PRE-EUROPEAN SETTLEMENT VEGETATION OF KANE COUNTY, ILLINOIS

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Summary

We mapped and analyzed the landscape pattern and composition of vegetation described by the U. S. Public Land Survey (PLS) of Kane County, Illinois, which was conducted between 1837 and 1840. Kane County was 61 % prairie, wet prairie and marsh, and 38 % timber, which occurred in large blocks in the northern half of the county and in the eastern edge of the county east of the Fox River. Timber west of the Fox River averaged less than 50 trees/ha, indicating widespread savanna conditions. However, tree densities averaged almost 100 trees/ha along the east side of the Fox River, indicating that this area supported forest conditions. Woodland, represented by 50-100 trees/ha, was less common than savanna or forest. Oaks dominated almost all tracts of timber. Bur oak was most important in savanna, where white oak and black oak were sub-dominant. White oak was dominant in woodland and forest, especially east of the river. Black oak and sugar maple were also sub-dominant east of the river, with sugar maple more important in woodland and forest. Other mesophytic species including red oak, elm, hickory, ash, basswood and ironwood were much less abundant and reached their greatest importance in woodland and forest, especially east of the Fox River. Woody understory vegetation was also most abundant in timber east of the Fox River, and was dominated by American hazelnut. The occurrences of forest vegetation with woody undergrowth on the eastern sides of watercourses supports the hypothesis that eastward-moving prairie fires driven by prevailing winds caused the pattern and structure of the vegetation of Kane County. These findings indicate that restoring fire processes in relation to landscape features, as well as ecologically appropriate species, should be important objectives in restoration and management of woody vegetation in this region. The co-occurrence of white oak and sugar maple in forest conditions with woody undergrowth dominated by hazel provides new information on the structure of such fire protected presettlement forests, and helps set restoration goals for this poorly understood type of vegetation.

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INTRODUCTION

At the time of European settlement (*ca.* 1820), northeastern Illinois was a broad mosaic of prairie and oak (*Quercus*)-dominated savanna, woodland and forest (Davis 1977, Schwegman et al. 1972, Anderson 1983, Anderson & Bowles 1999). This pattern was climatically induced and controlled by fires set by lightning and by indigenous people, with timber persisting on the lee sides of fire barriers such as topographic relief and water courses (Gleason 1913, Moran 1978, 1980, Grimm 1983, 1984, Anderson 1991, Leitner *et al.* 1991, Bowles *et al*. 1994). Most of this original vegetation has been lost because of wide-scale fragmentation by agriculture and urbanization, while remnants have deteriorated from fire suppression and overgrazing (Cottam 1949, McCune & Cottam 1985, Anderson 1991, Stearns 1991, Robertson & Schwartz 1994, Schwartz 1997, Bowles & McBride 1998). Consequently, management and restoration of this vegetation represents an important challenge (Apfelbaum & Haney 1991, Leach & Ross 1995, Bowles & McBride 1998). Conservationists need an understanding of the composition, structure, and dynamic processes of pre-European settlement (traditionally termed "presettlement") vegetation so as to better manage and restore its original biodiversity. Ecological models that apply presettlement processes to vegetation pattern, composition, and structure will best meet these needs (Leach & Ross 1995). In this report on the presettlement vegetation of Kane County, we interpret landscape vegetation pattern, structure and composition in relation to landscape features and fire processes and make management and restoration recommendations.

The Public Land Survey

A powerful approach to understanding the landscape pattern and structure of woody vegetation prior to European settlement is analysis of the Government Land Office Public Land Survey (PLS) vegetation notes, maps, and bearing tree data, which were recorded in the early 1800s in Illinois (Hutchison 1988, Ebinger 1997). This survey comprised a square-mile landscape grid upon which the identity, diameter, distance, and direction for one to four bearing trees were recorded at half mile intervals. These data were accompanied by measures of trees intercepted on section lines, section line vegetation summaries, other notes, and township plats distinguishing timber, prairie, and other important landscape features.

Despite evidence for biased or non-random selection of bearing trees (Bourdo 1956), the PLS data represent a large-scale vegetation survey that can be used to reconstruct landscape-scale pre-European vegetation (Brugam & Patterson 1996). These data can allow estimates of forest composition and ranking of species dominance, but the large sampling scale usually prevents accurate and detailed mapping of vegetation types (Manies & Mladenoff 2000). However, site-specific comparisons and precise mapping of vegetation boundaries may be possible (*e.g.* Bowles & McBride 1998). These data also can provide ecological information when landscape features, such as soils, topography, or fire barriers, are used to interpret the distribution pattern of different vegetation types based on their composition and structure (Leitner *et al*. 1991, Anderson & Anderson 1975, Moran 1978, 1980, Rogers & Anderson 1979, Bowles *et al.*1994, and Edgin & Ebinger 1997). For example, in DuPage and Will counties, Illinois, greater landscape cover of prairie and savanna occurred in areas with little landscape fire protection, while higher tree densities and greater abundance of fire-intolerant trees, as well as presence of woody undergrowth, occurred in more fire-protected landscape positions (Bowles *et al.* 1994). Previous studies of presettlement vegetation of Kane Co. support these findings. For example, Kilburn (1959) and found greater representation of bur oak west of the Fox River, and greater representation of sugar maple, ash, basswood and elm east of the river. However, Kilburn did not map vegetation based on tree densities. Moran (1980) also found a similar vegetation pattern for Kane County, with forest based on a threshold of 70 trees/ha essentially restricted to timber east of the Fox River. These studies suggest a need for greater investigation of the presettlement vegetation of Kane Co. using standardized measures.

Study objectives

We examined the presettlement woody vegetation pattern and structure in Kane County based on analysis of PLS maps and data. Our objectives were to: 1) assess how the PLS described and sampled vegetation and relate the results to modern concepts of savanna, woodland, and forest, 2) correlate vegetation pattern and structure with landscape features and fire processes, 3) describe presettlement vegetation based on the PLS data, and 4) apply these results toward management and restoration guidelines for native woody-dominated ecosystems.

Based on previous studies, we expected vegetation in Kane County to be patterned by an interaction between eastward moving prairie fires (driven by westerly winds) and landscape firebreaks such as steep topography or watercourses - in this case the Fox River. This process would result in persistence of timber on the leeward sides of waterways, ravines or bluffs, or in areas of rugged topography (Anderson 1991, Ebinger 1997). We also expected fire to affect forest structure and composition. For example, low tree density (savanna) and dominance by oaks (*Quercus* spp.) would be expected in areas receiving only moderate fire protection. Greater tree density and presence of fire sensitive species, such as maple (*Acer*), ash (*Fraxinus*), basswood (*Tilia*) and elm (*Ulmus*) species would be expected in more fire-protected areas. We also expected to find greater linear cover of woody undergrowth, and greater richness of undergrowth species, associated with greater fire protection.

STUDY AREA

Kane County lies along the western border of the Chicago region, and comprises 15 townships covering 135,672.5 hectares (335,111 acres). The glacial stratigraphy of Kane County is primarily Woodfordian-aged glacial drift and glacial lake plain deposits (Figure 1). Most of the drift is morainic, although outwash and valley train deposits occur along the Fox River valley (Willman & Frye 1970, Willman 1971). Glacial lake beds occur in the north central and west central portions of the county. Elevation is highest in the northern part of Kane County, with relief ranging from 169 meters above sea level along the Fox River to 324 meters on the Palatine moraine in the northwestern part of the county. Drainage east and south of the Palatine moraine is into the Fox River through Tyler Creek, Otter Creek, Mill Creek, Blackberry Creek and Big Rock Creek (see Figure 2). Drainage to the west is into the Kishwaukee River through Coon Creek and headwaters of the Kishwaukee River. Kane Co. comprises two Natural Division, the Morainal Natural Division and the Grand Prairie Natural

Division (Mierzwa 1984). The Kettle Moraine Section of The Morainal Natural Division covers the northern half of the county, while the Fox River Bluff Section includes forests of the Fox River Valley. The Grand Prairie Section of the Grand Prairie Natural Division occupies the western half of the county.

HISTORIC METHODS

The Kane County Public Land Survey was conducted by five deputy surveyors between 1837 and 1840 (Table 1) with most of the survey conducted by James and John Thompson. James Gallway, Eli Prescott and Ignatius Sprigg also surveyed some exterior township lines. Each township was mapped after completion of its survey, showing the distribution of timber, watercourses, and settlement features. The Kane Co. PLS also described different vegetation types, including *prairie, wet prairie, marsh, slough, swamp, scattering timber* and *timber*. The PLS indicated distances along section lines for transitions between these vegetation types, which facilitated their mapping. The primary data collected by the PLS were the identity, diameter, distance, and direction for one to four bearing trees, each located in one of the four quadrants at each section corner, as well as for two bearing trees located in different quadrants at section quarter-corners and river crossings. Surveyors also recorded the identity and diameter of line trees intercepted by section lines, summarized tree species present along section lines, and recorded the species present in undergrowth along each section line. In Kane Co., undergrowth was recorded only from timber or scattering timber. The distances along section lines with woody vegetation were also used as metrics for linear extent or cover or of woody undergrowth.

The surveyors identified about 21 different tree species as either bearing trees or line trees by common name, including most of the dominant native tree species. We assume that most witness tree species were correctly identified and placed them in modern species analogs following Swink & Wilhelm (1984). However, identification of oaks, especially members of the black oak group, appears to have been difficult or inconsistent among surveyors (Collins 1997, Clark 2000, Table 1). Hill's oak or jack oak (*Q. ellipsoidalis*), was not identified by the PLS for Kane Co., although it was apparently frequent in the Chicago region (Trelease 1919, Waterman 1920). References to pin oak by the Kane Co. PLS may have been Hill's oak as it is also known as northern pin oak (Kilburn 1959), and there are no modern records of pin oak (*Quercus palustris*) from Kane Co. (Swink & Wilhelm 1994). Numerous references to black oak (*Q. velutina*) in Kane Co. may have been Hill's oak or hybrids among Hill's, black and red oak, as pure black oak is infrequent in Kane Co. (Swink & Wilhelm 1994). A single identification of "water oak" may have been swamp white oak (*Q. bicolor*). This species probably occurred frequently in poorly drained soils with bur oak, with which it hybridizes (Swink & Wilhelm 1994). The term "maple" was applied to soft maple (*Acer saccharinum*), a floodplain species, while "sugar tree" was applied to *A. saccharum* and *A. nigrum*, species of mesic forest habitat (Swink & Wilhelm 1994). Ash species (*Fraxinius* sp.) probably included white ash (*Fraxinus americana*), red ash (*F. pennsylvanica*), green ash (*F. pennsylvanica* var. *sub-integerrima*), blue ash (*F. quadrangulata*) or black ash (*F. nigra*). The surveyors also identified six additional species present as woody undergrowth. Some of these, such as the shrub American hazelnut (*Corylus americana*), spice (probably *Lindera benzoin*) pawpaw

(*Asimina triloba*) and swamp dogwood (*Cornus* sp) could be assigned to species or genera, other names such as “vines” or “briars” are vague. Many shrub species may have been unknown to the surveyors (Clark 2000).

