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ROCKEFELLER PRAIRIE: A CASE STUDY ON THE USE OF PLANT GUILD CLASSIFICATION OF A TALLGRASS PRAIRIE

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Abstract. Guilds are composed of species that are closely related to one another in their use of a resource gradient in a given community. Eight commonly-known guilds of prairie plant species have been verified through multivariate analysis of 32 ecological and morphological traits. The guilds are: 1) warm-season graminoids ("C₄" grasses); 2) cool-season graminoids ("C₃" grasses and sedges); 3) annuals and biennials; 4) ephemeral spring forbs; 5) spring forbs; 6) summer/fall forbs; 7) legumes; and 8) woody shrubs. This case study of the University of Kansas' Rockefeller Native Prairie demonstrates how these guilds can be a useful tool for understanding and interpreting the plant species diversity of a native prairie. When used with statistical analysis of species composition, it appears that the guild perspective can offer a clearer understanding of species composition and community classification of tallgrass prairie than traditional techniques.

INTRODUCTION

The pre-settlement landscape of eastern Kansas was dominated by dense stands of tall grasses interspersed with large numbers of seasonally showy wildflowers and occasional patches of shrubs. Trees were confined to steep slopes and the borders of stream courses primarily due to prairie fires (Wells 1970). The land survey records for the study area, Jefferson County in northeast Kansas, indicate that the pre-settlement vegetation was 95% prairie and only 5% forest (Kansas State Board of Agriculture 1881). Since then, there has been a dramatic change in the landscape with agriculture converting most lands to cropland. Today, only about 1 or 2% of the landscape in the study area has native prairie of high-quality as its vegetation (Lauver 1989).

The term guild has been defined by Root (1967) as a group of species that exploit the same class of environmental resources. He used this definition for different bird taxa that share the same or similar functional niche (e.g. guilds of leaf gleaners or bark gleaners.) Historically, the term guild was first used to describe groups of plants with similar lifestyles, and specifically four distinct guilds were named: lianes, epiphytes, saprophytes, and parasites (Schimper 1898). Guild is the literal translation of the German word *Genossenschaft* originally adopted by Schimper who used it in a sense similar to a medieval union of skilled craftsmen plying the same trade. The guild concept for plants usually have not been tied to resources as obviously as animal guilds have, perhaps because of the difficulty in reconciling plant diversity with notions that resource partitioning structures com-

munities (Simberloff and Dayan 1991). In previous research (Kindscher 1991), the eight prairie plant guilds used in this study were proposed and verified using multivariate statistics of 32 ecological and morphological traits. These traits (representing plant habit, leaf characteristics, stem structures, root structures, and reproduction) were used because they give species different abilities to use environmental resources (nutrients, water, light, and etc.) Although the guilds proposed were not new, as many were mentioned by Weaver (1954, 1968), they were verified by detrended correspondence analysis and cluster analysis. Guilds of species have been discussed in the literature in terms of theory (Root 1967, Hawkins and MacMahan 1989, Simberloff and Dayan 1991) and as applied to management (Severinghaus 1981, Verner 1984, Szaro 1986, Reader 1988). Simberloff and Dayan (1991) stated that for the guild concept to be successfully used, two conditions must be met: 1) a clear statement is needed as to the criteria and considerations that have led to a particular guild assignment; and 2) if sympatric related biota are included in the study, the exclusion of one from the same guild as the other, should be explained.

Analysis and interpretation of the composition and quality of prairie remnants are often difficult. Through both vegetative sampling and traditional floristic analysis, a good understanding of the composition of a prairie can be obtained. When multivariate techniques are also included, particularly when species are grouped into guilds, a better interpretation of the area and its biodiversity may be achieved (Severinghaus 1981, Kindscher 1991, Grabherr 1989, Walker 1992). Besides determining which guilds of prairie species are present, the percentage of coverage for each guild can also be determined as can the ecological and morphological traits that are most important in determining each of these guilds. The analysis of the Rockefeller Native Prairie as a case study will demonstrate the value of these techniques for analyzing an individual prairie.

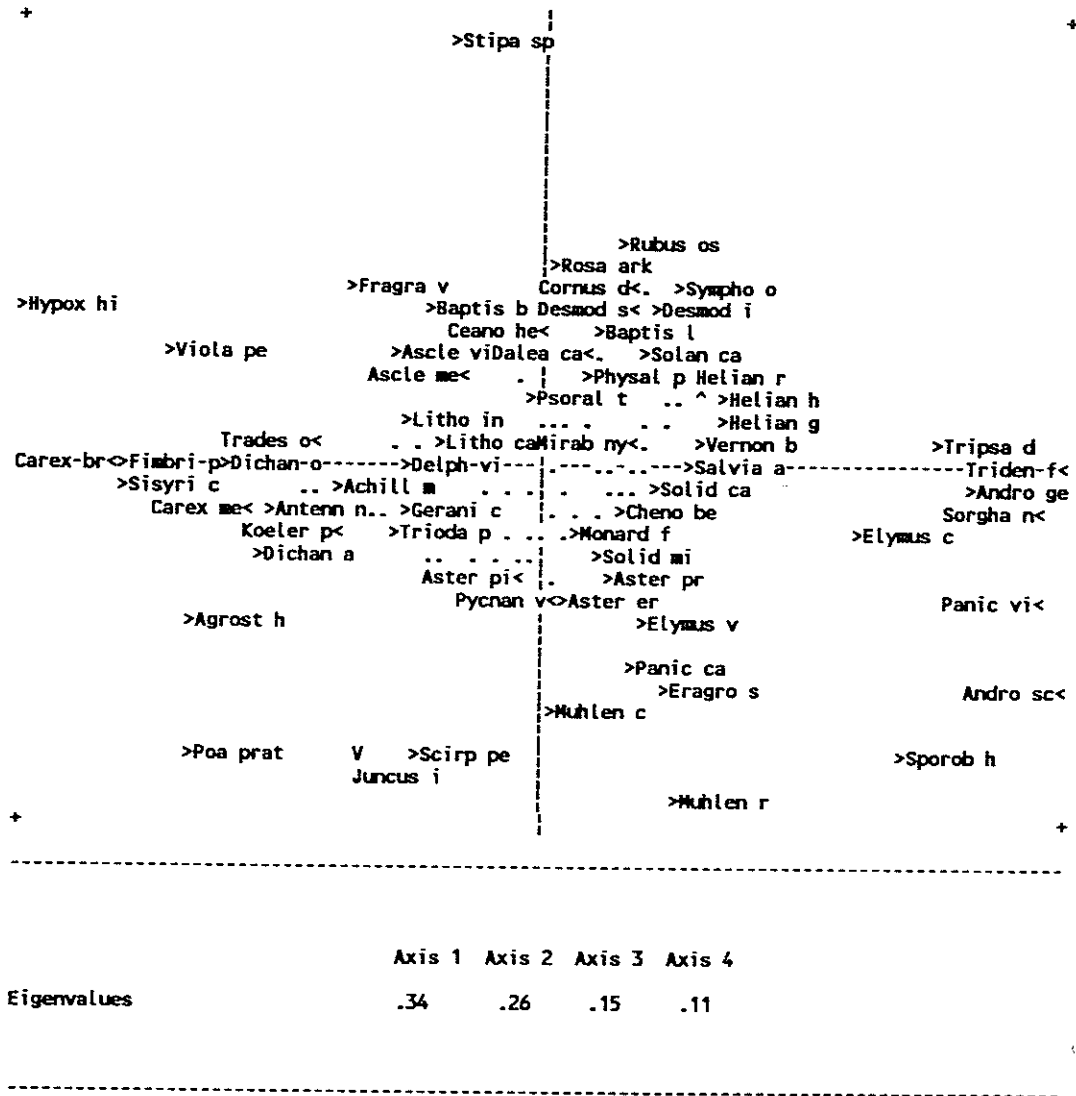


Figure 1. First two axes of a detrended correspondence analysis of species positions from 32 morphological and ecological traits of 121 species on the Rockefeller Tract Prairie, and eigenvalues for the first four axes. Species names abbreviated (see Appendix 1 for abbreviations) and printed where space allows. Species located at arrows, which point to species abbreviations. Some arrows represent more than one species. Species too close together to print are marked with a “.”.

