FIRE IMPACT ON GARLIC MUSTARD

Alliaria petiolata (Bieb.) Cavara and Grande

and GROUNDLAYER FLORA IN A MESIC SAND FOREST

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ABSTRACT

Groundlayer response to prescribed fire was monitored in a mesic sand forest in central Illinois between 1990 and 1994. The first of three annual fires resulted in a significant increase in herbaceous species frequency, density, and cover, and a modest decrease in woody cover. Successive fires maintained or slightly increased herb cover and abundance, and kept woody cover somewhat reduced. Prior to burning the forest understory was dominated by dense shrubs (74-89% cover) over a sparse herb layer (4-18% cover). After the first fire herb (forb and graminoid) cover increased over four-fold to 48-57%, and to 65-66% after the second fire. Species density increased over 50% after the first fire, from 6-7/m^2 to 9.8-10.8/m^2, due almost entirely to the increased frequency of herbaceous, and especially annual, species. Most of the post-fire increase in herbaceous cover was due to *Eupatorium rugosum* (white snakeroot), which increased from <5% cover pre-burn to 23-36% cover after the first fire, and 50-55% cover after the second fire. The alien biennial *Alliaria petiolata* was maintained in a reduced condition by repeated fires, but in the absence of fire doubled in cover every two years, from 4.6% to 8.7% to 16.9%. Fire reduced woody cover by some 20%, primarily due to a significant reduction in *Parthenocissus quinquefolia*, but did not affect frequency of woody vegetation. Herbaceous cover remained fairly high one year after no fire, while woody cover quickly returned to near pre-burn levels.

INTRODUCTION

Fire is a natural perturbation that occurred periodically in deciduous forests in Illinois (Anderson 1991) and throughout the midwest (Curtis 1959, Lorimer 1985, Ladd 1991, Rouse 1986, Stearns 1991) prior to settlement. Fires occurred frequently, often annually (Grimm 1984) and maintained savannas and forest in an open condition (White 1994). Following settlement, fire frequency decreased greatly, with a resulting surge in woody growth (Curtis 1959, White 1994). Prescribed fire is now used as a management tool in wooded communities to restore or maintain the presettlement aspect (Kline and McClintock 1994a, 1994b; Rouse 1986; Stritch 1990, White 1983, 1986), and to reduce presence of non-native plants (Apfelbaum and Haney 1991, Kline and McClintock 1994a, Nuzzo 1991). Much of the research has focused on optimal fire interval and response of woody plants (White 1983, 1986; Axelrod and Irving 1978), and less attention has been given to the groundlayer response. This research was undertaken to assess the impact of prescribed fire on native groundlayer flora, and on the invasive herb *Alliaria petiolata*, in a mesic sand forest in the early stages of *Alliaria* invasion.

METHODS

Study Site --- The study site is a Grade B (*sensu* White 1978) mesic sand forest located in the Sand Ridge State Forest in Mason County, Illinois. Black oak (*Quercus velutina*) is the dominant tree species (150 stems/ha), above a dense primarily woody understory (26,488 stems/ha) dominated by poison ivy (*Rhus radicans*), fragrant sumac (*Rhus aromatica*), prickley ash (*Xanthoxylum americanum*), and gray dogwood (*Cornus racemosa*) (Jenkins et al. 1991).

Three 1 ha plots separated by 10m buffers were established in 1990. Plots 1 and 2 each received three prescribed fires; Plot 1 was burned fall 1990, spring 1992, and spring 1993; Plot 2 was burned spring 1991, 1992, and 1993. Plot 3 was left unburned as a control. All fires were hot and fast, burning through 95-100% of the plots, with flame heights to 1.2m. No fires were conducted in 1994.

Data Collection --- In each plot three permanent parallel transects were located stratified random. Data were collected annually within $1m^2$ quadrats randomly located along the transects within 10m intervals, for a total of 40 quadrats/plot/year. Quadrat locations were rerandomized each year. Collected plant data consisted of presence and estimated percent cover by seven classes (>0-1%, >1-7%, >7-25%, >25-50%, >50-75%, >75-93%, >93%) of all herbaceous species, and all woody species <1m tall, and soil, wood, and leaf litter. Seedlings and resprouts of *Carya texana* and *Carya tomentosa* were difficult to separate, and the two species were combined as *Carya* species. Similarly, *Rubus* species includes *Rubus allegheniensis, Rubus occidentalis,* and a possible third *Rubus* species. Data were collected in early August 1990-1992, and late July 1993-1994, at the same phenological season each year.

Data were used to determine frequency and mean percent cover (based on cover class midpoints),

relative frequency and relative cover, and importance value ([relative frequency+relative cover]/2) of all species and of grouped life forms, and species density.

Data Analysis -- The statistical design was a two-way analysis of variance, with plot and year as the independent variables. Cover data were relativized and then arc-sine transformed, and density data were log transformed to base 10, to improve normality prior to analysis (Zar 1984). Graminoids were infrequent, and were therefore combined with forbs as herbaceous cover. Significant differences between means were determined by Least Significant Difference tests ($p<0.05$). Count data (absolute frequency and species abundance) were tested for significant differences with Chi Square. Statistical analysis was conducted with Systat 5.02 (Wilkinson 1990).

Multivariate analysis was conducted with PC-ORD (McCune 1994) to compare structure of plots over time, using Cluster and Bray-Curtis ordination.

RESULTS

Community -- Prior to burning all three plots had a dense shrub layer (74-89% cover) above a sparse herbaceous layer (4-18% cover)(Table 1). Woody cover declined significantly after the first fire in Burn Plot 1, and after the third fire in Burn Plot 2 (Tables 1 and 2). In both plots, woody cover averaged 84-88% prior to burning, and declined to 57-69% after three fires (Figure 1). In 1994, a fire-free year, woody cover returned to the approximate pre-burn levels in both burn plots. In the Control Plot 3, woody cover declined nonsignificantly over the same time period, from 74% to 61%. Frequency of woody plants was comparable in all years regardless of burn treatment (X^2=4.986, df=8, p=0.768).

After the first fire herbaceous cover more than quadrupled in the burn plots to 48-57%, a highly significant increase (Table 2, Figure 1). A smaller, but still significant, increase occurred after the second fire, when herb cover rose to 65-66%. The third fire produced relatively minor changes in herb cover. Following a fire-free winter, herbaceous cover declined in both burn plots to 40-53%, still significantly higher than the pre-burn levels.

The increase in herbaceous cover following the first fire was paralleled by a significant increase in mean species density (Table 2, Figure 2). In both burn plots, the number of species/m^2 increased >50% after a single fire, from 6.0 to 9.8 in Burn Plot 1, and 7.0 to 10.8 in Burn Plot 2. Subsequent fires did not significantly alter species density. In the control plot, species density varied non-significantly between 6.3 and 7.4 during the same five year period.

A total of 108 species were recorded in the three plots; 92 perennials, five biennials, and eleven annuals. Total number of species/plot increased significantly after fire (X_2 = 9.798, df=1, p=0.002), due primarily to a post-fire increase in herbaceous species in the two burn plots (Figure 3). Annuals showed the greatest response to fire, increasing in frequency more than three fold after the first fire, from 1 to 9 species in Burn Plot 1, and from 3 to 8 species in Burn Plot 2. Annual herbs gradually declined in both

plots with subsequent fires. Biennials were few throughout the five year period, ranging from 1 to 3 in any one year. In Burn Plot 1 perennial herbs increased from 12 to 19 after the first fire, and continued to increase after each additional fire. In contrast, no change was observed in the number of perennial herbs in Burn Plot 2 until after the third fire, when a total of 24 species were recorded. Burn Plot 2 had an open area, or "prairie opening", that provided habitat for perennial prairie herbs, and species richness was consequently and consistently higher in Plot 2 than in either of the other plots. In all plots, little change was observed in the number of woody species (Figure 3).

Individual Species -- The substantial post-fire increase in herbaceous cover was in large part due to the explosive and significant increase in white snakeroot (*Eupatorium rugosum*) cover, from ≤5% to >23% after the first fire, and >50% after the second fire (Table 2, Figure 4). Prior to burning, *E. rugosum* was present in all plots, comprising 4-5% of community importance (Tables in Appendix). After a single fire *E. rugosum* increased in both cover and frequency to became the community dominant in both burn plots, contributing 15-18% of community importance, more than twice that of any other single species. *E. rugosum* maintained its dominant status with successive fires. After a fire-free year, *E. rugosum* cover decreased by approximately half in both plots, but still remained significantly higher than prior to burning.

In 1990, prior to burning, the alien herb garlic mustard (*Alliaria petiolata*) was present in all three plots. Both cover and frequency were lower in the burn plots (I.V. 1-2%) than in the control plot (IV 6%) (Tables in Appendix). After the first fire rosette cover increased significantly from 1.1% to 4.6% in Burn Plot 1, but with subsequent fires, rosette cover remained consistently low in both burn plots (Figure 5, Table 2). Over the same time period, cover of *A. petiolata* cover approximately quadrupled in the Control Plot, from 4.6% in 1990, to 8.7% in 1992, and 17.0% in 1994 (Figure 5). Consequently, total herbaceous cover doubled (a significant increase) in the control plot after five years, due entirely to the contribution of *Alliaria* (Figure 4).

