

The effect of various management regimes on species composition in shale
glade communities, Union County, Illinois

Submitted by

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Executive Summary

1. Prescribed burning practices have been implemented every other year at Brown shale glade since 1991 and restoration of portions of the closed canopy of this site occurred through physical removal of woody vegetation during 1993 (Bittner *et al.*, 1994a). Two other shale glade sites, McClure school and Berryville shale glades have not been managed, although portions adjacent to Berryville has had significant restoration. This report summarizes the results of floristic analysis and compositional analyses on vegetation and soil attributes of these shale glade communities in Union County, Illinois.

2. The floristic surveys recorded 272 species from 78 families from these shale glade communities. Brown Shale glade had the highest number of species of the three sites with 244 species from 73 families. This high number of taxa can be expected due to the many disturbances that characterize this site. For example, adjacent to Brown Shale glade is State Route 146. There is a quarry on the south site of the site and an old utility line right-of-way through the northern edge of the site. In addition to the disturbances, the management regime certainly has had an effect on the number of prairie species associated with this site. This site is also the largest of the three with ca 1.6 ha while Berryville and McClure have only 0.4 ha each in the Natural Area.

Although Berryville Shale glade had the same number of families as Brown Shale glade, the number of species encountered was only 221. McClure had the fewest numbers of families but the same number of species as Berryville shale glade.

4. There were 25 non-native species across 15 families or 9.19% of the total flora for these communities. Non-native species that occurred across all sites were *Nothoscordum bivalve* (L.) Britt., *Poa pratensis* L., *Setaria faberi* Herrm., *Achilla millefolium* L., *Barbarea vulgaris* R.Br., *Lonicera japonica* Thunb., *Kummerowia striata* (Thunb.) Schindl., *Prunella vulgaris* L., *Plantago major* L., *P. rugelii* Dcne., and *Verbascum thapsus* L.

Brown Shale glade had the highest number of non-native taxa with 23 species or 8.45% of the shale glade flora. Again, this is probably due to the numerous types of disturbances at this site. Berryville and McClure sites are more isolated and have fewer disturbances than Brown. Berryville and McClure

had 12 non-native species each or 4.41%.

5. Detrended Correspondence Analysis showed that the Brown shale glade vegetation composition has significantly changed with the management techniques of prescribed burning (between 1988 & 1996) and clearing of woody vegetation (between 1993 & 1996). During 1988 the area showed degradation by the encroachment of woody vegetation and associated herb layer (Heikens, 1991). Following biennial burning from 1990 the vegetation changed compositionally to a transitional prairie-forest system. After then removing woody vegetation in 1994 the restored area is converging to a xeric prairie system. Both areas, the forest opening and the restored area, are converging in species composition towards a xeric prairie and a prairie structure, respectively.

6. Overall patterns of soil attributes show that Berryville Shale glade is more similar to McClure than to Brown. Furthermore, Brown new and old plots (1996) are more similar in soil composition than plots between Brown 1988 and 1996. The difference among all soil attributes between 1988 and 1996 shows that soils have changed over the past eight years. This provides additional evidence to support that change in vegetation, from a forest to a prairie system, has occurred. This seems to support management techniques of prescribed burning and the removal of woody vegetation.

7. This study suggests that woody encroachment is likely to occur at Berryville and McClure School Shale glades if management techniques are not implemented or fire suppression continues. The changes at Brown Shale glade show that these communities can be maintained through appropriate management and can continue to support unique plant communities.

INTRODUCTION

Forest openings are a rare and endangered community type in southern Illinois and hence are afforded a high degree of protection. These areas harbor species-rich communities that contain many endemic or endangered species. Although there have been several ecological studies performed in natural forest openings, detailed floristic surveys of individual sites have yet to be completed.

Presettlement barrens of southern Illinois were characterized by Hutchinson (1994) through the use of Public Land Survey notes recorded among 1820 and 1860. He stated that these notes are probably the best record of determining presettlement characteristics of the landscape, in a very altered and disturbed landscape.

Forest openings (Hill prairies) in southern Illinois were first extensively described by Evers (1955). He described them as grasslands on steep southwest or west facing slopes of the Mississippi River and other major river systems in the state. The dominant grasses are bunch grasses such as *Andropogon scoparius*, *Bouteloua curtipendula*, or *Sorghastrum nutans*.

Heikens (1991) and Heikens & Robertson (1995) gave an extensive review of barrens and forest openings in the Midwest and southern Illinois. Heikens also studied and classified the vegetation in 22 high quality forest openings in southern Illinois. The origin of these openings was primarily due to dry climate and the frequency of fire during the past 8300 years. However, there are other factors that can effect their formation and maintenance. These factors include infertile, poorly drained soils, geology, herbivory, topography, thin soils, Native American activity, and/or fire (Heikens, 1991).

Four of the 22 forest openings surveyed by Heikens (1991) were classified as barrens and the remaining 18 were classified as loess hill prairies (3), sandstone (5), limestone (5) and shale glades (2), and forest openings (3) (Heikens, 1991). This classification scheme was statistically supported by onsite soil characteristics. Native prairie grasses characterize loess hill prairies, limestone glades, and barrens. Soil depth varies greatly across natural openings. For example, loess hill prairies have a soil depth of > 40 cm and barrens often have soils less than 1 cm deep. The remaining sites had less than 10% cover by prairie species. Heikens also mentions that the majority of forest openings are being invaded by woody

species due to fire suppression.

The effect of prescribed biennial burns on trees and invading species of four hill prairies in southern Illinois was studied by Eisenheimer (1994). Her study supports the notion that burning will decrease woody biomass, over time, and increase the biomass of grasses and forbs. In addition to the above, Eisenheimer (1994) gave management recommendations for these hill prairies.

In contrast, Heikens *et al.*, (1994) studied the short-term response of chert and shale barren's vegetation to fire in southwestern Illinois and found out that fire did not reduce the woody vegetation nor increase the herbaceous components. However, Heikens and Robertson (1994) noted that fire frequency was greater 60 to 80 years ago in these oak-hickory forests of southern Illinois.

Bittner *et al.* (1994b) studied the vegetation of Brown Shale Barren prior to restoration (cleared). Brown Shale Barren was one of Heikens' (1991) natural forest opening study sites. They observed that vegetation composition significantly changed to a grass dominated community in three seasons. Furthermore, the large number of small trees present corresponds with changes observed between the 1938 and 1988 from aerial photographs of the region. Anderson & Schwegman (1971) studied the response of woody vegetation, specifically *Lonicera japonica* Thunb. (Japanese Honeysuckle), to prescribed burning on an Illinois barren. They observed that early spring prescribed burns were more effective in controlling this invasive species while promoting native prairie species. Anderson & Schwegman (1991) gave an extensive review on barren vegetation change over 20 years. They noted that the vegetation changed from a grassland to a woodland community with fire suppression.

There are only 2.4 ha of shale glades in Illinois. They are restricted to steep slopes that are continually shifting and eroding (Heikens, 1991). These shale glades are floristically, physiognomically, and edaphically more similar to the Mid-Appalachian Shale Barrens than to shale glades found in nearby Missouri (Heikens, 1991). A number of endemic species have been documented for the Mid-Appalachian Shale Barrens. The purpose of the research reported here was to provide not only needed floristic inventories, but also provide baseline information as well as evaluate management strategies of the only existing shale glades in the state.

Objectives. The objective of this study was to further our understanding of the effect of various management regimes, biennial burning and physical removal of woody invaders, on shale glades in southern Illinois. This was accomplished through floristic surveys and the monitoring of permanent plots.

Specifically, these objectives were:

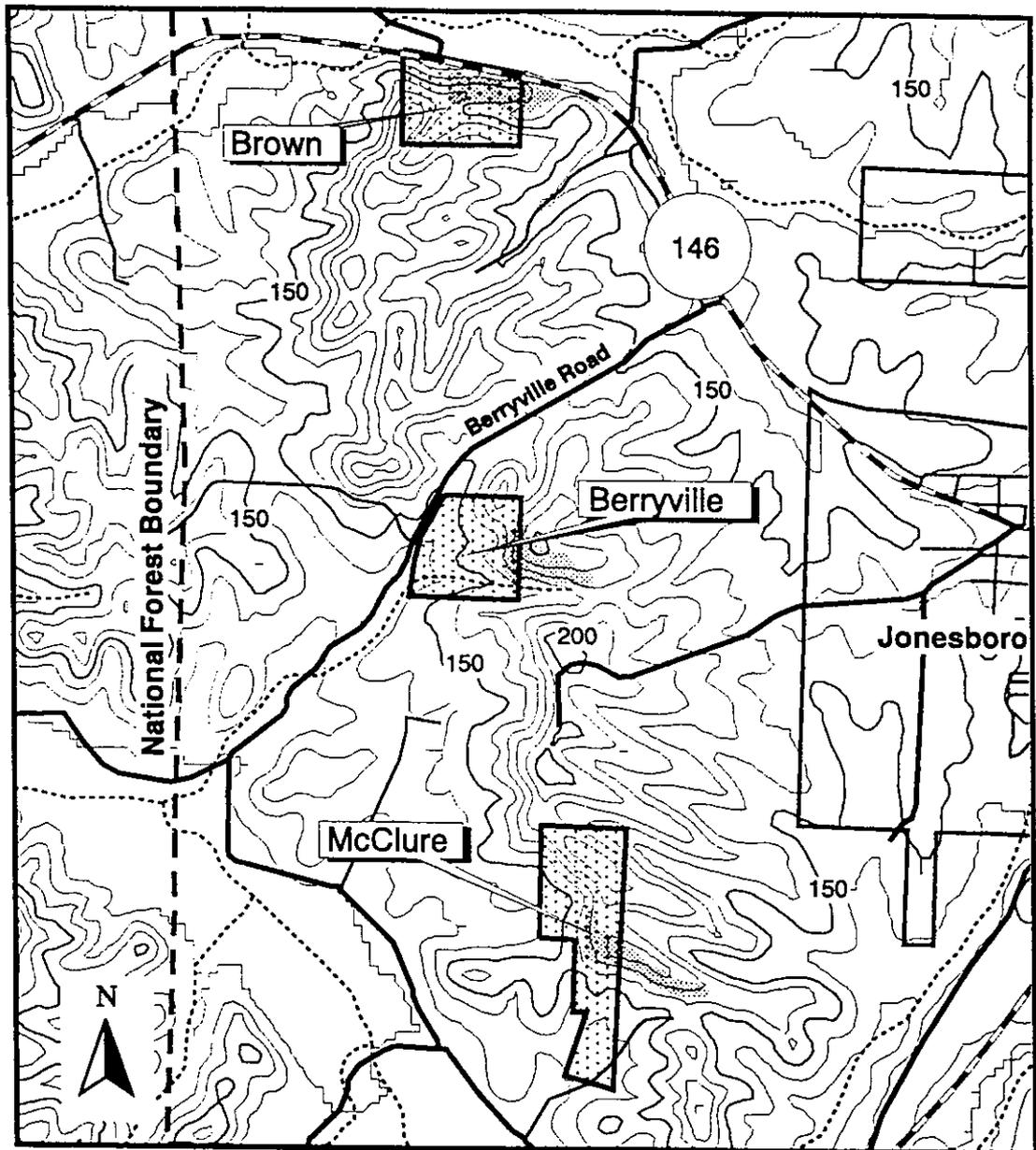
- (1) to inventory vascular plants species associated with each site,
- (2) to describe any rare, threatened, and endangered taxa as defined by Federal and State guidelines,
- (3) to inventory and compile an annotated checklist of vascular plants in each site and to prepare and deposit voucher specimens of all collections in the SIUC herbarium,
- (4) to identify both native and introduced taxa,
- (5) to identify and compare changes in species composition and abundance under different management regimes, and
- (6) to identify and characterize the soil composition under different management regimes.

METHODS AND MATERIALS

Study Sites. Three sites in southern Illinois (Union County), Brown Barrens, Berryville, and McClure School shale glade were selected based on the previous work and the rare nature of these sites in Illinois (Figure 1 and 2). Brown Barrens, McClure School, and Berryville shale glades are located in the Southern Ozark Hills natural division, in Union County Illinois (Figure 1). All sites have a shale substrate. Brown and McClure School barrens are characterized by having the same geological characteristics (Heikens, 1991). These formations are Peoria loess, Grassy Creek Shale, and Springville Shales. Brown Barrens and Berryville shale glade have the Stookey, Alford, and Muren (Typic Hapludalfs and Aquic Hapludalfs) soil association, whereas, McClure School shale barrens have the Hosmer, Stoy, and Weir associations (Typic Fragiudalfs, Aquic Fragiudalfs, and Typic Ochraqualfs). The period of origin of Brown Barrens and McClure School shale glade is Quaternary Devonian/Mississippian. Berryville shale glade has an additional three formations. These are Lingle, Fort Payne, and Alto formations, which were derived from Devonian, Quaternary, Mississippian, and Devonian/Mississippian Period substrates, respectively.

The Trail of Tears State Forest manages these three sites. Management includes prairie restoration and manual removal of woody species adjacent to Berryville shale glade. Prescribed burning was initiated in early spring of 1990 (Heikens *et al.*, 1994; Bittner *et al.*, 1994a & b) and has occurred at Brown during early spring of odd years since 1993. Portions of Brown Barrens was restored by the manual removal of woody species in 1993 (Bittner *et al.*, 1994a). The fire temperatures reported from a prescribed burn in early spring of 1995 at Brown shale glade ranged from 159 to 593°C (Franklin, 1996 & 1997) and ranged from 0 to 593°C in the early spring of 1997 (Ely & Gibson, unpublished data).

FLORA CHECKLISTS. Each site was visited twice monthly throughout the growing season (1996) and during each visit, the vascular plant species were inventoried. Voucher specimens were collected for any species not yet documented and deposited in Southern Illinois University Herbarium at Carbondale, Illinois. Native and Non-native taxa were identified. In addition, state and federal endangered and threatened lists were consulted to determine if any species were of botanical significance. Formal



source: IDNR, 1996; USGS DEM.

contours = 10 meters (32.8 feet)

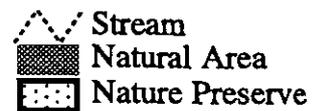
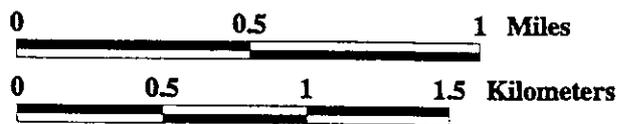


Figure 2. Contour map of Natural Shale Glades studied in Union County, Illinois.

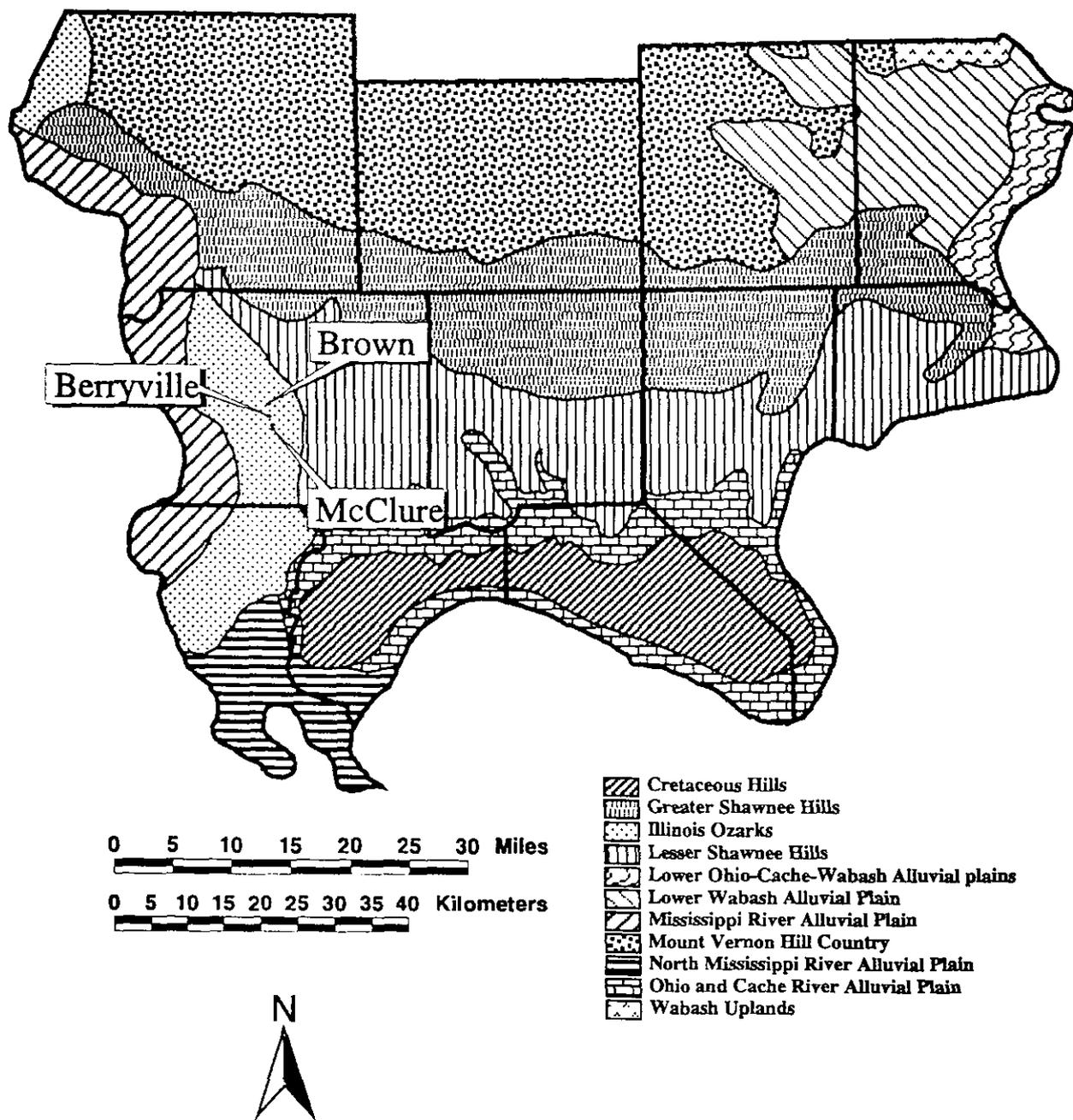


Figure 1. Natural Shale Glades studied in southern Illinois.

checklists were compiled and are given in Appendices A, B, and C. These flora checklists also include species recorded by Heikens (1991). Nomenclature follows Mohlenbrock (1986) for woody species, pteridophytes, forbs, and the grasses *Chasmanthium latifolium* and *Schizachyrium scoparium*, ; and Hitchcock (1971) for the remaining grasses. Heikens (1991) data from 1988 were included in all tables as a comparison to the present work.

COMPOSITIONAL CHANGES. Permanent plots that Heikens (1991) established in 1988 (referred hereafter as the old plots) were resurveyed in the fall of 1996 for species cover abundances. Additionally, Brown shale glade was also resurveyed in the fall of 1993. Specifically this includes eight 0.005 ha permanent plots (thirty-two 0.00125 ha sub-plots: four per plot) at Brown Shale glade, Berryville, and McClure Shale glades. New plots that were established by Bittner *et al.* (1994a) at Brown Shale glade were also surveyed. This includes an additional eight 0.005 ha (thirty-two 0.00125 ha sub-plots: four per plot) plots located 10 to 20 m upslope of Heikens plots under the canopy immediately prior to tree removal. Thus, each 0.005 ha plot was divided into four equal subplots of 0.00125 ha each.

A modified Daubenmire cover class technique (Daubenmire 1959; Abrams and Hulbert, 1987) was used to convert percentage estimate % canopy of each species into one of seven cover classes. These cover classes are 1 = < 1 %, 2 = 1 - 5 %, 3 = 6 - 25 %, 4 = 26 - 50 %, 5 = 51 - 75 %, 6 = 76 - 95 %, and 7 = > 96 %. The midpoint of each cover was used in subsequent analyses. This allows for quantitative comparisons to be made among sites and between management regimes. In addition, this provides a comparison of species composition and abundances between the 1988 sampling period (Heikens, 1991) and our 1996 sampling period.

Detrended Correspondence Analysis (DCA) was used to ordinate species and samples from each site. Heikens (1991) data from 1988 were also used in the analyses in order to observe compositional changes between 1988 and 1996. The permanent plots (established by Heikens, 1991) could not be relocated at McClure School Shale glade new plots were reestablished within the site in 1996. Furthermore, permanent plots of Heikens (1991) were re-located at Berryville Shale glade, but their plot numbers could not be identified. Thus direct comparisons between 1988 and 1996 could not be made

based on a plot by plot basis for either one of these sites. However, Berryville Shale glade does provide enough data to make overall comparisons.

Adequate records for eight plots of Heikens (1991) were maintained at Brown Shale glade. These allow for direct comparison of old plots between 1988, 1993, and 1996. In addition, the new plots (1993) were compared with our present data. Vector diagrams were drawn from the ordination samples between years to show compositional changes. Brown Shale glade was analyzed in further detail than the former two sites. For example, compositional changes were analyzed between 1988, prior to any restoration, and 1993 after a burning scheme was incorporated into the management policy. The data were further analyzed between 1993, before the removal of woody vegetation (Bittner *et al.* 1994), and 1996, after both management techniques were implemented. New plots were established in restored areas and monitored there after.

Ordinations were performed using data that was common (species and samples) to all sampling dates for comparisons between 1988 & 1993 and 1988 & 1996. Heikens (1991) grouped several important species under one category. Such species include the *Aristida* spp., *Carex* spp., *Dicanthelium* spp., *Erigeron* spp., *Hieracium* spp., *Oxalis* spp., *Panicum* spp., and *Solidago* spp. Furthermore, if a species was present only during one sampling period and not the other it was removed from the analysis. This is most unusual and our justification is that we need to compare similar data sets. However, because of the uniqueness of our data sets it does not allow community turnover to be investigated. Ordinations were performed on all sites at two sampling dates (1988 and 1996). In addition, an ordination was run on Brown shale glade for the 1993 data set. This was compared to other ordinations for 1988 and 1996. Furthermore, all ordinations were run with the mid-point of the cover classes of each species. These data sets were also analyzed on a presence/ absence basis consisting of zero's and one's in the data matrix. Similar results were obtained for both analyses and the quantitative analysis was retained for interpretation and presented here. Ordinations were run with PC-ORD (version 3.0 for Windows) (MjM Software Design, 1997). Although problems of instability (caused by the order of samples of the data set) in Detrended Correspondence Analysis have been recently documented (Oksanen & Minchin, 1997;

Tausch *et al.*, 1995) we have used the corrected version. This version uses a stricter criterion of tolerance and a maximum number of iterations.

Soil Attributes. Soil depth to the C-horizon (bedrock) at each site was measured using a soil probe. Soil depth was measured from each 0.00125 ha sub-plot at each site and were compared among sites and between new and old plots at Brown Shale glade. In addition, comparisons were made between soil depths recorded in 1988 (Heikens, 1991) and 1996.

Five soil sub-samples were collected using a standard soil probe from subplots at each plot for all plots at all sites. These 20 sub-samples from each plot were homogenized and combined into composite samples. In addition, there were four composite samples, composed of five sub-samples, taken from each study site. Thus, there were twelve composite samples collected from Berryville and McClure sites, eight from the permanent plots and four random samples from adjacent areas within the study site.

Soil samples collected from Brown shale glade were collected from old plots, N = 8 (thirty-two sub-plots), established by Heikens (1988) and new plots, N = 8 (thirty-two sub-plots), established by Bittner *et al.* (1994). As above, there were four additional composite samples, composed of five sub-samples, taken randomly at Brown shale glade. A total of 68 composite samples were collected from this site.

A total of 92 soil samples comprising 40 composite samples were collected among all sites. Each composite soil sample was analyzed for organic matter, available phosphorus, exchangeable potassium, magnesium, calcium, soil pH, cation exchange capacity, and percent cation saturation (ammonium acetate method) by A & L Laboratory, Memphis, Tennessee. The cation exchange capacity (CEC) of the soil is a measure of the number of negatively charged sites on individual soil particles that attract exchangeable cations (Marschner, 1995; Perry, 1994; & Barbour *et al.*, 1980). Specifically, the CEC is the pairing up of positively charged ions with negatively charged ions on clay surfaces in the soil (Marschner, 1995 & Perry, 1994). The percent cation saturation is the maximum amount a cation adheres to soil through the former.

Soil depths and soil chemical attributes were analyzed through one-way analysis of variance

(ANOVA) for the 1988 and 1996 sampling dates. ANOVA's were selected because of its' robustness against non-normality, specifically, this includes skewed and kurtic populations (Glass, *et al.*, 1972). The effects of violation are only slight with ANOVA's but can be significant with t-tests and other tests. In addition, ANOVA comparisons were also made between the new and old plots at Brown shale glade for 1996. Statistical significant differences from the one-way ANOVA are considered at the 0.05 α level unless otherwise noted. Due to pseudoreplication (Hurlbert, 1984) significant differences with other data can only be considered by non-overlapping standard errors.

RESULTS

Flora Checklists. There were 272 species comprising 78 families inventoried for southern Illinois Shale glade communities (Table 1). Of these 272 species, there were 7 Pteridophytes, 2 Gymnosperms, 73 Monocots, and 199 Dicots. The majority of species recorded belong to the Poaceae ($n = 36$, 13.09%) and Asteraceae ($n = 34$, 12.36%), (Table 2). These two taxonomic groups comprised 25% of the species encountered. Twelve families that contributed the most species to the flora are given in Tables 2, 4, 5, and 6. The remaining species are lump in to one group (Other Families). Other taxonomic groups that make up the majority of species in these glades are the Fabaceae (6.18%, $n = 17$), Cyperaceae (4.36%, $n = 12$), Fagaceae (3.27%, $n = 9$), Rosaceae (3.27%, $n = 9$), Rubiaceae (2.55%, $n = 7$), Brassicaceae (2.55%, $n = 7$), Laminaceae (2.55%, $n = 7$), Scrophulariaceae (2.55%, $n = 7$), Juglandaceae (2.18%, $n = 6$), and the Pteridophytes, comprising of two families, (2.55%, $n = 7$). These thirteen families consisted of 57.45% or 161 of the species encountered while the remaining 114 species or 42.55% are distributed among 65 families. Of the 272 species recorded, 25 were non-native elements (Tables 2 & 3). There were eleven Non-native taxa that were common to all sites (Table 3). The non-native elements were from nine families. This accounted for 9.19% of the species encountered.

