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Brownfield Woods, Illinois: Present Composition and Changes in Community Structure

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ABSTRACT

An inventory of the woody vegetation of Brownfield Woods in Champaign Co., Illinois, has been conducted at approximately 10-year intervals from 1925 to 1986. During the past 61 years, northern red oak (*Quercus rubra* L.), bur oak (*Quercus macrocarpa* Michx.) and chinkapin oak (*Quercus muhlenbergii* Engelm.), once the most prominent components of the community, have been largely replaced by more shade tolerant species. At present, sugar maple (*Acer saccharum* Marsh.) is the major dominant and should remain so in the years to come.

INTRODUCTION

Brownfield Woods is a 24 hectare (59.3 acres) remnant of a larger forest that once occupied approximately 2600 ha along the Salt Fork river NE of Urbana, Illinois. Forests were a striking feature in the prairie because they were usually isolated from the main bodies of forests which occured along streams and morainal ridges (Boggess, 1963). Gleason (1912) suggested that these "prairie grove" forests were isolated from the larger forests due to repeated prairie fires.

The University of Illinois leased Brownfield Woods in 1935 and later purchased the woodland in 1939. Prior to 1935, the woodland had been cut-over, heavily grazed by cattle, vandalized, and extensively used by the public as a recreational/picnic area (Telford, 1926). In spite of these disturbances, C.J. Telford described it as "one of the best upland stands growing in the state". Since its purchase by the University of Illinois, Brownfield Woods has been protected and maintained as a natural area, accessible only for educational and research purposes. The purpose of this paper is to report on the current species composition, and to relate the periodic changes in community structure with reference to long term studies of Brownfield Woods.

Past Work

Telford (1926) completed the first 100% inventory of Brownfield Woods in 1925. He measured only woody plants greater than 6.4 cm (2.5 inches) in diameter at breast height (dbh), and recorded them in the nearest 2.5 cm dbh class. Species of elm (*Ulmus*), ash (*Fraxinus*), and "white oak" (*Leucobalanus*) were analyzed as groups rather than individual species. Subsequent 100% inventories were completed in 1960 by Boggess and Bailey (1964), and in 1975 by Miceli et al. (1977).

Vestal and Heermans (1945) sampled the woodland in 1939 using 16 representative, 0.3 hectare plots (0.8 acre) and supplemented the data with strip cruises throughout the remainder of the woodland. Cortright (1952) remeasured the plots established by Vestal and Heermans, and reported the growth and mortality for the preceding 12 years. None of the inventory data prior to 1960 included woody plants less than 6.4 cm dbh.

METHODS AND MATERIALS

Study Area

Brownfield Woods is located NE of Urbana, Illinois, in the SE 1/4 of Section 34, R9E, T20N, 3rd PM, Champaign County, Illinois (40° 09' N. Lat., 88° 10' W. Long.). General topography is rolling upland with a maximum relief of about 9 meters. The most conspicuous topographic feature is a small intermittant stream extending diagonally from the northwest corner to the southeast corner. A detailed soil survey of the area was made by Alexander et al. (1974). Soils are of the Sabine-Sunbury-Birkbeck association. The major soils of this association are developed in shallow loess (100-150 cm) over loam glacial till. Drummer and Sawmill soils occur on poorly drained sites near the intermittent stream, while the Russell soil occurs in the thinner loess areas. Surface drainage throughout the majority of the woodland is good.

Brownfield Woods has been classified as a mixed-mesophytic forest developed on uplands once occupied by prairie grasslands (Vestal and Heermans, 1945). It is a sample of the type of forest which existed on the uplands of the upper Wabash drainage basin, and exhibits the great diversity of species characteristic of the Wabash region (Telford, 1926). Two species characteristic of the western mesophytic forest region described by Braun (1950), American beech (*Fagus grandifolia*) and yellow poplar (*Liriodendron tulipifera*), are not found in Brownfield Woods. These species are restricted to the Wabash River drainage in east-central Illinois, and are found in deeper valleys to the east in Vermillion County, Illinois. White oak (*Quercus alba*) is also missing from sample plots in the woodland, and Vestal and Heermans (1945) suggested its absence was characteristic of the type.

Although sugar maple is the dominant species, many large oaks 400+ years old still remain on prairie-forest transitional soils. These oaks may well be relicts of the most recent forest invasion of the prairie (Boggess and Bailey, 1964).

Methods

Sampling and analysis procedures follow those of Miceli et al. (1977). The woodland has been divided into 96, 50 square meter (0.25 hectare) permanently marked blocks. Each of the 96 blocks was divided into quadrants by extending diagonal lines from the permanent corner markers resulting in a total of 384 plots. In each quadrant, the diameter of each stem greater than 6.4 cm dbh was measured to the nearest 0.1 cm and recorded by species.

Nested, square subplots of 5 m^2 and 2 m^2 were systematically located in quadrant 1 of each of the 96 blocks. Stems 1.4 - 6.3 cm dbh (saplings) were measured in the 5 m^2 subplot and recorded by species and diameter classes of 2.5 cm and 5.0 cm. In the 2 m^2 subplot, all stems less than 1.3 cm dbh (seedlings) were measured and recorded by species. Height classes of less than 30 cm and greater than 30 cm were used to differentiate the seedling sizes.

