EVALUATION AND CLASSIFICATION OF SAVANNA, WOODLAND, AND BARRENS NATURAL AREAS IN NORTHERN ILLINOIS

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ABSTRACT

Fire-maintained oak savannas were one of the most common vegetation features of northern Illinois, but rapidly disappeared with settlement and fire-protection. Using a broad definition of 10-80% canopy cover, the Illinois Natural Areas Inventory (INAI) found few, if any, "high quality" examples of savanna vegetation. Since completion of the Inventory, numerous savannas have been reported, but have not been systematically inventoried for inclusion on the INAI. We evaluated over 40 northern Illinois sites on silt-loam and gravel substrates for inclusion on the INAI as savanna (10-50% canopy cover), woodland (50-80% canopy), or shrub prairie (<10% canopy). Ordination of canopy tree importance values allowed classification of savannas and woodlands along a dry, dry-mesic, mesic, and wet-mesic moisture continuum indicated by Quercus velutina, Q. alba, Q. rubra, & Q. bicolor, respectively. Quercus macrocarpa- and Q. ellipsoidalis-dominated savannas and woodlands also occurred on dry-mesic and mesic silt-loam and gravel soils.

We found that the most effective method for establishing natural quality was to evaluate the successional status of prairie vegetation in light gaps or graminoid openings. Many prairie forbs were also present in woodland, but were replaced by other species along an increasing shade gradient. In five natural divisions, we evaluated five savannas, 12 woodlands, and three shrub prairies that qualified either as high quality or best of their type natural areas. Two additional savannas and seven woodlands qualified as notable natural areas. In the Northeastern Morainal and Grand Prairie Natural Divisions, which were most thoroughly searched, we found two high quality savannas. One site, the Middlefork Savanna, qualifies as grade B due to past grazing. Savanna vegetation at Wolf Road Prairie also qualifies as grade B due to fire suppression and canopy closure. The Northeastern Morainal Natural Division also had six high quality or best of type woodlands, with two on glacial till and four on gravel substrate. The Grand Prairie Natural Division had one grade B and one best of type woodland. The three shrub prairies occurred in pioneer cemeteries. The Roberts Cemetery contained grade A vegetation, while the grade C Root and Tomlinson shrub prairies qualified as best of type because they occurred in different natural divisions.

Terms for classifying and differentiating between savanna, woodland, and shrub prairie communities are often ambiguous or misused, which can affect management. For example, woodlands with >50% crown cover that are burned are often classified and managed for savanna conditions. We suggest modifying the INAI savanna classification to accommodate woodland with 50-80% canopy cover. This will avoid confusion about classifying a wide range of oak-dominated natural areas and will help prevent management mistakes such as clearing native woody understories. Three woodlands identified by the INAI were classified as barrens because they were dry-mesic. Such sites on glaciated soils represent the dry-mesic end of savanna or woodland moisture gradients. Barrens as described by the PLS were shrub or oak-grub brush prairies. Two of the shrub prairies identified by this study were previously classified as savanna although they had no canopy trees. Research is needed to better correlate relations between tree density, basal area, and canopy cover, and to define a forest category for >80% canopy cover. More research is also needed to better understand the distribution of vegetation occurring along the savanna and woodland light gradients.

TABLE OF CONTENTS PAGE

INTRODUCTION AND PROBLEM

John Curtis, in his seminal study of the vegetation of Wisconsin (Curtis 1959), adapted the tropical definition of savanna as scattered trees in grassland (*e.g.* Walter 1973). He described the southern Wisconsin oak savannas as fire-maintained bur oak (*Quercus macrocarpa*) and mesic prairie, with 10-50% tree canopy cover. Black oak (*Q. velutina*) and white oak (*Q. alba*) formed dry-mesic savannas, and, along with bur oak, occurred as fire-sprouting grubs in brush prairie (Curtis 1959). These silt-loam savannas were formerly one of the most widespread natural community types of the Midwestern forest-prairie border (Kilburn 1959, Anderson 1991, Moran 1978). For example, in three DuPage County townsips, savanna (at >10-50 trees/ha) accounted for 49.5% of the landscape where tree densities exceeded 10 trees/ha. (Bowles *et al*. 1994).

Savanna vegetation quickly deteriorated with settlement and subsequent fire-protection. Less than 10 savanna remnants were found among the 1089 natural areas identified by the Illinois Natural Areas Inventory (INAI) in 1978, even though its savanna definition included 10-80% tree canopy cover. Since completion of the INAI, many additional savanna remnants have been identified and inventoried for plants (*e.g.* Apfelbaum *et al*. 1987, Apfelbaum 1988) and animals (*e.g.* Apfelbaum & Bowles 1986, Byers *et al*. 1986, Panzer & Stillwaugh 1986) but have not been evaluated for inclusion on the INAI. Further, because of changing savanna and oak woodland classification (*e.g.* Faber-Langendoen 1995) re-classification and re-evaluation of known savanna remnants is needed. This report summarizes a field evaluation of silt-loam savanna remnants, primarily in the Northeastern Morainal and Grand Prairie Natural Divisions of Illinois, for inclusion on the Illinois Natural Areas Inventory.

Lack of precise savanna information

A lack of baseline information on savanna vegetation structure complicates evaluating and classifying savanna remnants. After over a century of fire suppression and overgrazing, few (if any) examples of high quality undisturbed silt loam savanna exist (Curtis 1959, White & Madany 1978, Madany 1981, Packard 1991), and the assemblage of groundlayer vegetation thought to characterize savanna continues to be discussed (*e.g.* Madany 1981, Packard 1991, Betz & Lamp 1992, Bowles & McBride 1994). Further, although silt-loam savanna is often characterized as having a graminoid herb-layer (*e.g.* Curtis 1959, White & Madany 1978, Madany 1981, Apfelbaum & Haney 1991, Wilhelm 1991, Packard 1991,), Public Land Survey (PLS) notes indicate that woody understory vegetation was common in parts of the landscape continuum between forest and prairie, especially in areas of moderate fire protection (Bowles *et al*. 1994).

Changing classifications

Since completion of the INAI, important advances have been made in classifying savanna (Faber- Langendoen 1995). The models employed by Curtis (1959) and the INAI, for example, differentiate only between prairie, savanna, and forest. Although landscape fire was assumed the causal agent in development of savanna, it was generally not considered to have significant effects on forest structure. In a second generation model, fire-maintained woodland with intermediate canopy cover is placed between savanna and forest, usually with savanna at <50% canopy cover, woodland from 50%-80% canopy cover, and forest >80% canopy

cover (Faber-Langendoen 1995). In comparison, the INAI included woodland within the savanna canopy range, but did not recognize the communities as ecologically distinct. Presence of woody groundlayer vegetation adds complexity to this model, resulting in a three-layered savanna or woodland (herb layer, shrub/oak-grub layer, and canopy layer) or a two-layered shrub or brush prairie (herb layer & shrub/oak grub brush layer) condition. The latter fits the historic definition of barrens on silt-loam soils (White & Madany 1978, Bowles &McBride 1994, White 1994, Faber-Langendoen 1995). No examples of shrub prairie were found by the INAI for silt-textured soils, and the oak grub component of brush prairies was not treated as a natural community (White & Madany 1978).

OBJECTIVES

Our objectives were to evaluate, re-classify, and rank potential oak savanna and woodland natural areas and recommend high quality sites for inclusion on the Illinois Natural Areas Inventory. The study was restricted to sites on fine-textured glacial till or loess, and gravel, primarily in the Northeastern Morainal and Grand Prairie Natural Divisions of Illinois. This requires a multi-level approach, including assessing the degree of anthropogenic disturbance to herb layer vegetation and determining the presence of savanna indicator species (*e.g.* Madany 1981, Packard 1991, Bowles & McBride 1994, Pruka 1994, Bowles & McBride 1995). It can be supplemented by comparison of modern and historic lists from prairie, savanna, and barrens, and comparison of site locations to presettlement vegetation mapped by the PLS. This study does not include forest communities that occur in more fire-protected habitats. We assume that forests differ structurally and floristically from savanna and woodland by their greater presence of fire-intolerant trees, shrubs, and herbaceous vegetation.

METHODS

Selection of potential natural areas

Over 40 potential savanna or woodland natural areas were examined, primarily in the Northeastern Morainal and Grand Prairie Natural Divisions, with outliers in adjacent natural divisions (Figure 1). These sites were proposed by the Illinois Department of Natural Resources, Illinois Nature Preserves Commission, various county agencies, and other researchers. Although the INAI used a minimum 20-acre size for forest natural areas, it recognized smaller savannas, such as in cemeteries. We also did not use miminum size as a factor in site selection or evaluation because important savanna remnants may be small or transitional between other communities. Rather, sites were expected to be large enough to be protected and managed, or part of larger natural areas. However, scale affects classification because small savanna remnants may have so few trees that their density or canopy cover cannot be measured accurately.