There were 221 species recorded for Berryville Shale glade and of these species there were 5 Pteridophytes, 2 Gymnosperms, 55 Monocots, and 159 Dicots. As expected, the grass (Poaceae) and composite (Asteraceae) families dominated taxa encountered with 14.48% or 32 species and 12.67% or

Table 1. Number of Families and Species Associated with Shale glade Communities, Union County, IL.

	Hiekens (1991)		Ely & Gibson (1996)	
	Families	Species	Families	Species
Shale glades	46	110	78	272
Berryville	34	73	73	221
Brown	34	66	73	244
McClure	35	75	63	223

Table 2. Number of Families and species associated with shale glade communities, Union County, IL.

Family	Number of Species		Percent number of total species	
	Hiekens (1991)	Ely & Gibson	Hiekens (1991)	Ely & Gibson
Poaceae	15	36	13.51	13.09
Asteraceae	13	34	11.71	12.36
Fabaceae	6	17	5.41	6.18
Cyperaceae	1	12	0.90	4.36
Fagaceae	7	9	6.31	3.27
Rosaceae	4	9	3.60	3.27
Pteridophytes	3	7	2.70	2.55
Rubiaceae	3	7	2.70	2.55
Brassicaceae	0	7	0.00	2.55
Lamiaceae	3	7	2.70	2.55
Scrophulariaceae	3	7	2.70	2.55
Juglandaceae	5	6	4.50	2.18
Total :	63	158	56.76	57.45
Other Families:	47	114	43.24	42.55
Non-native Taxa:	4	25	3.60	9.19
Total number of species:	110	272	100.00	100.00

28 species, respectively, of the total flora at this site, (Table 4). Other noteworthy taxonomic groups include Fabaceae (6.33% or 14 species), Cyperaceae (5.43% or 12 species), Rosaceae (3.62% or 8 species), Fagaceae (3.17% or 7 species), Lamiaceae and Rubiaceae with 2.71% or 6 species each, Brassicaceae, Juglandaceae, Pteridophytes, and Scrophulariaceae each with 2.26% or 5 species each. These 13 families comprised over 60% of the species encountered. There were 88 species distributed among 60 other families. Non-native elements comprised 5.43% or 12 species from 10 families (Tables 3 & 4).

There were 244 species recorded for Brown Shale glade and of these species there were 6 Pteridophytes from 2 families, 1 Gymnosperms, 60 Monocots from 6 families, and 177 Dicots from 64 families. The grass (Poaceae) and composite (Asteraceae) families dominated taxa encountered with 13.93% or 34 species and 12.30% or 30 species, respectively, of the total flora at this site, (Table 5)

Rosaceae				
<i>Rosa multiflora</i> Thunb. - Multiflora Rose				X
Scrophulariaceae				
<i>Verbascum thapsus</i> L. - Woolly Mullein		X	X	X

Table 4. Number of Families and species associated with Berryville shale glade community, Union County, Illinois.

Family	Number of species		Percent number of total species	
	Heikens (1991)	Ely & Gibson	Heikens (1991)	Ely & Gibson
Poaceae**	6	32	7.69	14.48
Asteraceae**	10	28	12.82	12.67
Fabaceae	4	14	5.13	6.33
Cyperaceae**	1	12	1.28	5.43
Rosaceae**	3	8	3.85	3.62
Fagaceae	7	7	8.97	3.17
Lamiaceae	1	6	1.28	2.71
Rubiaceae	3	6	3.85	2.71
Brassicaceae	0	5	0.00	2.26
Juglandaceae	4	5	5.13	2.26
Pteridophytes*	3	5	3.85	2.26
Scrophulariaceae	2	5	2.56	2.26
Total :	44	133	56.41	60.18
Other Families:	29	88	43.59	39.82
Total number of species:	73	221	100.00	100.00
Non-native Taxa:	2	12	2.56	5.43

* denotes two families.

** denotes multispecies grouping associated with Heikens' observation.

For example, Heikens grouped many *Panicum* species into *Panicum* sp.

species), Rubiaceae, Scrophulariaceae, and Pteridophytes with 2.46% or 6 species each, Brassicaceae (2.05% or 5 species), and Juglandaceae with 1.64% or 4 species. These 13 families comprised over 56% of the species encountered. There were 106 species distributed among 60 other families. Non-native elements comprised 9.43% or 23 species across 14 families (Tables 3 & 5).

There were 223 species recorded for McClure School Shale glade and of these species there

were 6 Pteridophytes from 2 families, 1 Gymnosperm, 56 Monocots from 8 families, and 164 Dicots from 52 families. The grass (Poaceae) and composite (Asteraceae) families dominated taxa encountered with 13.90% or 31 species and 12.11% or 27 species, respectively, of the total flora at this site, (Table 6). Other noteworthy taxonomic groups include Fabaceae (7.50% or 16 species), Cyperaceae (5.38% or 12 species), Rosaceae (3.75% or 8 species), Brassicaceae, Fagaceae, and Rubiaceae with 3.14% or 7 species each, Lamiaceae, Juglandaceae, and Pteridophytes with 2.69% or 6 species each, and Scrophulariaceae with 2.24% or 5 species. These 13 families comprised nearly 62% of the species encountered. There were 85 species distributed among 50 other families. Non-native elements

Table 5. Number of Families and species associated with Brown Barren shale glade community, Union County, Illinois.

Family	Number of Species		Percent number of all Species	
	Heikens (1991)	Ely & Gibson	Heikens (1991)	Ely & Gibson
Poaceae**	6	34	8.70	13.93
Asteraceae	11	30	15.94	12.30
Cyperaceae**	1	12	1.45	4.92
Fabaceae	6	11	8.70	4.51
Rosaceae	3	9	4.35	3.69
Fagaceae	5	8	7.25	3.28
Lamiaceae	1	7	1.45	2.87
Pteridophytes*	3	6	4.35	2.46
Rubiaceae	3	6	4.35	2.46
Scrophulariaceae	2	6	2.90	2.46
Brassicaceae	0	5	0.00	2.05
Juglandaceae	4	4	5.80	1.64
Total:	45	138	65.22	56.56
Other Families:	21	106	34.78	43.44
Total number of species:	66	244	100.00	100.00
Non-native Taxa:	4	23	6.06	9.43

* denotes two families.

** denotes multispecies grouping associated with Heikens' observation.

For example, Heikens grouped many Panicum species into Panicum sp.

comprised 5.38% or 12 species from 9 families (Tables 3 & 6).

Compositional Changes. The results of the DCA ordination of McClure School Shale glade samples and species for 1988 (Heikens, 1991) and 1996 are given in Figures 3 and 4. There is a clear separation of the samples between 1988 and 1996 along the first ordination axis. However, because Heikens plots could not be re-sampled plot to plot changes in composition can not be made. A plot of the species ordination (Figure 4) shows the basis for the relationship between plots. Thus, species on the left of the plot were assigned a low ordination score along the first axis. These species are more associated with samples from 1988 and include *Vaccinium arboreum*, *Manfreda virginica*, *Rhus aromatic*, *Quercus stellata*, *Acer saccharum*, and *Amelanchier arborea*. The species on the right are more associated with samples from 1996 (*Rosa carolina*, *Woodsia obtusa*, *Danthonia spicata*, *Schizachyrium scoparium*,

Table 6. Number of Families and species associated with McClure School shale glade community, Union County, Illinois.

Family	Number of Species		Percent number of all Species	
	Heikens (1991)	Ely & Gibson	Heikens (1991)	Ely & Gibson
Poaceae**	6	31	7.50	13.90
Asteraceae	11	27	13.75	12.11
Fabaceae	6	16	7.50	7.17
Cyperaceae**	1	12	1.25	5.38
Rosaceae**	3	8	3.75	3.59
Brassicaceae	0	7	0.00	3.14
Fagaceae	6	7	7.50	3.14
Rubiaceae	3	7	3.75	3.14
Juglandaceae	4	6	5.00	2.69
Lamiaceae	1	6	1.25	2.69
Pteridophytes*	3	6	3.75	2.69
Scrophulariaceae	2	5	2.50	2.24
Total :	46	138	57.50	61.88
Other Families:	32	85	42.50	38.12
Total number of species:	75	223	100.00	100.00
Non-native Taxa:	0	12	0.00	5.38

* denotes two families.

** denotes multispecies grouping associated with Heikens' observation.

For example, Heikens grouped many *Panicum* species into *Panicum* sp.

Lechea tenuifolia, *Dicanthelium acuminatum*, *Cunila organoides*, *Aster patens*, *Helianthus divaricatus*, and *Penstemon digitalis*). There is no observable pattern of samples or species along the second ordination axis except that Heikens samples are more variable than those from 1996 whereas those from 1996 are not.

The DCA ordinations of Berryville Shale glade samples for 1988 (Heikens, 1991) and 1996 are given in Figures 5 and 6. Because the samples observed in 1996 were a portion of the samples from 1988 compositional changes can be interpreted with confidence. The first ordination axis separates plot number two sampled in 1996 from the rest of the samples. This plot was dominated by *Juglans nigra* and accounts for the clear separation. Analyses were run without this species and/or sample plot obtained the same results. Thus, the original analysis is used in our interpretations. In contrast to McClure, there is not a clear separation between the two sampling periods. However, the 1996 samples are restricted to the top half of the ordination plot with the exception of one sampling plot. Species more associated with the 1988 samples include *Dicanthelium laxiflorum*, *Vaccinium arboreum*, *Helianthus divaricatus*, *Rhus aromatica*, *Celtis tenuifolia*, *Lespedeza* spp., *Acalypha gracilens*, *Ulmus alata*, *Solidago nemoralis*, *Penstemon digitalis*, *Euphorbia corollata*, *Juniperus virginiana*, and *Quercus stellata*. Species associated with the 1996 samples includes *Aster patens*, *Antennaria plantaginifolia*, *Stylosanthes biflora*, mosses, *Tephrosia virginiana*, *Cunila organoides*, *Danthonia spicata*, *Aristida dichotoma*, and *Schizachyrium scoparium*.

The DCA ordinations of Brown Shale glade samples and species for 1988 (Heikens, 1991) and 1993 show that samples are similar to Berryville Shale glade ordination in that there is not a clear separation between sampling dates (Figures 7 and 8). However, because of the nature of these samples and their known locations, direct measurement between sampling periods is possible. The ordination of samples between 1988 and 1993 show a forest to grassland gradient along the first DCA ordination axis and a gradient between lower and upper slopes along the second axis. Samples recorded from 1988, prior to prescribed burning, and 1993, after burning, show that the 1988 and 1993 plots are converging, compositionally, along the first and second ordination axes. The species ordination plot confirm the relationship observed with the sample plot (Figure 8). Thus, species more associated with the 1988

samples are characteristic of a forest or a forest herb layer. These species have a high first axis ordination score and include *Vaccinium arboreum*, *Symphoricarpos orbiculatus*, *Crataegus pruinosa*, *Panicum spp.*, *Carex spp.*, *Asplenium platyneuron*, and *Oxalis stricta*. Species associated with the 1993 samples are more associated with prairie species or grasslands have a low first axis ordination. These include such species as *Cassia fasciculata*, *Schizachyrium scoparium*, *Solidago nemoralis*, *Stylosanthes biflora*, *Helianthus divaricatus*, *Euphorbia corollata*, *Manfreda virginica*, *Aster patens*, and *Dicanthelium acuminatum*. The second axis shows a gradient from the lower slopes to upper slopes. Thus higher second axis ordination scores characterized species found on the upper slopes. Such species include *Croton monanthogynus*, *Penstemon digitalis*, *Danthonia spicata*, *Aster patens*, *Dicanthelium acuminatum*, *Acalypha gracilens*, *Lespedeza procumbens*, and *Symphoricarpos orbiculatus*. The lower ordination scores for the second axis characterize species that are found on the lower slopes of the site; this includes *Ulmus alata*, *Elymus canadensis*, *Lonicera japonica*, *Carya texana*, *Ambrosia artemisifolia*, *Erigeron strigosus*, *Panicum spp.*, *Stylosanthes biflora*, and *Ruellia humilis*.

The DCA ordinations of Brown Shale glade samples and species for 1988 (Heikens, 1991) and 1996 (Figures 9 and 10) show that samples are similar to the former ordination except the clear pattern of an upper and lower slope gradient is not evident along the second axis (Figures 7 and 8). As stated in the materials and methods, species that were not common to both sampling dates were excluded from the analyses. The ordination of samples between 1988 and 1996 show a net movement of plots from a scattered to a clumped pattern along the second DCA ordination axis (Figure 9). This indicates that the 1988 samples are more diverse in composition than the 1996 samples. Species associated with the 1988 samples are, like the former ordination between 1988 and 1993, associated with a forest system and that the 1996 samples are more associated with grasslands (Figure 10).

The DCA ordinations of Brown Shale glade between 1993 and 1996 show that plots are compositionally converging along the first DCA ordination axes as shown by the vector diagrams or arrows (Figure 11). Specifically, the first axis shows a gradient from a forest community to a grassland community. Old plots 1993 (light gray triangles) and new plots 1996 (open triangles) are moving towards

the second axis in ordination space towards the old plots 1996 (dark gray triangles) and new plots 1996 (filled triangles, black). This shows that there is a greater change in composition of the new plots than the old plots, but both are changing compositionally.

Species on the far right side of the ordination plot are more associated with the new plots samples from 1993 (Figure 11 and 12). This region is characterized by a forest community and a forest herb layer. This includes such species as *Vaccinium pallida*, *Vitis aestivalis*, *Parthenocissus quiquifolia*, *Passiflora lutea*, *Smilax spp.*, *Quercus rubra* and *Q. velutina*, *Ostrya virginiana*, *Acer rubra*, *A. saccharum*, *Cercis canadensis*, *Sanicula canadensis*, and *Asimina triloba*.

Another transition zone, between a forest and a grassland, is represented in the middle of the plot that include the new samples for 1996. Species associated with area include *Danthonia spicata*, *Cunila organoides*, *Andropogon virginicus*, *Muhlenbergia sobolifera*, *Helianthus divaricatus*, *Chasmanthium latifolium*, *Pycnthemum tenuifolium*, *Aster spp.*, *Asplenium platyneuron*, *Vaccinium arboreum*, *Vitis cinera*, *Diospyus virginiana*, *Antennaria plantaginifolia*, and *Dicanthelium spp.* This represents the change in composition due to management practices of burning and burning and clearing.

The dynamic nature of the old plots show changes in patterns since 1993. They seem to be integrated with the former transition zone and old plots sampled in 1996, however. The region of overlap has low ordination scores for both axes. This area is also a transition zone like the former, however, this zone seems to be more like a grassland than the former. This includes such species as *Muhlenbergia capillaris*, *Croton monathogynus*, *Plantago virginica*, *Solidago nemoralis*, *Schizachyrium scoparium*, *Manfreda virginiana*, *Stylosanthes biflora*, *Dicanthelium spp.*, and *Acalypha gracilens*.

The upper left hand corner of the plot (Figures 11 & 12) is characterized by xeric grassland with thin soils. The samples and species have low first axis ordination scores. This area includes three old samples from 1993 and all samples from 1996. The species ordination plot confirms the relationship between sample plots. Species that characterize this region are *Lechea tenuifolia*, *Sporobolus vaginiflorus*, *Aristida dichotoma*, *Hypericum punctatum*, *Plantago virginica*, *Aster lateriflorus*, *Juncus interior*, and *Chamaescybe sp.*

The second DCA ordination axis shows a weak gradient from vegetation that characterizes the lower slopes and upper slopes of this site (Figure 11 and 12). This is evident with compositional changes in the plots since 1993. *Species with higher second axis ordination scores are found on the upper slopes and the species with lower second ordination scores are associated with the lower slopes of the site.* Species associated with the lower slopes include *Vaccinium arboreum*, *Blephilia hirsuta*, *Paronychia fastigiata*, *Panicum capillare*, and *Symphoricarpos orbiculatus*. Species associated with the upper slopes include *Cercis canadensis*, *Lespedeza virginica*, *Quercus coccinea*, *Chasmanthium latifolium*, *Heuchera americana* var. *hirsuticaulis*, *Rudbeckia hirta*, *Bromus pubescens*, and *Achillea millefolium*.

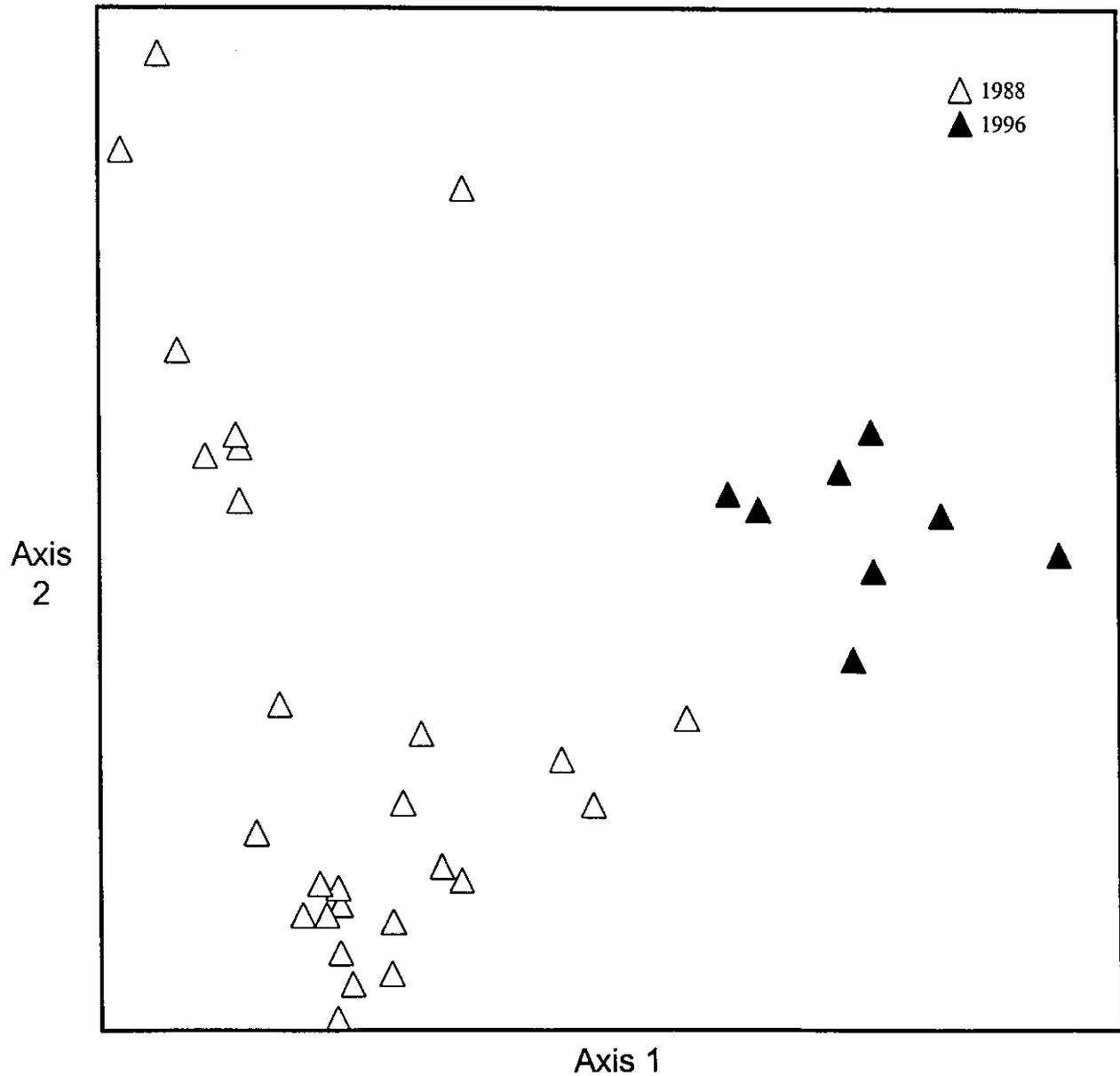


Figure 3. DCA plot ordination of McClure School Shale glade plots based upon species cover sampled in 1988 (Heikens, 1991) and 1993. Plots sampled from 1988 = open triangles and plots sampled during 1993 = closed triangles.

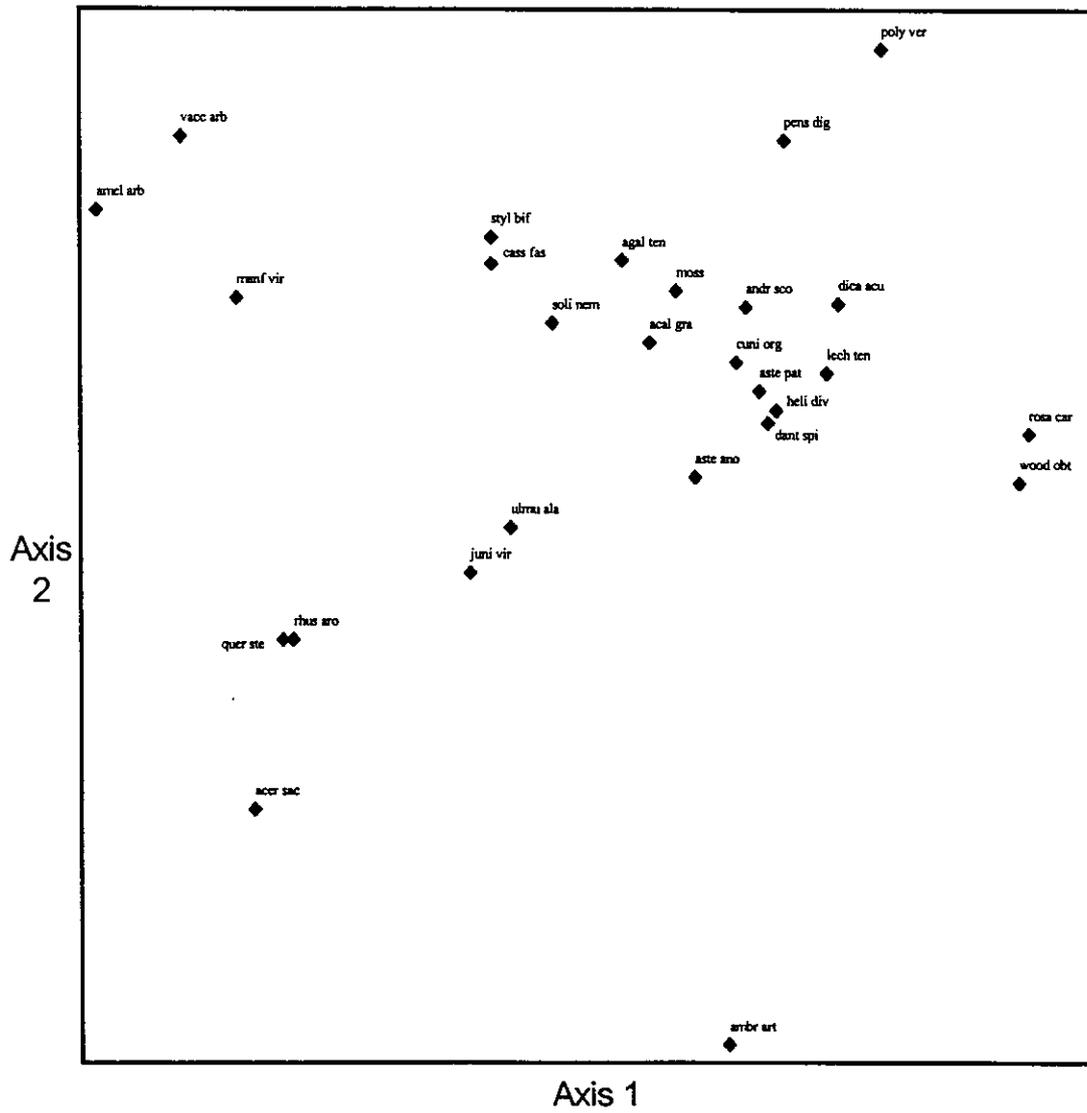


Figure 4. Species plot from DCA ordination of McClure School Shale glade plots based upon species cover sampled in 1988 (Heikens, 1991) and 1996. See Appendix C for Species codes. These codes are the first four letters of the genus and the last three letters are the first three letters of the specific epithet.

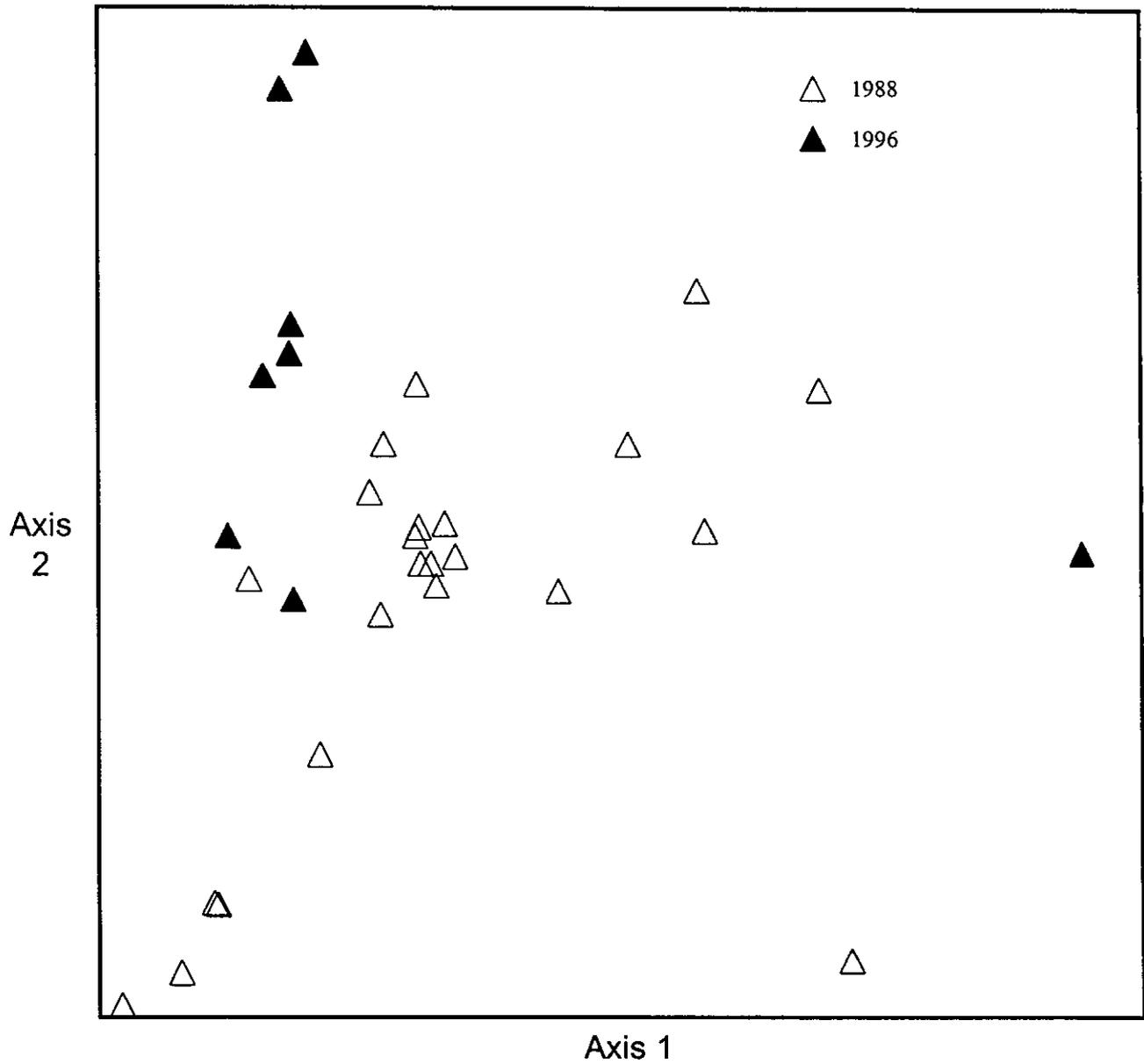


Figure 5. DCA plot ordination of Berryville Shale glade plots based upon species cover sampled in 1988 (Heikens, 1991) and 1996. Old plots sampled from 1988 = open triangles, plots sampled from 1996 = black filled triangles.