MODERN METHODS

Mapping and interpretation

We transcribed and analyzed the PLS data from microfilm copies of the original notes. These data were used to refine the original PLS vegetation plat maps by digitizing vegetation boundaries and bearing tree locations using ARC/INFO Geographical Information System (GIS) software (http://esri.com/). GIS was also used to add layers for section lines, bearing trees, section and quarter-corner tree densities, line trees, tree species summaries and woody undergrowth summaries. Features of European settlement, such as fields and roads, were not included in the GIS maps or landscape analysis. The total and percent coverage of vegetation types was calculated based on area of polygons for each type. This method may underestimate coverage of linear features such as streams or rivers that are not mapped as polygons.

Data analysis

We used all recorded bearing tree distances to calculate tree density for each section and quarter-corner. This procedure followed the modified point-center-quarter sampling method, where trees/hectare = $10{,}000\ m^2 \div (\bar{x}\ d)^2$, and $\bar{x}\ d$ = the mean distance of up to four bearing trees at each corner adjusted for the number of trees sampled (Cottam & Curtis 1956). A 400 trees/ha ceiling for tree densities was used to avoid artificially high values that can result from the point-center-quarter method. Corner and quarter corner bearing tree densities were used to calculate average densities for the PLS vegetation types of timber, scattering timber, prairie and wet prairie, and wetlands. For vegetation that usually did not support bearing trees, such as prairie, these densities represent only corners with trees, and thus local tree densities. According to Clark (2000) selection of the Q1 (nearest) bearing tree was least likely to be biased, and calculation of density using additional bearing trees from the same corner will result in low estimates of stand density. To reduce effects of this bias on vegetation classification, we placed density calculations into classes of *open savanna* (> 0-10 trees/ha), *savanna* (> 10-50 trees/ha), *woodland* (> 50-100 trees/ha) and *forest* (> 100 trees/ha) categories following Anderson & Anderson (1975) and Bowles *et al*. (1994). The total and relative (R) density (D) and basal area (BA) and importance value [IV = (RD + RBA)÷2] were calculated for each bearing tree species in all vegetation types and categories. Basal area was calculated in square meters by converting from the original measure of diameter in inches. These data are based on total occurrences within each vegetation type, thus represent an unbalanced sample. As a result, only relative data and importance values can be compared among vegetation types. We used dominance (relative BA) to compare differences in composition of timber east and west of the Fox River.

We determined the linear extent of woody undergrowth along section lines in each PLS vegetation type. The length of all section lines from which undergrowth was recorded was expressed as a percentage of the total length of these section lines. This statistic was also calculated for each species, and converted to relative abundance among all species recorded.

Using species basal area as a metric, we ordinated tree density classes and corresponding species groups with Detrended Correspondence Analysis (DECORANA) on PCORD software (McCune & Mefford 1995). A species bi-plot overlay was used to express species correlations with the first and second ordination axes. Group Averaging Cluster Analysis was used to identify species groups using a Relative Euclidean distance metric on PCORD. We used known ecological adaptations of different species (e.g. Swink & Wilhelm 1994) to make inferences about presettlement habitat conditions and vegetation types.

RESULTS

Vegetation pattern and structure

The presettlement vegetation of Kane County was predominantly grassland, which covered about 61 % of the landscape (Table 2, Figure 3). Wetland vegetation, primarily marsh, covered about 0.2 %, while lakes and rivers covered about 0.7 %. Woody vegetation covered almost 38 % of the landscape and was represented in every township, with about 36 % timber and less that 2 % scattering timber. About 80 % of timber and scattering timber occurred on forest soils (unpublished data). Linear cover of woody undergrowth on section lines was 50 % in timber and about 34 % in scattering timber. A large area of timber, described as “thin” or “thinly timbered,” occurred across the northern tier of townships, partly in association with Tyler Creek and the Fox River on the east and Coon Creek on the west. Smaller “thinly timbered” areas were described in association with stream drainages in the central and southern part of the county. A large block of timber known as the Big Woods (Kilburn 1959) bordered the east side of the Fox River in Aurora and Batavia townships. Small areas of scattering timber were mapped with timber along the west side of the Fox River, and with timber or “bur oak openings” in the northern tier of townships. Recognition of scattering timber was inconsistent. In some cases, the same deputy surveyor would record scattering timber along an exterior township line, but not along a section line at the point where it joined the exterior line from which scattering timber had been recorded. Small areas of wet prairie were mapped throughout the county, but were most extensive in the western and northern townships. Small swamps were mapped in the northern tier of townships, as well as a small section of the larger “Wabansie Swamp,” which occurred to the south in Kendall County. A large lake (“Mudd Lake”) was mapped with timber along the section line between Blackberry and Batavia townships.

Landscape vegetation structure based on tree density classes was about 65% open savanna and savanna, 15 % woodland, and about 18 % forest (Figure 4). Based on vegetation described by the PLS, over 95 % of the bearing tree corners were described as occurring in timber, with less than 10 % in scattering timber and less than 5 % in prairie and wetlands (Figure 4). Timber averaged about 60 trees/ha and was 65 % open savanna and savanna, while scattering timber averaged about 35 trees/ha and was over 85 % open savanna and savanna (Figure 4). Prairie and wetland habitats with bearing trees also averaged about 30 trees/ha and were almost 75 % open savanna (Figure 4).

Vegetation composition

Stand tables for all vegetation types are compiled in Appendices I-III. Overall, bur oak was the most important tree species, with white and black oak as the most important secondary species. Black oak was more important than white oak only in scattering timber; but was absent from wet prairie and marsh corners. White oak was absent from marsh corners with trees, which had only bur and red oak.

Among dominant bearing tree species, white oak and black oak averaged about 46 cm dbh, while bur oak averaged about 38 cm (bearing and line tree dbh's are in Appendix IV). Subdominant species were smaller, with red oak, sugar maple, ash and hickory averaging less than 35 cm dbh. Black oak, sugar maple and ash line trees were larger than bearing tree counterparts, but white oak and bur oak line and bearing trees were similar in size. These differences could indicate that surveyors were selecting smaller trees in some cases, but the differences may be confounded by the greater chances of larger line trees being intercepted by the line intercept method (Brower & Zar 1984).

There were structural and compositional differences east and west of the Fox River (Figure 5). Timber west of the river averaged about 45 trees/ha and was predominantly open savanna and savanna, while timber east of the river averaged almost 100 trees/ha with greater proportions of forest and savanna tree densities. In timber, the extent of woody undergrowth reached more than 80 % east of the river, but only about 40 % west of the river. In scattering timber, coverage of woody undergrowth was also about 40 % west of the river, but was much lower east of the river where little scattering timber was present.

Ordination aligned woody vegetation types in relation to locations west or east of the Fox River, as well differences in tree density (Figure 6). Higher first axis scores corresponded to woody vegetation located east of the river, as well as a gradient of increasing tree density. East of the river, forest and woodland corresponded to greater abundance of sugar maple, soft maple, ash, hackberry and ironwood. West of the river, open savanna, savanna and woodland corresponded to greater abundance of bur oak, black oak, white oak and hawthorn. Cluster analysis separated two groups with four distinct species sub-groups (Figure 6). One group comprised a black oak-white oak-hawthorn sub-group and a bur oak-red oak-pin oak sub-group. The second group included an ash-sugar maple-elm-basswood sub-group and a cherry-hackberry-soft maple-ironwood sub-group. They were also closely linked with a cottonwood-willow-walnut sub-group.

Tree species richness was greatest in forest conditions east of the Fox River, where 15 species were sampled. Pin oak was sampled only west of the river, while hackberry, soft maple, cottonwood and willow occurred only east of the river (Table 3). West of the Fox River, bur oak was the dominant tree species in open savanna, savanna and forest while white oak was more important in woodland (Figure 7). East of the Fox River, white oak was the dominant species in open savanna, woodland and forest, while bur oak was co-dominant with black and white oak in savanna. Black oak had secondary dominance west of the river and in open savanna and savanna east of the river, but it was exceeded in dominance by sugar maple and red oak in woodland and sugar maple in forest east of the river. Among secondary species, red oak was most important in savanna and woodland. It was exceeded by elm, ash and basswood in forests west of the Fox River, and by ash, elm, hickory and ironwood in forests east of the Fox River. Overall, woody undergrowth was dominated by hazel, followed by oak, black oak, briers and bur oak. Greater richness of undergrowth species occurred in timber, reaching ten species east of the river.

DISCUSSION

Factors shaping landscape vegetation pattern and structure

As in other Chicago region counties (Bowles et al. 1994, McBride & Bowles 2001), the presettlement landscape vegetation pattern in Kane County fits a landscape fire model in which prairie fires driven by prevailing south-westerly winds eliminated timber in fire-prone areas of the landscape (Gleason 1913, Moran 1978, Anderson 1991, Leitner *et al*. 1991). In this fire-caused process, scattering timber represents a transitional stage between timber and prairie, with prairie representing the final stage (Gleason 1922, Transeau 1935, Curtis 1959). Using tree density classes, scattering timber is most analogous to savanna, as it averaged about 35 trees/ha. This vegetation pattern began to develop between 6,000-8,000 years ago during the hottest and driest part of the Holocene in Illinois. It shifted spatially over time in response to changing climatic conditions, favoring either forest during periods of greater rainfall and less frequent fire, or prairie and savanna during periods of less rainfall and more frequent fire (Grimm 1984). However, it may have been stabilized by over short time periods with stable climatic conditions, such as at the time of the PLS (Anderson & Bowles 1999). The strong (79.5 %) correspondence of timber with forest soils adds support to this hypothesis. Areas of scattering timber that occur on prairie soils could either represent colonization of prairie by oak savanna during periods of low fire frequency, or persistence of trees during conversion of forest soils to prairie soils.

The structure and composition of landscape units in Kane Co. add support to the fire model, with greater tree density, greater linear coverage of woody undergrowth, and greater woody species richness in more fire-protected habitats. The landscape gradient of species composition also supports this model. Bur oak, which is considered the most fire-tolerant oak because of its thick bark, reaches its greatest abundance in open savanna west of the Fox River, and declines across an increasing tree density gradient east of the river. White oak, which is apparently less fire-tolerant, reaches greater dominance east of the Fox River. More fire-sensitive species, including elm, ash, basswood and sugar maple reach greater abundance in woodland and forest east of the Fox River. The dominance of oak species across all vegetation types suggests that fire affected the entire landscape continuum because oaks are fire dependent and shade intolerant (Lorimer 1985, Abrams 1992). Many fire-intolerant species are also shade-tolerant, which would allow them to persist at higher tree densities created by greater fire protection. Increasing shade would reduce soil moisture loss and favor species adapted to these conditions, such as maple, ash, basswood and elm species. This combination of environmental conditions would also reduce fuel flamability and further select against oak species in a feedback process.