The annual *Phyllanthus caroliniensis* showed a distinct response to fire, occurring only after a plot was burned, and absent from all plots not burned the prior year (Tables in Appendix). *P. caroliniensis* is a small herb, and never attained the community dominance of larger herbs.

Rubus species (*R.allegheniensis and R. occidentalis*) also increased in cover with repeated burning. In Burn Plot 2, *Rubus* cover rose from a pre-burn mean of 7.0% to a mean of 16.0% after three fires (Table 2, Figure 6), and increased slightly in Burn Plot 1. No change occurred in Control Plot 3 over the same time period. After a fire-free year, *Rubus* increased significantly in cover in both burn plots.

The ground-sprawling vine woodbine (*Parthenocissus quinquefolia*), a community dominant prior to burning, was significantly reduced by the first fire, declining from approximately 20% cover to less than 8% cover in both burn plots (Figure 6, Table 2). Cover remained low after subsequent fires, while increasing significantly in the Control Plot from a mean of 13.0% to a mean of 17.1% cover. After a fire-free year, woodbine cover continued to decline in Burn Plot 1, but increased in Burn Plot 2, although still significantly lower than pre-burn cover levels.

In contrast to woodbine, most woody species showed minimal decreases in cover following fire. Gray dogwood (*Cornus racemosa*) cover varied nonsignificantly in all three plots over the five year period (Figure 6, Table 2), while prickley ash (*Xanthoxylem americanum*) and bittersweet (*Celastrus scandens*) showed consistent and non-significant declines in all plots, independent of burn treatment (Table 2, Figure 6).

Abiotic -- Fire significantly reduced leaf cover by some 10% (Table 2). The effect was temporary, and leaf cover returned to pre-burn levels when fires were not conducted. As would be expected, exposed soil increased significantly as leaf cover declined, from approximately 1% to a mean of 4-8%. This effect was also temporary, and disappeared when fires were halted. Down wood decreased in all plots over the five year period, independent of fire effect (Table 2).

DISCUSSION

Herbaceous species -- Fire altered the composition of this sand forest by increasing the number, abundance and cover of herbaceous species, while maintaining frequency of woody species. The significant increase in species density following fire was due entirely to the post-fire abundance of forbs and, to a lesser extent, graminoids (Table 3). Frequency of these herbaceous species more than doubled following the first fire, from a pre-burn mean of 1.2-2.0/m^2 to a post-burn mean of 4.7-5.9/m^2. Species density remained stable after successive fires (4.08-5.6/m^2), and then declined to 3.4-3.7/m^2 after a fire-free year. In an Indiana black oak sand savanna, Bacone and Post (1986) similarly noted an increase in herbaceous species after one and two fires, followed by a modest decline and stabilization with continued burning. Cole et al. (1990) also recorded an increase in herbaceous species density after burning an Indiana sand savanna. At Sand Ridge, the majority of herbaceous species were forbs, and graminoids were infrequent and generally limited to the prairie openings. Most herbaceous species were present prior to burning, but at such low frequencies that they were not picked up during pre-burn sampling. After burning, these species increased in frequency and were then recorded. The exception to this was the annual *Phyllanthus caroliniensis*, which occurred only after fire, and disappeared in the absence of fire.

Annuals exhibited the greatest increase in frequency after the first fire. Kline and McClintock (1994a) recorded a similar upsurge in the abundance of annual species, including the disturbance-adapted *Solanum nigrum*. Tester (1989) recorded a significant increase in cover of annual and biennial herbs with increased fire frequency. Apparently, the changes associated with fire, including increased exposed soil and reduced leaf litter, provide habitat suitable for germination and survival of annual species, many of which are disturbance-adapted.

Post-fire cover of individual herbaceous species was usually <2%, but the cumulative cover of the larger number of species resulted in significantly higher total herbaceous cover. The few herbs that had cover >2% tended to be annuals (*Phyllanthus caroliniensis*, *Chenopodium alba*) or biennials (*Alliaria*

petiolata, *Hackelia americana*). Of the three perennials with post-fire cover >2%, two (*Galium circaezens* and *Teucrium canadense*) never exceeded 5% cover. Most of the increase in cover was produced by *E. rugosum*, which dominated the post-fire herbaceous layer and consistently contributed more cover than all other herbaceous species combined (Figure 4). This disturbance-adapted perennial exploded in cover after fire, increasing from a pre-burn mean of 2-5% cover to a mean of 23-36% cover after the first fire, and 50-55% cover after the second fire. Cover subsequently declined following a fire-free year to a mean of 19-31%, but *E. rugosum* remained a community dominant. Although *E. rugosum* comprised the majority of herbaceous cover, and cover of other herbs appeared to rise and fall relative to cover of *E. rugosum* (Figure 4), linear regression indicated no relationship between *E.rugosum* and other herbs (r^2=0.009, df=399, F=3.495, p=0.062). The increase in *E. rugosum* cover was paralleled by a sharp increase in height; *E. rugosum* was frequently the tallest species in each quadrat, and usually overtopped both herbaceous and woody species. In the unburned control plot, *E. rugosum* maintained low cover and frequency.

A. petiolata was the only herb that showed a dramatic and significant increase in the absence of fire (Figure 5). Repeated fires successfully prevented spread of this aggressive alien, but failed to eradicate it. Burn Plot 1 experienced a temporary increase in rosette cover after the first fire. Conducted in fall, the fire removed most of the leaf layer and exposed bare soil, which enhanced survival of seedlings that germinated the following spring. The spring fire in Burn Plot 2 was conducted during the germination period and resulted in direct mortality of some seedlings. Subsequent fires were conducted in spring, and limited *A. petiolata* spread by a combination of direct seedling mortality and elimination of adult plants prior to seed production, which resulted in a gradual reduction in seedbank reserves. Few seedlings germinated in spring 1994, a fire-free year, indicating that the seedbank was relatively depleted after three consecutive fires. In the absence of fire *A. petiolata* cover doubled every two years, but declined in alternate years, reflecting the biennial nature of this plant. The two-year high-low cycle implies that at this location *A. petiolata* seed has a 7 month dormancy, as also found by Baskin and Baskin (1992), and not the 19 month dormancy reported by Cavers et al. (1979).

Woody species -- Woody species as a group decreased modestly but significantly in cover following fire, due primarily to the significant decrease in woodbine (*Parthenocissus quinquefolia*) cover. *P. quinquefolia* is a fire-sensitive (Nuzzo 1992) ground-sprawling vine that averaged 19-21% cover prior to burning, and declined to 8% cover after the first fire.

Shrub cover remained low as long as the plots were burned. Once fire was halted, woody cover increased significantly, and approximated the pre-burn levels. Thus, repeated burning produced only a temporary reduction in understory woody cover, as also reported by White (1986) and Axelrod and Irving (1978) in a Minnesota sand savanna.

Frequency of woody plants remained relatively constant in all years, indicating that fire affected only the above-ground portion of most shrubs and vines. An exception is *Rubus* species (*R. occidentalis*

and *R. allegheniensis*) which increased in frequency after each fire. Fire apparently stimulated sprouting of these clonal shrubs. *Rubus* cover remained low when plots were burned, but substantially increased when the plots were fire-free for one year, and then became the dominant or co-dominant woody species.

Top-killed shrubs produced new sprouts each year from the undamaged rootstocks. Repeated fires killed the resprouts, but failed to reduce the frequency of woody vegetation. While stem density was not recorded in this study, other authors have documented equal or increased stem density following repeated burning (Axelrod and Irving 1978, Bacone and Post 1986, Evenson 1986). Once fire stopped, the rootstocks produced new sprouts that quickly regained most of their original height and cover. Consequently, fire produced only a temporary reduction in shrub height and cover, which was lost when fires were halted.

The most noticeable, but unmeasured, effect of fire on the shrub layer was the dramatic reduction in height. Before burning, the shrub layer was a 3m tall dense, nearly impenetrable, thicket; after burning, the top-killed shrubs produced resprouts usually <0.5m tall, that were kept short by repeated burning. This was a temporary response, however, and following a fire-free year many of the resprouts were >2m tall.

Community -- Termed a mesic savanna in 1976 (INAI), the site bore little resemblance to an open savanna in 1990, and had few of the species associated with sand savanna (White 1978), particularly those with prairie affinities. The majority of herbaceous species in this study were associated with forest, rather than prairie, communities, a response similar to that recorded by Kline and McClintock (1994a), who monitored a black oak sand forest subjected to repeated fires during the same five year period. Prairie species were present in the scattered "prairie openings", but had limited occurrence outside these open areas, both before and after burning. Apparently, the seed bank contained few propagules of these prairie species, and few or no dormant or depauperate plants were present. These results are comparable to those recorded by Kline and McCLintock (1994a, 1994b), and in contrast to findings of Holtz and Howell (1983). Continued burning may increase the frequency of prairie species: Tester (1989) reported that the number of "true prairie" herbs remained stable with few fires, and increased after some 9-19 fires.