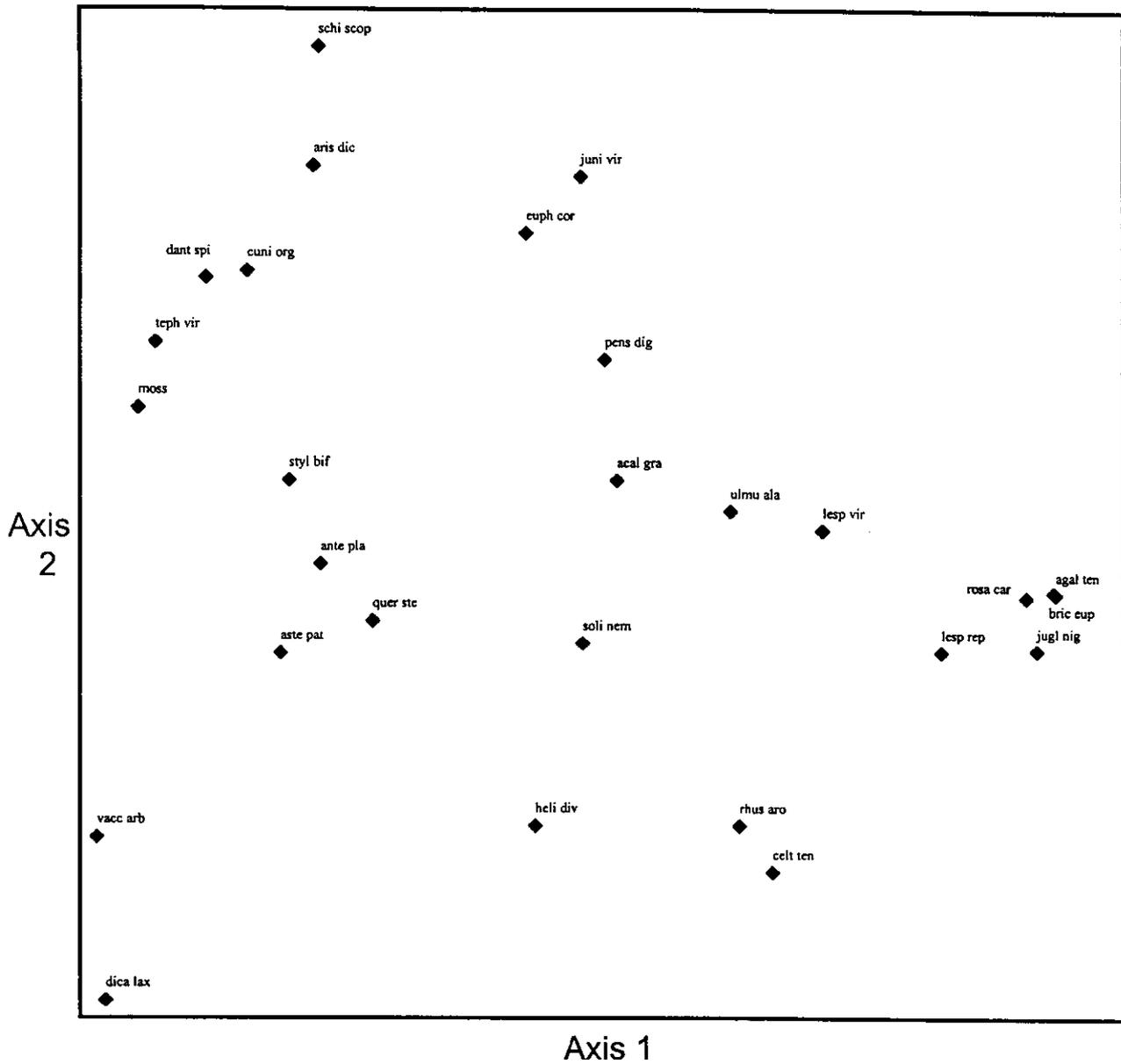


Figure 6. Species plot from DCA ordination of Berryville Shale glade plots based upon species cover sampled in 1988 (Hiekens 1991) and 1996. See Appendix A for Species codes. These codes are the first four letters of the genus and the last three letters are the first three letters of the specific epithet.

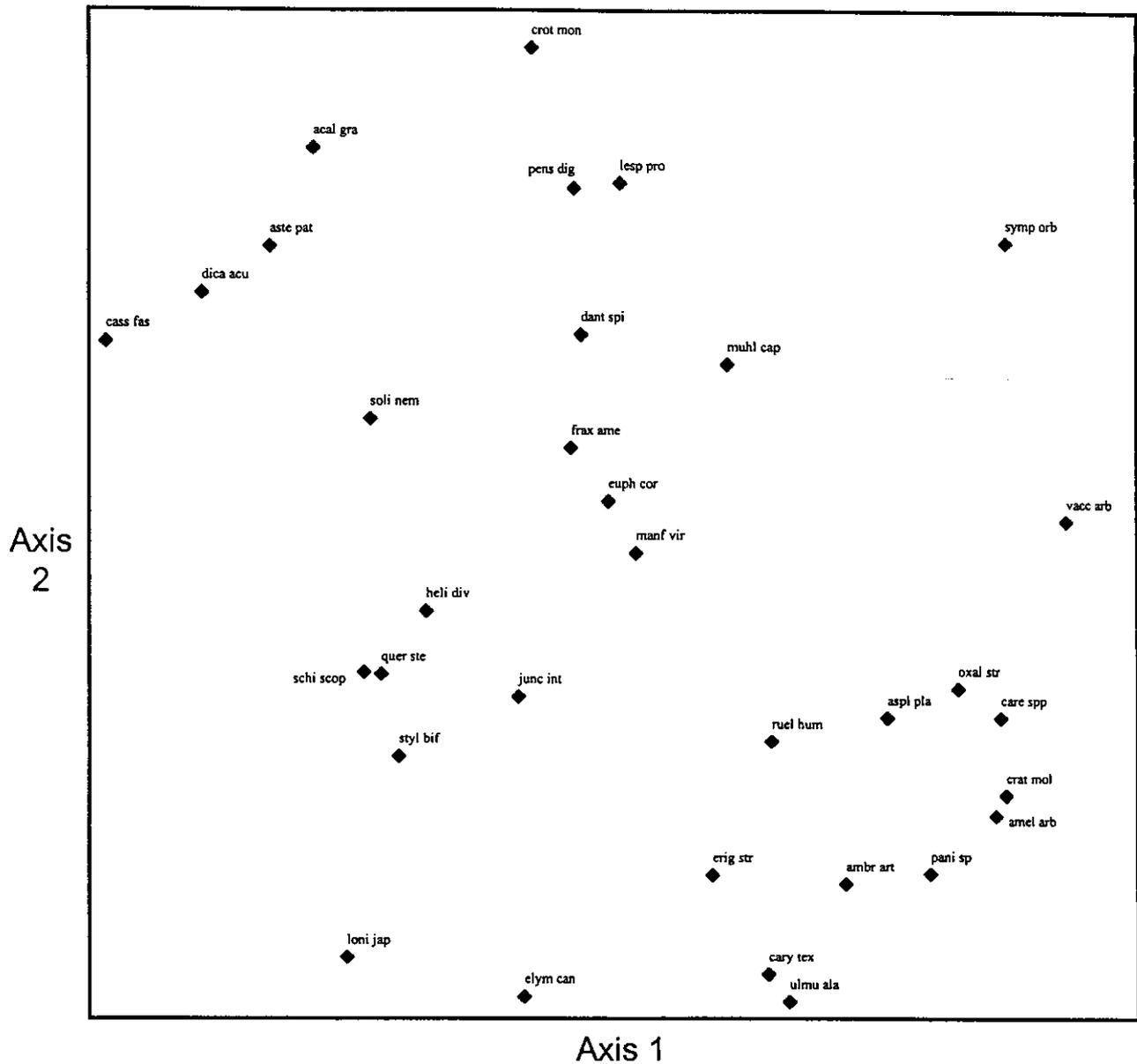


Figure 8. Species plot from DCA ordination of Brown Shale glade plots based upon species cover sampled in 1988 (Heikens, 1991) and 1993. See Appendix B for Species codes. These codes are the first four letters of the genus and the last four letters are the first three letters of the specific epithet.

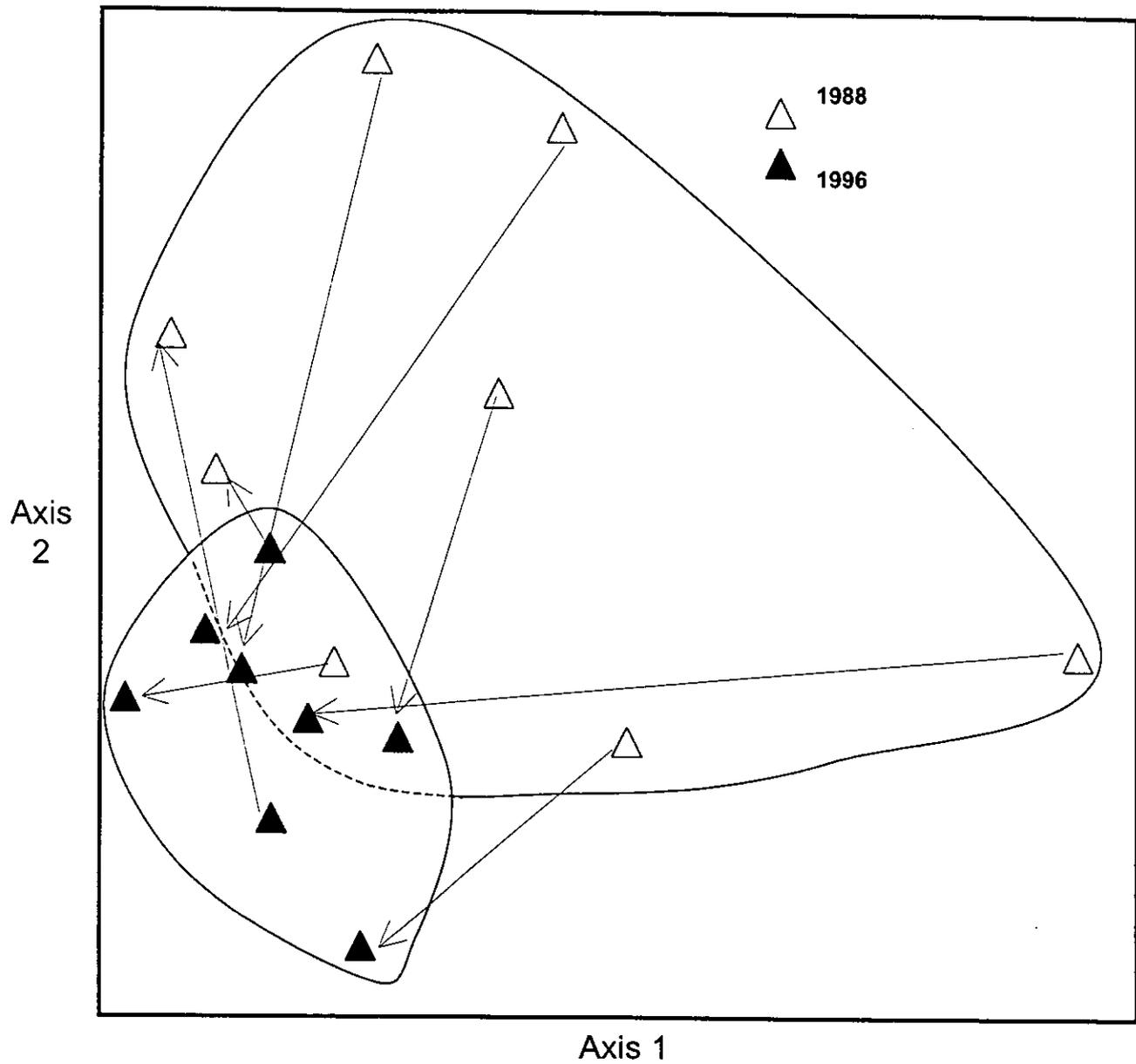


Figure 9. DCA plot ordination of Brown Shale glade plots based upon species cover sampled in 1988 (Heikens, 1991) and 1996. Plots sampled from 1988 = open triangles and plots sampled during 1996 = closed triangles. Vector diagrams drawn from 1988 to 1996 plots.

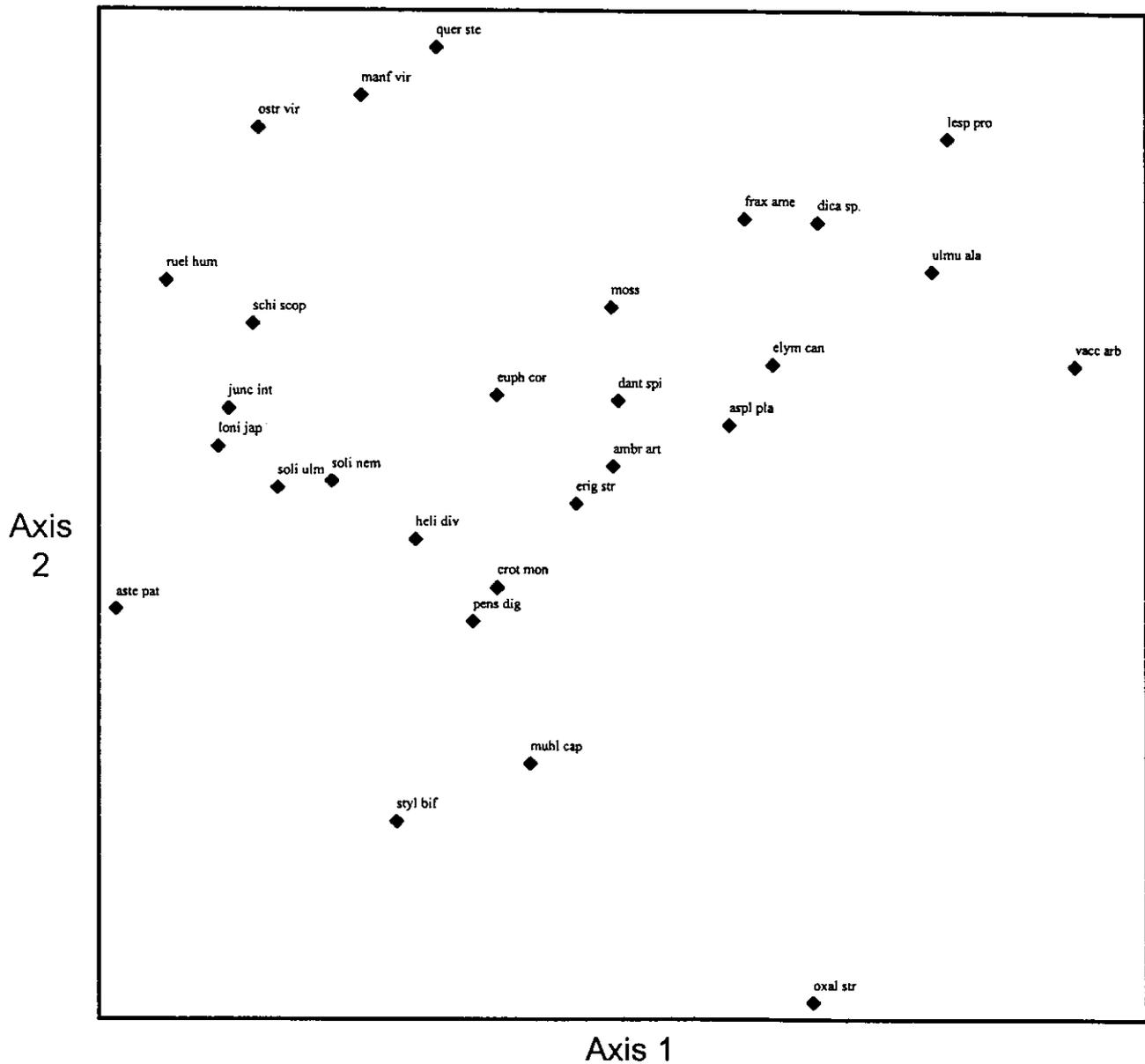


Figure 10. Species plot from DCA ordination of Brown Shale glade plots based upon species cover sampled in 1988 (Heikens, 1991) and 1996. See Appendix B for Species codes. These codes are the first four letters of the genus and the last four letters are the first three letters of the specific epithet.

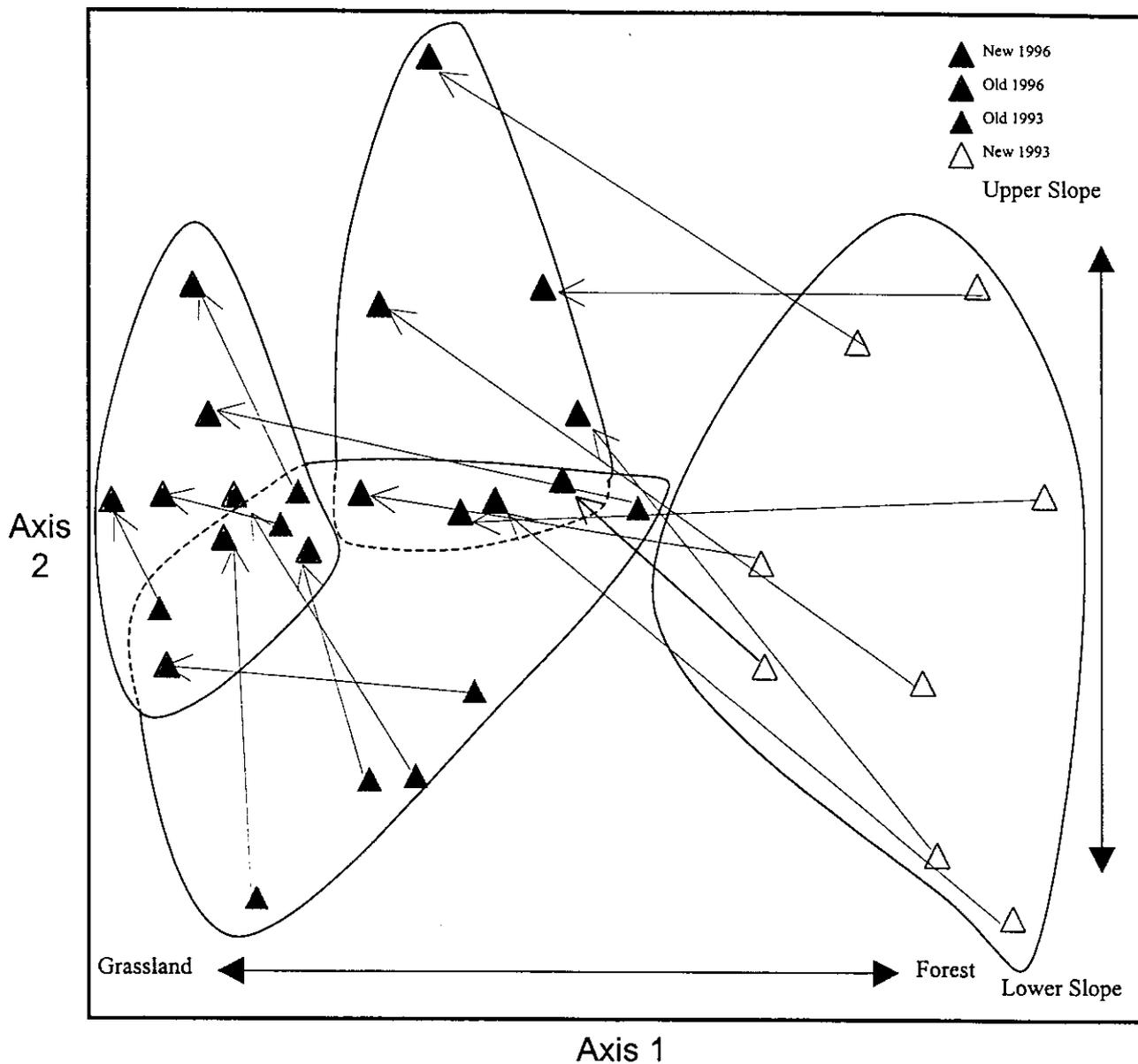


Figure 11. DCA plot ordination of Brown Shale glade plots based upon species cover sampled in 1993, prior to restoration, and 1996. Old plots sampled from 1993 = open triangles, New plots sampled from 1993 = light gray triangles, new plots sampled from 1996 = dark gray triangles, and new plots sampled from 1995 = black filled triangles. Vector diagrams drawn from new and old plots from 1993 to new and old plots 1996.

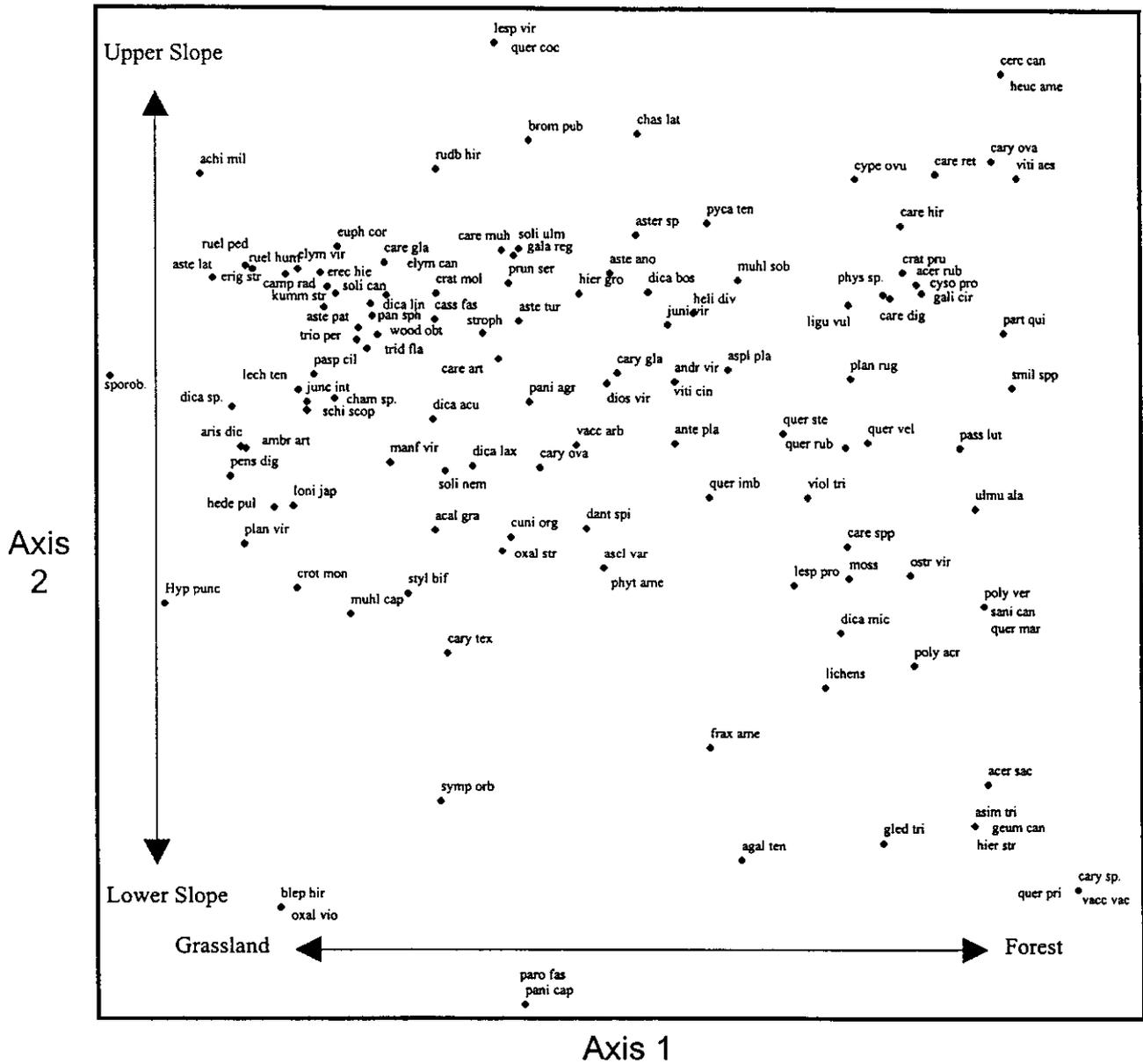


Figure 12. Species plot from DCA ordination of Brown Shale glade plots based upon species cover sampled in 1993 and 1996. See Appendix B for Species codes. These codes are the first four letters of the genus and the last three letters are the first three letters of the specific epithet.

Soil Attributes. The soil was generally higher in nutrients at Brown as compared to the other two shale glades; i.e. higher levels of K, Ca, Mg, organic matter, cation saturation of K, Ca, and Mg were recorded (Table 7, Appendices D, E, F, and G). The soil pH was also higher and the soil was deeper as compared with Berryville and McClure. Within Brown shale glade, levels of soil pH, P, K, Ca, Mg, organic matter, CEC and cation saturation for K, Ca, Mg, and H all increase significantly from 1988 to 1996 in the old plots. Compared with the old plots in 1996 the new plots had a higher buffer pH, lower levels of P and cation saturation of H, and deeper soils (Appendix D).