Composition and structure of woody vegetation types

Although the large scale of PLS vegetation data prevents accurate and detailed mapping of vegetation types, they provide estimates of forest composition and ranking of species dominance (Manies & Mladenoff 2000). By combining species dominance with section line summaries of woody undergrowth, we have added an additional layer of structural information. By overlaying this information with savanna, woodland and forest tree density classes in relation to effects of landscape ecological features such as firebreaks and soils information, we can refine description of these vegetation types.

Savanna

Savanna vegetation was widespread and dominated by bur oak in western Kane Co., especially in the Kettle Moraine Section. Savanna may have been abundant in this area because the rugged morainal topography reduced fire effects and allowed persistence of timber (Kilburn 1959). Nevertheless, the PLS description of this vegetation as “thinly timbered” suggests a strong landscape fire effect. As a result, tree species that had lower fire-tolerance were infrequent and only white and black oak had secondary importance. However, a minor shift in compositional structure occurred between open savanna and savanna, which may indicate a fire effect. In open savanna (> 0-10 trees/ha), bur oak was six times as important as white and black oak, while in savanna (>10-50 trees/ha), bur oak was only twice as important as white and black oak. Based on the 40 % linear extent of woody undergrowth west of the Fox River, the understory of savanna in this area appears to have been predominantly open grassland, with patchy occurrences of hazel and oak fire-sprouts. The presence of black and white oak in these habitats also suggests that drainage in much of the savanna west of the Fox River was dry-mesic. The minor representation of red oak, with lower importance of elm, hickory, ash, sugar maple and basswood indicates that more diverse savanna vegetation developed in mesic or wet mesic habitat conditions, probably along the west valley of the Fox River.

East of the Fox River, savanna developed as a border along woodland and forest south of the Big Woods and also occurred in a narrow band adjacent to the river to the north. The composition and structure of savanna in this area would have been developed less by head fires and more by backfires moving westward from prairies to the east. Although bur, black and white oak remained as dominant species, there was much lower dominance of bur oak and greater evenness among these species than in savanna west of the Fox River. Woody undergrowth dominated by hazel appears to have been more frequent in savanna east of the river, ranging from 40-80 % linear cover. The occurrence of mesic savanna east of the river is evidenced by minor representation of red oak, sugar maple, ash, elm, hickory. Savanna conditions for these species may have been restricted to lower areas of the Fox River valley.

Woodland

Although oak woodland (> 50-100 trees/ha) is often thought of as typifying the Chicago region’s presettlement oak timber, this vegetation was less frequent than savanna or forest vegetation types in Kane Co., represented by about 15 % of the bearing tree corners. West of the Fox River, woodland occurred along stream drainages or lakes, such as Big Rock Creek or Mudd Lake, or in the interior of tracts of timber, presumably in more fire-protected mesic situations than savanna. This vegetation was co-dominated by bur, black and white oak, with minor occurrences of other species, primarily red oak and hickory. Woody understory vegetation appears similar to savanna undergrowth, with about 40% linear cover and dominance by hazel and oak. East of the Fox River, woodland was also represented by only about 15 % of the bearing tree corners and was most frequent in the interior of the Big Woods. This vegetation was dominated by white oak, with sub-dominance of bur oak, sugar maple, red oak and black oak, and secondary representation by ash, elm, and hickory. Woody undergrowth dominated by hazel appears to have been frequent in woodland east of the river, reaching up to 80 % linear cover.

Forest

Forest conditions were infrequent west of the Fox River, represented by slightly over 10 % of the bearing tree corners. West of the river, forest tree densities occurred along Big Rock Creek, Tyler Creek and Mill Creek. Bur oak, black oak and white oak were dominant species in these conditions, although sugar maple was recorded as a single bearing tree, and as a line tree in Big Rock and Sugar Grove townships. More diverse forest stands developed east of the Fox River, apparently in upland and floodplain habitat (Kilburn 1959). As with woodlands, upland forests were dominated by white oak, but bur oak and black oak were less important and replaced by sugar maple as the leading sub-dominant species. Ash, elm, hickory and ironwood also reached their greatest importance in this habitat. Woody undergrowth dominated by hazel reached up to 80 % linear cover, and included spicebush and pawpaw, species that are usually restricted to forests and may be fire-sensitive. The composition and structure of this habitat gives some of the best available historic information about co-occurrence of sugar maple and white oak, species thought to have incompatible fire adaptations. Unfortunately, most of this vegetation has been lost to development. The occurrence of soft maple with ash, elm, and hackberry also indicate that floodplain forest developed along the Fox River valley.

MANAGEMENT AND RESTORATION IMPLICATIONS

<u>Issues of scale and accuracy</u>

Although the PLS sampling data provide meaningful information, applying restoration models based on these data to small-scale restoration and management can be problematic without an appropriate transfer of scale. For example, the landscape-scale PLS sample coverage would provide few sample points that might directly apply at a small scale to existing sites (Bowles & McBride 1998). Further, the point-center-quarter sampling method is vulnerable to non-random vegetation patterns and to sampling error, and may provide erroneous information with small sample sizes. The linear measure of woody undergrowth also represents a large-scale sample that does not directly translate to more precise small-scale measures of woody undergrowth. However, the landscape scale abundance of woody undergrowth is meaningful in a restoration context

Restoring fire processes and oak dominance

Management to restore presettlement or "natural" vegetation conditions must take into account the dynamic nature of vegetation. However, if presettlement vegetation pattern and structure changed very little during periods of stable climatic conditions, then conditions present in the early 1800's probably would have persisted after the 19th century. Therefore, the structure and composition of this vegetation represent a framework for setting restoration management goals and objectives, and for understanding the landscape processes needed to reach these goals. Landscape fire processes appear to have played a major role in shaping the presettlement vegetation pattern of Kane Co., and are therefore critical for restoring and managing these conditions. The dominance of oaks throughout all woody vegetation types, including wet-mesic forests, also indicates that fire affected the entire continuum of woody vegetation. However, other disturbance processes, such as replacement in tree fall gaps, probably also occurred at higher tree densities.

Restoring community composition and structure

The PLS results provide information for making choices of which vegetation types to restore based on their landscape position, as well as their former abundance. Clearly, restoration of savanna vegetation should be a primary concern, and developing appropriate savanna structure is a critical issue. The Kane Co. data agree with results from Dupage Co. indicating that savanna vegetation was often three-layered, with presence of woody understory vegetation dominated by American hazelnut, *Corylus americana* (Bowles *et al*. 1994). Therefore, propagation and reintroduction of this species should be an important management objective (Bowles & Spravka 1994). As shown by data from Kane Co., a useful model for restoring woody understory vegetation is based on fire frequency and intensity, with greater abundance of woody undergrowth in more fire-protected habitat.

PLS data also indicate that assumptions about former levels of abundance of woodland and forest need to be re-evaluated. Woodland is often considered to have been the predominant woody vegetation type of the Chicago region and is an important focus of restoration activities (Chicago Wilderness Biodiversity Council 1999). However, results from Kane Co. indicate that woodland occupied less than 20% of the landscape, and that forest vegetation was considerably more abundant. Many existing woody vegetation remnants that are considered representative of woodland (e.g. Bowles & McBride 1996) may have been formerly more open savanna communities (Bowles et al. 2000). As a result, management to restore woodland structure may not replicate the conditions present prior to settlement. In turn, some modern forest remnants may have been originally more open and similar to woodland. Restructuring these remnants to a former more open woodland structure will require the use of fire as well as supplemental mechanical canopy thinning. However, based on tree density classes, forest vegetation was also present in fire-protected habitat, and little information has been available about the fine-scale structure and composition of these forests. Data from the Big Woods area indicate co-occurrence of fire-dependent oak and hazel with sugar maple, a species thought to be fire-sensitive and shade tolerant. This information provides evidence that fire probably was important in structuring this vegetation. Because of the limited information about presettlement woodland and forest, applied research will be required to learn how to maintain biological diversity when these habitats are managed to replicate presettlement conditions (Bowles et al. 2000).

LITERATURE CITED

Abrams, M.D. 1992. Fire and the development of oak forests. BioScience 42:346-353.

Anderson. R.C. 1991. Presettlement forests of Illinois. Pages 9-19 in: Proceedings of the Oak Woods Management Workshop. G.V. Burger, J.E. Ebinger, & G.S. Wilhelm, eds. Eastern Illinois University, Charleston.

Anderson, R.C. 1983. The eastern prairie-forest transition - an overview. Pages 86-92 in: Proceedings of the Eighth North American Prairie Conference. R. Brewer, ed. Western Michigan University, Kalamazoo.

Anderson, R.C., & M.R. Anderson. 1975. The presettlement vegetation of Williamson County, Illinois. Castanea 40:345-363.

Anderson, R.C, & M.L. Bowles. 1999. Deep soil savannas and barrens of the midwestern United States. Pages 55-70 in: The savanna, barren, and rock outcrop communities of North America. R.C. Anderson, J.S. Fralish, & J. Baskin, eds., Cambridge University Press.

Apfelbaum, S.I. & A. W. Haney. 1991. Management of degraded oak savanna remnants in the upper Midwest: preliminary results from three years of study. Pages 81-90 in: Proceedings of the Oak Woods Management Workshop. G.V. Burger, J.E. Ebinger, & G.S. Wilhelm, eds. Eastern Illinois University, Charleston.

Bourdo, E.A., 1956. A review of the General Land Office Survey and of its use in quantitative studies of former forests. Ecology 37:754-768.

Bowles, M.L., & J.L. McBride. 1994. Presettlement barrens in the glaciated prairie region of Illinois. Pages 75-85 in: Proceedings of the North American Conference on Savannas and Barrens. J.S. Fralish, R.C. Anderson, J.E. Ebinger, & R. Szafoni, eds. Environmental Protection Agency, Great Lakes National Program Office, Chicago.

M.L. & J. McBride. 1996. Evaluation and classification of savanna, woodland , and barrens natural areas in northern Illinois. Report to the Illinois Department of Natural Resources. The Morton Arboretum, Lisle, Ill.

Bowles, M.L. & J.L. McBride. 1998. Vegetation composition, structure, and chronological change in a decadent midwestern North American savanna remnant. Natural Areas Journal 18:14-27.

Bowles, M., M.Jones, J. McBride, T. Bell, & C. Dunn. 2000. Structural composition and species richness indices for upland forests of the Chicago region. Erigenia 18:30-57.

Bowles, M. L. & J. L. McBride. 2001. Landscape Vegetation Pattern, Composition, and Structure of Will County, Illinois, as Recorded by the U. S. Public Land Survey. The Morton Arboretum, Lisle, Ill.