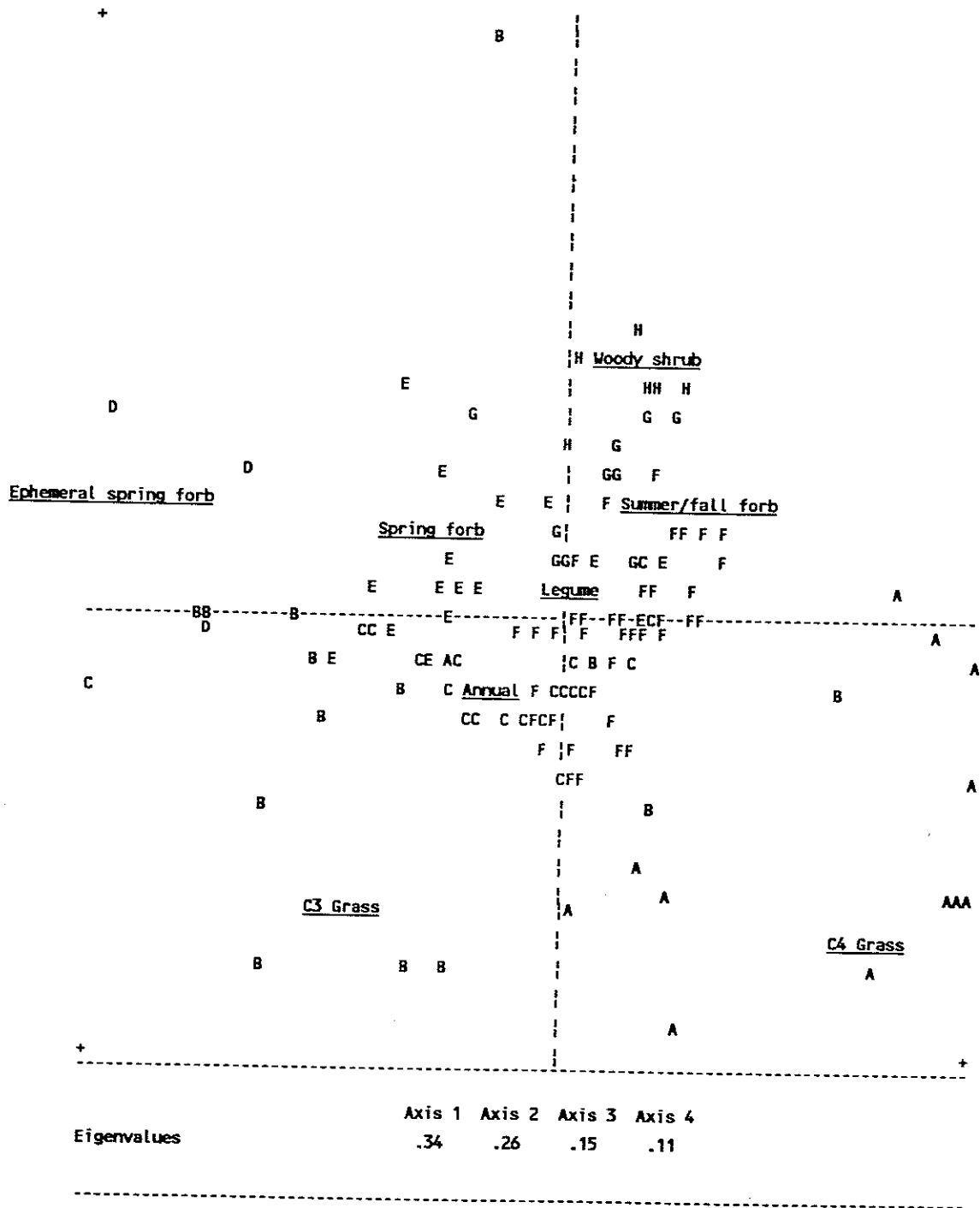


Figure 2. Guild groupings of species on first two axes of detrended correspondence analysis of species positions from 32 morphological and ecological traits of 121 prairie species on the Rockefeller Prairie, and eigenvalues for the first four axes. Letters mark individual species in the following guilds: A=C4 grass; B=C3 grass; C=Annual; D=Ephemeral spring forb; E=Spring forb; F=Summer and fall forb; G=Legume; and H=Woody shrub.

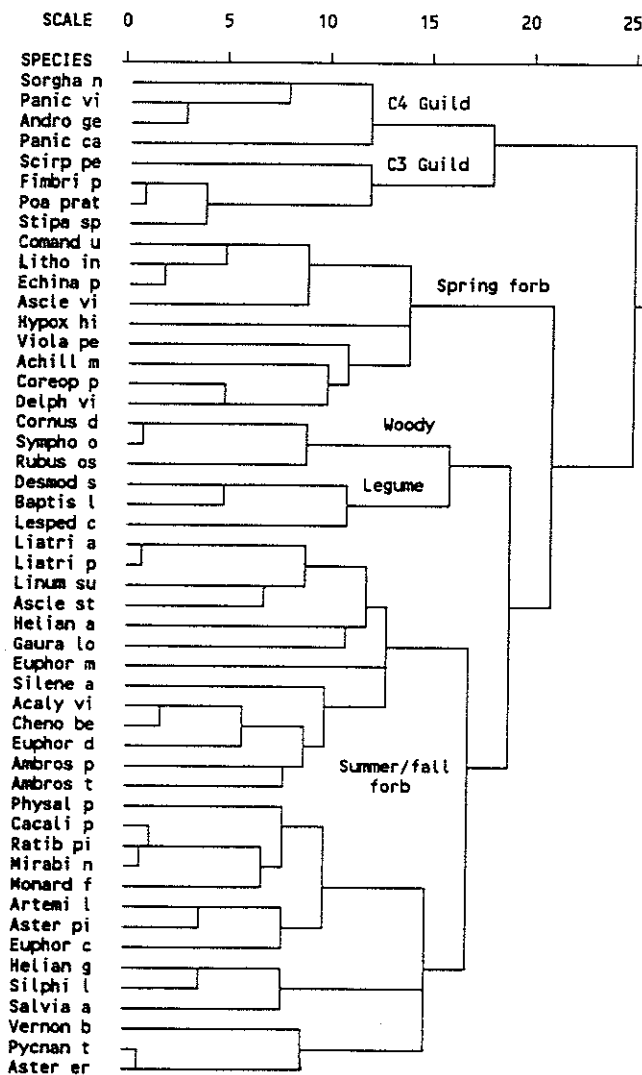


Figure 3. Cluster Analysis dendrogram using Ward method, showing 50 representative tallgrass prairie species (abbreviations for names in Appendix 1) and guilds.

METHODS

Study Site

The Rockefeller Native Prairie on the Rockefeller Experimental Tract of the University of Kansas is known as a highly diverse and floriferous remnant of the original native prairie flora (Fitch and Kettle 1988). It is a 4.6 hectare site, located 12 kilometers north of Lawrence, (Sec. 33, T11S, R20E) in Jefferson County, Kansas. Its soils are Pawnee series and Grundy silty clay loam (both are montmorillonitic, mesic, Aquic Argiudolls).

The U.S. Government land survey for Jefferson County was conducted in 1858, just prior to settlement. It reports that the Rockefeller Native Prairie was indeed in prairie vegetation

at that time, as the survey followed the section lines, which included the western and southern sides of the prairie. It is interesting that just north of the existing prairie, the survey reports that a forested area began as one enters a steep, rocky ravine. This area remains today a native oak-hickory forest. At the time of its acquisition in 1956 by the University of Kansas through a grant from the Rockefeller Foundation, the prairie was part of a private farm. It had been maintained by annual mowing for hay and burning of the remaining stubble. Since 1956, the prairie was managed by burning every three years until the late 1960's when it became obvious that woody vegetation was not being held in check (Fitch and Hall 1978) due to invasion from surrounding early-successional forest. A brush cutter was used to remove the woody vegetation and since then the prairie was managed by annual and biennial burning and occasional mowing. More recently, it was burned during the spring on a biennial basis (1986, 1988, 1990, 1992).