Frequency, density, and basal area were calculated for each species. Seedling and sapling frequency was expressed as a percentage of occurrence on 96 sample plots, and of trees as a percentage of occurrence on 384 sample plots. Following the procedures used by McIntosh (1957) to describe succession in York Woods in southern Wisconsin, species importance values were developed from the sum of the relative density and relative basal area. Nomenclature follows Mohlenbrock (1975).

DISCUSSION

Present Composition

A total of 32 tree species were encountered in Brownfield Woods. Two invaders of the native flora of the woodland were present, red maple (*Acer rubrum*) and river birch (*Betula nigra*). Their occurrence was presumably a result of seed from nearby ornamental plantings.

Density and frequency of all species in the seedling, sapling, and tree size classes are shown in Table 1. The seedling density of all species is 17,276 seedlings/ha. Sugar maple (*Acer saccharum*) accounted for 79.5% of the total number of seedlings in the woodland. Seedling densities of other species were greatest for pawpaw (*Asimina triloba*) and Ohio buckeye (*Aesculus glabra*). These two species represented 14.6% of the total seedling density. The tolerant buckeye seedlings with a higher frequency of occurrence, were more evenly distributed than the intolerant pawpaw seedlings which were aggregated in dense, even-aged clumps. American basswood (*Tilia americana*) and bitternut hickory (*Carya cordiformis*) seedlings were 1.1% of the total seedling density and were nearly equally distributed. No other species attributed more than 1% of the total seedling reproduction occurring on the sample plots. Twenty-seven species accounted for the remaining 3.7% of the total stand seedling density.

Northern red oak (*Quercus rubra*) and chinkapin oak (*Quercus muehlenbergii*), each with 27 stems/ha, were the only oak species with seedlings present on the sample plots. Four hickory species are present in Brownfield Woods, but only seedlings of bitternut hickory were recorded in the sample plots.

Nine species are represented in the sapling size classes and have a combined density of 1,218 stems/ha. Sugar maple is the dominant species with 71.8% of the total sapling density (874 stems/ha). Ohio buckeye ranks second with 15.2% of the total sapling density (185 stems/ha), followed in order by pawpaw, American basswood, ironwood (*Ostrya virginiana*), bitternut hickory, hackberry (*Celtis occidentalis*), green ash (*Fraxinus pennsylvanica*), and blue ash (*Fraxinus quadrangulata*).

Sugar maple also dominated the tree size classes. It occurs in all quadrants, and accounts for 55.5% of the total stand density of 422 stems/ha. It is the most abundant species in Brownfield Woods at 234.2 stems/ha. The next most abundant species is Ohio Buckeye with 11.6% of the total (48.6 stems/ha) followed by American basswood with 6.4% of the total (26.8 stems/ha).

The highest density of Ohio buckeye is in the small to mid-diameter classes, and its basal area of 0.9 m^2/ha is relatively low compared to other stand components. Hackberry, White ash (Fraxinus americana), and American basswood are presently concentrated in the 31-60 cm dbh class, and their basal areas are nearly equal at 1.9, 1.8, and 1.7 m^2/ha, respectively.

Figures from Table 2 indicate sugar maple has the greatest total basal area of all species with 15.1 m^2/ha. It accounts for 45% of the total stand basal area. An examination of the basal area distribution over the diameter classes, indicates that sugar maple basal area was heavily concentrated in the small to mid-diameter classes (Figure 1). Sugar maple was the most important stand component in 1986, dominating all species in the size classes below 60 cm dbh. Above 61 cm dbh, basal area of northern red oak exceeds that of sugar maple. In the 91+ cm dbh class, sugar maple ranks sixth in basal area, well below northern red oak, bur oak (*Quercus macrocarpa*), and chinkapin oak.

The oaks have a combined density of 21.8 stems/ha, thus ranking below maple, buckeye, and basswood in abundance (Table 1). Although northern red oak with 14.3 stems/ha, ranks sixth in total stand density (3.4% of total), its dominance is asserted in the large diameter classes (61 cm dbh and above) where it ranks first in both density and basal area (Table 2). Overall, northern red oak had the second highest importantance value in Brownfield Woods. Its relative density of 67% of the oak component, makes it the most important oak species present in the woodland.

It is important to note that the greatest densities of bur oak and chinkapin oak were in the 61 cm and larger diameter classes. The average dbh of these two oak species was 61.4 cm. One hundred-thirteen trees with a dbh greater than 91 cm were recorded in 1986. Twenty-five of them were bur oak, including the largest tree with a dbh of 165 cm.

Changes in Community Structure

Substantial changes have occured in species composition during the past 61 years. Sugar maple has been an important stand component since the first inventory in 1925, and its dominance is becoming increasingly important.