Overall patterns of soil attributes show that Berryville is more similar to McClure than to Brown.

There were little changes in soil attributes for Berryville and McClure between 1988 and 1996

Table 7. Mean (\pm 1 standard error) of soil attributes at the three shale glade sites.

Soil Attribute	Berryville	Brown			McClure
	Old Plots 1996 n = 12, except soil depth, n = 8	Old Plots 1988 n = 5	Old Plots 1996 n = 8	New Plots 1996 n = 8	Old Plots 1996 n = 12, except soil depth, n = 8
^{††} pH	4.70 \pm 0.11	5.48 \pm 0.30	9.37 \pm 0.80	8.01 \pm 0.42	4.92 \pm 0.14
[†] Buff pH	7.66 \pm 0.02	na	2.97 \pm 0.54	4.42 \pm 0.34	7.67 \pm 0.02
^{††} P (meq/100g)	15.58 \pm 1.98	4.40 \pm 1.44	11.64 \pm 0.52	10.12 \pm 0.32	25.50 \pm 1.97
[†] K (meq/100g)	81.00 \pm 6.84	152.60 \pm 20.94	266.26 \pm 21.65	245.32 \pm 8.40	91.92 \pm 10.11
[†] Ca (meq/100g)	424.08 \pm 130.11	906 \pm 307.84	1526.45 \pm 135.80	1424.54 \pm 47.04	779.25 \pm 217.64
[†] Mg (meq/100g)	68.83 \pm 14.96	133.00 \pm 12.62	261.56 \pm 15.49	293.73 \pm 2.64	84.58 \pm 12.46
[†] Organic (%)	4.11 \pm 0.32	5.02 \pm 0.74	7.91 \pm 0.82	5.91 \pm 0.54	5.22 \pm 0.38
Org ENR (%)	126.17 \pm 6.32	na	45.86 \pm 8.40	62.48 \pm 4.14	148.50 \pm 7.68
[†] CEC (%)	4.46 \pm 0.70	8.04 \pm 1.36	14.64 \pm 1.06	13.69 \pm 0.40	6.52 \pm 1.01
[†] CS %K	4.83 \pm 0.29	5.02 \pm 0.30	8.37 \pm 0.76	6.93 \pm 0.42	3.75 \pm 0.30
[†] CS %Ca	32.47 \pm 3.40	51.30 \pm 7.89	82.21 \pm 8.28	68.30 \pm 4.25	41.12 \pm 3.90
[†] CS %Mg	11.27 \pm 0.95	14.48 \pm 1.17	26.45 \pm 1.91	25.54 \pm 0.57	10.04 \pm 0.30
^{††} CS %H	51.60 \pm 3.58	29.20 \pm 6.69	59.47 \pm 3.22	50.33 \pm 2.34	44.41 \pm 3.58
[†] Soil Depth (cm)	8.0 \pm 1.6	7.9 \pm 0.6	9.3 \pm 1.3	20.3 \pm 4.2	4.1 \pm 0.6

[†] significant difference at $p < 0.05$, degrees of freedom = 11 for Brown old plots between 1988 and 1996.

^{††} significant difference at $p < 0.05$, degrees of freedom = 14 for Brown old and new plots for 1996.

(Apendices E & G). However, it must be noted that the 1996 comparisons are made only to one composite sample from 1988 for each site. The soil depths have changed very little among sites between 1988 and 1996.

DISCUSSION

Flora Checklists. Our first, second, and third objectives were to inventory the vascular plant species associated with each Shale glade community, to describe any threatened, rare or endangered species encountered, and to compile an annotated checklist of vascular plants at each Shale glade Community, respectively. Although there were not any threatened, rare or endangered species encountered we report an additional 32 families and 162 species for these rare communities. The lack of rare and/or endangered species is consistent with the predictions made by Hutchinson *et al.* (1986). Heikens (1991) reported only 34, 34, and 35 families and 73, 66, and 75 species for Berryville, Brown, and McClure shale glade communities, respectively. One species reported by Heikens (1991), *Echinacea pallida*, was not observed during our survey. The annotated checklists are given in Appendices A, B, and C.

Brown Shale glade had the highest number of species of the three sites with 244 species comprising 73 families. This can be expected due to many disturbances that characterize this site. For example, adjacent to Brown Shale glade is State Route 146 (Figure 2). There is a quarry on the south site of the site and an old utility line right-of-way through the northern edge of the site. These disturbances may account for some of the number of species encountered. In addition to the disturbances, the management regime certainly has had an effect on the number of prairie species associated with this site. This site is also the largest of the three with ca 1.6 ha while Berryville and McClure consists of only 0.4 ha each in the Natural Area.

Although Berryville Shale glade had the same number of families as Brown Shale glade, the number of species encountered was only 223. McClure had the fewest numbers of families but nearly the same number of species as Berryville Shale glade with 221 species encountered (Table 1). This shows that there is floristic variation among these latter two sites.

The grasses and composite families dominated the number of taxa encountered across all sites during 1988 and 1996. These two groups are characteristic of tall grass prairies. Of the thirteen most common families encountered across sites one family was a new record for these sites, the Brassicaceae

or the Mustard family with seven species being recorded or 2.55 % of the total flora. *Asclepias tuberosa*, a characteristic shale glade species (White and Medany, 1978) was not reported by Heikens (1991) for Berryville and McClure School Shale glades, however it was observed at both sites during 1996 growing season.

Our fourth objective was to identify any non-native taxa encountered. There were 25 non-native species across 15 families or 9.19% of the total flora for these communities. Non-native species that occurred across all sites were *Nothoscordum bivalve*, *Poa pratensis*, *Setaria faberi*, *Achilla millefolium*, *Barbarea vulgaris*, *Lonicera japonica*, *Kummerowia striata*, *Prunella vulgaris*, *Plantago major*, *P. rugelii*, and *Verbascum thapsus*. Heikens (1991) reported only 4 non-native elements or only 3.6% of the flora for Shale glade Communities in 1988

Brown Shale glade had the highest number of non-native elements with 23 species or 8.45% of the shale glade flora. Again, this is probably due to the numerous types of disturbances at this site. Heikens (1991) reported 4 non-native species or 6.1% of the flora. Berryville and McClure sites are more isolated and have fewer disturbances than Brown. Berryville and McClure had 12 non-native species each or 4.4%. Heikens (1991) only reported 2 non-native species for Berryville and none for McClure.

These results are consistent with other unpublished shale glade data. For example, there were 204 and 161 taxa reported for Brown and Berryville shale glades, respectively, in 1993 - 1994 (Allyssa Bosela, unpublished data). Furthermore, all species encountered by Bosela were also observed by us in 1996. In addition, Heikens *et al.* (1994) reported additional 21 vascular species to the flora at Brown shale glade after the initial burn, during early spring of 1990. The seed bank was studied in unrestored (old) and restored (new) plots by McCall *et al.* (1993) at Brown shale glade. They observed 50 species of which two have not been recorded previously nor with our study (*Carex blanda* Dew. and *Portulacca grandiflora* Hook.).

Compositional Changes. The vegetation for McClure Shale glade shows a clear change between 1988 and 1996. The ordinations of 1988 and 1996 reflect changes in species abundances. Berryville Shale glade has changed little since 1988. Patterns among the distribution of species in ordination space

show there is not a clear separation between samples from 1988 and 1996. It seems that the effect of clearing adjacent areas and the development of the restored tall grass prairie below the site has not affected the shale glade proper, at least yet.

It is believed that if McClure and Berryville Shale glades are not managed, through the removal of woody vegetation and/or the use of prescribed burning, these sites will be further encroached by woody vegetation. If the latter occurs, the eventual loss or at least the reduction of these unique and rare communities is certain. This is supported, in part, by a study performed by Franklin (1996). He has suggested that these forests have 'crossed some threshold', from a prairie-savanna to a forest, and fire dynamics of the system has changed. This is consistent with the recommendations of Heikens (1991) and Elsenheimer (1994).

The vegetation composition of Brown shale glade has significantly changed with the management techniques of prescribed burning and clearing of woody vegetation. This has been shown by the samples and species ordinations (Figures 7, 8, 9, 10, 11, & 12) between 1988 through 1996. During 1988 the area showed degradation by the encroachment of woody vegetation and associated herb layer (Heikens, 1991). When prescribed burning was implemented, the vegetation changed compositionally to a transitional prairie-forest system. After the effect of removing woody vegetation the restored area is converging to a xeric prairie system. Both areas, the forest opening and the restored area, are converging in species composition towards a xeric prairie and a prairie structure, respectively.

The ordinations for 1988 and 1993, 1988 and 1996, and 1993 and 1996 of Brown Shale glade show that the effects of management has significantly influenced species distributions and abundances. The prescribed burning between 1991 and 1993 has reduced forest vegetation of the old and new plots to a transitional zone of grasslands and forests. In addition, the prescribed burning and restoration since 1993 has further changed these plots to more of a grassland and a xeric grassland nature. The results of the ordination between 1988 and 1996 show that the old plots are converging to a clumped patterned rather than scattered. Our results are consistent with other 'Barren' restorations in Illinois such as a degraded bur oak savanna (Packard and Balaban, 1994), Simpson Barrens in the Shawnee National Forest (Stritch,

1990), Burke Branch Natural Area (Anderson & Schwegman, 1971), and Wolf Creek Chert Barrens, US Forest Service Federal Ecological Area (Heikens *et al.*, 1994). These results are supported by restoration projects across the eastern US and includes the restoration of a dry Oak Forest system in Wisconsin (Kline, 1994), Big Barrens Region of Kentucky and Tennessee (Baskin *et al.*, 1994), and Serpentine Barren restoration in Maryland (Tyndall, 1994).

These data show that the effects of management regimes, burning and clearing, maintain these unique grasslands. It also confirms the proposed hypothesis of Heikens (1991) that fire is a necessary element for the maintenance of these systems. In addition, the ordinations also showed within site structure. It separated the species associated with the upper and lower slopes on the second axis. This is probably due to the nature of this data set. Although this was not observed among all analyses, these trends were evident.

Soil Attributes. The patterns of soil attributes show that Berryville Shale glade is more similar to McClure than to Brown (Appendices D, E, F & G). Soil depths varied across sites (Table 7) with McClure having the shallowest soil. The soil depths have changed very little among sites between 1988 and 1996.

At Brown shale glade there were four differences in the soil between the old and new plots but these soils have changed considerably between 1988 and 1996. This is indicated by statistical significant differences among all of the soil chemical attributes. There has however been little change in soil attributes for Berryville and McClure between 1988 and 1996 (Appendices E & G). They show similar patterns among sites and between sampling periods.

This study provides evidence to support that change in vegetation composition from a forest to a prairie system has occurred at Brown shale glade. This supports the use of management techniques of prescribed burning and the removal of woody vegetation. Woody encroachment is likely to occur at Berryville and McClure School Shale glades if management techniques are not implemented or fire suppression continues. The results of the changes at Brown Shale glade with the management regime show that these communities can be maintained and can support unique communities.

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APPENDIX A

Flora of Berryville Shale glade, Union County, Illinois

* Denotes observation made by Heikens (1991).

+ Denotes non-native species.

FERNS

*Adiantaceae

**Cheilanthes lanosa* (Michx.) D.C. Eaton. - Hairy Lip Fern. Frequent in glade proper near shale outcrops.

*Aspleniaceae

**Asplenium platyneuron* (L.) Oakes. - Ebony Spleenwort. Frequent throughout Glade Proper.
Cyopteris protrusa (weatherby) Blasd. - Fragile Fern. Frequent throughout Glade Proper
Polystichum acrostichoides (Michx.) Schott. - Christmas Fern. Frequent on North-East slope and infrequent on or near ridgetop.
Woodsia obtusa (Spreng.) Torr. - Common Woodsia. Frequent throughout Glade Proper.

GYMNOSPERMS

*Cupressaceae

**Juniperus virginiana* L. - Red Cedar. Frequent throughout.

Pinaceae

+ *Pinus taeda* L. - Loblolly Pine. Rare, only one location.

ANGIOSPERMS

MONOCOTS

Commelineaceae

Tradescantia subaspera Ker. - Spiderwort. Frequent along upper slopes and near ridgetop.

*Cyperaceae

Carex artitecta Mack. Common in glade proper.
Carex caroliniana Schwein. - Carolina Sedge. Infrequent.
Carex cephalophora Willd. Common in glade proper.
Carex digitalis Willd. Infrequent.
Carex glaucoidea Tuckerm. Common in glade proper.
Carex granularis Willd. Infrequent.
Carex hirsutella Mack. - Hirsute Sedge. Common in glade proper.
Carex muhlenbergii Willd. Infrequent
Carex pennsylvanica Lam. Infrequent.
Carex retroflexa Willd. Uncommon.
Carex umbellata Schk. Common in glade proper.
Cyperus ovularis (Michx.) Torr. - Round-headed Sedge. Frequent to infrequent in glade proper.

Juncaceae

Juncus interior Wieg. - Rush. Common in glade proper.
Juncus secundus Beauv. - Rush. Infrequent throughout glade proper.
Juncus tenuis Willd. - Path Rush. Common in glade proper.
Luzula multiflora (Retz.) Legeune. - Wood Rush. Common in glade proper.

Liliaceae

Allium canadense L. - Wild Onion. Common throughout glade proper and adjacent woods.
Manfreda virginica (L.) Rose. - American Agave. Infrequent in glade proper absent elsewhere.

+*Nothoscordum bivale* (L.) Britt. - False Garlic. Common in glade proper.

*Orchidaceae

**Spiranthes cernua* (L.) Rich. - Little Ladies' Tresses. Rare, Less than 10 individuals along the upper slope near *Dodecatheon meadii* L. populations in semi wooded dry woods.

*Poaceae

Agrostis perrenans (Walt.) Tuckerm. - Upland Bent Grass. Rare in glade proper and absent elsewhere.

Aristida dichotoma Michx. - Three Awn. Infrequent to locally common.

Aristida oligantha Michx. - Three Awn. Infrequent throughout glade proper.

Aristida purpurascens Poir. - Arrowfeather. Infrequent throughout glade proper.

Bromus pubescens Muhl. - Canada Brome Grass. Infrequent to frequent in open woods and adjacent woods.

Chasmanthium latifolium (Michx.) Yates. - Sea Oats. Frequent to common in adjacent woods and glade proper.

**Danthonia spicata* (L.) Roem. & Schultes. - Curly Oat Grass. Common in glade proper.

**Dicanthelium acuminatum* (Sw.) Gould & Clark. - Panic Grass. Common in glade proper.

Dicanthelium boscii (Poir.) Gould & Clark. - Large-fruited Panic Grass. Common in glade proper.

**Dicanthelium laxiflorum* (Lam.) Gould. - Panic Grass. Common in glade proper.

Dicanthelium microcarpon (Muhl.) Mohlenbr. - Panic Grass. Common in glade proper.

Dichantherium dichotomum (L.) Gould. - Panic Grass. Common in glade proper.

Dichantherium linearifolium (Scribn.) Gould. - Panic Grass. Common in glade proper.

Dichantherium sphaerocarpon (Ell.) Gould. - Panic Grass. Common in glade proper.

Elymus virginicus L. - Virginia Wild Rye. Frequent to infrequent in glade proper and adjacent woods.

Elymus hystrix L. - Bottlebrush. Rare in adjacent woods and absent elsewhere.

**Eragrostis cappilaris* (L.) Nees. - Lace Grass. Locally frequent.

**Melica nitens* (Scribn.) Nutt. Three-flowered Melic Grass. Infrequent in glades proper.

Muhlenbergia bushii Pohl. - Muhly. Infrequent.

Muhlenbergia capillaris (Lam.) Trin. - Hair Grass. Common in glade proper.

**Muhlenbergia sobolifera* (Muhl.) Trin. - Muhly. Locally common in adjacent woods and locally frequent in open woods and glade proper.

Panicum capillare L. - Witch Grass. Frequent.

Panicum stipitatum Nash. - Panic Grass. Locally frequent otherwise infrequent throughout glade proper.

Paspalum ciliatifolium var. *muhlenbergii* (Nash.) Fern. - Bead Grass. Infrequent.

Poa angustifolia L. Bluegrass. Uncommon.

+*Poa pratensis* L. - Kentucky Bluegrass. Uncommon.

**Schizachyrium scoparium* (Michx.) Nash. - Little Bluestem. Common in glade proper.

+**Setaria faberi* Herrm. - Giant Foxtail. Common in disturbed areas.

Sporobolus vaginiflorus (Torr. & Gray) Wood. - Poverty Grass. Locally common in glade proper.

Sphenopholis obtusa (Michx.) Scribn. - Wedge Grass. Frequent throughout glade proper.

**Tridens flavus* (L.) Hitchcock. - Purple-top. Common in glade proper.

Vulpia octoflora (Walt.) Rydb. - Six-weeks Fescue. Frequent in thin soils in glade proper.

Smilacaceae

Smilax bona-nox L. - Catbrier. Frequent.

Smilax rotundifolia L. - Catbrier. Infrequent in adjacent woods.

DICOTS

*Aceraceae

**Acer saccharum* Marsh. - Sugar Maple. Frequent in adjacent woods.

Acer rubrum L. - Red Maple. Infrequent.

*Anacardiaceae

- **Rhus copallina* L. - Dwarf Sumac. Infrequent to scarce throughout glade proper.
- **Rhus aromatica* Ait. - Fragrant Sumac. Infrequent throughout glade.
- **Toxicodendron radicans* (L.) Kuntze. - Poison Ivy. Common throughout site.

Apiaceae

- Sanicula canadensis* L. - Canadian Black Snakeroot. Frequent in adjacent woods.
- Cryptotanaenia canadensis* (L.) DC. - Honewort. Infrequent along ridge and North-East Slope.

Acanthaceae

- Ruellia caroliniensis* (J.F. Gmel.) Steud. var. *dentata* (Nees) Fern. - Wild Petunia. Infrequent.
- Ruellia humilis* Nutt. - Wild Petunia. Frequent throughout Glade Proper.

Annonaceae

- Asimina triloba* (L.) Dunal. - Pawpaw. Common in adjacent woods.

Araceae

- Arisaema dracontium* (L.) Schott. - Green-dragon. Rare in adjacent moist woods.
- Arisaema triphyllum* (L.) Schott. - Jack-in-the-Pulpit. Rare in adjacent moist woods.

Araliaceae

- Aralia spinosa* L. - Hercules' Club. Infrequent on North-East slope and ridge top.

Asclepiadaceae

- Asclepias variegata* L. - Variagated Milkweed. Rare.
- Asclepias tuberosa* L. ssp. *interior* Woodson. - Butterfly-weed. Common throughout glade proper.

*Asteraceae

- +*Achillea millefolium* L. Common Yarrow. Infrequent throughout barren proper.
- **Ambrosia artemisiifolia* L. - Common Ragweed. Infrequent to locally frequent.
- **Antennaria plantaginifolia* (L.) Richards. - Pussytoes. Common in glade proper.
- **Aster anomalus* Engelm. - Blue Aster. Common to frequent in glade proper.
- **Aster ericoides* L. Heath Aster. Uncommon in glades proper.
- Aster lateriflorus* (L.) Britt. - Side-flowered Aster. Frequent in glade proper and adjacent woods.
- **Aster patens* Ait. - Spreading Aster. Common to frequent in glade proper.
- **Bidens bipinnata* L. Spanish Needles. Infrequent in glade proper.
- **Brickellia eupatorioides* (L.) Shinn. - False Boneset. Infrequent throughout glades proper.
- Conyza canadensis* (L.) Cronq. - Horseweed. Infrequent throughout glade proper.
- Erechtites hieracifolia* (L.) Raf. - Fireweed. Infrequent throughout glade proper.
- Erigeron annuus* (L.) Pers. - Daisy Fleabane. Infrequent throughout glade proper.
- Erigeron philadelphicus* L. - Marsh Fleabane.
- Erigeron strigosus* Muhl. - Daisy Fleabane. Infrequent throughout glades proper.
- Eupatorium rugosum* Houtt. - White Snakeroot. Rare in glade proper but more frequent in adjacent woods.
- Eupatorium serotinum* Michx. - Late Boneset. Rare in glade proper but more frequent in adjacent woods.
- Gnaphalium obtusifolium* L. - Sweet Everlasting; Catsfoot. Frequent in glade proper.
- Gnaphalium purpureum* L. - Early Cudweed. Common in glade proper.
- **Helianthus divaricatus* L. - Woodland sunflower. Common throughout glade and adjacent woods.
- Hieracium gronivii* L. - Hairy Hawkweed. Infrequent in glade proper.
- Hieracium scabrum* Michx. - Hairy Milkweed. Infrequent to somewhat frequent in glade proper.
- Krigia dandelion* (L.) Nutt. - Potato Dandelion. Common in glade proper.
- Prenanthes altissima* L. - Tall White Lettuce. Infrequent in glade proper.
- Solidago caesia* L. - Woodland Goldenrod. Common in adjacent woods and infrequent in glade proper.
- Solidago drommondii* Nutt. - Rough Goldenrod. Infrequent throughout.

- **Solidago nemoralis* Ait. - Field Goldenrod. Common throughout glade proper.
Solidago ulmifolia Muhl. - Elm-leaved Goldenrod. Common throughout glade proper.

Berberidaceae

- Podophyllum peltatum* L. Mayapple. Locally frequent in moist adjacent woods.

Bignoniaceae

- Campsis radicans* (L.) Seem. - Trumpet Creeper. Infrequent.

Boraginaceae

- Myosotis verna* Nutt. - Scorpoin Grass. Frequent.

Brassicaceae

- Arabis laevigata* (Muhl.) Poir. - Smooth Rock Cress. Infrequent to locally frequent.
 +*Barbarea vulgaris* R.Br. - Yellow Rocket. Infrequent to locally frequent.
Cardamine hirsuta L. - Spring Cress. Common.
Dentaria laciniata Muhl. - Tooth-wort. Common in adjacent woods.
Lepidium virginicum L. - Common Pepper Grass. Common throughout glade proper.

Campanulacea

- Lobelia inflata* L. - Indian Tobacco. Infrequent.

*Caprifoliaceae

- +**Lonicera japonica* Thunb. - Japanese Honeysuckle. Infrequent in glade proper.
Symphoricarpos orbiculatus Moench. - Coralberry. Common in glade proper.
 **Triodanis perfoliata* (L.) Nieuwl. - Venus' Looking-glass. Common in glade proper.
Viburnum prunifolium L. - Black Haw. Infrequent in glade proper.

*Cesalpiniaceae

- **Cassia fasciculata* Michx. - Partridge Pea. Common to frequent in glade proper.
Cassia nictitans L. - Wild Sensitive Plant. Infrequent in glade proper.
 **Cercis canadensis* L. - Redbud. Common in adjacent woods and rare in glade proper.
Gleditsia triacanthus L. - Honey Locust. Infrequent along ridgetop.

Celastraceae

- Euonymus atropurpurea* Jacq. -Wahoo. Frequent to locally common in glade proper.

Cistaceae

- Lechea tenuifolia* Michx. - Narrow-leaved Pinweed. Locally frequent in glade proper.

Cornaceae

- Cornus florida* L. - Flowering Dogwood. Frequent in adjacent woods.

*Corylaceae

- **Ostrya virginiana* (Mill.) K. Koch. - Hop Hornbeam. Common in adjacent woods and infrequent in glade proper.
Carpinus caroliniana Walt. - Ironwood. Common in adjacent woods.

*Ebenaceae

- **Diospyrus virginiana* L. - Common Persimmon. Common in adjacent woods and infrequent in glade proper.

*Ericaceae

- **Vaccinium arboreum* Marsh - Farkleberry. Common throughout glade, especially near upper slopes.
 **Vaccinium pallidum* Ait. - Low-bush Blueberry. Common throughout glade, especially near upper slopes.

*Euphorbiaceae

- **Acalypha gracilens* Gray. - Slender Three-seeded Mercury. Common throughout glade proper.
- Chamaesyce* sp. S.F. Gray. - Spurge. Infrequent throughout glade.
- **Croton monathogynus* Michx. - Croton. Locally common in glade proper.
- **Euphorbia corollata* L. - Flowering Spurge. Frequent throughout glade proper.

*Fabaceae

- Amphicarpa bracteata* (L.) Fern. - Hog Peanut. Locally frequent otherwise infrequent in glade proper.
- Clitoria mariana* L. - Butterfly Pea. Rare in glade proper.
- Dalea purpurea* Vent. - Purple Prairie Clover. Infrequent throughout glade proper and locally frequent in adjacent open woods..
- Desmodium laevigatum* (Nutt.) DC. - Tick Trefoil. Common in adjacent woods.
- Desmodium nudiflorum* (L.) DC. - White-flower Tick Trefoil.. Common in adjacent woods.
- Desmodium paniculatum* (L.) DC. - Panicked Tick Trefoil. Infrequent.
- Galactia regularis* (L.) BSP. - Milk Pea. Locally frequent in glade proper.
- + *Kummerowia striata* (Thunb.) Schindl. - Japanese Bush Clover. Common to frequent in glade proper.
- Lespedeza hirta* (L.) Hornem. - Hairy Bush Clover. Locally common to frequent in glade proper.
- Lespedeza procumbens* Michx. - Trailing Bush Clover. Locally common to frequent in glade proper.
- **Lespedeza repens* (L.) Bart. Creeping Bush Clover. Infrequent in glade proper.
- **Lespedeza virginica* (L.) Britt. - Slender Bush Clover. - Infrequent to uncommon in glade proper.
- **Stylosanthes biflora* (L.) BSP. - Pencil flower. Locally common to frequent in glade proper.
- Tephrosia virginiana* (L.) Pers. - Goats'-rue. Locally common in glade proper.

*Fagaceae

- Fagus grandifolia* Ehrh. var. *caroliniana* (Lud.) Fern. & Rehd. - Beech. Infrequent on moist lower slopes.
- **Quercus alba* L. - White Oak. Common in adjacent woods and infrequent in glade proper.
- **Quercus coccinea* Muenchh. - Scarlet Oak. In frequent.
- **Quercus marilandica* Muenchh. - Blackjack Oak. Common in glade proper.
- **Quercus rubra* L. - Northern Red Oak. Common in adjacent woods and infrequent in glade proper.
- **Quercus stellata* Wangh. - Post Oak. Common in glade proper.
- Quercus velutina* Lam. - Black Oak. Common in adjacent woods and infrequent in glade proper.