Plant Inventory

Data were collected from the Rockefeller Prairie during the 1989 and 1990 growing seasons (April-October) as part of some longer-term ecological work on plant guilds and community ecology. The prairie was inventoried every week to ten days to determine species composition. Voucher specimens were deposited at the McGregor Herbarium at the University of Kansas (KANU). All non-native species and tree species were not used in the subsequent data analysis. Tree species were not used because they are unable to reproduce on the prairie due to its management; they also comprise less than one percent of the species cover. This left 121 native prairie species (whose guild is listed in Appendix 1). Species nomenclature is from the *Flora of the Great Plains* (Great Plains Flora Association 1986).

In addition to the species inventory, 50 randomly placed quadrats (each 1 m²) were sampled on June 16 and 17, 1989 from the prairie. Sampling was conducted during this time of year in order to include both cool-season species along with warm-season vegetation. Species cover in each quadrat was determined by visually estimating the sum of greatest spread of foliage for each species in each plot using Daubenmire's sampling techniques (Daubenmire 1959).

Guilds of prairie species were previously determined using a multivariate analysis of ecological and morphological traits for species on the Rockefeller Native Prairie and two additional prairies in northeast Kansas (Kindscher 1991). The data below are a subset of the larger data set. They were collected for 32 ecological and morphological traits for each of the 121 native prairie species on the Rockefeller Native Prairie. These 32 traits represent five broad categories: plant habit, leaf characteristics, stem structures, root structures,

Table 1. Variables and correlation coefficients for species positions on the first two axes of a detrended correspondence analysis of 121 prairie species. One-tailed significance: * - 0.01; ** - 0.001.

ECOLOGICAL & MORPHOLOGICAL TRAITS	X1	Y1
Active growth during warm season	.6069 **	-.0644
Photosynthetic pathway, C ₄	.5732 **	-.4475 **
Flowering, late	.4793 **	-.3656 **
Height, tall	.4345 **	.2926 **
Leaf size, large	.3663 **	.3076 **
Clones, large	.2178 *	.1934
Seed weight, heavy	.1277	.5504 **
Flowering duration, long	.1210	-.1614
Woodiness	.0830	.3810 **
Phyllotaxy, opposite or whorled	.0677	.0888
Zoophilous seed dispersal	.0446	.5247 **
Nitrogen fixation root nodules	.0402	.3291 **
Leaves compound	.0155	.4247 **
Not palatable to large herbivores	.0035	.0948
Rooting habit, tap or fascicle	.0028	.3401 **
Forb life form	-.0706	.4003 **
Leaves sheathed	-.0836	.4271 **
Leaves hairy or glaucous	-.0904	.0161
Duration, annual or biennial	-.0990	-.1192
Leaves divided	-.1009	.0508
Leaf length/width ratio, large	-.1144	.3885 **
Sod or mat roots	-.1453	-.3123 **
Seed weight, light	-.1755	-.5779 **
Zoophilous pollination	-.1813	.4668 **
Bulbs	-.2241 *	.1185
Basal rosette	-.3151 **	.1127
Decumbent or prostrate stem	-.3215 **	.1830
Leaf size, small	-.3406 **	-.2823 **
Growth period, short	-.3952 **	.0395
Height, short	-.5203 **	.0009
Rooting depth, shallow	-.5477 **	-.3121 **
Flowering, early	-.6308 **	.3275 **

and reproduction. Information and data for these traits were collected from the field (Kindscher 1991) and botanical literature (Bare 1979, Steyermark 1981, Great Plains Flora Association 1986), or from the ecological literature (Weaver 1919, 1954, 1968, Weaver and Fitzpatrick 1934, Phillips Petroleum Company 1959, Downton 1975).

The data for these traits are discussed in detail in Kindscher 1991. Traits that reflected the standard or non-specialized types were coded with a 0; those with a specialized trait were coded with a 1. In an effort to make all variables discrete, for four traits (plant height, leaf size, time of flowering, and seed weight) three classes of data were coded by dividing the data into three equal-sized groups (for small or early, medium,

and large or late). The large and small classes are coded as specialized traits because each of these classes may confer special adaptive advantages to plant species that have this class trait.

The ordination of species was conducted by using a detrended correspondence analysis using the program CANOCO (ter Braak 1987). Detrended correspondence analyses are useful for ordination of environmental data because they produce results that can more easily be interpreted than other multivariate techniques (Hill and Gauch 1980, Peet et al. 1988). The interpretation of the first two ordination axes was assisted by correlating (using the Pearson product moment) the location of each species in the

Table 2. Canonical discriminant functions including Wilks' lambda and Chi-square and the significance of the functions being the same. Classification results. Abbreviations: Fcn=function; Cum Pct=cummulative percent; DF=degrees of freedom; Sig=significance; ANN=annual; C3=C₃ photosynthetic pathway sedge or grass; C4= C₄ photosynthetic pathway grass; ESP=ephemeral spring forb; FAL=summer or fall forb; SPR=spring forb; LEG=legume; WOO=woody shrub.

Fcn	Eigenvalue	Pct of Variance	Cum Pct	Canonical Corr	After Fcn	Wilks' Lambda	Chisquare	DF	Sig
1*	38.6652	47.28	47.28	.9873	0	.0000	1485.390	140	.0000
2*	26.0233	31.82	79.10	.9813	1	.0000	1095.260	114	.0000
3*	6.1848	7.56	86.66	.9278	2	.0009	745.810	90	.0000
4*	4.6567	5.69	92.36	.9073	3	.0063	536.781	68	.0000
5*	2.8269	3.46	95.81	.8595	4	.0358	353.100	48	.0000
6*	1.9337	2.36	98.18	.8119	5	.1368	210.843	30	.0000
7*	1.4914	1.82	100.00	.7737	6	.4014	96.760	14	.0000

* marks the 7 canonical discriminant functions in the analysis.

Classification Results -

Actual Group	Cases	No. of Predicted Group Membership (species per guild)							
		1	2	3	4	5	6	7	8
Group 1 ANN	21	21	0	0	0	0	0	0	0
		100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Group 2 C3	14	0	13	1	0	0	0	0	0
		0.0%	92.9%	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Group 3 C4	14	0	1	13	0	0	0	0	0
		0.0%	7.1%	92.9%	0.0%	0.0%	0.0%	0.0%	0.0%
Group 4 ESP	4	0	0	0	4	0	0	0	0
		0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Group 5 FAL	34	2	0	0	0	32	0	0	0
		5.9%	0.0%	0.0%	0.0%	94.1%	0.0%	0.0%	0.0%
Group 6 LEG	10	0	0	0	0	0	10	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Group 7 SPR	18	0	0	0	0	1	0	17	0
		0.0%	0.0%	0.0%	0.0%	5.6%	0.0%	94.4%	0.0%
Group 8 WOO	6	0	0	0	0	0	0	0	6
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%

Classification Processing Summary

121 Cases (species) were processed.

Percent of "grouped" cases correctly classified: 95.87%

detrended correspondence analysis with the 32 ecological and morphological traits (using the raw data matrix). To further corroborate the detrended correspondence analysis ordination, the data set was analyzed through Ward's method of cluster analysis in the program SPSS/PC+ (SPSS 1988). To test the validity of the eight guilds, a discriminant function analysis was performed using Mahalanobis distance as the selection criteria for the data set and using Wilk's lambda and F-tests as test statistics (SPSS, 1988).

Table 3. Total vegetative cover for 50 quadrats for the 20 species with greatest coverage on the Rockefeller Native Prairie. Also included are species of greatest cover for C₃ grass and spring ephemeral guilds; and percent cover/guild, listed in parenthesis adjacent to the species with the greatest cover in each guild. Note that total coverage of all 50 plots for individual species would result in a coverage figure of 50,000. Due to species overlap composite (for all species) total coverage is greater than 50,000.