Bowles, M. L. & J. L. McBride. 2002. Pre-European settlement vegetation of Cook County, Illinois, as Recorded by the U. S. Public Land Survey. The Morton Arboretum, Lisle, Ill.

Bowles, M.L., J. McBride, C. Dunn, M. Jones & T. Bell. 1997. Twenty-year woody vegetation changes in five Kane County, Illinois Forest Preserves. The Morton Arboretum, Lisle, Ill.

Bowles, M.L., M.D. Hutchison, & J.L. McBride. 1994. Landscape pattern and structure of oak savanna, woodland, and barrens in northeastern Illinois at the time of European settlement. Pages 65-73 in: Proceedings of the North American Conference on Savannas and Barrens. J.S. Fralish, R.C. Anderson, J.E. Ebinger, & R. Szafoni, eds. Environmental Protection Agency, Great Lakes National Program Office, Chicago.

Bowles, M.L. J. McBride, & L. Bell. 1999. Landscape Vegetation Pattern, Composition, and Structure of DuPage County, Illinois, as Recorded by the U. S. Public Land Survey (1821-1840). The Morton Arboretum, Lisle, Ill. & Ecological Services, Urbana, Ill.

Bowles, M & M. Spravka. 1994. American hazelnut, an overlooked native shrub in northeastern Illinois. the Morton Arboretum Quarterly 30:42-48.

Brower, J.E., & J.H. Zar. 1984. Field & laboratory methods for general ecology, second edition. W.C. Brown Publishers, DuBuque, Iowa.

Brugman, R.B. & M.J. Patterson. 1996. Application of a geographic information system to mapping presettlement vegetation in southwestern Illinois. Transactions Illinois Academy of Science 89:125-141.

Chicago Wilderness Biodiversity Council. 1999. Biodiversity Recovery Plan. Chicago Wilderness Biodiversity Council, Chicago, Ill..

Clark, D. C. 2000. The surveyors surveyed: investigations of bias in General Land Office surveyor data for northeastern Illinois,1837-1840. M. A. thesis, Northeastern Illinois University.

Collins, E. R. 1997. The pre-Euroamerican natural communities of the Nippersink Creek watershed in McHenry County. M. A. thesis, Northeastern Illinois University.

Cottam, G. 1949. The phytosociology of an oak woods in southwestern Wisconsin. Ecology 30:271-287.

Cottam, G. & J.T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology 37:451-460.

Curtis, J.T. 1959. The vegetation of Wisconsin - an ordination of plant communities. The University of Wisconsin Press, Madison.

Davis, A.M. 1977. The prairie-deciduous forest ecotone in the upper middle west. Annals of the Association of American Geographers 67:204-213.

Ebinger, J.W. 1997. Forest communities of the Midwestern United States. Pages 3-23 in: Conservation in highly fragmented landscapes, M.W. Schwartz, ed. Chapman & Hall, New York.

Edgin, B.R. & J.E. Ebinger. 1997. Barrens and the forest-prairie interface in presettlement Crawford County, Illinois. Castanea 62:260-267.

Gleason, H.A. 1913. The relation of forest distribution and prairie fires in the middle west. Torreya 13:173-181.

Gleason. H.A. 1922. Vegetational history of the Middle West. Association of American Geographers Annals 12:39-85.

Grimm, E. C. 1983. Chronology and dynamics of vegetation change in the prairie-woodland region of southern Minnesota, U.S.A. New Phytologist 93:311-350.

Grimm, E.C. 1984. Fire and other factors controlling the Big Woods vegetation of Minnesota in the mid-nineteenth century. Ecological Monographs 54:291-311.

Hutchison, M.D. 1988. A guide to using the Public Land Survey Notes in Illinois. Natural Areas Journal 8:245-255.

Kilburn, P.D. 1959. The forest-prairie ecotone in northeastern Illinois. The American Midland Naturalist 62:206-217.

Leach, M.K, & L. Ross (eds). 1995. Midwest oak ecosystems recovery plan: a call to action. U.S. Environmental Protection Agency, Chicago, Ill.

Leitner, L.A., C.P. Dunn, G.R. Guntenspergen, F. Stearns, & D.M. Sharpe. 1991. Effects of site, landscape features, and fire regime on vegetation patterns in presettlement southern Wisconsin. Landscape Ecology 5:203-217.

Lorimer, C.G. 1985. The role of fire in the perpetuation of oak forests. Pages 8-25 in Challenges in Oak Management and Utilization. J.E. Johnson, ed. Cooperative Extension Service, University of Wisconsin, Madison.

Manies, K.L. & D.J. Mladenoff. 2000. Testing methods to produce landscape-scale pre-settlement vegetation maps from the U.S. public land survey records. Landscape Ecology 15:742-754.

McBride, J.L. & M.L. Bowles. 2001. Vegetation pattern of DuPage and Will counties at the time of European settlement. In: Proceedings of the Northern Illinois Prairie Conference. C. Peterson, ed. College of DuPage, Glen Ellyn, IL.

McCune, B. & G. Cottam. 1985. The successional status of a southern Wisconsin oak woods. Ecology 66:1270-1278.

McCune, B. & M.J. Mefford. 1995. PC-ORD. Multivariate analysis of ecological data, Version 2.0. MjM Software Design, Gleneden Beach, Oregon, USA.

Mierzwa K. 1994. Natural Divisions of the Chicago Region. Pages 38-39 in Plants of the Chicago Region by Swink, F. & G. Wilhelm. Indiana Academy of Sciences.

Moran, R.C. 1978. Presettlement vegetation of Lake County, Illinois. Pages 12-18 in: Proceedings of the fifth Midwest Prairie Conference. Glenn-Lewin, D.C. and R.Q. Landers, eds. Iowa State University, Ames.

Moran, R.C. 1980. Presettlement (1830) vegetation of DeKalb, Kane and DuPage counties, Illinois. M.S. Thesis, Southern Illinois University, Carbondale.

Robertson, K.W. & M.W. Schwartz. 1994. Prairies. In Illinois Department of Energy and Natural Resources. The Changing Illinois Environment: Critical Trends. Technical Report of the Critical Trends Assessment Project. Vo. 3: Ecological Resources. Illinois Department of Energy and Natural Resources, Springfield.

Rogers, C.S. & R.C. Anderson. 1979. Presettlement vegetation of two prairie peninsula counties. Botanical Gazette 140 (2):232-240.

Schwartz, M.W. (*ed.*) 1997. Conservation in highly fragmented landscapes. Chapman & Hall, New York.

Schwegman, J.E., G.D. Fell, M. Hutchison, G. Pauson, W.M. Shepherd & J. White. 1973. Comprehensive Plan for the Illinois Nature Preserves System. Part II - The Natural Divisions of Illinois. Illinois Nature Preserves Commission, Springfield.

Stearns, F.W. 1991. Oaks woods: an overview Pages 1-7 in: Proceedings of the Oak Woods Management Workshop. G.V. Burger, J.E. Ebinger, & G.S. Wilhelm, eds. Eastern Illinois University, Charleston.

Swink, F. & G. Wilhelm. 1994. Plants of the Chicago Region. Indiana Academy of Science, Indianapolis.

Transeau, E.N. 1935. The prairie peninsula. Ecology 16:423-437.

Trelease, 1919. The jack oak (*Quercus ellipsoidalis*) Transactions Illinois Academy Science 12:108-125.

Waterman, W.G. 1920. Distribution of oaks on the Lake Chicago bars in Evanston and New Trier. Townships. Transactions Illinois Academy Science 13:239-242.

Willman, H.B. 1971. Summary of the geology of the Chicago area. Circular 460, Illinois State Geological Survey, Urbana.

Willman, H.B. & J.C. Frye. 1970. Pleistocence stratigraphy of Illinois. Illinois State Geological Survey Bulletin 94, Urbana.

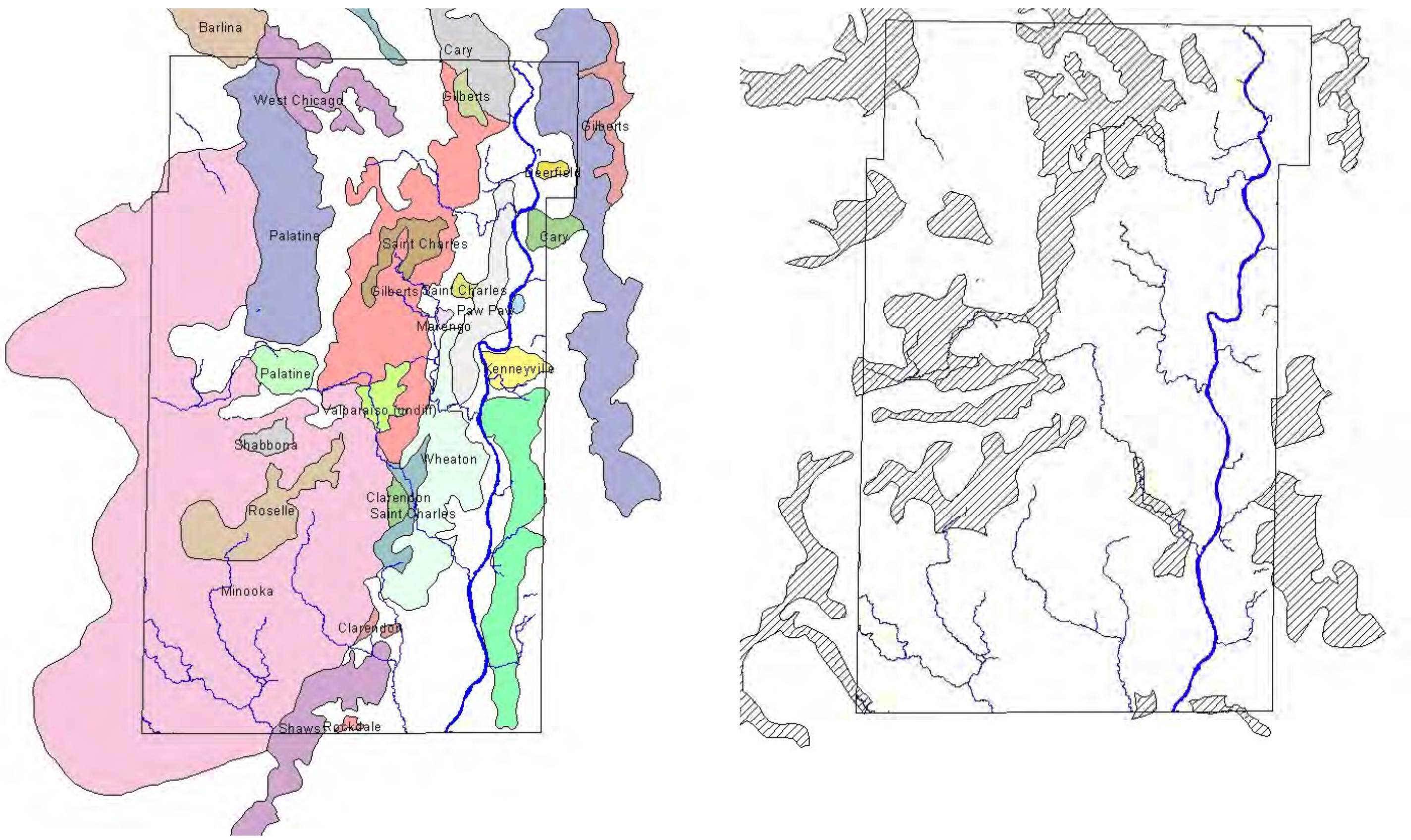

Figure 1. Glacial moraines (left) and glacial lakes (right) of Kane Co., Ill. (area within outline). Source: Illinois Natural Resources Geospatial Data Clearing House (www.isgs.uiuc.edu/nsdihome/ISGSindex).