Evaluation of natural quality

Natural quality, as defined by the INAI, is in part analagous to plant successional stages in which characteristic suites of species decrease or are lost after anthropogenic disturbance, such as grazing. Here, Grade "A" vegetation is essentially undisturbed, and late-successional species are frequent. In Grade "B" vegetation, mid-successional species are abundant and late-successional species are infrequent. Grade "C" vegetation is so heavily disturbed that late-

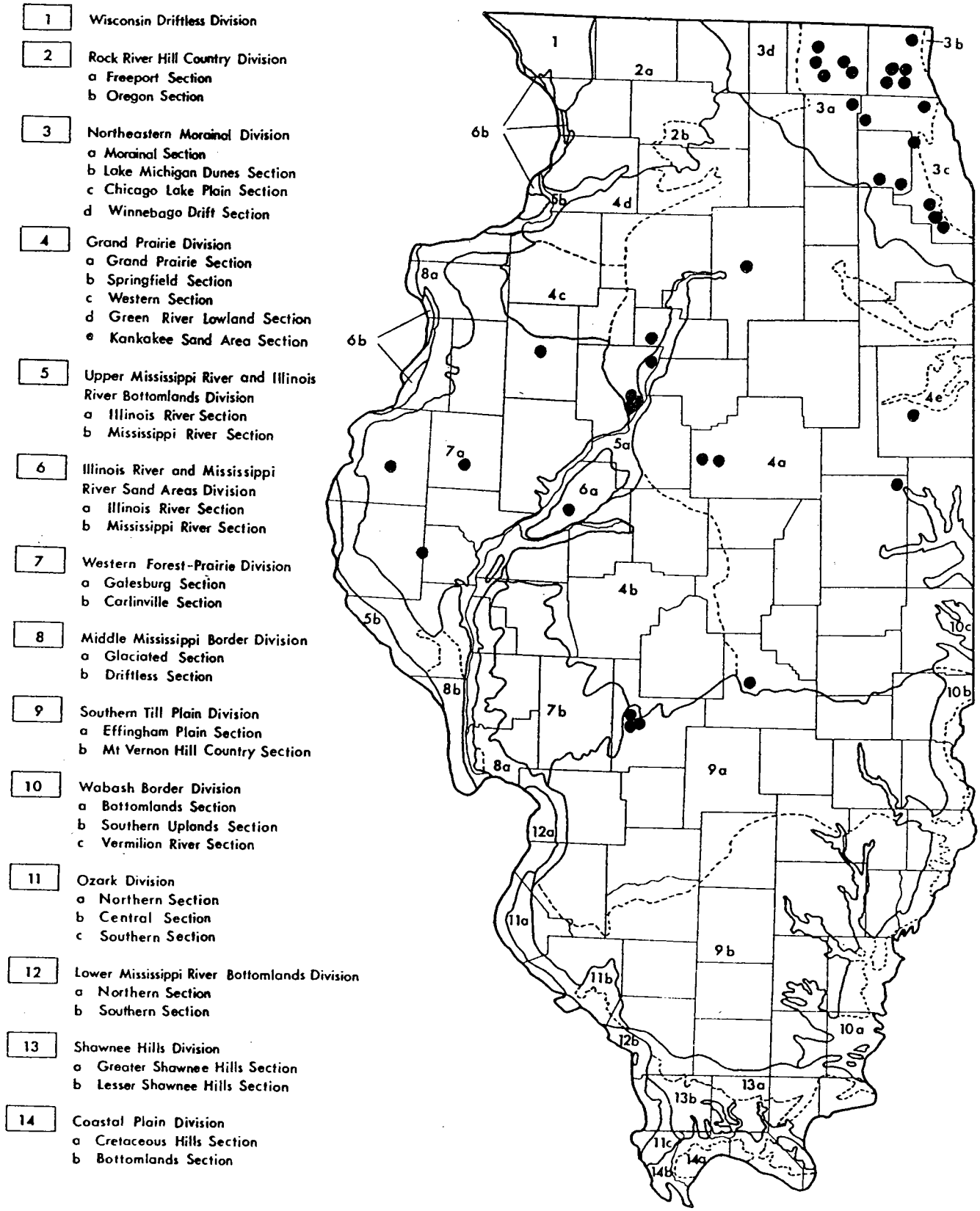

Figure 1. Location of study sites (solid circles) on the Natural Divisions of Illinois (Schwegman *et al.* 1973). Note: some circles represent multiple sites.

successional species are absent and early- to mid-successional species predominate. Only early-successional species are present in Grade "D" vegetation. This approach has been most frequently applied to prairie vegetation and should be applicable to savanna, where <50% canopy cover would allow dominance by shade-intolerant prairie vegetation. Thus we expected presence of late-successional prairie species in larger savanna canopy gaps or areas of light shade. However, savanna and woodland species change across a light intensity gradient (Gilbert & Curtis 1953, Bray 1958, Bray 1960, Pruka 1994, Bowles & McBride 1995), and there is little information about late-successional species that might occur across the canopy light gradient (Packard 1991). If late-successional prairie species were found to occupy light gaps, we assumed that shaded zones also reflected high natural quality, although fire protection and canopy closure might futher degrade this vegetation.

To further identify savanna vegetation, we also searched for potential savanna indicator species based on published lists (*e.g.* Madany 1981, Packard 1991, Bowles & McBride 1994, Pruka 1995, Bowles & McBride 1995). There is much confusion about the utility of these lists. For example, Packard (1991) contended that the "barrens" list of Mead (1846) represented tallgrass savanna, but noted its absence of grasses. However, presettlement barrens were fire-maintained shrub and oak brush prairies without canopy trees (Gleason 1922, Bowles & McBride 1994). Further, Madany (1981) had 24% floristic similarity between savannas and barrens (exclusive of sand savanna) sampled by the INAI, while Betz (1992) found less than 30% similarity between cemetery savanna floras and the "barrens" flora of Mead (1846). Because Public Land Survey data indicate that savanna or woodland light gaps had high frequencies of *Corylus americana* clones (Bowles *et al*. 1994), we also used the presence of this shrub as a savanna indicator.

Site descriptions

Field forms - Site evaluations were completed on INAI main data forms (White 1978). Information included descriptions of significant and exceptional features, natural character by community type, natural quality by acreage, management problems, preservation values, and supplemental materials such as species lists and sampling data.

Site mapping - Sites were mapped on 7.5' USGS topographic maps enlarged to an appropriate scale for each natural area. For more detail, natural area boundaries, natural communities, significant or exceptional features, and management problems were placed on larger scale site maps or traced on overlays of aerial photos.

Stratigraphy and soils map - Glacial stratigraphy was determined by locating most sites on the appropriate geology map. Site occurrences on forest soils (alfisols) prairie soils (mollisols) or transitional soils (savanna) were determined when easily available. This information may help site classification, but is not an absolute indicator of former savanna conditions (M. Bowles, unpublished data).

Public Land Survey forest-prairie map - Each site location was mapped in relation to the original forest-prairie boundary map prepared by the PLS. Comparison with the original forest-prairie location will help determine if the site was likely a presettlement savanna.

Data collection - Data collection included a preliminary list of vascular plant species

(many sites had lists or sampling data provided by other researchers), sampling of shrub prairies with 1/2m^2 plots, and point-center-quarter sampling (Cottam & Curtis 1949) of canopy tree (dbh >10cm) frequency, density, and basal area. In some cases, canopy tree data were acquired from other sources. The rapid point-center-quarter method allows direct comparison of modern vegetation to categories determined from PLS data, and can be adjusted to natural area size by altering distance between plots.

Data analysis

For each site, canopy tree species composition was analyzed to determine if sites and tree species aligned along floristic and ecological gradients that could be used to separate stands for community classification. We used our data from 22 transects sampled among 19 stands. One of these transects was from a northern flatwoods community at the Ryerson Nature Preserve, Lake Co, IL, which was *Quercus bicolor* dominated. To include additional data from *Quercus bicolor- Q. macrocarpa*-dominated wet-mesic and wet savannas, we added plot data collected by Flakne (1991) from Cook Co., IL. We also added plot data collected by J.E. Ebinger and W.E. McClain from McCree Creek Barrens, Brown Co., IL . For analysis, tree frequency, density, and basal area, were combined into importance values for a total of 29 transects or plots among 26 sites. Each transect data set was then ordinated by Detreneded correspondence analysis (DECORANA) on PCORD (McCune 1993). DECORANA is an eigenvector ordination technique based on reciprocal averaging and positions plots along strong environmental or successional gradients (Hill & Gauch 1980). Shrub prairie data sets were analyzed by comparing species richness and relative abundance of shrubs or oak grubs.

Community classification

We projected a conceptual classification for savanna and woodland using tree canopy indicator species from the INAI classification for savanna, barrens, northern flatwoods, and forest natural communities in northern Illinois (Table 1). These categories are based on ecological preferences of dominant *Quercus* species in relation to a moisture continuum. We used barrens and flatwoods communities in this continuum because the INAI did not provide a dry savanna nor a wet-mesic savanna category, replacing them with barrens and northern flatwoods, respectively (White & Madany 1978, Madany 1981). *Quercus macrocarpa* apparently has a bimodal distribution based on a preference for calcareous soils, and tolerance of fire and a wide moisture continuum. As a result, silt-loam and gravel substrates were also used to provide different classification units.

Table 1. Characteristic savanna and woodland oak species expected along a moisture continuum.

Savanna-woodland categories	**Similar INAI commuities**
Dry (*Q. velutina-stellata)*	Dry & dry-mesic barren, dry upland forest
Dry-mesic (*Q. alba-ellipsoidalis-macrocarpa*)	Dry-mesic savanna, dry-mesic upland forest
Mesic (*Q. rubra-macrocarpa*)	Mesic savanna, mesic upland forest
Wet-mesic (*Q. bicolor-macrocapa)*	Wet-mesic upland forest
Wet (*Q. bicolor)*	Northern flatwoods

Once moisture continuum categories were established, sites were placed in savanna or woodland categories. Because of difficulty in precisely measuring canopy cover, we used site tree density to differentiate between savanna (<50 trees/ha ~ <50% canopy cover)

and woodland (>50 trees/ha ~ >50% canopy cover). This density-canopy cover equivalent is based on the estimate that 50 trees/ha and 50% canopy cover were roughly equal for presettlement tree data (Anderson & Anderson 1975). We placed no upper limit on woodland tree density, but assumed a canopy cover of <80%. For the savanna category, we also examined groundlayer vegetation to determine if sites understories could be classified as predominantly graminoid or woody. We used two criteria for identifying shrub or grub prairies. We expected at least 30% sampling frequency of *Corylus americana, Ceanothus americanus*, or oak grubs, and a site position near the original forest prairie border as mapped by the public land survey (Bowles & McBride 1994).