SPECIES GUILD	(Cover/Guild)	COVER/SPECIES
<i>Andropogon gerardii</i>	C ₄ grass (67.5%)	29.020
<i>Andropogon scoparius</i>	C ₄ grass	20.320
<i>Silphium laciniatum</i>	Summer/fall forb (16.6%)	5.920
<i>Sporobolus heterolepis</i>	C ₄ grass	5.680
<i>Rhus glabra</i>	Woody shrub (7.6%)	5.350
<i>Sorghastrum nutans</i>	C ₄ grass	5.030
<i>Amorpha canescens</i>	Legume (5.3%)	2.730
<i>Eryngium yuccifolium</i>	Summer/fall forb	1.880
<i>Solidago rigida</i>	Summer/fall forb	1.685
<i>Helianthus rigidus</i>	Summer/fall forb	1.600
<i>Lespedeza violacea</i>	Legume	1.530
<i>Aster praealtus</i>	Summer/fall forb	1.280
<i>Ceanothus herbaceus</i>	Woody shrub	1.170
<i>Tripsacum dactyloides</i>	C ₄ grass	1.020
<i>Euphorbia corollata</i>	Spring forb (1.3%)	0.850
<i>Solidago canadensis</i>	Summer/fall forb	0.680
<i>Solidago missouriensis</i>	Summer/fall forb	0.490
<i>Ambrosia artemisiifolia</i>	Annual (0.8%)	0.380
<i>Baptisia bracteata</i>	Legume	0.350
<i>Apocynum cannabinum</i>	Summer/fall forb	0.305
<i>Dichanthelium oligosanthes</i>	C ₃ grass (0.5%)	0.115
<i>Viola pedatifida</i>	Spring ephemeral (0.1%)	0.065
*** Total for above species		87.450
*** Total for 176 Species ***		90.670

DISCUSSION

A total of 176 species was found on the Rockefeller Native Prairie. Of these species, 165 are native; 10 of these occur only along the forest edge, which is being encroached by successional woody species; seven others are tree species that will not reproduce on the prairie due to management (fire or mowing), which reduces them to root sprouts; and 27 were rare or uncommon and data could not be obtained for all 32 traits. The remaining 121 native prairie species were used in the multivariate analysis.

The first axis of the detrended correspondence analysis explained 34% of the variation and the first four axes explained 86% of the variation. The arrangement of species in two-dimensional space shows guild groupings (Figure 1). Eight guilds of prairie species were verified in this analysis: C₄ photosynthetic pathway grasses, C₃ grasses and sedges, annuals and biennials, ephemeral spring forbs, spring forbs, summer/fall forbs, legumes, and woody shrubs (Figure 2). These guilds were previously determined by making logical

groupings of the species ordination conducted through the detrended correspondence analysis (Kindscher 1991). Each native species on the Rockefeller Prairie was assigned to a guild (Appendix 1). Some species are listed in two guilds, the primary guild being the one of greatest affinity, determined by the detrended correspondence analysis. Correlations of the 121 species positions in the detrended correspondence analysis with the 32 ecological and morphological traits allows for the interpretation of which traits most highly influence the location of these prairie species and subsequently the groups or guilds of species (Table 1). For the X axis, the following ecological and morphological traits had the most significant positive correlations ($p \leq 0.001$): tall height, active growth during the warm season, large leaf size, C₄ photosynthetic pathway, and late flowering. The most significant negative correlations for the X axis are: decumbent or prostrate stem, short height, short growth period, basal rosette, small leaf size, shallow rooting depth, and early flowering.

For the Y axis, the following ecological and morphological traits had the most significant ($p \leq 0.001$) positive correlations (Table 2): forb life form, tall height, large leaf length/width ratio, large leaf size, compound leaves, sheathed leaves, woodiness, tap or fascicle roots, shallow rooting depth, early flowering, zoophilous pollination, zoophilous seed dispersal, and heavy seed weight. The traits most negatively correlated with the Y axis are: small leaf size, C₄ photosynthetic pathway, sod or mat roots, shallow rooting depth, late flowering, and light seed weight.

The cluster analysis of the data resulted in similar groupings as identified in Figure 3, which added corroborative evidence to the existence of the guilds. The C₃ and C₄ grass guilds were the most clearly defined groups. The summer/fall forb, spring forb, woody shrub, and legume guilds are also distinguishable clusters. Due to the small number of species (four) in the early spring ephemeral forb guild, this group is not clearly distinguishable, nor is the highly variable guild of annuals. It should also be noted that on this prairie, these two guilds only comprised 0.1% and 0.8% respectively of the total vegetative cover sampled.

The discriminant function analysis (Table 2) provides statistical evidence that these eight guilds represent the data set as 95.9% of the prairie species were correctly classified into one of the eight prairie plant guilds. This was confirmed with a 95.0% correct classification for the guilds when this prairie was combined with the original two other high-quality prairies from northeast Kansas (Kindscher, unpublished).

Plant Sampling

The twenty-two species with the highest total coverage ranged from 0.065 m² to 29.02 m² of the total cover with 50 m² being complete cover of all plots (Table 3). Because species overlap, total estimated cover values for all species per plot were greater than 1.00 m² (100%), averaging 1.84 m² (184%) per plot. Composite plot values of greater than 1.00 m² (100%) occurred because almost all plots were dominated by warm season grasses that had a variety of other herbaceous species that overlapped the grass cover. The two species with the greatest total cover were the warm season, C₄ photosynthetic pathway grasses, big bluestem (*Andropogon gerardii*), and little bluestem (*A. scoparius*, synonym = *Schizachyrium scoparium*). The forb with the greatest coverage was compass plant, (*Silphium laciniatum*) (Table 3).

Guilds of Species on the Rockefeller Native Prairie

Using the cover data from quadrats and the entire species list, the eight guilds will be discussed. The traits with significant correlation coefficients will be used to characterize each guild of species. They are discussed in general terms in order

that these guild descriptions could be used to classify other prairie species into guilds.

C₄ photosynthetic pathway grasses

This guild (Appendix 1) of 13 species (10.7% of the 121 prairie species in the ordination) dominates the visual appearance of the Rockefeller Native Prairie. The cover data for this prairie provide evidence for the dominance of the C₄ grasses as they compose 67.5% of the total cover. Of particular note in this prairie is the relatively high cover value of prairie dropseed (*Sporobolus heterolepis*) (5.68% of total), and the low cover (only 0.2% of total) of the often dominant switchgrass (*Panicum virgatum*).

Dominance of the C₄ grass guild is widespread (Weaver and Fitzpatrick 1934, Curtis 1959, Ray 1959, Dix and Smeins 1967, Weaver 1968, and Diamond and Smeins 1985). The guild of C₄ grasses essentially forms the matrix of vegetation within which species of other guilds occur. In addition to these ecological and morphological traits, C₄ grasses respond positively to fire and grazing (Hulbert 1969, Peet et al. 1976, and Collins and Wallace 1990).

C₃ photosynthetic pathway grasses and sedges

This guild of 13 species (10.7% of the prairie species ordered) is common to this and other prairies; however, it is not abundant (comprising only 0.5% of the cover of this prairie). The species are known as cool-season grasses, as they flower in the spring, although most have green foliage during the summer (Weaver 1954). The sedges formed a minor component of the cover of this guild.

Annuals

This guild is comprised of 20 opportunistic species (16.5% of the prairie species present) that generally colonize sites of micro-disturbance or survive in bare soil between other species. In a prairie such as this one, with a consistent management history of burning and mowing, annuals make up very little (only 0.8%) of the cover by species. The cover values of annuals generally increase through disturbance (Drew 1947, Launchbaugh 1955, Collins 1987, and Gibson 1989).

Many annual species on the Rockefeller Native Prairie, such as peppergrass (*Lepidium virginicum*) and spotted spurge (*Eupatorium maculata*), are found only along the foot path and in areas of shallowest soil. The difficulty that individual annual plants have in surviving on this prairie (and other high-quality prairies) was exemplified by the inability of the generally highly-productive annual sunflower (*Helianthus annuus*) to set seed during the droughty summer of 1989. During the same time, perennial prairie plants produced viable seeds. It should also be noted that many traits in this guild, such as seed weight, plant height, and seasonality were

extremely variable among species, reflecting the diversity of annual plant life forms.