Past disturbances suggest a reason for the increased density of sugar maple observed by Telford (1926). He surmised that the woodland was more open in the late 1800's with conditions favorable to seedling establishment. Either subsequent fires prevented further establishment of reproduction or, the use by man and cattle had destroyed the reproduction. These past disturbances whether natural or induced, led to conditions where sapling and pole-sized trees had thoroughly occupied the open areas and reproduction was limited to the more shade tolerant sugar maple.

Another important change in the composition of Brownfield Woods was the loss of the American elm (*Ulmus americana*). American elm was virtually eliminated by Dutch elm disease and phloem necrosis in the late 1950's. The extent of the losses included all stems except the very small sizes. Comparing data reported by Cortright (1952) with the current data, the basal area of American elm has decreased by 95% since 1951. Low residual basal area and low densities indicate that American elm is no longer an important component of the woodland.

Openings created by the loss of the American elm have been rapidly filled by sugar maple, American basswood, slippery elm (*Ulmus rubra*), and Ohio buckeye. High seedling densities (33,357 seedlings/ha) were recorded throughout the woodland in a 1960 inventory (Boggess, 1964) subsequent to the massive mortality of elm (Table 3). Exploitation of the openings by residual dominants and by reproduction of tolerant and moderately tolerant species has resulted in rapid canopy closure. A lower seedling density (10,651 seedlings/ha) recorded in the 1975 inventory was attributed to high seedling mortality and growth into larger size classes (Miceli et al., 1977). Similarly, the density of saplings decreased from 5,273 stems/ha in 1960 to 1,623 stems/ha in 1975. High mortality in the small size classes would be expected as competition became more severe and the canopy approached closure, but a great many of the saplings measured in 1960 had apparently grown into the 7-15 cm dbh tree class by 1975. Micelli reported a total increase of 204 stems/ha between 1960 and 1975, with 60% of that increase occurring in the 7-15 cm dbh tree class. The density of the 7-15 cm dbh class (218.4 stems/ha) in 1986 is less than reported in 1975 (288 stems per hectare), but is still the highest density size class for the woodland.

Seedling density of all species in 1986 was much higher than the total seedling density recorded in 1975. The increase was in response to openings created in 1983, when high winds uprooted many large trees in Brownfield Woods. The recorded seedling density was not equally distributed on all sample plots, but rather on those plots where uprooting occurred. The increased reproduction in these plots accounted for an increase over the entire woodland. The sapling size class does not yet reflect ingrowth from the increased number of seedlings found in 1986.

With the exception of sugar maple, all important species in 1986 have decreased in total density of tree sizes (Table 4). The previous trend was toward increasing density for most species. Total basal area of most species has gradually increased since 1925, with the greatest increase occurring between 1960 and 1975. A decrease in total basal area for all species in Brownfield Woods did occur however, between 1951 and 1960 (Boggess, 1964). This reduction was due to the loss of American elm.

Changes in Species Structure

Maple Component

Telford (1926) reported that sugar maple accounted for 49% of the total woodland population with its density being almost equal to the density of all other species combined. There was however, an uneven distribution of its density over the size classes. He found the majority of sugar maple stems were concentrated in the sapling and pole-size tree classes (2.5 - 30 cm dbh) where it comprised 62% of the total number of stems. In the 31 cm dbh and larger size classes, sugar maple represented only 14% of the total number of stems. By 1925, sugar maple had clearly established its dominance in the stand, particularly within the small size classes.

Sugar maple reproduction in Brownfield Woods continues to increase. The current density is much greater than the 5,101 seedlings/ha Micelli reported for sugar maple in 1975. Sugar maple seedlings comprised 79.5% of the total reproduction in 1986, compared to 47% in 1975. Boggess reported that sugar maple accounted for 65% of the total reproduction in 1960 (21,800 seedlings/ha). The increase in seedling numbers in 1960 and again in 1986 are a reflection of the rapidity with which the highly shade tolerant sugar maple responds to canopy openings. Sugar maple produces enough seeds in most years to saturate the stand (Hett and Loucks, 1971), and is a persistent species under shade conditions. In spite of its high tolerance of shade, seedling mortality of sugar maple is high as evidenced by comparing seedling and sapling densities from Table 1. Data reported for previous inventories (Boggess 1964; Miceli et al., 1977) and in 1986, indicate large numbers of sugar maple saplings and small trees. The high gap phase replacement potential of sugar maple enables it to take advantage of canopy openings as they occur.

Basal area of sugar maple has increased 2.1 m^2/ha since 1975 to a present total of 15.1 m^2/ha (Table 4). The largest increase in the basal area (3.5 m^2/ha) occurred between 1960 and 1975, presumably as pole-sized and smaller trees were released. The rate of increase in the basal area of sugar maple has averaged 0.23 m^2/ha/yr since 1960.

