

VEGETATION PATTERN OF DUPAGE AND WILL COUNTIES AT THE TIME OF EUROPEAN SETTLEMENT

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ABSTRACT: In the early 1800's the vegetation of the Chicago region was predominantly prairie, with much woody vegetation restricted to fire-protected sites. Since the time of the European invasion, this vegetation has undergone vast changes as a result of the disruption of landscape processes, particularly the pivotal role played by fire. Between the years of 1821 and 1846, the Government Land Office employed surveyors to conduct the Public Land Survey (PLS) in DuPage and Will counties. Parceling the land for European settlers, these surveyors walked township section lines, noting changes in vegetation and mapping the landscape as they went. They also recorded tree (and sometimes woody undergrowth) species present, and blazed one to four "bearing" trees at section and quarter section corners where available. We analyzed the maps, notes and witness tree data from the DuPage and Will County PLS and found an expected landscape pattern in the distribution of vegetation. Forests with high tree densities and fire-intolerant species such as sugar maple developed beyond the protection of barriers to eastward-moving prairie fires, while prairie and savanna characterized by fire-tolerant oaks often occurred on the western sides of landscape fire breaks. We can use the landscape pattern derived from the PLS maps and notes to interpret the former distribution, composition and structure of vegetation in the Chicago area and for developing guidelines for conservation and restoration.

Key words: General Land Office Public Land Survey, presettlement, DuPage County, Will County, bearing tree

INTRODUCTION

Prior to the European invasion, vegetation in the Chicago region was made up of prairie, oak-dominated savanna and forest, the boundaries between these communities being determined by fire. When fire processes were altered as a consequence of European settlement, the landscape changed drastically. Field notes from the Government Land Office Public Land Survey (PLS) contain a wealth of information about how vegetation was distributed at the time of European settlement. The PLS compiled landscape-scale vegetation descriptions and maps, including details on bearing trees. These records have been used by many researchers to determine vegetation patterns in various regions of the United States (Ellarson 1949, Potzger & Potzger 1950, Rodgers & Anderson 1979, Grimm, 1984, Schwarz 1994, Swigart & Anderson 2000).

When we studied the maps, notes and bearing tree data from the DuPage and Will County PLS, we found a gradient of increasing tree density extending from prairie through brush and scattering timber to timber. The predominant woody vegetation was described as timber, with smaller amounts of scattering timber, barrens, brush and hazel thickets.

The survey

The object of the U.S. General Land Office Public Land Survey was to divide land into parcels for European settlers. The surveyors established a grid system of townships six miles

square divided into 36 1-mile² sections with section lines running N-S and E-W. Measuring with chains (80 chains = 1 mile), surveyors noted general changes in vegetation, such as points on section lines where they crossed from prairie into timber, as well as distances of entering and leaving any type of water feature. At the end of each half mile, they described the quality of the soil and listed dominant tree (and sometimes undergrowth) species present along the line. Roads and fields were also noted. After completing a survey, the surveyors drew a rough map (plat) of features recorded in their notes for the township.

Surveyors placed section post markers at each mile and quarter-section post markers at each half mile along section lines. Where available, one to four bearing (witness) trees were blazed to mark a corner or quarter corner, one tree chosen from each quadrant around the corner. In addition to the common name of bearing trees, their distance from the corner and estimated diameter were recorded. Trees occurring directly on section lines (line trees) were also identified by species and diameter. There has been much discussion about potential surveyor bias regarding size and species when choosing bearing trees (Bourdo 1956). A small tree was more difficult to inscribe with the required location information; large trees were viewed as less likely to endure, in part because they made prime lumber. As Bourdo (1956) noted, bias regarding species was tempered by environmental factors that limited surveyors' choice of trees at each corner.

METHODS

DuPage County lies about 25 miles (40 km) west of Lake Michigan and the city of Chicago, Illinois. Will County is located directly south of DuPage, and extends eastward to the Indiana state line. DuPage contains nine complete and one fractional townships, and Will County contains 23 complete and two fractional townships. Total area for these two counties is approximately 306,603 hecatres (757,308 acres).

The two counties in our study area were surveyed by at least 12 surveyors between 1821 and 1840, with the exception of an island in the Kankakee River, which wasn't surveyed until 1846. In addition to township section lines, we looked at surveys of six reservations in Will County and the two Indian boundary lines, one of which occurred in DuPage County as well.