Ephemeral spring forbs

This guild has four species (3.3% of the prairie species ordered) that appear very early in the year, never grow very tall, often have ephemeral foliage, losing their photosynthetic abilities during the summer when the taller warm-season grasses over-top them. Although this guild comprised only 0.1% of the cover, its species were frequently encountered in the quadrats sampled.

Spring forbs

This guild of 17 species (14.0% of the prairie species ordered) is similar to the ephemeral spring forb guild, but differs by appearing a few weeks later in the spring, having slightly taller heights, and they are not ephemeral. These species make up much of the showy wildflower bloom characteristic of tallgrass prairies. The cover values for this guild are less than would be assumed based on observation as they comprise only 1.3% of total. This low value exemplifies how showy species may be over-represented in visually-based inventory work. This guild also includes the federally-protected, Mead's milkweed (*Asclepias meadii*).

Summer/fall forbs

This guild of 36 species (29.6% of the prairie species present) comprises the largest number of species in any guild. These species are generally tall and coarse forbs, that grow along with the warm-season grasses, flowering and setting seed in the summer and fall. Due to the large size of species, this guild comprises 16.6% of the total cover. It also includes the federally-protected, western prairie-fringed orchid (*Habenaria leucophaea*) {synonym = *Platanthera praeclara*}. In addition, this guild contains species that have either wind-dispersal of light seed (*Aster* and *Solidago*) or gravity dispersal of heavier seeds (*Helianthus* and *Silphium*).

Legumes

This guild of 10 species (8.3% of the prairie species ordered) is comprised of a group of variable species that have compound leaves with an odd number of leaflets and apparently have a competitive advantage due to their ability to fix atmospheric nitrogen (Bare 1979). The total cover of this group is 5.3%. Two species in this guild are also part of another guild. Showy partridge pea (*Cassia chamaecrista*) is both a legume and an annual; and leadplant (*Amorpha canescens*) is both a legume and a woody shrub. Both were classified with the legume guild due to their locations in the detrended correspondence analysis.

Woody shrubs

This guild of 6 species (5.0% of the prairie species ordered) is comprised of woody species which have some of their

overwintering buds above the ground's surface. These species, which persist in managed prairie remnants, are those that resist the effects of fire and mowing. Pastures are often invaded by trees, but trees do not generally reproduce when clipping (whether by grazing or machinery) is accompanied by fire. This guild represents 7.6% of the total cover. It is perhaps over-represented in cover on the Rockefeller Native Prairie due to the quadrat transects passing through a dense colony of smooth sumac (*Rhus glabra*). The spread of this colony and the invasion of other woody species from the surrounding areas of early-successional forest is of concern to the management of this prairie, and resulted in the frequency of burning or mowing being increased to every other year. The dense stand of sumac also provides habitat for some weedy understory forest species not found elsewhere in the prairie (white snakeroot {*Eupatorium rugosum*} and bitter-sweet {*Celastrus scandens*}), which are invading from the surrounding forest.

Other species not in prairie guilds

The species not represented in the above guilds include trees, forest edge species, and non-native species. All these species were rarely on the quadrats and had very low total cover values (their combined cover values are only 0.2% of the total). Trees such as box elder (*Acer negundo*) and slippery elm (*Ulmus rubra*) are unable to reproduce on the prairie due to management. It appears that the seed rain of early successional forest species, which surround the Rockefeller Native Prairie, would quickly change the species composition of this prairie if management by fire or mowing would cease. Forest edge species, including the weedy, black snakeroot (*Sanicula gregaria*) and gooseberry (*Ribes missouriense*), do not seem to be able to compete on the prairie and are restricted only to its shady edge or in the dense stand of smooth sumac (*Rhus glabra*). Non-native species, such as tansy mustard (*Descurainia pinnata*) and day flower (*Commelina communis*) are weedy and generally located along the edges and elsewhere in small areas of disturbed soil.

Classification of Tallgrass Prairie

The current methodologies used by ecologists for the classification, and subsequent recommended protection of prairies, such as through state natural heritage programs or state departments of natural resources, are based on species presence (especially designated indicator species) and especially presence of federally listed threatened and endangered species. In some cases, classification of prairies has been based on species coverage in quadrats; however, a considerable amount of time to conduct field work and statistical analysis is necessary for quadrat analysis and therefore it is generally not used by these programs.

Classification of tallgrass prairies, and determination of their quality, could be based on the analysis of guilds. They can be incorporated into survey work and ecological studies at various levels of analysis. At the most simplistic level, prairie species guilds can be used to quickly identify an area as native tallgrass prairie, even by those who do not know the identification of many prairie species. The identification process can be done through the use of guild identifications that follow:

Guild Identifications

C₄ photosynthetic pathway grasses--tall, warm season grasses, with flowers and fruit on stalks greater than three feet tall, flowering time mid-summer through fall; narrow, long leaves, often shades of red and orange in the fall;

C₃ photosynthetic pathway grasses and sedges--shorter (usually less than three feet tall), flowers and fruit (at least the onset) before summer, narrow long leaves, with no special coloration in the fall;

Annuals--No perennial root stock; variety of heights and leaf sizes and shapes; usually very fruitful (with many flowers, often not showy); generally found only in disturbed prairie areas;

Ephemeral spring forbs--very short, start flowering very early in the spring (March, usually), flowers usually showy, foliage dries up before summer;

Spring forbs--short, flowering occurs during the spring, often showy flowers and broad leaves; foliage persists into the summer;

Summer/fall forbs--variety of heights (many tall and coarse), flowering occurs during the summer and fall, and usually with non-linear leaves;

Legumes--usually evident during spring or summer, with odd number of leaflets, and flowers with typical pea-shape (bilaterally symmetrical); nitrogen-fixation root nodules present (but difficult to unearth and find);

Woody shrubs--medium to tall in height (but not trees), stems woody, found throughout the growing season, ability to resprout after fire or mowing.

A high-quality tallgrass prairie will probably have all of the guilds present. In three prairies previously studied, all eight guilds have been found (Kindscher 1991). June is the ideal month for survey work. If the survey work is done after June and before March, it may be difficult for the untrained person to determine if the ephemeral spring forb guild exists. The other seven guilds should be visually present.

Tallgrass prairies are relatively similar in species composition throughout their range (Weaver 1954, 1968). These guilds of species exist on tallgrass prairies in Manitoba, Canada, northern Iowa, eastern Nebraska, eastern Kansas, western Missouri, northern Oklahoma, and north-central Texas (Weaver 1954, 1968, personal observation, 1987-1990). They would also be found on tallgrass prairies outside this range, especially to the east and northeast. Midgrass and shortgrass prairies would be different, but would probably have many similarities in guild associations.

A second use of these guilds would be by those experienced in prairie plant species identification and can include guilds in their analysis. There has been much difficulty in determining which tallgrass prairie species are good indicators of high-quality prairies, that is prairies that are high in biodiversity. Even the suggested indicator species, lead plant (*Amorpha canescens*) and compass plant (*Silphium laciniatum*) (Gould 1941, Weaver 1954, Curtis 1959, Weaver 1968), are often found on non-prairie sites, especially disturbed roadsides and parcels planted to introduced cool-season grasses. Perhaps it would be easier and more informative to list the guilds of a tract of land being surveyed and two conservative or unusual species for each guild, than to use indicator species. The species listed could then give a good indication of the range of species found on the tract. This methodology will also lessen the bias of using showy forb species as the indicator species of a high-quality prairie. The use of guild classification and the listing of the most important species on the tract for each guild can also be useful in endangered species surveys and determinations of their associated species complexes.

A third, and possibly the most important, use of guilds is their incorporation into traditional statistical analysis of vegetative cover. For detailed field work that attempts to determine the actual composition of a tract of land, traditional canopy coverage analysis of plot data can be accompanied by guild analysis. The work conducted in this study of the Rockefeller Native Prairie can serve as a model example of integration of these techniques. By using the guild identifications above, native prairie species in addition to the 121 species listed in this study (Appendix 1) can easily be classified into guilds by plant ecologists who are familiar with the species in question. With the species categorized into guilds, it is then possible to supplement canopy coverage of plots with canopy coverage by guild of plots and then to determine what the coverage of each of these guilds is for a particular tract of land. The percent coverage by the guilds can help interpret the type and quality of the vegetation of a prairie remnant. As an example, on high-quality prairies, the coverage of the annual guild would be expected to be small and lower than

on a prairie that has been degraded through over-grazing by livestock, or human disturbance.