*Hypericaceae

- Hypericum drummodii* (Grev. & Hook.) Torr. & Gray. - Nits-and-Lice. Frequent in glade proper.
- Hypericum punctatum* Lam. - Spotted St. John's-wort. Frequent in glade proper.
- **Hypericum stragulum* P. Adams & Robson. - St. Andrews' Cross. Infrequent in glade proper.

*Juglandaceae

- **Carya glabra* (Mill.) Sweet. - Pignut Hickory. Common throughout.
- Carya ovalis* (Wang.) Sarg. - Sweet Pignut Hickory. Frequent throughout.
- **Carya ovata* (Mill.) K. Koch. - Shagbark Hickory. Common throughout.
- **Carya texana* Buckl. - Black Hickory. Uncommon.
- **Juglans nigra* L. - Black Walnut. Uncommon in adjacent woods and rare in glade proper.

*Lamiaceae

- Blephilia hirsuta* (Pursh) Benth. - Pagoda Plant. Infrequent in adjacent woods.
- **Cunila organoides* (L.) Britt. - Dittany. Common throughout.
- **Hedeoma pulegioides* (L.) Pers. - American Pennyroyal. Infrquent in glade proper and locally frequent in adjacent open woods.
- Monarda fistulosa* L. Wild Bergamont. Locally frequent in adjacent woods.

- + *Prunella vulgaris* L. - Self-heal. Locally common in adjacent open woods.
Pycnanthemum tenuifolium Schrad. - Slender Mountain Mint. Common throughout.

Lauraceae

- Sassafras albidum* (Nutt.) Nees. - Sassafras. Common in adjacent woods.

Magnoliaceae

- Liriodendron tulipifera* L. - Tulip Tree. Infrequent.

*Moraceae

- **Morus rubra* L. - Red Mulberry. Infrequent.

*Oleaceae

- **Fraxinus americana* L. - White Ash. Common in adjacent woods.

*Onagraceae

- **Oenothera linifolia* Nutt. - Thread-leaved Sundrops. Infrequent in glades proper.

*Oxalidaceae

- **Oxalis stricta* L. - Yellow Wood Sorrel. Common throughout glade proper.

- **Oxalis violacea* L. - Purple Oxalis. Common throughout glade proper.

Papaveraceae

- Corydalis flavula* (Raf.) DC. - Pale Corydalis. Infrequent in adjacent woods.

Passifloraceae

- Passiflora lutea* var. *glabriflora* Fern. - Small Passion-flower. Infrequent, but locally frequent.

Phrymaceae

- Phryma polystacha* L. - Lopseed. Somewhat frequent in adjacent woods and ridgetop.

*Phytolaccaeae

- **Phytolacca americana* L. - Pokeweed. Locally common in disturbed areas throughout glade proper.

Plantaginaceae

- +*Plantago major* L. - Common Plantain. Infrequent.

- +*Plantago rugelii* Dcne. - Rugel's Plantain. Infrequent.

- Plantago virginica* L. - Dwarf Plantain. Locally frequent in glade proper.

Polemoniaceae

- Phlox divaricata* L. spp. *laphamii* (Wood) Wherry. - Phlox. Locally frequent in adjacent moist woods.

Polygalaceae

- Polygala verticillata* L. - Whorled Milkwort. Locally infrequent in glade proper.

*Polygonaceae

- **Polygonum ramosissimum* Michx. - Knotweed. Uncommon throughout glade proper.

- Polygonum virginianum* L. - Virginia Knotweed. Uncommon throughout glade proper but locally frequent in adjacent woods.

*Primulaceae

- **Dodecatheon meadii* L. - Shooting-star. Locally frequent between mid slope to upper slopes.

Ranunculaceae

- Ranunculus hispidus* var. *marilandicus* (Poir.) L. Benson. - Bristly Buttercup. Common.

Ranunculus fascicularis Muhl. - Early Buttercup. Common.

*Rosaceae

- **Amelanchier arborea* (Michx. f.) Fern. - Shadbush. Infrequent.
- Agrimonia rostellata* Wallr. - Woodland Agrimony. Locally frequent.
- Crataegus pruinosa* (Wendl.) K. Koch. - Hawthorn. Infrequent throughout.
- Geum canadense* Jacq. - White Avens. Locally frequent.
- Potentilla simplex* Michx. - Common Cinquefoil. Frequent throughout glade proper.
- Prunus serotina* Ehrh. - Wild Black Cherry. Frequent in adjacent woods and infrequent in glade proper.
- **Rosa carolina* L. - Pasture Rose. Common to locally frequent throughout glade proper.
- Rubus* sp. Common to locally frequent.

*Rubiaceae

- Galium aparine* L. - Goosegrass. Frequent throughout.
- Galium circaezans* Michx. - Wild Licorice. Frequent throughout.
- Galium pilosum* Ait. - Hairy Bedstraw. Infrequent.
- Hedyotis longifolia* (Gaertn.) Hook. - Long-leaved Bluets. Locally frequent.
- **Hedyotis nigricans* (Lam.) Fosberg. - Narrow-leaved Bluets. Locally frequent.
- Hedyotis purpurea* (L.) Torr. & Gray. - Broad-leaved Bluets. Locally frequent.

*Saxifragaceae

- **Heuchera americana* L. var. *hirsuticaulis* (Wheelock) Rosend., Butt & Lak. - Tall Alumroot. Common on moist slopes.

*Scrophulariaceae

- **Agalinis tenuifolia* (Vahl) Raf. - Slender False Foxglove. Locally frequent otherwise absent.
- Penstemon digitalis* Nutt. - Foxglove Beardstongue. Locally frequent otherwise absent.
- **Penstemon pallidus* Small. - Pale Beardstongue. Locally frequent otherwise absent.
- Teucrium canadense* L. var. *virginicum* (L.) Eat. - American Germander. Locally frequent near ridgetop otherwise absent.
- +*Verbascum thapsus* L. - Woolly Mullein. Common in disturbed areas.

Solanaceae

- Physalis pubescens* L. - Annual Ground Cherry. Infrequent to locally frequent in glade proper.

*Ulmaceae

- **Ulmus alata* Michx. - Winged Elm. Common.
- **Celtis tenuifolia* Nutt. - Dwarf Hackberry. Infrequent.

Urticaceae

- Parietaria pensylvanica* Muhl. - Pellitory. Locally frequent.

Valerianaceae

- Valerianella radiata* (L.) Dufr. - Corn Salad. Common in glade proper.

*Violaceae

- **Hybanthus concolor* (T.F. Forst.) Spreng. - Green Violet. Common along lower slopes, otherwise absent.
- Viola rafinesquii* Green - Johnny-jump-up. Common throughout.
- Viola triloba* Schwein - Cleft Violet. Common throughout.

*Vitaceae

- **Parthenocissus quinquefolia* (L.) Planch. - Virginiana Creeper. Locally frequent in glade proper and adjacent woods.
- **Vitis aestivalis* Michx. - Summer Grape. Infrequent in glade proper and common in adjacent

woods.

**Vitis cinerea* Engelm. - Winter Grape. Infrequent in glade proper and common in adjacent woods.

APPENDIX B

Flora of Brown Barrens, Union County, Illinois

* Denotes observation made by Heikens (1991).

+ Denotes non-native species.

FERNS

*Adiantaceae

Adiantum pedatum [Tourn.] L. - Maidenhair Fern. Frequent on North-East slope.

**Cheilanthes lanosa* (Michx.) D.C. Eaton. - Hairy Lip Fern. Frequent in barren proper near shale outcrops.

*Aspleniaceae

**Asplenium platyneuron* (L.) Oakes. - Ebony Spleenwort. Frequent throughout Barrens Proper.

Cysopteris protrusa (weatherby) Blasd. - Fragile Fern. Frequent throughout Barrens Proper

Polystichum acrostichoides (Michx.) Schott. - Christmas Fern. Frequent on North-East slope and infrequent on or near ridgetop.

**Woodsia obtusa* (Spreng.) Torr. - Common Woodsia. Frequent throughout Barrens Proper.

GYMNOSPERMS

*Cupressaceae

**Juniperus virginiana* L. - Red Cedar. Infrequent throughout barrens proper.

ANGIOSPERMS

MONOCOTS

Commelineaceae

Tradescantia subaspera Ker. - Spiderwort. Locally common along lower moist slopes of barrens proper.

+*Commelina communis* L. - Common Day Flower. Uncommon in disturbed areas.

*Cyperaceae

Carex artitecta Mack. Common in barrens proper.

Carex caroliniana Schwein. - Carolina Sedge. Infrequent.

Carex cephalophora Willd. Common in barrens proper.

Carex digitalis Willd. Infrequent.

**Carex glaucoidea* Tuckerm. Common in barrens proper.

Carex granularis Willd. Infrequent.

Carex hirsutella Mack. - Hirsute Sedge. Common in barrens proper.

Carex muhlenbergii Willd. Infrequent

Carex pennsylvanica Lam. Infrequent.

Carex retroflexa Willd. Uncommon.

Carex umbellata Schk. Common in barrens proper.

Cyperus ovularis (Michx.) Torr. - Round-headed Sedge. Frequent to infrequent in barrens proper.

Iridaceae

Sisyrinchium albidum Raf. - Blue-eyed Grass. Common in disturbed areas and infrequent elsewhere.

*Juncaceae

**Juncus interior* Wieg. - Rush. Common in barrens proper.

Juncus secundus Beauv. - Rush. Infrequent throughout barren proper.

Juncus tenuis Willd. - Path Rush. Common in barrens proper.

Luzula multiflora (Retz.) Legeune. - Wood Rush. Common in barrens proper.

*Liliaceae

- Allium canadense* L. - Wild Onion. Common throughout barren proper and adjacent woods.
 +*Asparagus officinalis* L. - Asparagus. Rare in barrens proper.
 **Manfreda virginica* (L.) Rose. - American Agave. Infrequent in barrens proper.
 +**Nothoscordum bivale* (L.) Britt. - False Garlic. Common in barrens proper.
Trillium recurvatum Beck. - Wake Robin. Common in adjacent woods near State Route 146 and found in only one locale in open woods near utility line right-of-way and barrens proper.

*Poaceae

- Agrostis perrenans* (Walt.) Tuckerm. - Upland Bent Grass.
Andropogon virginicus L. - Broom Sedge. Only two known locations, near ridgetop and barrens proper.
Aristida dichotoma Michx. - Three Awn. Infrequent to locally common.
 **Aristida longespica* Poir. Three Awn. Infrequent throughout barren proper.
Bromus pubescens Muhl. - Canada Brome Grass. Infrequent to frequent in open woods and adjacent woods
Chasmanthium latifolium (Michx.) Yates. - Sea Oats. Frequent to common in adjacent woods and barrens proper.
 **Danthonia spicata* (L.) Roem. & Schultes. - Curly Oat Grass. Common in barrens proper.
 **Dicanthelium acuminatum* (Sw.) Gould & Clark. - Panic Grass. Common in barrens proper.
Dicanthelium boscii (Poir.) Gould & Clark. - Large-fruited Panic Grass. Common in barrens proper.
Dicanthelium laxiflorum (Lam.) Gould. - Panic Grass. Common in barrens proper.
Dicanthelium microcarpon (Muhl.) Mohlenbr. - Panic Grass. Common in barrens proper.
Dichantherium dichotomum (L.) Gould. - Panic Grass. Common in barrens proper.
Dichantherium linearifolium (Scribn.) Gould. - Panic Grass. Common in barrens proper.
Dichantherium sphaerocarpon (Ell.) Gould. - Panic Grass. Common in barrens proper.
 +*Festuca pratensis* Huds. - Meadow Fescue. Rare, one location near *Silphium perfoliatum* and route 146.
 **Elymus canadensis* L. - Nodding Wild Rye. Frequent to infrequent in barrens proper and adjacent woods.
Elymus virginicus L. - Virginia Wild Rye. Frequent to infrequent in barrens proper and adjacent woods.
Eragrostis capillaris (L.) Nees. - Lace Grass. Locally frequent.
Glyceria striata (Lam.) Hitchcock. - Fowl Manna Grass. Rare in moist low areas adjacent to North-East woods and State Route 146.
Muhlenbergia bushii Pohl. - Muhly. Infrequent.
 **Muhlenbergia capillaris* (Lam.) Trin. - Hair Grass. Common in barrens proper.
Muhlenbergia sobolifera (Muhl.) Trin. - Muhly. Locally common in adjacent woods and locally frequent in open woods and barrens proper.
 **Panicum capillare* L. - Witch Grass. Frequent.
Panicum stipitatum Nash. - Panic Grass. Locally frequent otherwise infrequent throughout barrens proper.
Paspalum ciliatifolium var. *muhlenbergii* (Nash.) Fern. - Bead Grass. Infrequent.
 +*Phleum pratense* L. Timothy. Rare, one location near *Silphium perfoliatum* and State Route 146.
 +*Poa pratensis* L. - Kentucky Bluegrass. Uncommon.
 **Schizachyrium scoparium* (Michx.) Nash. - Little Bluestem. Common in barrens proper.
 +*Setaria faberi* Herrm. - Giant Foxtail. Common in disturbed areas.
 +*Sorghum halepense* (L.) Pers. - Johnson Grass. Common in disturbed areas.
Sporobolus vaginiflorus (Torr. & Gray) Wood. - Poverty Grass. Locally common in barrens proper.
Sphenopholis obtusa (Michx.) Scribn. - Wedge Grass. Frequent throughout barrens proper.
 **Tridens flavus* (L.) Hitchcock. - Purple-top. Common in barrens proper.
Vulpia octoflora (Walt.) Rydb. - Six-weeks Fescue. Frequent in thin soils in barrens proper.

Smilacaceae

Smilax bona-nox L. - Catbrier. Frequent.

Smilax rotundifolia L. - Catbrier. Infrequent in adjacent woods near State Route 146.

DICOTS

*Aceraceae

**Acer rubrum* L. - Red Maple. Infrequent on lower slope of North-East.

Acer saccharum Marsh. - Sugar Maple. Frequent on North-East slope.

Acer negundo L. - Box Elder. Infrequent on lower slope of North-East.

*Anacardiaceae

**Rhus aromatica* Ait. - Fragrant Sumac. Infrequent throughout barren proper.

Rhus copallina L. - Dwarf Sumac. Scarce throughout barrens proper.

Rhus glabra L. - Smooth Sumac. Frequent along roadside cut, State Route 146.

Toxicodendron radicans (L.) Kuntze. - Poison Ivy. Frequent throughout Barrens Proper.

Apiaceae

Cryptotanaenia canadensis (L.) DC. - Honewort. Infrequent along ridge and North-East Slope.

+*Daucus carota* L. - Wild Carrot. Common along the lower North-East Slope and State Route 146.

Sanicula canadensis L. - Canadian Black Snakeroot. Frequent throughout Barrens Proper and North-East slope.

*Acanthaceae

Ruellia caroliniensis (J.F.Gmel.) Steud. var. *dentata* (Nees) Fern. - Wild Petunia.

**Ruellia humilis* Nutt. - Wild Petunia. Frequent throughout Barrens Proper.

Ruellia pedunculata Torr. - Wild Petunia. Infrequent throughout Barrens Proper.

Annonaceae

Asimina triloba (L.) Dunal. - Pawpaw. Frequent on North-East slope.

Apocynaceae

Apocynum cannabinum L. - Indian Hemp. Common along the lower North-East Slope and State Route 146.

Araceae

Arisaema dracontium (L.) Schott. - Green-dragon. Infrequent on North-East slope.

Arisaema triphyllum (L.) Schott. - Jack-in-the-Pulpit. Infrequent on North-East slope.

Araliaceae

Aralia spinosa L. - Hercules' Club. Infrequent on North-East slope and ridge top.

Asclepiadaceae

Asclepias variegata L. - Variagated Milkweed. Infrequent throughout barrens proper.

Asclepias tuberosa L. ssp. *interior* Woodson. - Butterfly-weed. Infrequent throughout barrens proper.

Asclepias syriaca L. Common Milkweed. Common along the lower North-East Slope and State Route 146.

*Asteraceae

+*Achillea millefolium* L. Common Yarrow. Infrequent throughout barren proper.

**Ambrosia artemisiifolia* L. - Common Ragweed. Infrequent in barrens proper and along roadside.

**Antennaria plantaginifolia* (L.) Richards. - Pussytoes. Common in barrens proper.

**Aster anomalus* Engelm. - Blue Aster. Common throughout barrens proper.

Aster lateriflorus (L.) Britt. - Side-flowered Aster. Frequent throughout barrens proper, semi-wooded areas, and along roadside.

**Aster patens* Ait. - Spreading Aster. Frequent throughout barrens proper.

- **Aster turbinellus* Lindl. - Aster. Uncommon.
Cacalia atriplicifolia L. - Pale Indian Plantain. Infrequent throughout woods between ridge and State Route 146.
Conyza canadensis (L.) Cronq. - Horseweed. Infrequent to frequent in barrens proper.
 ***Echinacea pallida* Nutt. - Pale Coneflower. - Infrequent throughout barren proper.
Erechtites hieracifolia (L.) Raf. - Fireweed. Infrequent in barrens proper.
Erigeron annuus (L.) Pers. - Daisy Fleabane. Infrequent in barrens proper.
Erigeron philadelphicus L. - Marsh Fleabane. Infrequent in barrens proper.
Erigeron strigosus Muhl. - Daisy Fleabane. Frequent in barrens proper.
Eupatorium rugosum Houtt. - White Snakeroot. Infrequent in Barrens proper but common in woods.
Eupatorium serotinum Michx. - Late Boneset. Infrequent in Barrens proper but common in woods
Gnaphalium obtusifolium L. - Sweet Everlasting; Catsfoot. Common in barrens proper.
Gnaphalium purpureum L. - Early Cudweed. Common in barrens proper.
 **Helianthus divaricatus* L. - Woodland sunflower. Common in barrens proper.
Helianthus microcephalus Torr & Gray. - Small wood sunflower.
Hieracium gronivii L. - Hairy Hawkweed. Infrequent in barrens proper.
Hieracium scabrum Michx. - Hairy Milkweed. Infrequent in barrens proper.
 **Krigia dandelion* (L.) Nutt. - Potato Dandelion. Common in barrens proper.
Prenanthes altissima L. - Tall White Lettuce. Infrequent in wooded areas and rare in barrens proper.
Rudbeckia hirta L. - Black-eyed Susan. Infrequent in barrens opening and adjacent woods near old utility line right-of-way.
Silphium perfoliatum L. - Cup-plant. Only one population near near property line and State Route 146.
Solidago canadensis L. - Tall Goldenrod. Common along roadside.
Solidago caesia L. - Woodland Goldenrod. Common in woodland areas,
 **Solidago nemoralis* Ait. - Field Goldenrod. Common in barrens proper.
Solidago ulmifolia Muhl. - Elm-leaved Goldenrod. Common in barrens proper.
 +*Taraxicum officinale* Weber. - Common Dandelion.

Balsaminaceae

- Impatiens capensis* Meerb. - Spotted Touch-me-not. Rare in wooded areas near utility line.

Berberidaceae

- Podophyllum peltatum* L. Mayapple. Common in wooded areas.

Bignoniaceae

- Campsis radicans* (L.) Seem. - Trumpet Creeper. Infrequent throughout.

*Boraginaceae

- **Myosotis verna* Nutt. - Scorpoin Grass. Frequent in barrens proper.

Brassicaceae

- Arabis laevigata* (Muhl.) Poir. - Smooth Rock Cress. Uncommon in barrens proper.
 +*Barbarea vulgaris* R.Br. - Yellow Rocket. Uncommon in barrens proper.
Cardamine hirsuta L. - Spring Cress. Common in barrens proper.
Dentaria laciniata Muhl. - Tooth-wort. Common in wooded areas and near ridge top.
Lepidium virginicum L. - Common Pepper Grass. Common in barrens proper.

Campanulacea

- Lobelia inflata* L. - Indian Tobacco. Infrequent in barrens proper.

*Caprifoliaceae

- +**Lonicera japonica* Thunb. - Japanese Honeysuckle. Infrequent in barrens proper and common along site edges.

- **Symphoricarpus orbiculatus* Moench. - Coralberry. Rare in barrens proper and absent elsewhere.
- **Triodanis perfoliata* (L.) Nieuwl. - Venus' Looking-glass. Common in barrens proper.
- Viburnum prunifolium* L. - Black Haw. Uncommon in barrens proper.

Caryophyllaceae

- Paronychia fastigata* (Raf.) Fern. - Forked Chickweed. Uncommon in barrens proper.

*Cesalpiniaceae

- **Cassia fasciculata* Michx. - Partridge Pea. Common in barrens proper.
- Cassia nictitens* L. - Wild Sensitive Plant. Common in barrens proper.
- Cercis canadensis* L. - Redbud. Common in adjacent woods.
- Gleditsia triacanthus* L. - Honey Locust. Uncommon, mostly found along State Route 146 and edge of woods.

Celastraceae

- Euonymus atropurpurea* Jacq. - Wahoo. Frequent to common in barrens proper.

Cistaceae

- Lechea tenuifolia* Michx. - Narrow-leaved Pinweed. Frequent in barrens proper.

Cornaceae

- Cornus florida* L. - Flowering Dogwood. Frequent in adjacent woods.

*Corylaceae

- **Ostrya virginiana* (Mill.) K. Koch. - Hop Hornbeam. Frequent throughout.
- Carpinus caroliniana* Walt. - Ironwood. Frequent in adjacent woods.

Dioscoreaceae

- Dioscorea villosa* L. - Wild Yam. Uncommon.

*Ebenaceae

- **Diospyrus virginiana* L. - Common Persimmon. Frequent in barrens proper and locally common elsewhere.

*Ericaceae

- **Vaccinium arboreum* Marsh - Farkleberry. Frequent near edges of barrens and barrens proper.
- **Vaccinium pallidum* Ait. - Low-bush Blueberry. Frequent near edges of barrens and barrens proper.

*Euphorbiaceae

- Acalypha gracilens* Gray. - Slender Three-seeded Mercury. Common in barrens proper.
- Chamaesyce* sp. S.F. Gray. - Spurge. Infrequent in barrens proper and somewhat common along roadside edges
- **Croton monathogynus* Michx. - Croton. Common in barrens proper.
- **Euphorbia corollata* L. - Flowering Spurge. Common in barrens proper.

*Fabaceae

- Amphicarpa bracteata* (L.) Fern. - Hog Peanut. Common in barrens proper.
- +*Coronilla varia* L. - Crown-vetch. Common in adjacent field and especially along State Route 146 near the eastern edge of the site. Also found near edges of the old utility line-right-of-way.
- Dalea purpurea* Vent. - Purple Prairie Clover. Rare throughout barrens proper.
- Desmodium laevigatum* (Nutt.) DC. - Glaucous Tick Trefoil. Frequent along ridgetop and in adjacent woods.
- Desmodium paniculatum* (L.) DC. - Panicked Tick Trefoil. Frequent along ridgetop and in adjacent woods.

- Galactia regularis* (L.) BSP. - Milk Pea. Frequent in barrens proper and adjacent open woods.
 +*Kummerowia striata* (Thunb.) Schindl. - Japanese Bush Clover. Common in barrens proper.
Lespedeza hirta (L.) Hornem. - Hairy Bush Clover. Common in barrens proper.
 **Lespedeza procumbens* Michx. - Trailing Bush Clover. Frequent in barrens proper.
 **Lespedeza virginica* (L.) Britt. - Slender Bush Clover. Frequent in barrens proper.
 **Stylosanthes biflora* (L.) BSP. - Pencil flower. Common in barrens proper.

*Fagaceae

- Fagus grandifolia* Ehrh. var. *caroliniana* (Lud.) Fern. & Rehd. - Beech. Frequent on North-East slope.
Quercus alba L. - White Oak. Common in barrens proper.
 **Quercus imbricaria* Michx. - Shingle Oak. Infrequent in barrens proper.
Quercus marilandica Muenchh. - Blackjack Oak. Common in barrens proper. Infrequent in barrens proper.
 **Quercus prinoides* Willd. var. *acuminata* (Michx.) Gl. - Yellow Chestnut Oak. Uncommon and Rare.
Quercus rubra L. - Northern Red Oak. Frequent near ridgetop and in woods on North-East slope.
 **Quercus stellata* Wangh. - Post Oak. Common in barrens proper.
Quercus velutina Lam. - Black Oak. Infrequent.

Geraniaceae

- Geranium carolinianum* L. - Wild Cranesbill. Infrequent.

Hamelidaceae

- Liquidambar styraciflua* L. - Sweet Gum. Infrequent to locally common in adjacent woods near route 146.

Hippocastanaceae

- Aesculus glabra* Willd. - Ohio Buckeye. Uncommon and locally found in adjacent woods near route 146.

Hydrangeaceae

- Hydrangea arborescens* L. - Wild Hydrangea. Frequent to locally common in adjacent woods near State Route 146.

*Hypericaceae

- Hypericum drummodi* (Grev. & Hook.) Torr. & Gray. - Nits-and-Lice. Infrequent to locally frequent in barrens proper.
 **Hypericum punctatum* Lam. - Spotted St. John's-wort. Infrequent to locally frequent in barrens proper.
 **Hypericum stragulum* P. Adams & Robson. - St. Andrews' Cross. Infrequent in barren proper.

*Juglandaceae

- **Carya glabra* (Mill.) Sweet. - Pignut Hickory. Frequent in local woods and infrequent in barrens proper.
Carya ovalis (Wang.) Sarg. - Sweet Pignut Hickory. Frequent in local woods and infrequent in barrens proper.
Carya ovata (Mill.) K. Koch. - Shagbark Hickory. Frequent in local woods and infrequent in barrens proper.
 **Carya texana* Buckl. - Black Hickory. Uncommon.

*Lamiaceae

- Blephilia hirsuta* (Pursh) Benth. - Pagoda Plant. Frequent in local areas.
 **Cunila organoides* (L.) Britt. - Dittany. Common in barrens proper.
Hedeoma pulegioides (L.) Pers. - American Pennyroyal. Frequent.
 +*Lamium applexuale* L. - Henbit. Common in disturbed areas along State Route 146.

Monarda fistulosa L. Wild Bergamont. Locally frequent in adjacent woods.

+*Prunella vulgaris* L. - Self-heal. Infrequent.

**Pycnanthemum tenuifolium* Schrad. - Slender Mountain Mint. Common in barrens proper.

Lauraceae

Sassafras albidum (Nutt.) Nees. - Sassafras. Common in adjacent woods.