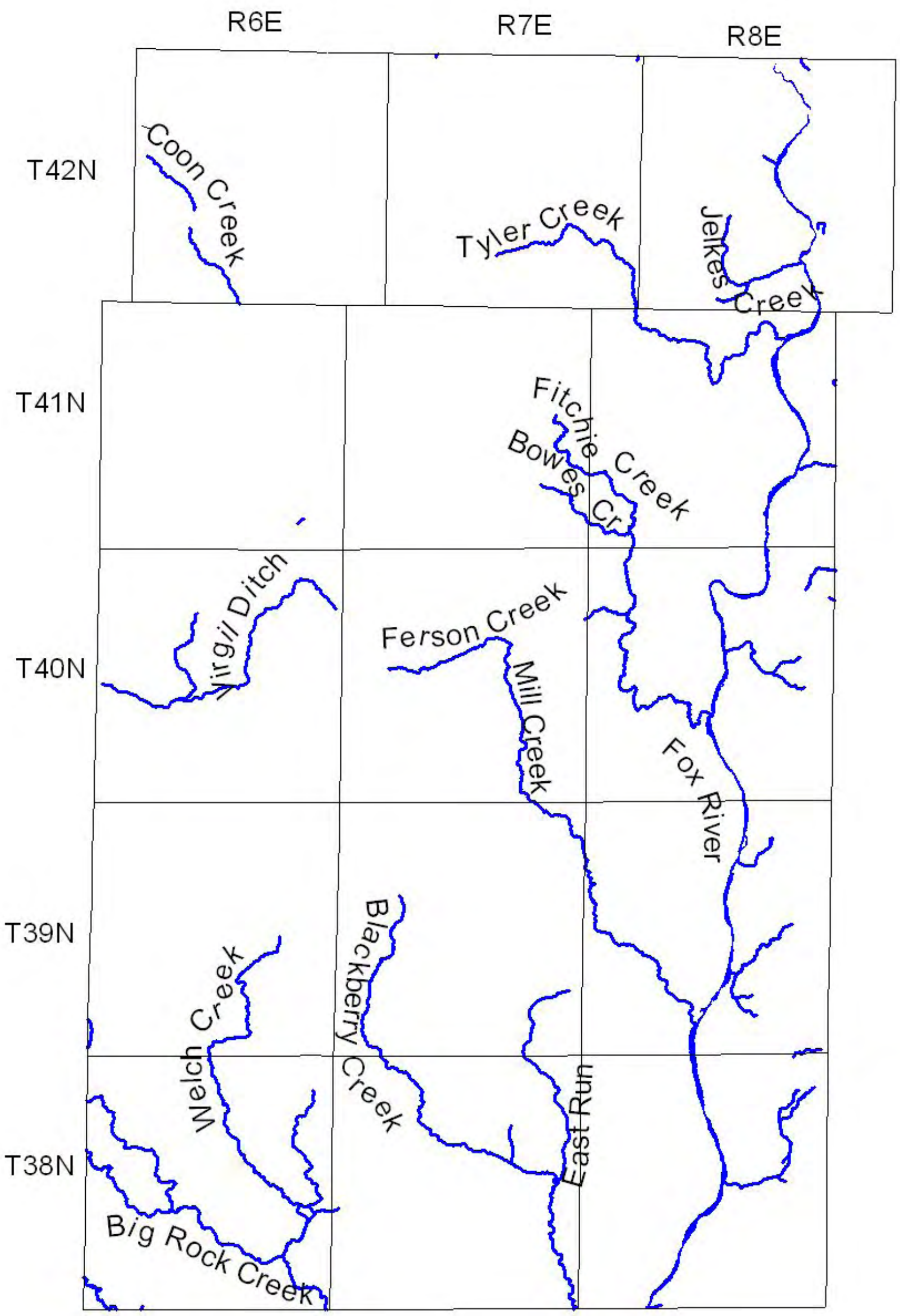

Figure 2. Public Land Survey Townships and streams Kane Co., Illinois.

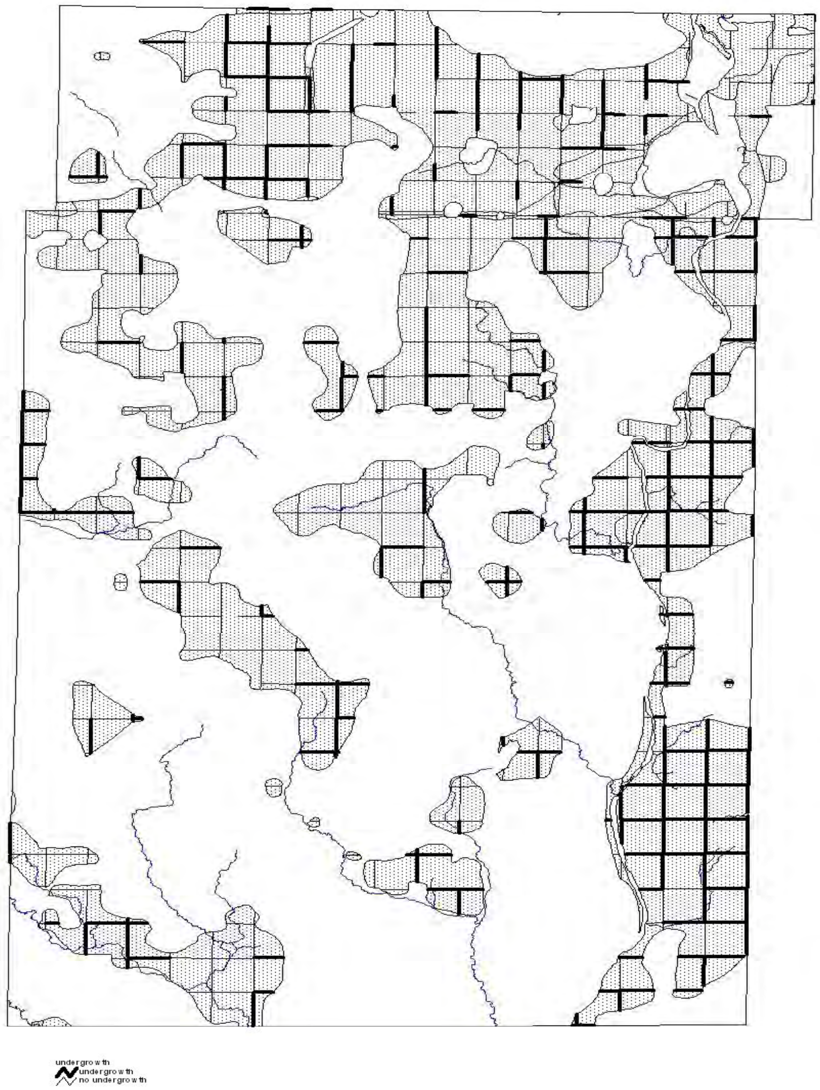

Figure 3. Landscape pattern of prairie, timber and scattering timber (shaded) and woody undergrowth woody (thickened section lines) recorded by the Public Land Survey in Kane Co., Ill.
areas represent timber and scattering timber.

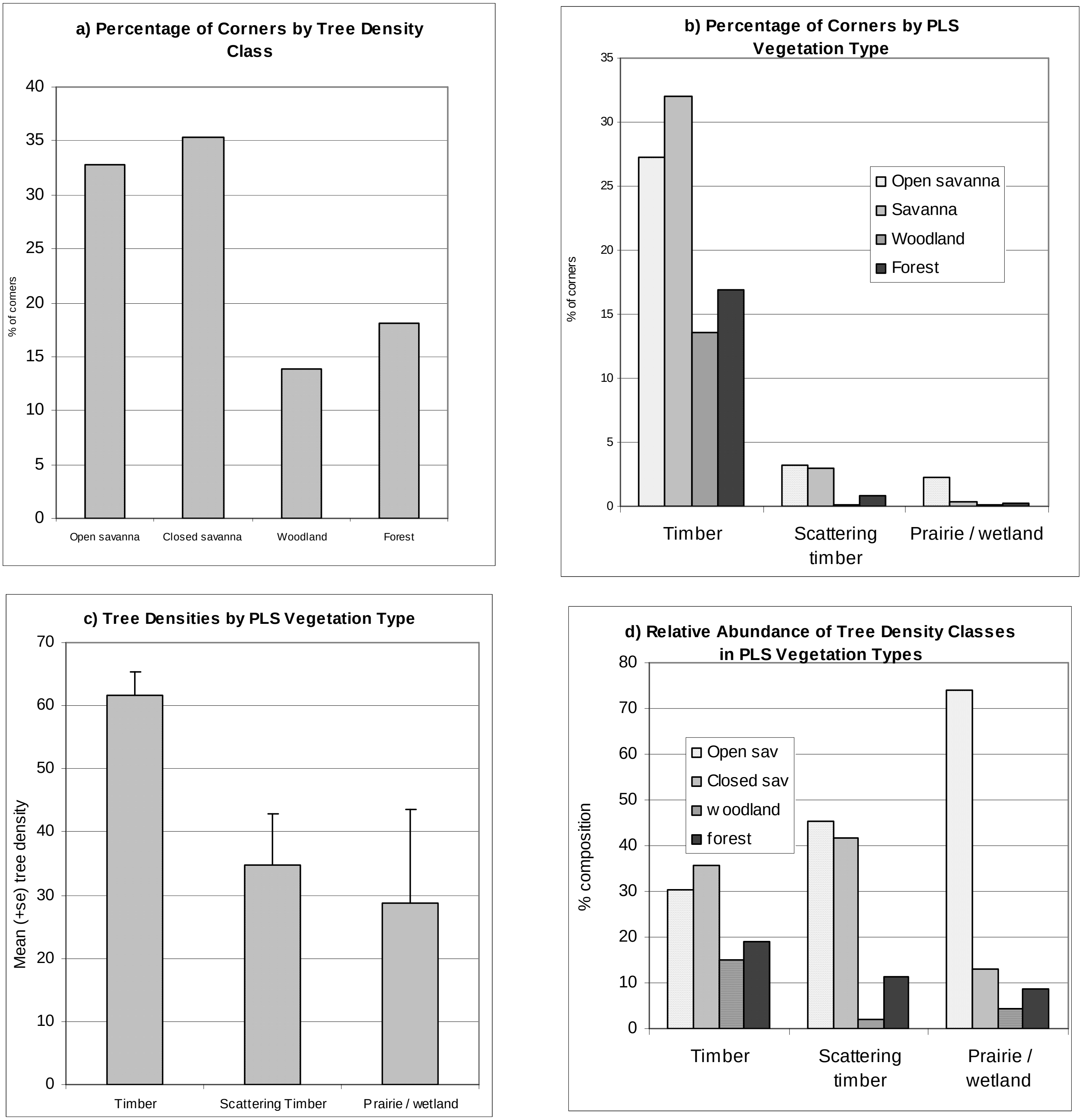

Figure 4. Landscape vegetation structure in Kane Co. a) percentage of PLS bearing tree corners by tree density classes; b) percentage of PLS bearing tree corners by PLS vegetation types; c) mean tree densities by PLS vegetation types; d) proportion of tree density classes within PLS vegetation types. Open savanna = < 10 trees/ha, savanna = > 10-50 trees/ha, woodland = > 50-100 trees/ha, forest = > 100 trees/ha.