Guild groupings can be a useful tool in increasing our understanding of the tallgrass prairie. They simplify the array of species into groups in order that ecosystem processes and functions can more easily be studied. They also can allow for a better understanding and interpretation of the diversity of life forms and life history of tallgrass prairie species. For more rigorous analysis of prairies, traditional statistical techniques for analysis of both species and guild groupings can be used to give a clearer understanding of species composition and community classification of tallgrass prairies.

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Appendix 1. Species (grouped by Family), Authority, Common Name, Abundance Code, Primary Guild, Secondary Guild, Total Cover in 50 m² Plots. Frequency Codes: C=Common; F=Frequent; I=Infrequent; E=Edge Only; and R=Rare. Guild codes are: ANN=annual; ESP=ephemeral spring forb; FAL=summer or fall forb; SPR=spring forb; LEG=legume; WOO=woody shrub; C3=C₃ photosynthetic pathway grass; and C4=C₄ grass. Additional codes for species not included in guild-determining multivariate analysis, but found at the site: INTR=introduced species; TREE=tree species; and EDGE=understory woodland species.

SPECIES	AUTHORITY	COMMON NAME	ABUNDANCE CODE	PRIMARY GUILD	SECOND GUILD	COVER
** FAMILY: Acanthaceae						
<i>Ruellia humilis</i>	Nutt.	Fringeleaf ruellia	I	SPR		0.040
** FAMILY: Aceraceae						
<i>Acer negundo</i>	L.	Box elder	I		TREE	0.000
** FAMILY: Amaranthaceae						
<i>Amaranthus rudis</i>	Sauer	Water hemp	I		ANN	0.000
** FAMILY: Anacardiaceae						
<i>Rhus aromatica</i>	Ait.	Fragrant sumac	E		WOO	0.000
<i>Rhus copallina</i>	L.	Dwarf sumac	I		WOO	0.000
<i>Rhus glabra</i>	L.	Smooth sumac	F	WOO		5.350
<i>Toxicodendron radicans</i>	(L.) O. Ktze.	Poison ivy	I		WOO	0.000
** FAMILY: Apiaceae						
<i>Eryngium yuccifolium</i>	Michx.	Button snakeroot	F	FAL		1.880
<i>Polytaenia nuttallii</i>	DC.	Prairie parsley	I		SPR	0.000
<i>Sanicula gregaria</i>	Bickn.	Black snakeroot	E		EDGE	0.000
** FAMILY: Apocynaceae						
<i>Apocynum cannabinum</i>	L.	Indian hemp dogbane	I	FAL		0.305
** FAMILY: Asclepiadaceae						
<i>Asclepias meadii</i>	Torr.	Mead's milkweed	R	SPR		0.000
<i>Asclepias stenophylla</i>	A.	Narrow-leaved milkweed	R	FAL		0.000
<i>Asclepias syriaca</i>	L.	Common milkweed	I	FAL		0.000
<i>Asclepias tuberosa</i>	L.	Butterfly milkweed	R	SPR		0.205
<i>Asclepias verticillata</i>	L.	Whorled milkweed	R	FAL		0.010
<i>Asclepias viridis</i>	Walt.	Spider milkweed	R	SPR		0.000
** FAMILY: Asteraceae						
<i>Achillea millefolium</i>	L.	Yarrow	I	ESP		0.000
<i>Ambrosia artemisiifolia</i>	L.	Common ragweed	I	ANN		0.380
<i>Ambrosia psilostachya</i>	DC.	Western ragweed	I	FAL		0.000
<i>Ambrosia trifida</i>	L.	Giant ragweed	I	ANN		0.000
<i>Antennaria neglecta</i>	Greene	Field pussy-toes	I	SPR		0.000
<i>Artemisia ludoviciana</i>	Nutt.	White sage	I	FAL		0.000
<i>Aster ericoides</i>	L.	White aster	I	FAL		0.000
<i>Aster oolentangiensis</i>	Ridd.	Azure aster	I	FAL		0.250
<i>Aster pilosus</i>	Willd.	Aster	I	FAL		0.135
<i>Aster praealtus</i>	Poir.	Willowleaf aster	F	FAL		1.280
<i>Bidens polylepis</i>	Blake	Coreopsis begger-ticks	I	ANN		0.010
<i>Cacalia plantaginea</i>	(Raf.) Shinners	Indian plantain	R	FAL		0.000
<i>Cirsium altissimum</i>	(L.) Spreng.	Tall thistle	I	FAL		0.000
<i>Conyza canadensis</i>	(L.) Cronq.	Horseweed	I	ANN		0.005
<i>Coreopsis palmata</i>	Nutt.	Finger coreopsis	I	SPR		0.000
<i>Echinacea pallida</i>	Nutt.	Purple coneflower	I	SPR		0.000
<i>Erigeron strigosus</i>	Muhl.	Fleabane	I	ANN		0.025

Appendix 1, continued.

SPECIES	AUTHORITY	COMMON NAME	ABUNDANCE CODE	PRIMARY GUILD	SECOND GUILD	COVER
<i>Eupatorium altissimum</i>	L.	Tall boneset	I		FAL	0.000
<i>Eupatorium rugosum</i>	Houtt.	White snakeroot	I		EDGE	0.040
<i>Euthamia gymnospermoides</i>	Greene	Viscid euthamia	I	FAL		0.000
<i>Helianthus annuus</i>	L.	Annual sunflower	I	ANN		0.010
<i>Helianthus grosseserratus</i>	Martens	Sawtooth sunflower	I	FAL		0.300
<i>Helianthus hirsutus</i>	Raf.	Hairy sunflower	I	FAL		0.000
<i>Helianthus rigidus</i>	(Cass.)	Stiff sunflower	I	FAL		1.600
<i>Krigia caespitosa</i>	(Raf.) Chambers	Dwarf dandelion	I	ANN		0.000
<i>Kuhnia eupatorioides</i>	L.	False boneset	I	FAL		0.065
<i>Lactuca ludoviciana</i>	(Nutt.) Ridd.	Wild lettuce	I	SPR		0.000
<i>Lactuca serriola</i>	L.	Prickly lettuce	I		INTR	0.000
<i>Liatris aspera</i>	Michx.	Gay-feather	R	FAL		0.000
<i>Liatris pycnostachya</i>	Michx.	Gay-feather	I	FAL		0.000
<i>Prenanthes aspera</i>	Michx.	Rattlesnake-root	R		FAL	0.000
<i>Ratibida pinnata</i>	(Vent.) Barnh.	Grayhead prairie coneflower	I	FA		0.000
<i>Rudbeckia hirta</i>	L.	Black-eyed susan	I	FAL		0.000
<i>Silphium laciniatum</i>	L.	Compass plant	F	FAL		5.920
<i>Solidago canadensis</i>	L.	Canada goldenrod	I	FAL		0.680
<i>Solidago missouriensis</i>	Nutt.	Prairie goldenrod	I	FAL		0.490
<i>Solidago rigida</i>	L.	Stiff goldenrod	F	FAL		1.685
<i>Taraxacum officinale</i>	Weber	Dandelion	E		INTR	0.000
<i>Vernonia baldwinii</i>	Torr.	Ironweed	I	FAL		0.000
** FAMILY: Berberidaceae						
<i>Podophyllum peltatum</i>	L.	May apple	E		EDGE	0.000
** FAMILY: Boraginaceae						
<i>Hackelia virginiana</i>	(L.)I.M. Johnst.	Stickseed	E		EDGE	0.000
<i>Lithospermum canescens</i>	(Michx.) Lehm.	Puccoon	I	SPR		0.000
<i>Lithospermum incisum</i>	Lehm.	Puccoon	I	SPR		0.000
<i>Myosotis verna</i>	Nutt.	Forget-me-not	I	ANN		0.005
** FAMILY: Brassicaceae						
<i>Alliaria petiolata</i>	(Bieb.) Cavara & Grande	Garlic mustard	E		INTR	0.000
<i>Descurainia pinnata</i>	(Walt.) Britt.	Tansy mustard	E		INTR	0.000
<i>Lepidium virginicum</i>	L.	Peppergrass	I	ANN		0.000
<i>Thlaspi arvense</i>	L.	Field pennycress	E		INTR	0.000
** FAMILY: Caesalpinaceae						
<i>Cassia chamaecrista</i>	L.	Showy partridge pea	I	LEG	ANN	0.010
** FAMILY: Campanulaceae						
<i>Triodanis perfoliata</i>	(L.) Nieuw.	Venus' looking glass	I	ANN		0.035
** FAMILY: Caprifoliaceae						
<i>Symphoricarpos orbiculatus</i>	Moench	Buckbrush	I	WOO		0.005
<i>Triosteum perfoliatum</i>	L.	Horse gentian	I		EDGE	0.000

Appendix 1, continued.

