

Woody Composition and Structure of Karcher's Post Oak Woods Nature Preserve, Hamilton County, Illinois

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ABSTRACT

The woody vegetation of the 16 ha Karcher's Post Oak Woods Nature Preserve was examined using three N/S transects 50 x 300 m in size. Tree density averaged 378.1 stems/ha with a basal area of 23.244 m²/ha. *Quercus stellata* Wangh. (post oak) dominated the overstory with 78 stems/ha, a basal area of 10.761 m²/ha and an importance value of 67.0 (IV = 200), with most individuals in the 40-70 cm diameter classes. In contrast, *Carya ovata* (Mill.) K. Koch (shagbark hickory), with an importance value of 63.2, was second, averaged 164 stems/ha with most individuals in the 10-30 cm diameter classes. Except for black oak, oak reproduction was low, indicating that the closed canopy of this woodland now favors the more shade-tolerant, fire-sensitive hickory species. This trend suggests a reduced importance of post oak in the future.

INTRODUCTION

Post oak (*Quercus stellata* Wang.) forests are common in the Midwest from Ohio to Missouri, being particularly abundant on the Illinois till plain (Telford 1926, Braun 1950). These woodlands once covered approximately 2.25 million ha in southern Illinois (Telford 1926). In Illinois, post oak commonly dominated barrens, occurring on thin soil over bedrock (Ebinger et al. 1994). Also common in flatwood forests, post oak is associated with *Q. bicolor* Willd. (swamp white oak), *Q. marilandica* Muenchh. (blackjack oak) and *Q. palustris* Muenchh. (pin oak), on poorly drained, seasonally wet, heavy clay soils having a claypan or fragipan near the surface (Telford 1926, Schwegman 1973, Fralish 1988, Coates et al. 1992, Taft et al. 1995). These extremely compact and impermeable soils impede drainage and root penetration.

On better drained soils, post oak is usually associated with *Q. velutina* Lam. (black oak), *Carya ovata* (Mill.) K. Koch (shagbark hickory), and *C. tomentosa* (Poir.) Nutt. (mockernut hickory). These forests on more mesic sites, with greater topographic relief, and lacking the edaphic and drainage properties of flatwoods, are not as common in Illinois. Except for some observations by Telford (1926) this forest type has not been studied in detail.

According to historical records, most upland forests on lands with gently rolling topography were relatively open (Anderson and Anderson 1975, Ebinger and McClain 1991), and could be characterized as open woodlands or savannas depending upon tree densities. These open canopy forests represented a transition between the extensive prairies on much of the uplands of the prairie peninsula and the closed forests of the dissected terrain of the river valleys. At the time of European settlement these open canopy forests were fashioned by periodic fires (McClain and Elzinga 1994). With the cessation of landscape fires, woody plant encroachment resulted in canopy closure (Ebinger 1986, Ebinger and McClain 1991). Native aborigines and later European settlers were probably responsible for most of these fires (Williams 1989, Davies 1994, McClain and Elzinga 1994).

The study area is commonly called Cartway Woods since it was traversed by an early 19th Century dirt road, or cartway. Mostly in private ownership, many parts of the woods show some recent disturbance; it appears that the woods were grazed and some timber was cut for firewood and lumber. The purpose of the present study is to determine the structure and composition of the overstory of Karcher's Post Oak Woods Nature Preserve.

DESCRIPTION OF THE STUDY AREA

Karcher's Post Oak Woods Nature Preserve is located in Dahlgren Township (T4S R5E) about eight miles northwest of McLeansboro, Hamilton County, Illinois in the Mt. Vernon Hill Country Section of the Southern Till Plain Natural Division of Illinois (Schwegman 1973). This natural division is characterized by nearly flat to gently rolling topography that was mostly timbered before European settlement. Though mostly composed of forest and savanna in presettlement times, extensive prairie inclusions were present. Four prairies were located within 4 km of the study site with the largest, about 5 km² in size, being described as a wet prairie by the Government Land Office (GLO) surveyors (GLO Field Notes Vol. 76, Illinois State Archives). Common notations in the GLO field notes for this area: "land flat and wet," "land thinly timbered post oak, otherwise prairie with scattered groves of timber."

The preserve, 16 ha in size, is located at the edge of the Mt. Vernon Hill Country Section near the broad bottomlands of Skillet Fork (NW1/4 Sec 2 T4S R5E). Altitude ranges from 134 m to 141 m above sea level. Only a few intermittent streams are found in the immediate area. Recently purchased by the Illinois Audubon Society, the site has been dedicated by the Illinois Nature Preserve Commission. The preserve contains 3 ha of old field in the perennial herb/pioneer tree stage of succession; about 2 ha of successional forest, the trees being less than 20 cm dbh; and the remainder is mature, second growth forest (Figure 1).