The shift in dominance of sugar maple within the size classes can be observed by comparing changes in basal area over time. Figure 2 is a comparison of sugar maple basal area in the five tree size classes for each inventory. In 1925, the highest basal area of sugar maple was in the 16-30 cm dbh class. In the three subsequent inventories, the highest basal areas were in the 31-60 cm dbh class. The young stand of saplings and pole-sized maples reported by Telford (1926) are now dominating the 31-60 cm dbh class. The high densities of maple seedlings reported by Boggess (1964), have now grown into and are dominating the 7-15 and 16-30 cm dbh classes. In Brownfield Woods, the data indicate that sugar maple has progressively dominated increasingly larger size classes since 1925.

<u>Oak Component</u>

The seedling densities of oak species in the woodland are extremely low with few growing into the sapling size classes (Table 1). Red oak is a species of disturbed mesic forests (Peet and Loucks, 1977) and the disturbances reported by Telford likely permitted the establishment and success of it. Vestal and Heermans (1939) and Cortright (1952) had also reported increased density of red oak reproduction on their sample plots, but seedling density declined by 1960 as conditions unfavorable to its seedling establishment and success prevailed. Seedling density of intolerant bur oak decreased slightly between 1939 and 1951, then increased by 1960. The increase in its seedling density was concurrent to the elimination of the American elm, and was probably a response to canopy openings with light conditions favorable to establishment. Both red oak and bur oak saplings were recorded (at low densities) in 1960, but only red oak saplings were recorded in 1975. No oak saplings were found on the sample plots in 1986.

Data from 1960 and 1975 indicate that all species in the tree size classes increased in density with the exception of red oak, bur oak, and American elm (Table 4). American elm density decreased due to disease, and it is not surprising that oak density was decreasing due to mortality and lack of stems in the lower size classes. It is generally accepted that if regeneration of oaks is to be successful, advance regeneration (saplings) with well established root systems must be present prior to overstory removal (Sander, 1977).

The total density of oak in the tree size classes decreased between 1960 and 1986, presumably due to mortality exceeding growth after canopy closure had taken its toll on oak reproduction. The decreased density recorded in 1986 also reflects the loss of large red oaks and bur oaks from wind damage in 1983. The density of chinkapin oak has remained relatively unchanged over the past 26 years.

Oaks continue to increase in basal area in the larger diameter classes, although their rate of increase appears to have slowed. Ranking second in total basal area, northern red oak has increased from 3.3 m^2/ha in 1925 to 6.1 m^2/ha in 1986. Bur oak ranks third in total basal area with 2.2 m^2/ha, but has not increased in basal area since 1975. Bur oak had previously increased its basal area at a rate of 0.02 m^2/ha per year (1960-1975). The basal area of chinkapin oak has remained fairly constant since 1925.

Oak is a major component of Brownfield Woods, but the uncertainty is whether or not they will continue to be as important in the decades to come. Basal areas for the oaks as a group were compared over the range of dbh classes for each inventory year in Figure 3. The basal area of oak in each size class indicate their importance since 1925 has been due to their great sizes. Oak basal area in 1925 was concentrated in the 31-60 cm dbh class, but is now in the 61-90 cm dbh class, reflecting the release and subsequent growth of the oak after the elm died. It is also evident that oak basal area is decreasing in the 16-30 and 31-60 cm dbh classes and is therefore declining in importance in these sizes (Figure 1). The dominant position and overall importance of oak in Brownfield Woods probably will decline as mortality within the larger size classes and absence of reproduction decrease its total basal area.

Other Species Component

Ohio buckeye, American basswood, white ash, and hackberry increased densities in all size classes in response to the openings left by the elms. Seedling density of Ohio buckeye has increased substantially between 1960 and 1975. Although it decreased in density after 1975, its basal area has steadily increased since 1925. Ohio buckeye will become an increasingly important stand component as its high seedling densities reported in 1960 grow into larger diameter classes.

Mid-tolerant white ash and hackberry had their greatest increases in density prior to 1960, while more tolerant American basswood increased the greatest after canopy closure (1960-1975). The basal areas of white ash and hackberry increased after closure as released individuals grew into larger diameter classes, but the basal area of American basswood concurrently decreased. The basal area of American basswood has changed little since 1960 indicating that its greatest densities were limited to the small size classes. Seedlings were successfully being established, but they had not grown into larger diameter classes. Almost half of its total stems/ha are presently concentrated in the 7-15 cm dbh class (Table 2). Many of the stems of American basswood are of sprout origin, which may account for its low frequency and poor distribution of seedlings and saplings. With their present densities, American basswood, white ash, and hackberry will probably maintain their current positions in the stand.

Hickory species make up less than 1% of the total density of the tree size classes. With the exception of bitternut hickory, hickory density has remained fairly constant since 1960. A high seedling density was recorded for bitternut hickory in 1986, but it is not well distributed throughout the woodland as evidenced by its low frequency of occurence (Table 1). Bitternut hickory is more tolerant than other hickories possibly accounting for its relatively higher densities in Brownfield Woods.

Bitternut hickory, slippery elm, and blue ash are important components of the stand, but their seedling densities have declined since 1975. These species have maintained a constant or slightly increasing basal area during the past 11 years, but their combined reproduction is low, accounting for only 3% of the 1986 stand total, and their importance in the woodland will probably decline.