SPECIES	AUTHORITY	COMMON NAME	ABUNDANCE CODE	PRIMARY GUILD	SECOND GUILD	COVER
** FAMILY: Caryophyllaceae						
<i>Silene antirrhina</i>	L.	Sleepy catchfly	I	ANN		0.025
** FAMILY: Celastraceae						
<i>Celastrus scandens</i>	L.	Bittersweet	I		TREE	0.000
** FAMILY: Chenopodiaceae						
<i>Chenopodium berlandieri</i>	Moq.	Lamb's quarters	I	ANN		0.000
** FAMILY: Clusiaceae						
<i>Hypericum perforatum</i>	L.	Common St. John's-wort	I		INTR	0.000
** FAMILY: Commelinaceae						
<i>Commelina communis</i>	L.	Dayflower	I		INTR	0.000
<i>Tradescantia ohiensis</i>	Raf.	Spiderwort	R	SPR		0.000
** FAMILY: Cornaceae						
<i>Cornus drummondii</i>	C.	Rough-leaved dogwood	I	WOO		0.215
** FAMILY: Cuscutaceae						
<i>Cuscuta glomerata</i>	Choisy.	Dodder	I		EDGE	0.000
** FAMILY: Cyperaceae						
<i>Carex brevior</i>	(Dew.) Mack.	Sedge	I	C3		0.115
<i>Carex davisii</i>	Schwein. & Torr.	Sedge	I		C3	0.000
<i>Carex meadii</i>	Dew.	Sedge	I	C3		0.110
<i>Fimbristylis puberula</i>	(Michx.) Vahl.	Sedge	I	C3		0.000
<i>Scirpus pendulus</i>	Muhl.	Bulrush	R	C3		0.000
<i>Scleria triglomerata</i>	Michx.	Nut rush	I	C3		0.010
** FAMILY: Euphorbiaceae						
<i>Acalypha virginica</i>	L.	Three-seeded mercury	I	ANN		0.210
<i>Croton capitatus</i>	Michx.	Woolly croton	I	ANN		0.005
<i>Euphorbia corollata</i>	L.	Flowering spurge	I	SPR		0.850
<i>Euphorbia cyathophora</i>	Murray	Fire-on-the-mountain	I		ANN	0.000
<i>Euphorbia dentata</i>	Michx.	Toothed spurge	I	ANN		0.000
<i>Euphorbia maculata</i>	L.	Spotted spurge	I	ANN	C4	0.000
<i>Euphorbia nutans</i>	Lag.	Eyebane	E		ANN	0.000
** FAMILY: Fabaceae						
<i>Amorpha canescens</i>	Pursh	Leadplant	I	LEG		2.730
<i>Baptisia bracteata</i>	Muhl. ex Ell.	Yellow wild indigo	I	LEG		0.350
<i>Baptisia lactea</i>	(Raf.) Thieret.	White wild indigo	I	LEG		0.000
<i>Dalea candida</i>	Michx.	White prairie clover	I	LEG		0.000
<i>Dalea purpurea</i>	Vent.	Purple prairie clover	I	LEG		0.000
<i>Desmodium glutinosum</i>	(Muhl. ex Willd.) Wood	Large-flowered tickclover	I		EDGE	0.000
<i>Desmodium illinoense</i>	A. Gray	Illinois tickclover	I	LEG		0.020
<i>Desmodium sessilifolium</i>	(Torr.) T. & G.	Sessile-leaved tickclover	C	LEG		0.030
<i>Lespedeza capitata</i>	Michx.	Round-head lespedeza	I	LEG		0.115
<i>Lespedeza stipulacea</i>	Maxim.	Korean lespedeza	I		INTR	0.000

Appendix 1, continued.

SPECIES	AUTHORITY	COMMON NAME	ABUNDANCE CODE	PRIMARY GUILD	SECOND GUILD	COVER
<i>Lespedeza violacea</i>	(L.) Pers.	Prairie lespedeza	I	LEG		1.530
<i>Psoralea esculenta</i>	Pursh	Prairie turnip	R		LEG	0.000
<i>Psoralea tenuiflora</i>	Pursh	Wild alfalfa	I	LEG		0.000
<i>Strophostyles leiosperma</i>	(T. and G.) Piper	Slick-seed bean	I		ANN	0.005
** FAMILY: Fagaceae						
<i>Quercus muehlenbergii</i>	Engelm.	Chinkapin oak	I		TREE	0.000
<i>Quercus velutina</i>	Lam.	Black oak	E		TREE	0.000
** FAMILY: Fumariaceae						
<i>Gentiana puberulenta</i>	Pringle	Downy gentian	R	FAL		0.060
** FAMILY: Geraniaceae						
<i>Geranium carolinianum</i>	L.	Cranesbill	I	ANN		0.010
** FAMILY: Grossulariaceae						
<i>Ribes missouriense</i>	Nutt.	Gooseberry	E		EDGE	0.000
** FAMILY: Juglandaceae						
<i>Juglans nigra</i>	L.	Black walnut	I		TREE	0.000
** FAMILY: Juncaceae						
<i>Juncus interior</i>	Wieg.	Inland rush	I	C3		0.000
** FAMILY: Lamiaceae						
<i>Monarda fistulosa</i>	L.	Wild bergamont	I	FAL		0.000
<i>Pycnanthemum tenuifolium</i>	Schrad.	Slender-mountian mint	I	FAL		0.175
<i>Salvia azurea</i>	Lam.	Pitcher sage	I	FAL		0.205
<i>Teucrium canadense</i>	L.	American germander	I	FAL		0.000
** FAMILY: Liliaceae						
<i>Allium vineale</i>	L.	Wild onion	E		INTR	0.000
<i>Hypoxis hirsuta</i>	(L.) Cov.	Yellow star grass	F	ESP		0.000
<i>Sisyrinchium campestre</i>	Bickn.	White-eyed grass	I	ESP		0.000
** FAMILY: Linaceae						
<i>Linum sulcatum</i>	Ridd.	Grooved flax	I	ANN		0.005
** FAMILY: Moraceae						
<i>Morus alba</i>	L.	Mulberry	I		TREE	0.030
** FAMILY: Nyctaginaceae						
<i>Mirabilis albida</i>	(Walt.) Heimerl.	White four o'clock	I	SPR		0.000
<i>Mirabilis nyctaginea</i>	(Michx.) MacM.	Wild four o'clock	I	SPR		0.000
** FAMILY: Oleaceae						
<i>Fraxinus americana</i>	L.	White ash	I		TREE	0.000
** FAMILY: Onagraceae						
<i>Gaura longiflora</i>	Spach	Large-flowered gaura	I	FAL		0.035
<i>Oenothera villosa</i>	Thunb.	Common evening primrose	I		FAL	0.000
** FAMILY: Orchidaceae						
<i>Habenaria leucophaea</i>	(Nutt.) A Gray	Prairie fringed orchid	R		FAL	0.000

Appendix 1, continued.