Magnoliaceae

Liriodendron tulipifera L. - Tulip Tree. Frequent in adjacent woods near State Route 146.

Moraceae

+*Morus rubra* L. - Red Mulberry. Infrequent.

*Oleaceae

**Fraxinus americana* L. - White Ash. Frequent in adjacent woods and somewhat rare in barrens proper.

+*Ligustrum vulgare* L. - Common Privet. Uncommon.

Onagraceae

Oenothera biennis L. - Evening-primrose. Common in disturbed areas along State Route 146 and roadside cut.

*Oxalidaceae

**Oxalis stricta* L. - Yellow Wood Sorrel. Common in barrens proper.

**Oxalis violacea* L. - Purple Oxalis. Common in barrens proper.

Papaveraceae

Sanguinaria canadensis L. Blood Root. Uncommon in moist woods near State Route 146.

Passifloraceae

Passiflora lutea var. *glabriflora* Fern. - Small Passion-flower. Uncommon along edges of barrens proper.

Phytolaccaeae

Phytolacca americana L. - Pokeweed. Locally common in disturbed areas throughout barren proper.

Phrymaceae

Phryma polystacha L. Lopseed. Uncommon along ridgetop and frequent in adjacent woods.

*Plantaginaceae

+*Plantago major* L. - Common Plantain. Infrequent in barrens but locally common in disturbed areas.

+**Plantago rugelii* Dcne. - Rugel's Plantain. Infrequent in barrens but locally common in disturbed areas.

Plantago virginica L. - Dwarf Plantain. Locally frequent in barrens proper and absent elsewhere.

Platanaceae

Platanus occidentalis L. - Sycamore. Scattered in moist woods near State Route 146.

Polygalaceae

Polygala verticillata L. - Whorled Milkwort. Locally found in barrens proper.

*Primulaceae

**Dodecatheon meadii* L. - Shooting-star. Locally common along lower moist slopes of barrens proper.

*Ranunculaceae

Delphinium tricornis Michx. - Dwarf Larkspur. Rare, only one location in moist woods near route 146.

Ranunculus hispidus var *marilandicus* (Poir.) L. Benson. - Bristly Buttercup. Frequent throughout.
Ranunculus fascicularis Muhl. - Early Buttercup. Frequent throughout.

*Rosaceae

Agrimonia rostellata Wallr. - Woodland Agrimony. Frequent throughout.

Amelanchier arborea (Michx. f.) Fern. - Shadbush. Rare.

**Crataegus pruinosa* (Wendl.) K. Koch. - Hawthorn. Locally uncommon.

Geum canadense Jacq. - White Avens. Rare.

**Potentilla simplex* Michx. - Common Cinquefoil. Frequent throughout barren proper.

Prunus serotina Ehrh. - Wild Black Cherry. Locally frequent in adjacent woods and ridgetop.

Rosa carolina L. - Pasture Rose. Frequent in barrens proper.

+*Rosa multiflora* Thunb. - Multiflora Rose. Locally common in disturbed areas especially along route 146.

Rubus sp. Locally frequent.

*Rubiaceae

Galium aparine L. - Goosegrass. Common in barrens proper.

**Galium circaezans* Michx. - Wild Licorice. Common in barrens proper.

**Galium concinnum* L. Torr. & Gray. - Shining Bedstraw. Infrequent.

Galium pilosum Ait. - Hairy Bedstraw. Common in barrens proper.

Hedyotis longifolia (Gaertn.) Hook. - Long-leaved Bluets. Common.

Hedyotis purpurea (L.) Torr. & Gray. - Broad-leaved Bluets. Common.

*Saxifragaceae

**Heuchera americana* L. var. *hirsuticaulis* (Wheelock) Rosend., Butt & Lak. - Tall Alumroot. Locally common throughout.

*Scrophulariaceae

Agalinis gattingeri (Small) Small. - Rough-stemmed False-Foxglove. Uncommon near ridgetop absent elsewhere.

Agalinis tenuifolia (Vahl) Raf. - Slender False Foxglove. Common near ridgetop absent elsewhere.

**Penstemon digitalis* Nutt. - Foxglove Beardstongue. Infrequent in barrens proper.

Penstemon pallidus Small. - Pale Beardstongue. Frequent to infrequent in barrens proper.

+**Verbascum thapsus* L. - Woolly Mullein. Common in disturbed areas.

Veronicastrum virginicum (L.) Fsrw. - Culvar's-root. Infrequent along roadside.

Solanaceae

Physalis pubescens L. - Annual Ground Cherry. Infrequent in barrens.

Tiliaceae

Tilia americana L. - Basswood. Uncommon in woods on the North-East slope.

*Ulmaceae

**Ulmus alata* Michx. - Winged Elm. Common in barrens proper.

Ulmus rubra Muhl. - Slippery Elm. Uncommon in low woods adjacent to State Route 146.

Urticaceae

Parietaria pensylvanica Muhl. - Pellitory. Infrequent.

Valerianaceae

Valerianella radiata (L.) Dufr. - Corn Salad. Common to infrequent in barrens proper.

Verbenaceae

Verbena simplex Lehm. - Narrow-leaved Vervain. Frequent along old utilityline right-of-way.

Violaceae

Hybanthus concolor (T.F. Forst.) Spreng. - Green Violet. Infrequent.

Viola rafinesquii Green - Johnny-jump-up. Common in barrens proper.

Viola triloba Schwein - Cleft Violet. Common in barrens proper.

Viola pubescens Ait. var. *eriocarpa* (Schwein.) Russell. - Smooth Yellow Violet. Locally common in woods on the North-East Slope.

*Vitaceae

**Parthenocissus quinquefolia* (L.) Planch. - Virginia Creeper. Locally frequent throughout.

Vitis aestivalis Michx. - Summer Grape. Locally frequent throughout.

*Liliaceae

- Allium canadense* L. - Wild Onion. Common throughout glade proper and adjacent woods.
 **Manfreda virginica* (L.) Rose. - American Agave. Infrequent in glade proper absent elsewhere.
 +**Nothoscordum bivale* (L.) Britt. - False Garlic. Common in glade proper.

Orchidaceae

- Spiranthes cernua* (L.) Rich. - Little Ladies' Tresses. Rare, Less than 10 individuals along the upper slope near *Dodecatheon meadii* L. populations in semi wooded dry woods.

*Poaceae

- Agrostis perrenans* (Walt.) Tuckerm. - Upland Bent Grass. Rare in glade proper and absent elsewhere.
Aristida dichotoma Michx. - Three Awn. Infrequent to locally common.
Aristida oligantha Michx. - Three Awn. Infrequent throughout glade proper.
Aristida purpurascens Poir. - Arrowfeather. Infrequent throughout glade proper.
Bromus pubescens Muhl. - Canada Brome Grass. Infrequent to frequent in open woods and adjacent woods
Chasmanthium latifolium (Michx.) Yates. - Sea Oats. Frequent to common in adjacent woods and glade proper.
 **Danthonia spicata* (L.) Roem. & Schultes. - Curly Oat Grass. Common in glade proper.
 **Dicanthelium acuminatum* (Sw.) Gould & Clark. - Panic Grass. Common in glade proper.
Dicanthelium boscii (Poir.) Gould & Clark. - Large-fruited Panic Grass. Common in glade proper.
 **Dicanthelium laxiflorum* (Lam.) Gould. - Panic Grass. Common in glade proper.
Dicanthelium microcarpon (Muhl.) Mohlenbr. - Panic Grass. Common in glade proper.
Dichanthelium dichotomum (L.) Gould. - Panic Grass. Common in glade proper.
Dichanthelium linearifolium (Scribn.) Gould. - Panic Grass. Common in glade proper.
Dichanthelium sphaerocarpon (Ell.) Gould. - Panic Grass. Common in glade proper.
Elymus virginicus L. - Virginia Wild Rye. Frequent to infrequent in glade proper and adjacent woods.
Elymus hystrix L. - Bottlebrush. Rare in adjacent woods and absent elsewhere.
Eragrostis capillaris (L.) Nees. - Lace Grass. Locally frequent.
Muhlenbergia bushii Pohl. - Muhly. Infrequent.
Muhlenbergia capillaris (Lam.) Trin. - Hair Grass. Common in glade proper.
Muhlenbergia sobolifera (Muhl.) Trin. - Muhly. Locally common in adjacent woods and locally frequent in open woods and glade proper.
 **Panicum capillare* L. - Witch Grass. Frequent.
Panicum stipitatum Nash. - Panic Grass. Locally frequent otherwise infrequent throughout glade proper.
Paspalum ciliatifolium var. *muhlenbergii* (Nash.) Fern. - Bead Grass. Infrequent.
Poa angustifolia L. Bluegrass. Uncommon.
 +*Poa pratensis* L. - Kentucky Bluegrass. Uncommon.
 **Schizachyrium scoparium* (Michx.) Nash. - Little Bluestem. Common in glade proper.
 +*Setaria faberi* Herrm. - Giant Foxtail. Common in disturbed areas.
Sporobolus vaginiflorus (Torr. & Gray) Wood. - Poverty Grass. Locally common in glade proper.
Sphenopholis obtusa (Michx.) Scribn. - Wedge Grass. Frequent throughout glade proper.
 **Tridens flavus* (L.) Hitchcock. - Purple-top. Common in glade proper.
Vulpia octoflora (Walt.) Rydb. - Six-weeks Fescue. Frequent in thin soils in glade proper.

*Smilacaceae

- **Smilax bona-nox* L. - Catbrier. Frequent.
 **Smilax glauca* Walt. Catbrier. Infrequent in glade proper.
Smilax rotundifolia L. - Catbrier. Infrequent in adjacent woods.

DICOTS

*Aceraceae

**Acer saccharum* Marsh. - Sugar Maple. Frequent in adjacent woods.

*Anacardiaceae

**Rhus copallina* L. - Dwarf Sumac. Infrequent to scarce throughout glade proper.

**Rhus aromatica* Ait. - Fragrant Sumac. Infrequent throughout glade.

**Toxicodendron radicans* (L.) Kuntze. - Poison Ivy. Common throughout site.

Apiaceae

Sanicula canadensis L. - Canadian Black Snakeroot. Frequent in adjacent woods.

Cryptotanaenia canadensis (L.) DC. - Honewort. Infrequent along ridge and North-East Slope.

*Acanthaceae

Ruellia caroliniensis (J.F.Gmel.) Steud. var. *dentata* (Nees) Fern. - Wild Petunia. Infrequent.

**Ruellia humilis* Nutt. - Wild Petunia. Frequent throughout Glade Proper.

Annonaceae

Asimina triloba (L.) Dunal. - Pawpaw. Common in adjacent woods.

Araceae

Arisaema dracontium (L.) Schott. - Green-dragon. Rare in adjacent moist woods.

Arisaema triphyllum (L.) Schott. - Jack-in-the-Pulpit. Rare in adjacent moist woods.

Araliaceae

Aralia spinosa L. - Hercules' Club. Infrequent on North-East slope and ridge top.

Asclepiadaceae

Asclepias variegata L. - Variagated Milkweed. Rare.

Asclepias tuberosa L. ssp. *interior* Woodson. - Butterfly-weed. Common throughout glade proper.

*Asteraceae

+*Achillea millefolium* L. Common Yarrow. Infrequent throughout barren proper.

**Ambrosia artemisiifolia* L. - Common Ragweed. Infrequent to locally frequent.

**Antennaria plantaginifolia* (L.) Richards. - Pussytoes. Common in glade proper.

**Aster anomalus* Engelm. - Blue Aster. Common to frequent in glade proper.

Aster lateriflorus (L.) Britt. - Side-flowered Aster. Frequent in glade proper and adjacent woods.

**Aster patens* Ait. - Spreading Aster. Common to frequent in glade proper.

**Aster turbinellus* Lindl. - Aster. Uncommon.

**Brickellia eupatoriodes* (L.) Shinn. - False Boneset. Infrequent throughout glades proper.

Conyza canadensis (L.) Cronq. - Horseweed. Infrequent throughout glade proper.

Erechtites hieracifolia (L.) Raf. - Fireweed. Infrequent throughout glade proper.

Erigeron annuus (L.) Pers. - Daisy Fleabane. Infrequent throughout glade proper.

Erigeron philadelphicus L. - Marsh Fleabane. Rare.

Erigeron strigosus Muhl. - Daisy Fleabane. Infrequent throughout glades proper.

Eupatorium rugosum Houtt. - White Snakeroot. Rare in glade proper but more frequent in adjacent woods.

Eupatorium serotinum Michx. - Late Boneset. Rare in glade proper but more frequent in adjacent woods.

Gnaphalium obtusifolium L. - Sweet Everlasting; Catsfoot. Frequent in glade proper.

Gnaphalium purpureum L. - Early Cudweed. Common in glade proper.

**Helianthus divaricatus* L. - Woodland sunflower. Common throughout glade and adjacent woods.

Hieracium gronivii L. - Hairy Hawkweed. Infrequent in glade proper.

Hieracium scabrum Michx. - Hairy Milkweed. Infrequent to somewhat frequent in glade proper.

**Krigia dandelion* (L.) Nutt. - Potato Dandelion. Common in glade proper.

Prenanthes altissima L. - Tall White Lettuce. Infrequent in glade proper.

Solidago caesia L. - Woodland Goldenrod. Common in adjacent woods and infrequent in glade proper.

- Solidago drommondii* Nutt. - Rough Goldenrod. Infrequent throughout.
 **Solidago nemoralis* Ait. - Field Goldenrod. Common throughout glade proper.
 **Solidago speciosa* Nutt. - Showy Goldenrod. Infrequent in glade proper.
 **Solidago ulmifolia* Muhl. - Elm-leaved Goldenrod. Common throughout glade proper.

Berberidaceae

Podophyllum peltatum L. Mayapple. Locally frequent in moist adjacent woods.

Bignoniaceae

Campsis radicans (L.) Seem. - Trumpet Creeper. Infrequent.

*Boraginaceae

**Myosotis verna* Nutt. - Scorpion Grass. Frequent.

Brassicaceae

- Arabis laevigata* (Muhl.) Poir. - Smooth Rock Cress. Infrequent to locally frequent.
Arabis canadensis L. - Sicklepod. Uncommon to rare in glade proper.
 +*Barbarea vulgaris* R.Br. - Yellow Rocket. Infrequent to locally frequent.
Cardamine hirsuta L. - Spring Cress. Common.
 +*Descurainia sophia* (L.) Webb. Tansy Mustard. Uncommon in glade proper.
Dentaria laciniata Muhl. - Tooth-wort. Common in adjacent woods.
Lepidium virginicum L. - Common Pepper Grass. Common throughout glade proper.

Campanulacea

Lobelia inflata L. - Indian Tobacco. Infrequent.

Caprifoliaceae

- +*Lonicera japonica* Thunb. - Japanese Honeysuckle. Infrequent in glade proper.
Symphoricarpos orbiculatus Moench. - Coralberry. Common in glade proper.
Triodanis perfoliata (L.) Nieuwl. - Venus' Looking-glass. Common in glade proper.
Viburnum prunifolium L. - Black Haw. Infrequent in glade proper.

Caryophyllaceae

Paronychia fastigata (Raf.) Fern. - Forked Chickweed

*Cesalpiniaceae

- **Cassia fasciculata* Michx. - Partridge Pea. Common to frequent in glade proper.
Cassia nictitans L. - Wild Sensitive Plant. Infrequent in glade proper.
Cercis canadensis L. - Redbud. Common in adjacent woods and rare in glade proper.
Gleditsia triacanthus L. - Honey Locust. Infrequent along ridgetop.

Celastraceae

Euonymus atropurpurea Jacq. - Wahoo. Frequent to locally common in glade proper.

*Cistaceae

**Lechea tenuifolia* Michx. - Narrow-leaved Pinweed. Locally frequent in glade proper.

Cornaceae

Cornus florida L. - Flowering Dogwood. Frequent in adjacent woods.

*Corylaceae

- **Ostrya virginiana* (Mill.) K. Koch. - Hop Hornbeam. Common in adjacent woods and infrequent in glade proper.
Carpinus caroliniana Walt. - Ironwood. Common in adjacent woods.

Ebenaceae

Diospyrus virginiana L. - Common Persimmon. Common in adjacent woods and infrequent in glade proper.

*Ericaceae

**Vaccinium arboreum* Marsh - Farkleberry. Common throughout glade, especially near upper slopes.

Vaccinium pallidum Ait. - Low-bush Blueberry. Common throughout glade, especially near upper slopes.

*Euphorbiaceae

**Acalypha gracilens* Gray. - Slender Three-seeded Mercury. Common throughout glade proper.

Chamaesyce sp. S.F. Gray. - Spurge. Infrequent throughout glade.

Croton monathogynus Michx. - Croton. Locally common in glade proper.

**Euphorbia corrollata* L. - Flowering Spurge. Frequent throughout glade proper.

*Fabaceae

Amphicarpa bracteata (L.) Fern. - Hog Peanut. Locally frequent otherwise infrequent in glade proper.

Clitoria mariana L. - Butterfly Pea. Rare in glade proper.

Dalea purpurea Vent. - Purple Prairie Clover. Infrequent throughout glade proper and locally frequent in adjacent open woods..

**Desmodium canescens* (L.) DC. Hoary Tick Trefoil. Infrequent in glade proper.

Desmodium laevigatum (Nutt.) DC. - Tick Trefoil. Common in adjacent woods.

Desmodium nudiflorum (L.) DC. - White-flower Tick Trefoil.. Common in adjacent woods.

Desmodium paniculatum (L.) DC. - Panicked Tick Trefoil. Infrequent.

Galactia regularis (L.) BSP. - Milk Pea. Locally frequent in glade proper.

+*Kummerowia striata* (Thunb.) Schindl. - Japanese Bush Clover. Common to frequent in glade proper.

Lespedeza hirta (L.) Hornem. - Hairy Bush Clover. Locally common to frequent in glade proper.

**Lespedeza procumbens* Michx. - Trailing Bush Clover. Locally common to frequent in glade proper.

**Lespedeza repens* (L.) Bart. - Creeping Bush Clover. Frequent in glade proper.

Lespedeza Xsimulata Mack. & Bush. - Bush Clover. Infrequent in glade proper.

**Lespedeza virginica* (L.) Britt. - Slender Bush Clover. - Infrequent to uncommon in glade proper.

**Stylosanthes biflora* (L.) BSP. - Pencil flower. Locally common to frequent in glade proper.

**Tephrosia virginiana* (L.) Pers. - Goats'-rue. Locally common in glade proper.

*Fagaceae

Quercus alba L. - White Oak. Common in adjacent woods and infrequent in glade proper.

**Quercus coccinea* Muenchh. - Scarlet Oak. In frequent.

**Quercus marilandica* Muenchh. - Blackjack Oak. Common in glade proper.

**Quercus prinoides* Willd. var. *acuminata* (Michx.) Gl. - Yellow Chestnut Oak. Uncommon and Rare.

**Quercus rubra* L. - Northern Red Oak. Common in adjacent woods and infrequent in glade proper.

**Quercus stellata* Wangh. - Post Oak. Common in glade proper.

**Quercus velutina* Lam. - Black Oak. Common in adjacent woods and infrequent in glade proper.

*Hypericaceae

Hypericum drummodii (Grev. & Hook.) Torr. & Gray. - Nits-and-Lice. Frequent in glade proper.

Hypericum punctatum Lam. - Spotted St. John's-wort. Frequent in glade proper.

**Hypericum stragulum* P. Adams & Robson. - St. Andrews' Cross. Infrequent in glade proper.

*Juglandaceae

Carya glabra (Mill.) Sweet. - Pignut Hickory. Common throughout.

Carya ovalis (Wang.) Sarg. - Sweet Pignut Hickory. Frequent throughout.

**Carya ovata* (Mill.) K. Koch. - Shagbark Hickory. Common throughout.

- **Carya texana* Buckl. - Black Hickory. Uncommon.
- **Carya tomentosa* (Poir.) Nutt. - Mockernut Hickory. Uncommon.
- **Juglans nigra* L. - Black Walnut. Uncommon in adjacent woods and rare in glade proper.

*Lamiaceae

- Blephilia hirsuta* (Pursh) Benth. - Pagoda Plant. Infrequent in adjacent woods.
- **Cunila organoides* (L.) Britt.) - Dittany. Common throughout.
- Hedeoma pulegioides* (L.) Pers. - American Pennyroyal. Infrequent in glade proper and locally frequent in adjacent open woods.
- Monarda fistulosa* L. Wild Bergamont. Locally frequent in adjacent woods.
- +*Prunella vulgaris* L. - Self-heal. Locally common in adjacent open woods.
- Pycnanthemum tenuifolium* Schrad. - Slender Mountain Mint. Common throughout.

Lauraceae

- Sassafras albidum* (Nutt.) Nees. - Sassafras. Common in adjacent woods.

*Menispermaceae

- **Menispermum canadense* L. - Moonseed. Uncommon in shale glade.

*Oleaceae

- **Fraxinus americana* L. - White Ash. Common in adjacent woods.

*Oxalidaceae

- **Oxalis stricta* L. - Yellow Wood Sorrel. Common throughout glade proper.
- **Oxalis violacea* L. - Purple Oxalis. Common throughout glade proper.

Papaveraceae

- Corydalis flavula* (Raf.) DC. - Pale Corydalis. Infrequent in adjacent woods.

Passifloraceae

- Passiflora lutea* var. *glabriflora* Fern. - Small Passion-flower. Infrequent, but locally frequent.

Phrymaceae

- Phryma polystacha* L. Lopseed. Somewhat frequent in adjacent woods and ridgetop.

Phytolaccaceae

- Phytolacca americana* L. - Pokeweed. Locally common in disturbed areas throughout glade.

Plantaginaceae

- +*Plantago major* L. - Common Plantain. Infrequent.
- +*Plantago rugelii* Dcne. - Rugel's Plantain. Infrequent.
- Plantago virginica* L. - Dwarf Plantain. Locally frequent in glade proper.

Polemoniaceae

- Phlox divaricata* L. spp. *laphamii* (Wood) Wherry. - Phlox. Locally frequent in adjacent moist woods.

Polygalaceae

- Polygala verticillata* L. - Whorled Milkwort. Locally infrequent in glade proper.

*Primulaceae

- **Dodecatheon meadii* L. - Shooting-star. Locally frequent between mid slope to upper slopes.

Ranunculaceae

- Ranunculus hispidus* var. *marilandicus* (Poir.) L. Benson. - Bristly Buttercup. Common.
- Ranunculus fascicularis* Muhl. - Early Buttercup. Common.

*Rosaceae

- **Amelanchier arborea* (Michx. f.) Fern. - Shadbush. Infrequent.
- Agrimonia rostellata* Wallr. - Woodland Agrimony. Locally frequent.
- Crataegus pruinosa* (Wendl.) K. Koch. - Hawthorn. Infrequent throughout.
- Geum canadense* Jacq. - White Avens. Locally frequent.
- Potentilla simplex* Michx. - Common Cinquefoil. Frequent throughout glade proper.
- **Prunus serotina* Ehrh. - Wild Black Cherry. Frequent in adjacent woods and infrequent in glade proper.
- **Rosa carolina* L. - Pasture Rose. Common to locally frequent throughout glade proper.
- Rubus* sp. Common to locally frequent.

*Rubiaceae

- Galium aparine* L. - Goosegrass. Frequent throughout.
- **Galium circaezans* Michx. - Wild Licorice. Frequent throughout.
- **Galium concinnum* L. Torr. & Gray. - Shining Bedstraw. Infrequent.
- Galium pilosum* Ait. - Hairy Bedstraw. Infrequent.
- Hedyotis longifolia* (Gaertn.) Hook. - Long-leaved Bluets. Locally frequent.
- Hedyotis purpurea* (L.) Torr. & Gray. - Broad-leaved Bluets. Locally frequent.
- **Hedyotis nigricans* (Lam.) Fosberg. - Narrow-leaved Bluets. Infrequent.

*Saxifragaceae

- **Heuchera americana* L. var. *hirsuticaulis* (Wheelock) Rosend., Butt & Lak. - Tall Alumroot. Common on moist slopes.

*Scrophulariaceae

- **Agalinis tenuifolia* (Vahl) Raf. - Slender False Foxglove. Locally frequent otherwise absent.
- Penstemon digitalis* Nutt. - Foxglove Beardstongue. Locally frequent otherwise absent.
- **Penstemon pallidus* Small. - Pale Beardstongue. Locally frequent otherwise absent.
- Teucrium canadense* L. var. *virginicum* (L.) Eat. - American Germander. Locally frequent near ridgetop otherwise absent.
- +*Verbascum thapsus* L. - Woolly Mullein. Common in disturbed areas.

*Solanaceae

- **Physalis pubescens* L. - Annual Ground Cherry. Infrequent to locally frequent in glade proper.

*Ulmaceae

- **Ulmus alata* Michx. - Winged Elm. Common.
- **Celtis tenuifolia* Nutt. - Dwarf Hackberry. Infrequent.

Urticaceae

- Parietaria pensylvanica* Muhl. - Pellitory. Locally frequent.

Valerianaceae

- Valerianella radiata* (L.) Dufr. - Corn Salad. Common in glade proper.

Violaceae

- Hybanthus concolor* (T.F. Forst.) Spreng. - Green Violet. Common along lower slopes, otherwise absent.
- Viola pubescens* Ait. Var. *eriocarpa* (Schwein.) Russell. - Smooth Yellow Violet.
- Viola rafinesquii* Green - Johnny-jump-up. Common throughout.
- Viola triloba* Schwein - Cleft Violet. Common throughout.

*Vitaceae

- **Parthenocissus quinquefolia* (L.) Planch. - Virginiana Creeper. Locally frequent in glade proper and adjacent woods.
- Vitis aestivalis* Michx. - Summer Grape. Infrequent in glade proper and common in adjacent

woods.

**Vitis cinerea* Engelm. - Winter Grape. Infrequent in glade proper and common in adjacent woods.

APPENDIX D. Raw data of soil depths (cm) for Shale Glade Communities
Union County, Illinois.