Density of slippery elm has decreased from 45.2 in 1975 to 11.3 trees/ha at present (Table 4). The basal area of slippery elm (0.6 m^2/ha) has not changed as dramatically during the past 11 years as has its density. Slippery elm was the third most abundant species in 1975. Although it did not escape the effects of phloem necrosis and the Dutch elm disease, slippery elm along with sugar maple rapidly filled the openings created by the loss of the American elms. Typically, slippery elm does not form pure stands, and increased shade with canopy closure of the gaps has favored the more tolerant buckeye and sugar maple over slippery elm, reducing the high densities recorded in 1975. The increase and subsequent decrease in the density of slippery elm has been primarily limited to seedlings and the smaller diameter classes, therefore its total basal area has remained relatively unchanged. Although it is currently an important woodland component, it's relative dominance has diminished since 1975, and will probably continue to decline in importance.

SUMMARY

Each occurence of a canopy opening has resulted in an increase of sugar maple density. The high seedling densities of sugar maple recorded since 1960, coupled with its increases in basal area, has assured its continued dominance in the woodland. Sugar maple presently exceeds all tree species both in density and in basal area for all size classes below 60 cm dbh.

Brownfield Woods will continue to be a mesophytic forest dominated by maple, with buckeye becoming increasingly important as its basal area increases. Basswood and hackberry are important components of the stand, but less so today than previous inventory data had indicated. The oaks continue to be an important stand component because of their large basal area, but with virtually no oak reproduction occurring, their future decline is probable.

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TABLE 1. 1986 Density (stems per hectare) and Frequency of occurence (%) for all species.

# Species	## Relative Tolerance	Seedlings: Height Class < 30 cm	Seedlings: Height Class > 30 cm	Seedlings: Total	Seedlings: % Freq	Saplings: DBH Class 2.5 cm Density	Saplings: % Freq	Saplings: DBH Class 5.0 cm Density	Saplings: % Freq	Trees: DBH Class 6.4+ cm Density	Trees: % Freq
Acer saccharum Marsh.	very high	6566	7170	13736	59	703	59	171	32	234.2	100
Aesculus glabra Willd.	high	220	989	1209	29	132	18	53	10	48.6	72
Tilia americana L.	high	55	137	192	4	18	4	18	4	26.8	57
Ostrya virginiana (Mill.) K.Koch.	very high	---	137	137	5	9	2	18	3	18.9	38
Celtis occidentalis L.	moderate	55	55	110	2	4	1	4	1	17.6	42
Quercus rubra L.	moderate	---	27	27	1	---	---	---	---	14.3	52
Ulmus rubra Muhl.	moderate	55	27	82	3	---	---	---	---	11.2	31
Fraxinus americana L.	moderate	55	---	55	2	---	---	---	---	11.1	36
Asimina triloba (L.) Dunal	low	275	1044	1319	26	44	5	18	3	7.6	14
Prunus serotina Ehrh.	low	---	27	27	1	---	---	---	---	4.8	7
Quercus macrocarpa Michx.	moderate	---	---	---	---	---	---	---	---	4.4	17
Fraxinus quadrangulata Michx.	moderate	---	82	82	3	4	1	---	---	4.3	19
Juglans nigra L.	low	---	---	---	---	---	---	---	---	3.5	15
Quercus muhlenbergii Engelm.	moderate	27	---	27	1	---	---	---	---	2.7	17
Ulmus americana L.	moderate	27	---	27	1	---	---	---	---	1.9	10
Carya cordiformis (Wang.) K.Koch.	low-moderate	137	55	192	3	9	2	4	1	1.8	8

continued on next page.

TABLE 1. continued.

* Species	** Relative Tolerance	Seedlings: Height Class < 30 cm	Seedlings: Height Class > 30 cm	Seedlings: Height Class Total	Seedlings: % Freq	Saplings: DBH Class 2.5 cm Density	Saplings: % Freq	Saplings: DBH Class 5.0 cm Density	Saplings: % Freq	Trees: DBH Class 6.4+ cm Density	Trees: % Freq
Crataegus mollis Scheele	low	---	---	---	---	---	---	---	---	1.3	1
Gymnocladus dioicus (L.) K.Koch	low	---	---	---	---	---	---	---	---	1.1	5
Cornus sp.	very high	---	---	---	---	---	---	---	---	1.0	3
Betula nigra L.	low	---	---	---	---	---	---	---	---	1.0	1
Carya ovata (Mill.) K. Koch	low	---	---	---	---	---	---	---	---	0.9	3
Fraxinus pennsylvanica Marsh.	moderate	---	---	---	---	---	---	9	1	0.8	5
Gleditsia triacanthos L.	low	---	---	---	---	---	---	---	---	0.5	2
Acer saccharinum L.	high	---	---	---	---	---	---	---	---	0.3	< 1
Quercus imbricaria Michx.	moderate	---	---	---	---	---	---	---	---	0.3	6
Juglans cinerea L.	low	---	---	---	---	---	---	---	---	0.2	2
Carya laciniosa (Michx.f.) Loud	low	---	---	---	---	---	---	---	---	0.2	1
Platanus occidentalis L.	low-moderate	---	---	---	---	---	---	---	---	0.2	2
Quercus velutina Lam.	moderate	---	---	---	---	---	---	---	---	0.1	6
Carpinus caroliniana Walt.	very high	---	---	---	---	---	---	---	---	0.0	< 1
Carya tomentosa (Poir.) Nutt.	low	---	---	---	---	---	---	---	---	0.0	< 1
Acer rubrum L.	high	27	---	27	1	---	---	---	---	---	---
Lindera benzoin (L.) Blume	high	---	27	27	1	---	---	---	---	---	---
	Totals:	7499	9777	17276		923		295		422	