Fire -- The presence of fire resulted in significant changes in community structure, with the majority of change associated with the first fire. Recurring fires tended to maintain or augment the effect of the first fire at the community level. Fire, more than the frequency of fire, was the critical factor: Cluster analysis of the 15 data sets (3 plots over five years) first separated the never burned plots from the burned plots, and subsequently separated plots with less frequent fire from those with more frequent fire (Figure 7).

Both burn plots responded similarly to the first fire, indicating that season of fire (spring vs fall) was not a factor in terms of community response. This is apparent in the ordination of the three plots over time, which indicates that the direction of change was comparable for both burn plots, and differed sharply from the minimal change exhibited in the control plot (Figure 8).

Between-plot differences in fire response were due primarily to differences in pre-burn composition:

both burn plots were located in sand forest, but Burn Plot 2 contained a small prairie opening, which provided habitat for prairie species in addition to forest species. This plot consistently had higher species richness and density.

Fire effects were fairly ephemeral, lasting as long as fires were conducted, and fading in the absence of fire. This is evident in the ordination (Figure 8), which shows both burn plots returning towards the pre-burn position in two-dimensional space in the last (fire-free) year of the study.

For woody vegetation in particular the effects were only temporary, as most shrubs and vines native to sand forest are very fire tolerant. The exception was *P. quinquefolia*, which remained significantly lower in cover after fires were halted. Sand forest was historically subjected to frequent fires, and it is unlikely that *P. quinquefolia* was a community dominant prior to fire cessation. Curtis (1959) listed this vine as modal in dry oak forest, and prevalent in dry-mesic forest. However, most of the stands studied by Curtis were fire-protected, and the abundance of this vine may simply indicate that *P. quinquefolia* increases in both frequency and cover in the absence of fire.

The effect of fire on the herb layer was more long-lasting, with herbaceous species density, richness, frequency, and cover remaining higher after fires were halted. This resulted in an increase in the relative importance of the herb layer, from <21% IV to 46-48% IV, and a consequent reduction in woody importance.

Vegetation responded differently to the absence of fire, depending on life form and species. Percent cover of woody species as a group increased when plots were not burned for a year, and approached the pre-burn cover. The exception was *P. quinquefolia*, which remained at low cover in Burn Plot 1, and increased somewhat in Burn Plot 2. Cover of herbaceous species declined somewhat without fire, but still remained significantly higher than prior to burning. Much of the decline in cover was due to a decline in *E. rugosum* (Figure 4). In contrast, the biennial *A. petiolata* increased four-fold over the five year period in unburned Control Plot 3, while remaining at very low cover in the two burn plots.

As evidenced in this study, repeated burning increases abundance of herbaceous species, particularly those associated with a forest community, but does not reduce the abundance of shrubs. Thus, continued burning of this sand forest would probably maintain a visually open aspect and high herb abundance, but would not convert the forest to a sand savanna as defined by White (1978) i.e.; scattered oaks with a minimal shrub layer and a prairie groundlayer. Frequent high intensity (crown killing) fires would be necessary to reduce overstory tree density, and understory shrub cover, sufficiently to permit development of the prairie-dominated groundlayer associated with sand savanna.

The response of sand forest to periodic, rather than annual, fires was not studied. Natural fire frequency in this community forest is unknown, but likely varied between one and five years, based on historical accounts (White 1994), and savanna response to different fire intervals (Henderson 1982, White 1986). In Missouri oak forests, presettlement fire return interval was documented at 2.8-4.3 years (Cutter and Guyette 1994, Guyette and Cutter 1991), while in Minnesota, Tester (1989) determined that highest species richness occurred at two year burn intervals in a sand savanna. It is possible that biennial or

triennial fires might increase species diversity and permit expansion of herbs in addition to *E. rugosum*, but might also allow greater growth of shrubs and *A. petiolata*. Additional study is needed to determine optimal fire regime for mesic sand forest.

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TABLE 1 Mean cover and species richness in three plots over five years. Different lettters indicate statistically different means ($p<0.05$) within a column. * = prescribed burn.

	Mean Cover							Number of Species
	Graminoid	Forb	Woody	Total	Alliaria	Per M2	Per Plot	Gram/Forb/Woody
BURN PLOT 1								
1990	0.00	4.3 a	84.8 b	88.13	1.1 ab	6.0 a	34	0/14/20
1991*	0.81	48.0 c	62.7 a	111.49	4.6 b	9.8 bc	51	3/30/18
1992*	0.14	65.3 cd	63.8 a	129.20	0.2 a	9.0 b	52	2/31/19
1993*	0.15	64.5 cd	56.7 a	121.39	1.7 ab	8.3 b	52	2/33/17
1994	0.61	53.4 c	71.6 b	125.60	1.5 ab	7.9 b	43	2/22/19
BURN PLOT 2								
1990	0.70	14.1 a	88.5 b	103.38	1.1 ab	7.0 a	49	3/26/30
1991*	0.60	56.6 c	74.2 ab	131.40	1.4 ab	10.8 c	58	6/31/21
1992*	0.76	64.7 cd	70.5 ab	136.03	0.5 ab	8.5 b	56	4/32/20
1993*	4.25	71.5 d	69.1 a	144.92	2.4 ab	10.3 c	63	8/35/20
1994	1.19	40.1 b	83.0 b	124.33	1.0 ab	8.9 bc	61	5/33/23
CONTROL PLOT 3								
1990	0.03	18.0 a	74.0 ab	92.00	4.6 b	6.8 a	38	1/18/19
1991*	0.03	11.7 a	60.0 a	71.73	2.0 ab	7.4 a	40	2/19/19
1992*	0.01	19.9 a	62.1 a	81.99	8.7 c	6.3 a	35	1/17/17
1993*	0.00	15.0 a	61.5 a	76.58	1.2 ab	6.3 a	38	0/20/18
1994	0.01	30.8 b	60.7 a	91.55	16.9 d	6.9 a	37	1/19/17

TABLE 2 Summary tables of two-way ANOVA for cover of woody and herbaceous species, species density, individual species, and cover of leaf litter, soil, an down wood in three plots over five years.

Source of Variation	df	SS	MS	F	P
Woody Vegetation Cover					
Plot	2	1624.15	812.07	6.828	0.001
Year	4	3167.50	791.87	6.658	<0.001
Plot X Year	8	650.07	81.26	0.683	0.707
Error	585	69574.61	118.93		
Herbaceous Vegetation Cover					
Plot	2	27451.82	13725.91	95.971	<0.001
Year	4	32293.40	8073.35	56.449	<0.001
Plot X Year	8	22021.40	2752.68	19.247	<0.001
Error	585	83667.27	143.02		
Species Density					
Plot	2	1.078	0.269	17.006	<0.001
Year	4	1.446	0.723	45.678	<0.001
Plot X Year	8	0.590	0.074	4.662	<0.001
Error	585	9.258	0.016		
Alliaria petiolata					
Plot	2	6370.21	3185.11	41.912	<0.001
Year	4	1932.09	483.02	6.356	<0.001
Plot X Year	8	5493.23	686.65	9.035	<0.001
Error	585	44457.19	76.00		
Eupatorium rugosum					
Plot	2	87602.45	43801.22	217.618	<0.001
Year	4	51951.97	12987.99	64.528	<0.001
Plot X Year	8	34258.51	4316.06	21.444	<0.001
Error	585	117746.07	201.28		
Rubus species					
Plot	2	10270.87	5135.43	26.239	<0.001
Year	4	3731.00	932.75	4.766	0.001
Plot X Year	8	4724.01	590.50	3.017	0.003
Error	585	114493.58	195.72		
Parthenocissus quinquefolia					
Plot	2	1811.23	905.62	5.174	0.006
Year	4	7133.23	1783.31	10.189	<0.001
Plot X Year	8	5350.56	668.82	3.821	<0.001
Error	585	102385.72	175.02		

Source of Variation	df	SS	MS	F	P
Cornus racemosa					
Plot	2	1330.64	665.32	3.970	0.019
Year	4	915.92	228.98	1.366	0.244
Plot X Year	8	1753.99	219.25	1.308	0.236
Error	585	98049.97	167.61		
Celastrus scandens					
Plot	2	4461.28	2230.64	24.458	<0.001
Year	4	1208.85	302.21	3.314	0.011
Plot X Year	8	1015.88	126.99	1.392	0.197
Error	585	53353.53	91.20		
Xanthoxylum americanum					
Plot	2	1879.85	939.92	7.705	<0.001
Year	4	1588.16	397.04	3.255	0.012
Plot X Year	8	1327.95	165.99	1.361	0.211
Error	585	71364.34	121.99		
Leaf Litter					
Plot	2	3439.82	1719.91	15.089	<0.001
Year	4	3610.32	902.58	7.919	<0.001
Plot X Year	8	3057.36	382.17	3.353	0.001
Error	585	66679.36	113.98		
Soil					
Plot	2	1142.99	571.49	14.650	<0.001
Year	4	3777.81	944.45	24.211	<0.001
Plot X Year	8	1199.93	149.99	3.845	<0.001
Error	585	22820.27	39.01		
Down Wood					
Plot	2	130.89	65.44	0.584	0.558
Year	4	5693.43	1423.36	12.71	<0.001
Plot X Year	8	1421.40	177.68	1.587	0.126
Error	585	65511.43	111.99		

TABLE 3 Mean species density/m2 by life form. * = prescribed burn.