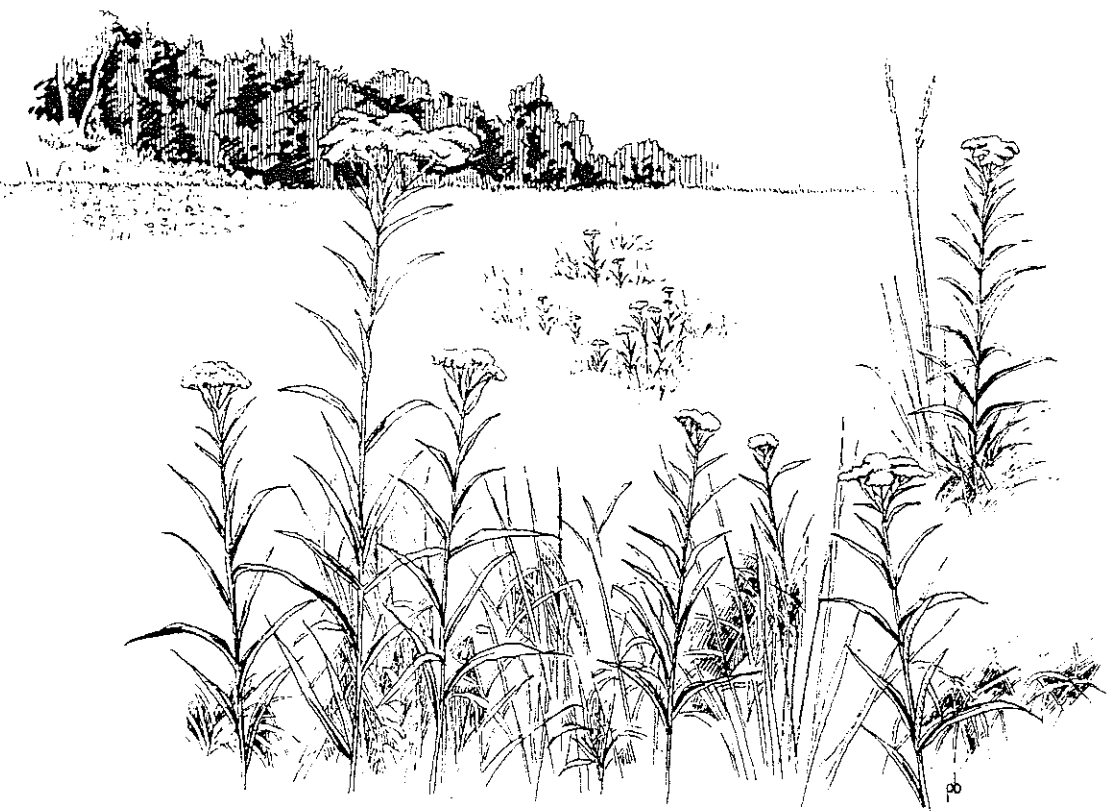
SPECIES	AUTHORITY	COMMON NAME	ABUNDANCE CODE	PRIMARY GUILD	SECOND GUILD	COVER
** FAMILY: Oxalidaceae						
<i>Oxalis dillenii</i>	Jacq.	Gray-green wood sorrel	I	SPR		0.100
<i>Oxalis violacea</i>	L.	Violet wood sorrel	I		SPR	0.000
** FAMILY: Plantaginaceae						
<i>Plantago virginica</i>	L.	Pale-seeded plantain	I		INTR	0.000
** FAMILY: Poaceae						
<i>Agrostis hyemalis</i>	(Walt.) B.S.P.	Ticklegrass	I	C3		0.000
<i>Andropogon gerardii</i>	Vitman	Big bluestem	C	C4		29.020
<i>Andropogon scoparius</i>	Michx.	Little bluestem	C	C4		20.320
<i>Bouteloua curtipendula</i>	(Michx.) Torr.	Sideoats grama	C	C4		0.000
<i>Bromus inermis</i>	Leyss.	Smooth brome	I		INTR	0.000
<i>Dichanthelium acuminatum</i>	(Sw.) Gould & Clark	Panic grass	I	C3		0.000
<i>Dichanthelium oligosanthes</i>	(Schult.) Gould	Scribner dichanthelium	I	C3		0.115
<i>Elymus canadensis</i>	L.	Canada wild rye	I	C3		0.030
<i>Elymus virginicus</i>	L.	Virginia wild rye	I	C3		0.000
<i>Eragrostis spectabilis</i>	(Pursh) Steud.	Purple lovegrass	I	C4		0.000
<i>Koeleria pyramidata</i>	(Lam.) Beauv.	June grass	I	C3		0.000
<i>Muhlenbergia frondosa</i>	(Poir.) Fern.	Wirestem muhly	I		C4	0.000
<i>Muhlenbergia racemosa</i>	(Michx.) B.S.P.	Marsh muhly	R	C4		0.000
<i>Panicum capillare</i>	L.	Common witchgrass	I	C4		0.000
<i>Panicum virgatum</i>	L.	Switchgrass	C	C4		0.160
<i>Poa compressa</i>	L.	Canada bluegrass	I		INTR	0.000
<i>Poa pratensis</i>	L.	Kentucky bluegrass	I	C3		0.090
<i>Sorghastrum nutans</i>	(L.)	Nash Indian grass	C	C4		5.030
<i>Sporobolus asper</i>	Torr.	Rough dropseed	F	C4		0.000
<i>Sporobolus heterolepis</i>	Gray	Prairie dropseed	F	C4		5.680
<i>Stipa spartea</i>	Trin.	Porcupine grass	I	C3		0.010
<i>Tridens flavus</i>	(L.) Hitche.	Redtop	I	C3		0.005
<i>Tripsacum dactyloides</i>	L.	Eastern gammagrass	I	C4		1.020
** FAMILY: Polemoniaceae						
<i>Phlox pilosa</i>	L.	Prairie phlox	I	SPR		0.005
** FAMILY: Polygalaceae						
<i>Polygala verticillata</i>	L.	Whorled milkwort	I		ANN	0.000
** FAMILY: Ranunculaceae						
<i>Anemone virginiana</i>	L.	Tall anemone	E		EDGE	0.000
<i>Delphinium virescens</i>	Nutt.	Prairie larkspur	I	SPR		0.000
** FAMILY: Rhamnaceae						
<i>Ceanothus herbaceous</i>	Raf.	New Jersey tea	I	WOO		1.170
** FAMILY: Rosaceae						
<i>Fragaria virginiana</i>	Duchn.	Wild strawberry	I	UNCL		0.000

Appendix 1, continued.

SPECIES	AUTHORITY	COMMON NAME	ABUNDANCE CODE	PRIMARY GUILD	SECOND GUILD	COVER
<i>Geum canadense</i>	Jacq.	White avens	E		EDGE	0.000
<i>Rosa arkansana</i>	Porter	Prairie wild rose	I	WOO		0.070
<i>Rubus flagellaris</i>	L.	Northern dewberry	I		WOO	0.000
<i>Rubus ostryifolius</i>	Rydb.	High-bush blackberry	I	WOO		0.085
** FAMILY: Rubiaceae						
<i>Galium circaezans</i>	T. & G.	Shining bedstraw	E		EDGE	0.060
<i>Hedyotis crassifolia</i>	Raf.	Small bluets	I	ANN		0.000
** FAMILY: Santalaceae						
<i>Comandra umbellata</i>	(L.) Nutt.	Bastard toadflax	I	SPR		0.000
** FAMILY: Scrophulariaceae						
<i>Veronicastrum virginicum</i>	(L.) Farw.	Culver's root	R	FAL		0.000
** FAMILY: Solanaceae						
<i>Physalis pumila</i>	Nutt.	Prairie ground cherry	I	FAL		0.005
<i>Solanum carolinense</i>	L.	Carolina horse nettle	I	FAL		0.005
** FAMILY: Ulmaceae						
<i>Ulmus rubra</i>	Muhl.	Slippery elm	I		TREE	0.065
** FAMILY: Verbenaceae						
<i>Verbena canadensis</i>	(L.) Britt.	Rose vervain	E		SPR	0.000
<i>Verbena hastata</i>	L.	Blue vervain	E		FAL	0.000
<i>Verbena urticifolia</i>	L.	Nettle-leaved vervain	I		FAL	0.000
** FAMILY: Violaceae						
<i>Viola pedatifida</i>	G. Don	Prairie violet	F	ESP		0.065
** FAMILY: Vitaceae						
<i>Vitis riparia</i>	Michx.	River-bank grape	I		WOO	0.000

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