* Ranked in descending order of density in tree size class.

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TABLE 2. 1986 Density (stems/ha), Basal Area (m^2/ha), and Importance Value (IV) by diameter classes.

* Species	7-15 #	7-15 BA	7-15 IV	16-30 #	16-30 BA	16-30 IV	31-60 #	31-60 BA	31-60 IV
Acer saccharum	120.6	1.0	112.2	50.8	2.2	110.5	56.4	9.4	139.6
Quercus rubra	0.8	0.0	0.8	1.1	0.1	2.5	2.3	0.4	6.0
Aesculus glabra	40.3	0.3	36.6	6.6	0.3	13.7	1.6	0.2	3.6
Tilia americana	13.0	0.1	13.0	7.5	0.3	16.4	5.2	0.8	12.2
Celtis occidentalis	4.0	0.1	4.7	7.9	0.4	17.6	4.2	0.6	9.8
Fraxinus americana	2.0	0.0	0.9	3.5	0.2	7.7	3.8	0.7	9.8
Quercus macrocarpa	---	---	---	0.5	0.0	1.2	1.2	0.2	3.2
Ulmus rubra	5.4	0.1	5.4	3.6	0.2	7.7	1.8	0.2	4.0
Quercus muehlenbergii	---	---	---	---	---	---	0.8	0.2	2.3
Juglans nigra	0.5	0.0	0.2	1.1	0.1	2.6	0.8	0.2	2.2
Fraxinus quadrangulata	2.1	0.0	0.9	1.5	0.1	3.3	0.4	0.1	1.1
Prunus serotina	2.3	0.0	1.1	2.0	0.1	4.3	0.5	0.1	1.1
Carya cordiformis	0.7	0.0	0.3	0.7	0.0	0.7	0.4	0.0	0.5
All others	27.7	0.2	23.9	6.2	0.2	11.8	1.8	0.3	4.5
Totals:	219.4	1.8		92.9	3.9		81.3	13.4	

Diameter Class (cm)

* Species	61-90 #	61-90 BA	61-90 IV	91+ #	91+ BA	91+ IV	Stand Total #	Stand Total BA	Stand Total IV
Acer saccharum	6.3	2.4	50.4	0.1	0.1	3.5	234.2	15.1	100.2
Quercus rubra	8.0	3.9	72.8	2.1	1.7	87.3	14.3	6.1	21.6
Aesculus glabra	0.1	0.1	1.1	---	---	---	48.6	0.9	14.1
Tilia americana	1.0	0.4	8.3	---	---	---	26.8	1.7	11.3
Celtis occidentalis	1.2	0.5	10.4	0.3	0.3	13.7	17.6	1.9	9.7
Fraxinus americana	1.5	0.6	12.4	0.4	0.3	16.9	11.1	1.8	8.1
Quercus macrocarpa	1.5	0.7	13.6	1.2	1.2	55.6	4.4	2.2	7.5
Ulmus rubra	0.5	0.2	3.7	---	---	---	11.2	0.6	4.5
Quercus muehlenbergii	1.3	0.6	11.5	0.5	0.5	23.0	2.7	1.2	4.3
Juglans nigra	1.1	0.5	9.2	---	---	---	3.5	0.7	2.9
Fraxinus quadrangulata	0.3	0.1	2.5	---	---	---	4.3	0.3	1.9
Prunus serotina	---	---	---	---	---	---	4.8	0.2	1.7
Carya cordiformis	---	---	---	---	---	---	1.8	0.1	0.7
All others	0.5	0.2	4.1	---	---	---	36.2	1.0	11.6
Totals:	23.3	10.2		4.7	4.1		421.6	33.7	

* Ranked by Importance Value for all size classes.

Table 3. 1925-1986 Changes in stand density for all species by size classes.

Inventory Year	Size Class: Seed-lings	Sap-lings	7-15 (cm)	16-30 (cm)	31-60 (cm)	61-90 (cm)	91+ (cm)
1925	*	*	76.9	114.7	80.8	10.5	1.5
1960	33357	5273	112.5	74.0	72.4	19.7	1.7
1975	10651	1623	288.0	92.3	77.6	22.0	3.4
1986	17276	1218	218.4	93.0	81.3	23.3	4.6

* Reproduction not tabulated.