Interpreting PLS notes

Surveyors identified 27 bearing tree species by common name in DuPage and Will counties. We assumed that most tree species were correctly identified and placed them in contemporary species classifications as found in Swink & Wilhelm (1994). According to survey instructions, "sugartree" denoted sugar maple, while "maple" referred to soft maple (White 1983). We recognized "hickory" as shagbark hickory and yellow oak as chinquapin oak. Walnut was assumed to be black walnut, unless white walnut (butternut) was specified. Sometimes surveyors were less specific, leaving us with ambiguous abbreviations. References to "B" oak could be either bur or black oak. We assigned those trees located on sand in Will County to black oak, and trusted that the many others were really bur oaks. The few trees recorded as "P" oak were grouped with the pin oaks, and "S" oak trees were placed with Spanish and scarlet oak. Post oak, jack oak, and overcup oak, species well out of their range, remain unresolved.

In some townships, neither presence nor absence of woody undergrowth was noted, even in areas with heavy timber. We assume that when these townships were surveyed, undergrowth information was simply not recorded, so we in turn did not include these areas in undergrowth analysis.

We used the modified point-centered quarter method to estimate tree density per hectare at each section and quarter-section corner based on recorded distances to bearing trees. If two trees were recorded in the same quadrant, we only used the tree with the shorter distance. We did not include trees with bearing designated as a cardinal direction. Based on estimated tree density, we assigned points to one of four tree density categories: open savanna (>0-10 trees/hectare), closed savanna (>10-50 trees/hectare), woodland (>50-100 trees/hectare) and forest (>100 trees/hectare). Basal area was calculated in square meters by converting from the original measure of diameter in inches. Total and relative (R) density (D) and basal area (BA) and importance value $[IV = (RD+RBA)/2]$ were calculated for each bearing tree species.

Interpreting PLS maps

Surveyors usually drew scattering timber with an incomplete border or simply as a brief line on their plats. Another incomplete vegetation feature was wet prairie, which, though recorded at specific points along section lines, was not outlined on the plats. Occasionally topographic lines guided us in completing missing lines, but other times information from adjacent section lines was used to determine boundaries. When the placement of features on the plats deviated from distances recorded along section lines, we used the information from the notes. We did not include fields or roads on our map, though DuPage County already contained many fields at the time of the PLS.

We used the geographic information systems software ARC/INFO to map the primary vegetation types, with additional layers for section lines, bearing trees, section and quarter-corners identified by tree density class, line trees, and half-mile summaries of tree and undergrowth species. We used ARC/INFO and ArcView to determine proportional cover of different vegetation types and to analyze vegetation patterns.

RESULTS

The pre-European settlement vegetation of DuPage and Will counties was predominantly prairie, accounting for approximately 80% of the landscape. Prairie wetlands comprised less than 3% of the landscape but were widespread in the southeastern and south central parts of Will County (Figure 1). Timber and other woody vegetation made up almost 19% of the landscape, with scattering timber accounting for about 3.3% of the total. The largest blocks of timber were associated with the rivers, with isolated smaller groves occurring on sites with creeks and associated topography. The eastern parts of DuPage County and the south central part of Will County were largely treeless. The overall landscape vegetation pattern in these two counties based on tree density class was equally distributed between open savanna (37.1%) and closed savanna (32.3%).

Timber

Areas of timber were dominated (>40 IV) by white oak with secondary importance (10-40 IV) of bur oak and minor importance (5-10 IV) of black oak. Red oak, hickory and 21 other species had lower importance (Table 1). More than 90% of corners classified as woodland (>50-100 trees/ha) occurred in areas called timber. Tree density in DuPage County timber averaged 125.4 trees/ha, while in Will County it was 84.7. Nonetheless, Will County timber had higher tree species richness. In addition, some unusual species were mentioned in section line summaries in Will County. At a few locations on the east bank of the Kankakee River cedars were noted, while beech was mentioned in a steep ravine in the central part of the county.

Over 25% of the section lines in timber had woody undergrowth, with a total of 30 different species. Hazel and "oak" were the dominant species, followed by hickory. Other common woody undergrowth included vines and "briers", with plum and grape mentioned less frequently. Although red oak had 43% frequency in DuPage County undergrowth, none was recorded in Will County. Witch hazel and dogwood were noted infrequently in DuPage County, and not at all in Will. Sassafras was mentioned once in Will County, as were sumac and blackberry.