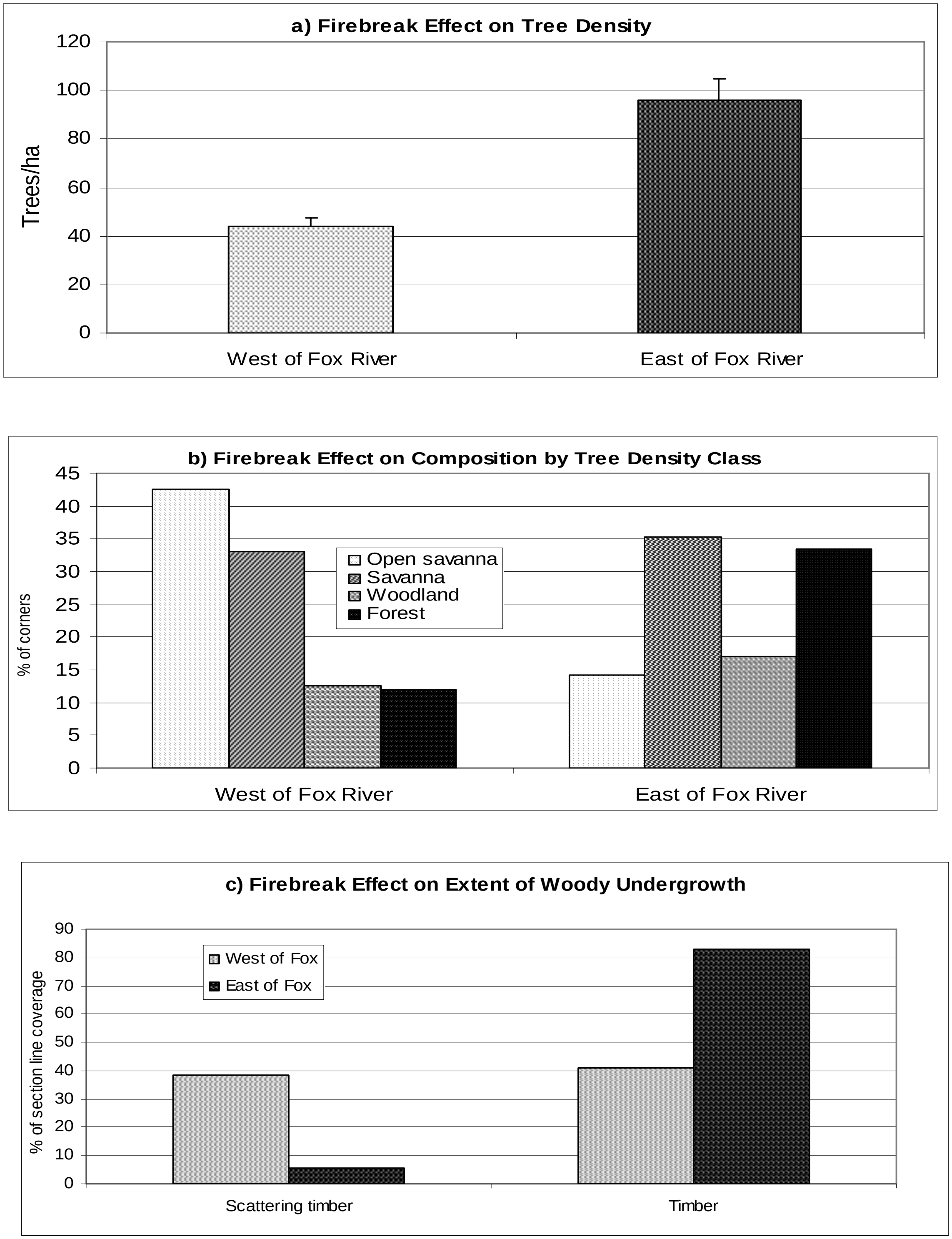

Figure 5. Landscape firebreak effect of the Fox River. a) effect on tree density; b) effect on abundance of tree density classes; c) effect on woody undergrowth. Open savanna = < 10 trees/ha, savanna = > 10-50 trees/ha, woodland = > 50-100 trees/ha, forest = > 100 trees/ha.

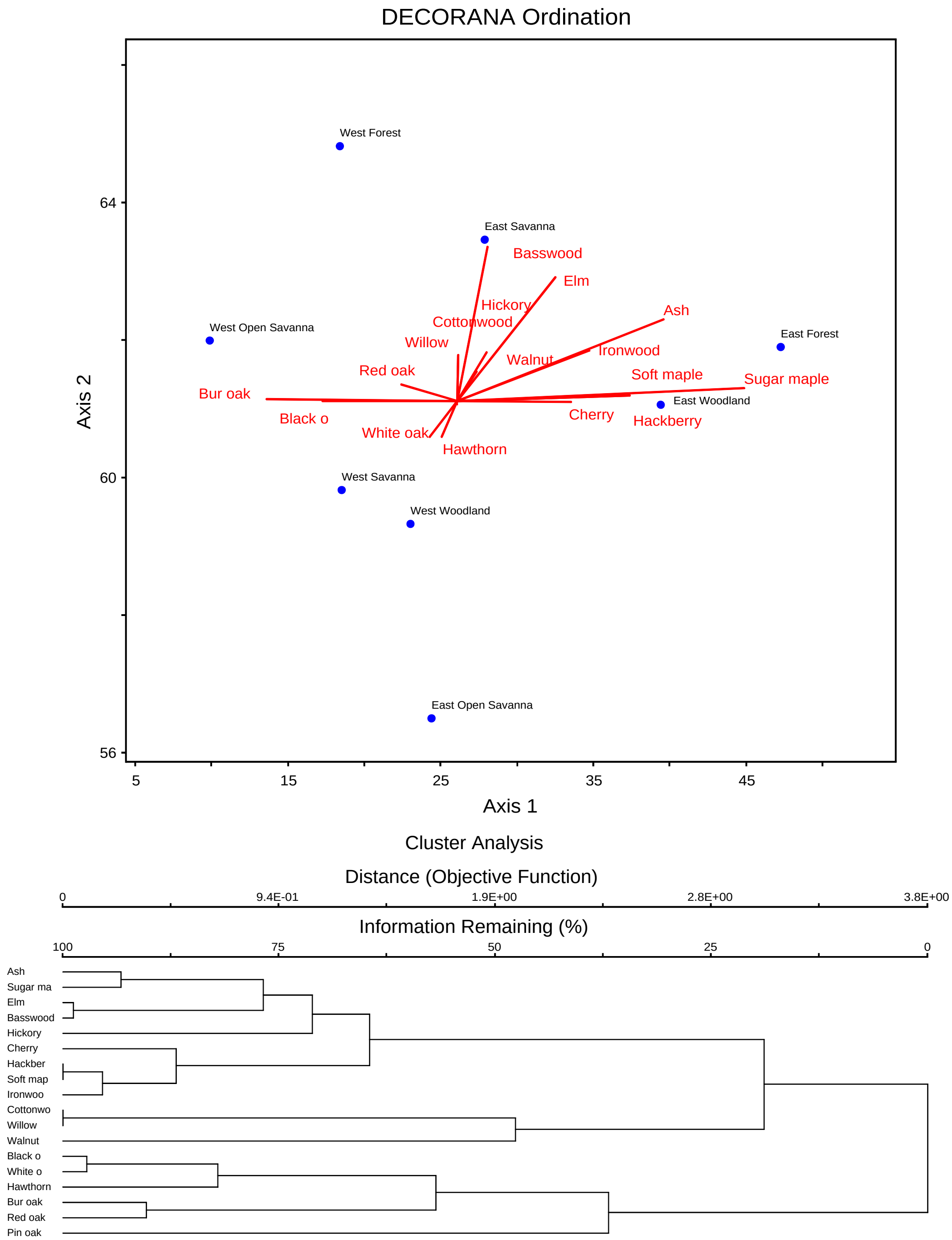

Figure 6. Decorana ordination (upper) and group averaging cluster analysis (lower) of presettlement vegetation of Kane Co., IL