The soils of the study areas are Wynoose and Bluford silt loams (Currie 1986). These nearly level soils are poorly drained, and occur on broad, loess-covered till plains. The seasonal water table ranges from 15 to 95 cm below the surface in most years, and surface run-off is slow. The surface and subsoil layers are generally strongly acidic.

The climate is continental, characterized by humid, hot summers and cold winters. Average annual precipitation is 105 cm, with a record high of 157.5 cm in 1945 and a record low of 68.3 cm in 1936. The highest temperature on record is 45.6°C for 14 July 1936, the record low is -31°C for 18 January 1930. During an average year there are 51 days with temperatures higher than 30°C, and 108 days lower than 0°C. The frost-free growing period averages 184 days (Bryan and Wendland 1995).

METHODS

In the mature second growth forest two N/S transects 50 x 300 m, were located in the preserve during the summer of 1999, a third transect being added in 2000. The transect boundaries were marked with permanent metal stakes for future studies, and divided into quadrats 25 m on a side. In each quadrat all living and dead-standing woody individuals 10.0 cm dbh and above were identified and their diameters recorded. From these data the living-stem density (stems/ha), basal area (m²/ha), relative density, relative dominance, importance value (IV), and average diameter (cm) were calculated for each species. Determination of the IV follows the procedure used by McIntosh (1957), and is the sum of the relative density and relative dominance. Dead-standing stem density (stems/ha), basal area (m²/ha), and average diameter were also determined for each species.

Woody understory composition and density (stems/ha) were determined using nested circular plots randomly located at 20 meter intervals along line transects within the study areas. A random numbers table was used to determine the number of meters the center point of the nested circular plots was located to the right (odd numbered plots) or to the left (even numbered plots) of the transect line. Four additional 0.0001 ha circular plots were located 7 m from of each center point on each of the four cardinal compass directions. In the 0.0001 ha plot, seedlings (<50 cm tall) and all shrubs were counted; in the 0.001 ha circular plots small saplings (>50 cm tall and <2.5 dbh) were recorded; and in the 0.01 ha circular plots large saplings (2.5-9.9 cm dbh) were tallied. Nomenclature follows Mohlenbrock (1986).

RESULTS AND DISCUSSION

Tree density in the woodlot averaged 378.1 stems/ha with a basal area of 23.244 m²/ha (Table 1). Of the 19 arborescent species encountered, post oak ranked first with an IV of 67.0, averaged 78.3 stems/ha, and accounted for more than 46% of the total basal area (10.761 m²/ha). Most of the post oaks were in the larger diameter classes, only a few being found in the 10-19 cm class. Also, the average diameter of 39.9 cm dbh, and the open-grown appearance of the larger post oaks gives an indication of the open nature of this forest in the distant past. No seedlings or saplings of post oak were encountered during the understory survey (Table 2).

Of the remaining oak taxa, black oak ranked fifth in IV (24.7), averaged 17.9 stems/ha, and had most individuals in the smaller diameter class as indicated by the average diameter of 27.8 cm dbh (Table 1). This species ranked third in seedlings with 812 stems/ha, and saplings were relatively common (Table 2). Other relatively common oak taxa included *Q. alba* L. (white oak) and *Q. rubra* L. (red oak) which ranked sixth and seventh in IV respectively. Both had IV's less than 10, and were not well represented in the seedlings and sapling categories.

Hickories were important components of the woodlot. Shagbark hickory ranked second in IV mostly due to the large number of individuals present. As indicated by the average diameter of 17.3 cm dbh, most were in the 10-20 cm diameter class (Table 1). This taxon ranked first in seedlings (2593 stems/ha), second in small saplings (640 stems/ha), and first in large saplings (300 stems/ha) (Table 2). Of the remaining hickory taxa, *Carya glabra* (Mill.) Sweet. (pignut hickory) and mockernut hickory ranked third and fourth in IV. They were well represented in the smaller tree diameter classes (Tables 1).

The remaining woody species were not common none had an IV greater than 1.0, or a density greater than 3 stems/ha. Of these, some were common in the seedling and sapling categories, particularly *Fraxinus pennsylvanica* Marsh. (green ash) and *Prunus serotina* Ehrh. (wild black cherry). Understory trees included *Cornus florida* L. (flowering dogwood), *Morus rubra* L. (red mulberry), *Cercis canadensis* L. (redbud) and *Asimina triloba* (L.) Dunal (pawpaw) (Table 2).

In the woodlot, tree mortality averaged 27.7 stems/ha with a basal area of 1.732 m²/ha (Table 3). Post oak had the highest mortality followed by black oak and shagbark hickory. The average diameter of the dead-standing individuals of post oak was 34.6 cm with the largest individual being 59 cm dbh.

The open-grown structure of the extant large post oaks, the comments made by the surveyors in the GLO survey notes, and the lack of post oak reproduction all indicate a more open forest in the past. Also, many of the cut stumps examined on surrounding properties exceeded 200 years in age and contained scars from 101 separate fire events from 1776 to 1990, indicating that fire was important in maintaining the open condition of these forest tracts (McClain and Ebinger 2002, McClain et al. 2003).