Scattering Timber and Barrens

Scattering timber often had an intermediate landscape position between either timber and prairie or timber and barrens (Figure 1). Surveyors also mentioned scattering timber on "river margins." Areas of scattering timber mapped by the PLS were dominated ($IV > 30$) by white oak, with secondary importance ($IV > 10-30$) of bur oak and black oak, and minor importance ($IV > 5-10$) of scarlet oak. Red oak and four other species had lower importance (Table 1). Here, too, tree density was higher in DuPage County, where scattering timber had an average of 70.3 trees/ha compared to Will County's average of 29.7 trees/ha. Fifty-five percent of corners in scattering timber had tree densities in the open savanna category, with only 7.3% of the points in woodland and 9.2% in forest. Scattering timber had comparatively low species richness, with a total of eight recognizable tree species recorded in our study area. About 38% of the section lines in scattering timber had woody undergrowth of oak, hickory and/or hazel.

There were no witness trees in the two small areas of barrens in Will County, but at three points in DuPage County red oak and hickory had slightly higher IVs than white oak (Table 1). Sixty-seven percent of barrens section lines had woody undergrowth with relatively low species richness and dominance by hazel, with lower frequency of oak and hickory. Cryptically, barrens was listed as a type of undergrowth along three section lines in Will County, occurring with willow on one of them. Also in Will County, two areas described as prairie by one surveyor were referred to as barrens by a surveyor approaching on another line.

Prairie

There were 96 bearing tree points located in prairie, accounting for approximately 5% of all corners in prairie in our study area. At these points white oak was dominant ($IV > 40$), with secondary importance ($IV > 10-40$) of bur oak, minor importance ($IV > 5-10$) of elm and black oak, and lower importance of pin oak, red oak, hickory and eight other species (Table 1). Seventy-six percent of the prairie corners with trees had densities in the open savanna category, with an overall average tree density of 10.8 trees/ha. Species richness was moderate (Table 2), and included a willow and cottonwoods near rivers. Less than 1% of section lines in prairie had woody undergrowth. Hazel was the most frequently noted species, though oak was also recorded.

Comparisons among tree species

Tree species differed in their distribution across the tree density gradient from open savanna to forest. White oak was dominant ($IV > 40$) and bur oak had secondary importance ($IV > 10-40$) in all four tree density classes. Red oak had minor importance in woodland and closed savanna ($> 10-50$ trees/ha), with lower importance in forest and open savanna. Black oak had minor importance in forest, woodland, and closed savanna, but secondary importance in open savanna. Scarlet oak had minor importance in closed savanna, and was less important in other classes. Oaks reached their greatest abundance in open savanna, declining in importance as tree density increased. Though species richness was about the same in all tree density classes, three species (white oak, bur oak, and black oak) accounted for 88% of all bearing trees in open savanna.

Although oaks were also the most important trees in woodland and forest, hickory, elm, ash, ironwood and other species reached their greatest abundance in these habitats. Hickory had minor importance (IV>5-10) in forest (>100 trees/ha) and woodland, and declined in importance at lower tree densities. Hackberry, cherry and ironwood had greatest importance in woodland, while ash, basswood, sugar maple and walnut were more prominent in forest. Sugar maple was restricted to the Big Woods area east of the Fox River and along or east of the Des Plaines River or tributaries of the DuPage River. The only bearing tree species mentioned in DuPage County but not Will was aspen, while trees recorded in Will County but not DuPage included hackberry, Kentucky coffee trees, and buckeye. Species recorded as line trees Will County but not included in the bearing tree sample included white hickory (butternut) and an overcup oak, a species out of its range.

DISCUSSION

The prairie remaining after the climate began to cool at the conclusion of the drying and warming trend known as the Hypsithermal Period (8000-6000 BP) was maintained by periodic drought and aridity as well as fire (Taft 1997). Native Americans set fires to hunt bison, among other reasons (Pyne 1984), having a notable effect on the vegetation. Unfortunately, their culture has been nearly obliterated by the invading Europeans, depriving us of their historic knowledge of fire processes.

When Gleason (1913) studied PLS records and found prairies on the west sides of streams and other firebreaks, he attributed this pattern to prevailing westerly winds that drove the fires. Fire tolerant timber such as oak woodlands could persist on the west side of rivers, while mesic forests with thin-barked species such as basswood and sugar maple would be restricted to fire-protected sites along river courses or on rugged topography. Surveyors in our study area mentioned sign of fire several times, both in timber and prairie. The reduced amount of topographic relief in Will County as compared to DuPage might explain the lower tree densities there, as well as the lower frequency of undergrowth in timber.