	BURN PLOT 1		BURN PLOT 2		CONTROL PLOT 3	
	Herbaceous	Woody	Herbaceous	Woody	Herbaceous	Woody
1990	1.18	4.95	1.98	5.05	2.13	4.70
1991*	4.65	5.10	5.85	4.98	2.43	4.98
1992*	4.23	4.85	4.08	4.40	2.23	4.15
1993*	4.08	4.23	5.60	4.65	2.33	4.03
1994	3.40	4.50	3.75	5.13	2.88	4.05

FIGURE 1: Herbaceous and woody cover 1990-1994. Fires conducted 1991, 1992, and 1993.

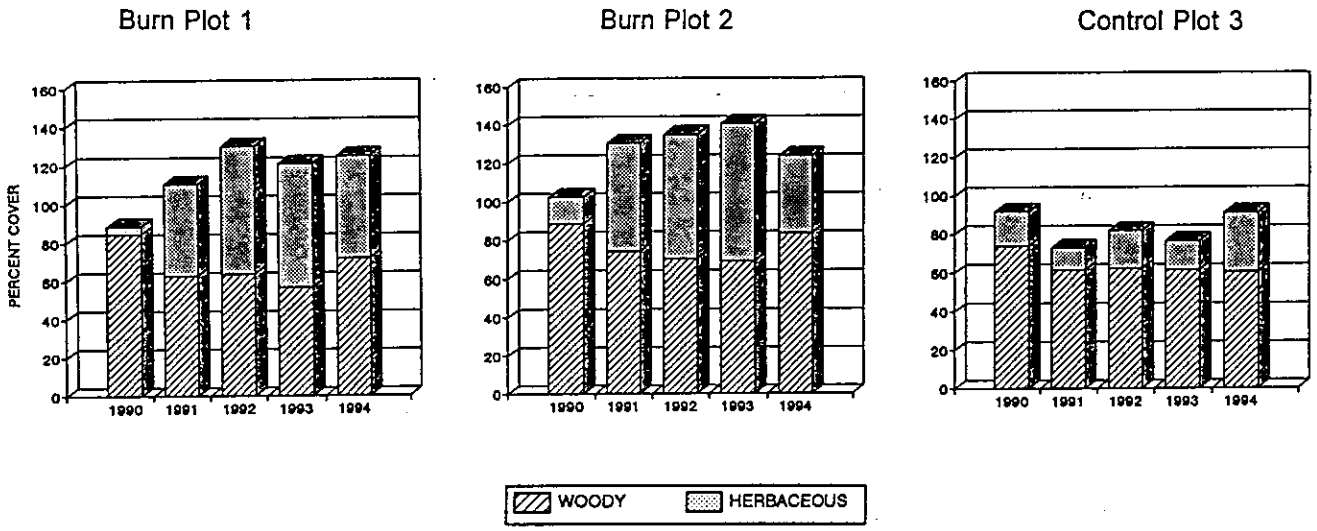


FIGURE 2 Changes in species density (number/m^2), 1990-1994. Fires conducted 1991, 1992, 1993.

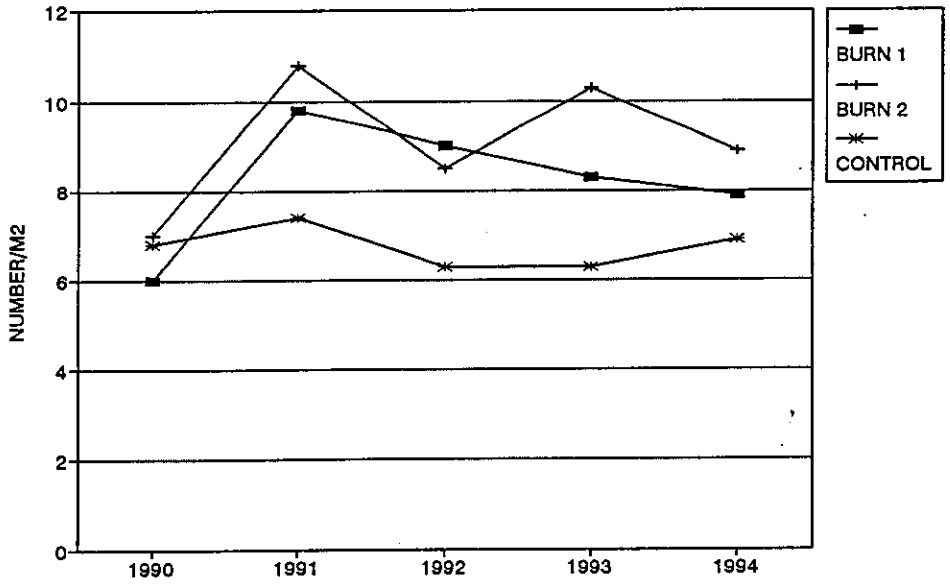


FIGURE 3: Number of species per plot 1990-1994. Fires conducted 1991, 1992, and 1993.

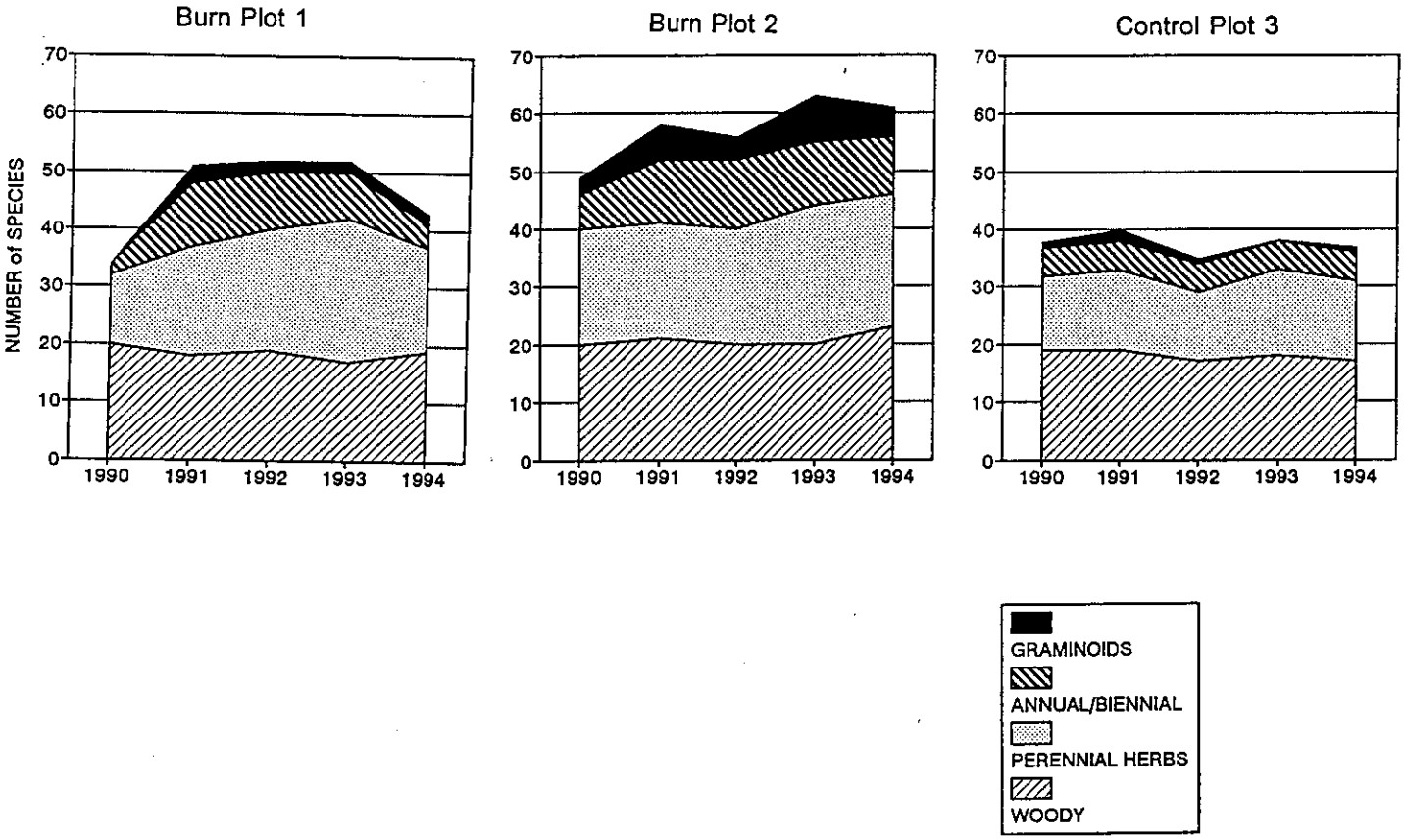


FIGURE 4: Composition of herbaceous cover 1990-1994.