Recommending and ranking sites

To determine if potential sites qualified for inclusion on the INAI, they were first organized by Illinois Natural Division location. Within each natural division, sites were subdivided into shrub prairie, savanna, or woodland categories. These sites were further subdivided by silt-loam or gravel substrate, which are similar to categories established for prairie by the INAI. Within each of these catetgories, sites were further subdivided by moisture continuum classification based on dominant tree canopy species, or equivalent prairie species for shrub prairie. Once this final category was reached, sites were ranked by natural quality. All high quality sites (grade A or B) were nominated for inclusion on the INAI. When no grade A or B sites were present, best of type sites were nominated if they reached grade C quality. Additional C sites, or those with some other important feature were nominated as notable natural areas.

RESULTS

Ordination of study sites

Stands aligned on the first ordination axis corresponding to the expected gradient of dominant oak species moisture requirements (Figure 2). *Quercus velutina, Q. alba, Q. rubra,* and *Q. bicolor* had strong positive or negative correlations with the first axis, while *Q. macrocarpa* and *Q. ellipsoidalis* had strong correlations (positive) only with the second axis (Figure 3). As indicated, the first axis appears to be primarily a moisture gradient, while the second axis is more complex because *Quercus macrocarpa* and *Q. ellipsoidalis* occur on dry-mesic gravel or till habitats, or on sites with a strong fire history.

Classification of study sites

Based on the ordination, we developed a community classification for the savanna and woodland study sites (Table 2). Here, *Quercus velutina, Q. alba, Q. rubra,* and *Q. bicolor* indicate dry-, dry-mesic, mesic- and wet-mesic woodland habitats, respectively while *Quercus ellipsoidalis* and *Q. macrocarpa* indicate dry-mesic and mesic savanna or woodland, respectively. In this classification, we differentiate shrub/oak grub brush prairie (<10 trees/ha), savanna (10-<50 trees/ha) and woodland (≥ 50 trees/ha). There was no maximum tree density transition from woodland to forest, and density reached over 300 trees/ha for some study sites that were managed by burning. The savanna ground layer should be dominated primarily by prairie vegetation with minor representation by shade-adapted species. In contrast, the woodland ground layer should be dominated primarily by vegetation occurring along an increasing shade gradient. The savanna and woodland categories are futher differentiated between gravel and fine-texture glacial till or loess.

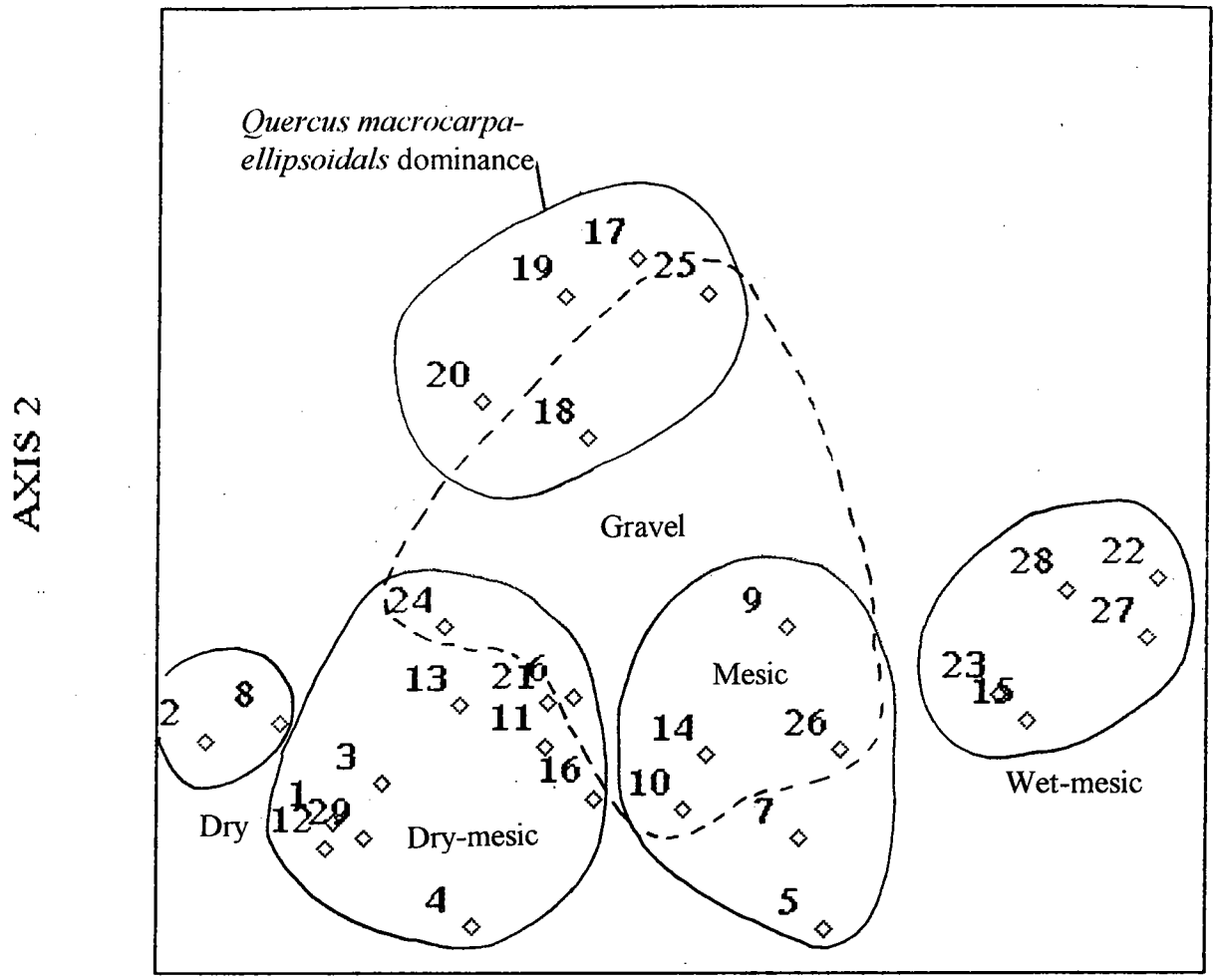

Figure 2. DECORANA ordination of northern Illinois savannas and woodlands. Axis 1 is increasing moisture gradient, Axis 2 is increasing dominance by *Quercus ellipsoidalis* and *Q. macrocarpa.* Solid lines encompass moisture categories, dashed line encompasses gravel substrate (excluding No. 14).

Dry: 2 = Lake Lou Yaeger, 8 = Pecumsaugan Creek; **Dry-mesic**: 1 = Rocky Hollow, 3 = Singing Woods, 4 = Robinson Hills, 6 = Bluff Springs Fen (upland), 11 = Emerywood, 12 = Shelbyville, 13 = Hickory Grove, 16 = Wayne Grove, 21 = Moraine Hills (Oak Opening), 24 = Glacial park (north slope), 29 =McKee Creek; **Mesic**: 5 = Paddock Woods, 7 = Elm Road, 9 = Freem Kame (south slope), 10 = Moraine Hills, 14 = Spears Woods (woodland); **Wet-mesic:** 15 = Ryerson, 22, 23, 27, 28 = Flakne (1991); 17 = Wolf Road, 18 =Glacial Park (south slope), 19 = Vestal Grove, 20 = Middlefork, 25 = Bluff Springs Fen (south slope).

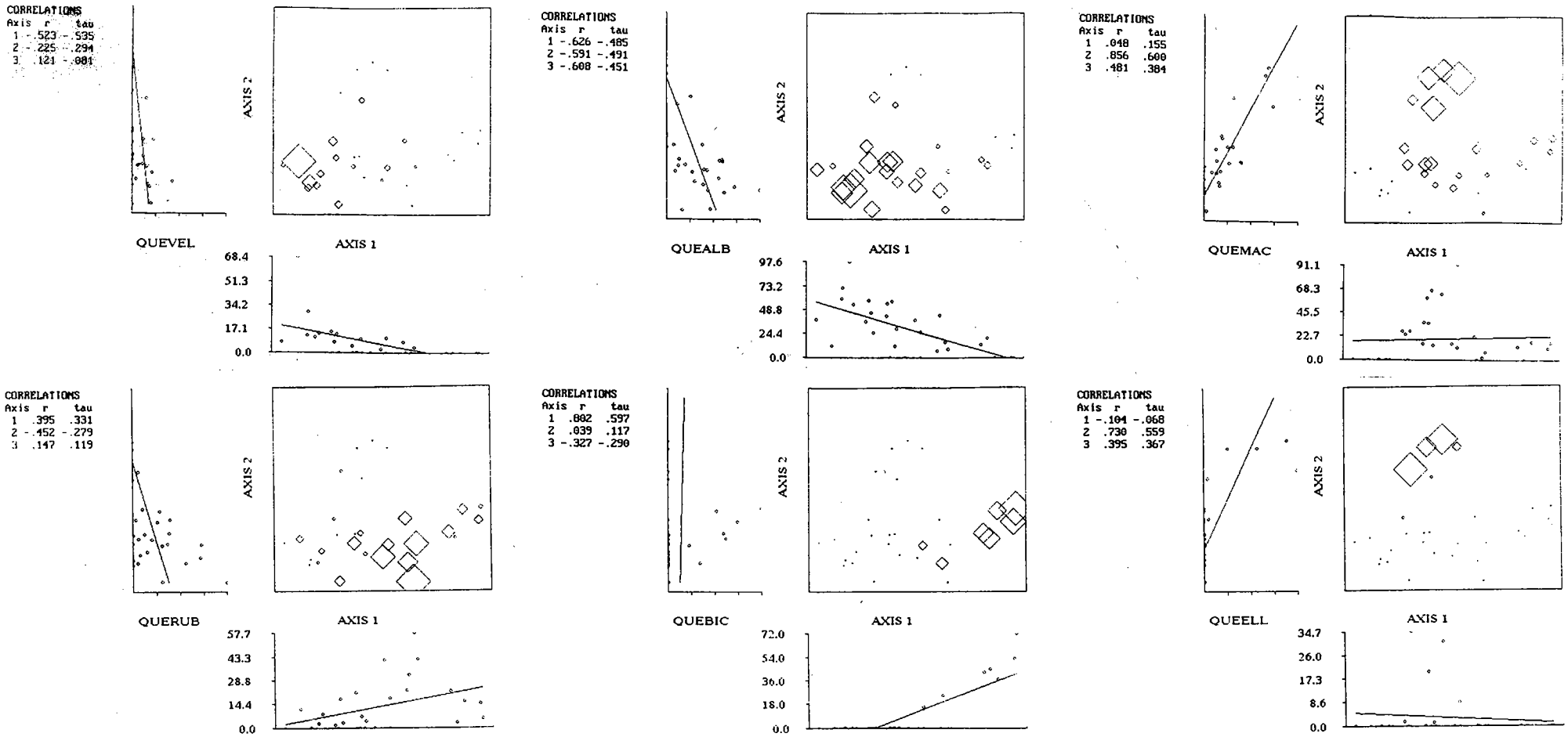

Figure 3. Correlations of *Quercus* species importance values with three DECORANA ordination axes for northern Illinois savannas and woodlands. Size of diamond correlates with species importance value. QUEVEL = Quercus velutina, QUEALB = *Quercus alba*, QUEMAC = *Quercus macrocarpa*, QUERUB = *Quercus rubra*, QUEBIC = *Quercus bicolor*, QUEELL = *Quercus ellipsoidalis*.