Table 4. 1925-1986 Changes in Density, Basal Area, and Importance Value for trees larger than 6.4 cm dbh.

Species	Stems/ha				Basal Area (m^2/ha)				Importance Value			
	1925	1960	1975	1986	1925	1960	1975	1986	1925	1960	1975	1986
Acer saccharum	139.3	126.0	218.3	234.2	5.9	9.5	13.0	15.1	73.6	79.7	85.7	100.1
Quercus rubra	19.5	15.6	15.3	14.3	3.3	4.8	5.9	6.1	20.4	23.2	21.6	21.6
Aesculus glabra	2.2	18.8	51.4	48.6	0.1	0.3	0.7	0.9	1.3	7.9	12.8	14.1
Tilia americana	21.0	21.2	36.1	26.8	2.3	1.7	1.6	1.7	16.7	13.7	12.6	11.3
Celtis occidentalis	5.7	23.5	29.4	17.6	0.9	1.4	1.9	1.9	5.5	13.6	12.0	9.7
Fraxinus americana	*	11.9	17.0	11.1	*	1.3	2.0	1.8	*	9.1	9.7	8.1
Quercus macrocarpa	*	5.7	5.2	4.4	*	1.9	2.2	2.2	*	9.0	7.8	7.5
Ulmus rubra	*	15.1	45.2	11.3	*	1.0	1.0	0.6	*	8.9	12.6	4.5
Quercus muehlenbergii	*	3.0	3.2	2.7	*	1.1	1.3	1.2	*	3.2	4.7	4.3
Juglans nigra	3.2	2.2	5.4	3.5	0.3	0.5	0.7	0.7	2.6	2.5	3.4	2.9
Fraxinus quadrangulata	*	7.7	9.1	4.3	*	1.1	0.3	0.3	*	6.9	2.8	1.9
Prunus serotina	NA	5.4	5.4	4.8	NA	0.6	0.2	0.2	NA	4.1	1.7	1.7
Carya spp.	3.2	2.7	3.5	2.8	NA	0.5	0.2	0.2	NA	2.8	1.3	1.3
Ulmus americana	*	9.9	8.2	1.9	*	0.8	0.1	0.1	*	6.3	2.0	0.6
All others	3.2	11.9	31.1	33.6	0.4	0.8	0.9	0.9	4.1	7.0	9.2	10.6
Leucobalanus	9.9	8.6	8.4	7.4	2.7	3.0	3.5	3.4	14.6	14.2	12.6	11.9
Fraxinus	26.2	19.5	26.2	16.1	2.9	2.5	2.3	2.2	21.1	16.0	12.5	10.3
Ulmus	50.9	24.7	53.4	13.3	5.3	1.7	1.2	0.7	40.1	15.0	14.6	5.1
** Totals:	284.3	280.3	483.9	421.9	24.1	27.3	32.0	33.7				

* In the 1925 inventory, species were grouped into Leucobalanus, Fraxinus, and Ulmus.

** 1925 data totals include species groups.

NA Figures not available.

FIGURE 1. 1986 RELATIVE DOMINANCE.
(WITHIN SIZE CLASSES)