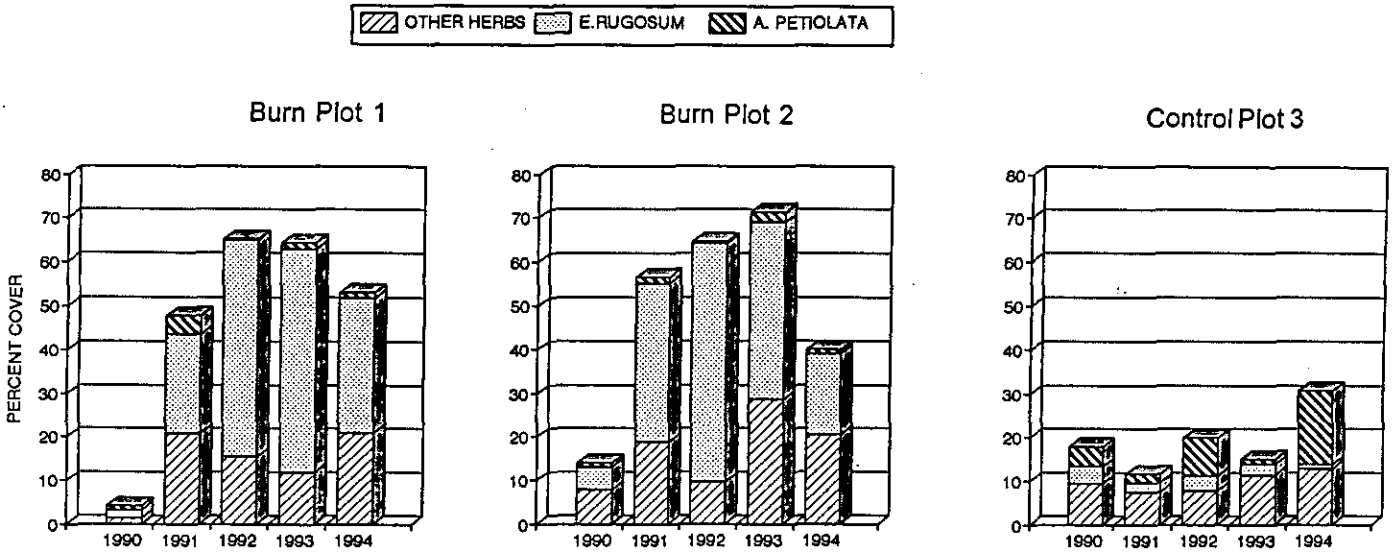


FIGURE 5: Change in *Alliaria petiolata* cover 1990-1994. Fires conducted 1991, 1992, and 1993.

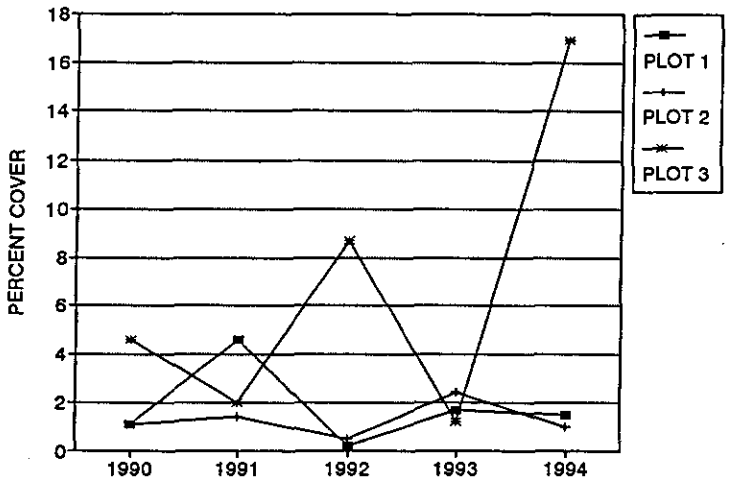


FIGURE 6 Changes in percent cover of five woody species, 1990-1994. Fires conducted 1991, 1992, 1993.

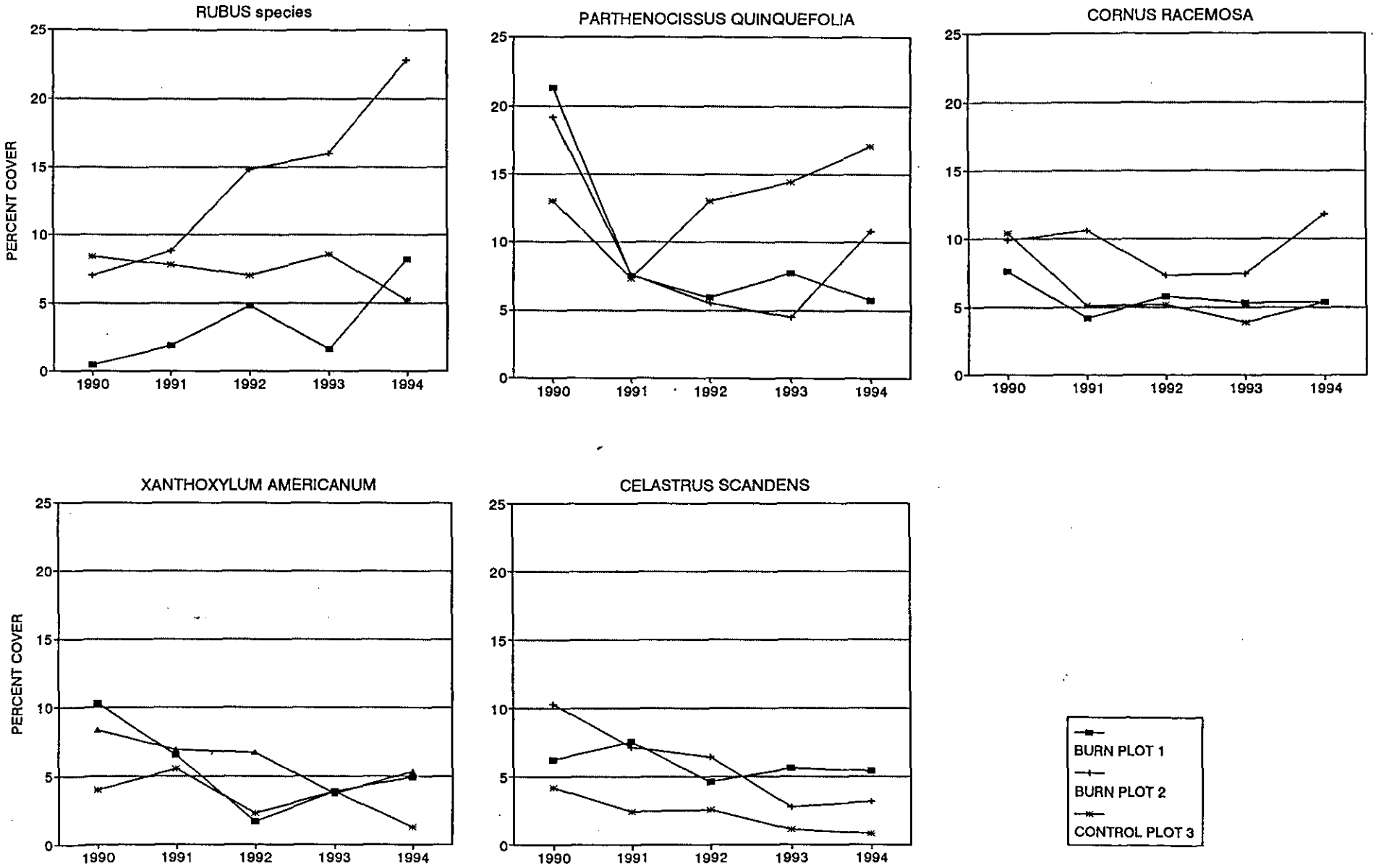


FIGURE 7 Cluster analysis of three plots over five years. Plots numbered 1, 2, and 3. T = year: 0 = 1990, 1 = 1991, etc. Fires conducted 1991, 1992, 1993.