Table 2. Classification of shrub and oak grub brush prairie, savanna, and woodland communities found on glacial till or loess, or on gravel substrate in the Northeastern Morainal and Grand Prairie Natural Divisions of Illinois. Species names indicate those with highest frequencies (shrubs) or importance values (trees) in a stand. Tree species in parentheses are sub-dominant. See Tables 3-5 for all species importance values.

Prairie Trees density <10/hectare (≲10% canopy)
- Graminoid dominance = **prairie** (shrubs = *Amorpha canescens, Rosa carolina, Salix humilis*)
- Shrub or oak grub dominance (≳30% woody species absolute frequencies, ≳15% relative frequencies).
  - Shrub species predominant = **shrub brush prairie** (*Corylus americana-Ceanothus americanus, Rubus* spp) - Only dry-mesic examples found.
  - Oak grubs predominant = **oak grub brush prairie** (*Quercus* species) - no pure examples found

Savanna Tree density 10-50 trees/hectare (~10-50% canopy)
- Substrate-gravel (no examples found)
- Substrate-silt-loam
  - **Dry-mesic *Quercus ellipsoidalis* (*macrocarpa*) savanna**
  - **Mesic *Quercus macrocarpa* (*ellipsoidalis*) savanna**
    - Graminoid ground layer = **Graminoid savanna**
    - Shrub/oak grub-dominated ground layer = **Shrub/oak grub savanna**

Woodland Tree density more than 50 trees/hectare (~≥50% canopy)
- Substrate-gravel
  - **Dry-mesic gravel *Q. macrocarpa* woodland**
  - **Mesic gravel *Q. rubra* woodland**
- Substrate-till/loess
  - **Dry *Q. velutina* (*alba*) woodland**
  - **Dry-mesic *Q. alba* (*rubra*) woodland**
  - **Mesic *Q. rubra* (*alba*) woodland**
  - **Wet-mesic *Q. bicolor* (*Q. macrocarpa*) woodland**
  - **Wet *Q. bicolor* woodland - no examples found**

In the Northeastern Morainal Natural Division, silt-loam soils were found to support either dry-mesic or mesic *Q. ellipsoidalis/Q. macrocarpa* savanna or woodland, or a continuum of dry-mesic *Q. alba* woodland, mesic *Q. rubra* woodland, or wet-mesic *Q. bicolor-Q. macrocarpa* woodland (Table 3). Similarly, gravel substrate was found to support either dry-mesic *Q. macrocarpa* or *Q. alba* woodland, or mesic *Q. rubra* woodland (Table 4). *Tilia americana* also indicated mesic gravel substrate, especially with historic fire protection. Although no savannas were found on gravel substrates, they probably occured on gravel at the time of settlement, especially on south or west gravel slopes, where *Quercus macrocarapa* is most important. In the Grand Prairie Natural Division, glacial till or drift habitats were found to support a continuum of dry *Q. velutina* woodland, dry-mesic *Q. alba woodland*, or mesic *Q. rubra* woodland (Table 5).

Table 3. Tree species importance values (relative frequency, density & basal area), for silt-loam oak savannas and woodlands in the Northeastern Morainal Natural Division. **Bold face** IV's represent dominant species for each site.

	Middle-fork	Somme (Vestal)	Hickory Grove	Emery wood	Paddock Woods	Elm Road
	<---------->		<----------			---------->
	dry-mesic savanna	mesic woodland	dry-mesic woodland			wet-mesic woodland
Trees/hectare	56.32	219.7	121.35	154.04	166.71	154.86
Basal area m^2/hectare	8.12	32.74	28.59	32.67	38.44	31.3
SPECIES						
Quercus macrocarpa	27.9	**58.9**	24.30	16.05		2.48
Quercus ellipsoidalis	**34.8**	20.0				
Quercus velutina			8.10	4.82		
Quercus alba	25.4		**58.53**	**42.03**	16.13	**43.18**
Quercus rubra	3.16			21.29	**57.79**	32.18
Quercus bicolor						24.63
Carya ovata	8.76	17.6	9.07	15.81		
Prunus serotina					13.4	
Juglans nigra					7.43	
Fraxinus americana					2.76	

Table 4. Tree species importance values (relative frequency, density & basal area) for gravel substrate oak woodlands in the Morainal Section of the Northeastern Morainal Natural Division. **Bold face** IV's are dominant species for each site.

	Glacial Park		Bluff Springs		Moraine Hills	Freeman Kame	
	dry-mesic <----------					----------> mesic	
Trees/hectare	136.4	115.6	149.7	200.1	282.66	194.6	344.3
Basal area m^2/hectare	15.6	17.3	56.92	30.38	45.48	28.52	65.97
	S.W.	N.E.	Lower	upper		S. slope	N. slope
SPECIES							
Quercus macrocarpa	**66.7**	27.9	**91.11**	35.33	15.38	22.4	7.78
Quercus velutina	10.18	15.4			2.73	7.81	4.06
Quercus elllipsoidalis	1.36	1.72	8.89				
Quercus alba	11.74	**37.2**		**57.52**	38.24	8.21	9.15
Quercus rubra		1.91		7.15	**41.27**	**22.5**	**41.08**
Carya ovata	10.01	15.93			2.37		
Prunus serotina						13.40	12.68
Tilia americana						24.20	21.29

Table 5. Tree species importance values (relative frequency, density & basal area) for oak woodlands on glacial drift in the Grand Prairie Section of the Grand Prairie Natural Division. **Bold face** IV's represent dominant species for each site. Data for Merwin Preserve based on Anderson *et al*. (1994).

	Peckaum-saugan	Shelby-ville	Merwin Preserve slope	Merwin Preserve crest	Merwin Preserve upland	Singing Woods	Robinson Hills
	dry<----------						----------->dry-mesic
Trees/hectare	174.15	193.24	311	267	516	321.74	259.73
Basal area m^2/hectare	19.02	21.52	22.7	25.2	23.5	23.39	16.15
SPECIES							
Quercus macrocarpa			19.8				
Quercus velutina	**68.41**	12.45		15.8		14.26	13.6
Quercus imbricaria	2.03				**43.8**		
Quercus alba	11.94	**59.82**		**40.9**	20.1	**54.24**	**45.77**
Quercus muhlenbergii							12.7
Quercus rubra	11.33		**25.6**			8.7	17.63
Carya ovata		13.71	22.5	14.0		22.8	5.81
Carya species	2.01	10.85					

Distrbution and characterisitcs of savannas and woodlands

In five natural divisions, we evaluated three shrub prairies, five savannas, and 12 woodlands that qualified either as high quality or best of their type natural areas; two additional savannas and six woodlands were also examined that qualified as notable natural areas (Table 6). Appendix I provides a narrative for each notable, best of type, or high quality area. Three of the woodlands were previously included on the INAI as barrens. In the Northeastern Morainal and Grand Prairie Natural Divisions, which were most thoroughly searched, we found no high quality savannas that met an absolute 50 trees/ha maximum tree density for savanna. One site, the Middlefork Savanna, had 56.4 trees/ha, and qualifies as grade B savanna due to past grazing. Grade B savanna at Wolf Road Prairie had 17.6 canopy trees/ha and was degraded by shade from 664.5 subcanoppy (<2.0m dbh) trees/ha (Bowles & McBride 1995). The Northeastern Morainal Natural Division also had five high quality or best of type woodlands, with two on glacial till and three on gravel substrate. The Grand Prairie Natural Division had one grade B and one best of type woodland. Few savanna or woodland natural areas were found that occurred as isolated remnants, and most persisted because of anthropogenic disturbance. For example,

Table 6. Grade A, B, or C (best of type), and notable silt loam or gravel shrub and oak grub brush prairies, savannas, and woodlands natural communities organized by Natural Division.