Plot	Site			
	Berryville 1996	Brown 1996 Old	Brown New1996	McClure 1996
1a	5.5	29.3	37.9	7.5
1b	11	8	45.5	6.3
1c	1	5.2	45.6	0.5
1d	9	6	50.2	4.9
2a	0.5	8.4	7	2.6
2b	4	1	27.9	10
2c	5.2	11.1	14.7	3.1
2d	1.5	7.5	33	6
3a	5	18.2	31	1.3
3b	0.1	16.5	12.9	3.8
3c	7.5	23.8	19.5	4.5
3d	4.4	0.5	20.8	3.1
4a	4.8	5.8	38	1.5
4b	10.5	8.5	27	1
4c	6	3.4	4	4.8
4d	8.8	7.6	45	5.5
5a	8.5	8	14	3.1
5b	17.5	0.5	9.2	12
5c	0.5	1	0.5	6.5
5d	14.4	7	11.2	4.6
6a	6	7.7	16	9.4
6b	6.2	13.8	14.2	5.5
6c	18.3	15.3	4.2	2.5
6d	31	12.2	7.8	2.8
7a	2.5	3.5	4.5	0.1
7b	6	17	7.1	0.4
7c	3.5	15.3	19.8	0.6
7d	3.5	4.8	28.8	5
8a	24.9	4.6	11.3	4
8b	11	0.5	8.2	3.8
8c	7.3	7	8.5	0.1
8d	9	19.3	24	4.5
	1988	1988	na	1988
mean value	10	6	na	5.5
mean value	13.5	8.5	na	4.5
mean value	6	9	na	5
mean value	6	9	na	6
mean value	7	7	na	6.5

Appendix E. Raw data table for soil chemical attributes for Berryville Shale Glade, Union County, Illinois (1988 and 1996).

Sample	1988	1996 one	1996 two	1996 three	1996 four	1996 five	1996 six	1996 seven	1996 eight	1996 b20m	1996 b60L	1996 b100L	1996 b100
Soil Attribute													
pH	4.9	4.5	4.6	4.5	4.6	4.3	4.6	4.4	4.7	4.6	5.1	5.8	4.7
Buff pH	na	7.64	7.57	7.59	7.75	7.6	7.66	7.63	7.7	7.6	7.7	7.75	7.72
P (meq/100g)	7	14	25	14	8	11	20	13	10	13	32	13	14
K (meq/100g)	115	82	107	78	48	59	85	67	54	87	123	113	69
Ca (meq/100g)	390	251	415	292	134	188	271	186	195	364	867	1716	210
Mg (meq/100g)	28	37	61	35	25	35	116	43	38	72	113	203	48
Organic (%)	4.1	4.4	5.9	4.3	3.4	6.6	4.1	3.1	3.2	3.5	3.9	3.5	3.4
Org ENR (%)	na	132	162	130	112	176	126	106	108	114	122	114	112
CEC	4.4	3.5	5.1	3.8	1.8	3.4	4.7	3.2	2.4	4.8	7.4	10.6	2.8
CS %K	6.7	5.6	5.1	4.9	6.4	4.2	4.4	5	5.4	4.4	4	2.6	5.9
CS %Ca	44	28.3	32.1	30.4	29.4	21.8	22.8	23	32.1	30	46.3	63.9	29.6
CS %Mg	5.3	8.1	9.2	7.1	10.6	7.9	18.9	10.3	12.1	11.5	11.7	14.7	13.1
CS %H	44	58.1	54.4	58.5	54.6	65.8	54.1	62.5	50.7	53.8	38	19	49.7

Appendix F. Raw data for soil chemical attributes for Brown Shale Glade, Union County, Illinois (1988 and 1996).

Sample	1996 new1a	1996 new1b	1996 new1c	1996 new1d	1996 new2a	1996 new2b	1996 new2c	1996 new2d	1996 new3a	1996 new3b	1996 new3c	1996 new3d	1996 new4a	1996 new4b
Soil Attribute														
pH	4.7	4.9	4.8	4.8	5.2	5.1	5.1	5.4	5.4	5.3	5.1	5.1	4.8	4.7
Buff pH	6.48	6.57	6.59	6.6	6.54	6.54	6.57	6.63	6.53	6.54	6.59	6.6	6.58	6.43
P (meq/100g)	11	10	15	13	10	12	10	11	32	25	19	16	7	6
K (meq/100g)	134	143	152	145	205	184	198	204	173	175	170	166	158	177
Ca (meq/100g)	950	903	791	740	1544	1195	1339	1452	1240	1235	784	852	689	649
Mg (meq/100g)	214	223	185	192	283	216	240	212	184	180	161	177	202	214
Organic %	2.9	2.4	3.2	2.9	3.8	3.2	2.9	3.1	4.1	3.8	3	3.2	2.7	2.6
Org ENR %	102	92	108	102	120	108	102	106	126	120	104	108	98	96
CEC %	11.5	10	9.3	9	13.4	11	12.3	11	9.4	9.7	7.6	8.3	8.8	9.4
CS %K	2.8	3.4	3.9	3.9	3.7	4	3.9	4.5	4.4	4.3	5.4	4.8	4.3	4.5
CS %Ca	32.6	35.7	33.6	32.5	45.5	42.9	43	52.1	52.1	50.3	40.7	40.5	30.9	27.3
CS %Mg	14.3	17.1	15.3	16.4	16.2	15.1	15	14.8	15	14.2	16.2	16.3	17.6	17.5
CS %H	50.7	44.2	46.8	46.7	34.4	38	37.9	28.5	28.5	30.9	38.2	37.8	46.9	50.3

Sample	1988	1996 old1a	1996 old1b	1996 old1c	1996 old1d	1996 old2a	1996 old2b	1996 old2c	1996 old2d	1996 old3a	1996 old3b	1996 old3c	1996 old3d	1996 old4a	1996 old4b
pH	5.48	4.9	5	5.3	5.2	5	5.2	5.2	5.1	5.4	5.2	5.2	5.1	5.1	5.1
Buff pH	na	6.49	6.55	6.67	6.66	6.7	6.58	6.43	6.57	6.58	6.63	6.54	6.38	6.57	6.64
P (meq/100g)	4.4	6	10	13	8	8	17	27	11	23	22	38	44	28	25
K (meq/100g)	153	176	156	186	189	213	214	202	221	185	178	185	185	160	170
Ca (meq/100g)	906	1005	891	1000	1109	1019	963	907	1046	1029	866	992	907	826	897
Mg (meq/100g)	133	347	246	260	311	258	241	205	251	231	203	143	155	165	136
Organic %	78	2.9	3	2.5	2.3	2.3	2.9	2.9	3	3.1	2.7	5.9	4.3	3.2	3
Org ENR %	na	102	104	94	90	90	102	102	104	106	98	162	130	108	104
CEC %	8.04	12.6	9.8	9.3	11	11	9.4	8.6	10.6	8.8	8.3	8.3	8.4	7.9	8.1
CS %K	5.02	3.4	3.8	4.8	4.1	4.7	5.5	5.7	5	5.1	5.2	5.4	5.3	4.9	5.1
CS %Ca	51.3	31.5	35.9	42.5	39.8	36.6	40.5	41.7	39	46.2	41.2	47.2	42.7	41.3	43.7
CS %Mg	14.48	21.1	19.2	21.4	21.7	18	19.7	18.3	18.2	20.1	18.8	13.2	14.1	16	12.9
CS %H	29.2	44	41	30.9	34.6	41.2	34.6	34.5	38.1	28.5	34.3	34.7	38.1	38.1	37.8

1996 new4c	1996 new4d	1996 new5a	1996 new5b	1996 new5c	1996 new5d	1996 new6a	1996 new6b	1996 new6c	1996 new6d	1996 new7a	1996 new7b	1996 new7c	1996 new7d	1996 new8a	1996 new8b	1996 new8c	1996 new8d
4.9	4.8	5.4	5.1	5.4	5.2	5.2	5	5.4	5.1	4.8	5	5.1	4.9	4.5	4.7	5.7	4.8
6.5	6.47	6.59	6.61	6.57	6.5	6.59	6.59	6.66	6.57	6.53	6.6	6.55	6.49	6.47	6.57	6.65	6.62
6	7	32	36	35	28	20	28	29	33	16	18	10	11	29	26	40	22
191	165	186	192	208	210	174	182	188	193	184	201	193	221	190	155	189	180
1192	576	1232	970	1135	1198	928	678	947	720	871	910	1005	819	509	418	1311	514
254	190	128	114	140	115	88	97	129	93	147	196	258	238	75	56	103	64
2.9	2.2	4.7	4	3.7	4.6	3.5	3	3.5	3.6	3.4	2.9	2.9	2.2	3.1	3.2	4.1	3.2
102	88	138	124	118	136	114	104	114	116	112	102	102	88	106	108	126	108
12.2	7.8	8.8	8.3	8.5	9.3	7.3	6.5	7.2	6.5	9.5	9.5	10.3	10	7.2	5	8.1	5.6
3.8	5.1	5.1	5.6	5.9	5.4	5.7	6.7	6.3	7.2	4.7	5.1	4.5	5.3	6.4	7.5	5.6	7.7
36.5	29.2	55.3	46.2	52.7	50.9	50.2	41.2	52	43.8	36.2	37.8	38.5	32.4	27.9	33	63.9	36.3
16	18.7	11.2	10.5	12.6	9.5	9.2	11.4	13.7	11	11.9	15.8	19.2	18.2	8	8.6	9.7	8.8
44.1	46.9	28.5	38.2	28.4	34.7	34.3	41.3	28.7	37.9	46.8	40.8	38.2	43.9	58.4	50.1	21.1	46.8
1996 old4c	1996 old4d	1996 old5a	1996 old5b	1996 old5c	1996 old5d	1996 old6a	1996 old6b	1996 old6c	1996 old6d	1996 old7a	1996 old7b	1996 old7c	1996 old7d	1996 old8a	1996 old8b	1996 old8c	1996 old8d
5	5.4	5.1	5.1	5.2	5.4	4.8	4.6	4.8	5	4.8	4.6	4.7	4.9	5.1	5	4.6	4.5
6.66	6.53	6.54	6.57	6.58	6.66	6.52	6.21	6.51	6.57	6.51	6.44	6.36	6.54	6.57	6.56	6.35	6.44
28	31	14	22	37	18	23	18	21	23	18	12	19	12	18	22	18	16
189	222	160	160	172	170	149	138	155	133	137	129	124	131	185	170	126	113
919	1613	921	894	882	961	657	437	755	526	539	462	588	741	896	770	388	386
131	222	228	179	172	198	123	90	185	142	143	132	133	196	229	197	117	122
3.1	3.8	2.4	2.7	3.7	3.3	3.2	3.3	3.6	2.9	2.9	2.5	2.9	2.6	2	3.5	3.2	2.8
106	120	92	98	118	110	108	110	116	102	102	94	102	96	84	114	108	100
8.6	12	9.3	8.5	8	8	7.4	6	9	5.9	6.7	6.8	7.4	8.5	9.3	8.4	5.9	6.5
5.3	4.5	4.1	4.5	5.2	5.1	4.9	5.5	4.2	5.4	4.9	4.6	4	3.7	4.8	4.9	5.1	4.2
42.2	53.1	39.1	41.5	43.5	47.4	35.1	28.8	33.1	35.2	31.8	26.8	31.4	34.4	38.1	36.2	26	23.5
11.7	14.2	18.8	16.1	16.5	19	12.7	11.5	15.8	18.5	16.4	14.9	13.8	17.7	18.9	18	15.2	14.4
41.1	28.6	38	38.1	34.3	28.5	46.7	53.8	47	41.1	47.1	54.3	50.2	43.9	37.8	41	54.4	58

1996	1996	1996	1996
bba23	bba17	bba9	bba7
5	4.9	4.9	4.9
7.56	7.51	7.64	7.55
18	14	15	21
75	78	77	82
492	671	361	488
143	169	116	131
2.7	3.7	3.4	3.4
98	118	112	112
5.5	7.4	4.5	5.6
3.3	2.5	4.1	3.5
35.3	35.8	31.7	34.4
19.9	17.5	19.8	17.9
40.7	43.9	43.7	43.9

Appendix G. Raw data for soil chemical attributes for McClure School Shale Glade, Union County, Illinois (1988 and 1996).

Sample	1988	1996	1996	1996	1996	1996	1996	1996	1996	1996	1996	1996	1996
		one	two	three	four	five	six	seven	eight	ma16	ma12	ma13	ma9
Soil													
Attribute													
pH	4.9	4.8	4.7	5	4.8	4.6	4.9	6.4	5	5	4.7	4.5	4.6
Buff pH	na	7.59	7.7	7.64	7.63	7.61	7.78	7.79	7.66	7.74	7.77	7.56	7.61
P (meq/100g)	7	30	26	30	42	26	21	14	23	20	23	27	24
K (meq/100g)	128	68	66	109	105	70	74	179	134	88	60	79	71
Ca (meq/100g)	350	539	380	1025	790	358	910	2954	1136	528	245	243	243
Mg (meq/100g)	67	71	53	140	104	61	91	166	135	74	39	39	42
Organic (%)	3.2	5.2	4.9	6.1	8.6	5.2	4.6	5.1	5.8	4.1	4.1	5.7	3.3
Org ENR (%)	na	148	142	166	216	148	136	146	160	126	126	158	110
CEC %	4.7	5.4	4.2	9.1	7.9	4.5	8	14.7	9.9	4.9	2.9	3.5	3.2
CS %K	7	3	3.8	2.9	3.2	3.7	2.2	2.9	3.3	4.3	5	5.4	5.3
CS %Ca	37.1	39.4	35.7	44.5	39.5	31.4	44.9	79.4	45.3	42.6	33.4	27.4	30
CS %Mg	11.9	10.1	9.7	11.8	10.1	10.4	8.7	8.7	10.5	11.6	10.3	8.5	10.1
CS %H	44	46.6	50.2	41.1	46.8	53.5	43.9	9	41	40.6	49.7	57.2	53.3

Appendix H. Species % cover values for 1988 and 1996, Berryville shale glade, Union County, Illinois.

The first four letters of the species and the last three represent the first four letters of the genus name and last three represent the first three letters of the specific epithet (Appendix A).

Species	acal gra	andr sco	ante pla	aris dic	aste pat	bric eup	celt ten	cuni org	dant spi	dica lax	euph cor	heli div	jugl nig	
Sample														
1 1988		0	0.5	0	0	0	0	0	0	0.5	0	0	0	0
2 1988		0	0.5	0	0	0	0	0	0.5	0.5	0.5	0	0	0
3 1988		0	0	0	0	0	0	0	0	0.5	0	0.5	0	0
4 1988		0	0	0	0	0	0	0	0.5	0.5	0	0	0	0
5 1988		0	0	0	0	0	0	0	0.5	0.5	0	0	0.5	0
6 1988		0	0	0	0	0	0	0	0.5	0.5	0	0	0.5	0
7 1988		0.5	0.5	0	0	0	0	0	0.5	0.5	0	0.5	0.5	0
8 1988		0	0.5	0	0.5	0	0	0	0.5	0.5	0	0	0	0
9 1988		0	0	0.5	0	0	0	0	0.5	0.5	0	0	0.5	0
10 1988		0.5	0	0.5	0	0.5	0	0	0.5	0.5	0	0.5	0.5	0
11 1988		0	0.5	0.5	0	0	0	0	0.5	0.5	0	0	0.5	0
12 1988		0	0.5	0.5	0	0.5	0	0	0.5	0.5	0	0.5	0.5	0
13 1988		0.5	0.5	0	0	0	0	0	0.5	0.5	0	0	0.5	0
14 1988		0.5	0	0.5	0	0	0	0	0.5	0.5	0	0.5	0.5	0.5
15 1988		0.5	0.5	0	0	0	0	0	0.5	0.5	0	0.5	0.5	0
16 1988		0	0	0	0	0	0	4	0.5	0.5	0	0	0.5	4
17 1988		0.5	0	0	0	0	0.5	4	0.5	0.5	0	0.5	4	0
18 1988		0.5	0	0	0	0	0	0.5	0.5	0.5	0	0.5	4	0
19 1988		0	0	0	0	0	0	0	0.5	0.5	0	0	0.5	0
20 1988		0	0	0	0	0	0	0	0.5	0.5	0	0	0.5	0
21 1988		0	0	0	0	0	0	0	0.5	0.5	0	0.5	0.5	0
22 1988		0	0	0	0	0	0	0	0.5	0.5	0	0.5	0	0
23 1988		0	0	0	0	0	0	0	0.5	0.5	0	0	0	0
1 1996		0	0	0	0	0	0	0	4	16	0	0	0.5	0
2 1996		0	0	0	0	0	16	0.5	0	0	0	0	4	37.5
3 1996		0	0	0	0	0	0	0	4	4	0	0	0	0
4 1996		0	0	0	0	0	0	0	0.5	4	0	0	0	0
5 1996		0.5	0	0	0	0	0	0	4	16	0.5	0	62.5	0
6 1996		0.5	4	0	0	0	0	0	16	37.5	0	0.5	4	0
7 1996		0	16	0	0.5	0	0	0	16	16	0	4	0.5	0
8 1996		0	4	4	0	0.5	0	0	37.5	37.5	0	0	4	0

juni vir	lesp rep	lesp vir	moss	pens dig	quer ste	rhus aro	rosa car	soli nem	styl bif	teph vir	ulmu ala	vacc arb	
0	0.5	0	4	0	0	0	0	0	0	0	0.5	0	84
0	0.5	0	0.5	0	37.5	0	0	0	0	0	0.5	0	84
0	0.5	0	0.5	0	37.5	0	0	0	0	0	0.5	0.5	84
0	0	0	0.5	0	37.5	0	0	0	0	0	0.5	0	0
0	0.5	0	16	0	16	0	0	0	0	0	0.5	0.5	16
0	0	0	4	0	16	0	0	0	0	0	0	0	0.5
0	0.5	0	4	0	16	0	0	0	0	0.5	0.5	0	0.5
4	0	0.5	0.5	0	37.5	0	0	0	0	0	0.5	0.5	4
0	0.5	0	0.5	0	62.5	0	0	0.5	0.5	0.5	0	0.5	37.5
0	0.5	0	0.5	0	0.5	0	0	0	0.5	0.5	0	4	62.5
0	0.5	0	0.5	0	16	0	0	0	0.5	0.5	0	0	4
0	0.5	0	0.5	0	62.5	0	0	0	0.5	0.5	0	4	0
4	0	0	0.5	0.5	4	0	0	0	0.5	0	0	16	0.5
0	0	0	0	0.5	16	0	0.5	0	0	0	0	16	0
0	0	0	0	0	0	0	4	0.5	0.5	0	0	37.5	0
0	0	0	0	0	0	0	16	0.5	0	0	0	0	0
0	0	0	0	0	37.5	16	0	0	0	0	0	62.5	0
0	0	0	0.5	0.5	16	4	0	0	0	0	0	4	0
0	0.5	0	0	0.5	62.5	0.5	0	0	0	0	0	0	0
0	0.5	0	4	0	37.5	0	0	0	0	0	0	4	0
0	0	0	0	0	37.5	0	0.5	0	0	0	0.5	0	0
0	0	0	0	0	4	0	0	0	0	0	0	0	0
0	0	0	0	0	16	0	0	0	0	0	0.5	0	0
0	0	0	37.5	0	37.5	0	0	0	0	0	0	0	16
0	16	0.5	0	0	0	0	16	0	0	0	0	16	0.5
0	0	0	62.5	0	62.5	0	0	0	0	0	4	0	0
0	0	0	84	0	62.5	0	0	0	0	0	0.5	0	62.5
0	0	0	62.5	0	62.5	0.5	0	0	0	0	0.5	0	62.5
0	0	0	16	0	16	0.5	0	0	0	0.5	4	0.5	4
4	0	0	37.5	0.5	16	0	0	0	0	0.5	0.5	4	4
0	0	0	37.5	0	84	0	0	0	0.5	0	0.5	0	37.5

Appendix I. Species % cover values for old and new plots for 1988, 1993, and 1996, Brown shale glade, Union County, Illinois.

The first four letters of the species and the last three represent the first four letters of the genus name and last three represent the first three letters of the specific epithet (Appendix B).

Species	acal gra	acer rub	acer sac	achi mil	agal ten	ambr art	amel arb	andr sco	andr vir	ante pla	aris dic	ascl var	asim tri
Plot													
1old88	0	0	0	0	0	0	0	16	0	0	0	0	0
2old88	0	0	0	0	0	0.5	0	37.5	0	0	0	0	0
3old88	0	0	0	0	0	0.5	0	37.5	0	0	0	0	0
4old88	0	0	0	0	0	0.5	0	16	0	0	0	0	0
5old88	0	0	0	0	0	0.5	0.5	0.5	0	0	0	0	0
6old88	0	0	0	0	0	0.5	0	0.5	0	0	0	0	0
7old88	0	0.5	0	0	0	0.5	0.5	4	0	0	0	0	0
8old88	0	0	0	0	0	0.5	0.5	0.5	0	0	0	0	0
1old93	5.5	0	0	0	0	0	0	44.625	0	0	0	0	0
2old93	26.75	0	0	0	0	0	0	21.125	0	0	0	0	0
3old93	5	0	0	0	0	0.125	0	20.25	0	0	0	0	0
4old93	1.75	0	0	0	0	0	0	8.875	0	4.125	0	0	0
5old93	0.25	0	0	0	0	0	0	16	0	1	0	0	0
6old93	1.125	0	0	0	0.125	0.25	0	32.125	0	0.125	0	0	0
7old93	0.5	0	0	0	0	0.25	0	55.375	0	0	0.75	0	0
8old93	0.5	0	0	0	0	1.5	0	64.75	0	0	4.125	0	0
1old96	0.5	0	0	0.5	0	0	0	62.5	0	0	0	0	0
2old96	0.5	0	0	0	0	0	0	37.5	0	0	0.5	0	0
3old96	0.5	0	0	0	0	0.5	0	37.5	0	0	0	0	0
4old96	16	0	0	0	0	0	0	37.5	0	16	0	0	0
5old96	4	0	0	0	0	0	0	62.5	0	4	4	0	0
6old96	4	0	0	0	0	4	0	37.5	0	0	0	0	0
7old96	4	0	0	0	0	0.5	0	62.5	0	0	0	0	0
8old96	4	0	0	0	0	4	0	84	0	0	0.5	0	0
1new93	0.5	0	0	0	0	0	0	0	0	0	0	0	0
2new93	0.25	0.25	0	0	0	0	0	0	0	0	0	0	0
3new93	0.5	0	0	0	0	0	0	0.875	0	0	0	0	0
4new93	0.5	0	0	0	0	0	0	0	0	4.125	0	0	0

aspl pla	aste ano	aste lat	aste pat	aste tur	aster sp	blep hir	brom pub	c&mp rad	care art	care dig	care gla	care hir	care muh
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.5	0	0	0.5	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.5	0	0	0.5	0	0	0	0	0	0	0	0	0	0
0.5	0	0	0	0	0.5	0	0	0	0	0	0	0	0
0	0	0	0.5	0	0.5	0	0	0	0	0	0	0	0
0	0	0	0.5	0	0.5	0	0	0	0	0	0	0	0
0	0	0	0.5	0	0	0	0	0	0	0	0	0	0
0	16.375	0	8.75	0	0	0	0	0	0	0	0.125	0	0
0	0.875	0	9.625	0	0	0	0	0	0	0	0	0	0
0.875	0.875	0	2.375	0	0	0.125	0	0	4.875	0	0	0	0
0.5	2.375	0	0.25	0	0	0	0	0.125	1.125	0	0.875	0	0
0	0.25	0	0.875	0	0	0	0	0	0.5	0	0.125	0	0
1.625	0	0	0	0	0	0	0.125	0	9.5	0	1.625	0	0.25
0.125	0.125	0	0	0	0	0	0	0	9.5	0	1.75	0	0.125
0.125	0	0	0	0	0	0	0	0	3	0	0.25	0	0
0	0	0	16	0	0	0	0	0	4	0	4	0	4
0.5	0	0	4	0	0	0	0.5	0	4	0	4	0	0
0.5	0.5	0	16	0	0	0	0.5	0	37.5	0	0.5	0	0
0	0.5	0.5	0.5	0	0	0	0	0.5	62.5	0	16	0	0
0	4	0	4	0	0	0	0.5	0	16	0	4	0	4
0.5	0	0	4	0	0	0	0	0	16	0	4	0	4
4	0	0	4	0	0	0	0	0	4	0	4	0	0.5
0	0	0	0.5	0	0	0	0	0	16	0	4	0	0.5
0.125	0.25	0	0.125	0.125	0	0	0.375	0	0	0.125	0	0.125	0.375
0.875	4.375	0	0	0	0	0	0	0	0	0	0	0	0
0.5	0.375	0	0.125	0	0	0	0.25	0	0	0	0.125	0.25	0.25
6.25	1	0	0.25	0	0	0	0	0	5.625	0.375	0.125	0	0

crot mon	cuni org	cype ovu	cyso pro	dant spi	dica acu	dica bos	dica lax	dica lin	dica mic	dica sp.	dios vir	echi pal	elym can
0	0	0	0	0.5	0	0	0	0	0	0	0	0	0
0	0	0	0	0.5	0	0	0	0	0	0	0	0	0
0	0	0	0	0.5	0	0	0	0	0	0	0	0.5	0
0	0	0	0	0.5	0	0	0	0	0	0	0	0	0.5
0	0	0	0	4	0	0	0	0	0	0	0	0	0
0.5	0	0	0	4	0	0	0	0	0	0	0	0.5	0
0	0	0	0	4	0	0	0	0	0	0	0	0	0
0	0	0	0	16	0	0	0	0	0	0	0	0	0
0	0	0.125	0	16	32.125	0	13.375	0	0	0	0	0	0
8	0	0	0	61.625	20.25	0	29	0	0	0	0	0	0
18.125	0.75	0	0	33	5.625	0	23.5	0	0	0	0	0	0
0.125	0	0	0	22.125	0	0.125	5.625	0	0	0	0	0	0.75
0	0	0	0	26.75	1.125	0	6.25	0	0	0	0	0	0
0.375	0	0	0	4.375	5.625	0	9.5	0	0	0	0	0	0
0.125	0	0	0	0.875	5.625	2.375	0	0	0.125	0	0	0	0
0.25	0	0	0	0	1.125	5	0	0	0	0.125	0	0	0
0.5	0	0	0	4	4	4	16	0	0	0	0	0	0
4	0	0	0	16	4	16	4	0	0	0	0	0	0
16	0.5	0	0	16	4	0.5	37.5	0.5	0	4	0	0	0
16	0	0	0	37.5	16	0.5	16	16	0	0	0	0	16
0	0	0	0	37.5	4	0	16	16	0	0	0	0	0.5
4	0	0	0	37.5	4	0.5	37.5	16	0	0	0	0	0
0	0	0	0	16	4	4	16	16	0	0	0	0	0
0	0.5	0	0	4	4	4	16	4	0	16	0	0	0
0	0	0.125	0	0	0.375	1.75	1.125	0	0	0	0	0	0
0	0.25	0	0.25	4	2.25	13.625	0.875	0	0	0	0	0	0
0.125	0	0	0	27.625	0.5	0	1.125	0	0	0	0	0	0
0	0	0	0	38.375	1	4.125	1.125	0	0	0	0	0	0

elym vir	erec hie	erig str	euph cor	frax ame	gala reg	gali cir	geum can	gled tri	hede pul	heli div	heuc ame	hier gro	hier str
0	0	0.5	0	0	0	0	0	0	0	0	0	0	0
0	0	0.5	0	0	0	0	0	0	0	4	0	0	0
0	0	0	0	0	0	0	0	0	0	4	0	0	0
0	0	0	0	16	0	0	0	0	0	16	0	0	0
0	0	0	0	0	0	0	0	0	0	0.5	0	0	0
0	0	0.5	0.5	4	0	0	0	0	0	0.5	0	0	0
0	0	0.5	0.5	4	0	0	0	0	0	4	0	0	0
0	0	0.5	0	0	0	0	0	0	0	0.5	0	0	0
0	0.75	0	0	0	0	0	0	0	0	4.875	0	0	0
0	0	0	0.125	0	0	0	0	0	0	14.875	0	0	0
0	0	0	0.25	25	0	0	0	0	0	12.75	0	0	0
0	0	0	0.125	0.25	0	0.375	0	0	0	38.375	0	0	0
0	0	0	0	0	0	0	0	0	0	6.25	0	0	0
0	0	0	0	0	0.25	0.125	0	0.125	0	10.875	0	0	0
0	0	0	0	0	0	0	0	0	0.125	25.875	0	0	0
0	0	0.25	0	0	0	0	0	0	0.125	2.25	0	0	0
0	0	4	0.5	0	4	0	0	0	0	16	0	0	0
0	0	0.5	4	0	0	0	0	0	0	4	0	0	0
0	0	4	4	0	0	0	0	0	0	37.5	0	0	0
16	0	16	16	0.5	0.5	0	0	0	0	37.5	0	0	0
0	0	4	4	0	4	0	0	0	0	37.5	0	0	0
0	0	4	4	0	0.5	0	0	0	0	37.5	0	0	0
0	0	0	4	0	0	0	0	0	0	4	0	0	0
0	0	0	4	0	0	0	0	0	0	16	0	0	0
0.75	0	0	0	0.875	1.125	1.125	0	0	0	21.375	0.125	0	0
0	0	0	0	0	0	5.625	0	0	0	73.25	0	0	0
0	0	0	0.125	2.375	0.125	0.375	0	0	0	39.25	0	0.125	0
0	0	0	0	9.5	0	0.875	0	0	0	21.375	0	0	0