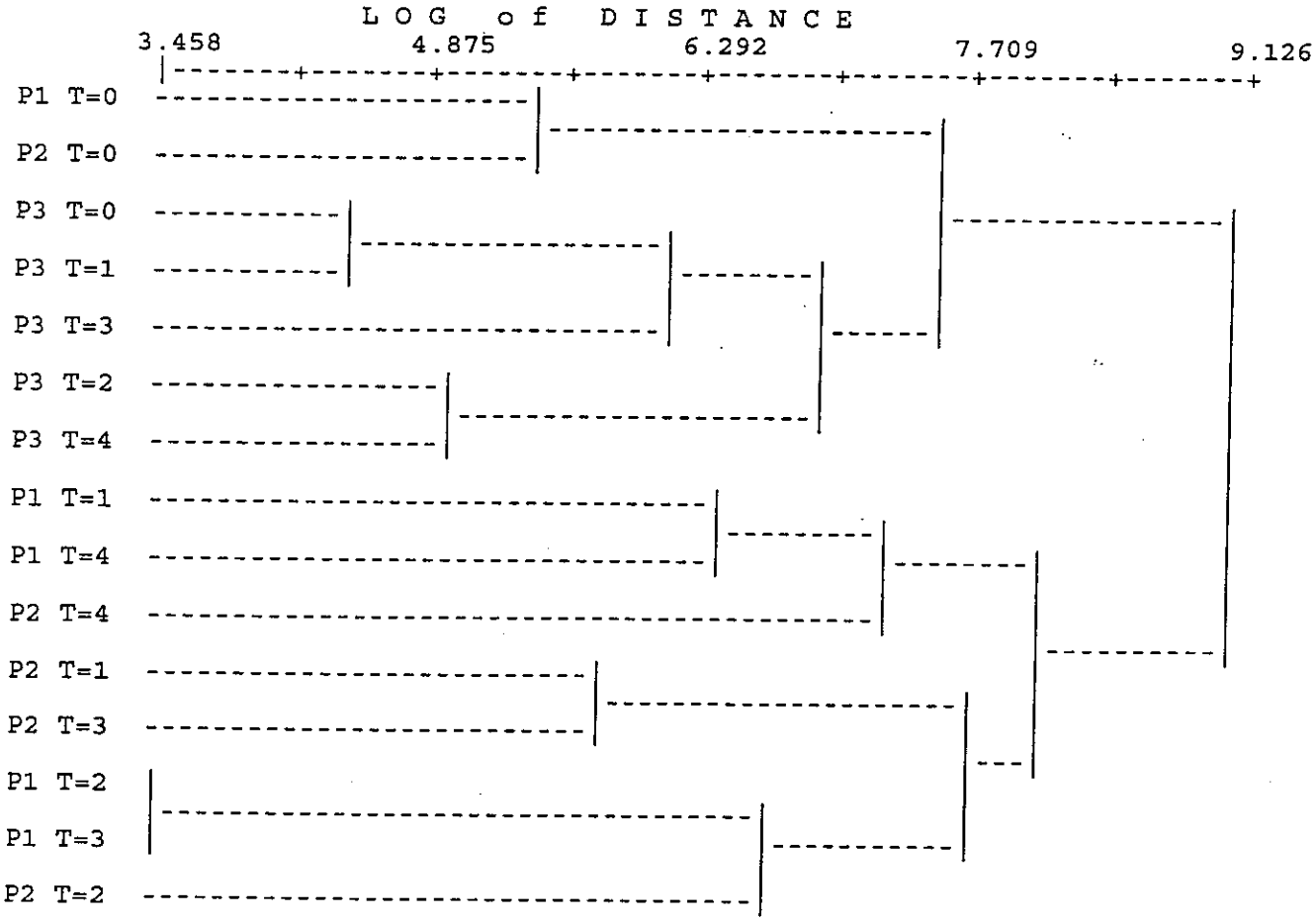
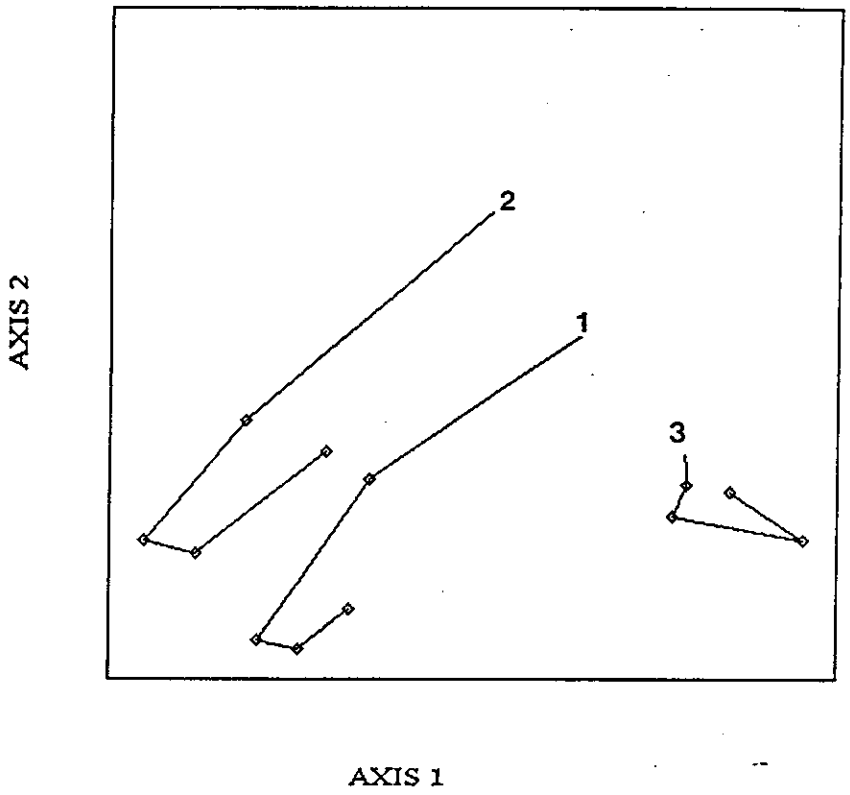


FIGURE 8 Bray-Curtis ordination of three plots over five years. Plot numbers at 1990 position. Fires conducted 1991, 1992, 1993.



APPENDIX

SAND RIDGE 1990 **Plot 1 (n=40 1m2 quadrats) Data collected 8-7-90.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
subtotal graminoids	**0**	**0.000**	**0.00%**	**0.00%**	**0.00%**
FORBS					
Alliaria petiolata	6	1.013	2.50%	1.15%	1.82%
Anemone cylindrica	1	0.025	0.42%	0.03%	0.22%
Chenopodium alba	1	0.013	0.42%	0.01%	0.22%
Eupatorium rugosum	13	1.938	5.42%	2.20%	3.81%
Euphorbia corrolata	2	0.025	0.83%	0.03%	0.43%
Fragaria virginiana	1	0.100	0.42%	0.11%	0.27%
Galium circaezens	5	0.150	2.08%	0.17%	1.13%
Helianthus divaricatus	1	0.100	0.42%	0.11%	0.27%
Polygonum scandens	4	0.525	1.67%	0.60%	1.13%
Potentilla simplex	1	0.100	0.42%	0.11%	0.27%
Smilacina racemosa	5	0.237	2.08%	0.27%	1.18%
Smilax ecchirata	3	0.038	1.25%	0.04%	0.65%
Sonchus sp.	1	0.013	0.42%	0.01%	0.22%
Unknown Forb	3	0.038	1.25%	0.04%	0.65%
subtotal forbs	**47**	**4.315**	**19.58%**	**4.90%**	**12.24%**
WOODY					
Carya texana/tomentosa	9	3.613	3.75%	4.10%	3.92%
Celastrus scandens	21	6.238	8.75%	7.08%	7.91%
Celtis occidentalis	1	0.100	0.42%	0.11%	0.27%
Cornus racemosa	17	7.625	7.08%	8.65%	7.87%
Morus alba	2	0.112	0.83%	0.13%	0.48%
Parthenocissus quinquefolia	31	21.288	12.92%	24.15%	18.54%
Prunus serotina	14	1.350	5.83%	1.53%	3.68%
Prunus virginiana	4	0.613	1.67%	0.70%	1.18%
Quercus marylandica	1	0.400	0.42%	0.45%	0.44%
Quercus velutina	10	1.638	4.17%	1.86%	3.01%
Rhus aromatica	16	8.425	6.67%	9.56%	8.11%
Rhus radicans	11	12.462	4.58%	14.14%	9.36%
Ribes missouriense	12	1.925	5.00%	2.18%	3.59%
Rosa caroliniana	1	0.100	0.42%	0.11%	0.27%
Rubus allegheniensis/occidentalis	3	0.443	1.25%	0.50%	0.88%
Smilax hispida	11	4.550	4.58%	5.16%	4.87%
Vitis riparia	8	2.662	3.33%	3.02%	3.18%
Xanthoxylum americanum	21	10.275	8.75%	11.66%	10.20%
subtotal woody	**193**	**83.819**	**80.42%**	**95.10%**	**87.76%**
TOTAL	**240**	**88.134**	**100.00%**	**100.00%**	**100.00%**