Natural Division& Section	Shrub and oak grub brush prairie	Savanna (<50 trees/hectare)	Woodland (>50 trees/hectare)
Northeastern Morainal	**Mesic**	**Mesic**	**Silt loam (dry-mesic - wet-mesic)**
Morainal Section	(none)	Middlefork (B)	Emerywood (C best of type)
	Dry-mesic	Wolf Road (B)	Paddock Woods (B)
	(none)	Turner Lake (notable)	Elm Road (C notable)
			Hickory Grove (notable)
			Somme (Vestal Grove C notable)
		Dry-mesic	**Gravel (dry-mesic - mesic)**
		Harvard (notable)	Freeman Rd. Kame (B)
			Kettle Moraine (C best of type)
			Bluff Springs Fen (C best of type)
			Glacial Park (C best of type)
Grand Prairie	**Mesic**	**Mesic**	**Mesic**
Grand Prairie Section	(none)	(none)	(none)
	Dry-mesic	**Dry-mesic**	**Dry-mesic**
	Tomlinson	Springdale Cemetery (B)[1]	Merwin Savanna (C notable)
	(C best of type)		Singing Woods (C notable)
			Robinson Hills (B)
			Shelbyville (C notable)
			Hopewell (C notable)
			Dry
			Pecumsaugan Creek (C best of type)
Western Section	**Mesic**	**Mesic**	**Mesic**
	(none)	Copley Cemetery (B)[1]	(none)
	Dry-mesic	**Dry-mesic**	**Dry-mesic**
	(none)	(none)	(none)
Western Forest-Prairie	**Mesic**	**Mesic**	**Mesic**
Galesburg Section	(none)	(none)	(none)
	Dry-mesic	**Dry-mesic**	**Dry-mesic**
	(none)	Hancock Savanna	Argyle Barrens (B)[2]
		(C best of type)	McKee Creek Barrens (B)[2]
			Siloam Springs State Park (notable)
Upper Mississippi &	**Mesic**	**Mesic**	**Dry-mesic**
Illinois River Bottomlands	(none)	(none)	(none)
Illinois River Section	**Dry-mesic**	**Dry-mesic**	**Dry-mesic**
	Root Cemetery	(none)	(none)
	(C best of type)		
Southern Till Plain	**Mesic**	**Mesic**	**Mesic**
Effingham Section	(none)	(none)	(none)
	Dry-mesic	**Dry-mesic**	**Dry-mesic**
	Roberts Cemetery (A)[3]	(none)	Rocky Hollow (A)
			Lake Lou Yaeger (A)[4]

[1] Formerly on INAI as grade B savanna, [2] Formerly on INAI as grade B barrens, [3] Formerly on INAI as grade B prairie
[4] Formerly on INAI as grade C barrens

the Middlefork Savanna was lightly grazed, and occurs in a more heavily grazed savanna and prairie matrix. It is adjacent to a railroad right of way that probably provided a source of fires and propagules for recolonization of the savanna. Savanna occurs at Wolf Road Prairie as part of a larger natural area that persisted because of a failed 1930's subdivision. It was maintained by annual fires until the mid 1960's, after which it began to deteriorate as oak grubs matured (Bowles & McBride 1995). The Hancock Savanna was maintained by historic light grazing. The Emerywood and Hopewell woodlands survived in subdivisions by occasional mowing, which prevented subcanopy closure but reduced their summer flora. Both sites are threatened with continued subdvision expansion. The high quality Paddock Woods occurs in a matrix of more heavily grazed woodlands but appears to have had only light historic grazing. Many canopy openings at this site were caused by recent mortality of adult *Quercus rubra*. Most of the woodlands identified in the Grand Prairie Natural Division occur on narrow dry- or dry-mesic uplands adjacent to dry slopes with prairie vegetation. The well-drained conditions probably prevented rapid woody plant invasion, while occasional fires allowed maintenance of woodland. Infrequent catastrophic fires may have caused dynamic vegetation shifts between savanna and woodland in these habitats, as shown by historic aerial photos of the Robinson Hills site (Ritterbusch & Monoson 1991).

Shrub and oak grub brush prairie distribution and characteristics

We found three examples of shrub prairies and no pure examples of oak grub prairies. All three sites occurred in pioneer cemetery prairie Nature Preserves, two of which had been identified as prairie by the INAI. These sites were located on forest-prairie boundaries as mapped by the PLS, but differed from savanna because they essentially lacked canopy trees. They differed from prairie by comparatively high (12-18%) relative frequencies of shrubs such as *Corylus americana*, *Ceanothus americanus*, and *Rubus* species (Table 7). The clonal structure of *C. americana* formed a patterned mosaic with graminoid openings across these sites. Sunflowers such as *Helianthus hirsutus* and *H. divaricatus* were also dominant species, occurring with other potential "indicator" species (Table 7). The Roberts Cemetery had extensive hazel clones and fewer *Quercus stellata* and *Q. velutina* grubs. The eastern border of this site abutted a tree canopy, under which occurred *Liatris scariosa* var. *nieuwlandii*, a potential savanna indicator species (Bowles *et al*. 1988). The Root Cemetery has a long history of fire (Solecki & Frye 1993) and was mapped as "barrens" by the PLS. This site also had hazel clones along with fewer *Quercus macrocarpa* and *Q. imbricaria* grubs. The Tomlinson Cemetery lacked oak grubs but had high frequencies of *Corylus americana*, *Ceanothus americanus*, and *Helianthus hirsutus*.

Evaluating natural quality

As expected, we found presence of prairie vegetation to be the most useful indicator of high quality savanna conditions. For example, presence of high quality prairie vegetation in the largest savanna light gap at Wolf Road Prairie indicates that the site probably had very little, if any, grazing impact. However, adjacent areas that were heavily shaded had essentially no grass or sedge cover, but high frequencies of *Camassia scilloides* and other shade-tolerant woodland herbs. Because the site has a recent history of fire protection, this

Table 7. Vegetation composition and structure of shrub prairies qualifying for addition to the Illinois Natural Areas Inventory. Native species with >10% frequencies sampled by 0.5m^2 plots (0.25m^2 at Roberts). P = present, but not sampled. Frequencies of dominant species (>50% cumulative relative frequency) are in **bold**. Species with asterisks (*) are not typical of tallgrass prairie and may have "indicators" values for shrub prairie. Roberts = Roberts Cemetery Nature Preserve,
Root = Root Cemetery Nature Preserve, Tomlinson = Tomlinson Cemetery Nature Preserve.

	SITE		
Species	Roberts	Root	Tomlinson
Andropogon gerardii	**54.6**	**51.1**	**34.3**
Aster pilosus	0.9	-----	11.4
Carex brevior	P	11.1	-----
Carex lanunginosa	**58.3**	-----	P
Carex sp	16.7	**28.9**	5.7
**Cammasia scilloides*	P	P	11.3
Cassia fasciculata	P	15.5	-----
**Ceanothus americanus*	17.6	P	14.3
Convolvulus sepium	13.9	-----	-----
Convolvulus spithamaeus	-----	-----	**17.1**
**Corylus americana*	**23.15**	15.6	**31.4**
**Desmodium dellenii*	**25.0**	-----	-----
Desmodium illinoense	-----	-----	14.3
Elymus canadensis	P	P	**25.7**
Euphorbia corollata	10.2	P	**25.7**
Fragaria virginiana	**28.7**	P	11.4
**Helianthus hirsutus*	-----	**46.7**	**91.4**
**Helianthus divaricatus*	**29.6**	**26.7**	2.9
Helianthus mollis	12.0	P	-----
Lactuca canadensis	P	-----	**17.1**
Monarda fistulosa	17.6	P	5.71
Panicum oligosanthes	11.1	-----	-----
Potentilla simplex	**25.0**	-----	-----
**Psoralea onobrychis*	P	**31.1**	-----
Physalis heterophylla	11.1	P	-----
**Rosa carolina*	13.0	-----	5.7
**Rhus glabra*	P	17.8	-----
**Rubus allegheniensis*	-----	**24.4**	11.4
**Rubus flagellaris*	**61.1**	-----	-----
**Silene stellata*	P	P	14.3
**Smilax lasioneura*	-----	11.1	8.6
Solidago canadensis	**46.3**	15.6	-----
Sorghastrum nutans	**30.6**	**31.1**	**88.6**
Veronicastrum virginicum	P	22.2	-----
Viola soraria	**25.0**	-----	14.3
Vitis riparia	P	15.6	2.86
Summary			
N (sample size)	108	54	35
Total species sampled	109	38	47
Mean plot species richness (±s.e.)	8.1 (±.23)	4.6 (±.22)	6.2 (±.26)
Graminoid relative frequency	29.5	28.5	28.3
Forb relative frequency	51.9	53.1	59.4
Woody relative frequency	18.6	18.4	12.3

suggests that it underwent a loss of grasses and forbs, but not shade-tolerant herbs (Bowles & McBride 1995). As a result, the site would qualify as grade B. At Middlefork Savanna, historic light grazing had obviously reduced the quality of prairie vegetation, but helped maintain graminoid ground layer vegetation throughout the savanna.. Here, the light gaps and canopy have both been disturbed and rank as grade B. At both sites, light gaps had high frequencies of *Corylus americana* clones, which apparently was a feature of presettlement savannas and woodlands (Bowles *et al*. 1994).

Evaluating quality of woodlands was more difficult due to the lack of baseline information on successional stages and occurrence of species along light gradients. It appears that prairie grasses are more sensitive to shade than prairie forbs and are the first suite of species to decline along an increasing shade gradient. We observed prairie forbs, including *Coreopsis palmata, Petalostemum purpureum, Petalostemum candidum, Silphium terebinthinaceum*, and *Baptisia leucantha* and the shrubs *Amorpha canescens* and *Ceanothus americanus* persisting in woodland habitat at several sites that were mowed or burned. Woodland grasses (*e.g. Hystrix patula, Bromus pubescens, Brachelytrum erectum*) and sedges (*e.g. Caerex pensylvanica, C. hirsutella*) appear to be the replacement fuel species with increasing shade (Packard 1991, Swink & Wilhelm 1994). An increasing shade gradient appears to reduce or eliminate competiton from prairie grasses in shade, allowing persistence of shade-tolerant savanna vegetation, while competition from prairie grasses may reduce competitive abilities of savanna vegetation in full sun. With fire-protection, grazing, mowing, or other human disturbances may maintain a "coarse grained" savanna structure, but with the loss of disturbance intolerant species. Human disturbance may allow persistence of some plants thought to be savanna "indicator species," but their former abundance and role in savanna plant communities is unknown. We found a wide range of potential "savanna indicators" in almost all study sites, but more information is needed to assess their abundance in relation to successional stages or light gradients.

