 large sapling tree taxa based on the combined data for 15 20- x 20-m plots^a in the Powers Hill woodland, Gettysburg National Military Park, June 1992.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Ash spp.	27	7	2571	57	0.26	0.36	0.34	0.96
Hickory spp.	25	6	1476	43	0.25	0.21	0.26	0.72
Black-gum	12	7	557	15	0.12	0.08	0.09	0.29
Elm, American	8	8	615	11	0.08	0.09	0.07	0.24
Maple, red	8	6	510	14	0.08	0.07	0.08	0.23
Oak, white	6	10	489	6	0.06	0.07	0.04	0.17
Poplar, yellow	6	8	342	6	0.06	0.05	0.04	0.15
Cherry, wild black	4	4	70	6	0.04	0.01	0.04	0.09
Cedar, eastern red	2	7	135	4	0.02	0.02	0.02	0.06
Oak, black	2	9	114	2	0.02	0.02	0.1	0.05
Cherry, sweet	1	11	95	1	0.01	0.01	^d	0.03
Oak, chestnut	1	11	95	1	0.01	0.01	^d	0.03

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D15. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 13 overstory tree taxa based on the combined data for 15 20- x 20-m plots^a in the Spangler woodland, Gettysburg National Military Park, 1991-1992.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Oak, white	23	48	67814	32	0.15	0.44	0.15	0.74
Cherry, wild black	23	16	7816	39	0.15	0.05	0.18	0.38
Hickory spp.	18	33	24874	23	0.12	0.16	0.11	0.39
Oak, black	21	24	15900	25	0.14	0.10	0.11	0.35
Ash spp.	19	20	13747	28	0.12	0.09	0.13	0.34
Cherry, sweet	19	15	5452	29	0.12	0.04	0.13	0.29
Oak, northern red	11	26	12249	20	0.07	0.08	0.09	0.24
Maple, red	8	17	2730	10	0.05	0.02	0.05	0.12
Black-gum	6	21	2310	6	0.04	0.02	0.03	0.09
Elm, American	3	13	400	3	0.02	^d	0.01	0.03
Elm, slippery	1	21	346	1	^d	^d	^d	0.02
Sassafras	2	14	310	2	0.01	^d	^d	0.02

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for a total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Table D16. Frequency, average dbh, basal area, number of trees, relative frequency (RF), relative coverage (RC), relative density (RD), and importance value (IV) for 13 large sapling tree taxa based on combined data for 15 20- x 20-m plots^a in the Spangler woodland, Gettysburg National Military Park, 1991-1992.

Taxa	Freq- uency ^b	Average dbh (cm)	Basal area (cm ²)	Number of trees ^c	RF	RC	RD	IV
Hickory spp.	46	5	3838	146	0.23	0.23	0.28	0.74
Ash spp.	40	5	3211	141	0.20	0.20	0.27	0.67
Cherry, wild black	37	6	3456	95	0.18	0.21	0.18	0.67
Cherry, sweet	32	7	3095	67	0.16	0.19	0.13	0.48
Black-gum	10	7	665	19	0.05	0.04	0.04	0.13
Maple, red	10	5	375	15	0.05	0.02	0.03	0.10
Sassafras	6	7	617	14	0.03	0.04	0.03	0.10
Oak, black	7	7	353	8	0.03	0.02	0.02	0.07
Oak, northern red	5	7	255	5	0.02	0.02	0.01	0.05
Elm, American	5	6	222	7	0.02	0.01	0.01	0.04
Elm, slippery	3	8	156	3	0.01	0.01	^d	0.03
Maple, Norway	1	10	79	1	^d	^d	^d	0.01
Oak, white	1	10	79	1	^d	^d	^d	0.01

^aTotal area for 15 plots was 0.6 ha.

^bThe number of subplots, each 10 m², that contained the taxa; there were four subplots for each of the 15 plots, for total of 60 subplots.

^cTotal number of overstory tree counted in the 15 20- x 20-m plots.

^dValue was < 0.01.