SAND RIDGE 1991 **Plot 1 (n=40 1m2 quadrats) Data collected 8-5-91.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Carex pensylvanica	1	0.400	0.26%	0.36%	0.31%
Carex sp.	1	0.400	0.26%	0.36%	0.31%
Graminoid sp.	1	0.013	0.26%	0.01%	0.13%
subtotal graminoids	**3**	**0.813**	**0.77%**	**0.73%**	**0.75%**
FORBS					
Acalypha rhomboidea	2	0.112	0.51%	0.10%	0.31%
Alliaria petiolata	14	4.238	3.59%	3.80%	3.70%
Amphicarpa bracteata	5	0.237	1.28%	0.21%	0.75%
Anemone quinquefolia	3	0.038	0.77%	0.03%	0.40%
Apocynum sp.	3	0.900	0.77%	0.81%	0.79%
Cacalia atriplicifolia	1	0.400	0.26%	0.36%	0.31%
Chenopodium sp.	16	2.362	4.10%	2.12%	3.11%
Chenopodium alba	2	0.025	0.51%	0.02%	0.27%
Circaea quadrisulcata	1	0.013	0.26%	0.01%	0.13%
Erigeron canadensis	11	0.138	2.82%	0.12%	1.47%
Eupatorium rugosum	39	22.837	10.00%	20.48%	15.24%
Fragaria virginiana	1	0.013	0.26%	0.01%	0.13%
Galium circaezens	4	0.613	1.03%	0.55%	0.79%
Geum canadense	4	0.050	1.03%	0.04%	0.54%
Hackelia americana	18	3.362	4.62%	3.02%	3.82%
Helianthus divaricatus	5	1.100	1.28%	0.99%	1.13%
Oenothera biennis	3	0.600	0.77%	0.54%	0.65%
Phlox bifida	2	0.025	0.51%	0.02%	0.27%
Phyllanthus caroliniensis	11	6.750	2.82%	6.05%	4.44%
Phytolacca americana	10	0.112	2.56%	0.10%	1.33%
Polygonatum biflorum	1	0.100	0.26%	0.09%	0.17%
Polygonum scandens	11	1.737	2.82%	1.56%	2.19%
Potentilla simplex	1	0.400	0.26%	0.36%	0.31%
Scrophularia marilandica	2	0.950	0.51%	0.85%	0.68%
Smilacina racemosa	1	0.100	0.26%	0.09%	0.17%
Solanum nigrum	4	0.438	1.03%	0.39%	0.71%
Sonchus sp.	2	0.112	0.51%	0.10%	0.31%
Teucrium canadense	3	0.038	0.77%	0.03%	0.40%
Unknown Forb	3	0.213	0.77%	0.19%	0.48%
subtotal forbs	**183**	**48.013**	**46.92%**	**43.07%**	**44.99%**
WOODY					
Carya texana/tomentosa	11	4.487	2.82%	4.02%	3.42%
Celastrus scandens	25	7.537	6.41%	6.76%	6.59%
Celtis occidentalis	1	0.938	0.26%	0.84%	0.55%
Cornus racemosa	22	10.550	5.64%	9.46%	7.55%
Parthenocissus quinquefolia	30	7.512	7.69%	6.74%	7.22%
Prunus serotina	4	0.613	1.03%	0.55%	0.79%
Prunus virginiana	1	0.100	0.26%	0.09%	0.17%
Quercus marylandica	2	0.025	0.51%	0.02%	0.27%
Quercus velutina	3	0.300	0.77%	0.27%	0.52%
Rhus aromatica	17	5.475	4.36%	4.91%	4.63%
Rhus radicans	8	9.613	2.05%	8.62%	5.34%
Ribes missouriense	17	2.162	4.36%	1.94%	3.15%
Rubus allegheniensis/occidentalis	20	1.900	5.13%	1.70%	3.42%
Smilax hispida	10	1.938	2.56%	1.74%	2.15%
Ulmus americana	1	0.100	0.26%	0.09%	0.17%
Vitis riparia	12	1.750	3.08%	1.57%	2.32%
Xanthoxylum americanum	20	7.662	5.13%	6.87%	6.00%
subtotal woody	**204**	**62.662**	**52.31%**	**56.21%**	**54.26%**
TOTAL	**390**	**111.488**	**100.00%**	**100.00%**	**100.00%**

SAND RIDGE 1992 **Plot 1 (n=40 1m2 quadrats) Data collected 8-6-92.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Carex sp.	2	0.112	0.55%	0.09%	0.32%
Graminoid sp.	2	0.025	0.55%	0.02%	0.29%
subtotal graminoids	**4**	**0.137**	**1.11%**	**0.11%**	**0.61%**
FORBS					
Acalypha rhomboidea	5	0.538	1.39%	0.42%	0.90%
Alliaria petiolata	2	0.200	0.55%	0.15%	0.35%
Amphicarpa bracteata	11	0.837	3.05%	0.65%	1.85%
Anemone cylindrica	6	0.162	1.66%	0.13%	0.89%
Apocynum sp.	2	0.412	0.55%	0.32%	0.44%
Cacalia atriplicifolia	1	0.400	0.28%	0.31%	0.29%
Chenopodium sp.	17	0.475	4.71%	0.37%	2.54%
Chenopodium alba	3	1.138	0.83%	0.88%	0.86%
Erigeron canadensis	6	0.075	1.66%	0.06%	0.86%
Eupatorium rugosum	39	49.525	10.80%	38.34%	24.57%
Fragaria virginiana	2	0.112	0.55%	0.09%	0.32%
Galium circaezens	13	3.138	3.60%	2.43%	3.02%
Geum canadense	3	0.425	0.83%	0.33%	0.58%
Hackelia americana	2	0.500	0.55%	0.39%	0.47%
Helianthus divaricatus	5	1.100	1.39%	0.85%	1.12%
Oenothera biennis	3	0.125	0.83%	0.10%	0.46%
Phlox bifida	1	0.013	0.28%	0.01%	0.14%
Phyllanthus caroliniensis	12	2.825	3.32%	2.19%	2.76%
Phryma leptostachya	1	0.013	0.28%	0.01%	0.14%
Phytolacca americana	8	0.925	2.22%	0.72%	1.47%
Polygonum scandens	4	0.050	1.11%	0.04%	0.57%
Potentilla simplex	1	0.100	0.28%	0.08%	0.18%
Sanicula sp.	3	0.213	0.83%	0.16%	0.50%
Scrophularia marilandica	1	0.400	0.28%	0.31%	0.29%
Senecio plattensis	1	0.013	0.28%	0.01%	0.14%
Smilacina racemosa	4	1.212	1.11%	0.94%	1.02%
Solanum nigrum	2	0.025	0.55%	0.02%	0.29%
Sonchus sp.	1	0.100	0.28%	0.08%	0.18%
Teucrium canadense	2	0.200	0.55%	0.15%	0.35%
Tradescantia ohiensis	1	0.013	0.28%	0.01%	0.14%
Unknown Forb	1	0.013	0.28%	0.01%	0.14%
subtotal forbs	**163**	**65.277**	**45.15%**	**50.54%**	**47.84%**
WOODY					
Acer negundo	1	0.100	0.28%	0.08%	0.18%
Carya texana/tomentosa	12	5.963	3.32%	4.62%	3.97%
Celastrus scandens	29	4.563	8.03%	3.53%	5.78%
Celtis occidentalis	2	0.500	0.55%	0.39%	0.47%
Cornus racemosa	22	7.325	6.09%	5.67%	5.88%
Corylus americana	1	0.400	0.28%	0.31%	0.29%
Parthenocissus quinquefolia	26	5.850	7.20%	4.53%	5.87%
Prunus serotina	8	3.612	2.22%	2.80%	2.51%
Prunus virginiana	1	0.100	0.28%	0.08%	0.18%
Quercus marylandica	5	0.063	1.39%	0.05%	0.72%
Quercus velutina	2	1.038	0.55%	0.80%	0.68%
Rhus aromatica	15	6.063	4.16%	4.69%	4.42%
Rhus radicans	15	15.976	4.16%	12.37%	8.26%
Ribes missouriense	10	1.413	2.77%	1.09%	1.93%
Robinia pseudo-acacia	1	0.400	0.28%	0.31%	0.29%
Rubus allegheniensis/occidentalis	18	4.775	4.99%	3.70%	4.34%
Smilax hispida	3	0.125	0.83%	0.10%	0.46%
Vitis riparia	11	3.737	3.05%	2.89%	2.97%
Xanthoxylum americanum	12	1.750	3.32%	1.35%	2.34%
subtotal woody	**194**	**63.753**	**53.74%**	**49.36%**	**51.55%**
TOTAL	**361**	**129.167**	**100.00%**	**100.00%**	**100.00%**