As with savannas and woodands, the quality of shrub prairies was not easily determined because their is are no baseline data on their presettlement composition and structure. Although they usually lacked canopy trees and the distribution of species along a light gradient, the clonal structure of shrubs in shrub prairies caused vegetation pattern. We evaluated their quality by the presence of late-successional prairie species in graminoid openings between shrub clones, lack of obvious human disturbance, and levels of native species richness. The Roberts Cemetery was graded A due to its comparatively high species richness, presence of late-successional prairie species such as *Coreopsis palmata*, extensive hazel clones, and presence of *Quercus stellata* and *Q. velutina* oak grubs. At the Roberts cemetery, 109 species were sampled in 108 0.25m^2 plots with 8.1 (±.22 s.e.) mean plot species richness. In comparison, mean plot species richness was 4.6 (±.23 s.e.) species at the grade C Root Cemetery, and 6.2 (±.26 s.e.) species at the grade C Tomlinson Cemetery. This difference in plot species richness ocurred despite the larger plot size (0.5m^2) at Root and Tomlinson.

CONCLUSIONS

Summary

Although savannas were one of the most extensive Illinois plant communities at the time of settlement, they have essentially disappeared. In our survey of over 40 potential savanna natural areas in northern Illinois, we observed only five high quality or best of type savanna remnants, and twelve such woodlands. The successional stage of prairie vegetation persisting in savanna light gaps or in light shade appears to be most useful in assessing savanna natural quality. Savanna "indicator species" can be helpful in identifying savanna remnants, but they may not be extremely useful in evaluating the successional stage or "quality" of sites if they persisted due to human disturbance. Further research is needed on high quality savannas to determine the relative abundance of all savanna and woodland species along canopy light gradients (*e.g.* Pruka 1994, Bowles & McBride 1995).

Although savanna vegetation structure is often described as two-layered with a graminoid understory (*e.g.* Madany 1981), we found that *Corylus americana* clones, oak grubs, or multiple stemmed trees that had matured from grubs were consistently present in savannas and woodlands. Thus, although large open-grown oaks may not indicate presettlement savanna (Szafoni *et al*. 1994), the size and abundance of trees matured from oak grubs can be indicators of past fire frequency and the former relative cover of graminoid and woody groundlayer vegetation (Bowles & McBride 1995). This information can be extremely useful in structuring savanna restorations. Research is needed to determine if cutting oak coppice sprouts back to grubs can be a useful tool in savanna restoration, such as at Wolf Road Prairie. For woodlands or savannas that are removed from the former forest-prairie border, infrequent catastrophic fires may have caused dramatic shifts between savanna and woodland that can only be replicated by tree cutting if fire safety is a problem.

Problems in natural community terminology and classification

Terms for classifying and differentiating between savanna and woodland communities are commonly misused. By expanding savanna canopy cover to 80% The INAI was progressive in recognizing the wide canopy range of fire-effected oak ecosystems. As a result, Illinois conservationists often refer to any fire-managed woodland as "savanna." However, historic and traditional ecological definitions describe savanna as scattered trees in grassland, with <50% canopy cover, while greater canopy cover is usually woodland. The misuse of these definitions can lead to confusion about how to identify oak-dominated natural areas and can lead to management mistakes such as clearing native woody understories (Bowles *et al*. 1994).

Barrens is a particularly ambiguous term (White & Madany 1978). Its traditional use was for sites thought to represent habitat conditions that were not suitable for tree growth, and in that regard it was applied as a xeric subtype of savanna by the INAI (White & Madany 1978). Such sites on glaciated soils also can be considered to represent the dry- or dry-mesic end of savanna or woodland moisture gradients. Barrens was applied to shrub and oak grub brush prairies by the Public Land Survey (Bowles & McBride 1994, White 1994), and not necessarily to dry- or dry-mesic savannas or woodlands. All three shrub prairies found by this study had been classified by the Illinois Department of

Natural Resources and Illinois Nature Preserves Commission as savannas. Thus, some savannas have been misclassified as barrens, while glacial barrens (shrub prairies) were misclassified as savannas.

Suggestions

We offer the following suggestions for modifying INAI natural community classifications and further investigations into savanna and woodland evaluation, classification, and management.

1) Develop a brush prairie classification that is subdivided to include shrub and oak grub brush prairies. Although no examples of pure oak grub brush prairie were found, frequent or intense burning of *Quercus velutina, Q. alba*, or *Q. ellipsoidalis* woodland may create such conditions. Restoration research is needed for these communities

2) Subdivide savanna into graminoid- and oak grub/shrub-dominated groundlayers. Although there are few clear examples of either type (Copley Cemetery was the only graminoid savanna found), management or restoration needs may benefit from separate definitions.

3) Reduce the canopy cover range for savanna from 10-80% to 10-50% and add a second category extending from 50%-80% canopy cover for fire-managed woodlands.

4) Determine if canopy cover correlates with tree density and basal area for classifiying savanna and woodland communities.

5) Maintain a forest category for >80% canopy cover and determine if threshold limits for tree density and basal area can be established. Identify structural and vegetative differences between woodland and forest (*e.g.* canopy structure), and the degree to which fire should be used to manage forest.

6) Eliminate the dry-mesic barrens category on glaciated soils and replace it with dry savanna or woodland, depending upon canopy cover and tree density.

7) Use oak species and substrates as modifiers for clarifying community classification of savannas and woodlands (*e.g.* Faber-Langendoen 1995).

8) Investigate methods for restoring savanna from woodland produced by grub sprouting. For example, at what rate will oaks sprout after cutting, and how does the ground layer vegetation respond?

9) Investigate the relationship between indicator species, canopy light gradients, and natural quality of savanna and woodlands.

10) This survey was far from complete as it concentrated on two natural divisions. Further inventories are needed in the Wisconsin Driftless, Rock River Hill Country, Springfield Section of the Grand Prairie, and Western Forest Prairie Natural Division.

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APPENDIX I. NOMINATIONS AND CHANGES FOR THE ILLINOIS NATURAL AREAS INVENTORY

Northeastern Morainal Natural Division - Morainal Section

Shrub/brush prairie - No examples were found in this category

Savanna

Middlefork Savanna, Lake Co. (grade B mesic *Quercus macrocarpa* savanna, 56.4 trees/ha, 8.12m^2/ha basal area) This 29-acre savanna is one of two high quality mesic savanna remnant on glacial till in the Northeastern Morainal Natural Division of Illinois. It persisted due to past light grazing and apparently due to fire and species colonization from the adjacent railroad right-of-way. Dominance is shared by *Quercus macrocarpa, Q. alba,* and *Q. ellipsoidalis.* The understory is primarily graminoid, but with frequent hazel clones and locally abundant *Rhamnus cathartica*. There are extremely high woody stem densities at <2.5cm, which reflects recent fire protection. It contains a small population of the Federal threatened orchid *Platanthera leucophaea*, and the orchid *Cypripedium calceolus.* Savanna indicators include the state threatened *Lathyrus ochroleucus, Gentiana flavida*, *Veronicastrum virginicum, Helianthus divaricatus, Coreopsis tripteris, & Smilax lasioneura*. The site is owned by the Lake Co. Forest Preserve District and is fire-managed. It has been studied in detail and is part of a larger complex recommended for dedication as an Illinois Nature Preserve. (Brown & Schennum 1979, Apfelbaum & Bowles 1986, Byers *et al.* 1986, Apfelbaum *et al.* 1987, Keseey 1987, Panzer 1989, Wolff 1990, Newman & Wolff 1990, Mierzwa 1993, Reudebusvch & Nyberg 1994, Schennum 1993).

Wolf Road Prairie Savanna, Cook Co. (grade B mesic *Quercus macrocarpa* savanna). This five-acre savanna has an old growth *Q. macrocarpa* canopy with 17.6 trees/hectare, but fire protection since 1965 has allowed an oak grub layer to form a 805.6 trees/ha subcanopy that heavily shades the herb layer. As a result, graminoid species are extremely rare. However, the site is apparently ungrazed and retains important savanna structure with *Corylus americana* in light gaps, high quality (grade A) prairie vegetation in one large light gap, and savanna indicator species such as *Camassia scilloides, Asclepias purpurescens, & Asclepias exaltata*. This combination of vegetation indicates that the savanna retains natural quality. Because of their ability to sprout after cutting, the subcanopy oaks can be easily returned to a grub level. However, the lack of graminoid vegetation and predominance of shrubs and vines indicates that these species may increase with opening of the canopy. Spread by *Alliaria petiolata, Cornus racemosa, Rhamnus frangula, R. cathartica, & Rubus allegheniensis* may occur initially after burning. (Apfelbaum & Riggins 1990, Bowles 1994, Bowles & McBride 1994, Greenberg 1986, Hanson 1975, LaForce 1988, Packard 1980).

Harvard Savanna, McHenry Co. (Grade C dry-mesic notable savanna). This area was added to the INAI as a best of type grade C savanna in 1990. Since that time, the site has been degraded by railroad maintenance and continued fire supression. It should be reclassified as a notable natural area, but still qualifies as a Categroy II site because of the presence of *Cypripedium candidum*. (W. Schennum, pers. comm.).

Turner Lake Savanna, Lake Co. (Grade C notable mesic *Quercus macrocarpa* Savanna). This small savanna consists of several bur oaks with prairie and some savanna understory vegetation. It occurs on glacial till elevated above surrounding grade C sedge meadow at Chain 'O Lakes State Park.

Woodland (silt-loam substrate)

Somme-Vestal Grove, Cook Co. (Grade C notable mesic-*Quercus macrocarpa* woodland, 219.7 trees/ha, 32.74m^2/basal area) This 100-acre tract is the oldest and highest quality savanna and woodland restoration in the Chicago region, and includes a mosaic of prairie, sedge meadow, savanna, and woodland. The woodland includes mature *Quercus macrocarpa,* while the open savanna comprises younger oaks that may have established in former prairie or brush prairie after settlement and fire protection. The site has been much improved in quality by prescribed burning,

brush removal, and species introduction since 1980. Savanna indicators include *Camassia scilloides*. The Illinois endangered and Federal threatened *Platanthera leucophaea* has been introduced in sedge meadow. (Apfelbaum *et al.* 1987, Byers *et al.* 1986, Packard 1994).