Appendix E. The estimated number (stems/hectare) of small saplings for taxa present in the six woodlots at Gettysburg National Military Park and Eisenhower National Historic Site, and taxa not found as small saplings but observed as overstory or large sapling stems.

Table E1. Estimated number of stems per hectare of small saplings for taxa present in the six woodlots at the Gettysburg National Military Park and Eisenhower National Historic Site.

Taxa	Woodlot					
	Biesecker	Pitzer	Bushman	Herr Ridge	Powers Hill	Spangler
Ash spp.	3	110	2	45	7	37
Black-gum	1	0	0	0	0	0
Cedar, eastern red	0	0	0	0	2	0
Cherry, Sweet	1	7	0	2	0	0
Cherry, wild black	36	27	5	275	12	3
Elm, American	0	1	0	3	0	0
Elm, slippery	0	1	0	0	0	0
Hackberry	0	2	0	0	0	0
Hickory spp.	6	6	0	55	3	2
Maple, red	0	9	0	0	0	0
Oak, northern red	1	0	0	7	2	0
Oak, white	14	1	0	5	0	0
Sassafras	0	0	2	0	0	0

Table E2. List of tree taxa present as large saplings and/or overstory but absent as small saplings in long-term monitoring plots in six woodlots at Gettysburg National Military Park and Eisenhower National Historic Site.

Taxa
Catalpa, northern
Cherry, pin
Hemlock, eastern
Maple, Norway
Maple, sugar
Oak, black
Oak, chestnut
Oak, pin
Oak, scarlet
Pine, eastern white
Pine, pitch
Pine, scots
Poplar, yellow
Sycamore, American
Walnut, black

Addendum I

Soil Description of Study Area

There are three dominant soil associations running from the northeast to the southwest across the Gettysburg National Military Park and Eisenhower National Historic Site. These soil associations relate directly to their parent rock formations (U.S. Dept. Agric. 1967).

The Penn-Reddington-Croton Association contains shaly soils low in natural fertility but easy to farm where slopes are slight. The Penn soils are deep, well drained, and a reddish color which is derived from the parent red shale and sandstone. The Reddington and Croton soils are poorly drained and have moderate limitations for agriculture. Any of these soils with a slope in excess of 8% are highly susceptible to erosion. In general, these soils are good to excellent in terms of their suitability for timber production and would be difficult to keep cleared unless they are grazed or cultivated.

The Lehigh-Brecknock Association extends through the park in a narrow band roughly paralleling Business U.S. 15. These soils are bluish-gray because the parent material is metamorphosed shale.

The Montalto-Mt. Lucas Watchung soil association covers most of the remainder of the parks. These soils are associated with the prominent ridges and large boulders of the diabase sill. Most of these soils are too stony for farming but, on occasion, cleared fields in the deep, well drained, Montalto soils can be adequately farmed. The Mt. Lucas and Watchung soils are poor for crop production and are best suited for pasture or woodland.

The soil series represented in each of the woodlots examined for this study are presented below.

Woodlot	Soil Series
Biesecker	Lehigh silt loam (LhB ₂)
Pitzer	Croton silt loam (CrB ₂) Legore Channery silt loam (LhB ₂) Lehigh silt loam (LhB ₂) Lehigh silt loam (LtC ₃)

Bushman

Montalto very stony silt loam (MsB)
Montalto very stony silt loam (MsD)
Watchung silt loam (WaA)

Herr Ridge

Croton silt loam (CrA)
Lehigh silt loam (LhA)
Lehigh silt loam (LhB₂)
Lehigh silt loam (LtC₃)

Powers Hill

Montalto very stony silt loam (MsB)
Montalto very stony silt loam (MsD)
Watchung very stony silt loam (WcA)

Spangler

Abbottstown silt loam (AbB₂)
Lehigh very stony silt loam (LvB)

Cobean (Butterfield Farm)

Lehigh silt loam (LhB₂)
Montalto silt loam (MoB₂)

Slyder (Granite Farm)

Lehigh very stony silt loam (LvB)
Montalto very stony silt loam (MsB)
Montalto very stony silt loam (MsD)
Watchung silt loam (WaA)
Watchung very stony silt loam (WcA)