This decrease in oak regeneration and the subsequent increase in more mesic, fire-sensitive taxa occurring throughout the Midwest (Ebinger and McClain 1991), is probably due to fire suppression. The result is canopy closure that favors the growth of shade-tolerant, fire-sensitive species at the expense of most oaks. Consequently, young post oaks are not present in the understory to take advantage of canopy openings as veteran trees die. Instead, more shade-tolerant, fire-sensitive species having higher gap-phase-replacement potentials, such as many hickory species, are entering the canopy.

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Table 1. Densities (stems/ha), diameter classes, basal areas (m²/ha), relative values, importance values and average diameters of woody species in Karcher's Post Oak Woods Nature Preserve, Hamilton County, Illinois.

	Diameter Classes (cm)						Total stems/ha	Basal Area m ² /ha	Rel. Den.	Rel. Dom.	I.V.	Av. Diam. (cm)
	10-19	20-29	30-39	40-49	50-59	60-69						
<i>Quercus stellata</i>	3.1	14.7	24.9	19.1	10.9	5.6	78.3	10.761	20.7	46.3	67.0	39.9
<i>Carya ovata</i>	128.9	26.0	6.2	2.9	0.7	0.2	164.9	4.552	43.6	19.6	63.2	17.3
<i>Carya glabra</i>	14.9	15.1	10.9	5.1	1.1	--	47.1	3.053	12.4	13.2	25.6	26.6
<i>Carya tomentosa</i>	25.6	11.6	4.7	1.1	--	--	43.0	1.539	11.3	6.6	17.9	19.6
<i>Quercus velutina</i>	7.1	2.2	5.3	2.2	1.1	--	17.9	1.298	4.7	5.6	10.3	27.8
<i>Quercus alba</i>	4.9	0.9	2.4	0.9	1.3	1.6	12.0	1.310	3.2	5.6	8.8	32.4
<i>Quercus rubra</i>	0.9	1.3	0.4	0.2	0.7	0.2	3.7	0.420	1.0	1.8	2.8	33.7
Others (12)	8.9	1.9	0.2	--	0.2	--	11.2	0.311	3.1	1.3	4.4	
Totals	194.3	73.7	55.0	31.5	16.0	7.6	378.1	23.244	100.0	100.0	200.0	

Table 2. Density (stems/ha) of the seedlings and shrubs, and small and large saplings in Karcher's Post Oak Woods Nature Preserve, Hamilton County, Illinois.

Species	Seedlings and Shrubs	Small Saplings	Large Saplings
<i>Carya ovata</i>	2593.8	640.6	300.0
<i>Symphoricarpos orbiculatus</i>	1718.8	--	--
<i>Quercus velutina</i>	812.5	390.6	26.6
<i>Fraxinus pennsylvanica</i>	468.8	781.3	--
<i>Prunus serotina</i>	375.0	31.3	1.6
<i>Diospyros virginiana</i>	281.1	78.1	3.1
<i>Sassafras albidum</i>	218.8	109.4	18.8
<i>Quercus alba</i>	218.8	109.4	3.1
<i>Quercus imbricaria</i>	187.5	--	--
<i>Carya glabra</i>	93.8	15.6	--
<i>Ulmus americana</i>	62.5	78.1	12.5
<i>Quercus rubra</i>	62.5	15.6	--
<i>Carya tomentosa</i>	31.3	15.6	40.6
<i>Celtis occidentalis</i>	31.3	15.6	1.6
<i>Ulmus rubra</i>	--	31.3	1.6
<i>Cercis canadensis</i>	--	31.3	--
<i>Asimina triloba</i>	--	15.6	--
<i>Cornus florida</i>	--	--	3.1
<i>Morus rubra</i>	--	--	1.6
Totals	7156.6	2359.4	414.2

Table 3. Density (stems/ha), basal area (m²/ha) and average diameter (cm) of the dead-standing trees in Karcher's Post Oak Woods Nature Preserve, Hamilton County, Illinois.

Species	Density (stems/ha)	Basal Area (m ² /ha)	Average Diameter (cm)
<i>Quercus stellata</i>	10.7	1.179	34.6
<i>Quercus velutina</i>	5.6	0.143	17.4
<i>Carya ovata</i>	4.0	0.125	17.2
<i>Carya glabra</i>	2.4	0.123	16.3
<i>Sassafras albidum</i>	1.6	0.019	20.8
<i>Carya tomentosa</i>	1.1	0.091	29.1
<i>Prunus serotina</i>	0.9	0.018	16.0
<i>Quercus alba</i>	0.7	0.022	19.7
Others	0.7	0.012	--
Totals	27.7	1.732	

Figure 1. Aerial photograph showing the location of the Karcher's Post Oak Woods Nature Preserve, Hamilton County, Illinois (a = old field, b = successional forest, c = mature second growth forest and study area).