Emerywood, McHenry Co. (grade C best of type dry-mesic-*Quercus alba* woodland, 154 trees/ha, 32.7m^2 /ha basal area) This 6.75-acre area represents the best known example of *Quercus alba*-dominated oak woodland in the Morainal Section of the Northeastern Morainal Natural Division. The area has a depressed shrub-layer and late summer flora due to current mowing. However, the *Carex pensylvanica*-dominated herb-layer vegetation is floristically rich, including the Illinois threatened *Lathyrus ochroleucus*. The site is being destroyed due to fragmentation and subdivision. The cost of lots (~$100,000) appears prohibitive to preservation. Landowner contact has resulted in short-term protection of two isolated lots. (S.I. Apfelbaum, pers. comm.)

Hickory Grove, DuPage Co. (grade C notable dry-mesic *Quercus alba* woodland, 121.35 trees/ha, 28.6m^2/basal area) This woodland has been degraded by past grazing and is dominated by alien grasses and *Rubus* species. But, the area retains a diverse native flora, including local dominance by *Carex pensylvanica*, *Smilacina racemosa, & Apocynum androsaemifolium*. Indicator species such as *Asclepias exaltata, Camassia scilloides, Ceanothus americanas & Dodecatheon meadia* are also present. The open structure of this woodland and its lack of dominance by aggressive alien species makes it one of the most important woodland restoration sites in the Northeastern Morainal Natural Division.

Paddock Woods, Cook Co. (grade B mesic *Quercus rubra* woodland, 166.7 trees/ha, 38.4m^2/ha basal area) Paddock Woods comprises a 40-acre tract of high quality old second growth mesic woodland managed by presecribed burning, and is the best such example in the Northeastern Morainal Natural Division of Illinois. It contains high species richness, including important woodland herbaceous species such as *Asclepias exaltata, Aster shortii, Solidago flexicaulis, Apocynum androsaemifolium, Panax quinquefolius, Hepatica acutiloba, Uvularia grandiflora, Helianthus decapetalus, H. divaricatus, & H. strumosus.* Also present are woodland grasses such as *Brachyletrum erectum & Bromus pubescens,* and the shrub *Corylus americana*. Paddock Woods was initially investigated by the INAI but was not recognized as a natural area. It was re-examined in 1990 by The Nature Conservancy and identified as a high priority site for restoration management based on a five-year management plan initiated in 1991. (Thornton & Martinez 1991, King & Zors 1992)

Elm Road, Lake Co. (notable grade C dry-wet-mesic-*Quercus alba-rubra-bicolor* woodland, 154 trees/hectare, 31.3$m^{2/}$ha basal area) This 40-acre tract contains a woodland continuum extending from dry-mesic to wet-mesic conditions. The *Q. bicolor* community is transitional to northern flatwoods. The herb layer has been degraded by past grazing and is *Carex pensylvanica*-dominated. Indicator species include *Asclepias purpurascens & Lathyrus ochroleucus*.

Woodland (gravel substrate)

Bluff Spring Fen, Cook Co. (grade C best of type dry-mesic-*Quercus macrocarpa* woodland, 149.9 trees/ha, 56.9$m^{2/}$ha basal area) This three-acre *Quercus macrocarpa* - dominated woodland was determined to be one of two best of type examples of this community on gravel soils in the Morainal Section of the Northeastern Morainal Natural Division of Illinois. An adjacent 3-acre woodland dominated by *Q. alba* is a notable natural area. Total density among both tracts is 175 trees/ha with 44.31m^2/ha basal area. The Illinois Natural Areas Inventory identified this area as grade D savanna in 1978. However, prescribed burning and species introduction have increased the natural quality of this plant community. Important herbaceous species in the *Q. macrocarpa* woodland include *Carex pensylvanica, Galium concinnum, Geranium maculatum, Desmodium glutinosum, Elymus villosus, & Hystrix patula*. (S. Byers, pers. comm.)

Glacial Park, McHenry Co. (grade C best of type dry-mesic-*Quercus macrocarpa* woodland, 136.39 trees/ha, 15.61$m^{2/}$ha basal area.) The 35-acre dominated woodland was determined to be one of two best of type examples of this community on gravel soils in the Morainal Section of the Northeastern Morainal Natural Division of Illinois. Contiguous with this tract are a 15-acre *Q. alba* woodland and a 10-acre *Q. rubra* woodland, which are notable natural areas. Prescribed burning and species introduction have increased the natural quality of the *Q. macrocarpa*-dominated woodland. Important herbaceous species in this plant community include *Carex pensylvanica, Galium concinnum, Geranium maculatum, Smilacina racemosa, Desmodium glutinosum, Elymus villosus,* and *Hystrix patula*. (Byers & Schennum 1992; W.E. Schennum & E. Collins, pers. comm.)

Freeman Kame, McHenry Co. (grade B mesic-*Quercus rubra* woodland, 248.9 trees/ha, 41.72m^2/ha basal area) Freeman Kame was identified as grade A dry-mesic woodland but was not included on the INAI because it did not meet the 20-acre minimum acreage requirement. In 1995, this area was found to be the the only high quality mesic *Q. rubra* woodland on gravel soils in the Morainal Section of the Northeastern Morainal natural division. The dry-mesic woodland appears to have undergone light grazing in the past, as indicated by degraded adjacent prairie vegetation; it almost certainly burned prior to settlement because it was surrounded by prairie and prairie wetlands. The past grazing and infrequent current burning appear to have accelerated invasion by the alien *Alliaria petiolata & Arctium minus*. *Eupatorium purpureum & Elymus villosus* have been introduced to the site. There are significant ecological differences between dry-mesic woodland on the the south and north slopes of the kame On the south (and west) slope dominance is shared equally by *Tilia americana, Quercus rubra*, *& Q. macrocarpa* with all trees totaling 194.6 trees/hectare, and basal area of 28.5m^2/hectare. On the north slope, density is 344.3 trees/ha and basal area is 65.97m^2/hectare; *Quercus rubra* is dominant, with 50% lower importance by *Tilia americana,* and a minor representation by *Quercus alba* and *Q. macrocarpa*. (Wilhelm 1978, Bowles & Radke 1992).

Kettle Moraine Woodland, McHenry Co. (grade C best of type mesic *Quercus rubra-Q.alba* woodland, (282.7 trees/ha, 45.5 m^2/ha basal area) This 30-acre woodland is the best known example of a *Quercus rubra-Q. alba* woodland. This structure apparently developed under post-settlement fire protection, as the Public Land Survey notes describe the area as a *Quercus alba-Q. velutina* savanna, with 20.5 trees/ha. The site was maintained by moderate grazing, which reduced plot species richness but allowed survival of a comparatively large number of native species. The herb layer is dominated by *Carex pensylvanica. Fragaria virginiana, Allium cernuum, Antennaria plantaginifolia, & Amphicarpa bracteata*. However, there are local populations of prairie species such as *Andropogon scoparius, Heuchera richardsonii, Amorpha canescens, & Ceanothus americanus*, and woodland species such as *Carex hirsutella, Smilacina stellata, Dodecatheon meadia, & Hepatica americana*. The Illinois endangered *Corallorhiza maculata* and *Lechea intermedia* and threatened *Lathyrus ochroleucus* occur in the woodland. The tract is dedicated Nature Preserve, and is being managed by prescribed burning. (Schennum 1984)

Grand Prairie Natural Division - Grand Prairie Section

Shrub/brush prairie

Tomlinson Cemetery, Champaign Co. (grade C best of type shrub prairie) Tomlinson Cemetery is the only known example of a mesic shrub prairie in the Grand Prairie Section of the Grand Prairie Natural Division. *Corylus americana* and *Ceanothus americanus* are indicator species of this community, and occur in a matrix of *Sorghastrum nutans, Andropogon gerardii* & *Helianthus hirsutus*. *Corylus americana* occurs at 31% frequency, and also forms a large clone along the south boundary. *Camassia scilloides* is an important herbaceous species. Tomlinson Cemetery occurs along the original timber-prairie interface, separated by the Vermilion River.

Savanna

Springdale Cemetery, Peoria Co. (identified as grade B dry-mesic prairie by the INAI) This savanna is characterized by a *Quercus alba* canopy. Dominant and characteristic species include *Sorghastrum nutans, Andropogon scoparius, Aster azureus, Solidago speciosa, Psoralea onobrychis, & Castilleja coccinea.*

Woodland

Hopewell Woodland, Peoria Co. (grade C? notable dry-mesic *Quercus alba-velutina* woodland, 116 trees/ha**)** This woodland comprises two lots in the Hopewell Estates subdivsion, which occurs adjacent to the Hopewell Estates Hill Prairie INAI natural area. The lots were periodically mowed, and have maintained a diverse groundlayer including the shrubs *Corylus americana* and *Ceanothus americanus,* many woodland grasses and sedges, and a diversity of woodland herbs including *Baptisia leucantha, Apocynyum androsaemifolium, Aruncus dioica, Cacalia atriplicifolia, Cirsium altissimum, Desmodium* species, and *Helianthus strumosus.*

Pecumsaugan Creek-Blackball Mines, LaSalle Co. (grade C best of type dry *Quercus velutina* woodland, 174.15 trees/ha, 19.02m^2/ha basal area) This 4.5-acre dry-mesic *Quercus velutina* woodland was found to be the best example of its type in the Grand Prairie Section of the Grand Prairie Natural Division of Illinois. Dominant ground layer species include *Andropogon scoparius, & Helianthus divaricatus*. This natural area occurs on loess soils along the north bluff of the Illinois River. It grades into a 2-acre grade B dry-mesic sand savanna developed in St. Peter Sandstone on the slopes of the valley wall.