Hyp punc	junc int	juni vir	kumm str	lech ten	lesp pro	lesp vir	lichens	ligu vul	loni jap	manf vir	moss	muhl cap	muhl sob	
0	0	0	0	0	0	0	0	0	0	0.5	0	4	0	
0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	
0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	
0	0	0	0	0	0.5	0	0	0	0	0	0.5	4	0	
0	0.5	0	0	0	0.5	0	0	0	0.5	0	0	4	0	
0	0	0	0	0	0.5	0	0	0	0	0	0.5	0	0	
0	0	0	0	0	0.5	0	0	0	0	0.5	0.5	0	0	
0	0.125	0	0	0	0.875	0	0	0	0	0	1.75	0	0	
0	0	0	0	0	8.875	0	0	0	0	0	1	5.625	22.5	0
0	0.125	0	0	0	1	0	0	0	0	0	0	0.5	29.75	0.75
0	0.25	0	0.125	0.125	0	0	0	0	0	0	0	1.75	0	0
0	0	0	0	0	0.125	0	0	0	0	0	0	8.125	4.75	0
0	0.25	0	0	0.125	0.25	0	0	0	0	0	0	5	19.5	1.5
0	0	0.75	0	0.5	0.125	0	0.25	0	0.125	0	0	1.75	5.5	0
0	0.125	0	0.125	0.5	0	0	1.625	0	4.75	0.125	1.125	8.125	0	0
0	0	0	0.5	0	0.5	0	0	0	0	0	0	0	0	4
0	4	0	0	0	0.5	0	0	0	0.5	4	0.5	16	4	4
0	0.5	0	0.5	0.5	0	0	0	0	0	0	0	4	16	0
0	0.5	0	0	0.5	0	0	0	0	0	0	0	0	0.5	0
0	0.5	0	0.5	0.5	0.5	0	0	0	0	0	0	0	16	0.5
0.5	4	0	0.5	0	0	0	0	0	0	0	0	0	62.5	0.5
0	4	0	0	0	0	0	0	0	0	0	0	4	16	0.5
0	0.5	0	0	4	0	0	0	0	4	0	0	0	16	0
0	0.125	0	0	0	0	1	0	0	0	0	0	1.125	0	1.125
0	0	0	0	0	0	2.375	0	0	0	0	0	0.5	0	1.625
0	0	0.125	0	0	0	0.25	0	0	0.125	0	0	0.5	0	0.375
0	0	0	0	0	0	1.125	0	0	0	0	0	0.5	0	1

plan rug	plan vir	poly acr	poly ver	pote sim	prun ser	pyca ten	quer coc	quer imb	quer mar	quer pri	quer rub	quer ste	quer vel
0	0	0	0	0.5	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	4	0
0	0	0	0	0.5	0	0	0	0	0	0	0	16	0
0	0	0	0	0.5	0	0	0	0	0	0	0	16	0
0	0	0	0	0	0	0	0	0	0	0	0	0.5	0
0	0	0	0	0.5	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	37.5	0
0	0	0	0	0	0	0	0	0	0	0.5	0	37.5	0
0	0	0	0	0	0	14.25	0	0	0	0	0.875	19.625	0
0	0	0	0	0	0	4.875	0	0	0	0	0	45.375	0
0	0	0	0	0	0	0	0	0	0	0	0	12.75	0
0	0	0	0	0	0	0	0	0	0	0	0	56.25	0
0	0	0	0	0	0	0	0	0.125	0	0	0	12.75	0.25
0	0	0	0	0	0	0	0	0	0	0	0	46	0
0	0.125	0	0	0	0	0.125	0	0	0	0	0	25.125	0
0	0.375	0	0	0	0	0	0	0	0	0	0	22.625	0
0	0	0	0	0	0	16	0	0	0	0	0	4	0
0	0	0	0	0	0	4	0	0	0	0	0	37.5	0
0	0	0	0	0	0	0	0	0	0	0	0	16	0
0	0	0	0	0	0	0	0	0	0	0	0	16	0
0	0	0	0	0	0	0	0	0.5	0	0	0	16	0
0	0	0	0	0	0	0	0	0	0	0	0	4	0
0	0	0	0	0	0	0	0	0	0	0	0	16	0
0	0	0	0	0	0.5	0	0	0	0	0	0	16	0
0	0	0	0	0	0.125	5.625	0	0	0	0	0.125	36.875	0.125
0	0	0	0	0	0	21.375	0	0	0	0	0	41.375	1.75
0.125	0	0	0	0	0	0.375	0	0	0	0	0.125	61.625	0.25
0.125	0	0.125	0	0	0	0	0	0	0	0	9.625	67.875	0

rhus aro	rhus gla	ru db hir	ru el hum	ru el ped	sani can	smil spp	sol i can	sol i nem	sol i ulm	sporob.	stroph	styl bif	symp orb
0	0	0	0.5	0	0	0	0	0.5	0	0	0	0	0
0	0	0	0.5	0	0	0	0	0	0	0	0	0.5	0
0	0	0	0	0	0	0	0	0.5	0	0	0	0	0
0.5	0	0	0	0	0	0	0	0.5	0	0	0	0.5	0
0	0	0	0	0	0	0	0	0.5	0	0	0	0	0.5
0	0	0	0.5	0	0	0	0	0.5	0	0	0	0.5	0
0	0	0	0.5	0	0	0	0	0.5	0	0	0	0	0
0	0	0	0	0	0	0	0	0.5	0	0	0	0.5	0
0	0	0	0	0	0	0	0	12.75	0	0	0	0.125	0
0	0	0	0	0	0	0	0	11.625	0	0	0	0	0.75
0	0	0	0.125	0	0	0	0	18.125	0	0	0	0.75	0
0	0	0	0	0	0	0	0	2.375	0	0	0	0	0
0	0	0	0	0	0	0	0	5.625	0	0	0	0.25	0
0	0	0	0	0	0	0	0	12.75	0	0	0	1.75	0
0	0	0	0	0	0	0	0	26.75	0	0	0	1.5	0
0	0	0	0	0	0	0	0	3	0	0	0	1.75	0
0	0	4	4	4	0	0	0	16	16	0	0	0	0
0	0	0	4	0.5	0	0	0	16	4	0	0.5	0	0
0	0	0.5	4	4	0	0	4	16	4	0	0.5	4	0
0	0	0.5	0	0	0	0	16	16	16	0	0.5	0	0
0	0	0	0	0	0	0	0.5	16	4	0	4	0	0
0	0	0	0	0	0	0	0.5	16	4	0	0	0.5	0
0	0	0	0	0	0	0	4	16	16	0	0	0	0
0	0	0	0	0	0	0	4	0	4	0.5	0	0	0
0	0	0	0	0	0	0	0	0.125	9.5	0	0	0	0
0	0	0	0	0	0	0	0	8.875	0	0	0	0	0
0	0	0	0	0	0	0	0	4.75	4.75	0	0	0	0
0	0	0	0	0.125	0	0	0	1.125	0	0	0	0	0

trid fla	trio per	ulmu ala	vacc arb	vacc vac	verb tha	viol tri	viti aes	viti cin	wood obt
0	0	0.5	4	0	0	0	0	0	0
0	0	4	0.5	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	16	0	0	0	0	0	0	0
0	0	4	37.5	0	0	0	0	0	0
0	0	4	0.5	0	0	0	0	0	0
0	0	0.5	0	0	0.5	0	0	0	0
0	0	16	0	0	0	0	0	0	0
1.625	0	0.25	0	0	0	0	0	0	0
0.875	0	0.125	0	0	0	0	0	0	0
0.875	0.75	0.125	4	0	0	0	0	0	0
0.75	1	0.25	4.375	0	0	0	0	0	0
0.875	0	0	1.125	0	0	0	0	0	0
2.375	0.375	22	0	0	0	0	0	0	0.125
0.25	0	0.375	0	0	0	0	0	0	0
1	0.125	1	0	0	0	0	0	0	0
4	0.5	0.5	0	0	0	0	0	0	0
4	0.5	0	0	0	0	0.5	0	0	0
4	4	0.5	0.5	0	0	0	0	0	0
16	16	0.5	16	0	0	0	0	0	0
4	4	0	4	0	0	0	0	0	0
4	4	0.5	0.5	0	0	0	0	0	0.5
4	0.5	0.5	0	0	0	0	0	0	4
4	4	0	0	0	0	0	0	0	0
0	0	38.375	0	0	0	0	0.25	0	0
0.25	0	52.375	0	0	0	0	0	0	0
0	0	19.875	0	0	0	0	0	0	0.25
1.75	0	23.5	0	0	0	0	0	0	0.125

Ely & Gibson 89

5new93	0.5	0	0	0	0	0	0	0	0	0	0	0	0
6new93	0.5	0	0.75	0	0	0	0	0.375	0	0	0	0	0.375
7new93	0.5	0	0.25	0	0	0	0	4.125	0	0	0	0	0
8new93	0.25	0	0.125	0	0	0	0	0	0	4.25	0	0	0
1new96	4	0	0	0	0	0	0	4	0	0	0	0	0
2new96	0	0	0	0	0	0	0	4	0	0	0	0	0
3new96	4	0	0	0	0	0	0	16	0	0	0	0	0
4new96	4	0	0	0	0	0	0	4	0	4	0	0	0
5new96	4	0	0	0	0	0	0	4	0	0	0	0	0
6new96	0.5	0	0	0	0	0	0	4	0.5	0	0	0	0
7new96	4	0	0	0	0	4	0	16	0	0	0	0	0
8new96	4	0	0	0	0	0	0	4	0	4	0	0.5	0

Ely & Gibson 90

1.125	0.125	0	0	0	0	0	0	0	5.625	0	0	0	0
1.125	1.125	0	0	0	0	0	0	0	3	0	0	0	0.375
0.375	0.125	0	0.125	0	0	0	0	0	9.5	0	0	0	0.25
0.375	0.375	0	0	0	0	0	0	0	0.25	0	0	0	0
0	4	0	4	0	4	0	4	0	16	0	4	0	4
4	16	0	4	0	0	0	16	0	16	0	16	0	16
4	4	0	4	4	0	0	4	0	16	0	4	0	4
4	4	0	4	0.5	0	0	0	0	16	0	4	0	4
0.5	0.5	0	0.5	0	0	0	0.5	0	16	0	0.5	0	4
4	16	0	0.5	0	0	0	0	0	16	0	0	0	4
0	0	0	4	0	0	0	0	0	16	0	4	0	4
4	4	0	4	0	0	0	0	0	37.5	0	4	0	4

Ely & Gibson 92

0	0	0	0	4.75	0.5	1	1.125	0	0	0	0	0	0
0.75	0.125	0	0	18.125	0.5	1	1	0	0.125	0	0	0	0
0	0	0	0	0.25	0.5	0	1.125	0	0	0	0	0	0
0	0	0	0	6.25	0.375	1	12.75	0	0	0	0	0	0
0	0	0	0	4	4	4	16	4	0	0	4	0	4
0	0	0	0	16	4	16	16	16	0	0	0.5	0	0
0	0	0	0	37.5	4	4	16	4	0	0	0.5	0	0
0	0	0	0	37.5	4	4	16	4	0	4	0.5	0	0
0	0	0	0	37.5	4	16	16	4	0	0	4	0	0
0	0.5	0	0	16	4	4	4	4	0	0	4	0	0
0	0.5	0	0	4	4	4	16	16	0	0	0	0	0
0	0	0	0	37.5	4	4	4	16	0	0	4	0	0

Ely & Gibson 93

0	0	0	0	0	0	0.5	0	0	0	14.25	0	0	0
0	0	0	0	4.875	0.375	0.375	0.125	0.125	0	6.25	0	0	0.875
0	0	0	0	0.25	0.125	0.25	0	0	0	2.375	0	0	0
0	0	0	0	0	0	0.375	0	0	0	6.25	0	0	0
0	0	0.5	4	0	0	0	0	0	0	62.5	0	0	0
0	0	4	16	0	0	0	0	0	0	62.5	0	0	0
0	0	0	4	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	62.5	0	0	0
0	0	0	0	0	0	0	0	0	0	37.5	0	0	0
0	0	0	0	0	0	0.5	0	0	0	37.5	0	0	0
0	0	0	4	0	0	0	0	0	0	37.5	0	0.5	0
0	0	0	0	0	0	0	0	0	0	16	0	0	0

Ely & Gibson 94

0	0	0.125	0	0	1	0	0	0	0	0	0.5	0	0.125
0	0	0	0	0	1.125	0	1.75	0	0.25	0	21.375	4.75	1.75
0	0	0	0	0.125	0.25	0	0	0	0.25	0	0.25	0	12.125
0	0	0	0	0	0.5	0	0	0	0	0	26.75	1	0.25
0	0.5	0	0.5	0.5	0	0	0	0	0	0	4	0	4
0	0	0	0	0	0	0.5	0	0	0	0	16	0.5	16
0	0.5	0	0	0	0	0	0	0	0	0	4	4	4
0	0.5	0	0	0	0	0	0	0	0	0	4	0.5	4
0	0	0	0	0.5	0	0	0	0	0	0	4	4	4
0	0	0	0	0	0	0	0	0	0.5	0	4	4	4
0	0.5	0	0	0.5	0	0	0	0	0	0	0	0.5	16
0	0	0	0	0.5	0	0	0	0	0	0	16	0	0.5

Ely & Gibson 95

0.125	0.125	0	0	0	0	0	0	0	0.375	0	0	0	0	0
5	0.375	0	0	0	0	0	0	0	0.25	0	0	0	0	0
0.375	0.25	0	0	0	0	0	0	0	0.25	0	0.125	0	0	0
1.75	0	0	0	0	0	0	0	0	0.25	0	0.25	0	0	0
0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	4	0	0	0	0	0	0	0	0	0.5	0	0
0	0	0	0	0.5	0	0	0	0	0	0	0	0.5	0	0
0	4	0	4	0	0	4	0	0	0	0	0	0	0	0
0	0	0	4	0.5	0	0	0	0	0	0	0	0	0	0
0	0.5	0	16	0	0	0	0	0	0	0	0	0.5	0	0
0	0	0	4	0	0	4	0	0	0	0	0	0	0	4

Ely & Gibson 96

0	0	0	0	0	0	0	0	0	0	0	0	0.25	31.25	0
0	0	0.125	0	0	0	0	0	0	0	0	0	0	46.75	0
0	0	0	0.125	0	0	0	0	0	0	40.625	0	0	29.125	0.125
0	0	0	0	0	0	0	0	0.25	0	0	0.125	0	18.125	0.375
0	0	0	0	0	0	16	0	0.5	0	0	0	0	84	0
0	0	0	0	0	0	16	84	0	0	0	0	0	0	0
0	0	0	0	0	0	4	0	0	0	0	0	0	16	0
0	0	0	0	0	0	0	0	0	0	0	0	0	84	0.5
0	0	0	0	0	0	0	0	0.5	0	0	0	0	16	0.5
0	0	0	0	0	0	0	0	0	0	0	0	0	62.5	0.5
0	0	0	0	0	0	0.5	0	0	0	0	0	0	37.5	0
0	0	0	0	0	0	0	0	0	0	0	0	0	62.5	0

Ely & Gibson 97

0	0	0	0	0	0	0.125	0	0.75	0	0	0	0	0
0	0	0	0	0	0	0.125	0.125	0.25	0	0	0	0.125	0
0	0	0	0	0	0.125	0	0	0.375	0	0	0	0.25	0
0	0	0	0	0	0	0	0	0.875	0	0	0	0	0
0	0	4	0	0	0	0	4	4	16	0	4	0	0
0	0	4	0.5	0	0	0	4	0.5	16	0	0	0	0
0	0	0.5	0	0	0	0	0.5	4	4	0	0	0	0
0	0	0	0	0	0	0	4	16	4	0	0	0	0
0	0	0	0	0	0	0	0	4	4	0	0.5	0	0
0	0	0	0	0	0	0	4	4	4	0	0	0	0
0	0	0	0	0	0	0	4	0.5	4	0	0	0	0
0	4	0	0	0	0	0	4	4	4	0	4	0	0

Ely & Gibson 98

0	0	61.625	0	0	0	0	0.25	0	0.125
0.375	0	67	0	0	0	0	0	0	0
0.125	0	44.625	5.625	0	0	0	0.125	0	0
0	0	96.5	0	0.125	0	0.875	0	0	0
4	4	0.5	0	0	0	0	0	0	0
0.5	0	0.5	0	0	0	0	0	0	0
0.5	4	4	0	0	0	0	0	0	4
0.5	4	4	0	0	0	0	0	0	0
0.5	0	0.5	0	0	0	0	0	0	0
0	0.5	0.5	0	0	0	4	0	0.5	0
4	4	0	0	0	0	0	0	0	0
4	4	0.5	0	0	0	0	0	0	0

Appendix J. Species % cover values for 1988 and 1996, McClure School shale glade, Union County, Illinois.
 The first four letters of the species and the last three represent the first four letters of the
 genus name and last three represent the first three letters of the specific epithet (Appendix C).

Species	acal gra	acer sac	agal ten	ambr art	amel arb	andr sco	aste ano	aste pat	cass fas	cuni org	dant spi	dica acu	heli div
Plot													
1 1988	0.5	0	0	0.5	0	4	0.5	0	0	0.5	0.5	0.5	4
2 1988	0.5	0	0	0.5	0	0.5	0.5	0	0	0.5	0.5	0	0.5
3 1988	0.5	0	0	0	4	0.5	0.5	0	0	4	0.5	0.5	0.5
4 1988	0.5	0	0	0	4	0.5	0.5	0	0	0.5	0.5	0	0.5
5 1988	0.5	0	0	0	0.5	0.5	0.5	0	0	0.5	0.5	0	0.5
6 1988	0.5	0	0	0	0.5	0.5	0.5	0	0.5	0.5	0.5	0	0.5
7 1988	0.5	0	0	0	0	0.5	0.5	0	0	0.5	0.5	0	0.5
8 1988	0.5	0	0.5	0	0	0.5	0.5	0	0	0.5	0.5	0.5	0.5
9 1988	0.5	0	0	0	4	0.5	0.5	0	0	0.5	0.5	0	0.5
10 1988	0.5	0	0.5	0	4	0.5	0.5	0	4	0.5	0.5	0	0.5
11 1988	0	0	0	0	0.5	0.5	0.5	0	0	0.5	0.5	0	0.5
12 1988	0.5	0	0	0	4	0.5	0.5	0	0	0.5	0.5	0	0.5
13 1988	0.5	0	0	0	4	0.5	0.5	0	0	0.5	0.5	0	0.5
14 1988	0	0.5	0.5	0	0.5	0.5	0.5	0	0	0.5	0.5	0.5	0.5
15 1988	0.5	0.5	0.5	0.5	0	0.5	0.5	0	0	0.5	0.5	0.5	0.5
16 1988	0.5	0.5	0	0	4	0.5	0.5	0	0	0.5	0.5	0	4
17 1988	0	0	0	0	4	0.5	0.5	0	0	0.5	0.5	0	0.5
18 1988	0.5	0	0.5	0	4	0.5	0.5	0.5	0	0.5	0.5	0	0.5
19 1988	0.5	0	0.5	0	4	0.5	0.5	0	0	0.5	0.5	0	0.5
20 1988	0	0	0.5	0	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5
21 1988	0	0	0.5	0	0.5	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5
22 1988	0	0.5	0.5	0	0.5	0.5	0.5	0.5	0	0.5	0.5	0	0.5
23 1988	0	0	0.5	0	16	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5
24 1988	0	0	0.5	0	4	0.5	0.5	0	0	0.5	0.5	0	0.5
25 1988	0	0	0.5	0	4	0.5	0.5	0	0	0.5	0.5	0	0.5
26 1988	0.5	0	0.5	0	0	0.5	0.5	0.5	0	0.5	0.5	0	0.5
27 1988	0	0	0.5	0	4	0.5	0.5	0.5	0	0.5	0.5	0.5	0.5
1 1996	4	0	4	0.5	0	16	0	0	4	16	16	16	16
2 1996	0.5	0	4	0.5	0	16	16	0	0.5	16	16	16	16
3 1996	0.5	0	0	4	0	4	4	0	0	4	16	4	16
4 1996	0.5	0	0.5	0.5	0	4	4	4	0	16	16	4	4
5 1996	0.5	0	0.5	0	0	4	0	0	0	4	16	0	16
6 1996	4	0	4	0	0	16	0	4	0	4	16	0	16
7 1996	4	0	0	0	0	4	4	4	0	4	4	0	16
8 1996	4	0	0	0	0	4	0	0	0	16	16	0	0

juni vir	lech ten	manf vir	moss	pens dig	poly ver	quer ste	rhus aro	rosa car	soli nem	styl bif	ulmu ala	vacc arb	wood obt
0	0	0	0.5	0	0	16	4	0	0.5	0	16	4	0
4	0	0	0.5	0	0	62.5	4	0	0.5	0	4	0	0
0	0.5	0	0.5	0	0	37.5	0	0.5	0.5	0	16	0	0
0	0	0	0	0	0	37.5	0.5	0.5	0.5	0	37.5	0	0
0	0	0	0.5	0	0	37.5	0	0	0.5	0	4	16	0
0	0	0	0	0	0	37.5	0	0.5	0.5	0	4	0	0
0.5	0	0	0.5	0	0	37.5	0.5	0.5	0.5	0	4	4	0
0.5	0	0.5	0.5	0.5	0	37.5	0.5	0	0.5	0	4	37.5	0
0	0	0.5	0.5	0	0	84	0	0	0.5	0	4	16	0
0	0	0	0.5	0	0	37.5	0	0	0.5	0.5	0	37.5	0
0	0	0	4	0.5	0	37.5	0.5	0	0.5	0	4	0.5	0
0	0	0	0.5	0.5	0	37.5	0.5	0	0.5	0	4	0	0
0	0	0.5	4	0	0	37.5	0	0	0.5	0	16	4	0.5
0.5	0	0	4	0	0	16	0	0	0.5	0.5	37.5	0.5	0
4	0	0.5	0.5	0	0	37.5	0.5	0	0	0.5	4	0	0.5
0	0	0	0.5	0	0	62.5	0.5	0	0.5	0	4	0	0.5
0	0	0	4	0	0	0.5	0	0	0.5	0.5	0	4	0
0	0	0	0.5	0	0	37.5	0	0	0.5	0.5	4	0	0
0.5	0	0	0.5	0	0	16	0.5	0	0.5	0.5	0	16	0
0	0	0	0.5	0.5	0	16	0	0	0.5	0.5	4	4	0
0	0	0	0.5	0	0	37.5	0	0	0.5	0.5	0	4	0
0	0	0.5	0.5	0	0	37.5	0	0	0.5	0.5	0.5	62.5	0
0	0	0.5	0.5	0	0	16	0.5	0	0.5	0.5	0	62.5	0
0	0.5	0	0.5	0	0	16	0	0	0.5	0.5	0	16	0
0.5	0	0	0.5	0	0	37.5	0	0	0.5	0.5	0.5	0	0
0.5	0.5	0	0.5	0	0	4	0	0	0.5	0.5	4	0	0
0.5	0	0.5	0	0	0	4	0	0	0.5	0.5	4	62.5	0
0.5	4	0	16	16	4	16	0	0	0	0	16	16	0
0	4	0	4	0	0	16	0	0	4	4	4	4	0
0	4	0	4	0	0	16	0	0	0	0	16	4	0
0	4	0	16	0	0	16	0	0	0	0	16	4	4
0	4	0	16	0	0	16	0	0	0	0	16	16	0
4	16	0	4	4	0	16	0	0	0	0	4	16	0
0	0	0.5	4	0	0	4	0	16	4	0	4	0	16
4	0	0	16	4	0	16	0	0	4	0	16	16	0