Based on historic descriptions, we expected a savanna transition between prairie and timber, particularly along fire-impacted western borders of timber. We found such a transition in larger blocks of timber, sometimes in the form of barrens. Bur and white oak were, as expected, most abundant at lowest tree densities, where fires would be most frequent. Red oak, which is less fire-resistant and has higher moisture requirements, was more abundant at higher tree densities. Even hickory was more important at higher tree densities, and more abundant in timber than in scattering timber. Fire-intolerant, shade-tolerant sugar maple and ash were most abundant where tree density was highest.

The results of our study of the PLS notes also indicate that hazel and other woody undergrowth species were an important component of our area's woody vegetation. Undergrowth species richness was higher in timber than in scattering timber, another reflection of how fire protection or lack thereof affected woody species distribution.

CONCLUSION

A far-reaching result of European colonization of Illinois has been a drastic decline in fire frequency. As Bourdo wrote, "forest and prairie as the first settlers found them, have been almost

completely destroyed by the advance of civilization." As prairies were opened up to agriculture, landscape-scale fires were suppressed. Some remaining prairies then grew up into woodland as various tree species were able to invade.

Of course, the PLS record represents the Chicago area at a certain point of time. Grassland and forest have been pushing and chewing at each other for thousands of years (Anderson 1970). Yet this is indeed a record of how the landscape was developing and functioning before intense human manipulation. Reduction of fire frequency since European settlement has changed savannas in our area to closed canopy forests with a larger component of shade-tolerant, fire-sensitive trees.

Site-specific comparisons with PLS records are difficult because the large PLS sampling scale rarely results in data points within our small forest fragments. However, when we look at bearing tree information from the larger groves that once encompassed the sites that are now our natural areas, there is a repeated pattern of white oak importance being usurped by sugar maple.

Reconstructing distributions of timber and grassland communities helps us understand the ecology of our native plant communities, which hopefully guides restoration and management. Restoration of vegetation types as represented in the PLS maps is problematic. Once the PLS laid down that grid, the land was subjected to repeated bisecting and parceling, leaving the fragments of natural areas inadequate for sustaining historic landscape-scale fire and species immigration processes. Yet it is possible to work towards restoration of savanna and woodland with oak dominance and a woody understory featuring hazel.

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Table 1. DuPage and Will County bearing tree species importance values [IV = (relative density + relative basal area)/2] in PLS vegetation types. N = No.of corners.

Species	TIMBER (N = 523)	SC.TIMBER (N = 104)	BARRENS (N = 3)	PRAIRIE (N = 96)
White oak	50.64	38.22	25.31	41.21
Bur oak	17.72	28.41	-----	30.32
Black oak	9.25	17.43	-----	5.34
Red oak	4.39	4.62	39.06	2.72
Hickory	3.68	2.44	35.62	2.25
Scarlet oak	2.68	5.75	-----	1.94
Sugar maple	1.95	-----	-----	-----
Elm	1.72	-----	-----	7.99
Basswood	1.55	-----	-----	-----
Walnut	1.52	-----	-----	0.47
Ash	1.29	-----	-----	1.61
Pin oak	1.26	0.88	-----	3.07
Hackberry	0.50	-----	-----	0.55
Silver Maple	0.37	-----	-----	0.54
Ironwood	0.31	-----	-----	-----
Chinquapin oak	0.20	-----	-----	0.70
Cherry	0.17	1.65	-----	0.41
KY Coffeetree	0.17	-----	-----	-----
Sycamore	0.11	-----	-----	-----
Oak	0.11	-----	-----	-----
Table 1. Continued.				
Cottonwood	0.09	-----	-----	0.47
Hawthorn	0.09	-----	-----	-----
Jack oak	0.09	-----	-----	-----
Buckeye	0.07	-----	-----	-----
Aspen	0.06	-----	-----	-----
Box elder	0.05	-----	-----	-----
Post oak	-----	0.59	-----	-----
Willow	-----	-----	-----	0.41
	100.00	100.00	100.00	100.00

Table 2. Structure and richness of PLS vegetation types. N = No. Witness trees. Dbh is in centimeters, density is trees/ha. R = species richness, % = percent of section lines with undergrowth.

	Bearing Trees				Undergrowth	
	<u>N</u>	<u>xdbh</u>	<u>xdensity</u>	<u>R</u>	<u>%</u>	<u>R</u>
Timber	1271	41.94	93.92	25	25.5	31
Scattering timber	175	37.06	48.44	9	38.6	8
Barrens	5	28.55	19.26	3	66.7	4
Prairie	136	21.51	14.63	16	0.6	4