Robinson Hills, Peoria Co. (Grade B dry-mesic-*Quercus alba* woodland, 259 trees/ha, 16m^2/ha basal area) This woodland was found to be the only high quality example of dry-mesic *Quercus alba* woodland in the Grand Prairie Section of the Grand Prairie Natural Division. *Quercus. rubra, Q. velutina, & Q. muhlenbergii* are also present at lower importance values. Important herb-layer species include *Carex pensylvanica, Hystrix patula, Amorpha canescens, Aster shortii, A. anomalus, Liatris aspera, Coreopsis palmata, Baptisia leucantha, & B. leucophaea.* This 7.5-acre site occurs adjacent to the Gentiana Hill Prairies natural area identified by the INAI, and its quality has been improved by prescribed burning and removal of invasive woody species. Many herbaceous species may have invaded from the adjacent glacial drift prairie. Although this natural area qualifies as high quality woodland, aerial photos indicate that it was formerly open savanna with oak grubs. This is also indicated by 20% frequency of multiple trunked trees that appear to have matured from oak grubs after a catastrophic 1956 fire. (Ritterbusch & Monoson 1991)

Merwin Savanna, McLean Co. (grade C notable dry-mesic-*Quercus alba* woodland) This ecologically diverse woodland comprises the slope, crest, and adjacent upland bordering the Mackinaw River. It is owned and managed by Parklands Foundation with assistance from volunteers and Illinois State University biologists. *Quercus rubra, Carya ovata*, and *Q. macrocarpa* dominate the slope, *Q. alba, Q. velutina*, and *C. ovata* occur on the crest, and *Q. imbricaria, Q. alba*, and *Carya tomentosa* on the adjacent upland. Although past grazing and canopy closure have reduced species diversity, prescribed burning and clearing has opened the woodland canopy and is allowing recovery of graminoid and herbaceous species. Tree density is lowest (267 trees/ha, with 25.2 m^2/ha basal area/ha) on the crest which has large open grown *Q. alba*. Important herbaceous species include *Tradescantia virginiana, Agrimonia rostellata* and *Panicum implicatum*. *Dodecatheon meadia* and *Camassia scilloides* are locally abundant. (Anderson *et al.* 1994)

Singing Woods, Peoria Co. (grade C notable dry-mesic *Quercus alba* woodland, 321 trees/ha, 23.4 m^2/ha basal area) This woodland is located adjacent to a grade B INAI glacial drift prairie. The woodland and prairie are being managed by prescribed burning; invasive trees have been removed, and prairie vegetation is invading the burned woodland. *Carya ovata & Q. velutina* are secondary canopy trees; dominant and characteristic herb-layer species include *Carex pensylvanica, Muhlenbergia sobolifera, Helianthus divaricatus, Corylus americana, Baptisia leucantha, Hystrix patula, & Aureolaria*

grandiflora.

Shelbyville, Shelby Co. (grade C notable dry-mesic *Quercus alba* woodland, 193.2 trees/ha, 21.5m^2/ha basal area) These woodlands occur on a series of dry-mesic ridge tops and their south slopes, which are separated by ravines draining eastward into Lake Shelbyville. The broader ridges have open prairie-like vegetation with *Andropogon scoparius* and *Liatris aspera*. This vegetation grades into *Q. alba* woodand with *Q. velutina* and *Cary ovata* as secondary trees. Important herb-layer species include *Carex umbellata, Carex cephalophora, Panicum implicatum, Tephrosia virginiana, Helianthus divaricatus, Aster anomolus, Baptisia leucophaea, & Pycnanthemum pilosum*. These woodlands probably were more open prior to settlement. The largest oaks are 110-120 years old, dating back to the 1870's. (R.E. Szafoni, pers. comm.)

Grand Prairie Natural Division - Western Section

Shrub/brush prairie - No examples were found in this category

Savanna

Copley Cemetery, Knox Co. (identified by INAI as grade B mesic savanna) This site represents a classic *Quercus macrocarpa*-dominated savanna with a graminoid understory dominated by prairie vegetation. Dominant and characteristic species include *Sorghastrum nutans, Andropogon gerardii, Ratibida pinnata, Viola pedatifida, Rudbeckia hirta, Petalostemum purpureum, Heuchera richardsonii, Ceanothus americanus* & *Echinacea pallida*. (Betz & Lamp 1992).

Woodland - No examples were found in this category

Western Forest-Prairie Natural Division - Galesburg Section

Shrub/brush prairie - No examples were found in this category

Savanna

Hancock Savanna, Hancock Co. (grade C best of type mesic *Quercus bicolor* savanna) Hancock Savanna is the best known example of mesic savanna (<50 trees/ha) in the Galesburg section of the Western Forest-Prairie Natural Division. The savanna canopy trees are associated primarily with a ravine system that crosses an upland, which may be responsible for the occurrence of *Q. bicolor* in an otherwise dry-mesic prairie habitat. The prairie vegetation has been degraded by past grazing. However, many savanna indicator species are present, including *Asclepias purpurascens, Camassia scilloides, Dioscorea villosa,* and clones of *Corylus americana*. The Public Land Survey mapped the area near the forest-prairie border in the vicinity of barrens. During a survey for potential *Asclepias meadii* habitat, the prairie at Hancock Savanna was identified as the best restoration habitat for this milkweed in the Galesburg section of the Western Forest-Prairie Natural Division.

Woodland

Argyle Barrens, McDonough Co. (identified by INAI as grade B barrens) This natural area should be reclassified as grade B dry-mesic *Q. alba* woodland. Tree density is 208 trees/ha, with 21.3m^2/ha basal area, and 94.6% dominace by *Quercus alba*. Dominant herb-layer species inlcude *Carex pensylvanica, Parthenocissus quinquefolia, Rubus flagellaris, & Solidago ulmifolia*. (J.E. Ebinger & W. McClain, pers. comm.)

McKee Creek Barrens, Brown Co. **(**identified by INAI as grade B barrens) This natural area should be reclassified as grade B dry-mesic *Q. alba* woodland. In a burned plot, tree density was 256 trees/ha, with 26.5^2/ha basal area, and 68% dominace by *Quercus alba*. Dominant herb-layer species inlcude *Carex pensylvanica, Parthenocissus quinquefolia, Helianthus divaricatus, & Solidago ulmifolia*. The Illinois endangered *Trifolium refexum* is present. (J.E. Ebinger & W. McClain, pers. comm.)

Siloam Springs State Park, Adams & Brown Co. (grade C woodland) This park contains extensive dry-mesic prairie, which grades through savanna into woodland. This vegetation has been degraded by past grazing, and possibily agriculture. However, the site has high overall habitat diversity

and species richness. Characteristic prairie vegetation includes *Andropogon gerardi* and *Sorghastrum nutans*; *Quercus velutina* and *Q. imbricaria* form savanna canopy trees and grubs, while *Corylus americana* and *Salix humilis* occur along the woodland borders. *Liatris scariosa* var. *nieuwlandii* occurs locally in open woodland.

Upper Mississippi & Illinois River Bottomlands Natural Division - Illinois River Section

Shrub/brush prairie -

Root Cemetery, Peoria Co. (grade C best of type shrub prairie) Root Cemetery is the best known example of a shrub prairie in the Illinois River Section of the Upper Mississippi River and Illinois River Bottomlands Natural Division. This natural area is situated at the original forest-prairie interface, and was mapped as "barrens" by the Public Land Survey. The preserve comprises two subtypes of barrens: closed shrub praire with *Psoralea onobrychis, Carex sp, Helianthus hirsutus, Rhus glabra,* and open graminoid vegetation with *Andropogon gerardi, Helianthus hirsutus, & Sorghastrum nutans* combined with scattered *Corylus americana* and *Quercus* grubs. The site is maintained by burning (Solecki & Frye 1993).

Savanna - No examples were found in this category

Woodland - No examples were found in this category

Southern Till Plain Natural Division - Effingham Section

Shrub/brush prairie

Roberts Cemetery, Montgomery Co. (identified by the INAI as grade B dry-mesic prairie) This natural area should be reclassified as grade A dry-mesic shrub prairie; it represents the only known high quality example of this natural community in Illinois. The 1.5-acre site is located on the forest-prairie border and is characterized by scattered *Corylus americana* clones. *Solidago canadensis, Sorghastrum nutans, & Desmodium dillenii* are most frequent along the western portion of the cemetery, which merges into prairie; *Ceanothus americanus, Andropogon scoparius, & Helianthus mollis* are most frequent in the central portion, and *Corylus americana, Sanicula canadensis, Cornus racemosa, & Apios americana* are most abundant along the eastern edge, which merges into forest. The Illinois threatened *Liatris scariosa* var. *nieuwlandii* occurs under partial canopy shade at the east edge of the preserve. (Bowles *et al.*1988).

Savanna - No examples were found in this category

Woodland

Lake Lou Yaeger Barrens, Montgomery Co. (identified by INAI as grade C barrens) This natural area should be reclassified as grade A dry *Quercus stellata-alba* woodland. Tree density is 197.3 trees/ha, with 12.3^2/ha basal area. *Quercus alba* and *Q. stellata* are ; co-dominant, while *Q. velutina* and *Q. marilandica* are also present. Dominant herb-layer species inlcude *Carex pensylvanica, Andropogon scoparius, Helianthus divaricatus, Solidago ulmifolia, Rosa carolina, Ceanothus americanus, & Solidago ulmifolia*. The Illinois endangered *Trifolium refexum* is present. (J.E. Ebinger & W. McClain, pers. comm.)

Rocky Hollow, Montgomery Co. (grade A dry-mesic-*Quercus alba* woodland, 219.5 trees/ha, $24m^2$/ha basal area) This 3.5-acre tract appears to be one of only two high quality dry-mesic woodlands in the Effingham Section of the Southern Till Plain Natural Division. *Quercus velutina* is a secondary canopy tree, while *Ceanothus amricanus, Rosa carolina, Helianthus divaricatus*, and *Solidago ulmifolia* are the most abundant herb-layer species. Prairie species present in the woodland include *Coreopsis palmata, Silphium terebinthinaceum*, *Petalostemum purpureum, P. candidum, Echinacea pallida, Sorghastrum nutans, & Andropogon gerardii.* This tract has been managed by prescribed burning and selective removal of overstory trees. No species have been introduced.