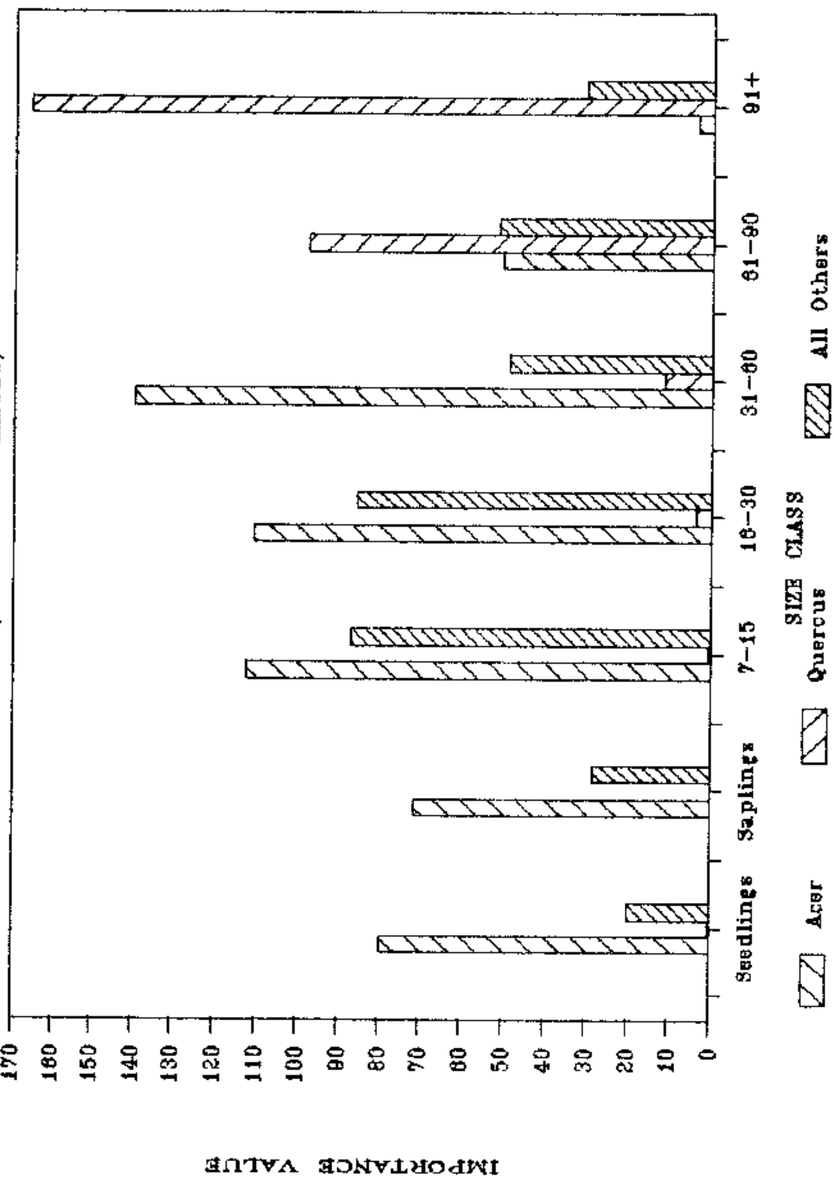

FIGURE 2. BASAL AREA OF SUGAR MAPLE

FOR STEMS 6.4 cm DBH AND LARGER

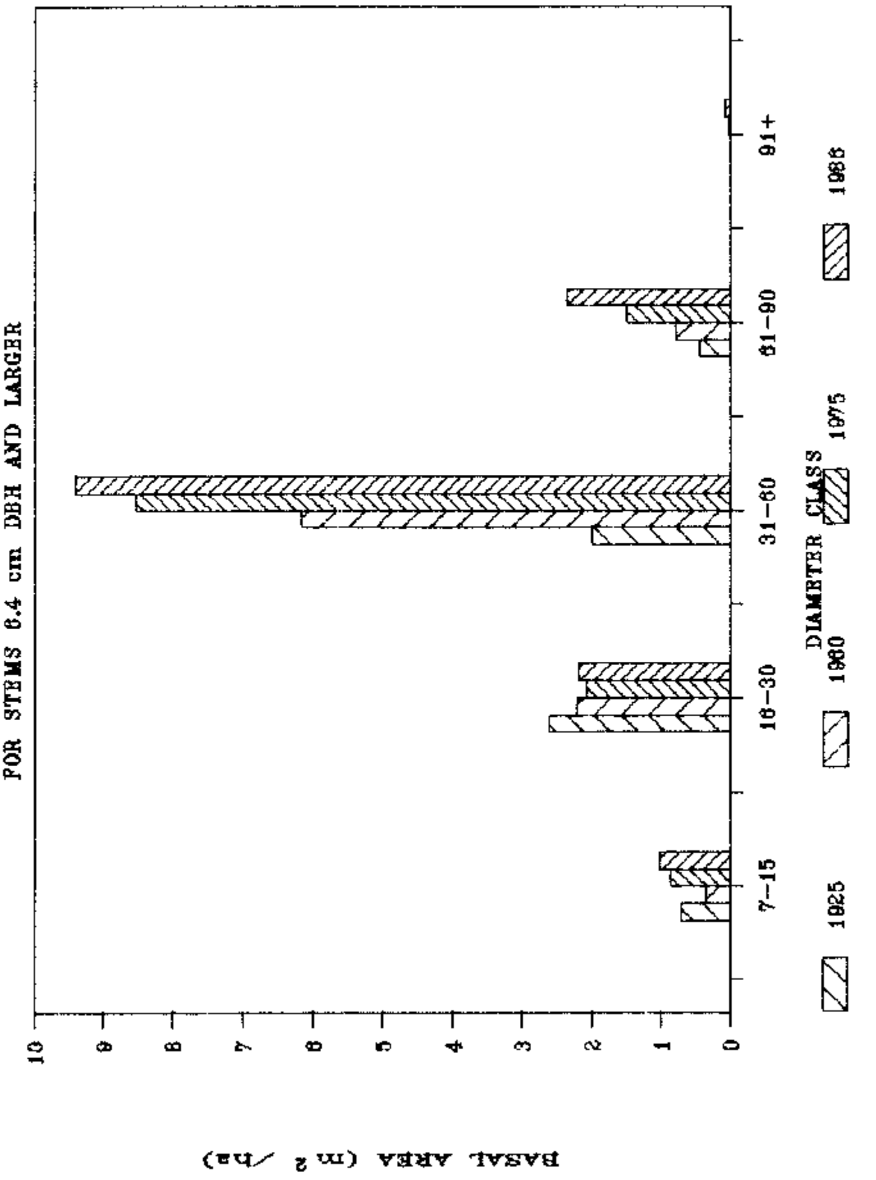

FIGURE 3. BASAL AREA OF QUERCUS

FOR STEMS 6.4 cm DBH AND LARGER