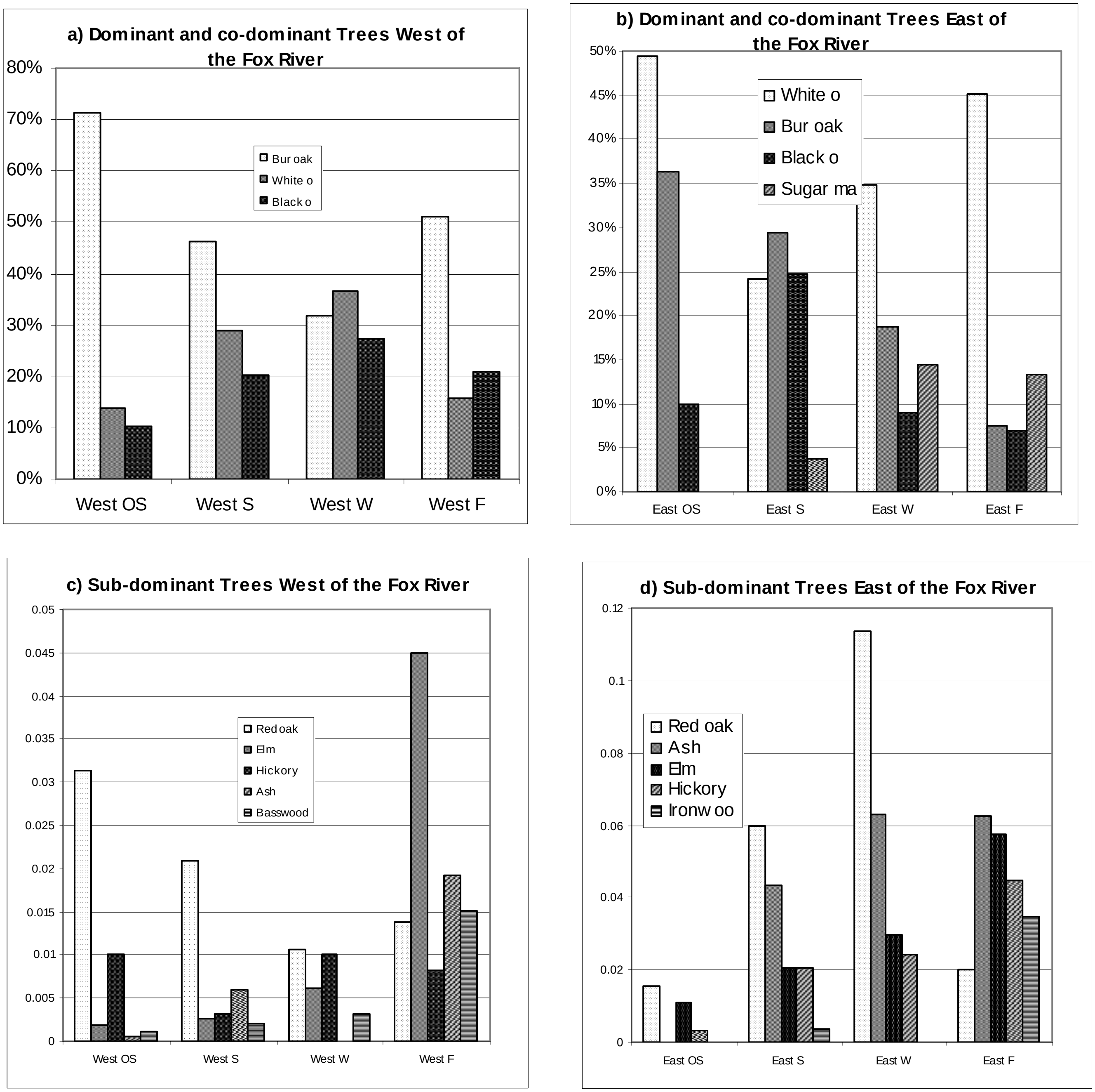

Figure 7. Landscape effects of the Fox River on tree species dominance by density class. a) dominant trees west of the Fox River; b) dominant trees east of the Fox River; c) sub-dominant trees west of the Fox River; d) sub-dominant trees east of the Fox River. OS = open savanna (< 10 trees/ha), S = savanna (> 10-50 trees/ha), W = woodland (> 50-100 trees/ha), F = forest (> 100 trees/ha).

Table 1. Year of survey and species translations for bearing trees identified by Deputy Surveyors for the Public Land Survey of Kane Co., Ill. Black oak* may include Hill's oak (*Q. ellipsoidalis*).

Common name	Scientific Name	1837 James Gallway	1837 & 1839-1840 James Thompson	1837-1838 E. Prescott	1839-1840 John Thompson	1837 I. Sprigg
Bur oak	*Quercus macrocarpa*	Bur oak	Bur oak	Bur oak	Bur oak	Bur oak
White oak	*Quercus alba*	White oak	White oak	White oak	White oak	White oak
Black oak*	*Quercus velutina*	Black oak	Black oak	Black oak	Black oak	
Poplar	*Populus*			White poplar	Popple	
Swamp white oak	*Quercus bicolor*	Water oak				
Elm	*Ulmus sp.*		Elm	Elm	Elm	
Sugar maple	*Acer saccharum*		Sugartree	Sugartree	Sugartree	
Hickory	*Carya*		Hickory	Hickory	Hickory	
Sycamore	*Platanus occidentalis*			Sycamore		
Black walnut	*Juglans nigra*			Black walnut	Black walnut	
Basswood	*Tilia americana*		Lynn, Linn	Lynn	Lynn	
Hawthorn	*Crataegus?*				Haw tree, Red haw	
Cherry	*Prunus*				Cherry	
Ash	*Fraxinus sp.*		Ash		Ash	
Red oak	*Quercus rubra*		Red oak		Red oak	Red oak
Ironwood	*Ostrya virginiana*		Ironwood		Ironwood	
Walnut	*Juglans*				Walnut	
Hackberry	*Celtis occidentalis*				Hackberry	
Cottonwood	*Populus deltoides*		Cottonwood			
Soft maple	*Acer saccharinum*		Maple			
Willow	*Salix sp.*		Willow			
Pin oak	*Quercus palustris*		Pin oak			

Table 2. Coverage of pre-European landscape features of Kane Co., Illinois. Aquatic features may be under-represented. Percent cover for woody undergrowth represents linear cover of section lines.

Vegetation Type	Community	Hectares	Percent
Prairie		**83213.68**	**61.34**
	Prairie	77657.12	57.24
	Wet prairie	5556.56	4.10
Wetland		**279.57**	**0.20**
	Marsh	188.68	0.14
	Slough	3.67	0.003
	Swamp	87.23	0.06
Woody		**51260.06**	**37.78**
	Timber	49051.78	36.15
	(Woody undergrowth)		(49.82)
	Scattering Timber	2208.28	1.63
	(Woody undergrowth)		(33.95)
Aquatic		**919.18**	**0.68**
	Lakes	120.15	0.09
	Rivers	799.04	0.59
Total		135672.50	100.00

Table 3. Landscape effect on composition and dominance (% relative BA) of bearing trees sampled by the Public Land Survey east and west of the Fox River in Kane Co., Ill. Species ranked by dominance. O. savanna = < 10 trees/ha, Savanna = > 10-50 trees/ha, Woodland = > 50-100 trees/ha, Forest = > 100 trees/ha.

	West	West	West	West
Species	**O. savanna**	**Savanna**	**Woodland**	**Forest**
Bur oak	71.33%	46.15%	31.94%	51.10%
White oak	13.67%	28.76%	36.62%	15.68%
Black oak	10.43%	20.12%	27.37%	20.88%
Red oak	3.13%	2.10%	1.07%	1.39%
Elm	0.18%	0.27%	0.62%	4.50%
Hickory	1.01%	0.32%	1.00%	0.82%
Ash	0.05%	0.60%	0.00%	1.92%
Basswood	0.12%	0.21%	0.31%	1.52%
Ironwood	0.00%	0.00%	0.00%	1.26%
Hawthorn	0.08%	0.20%	0.75%	0.00%
Walnut	0.00%	0.00%	0.00%	0.92%
Pin oak	0.00%	0.60%	0.00%	0.00%
Sugar maple	0.00%	0.55%	0.00%	0.00%
Cherry	0.00%	0.12%	0.31%	0.00%
Hackberry	0.00%	0.00%	0.00%	0.00%
Soft maple	0.00%	0.00%	0.00%	0.00%
Cottonwod	0.00%	0.00%	0.00%	0.00%
Willow	0.00%	0.00%	0.00%	0.00%
Total species	9	12	9	10
	East	**East**	**East**	**East**
Species	**O. savanna**	**Savanna**	**Woodland**	**Forest**
White oak	49.42%	24.24%	34.79%	45.19%
Bur oak	36.26%	29.44%	18.72%	7.49%
Black oak	9.84%	24.64%	9.05%	7.02%
Sugar maple	0.00%	3.74%	14.33%	13.30%
Red oak	1.55%	6.00%	11.37%	1.99%
Ash	0.00%	4.32%	6.32%	6.26%
Elm	1.07%	2.05%	2.98%	5.75%
Hickory	0.31%	2.03%	2.43%	4.49%
Ironwood	0.00%	0.39%	0.00%	3.45%
Walnut	1.55%	1.32%	0.00%	0.84%
Basswood	0.00%	1.13%	0.00%	1.96%
Cherry	0.00%	0.00%	0.00%	1.16%
Hackberry	0.00%	0.00%	0.00%	0.53%
Cottonwod	0.00%	0.41%	0.00%	0.00%
Hawthorn	0.00%	0.00%	0.00%	0.29%
Soft maple	0.00%	0.00%	0.00%	0.29%
Willow	0.00%	0.28%	0.00%	0.00%
Pin oak	0.00%	0.00%	0.00%	0.00%
	7	13	8	15

Table 4. Linear distribution and relative abundance of woody undergrowth species encountered by the Public Land Survey in scattering timber and timber east and east of the Fox River in Kane Co., Ill. Data represent % of total linear length of section lines in which undergrowth was recorded as present or a absent.

Species	West S. timber Length	West S. timber Rel. abund.	West Timber Length	West Timber Rel. abund.
Hazel	10.11	20.65	34.33	74.43
Oak	14.47	29.57	5.24	11.37
Black oak	15.34	31.34	2.84	6.16
Briers	0.00	0.00	1.52	3.31
Bur oak	5.15	10.52	0.26	0.57
Willow	3.87	7.91	0.57	1.24
Spicebush	0.00	0.00	0.00	0.00
Ash	0.00	0.00	0.00	0.00
Vines	0.00	0.00	1.18	2.57
White oak	0.00	0.00	0.17	0.36
Pawpaw	0.00	0.00	0.00	0.00
Swamp dogwood	0.00	0.00	0.00	0.00
Total species	5		8	

Species	East S. timber Length	East S. timber Rel. abund.	East Timber Length	East Timber Rel. abund.
Hazel	24.08	100.00	80.81	78.34
Oak	0.00	0.00	2.18	2.12
Black oak	0.00	0.00	0.60	0.58
Briers	0.00	0.00	8.84	8.56
Bur oak	0.00	0.00	0.00	0.00
Willow	0.00	0.00	0.00	0.00
Spicebush	0.00	0.00	4.34	4.21
Ash	0.00	0.00	3.69	3.58
Vines	0.00	0.00	1.43	1.39
White oak	0.00	0.00	0.86	0.83
Pawpaw	0.00	0.00	0.20	0.19
Swamp dogwood	0.00	0.00	0.20	0.19
Total species	1		10	

Appendix I. Abundance, basal area, and importance values of bearing tree species by tree density classes.
Open savanna = > 0-10 trees/ha, savanna = >10-50 trees/ha, Woodland = > 50-100 trees/ha, Forest => 100 trees/ha.

Open savanna	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
Bur oak	370	57.26	70.08	66.36	68.22
White oak	69	15.25	13.07	17.67	15.37
Black oak	59	10.19	11.17	11.81	11.49
Red oak	15	2.25	2.84	2.61	2.73
Hickory	9	0.79	1.70	0.92	1.31
Elm	2	0.23	0.38	0.26	0.32
Walnut	1	0.16	0.19	0.19	0.19
Lynn	1	0.07	0.19	0.08	0.14
Red haw	1	0.05	0.19	0.06	0.12
Ash	1	0.03	0.19	0.04	0.11
total	528	86.29	100.00	100.00	100.00

Savanna	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
Bur oak	325	39.84	51.42	43.23	47.33
White oak	136	25.11	21.52	27.25	24.38
Black oak	105	19.83	16.61	21.51	19.06
Red oak	23	2.48	3.64	2.69	3.16
Ash	11	1.14	1.74	1.24	1.49
Sugartree	7	1.00	1.11	1.09	1.10
Hickory	7	0.73	1.11	0.80	0.95
Elm	5	0.53	0.79	0.58	0.68
Basswood	3	0.33	0.47	0.36	0.42
Pin oak	2	0.37	0.32	0.40	0.36
Walnut	2	0.24	0.32	0.26	0.29
Black walnut	1	0.29	0.16	0.32	0.24
Ironwood	2	0.07	0.32	0.07	0.20
Cherry	1	0.07	0.16	0.08	0.12
Popple	1	0.07	0.16	0.08	0.12
Willow	1	0.05	0.16	0.05	0.11
total	632	92.16	100.00	100.00	100.00

Woodland	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
Bur oak	87	10.44	36.55	28.97	32.76
White oak	60	12.69	25.21	35.22	30.22
Black oak	46	8.45	19.33	23.46	21.39
Red oak	13	1.38	5.46	3.84	4.65
Sugartree	11	1.27	4.62	3.51	4.07
Ash	6	0.54	2.52	1.50	2.01
Hickory	6	0.45	2.52	1.25	1.89
Elm	4	0.41	1.68	1.14	1.41
Basswood	2	0.24	0.84	0.66	0.75
Cherry	1	0.07	0.42	0.20	0.31
Haw Tree	1	0.07	0.42	0.20	0.31
Black walnut	1	0.02	0.42	0.05	0.24
total	238	36.04	100.00	100.00	100.00

Forest	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
Bur oak	114	11.87	34.76	29.72	32.24
White oak	72	11.29	21.95	28.28	25.12
Black oak	36	7.46	10.98	18.68	14.83
Sugartree	30	2.48	9.15	6.22	7.68
Ash	15	1.36	4.57	3.41	3.99
Elm	9	1.80	2.74	4.51	3.63
Ironwood	16	0.83	4.88	2.07	3.47
Hickory	10	0.93	3.05	2.32	2.69
Red oak	9	0.59	2.74	1.49	2.12
Basswood	8	0.61	2.44	1.53	1.99
Walnut	3	0.31	0.91	0.78	0.85
Cherry	2	0.20	0.61	0.51	0.56
Hackberry	2	0.09	0.61	0.23	0.42
Red haw	1	0.05	0.30	0.13	0.22
Maple	1	0.05	0.30	0.13	0.22
total	328	39.93	100.00	100.00	100.00

Appendix II. Abundance, basal area, and importance values of bearing tree species by Public Land Survey Vegetation types.

Scattering timber	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
Bur oak	78	8.15	63.41	53.72	58.57
Black oak	30	4.53	24.39	29.90	27.15
White oak	9	1.71	7.32	11.27	9.29
Pin oak	2	0.37	1.63	2.42	2.02
Hickory	2	0.24	1.63	1.56	1.59
Red oak	2	0.17	1.63	1.13	1.38
total	123	15.16	100.00	100.00	100.00

Timber	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
Bur oak	796	107.36	50.86	46.08	48.47
White oak	322	61.76	20.58	26.51	23.54
Black oak	212	40.74	13.55	17.49	15.52
Red oak	55	5.87	3.51	2.52	3.02
Sugartree	48	4.75	3.07	2.04	2.55
Ash	33	3.09	2.11	1.33	1.72
Hickory	27	2.47	1.73	1.06	1.39
Elm	20	2.97	1.28	1.28	1.28
Ironwood	18	0.90	1.15	0.38	0.77
Basswood	14	1.25	0.89	0.54	0.72
Walnut/blk walnut	8	1.02	0.51	0.44	0.47
Cherry	4	0.35	0.26	0.15	0.20
Red haw	2	0.10	0.13	0.04	0.09
Hackberry	2	0.09	0.13	0.04	0.08
Popple	1	0.07	0.06	0.03	0.05
Haw tree	1	0.07	0.06	0.03	0.05
Willow	1	0.05	0.06	0.02	0.04
Maple	1	0.05	0.06	0.02	0.04
total	1565	232.97	100.00	100.00	100.00

Prairie	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
Bur oak	21	2.31	65.63	63.83	64.73
White oak	5	0.68	15.63	18.68	17.15
Black oak	2	0.36	6.25	10.06	8.16
Hickory	3	0.20	9.38	5.42	7.40
Red oak	1	0.07	3.13	2.01	2.57
total	32	3.63	100.00	100.00	100.00

Wet prairie	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
Bur oak	5	0.66	83.33	76.43	79.88
White oak	1	0.20	16.67	23.57	20.12
total	6	0.86	100.00	100.00	100.00

Marsh	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
Bur oak	6	0.93	66.67	61.14	63.90
Red oak	3	0.59	33.33	38.86	36.10
total	9	1.53	100.00	100.00	100.00

Appendix III. Abundance, basal area, and importance values of line tree species by Public Land Survey Vegetation types.

Prairie
Bur oak 12" dbh

Wet prairie
White oak 24" dbh

Scattering timber	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
Bur oak	11	44	1.29	36.06	40.03
Black oak	6	24	1.08	30.43	27.22
White oak	6	24	0.96	26.85	25.42
Basswood	1	4	0.16	4.61	4.30
Hickory	1	4	0.07	2.05	3.02
	25	100	3.56	100.00	100.00

Timber	**Number**	**Basal area**	**Rel. abund.**	**Rel. BA**	**IV**
White oak	103	29.01	19.75	32.60	30.80
Bur oak	117	32.96	15.29	25.24	29.10
Black oak	72	20.28	16.21	26.75	23.52
Sugar maple	16	4.51	3.41	5.63	5.07
Red oak	12	3.38	1.76	2.90	3.14
Ash	6	1.69	1.13	1.87	1.78
Hickory	8	2.25	0.52	0.86	1.55
Walnut	4	1.13	0.81	1.34	1.23
Basswood	5	1.41	0.46	0.76	1.08
Elm	3	0.85	0.62	1.02	0.93
Ironwood	4	1.13	0.20	0.33	0.73
Sycamore	1	0.28	0.16	0.27	0.28
Cottonwood	1	0.28	0.13	0.21	0.25
White poplar	1	0.28	0.07	0.12	0.20
Cherry	1	0.28	0.03	0.05	0.17
Poplar	1	0.28	0.03	0.05	0.17
	355	100.00	60.60	100.00	100.00

Appendix IV. Number and mean dbh (in cm) of bearing and line trees recorded by the Public Land Survery in Kane Co., Ill.

Bearing trees

Species	Number	Mean dbh	std. dev.
Pin oak	2	48.26	1.41
White oak	337	46.27	6.72
Black oak	246	45.69	6.72
Elm	20	41.02	5.83
Bur oak	906	38.37	5.65
Walnut	6	38.10	3.29
Black walnut	2	38.10	12.73
Red oak	61	34.94	5.33
Sugar maple	48	33.50	4.68
Basswood	14	33.02	2.91
Cherry	4	33.02	2.00
Ash	33	32.71	4.43
Hickory	32	32.39	4.15
Poplar	1	30.48	0.00
Haw tree	1	30.48	0.00
Red haw	2	25.40	0.00
Willow	1	25.40	0.00
Maple (soft)	1	25.40	0.00
Ironwood	18	24.84	1.66
Hackberry	2	24.13	0.71
	1737		

Line trees

Species	Number	Mean dbh	std. dev.
Black oak	78	51.00	5.92
Sugar maple	16	50.17	5.74
Walnut	4	50.17	3.69
Elm	3	47.41	9.24
White oak	110	47.08	5.79
Ash	6	45.72	7.59
Sycamore	1	45.72	0.00
Red oak	12	41.49	4.89
Cottonwood	1	40.64	0.00
Bur oak	129	37.86	5.73
Basswood	6	35.56	3.35
White poplar	1	30.48	0.00
Hickory	9	27.09	4.24
Ironwood	4	25.40	0.00
Cherry	1	20.32	0.00
Poplar	1	20.32	0.00
	382		

Appendix V. Comparison of composition and dominance (relative BA) of forest types based on tree density classes sampled by the Public Land Survey east and west of the Fox River in Kane Co., Ill. O. savanna = < 10 trees/ha, Savanna = > 10-50 trees/ha, Woodland = > 50-100 trees/ha, Forest = > 100 trees/ha.

Species	West Open savanna	West Savanna	West Woodland	West Forest
Bur oak	71.33	46.15	31.94	51.10
White oak	13.67	28.76	36.62	15.68
Black oak	10.43	20.12	27.37	20.88
Red oak	3.13	2.10	1.07	1.39
Elm	0.18	0.27	0.62	4.50
Hickory	1.01	0.32	1.00	0.82
Ash	0.05	0.60	0.00	1.92
Basswood	0.12	0.21	0.31	1.52
Ironwood	0.00	0.00	0.00	1.26
Hawthorn	0.08	0.20	0.75	0.00
Walnut	0.00	0.00	0.00	0.92
Pin oak	0.00	0.60	0.00	0.00
Sugar maple	0.00	0.55	0.00	0.00
Cherry	0.00	0.12	0.31	0.00
Hackberry	0.00	0.00	0.00	0.00
Soft maple	0.00	0.00	0.00	0.00
Cottonwod	0.00	0.00	0.00	0.00
Willow	0.00	0.00	0.00	0.00
Total species	9	12	9	10

Species	East Open savanna	East Savanna	East Woodland	East Forest
White oak	49.42	24.24	34.79	45.19
Bur oak	36.26	29.44	18.72	7.49
Black oak	9.84	24.64	9.05	7.02
Sugar maple	0.00	3.74	14.33	13.30
Red oak	1.55	6.00	11.37	1.99
Ash	0.00	4.32	6.32	6.26
Elm	1.07	2.05	2.98	5.75
Hickory	0.31	2.03	2.43	4.49
Ironwood	0.00	0.39	0.00	3.45
Walnut	1.55	1.32	0.00	0.84
Basswood	0.00	1.13	0.00	1.96
Cherry	0.00	0.00	0.00	1.16
Hackberry	0.00	0.00	0.00	0.53
Cottonwod	0.00	0.41	0.00	0.00
Hawthorn	0.00	0.00	0.00	0.29
Soft maple	0.00	0.00	0.00	0.29
Willow	0.00	0.28	0.00	0.00
Pin oak	0.00	0.00	0.00	0.00
	7	13	8	15