SAND RIDGE 1993 **Plot 1 (n=40 1m2 quadrats) Data collected 7-19-93.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Carex pensylvanica	4	0.138	1.20%	0.11%	0.66%
Carex sp.	1	0.013	0.30%	0.01%	0.16%
subtotal graminoids	**5**	**0.151**	**1.51%**	**0.12%**	**0.82%**
FORBS					
Acalypha rhomboidea	7	0.262	2.11%	0.22%	1.16%
Agrimonia gryposepela	1	0.100	0.30%	0.08%	0.19%
Alliaria petiolata	12	1.563	3.61%	1.29%	2.45%
Ambrosia artemesiifolia	2	0.112	0.60%	0.09%	0.35%
Amphicarpa bracteata	8	1.612	2.41%	1.33%	1.87%
Anemone cylindrica	2	0.112	0.60%	0.09%	0.35%
Anemone quinquefolia	1	0.100	0.30%	0.08%	0.19%
Apocynum sp.	4	0.913	1.20%	0.75%	0.98%
Cacalia atriplicifolia	1	0.013	0.30%	0.01%	0.16%
Chenopodium alba	7	0.175	2.11%	0.14%	1.13%
Circaea quadrisulcata	1	0.100	0.30%	0.08%	0.19%
Erigeron canadensis	4	0.125	1.20%	0.10%	0.65%
Eupatorium rugosum	40	51.013	12.05%	42.02%	27.04%
Fragaria virginiana	3	0.213	0.90%	0.18%	0.54%
Galium circaezens	12	2.375	3.61%	1.96%	2.79%
Geum canadense	1	0.013	0.30%	0.01%	0.16%
Helianthus divaricatus	7	1.600	2.11%	1.32%	1.71%
Oenothera biennis	2	0.200	0.60%	0.16%	0.38%
Oxalis sp.	1	0.013	0.30%	0.01%	0.16%
Phlox bifida	1	0.013	0.30%	0.01%	0.16%
Phyllanthus caroliniensis	7	0.262	2.11%	0.22%	1.16%
Physalis sp.	1	0.013	0.30%	0.01%	0.16%
Phytolacca americana	3	0.125	0.90%	0.10%	0.50%
Polygonatum biflorum	2	0.112	0.60%	0.09%	0.35%
Polygonum scandens	4	0.050	1.20%	0.04%	0.62%
Potentilla simplex	2	0.200	0.60%	0.16%	0.38%
Sanicula sp.	2	0.112	0.60%	0.09%	0.35%
Scrophularia marilandica	3	0.900	0.90%	0.74%	0.82%
Smilacina racemosa	3	0.300	0.90%	0.25%	0.58%
Sonchus sp.	1	0.100	0.30%	0.08%	0.19%
Teucrium canadense	6	1.438	1.81%	1.18%	1.50%
Tradescantia ohiensis	3	0.038	0.90%	0.03%	0.47%
Unknown Forb	4	0.225	1.20%	0.19%	0.70%
subtotal forbs	**158**	**64.502**	**47.59%**	**53.14%**	**50.36%**
WOODY					
Carya texana/tomentosa	11	3.662	3.31%	3.02%	3.16%
Celastrus scandens	28	6.550	8.43%	5.40%	6.91%
Cornus racemosa	19	7.412	5.72%	6.11%	5.91%
Corylus americana	3	0.813	0.90%	0.67%	0.79%
Parthenocissus quinquefolia	21	7.675	6.33%	6.32%	6.32%
Prunus serotina	9	2.162	2.71%	1.78%	2.25%
Quercus marylandica	3	0.038	0.90%	0.03%	0.47%
Rhus aromatica	15	5.037	4.52%	4.15%	4.33%
Rhus radicans	11	14.563	3.31%	12.00%	7.66%
Ribes missouriense	8	0.450	2.41%	0.37%	1.39%
Robinia pseudo-acacia	1	0.100	0.30%	0.08%	0.19%
Rosa caroliniana	1	0.400	0.30%	0.33%	0.32%
Rubus allegheniensis/occidentalis	13	1.550	3.92%	1.28%	2.60%
Smilax hispida	4	1.150	1.20%	0.95%	1.08%
Vitis riparia	8	1.225	2.41%	1.01%	1.71%
Xanthoxylum americanum	14	3.950	4.22%	3.25%	3.74%
subtotal woody	**169**	**56.737**	**50.90%**	**46.74%**	**48.82%**
TOTAL	**332**	**121.39**	**100.00%**	**100.00%**	**100.00%**

SAND RIDGE 1994 **Plot 1 (n=40 1m2 quadrats) Data collected 7-16-94.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Carex pensylvanica	3	0.512	0.95%	0.41%	0.68%
Carex sp.	1	0.100	0.32%	0.08%	0.20%
subtotal graminoids	**4**	**0.612**	**1.27%**	**0.49%**	**0.88%**
FORBS					
Acalypha rhomboidea	2	0.112	0.63%	0.09%	0.36%
Alliaria petiolata	13	1.462	4.11%	1.16%	2.64%
Amphicarpa bracteata	20	7.113	6.33%	5.66%	6.00%
Anemone cylindrica	5	0.800	1.58%	0.64%	1.11%
Apocynum sp.	4	1.000	1.27%	0.80%	1.03%
Chenopodium sp.	1	0.013	0.32%	0.01%	0.16%
Eupatorium rugosum	37	30.875	11.71%	24.58%	18.15%
Fragaria virginiana	1	0.100	0.32%	0.08%	0.20%
Galium circaezens	16	1.850	5.06%	1.47%	3.27%
Geum canadense	1	0.100	0.32%	0.08%	0.20%
Helianthus divaricatus	7	2.975	2.22%	2.37%	2.29%
Oenothera biennis	1	0.100	0.32%	0.08%	0.20%
Penstemon sp.	2	0.200	0.63%	0.16%	0.40%
Physalis sp.	1	0.100	0.32%	0.08%	0.20%
Phytolacca americana	1	0.938	0.32%	0.75%	0.53%
Potentilla simplex	1	0.400	0.32%	0.32%	0.32%
Sanicula sp.	2	0.025	0.63%	0.02%	0.33%
Scrophularia marylandica	11	3.675	3.48%	2.93%	3.20%
Silene stellata	1	0.938	0.32%	0.75%	0.53%
Smilacina racemosa	2	0.500	0.63%	0.40%	0.52%
Teucrium canadense	2	0.112	0.63%	0.09%	0.36%
Tradescantia ohiensis	1	0.013	0.32%	0.01%	0.16%
subtotal forbs	**132**	**53.401**	**41.77%**	**42.52%**	**42.14%**
WOODY					
Carya texana/tomentosa	7	1.513	2.22%	1.20%	1.71%
Celastrus scandens	30	5.438	9.49%	4.33%	6.91%
Celtis occidentalis	6	1.800	1.90%	1.43%	1.67%
Cornus racemosa	21	11.837	6.65%	9.42%	8.03%
Parthenocissus quinquefolia	20	5.662	6.33%	4.51%	5.42%
Prunus serotina	9	2.550	2.85%	2.03%	2.44%
Prunus virginiana	2	0.500	0.63%	0.40%	0.52%
Ptelea trifoliata	1	0.400	0.32%	0.32%	0.32%
Quercus velutina	3	0.900	0.95%	0.72%	0.83%
Rhus aromatica	12	3.750	3.80%	2.99%	3.39%
Rhus radicans	12	17.263	3.80%	13.74%	8.77%
Ribes missouriense	7	3.825	2.22%	3.05%	2.63%
Robinia pseudo-acacia	1	0.100	0.32%	0.08%	0.20%
Rubus allegheniensis/occidentalis	16	8.150	5.06%	6.49%	5.78%
Smilax hispida	4	0.400	1.27%	0.32%	0.79%
Tilia americana	1	0.013	0.32%	0.01%	0.16%
Vitis riparia	14	2.450	4.43%	1.95%	3.19%
Xanthoxylum americanum	14	5.037	4.43%	4.01%	4.22%
subtotal woody	**180**	**71.588**	**56.96%**	**57.00%**	**56.98%**
TOTAL	**316**	**125.601**	**100.00%**	**100.00%**	**100.00%**

SAND RIDGE 1990 **Plot 2 (n=40 1m2 quadrats) Data collected 8-7-90.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Andropogon scoparius	1	0.400	0.35%	0.39%	0.37%
Carex pensylvanica	2	0.200	0.71%	0.19%	0.45%
Panicum sp.	1	0.100	0.35%	0.10%	0.23%
subtotal graminoids	**4**	**0.700**	**1.41%**	**0.68%**	**1.05%**
FORBS					
Alliaria peticlata	5	1.075	1.77%	1.04%	1.40%
Amphicarpa bracteata	1	0.013	0.35%	0.01%	0.18%
Apocynum sp.	2	0.800	0.71%	0.77%	0.74%
Asclepias sp.	1	0.400	0.35%	0.39%	0.37%
Chenopodium alba	5	0.625	1.77%	0.60%	1.19%
Eupatorium rugosum	16	5.200	5.65%	5.03%	5.34%
Fragaria virginiana	2	0.200	0.71%	0.19%	0.45%
Galium aparine	2	0.100	0.71%	0.10%	0.40%
Galium circaezens	10	0.775	3.53%	0.75%	2.14%
Geum canadense	1	0.013	0.35%	0.01%	0.18%
Hackelia americana	3	0.512	1.06%	0.50%	0.78%
Helianthus divaricata	2	0.500	0.71%	0.48%	0.60%
Oenothera biennis	1	0.400	0.35%	0.39%	0.37%
Opuntia humifusa	2	0.800	0.71%	0.77%	0.74%
Phlox bifida	2	0.200	0.71%	0.19%	0.45%
Polygonum scandens	1	0.013	0.35%	0.01%	0.18%
Potentilla simplex	2	0.500	0.71%	0.48%	0.60%
Sanicula sp.	1	0.013	0.35%	0.01%	0.18%
Smilacina racemosa	4	1.000	1.41%	0.97%	1.19%
Solanum nigrum	1	0.100	0.35%	0.10%	0.23%
Sonchus sp.	1	0.100	0.35%	0.10%	0.23%
Tephrosia virginiana	1	0.100	0.35%	0.10%	0.23%
Teucrium canadense	1	0.100	0.35%	0.10%	0.23%
Tradescantia ohiensis	1	0.400	0.35%	0.39%	0.37%
Unknown Forb	7	0.138	2.47%	0.13%	1.30%
subtotal forbs	**75**	**14.077**	**26.50%**	**13.62%**	**20.06%**
WOODY					
Carya texana/tomentosa	16	6.787	5.65%	6.57%	6.11%
Celastrus scandens	25	10.262	8.83%	9.93%	9.38%
Celtis occidentalis	2	0.025	0.71%	0.02%	0.37%
Cornus racemosa	11	4.188	3.89%	4.05%	3.97%
Corylus americana	1	0.075	0.35%	0.07%	0.21%
Parthenocissus quinquefolia	36	19.225	12.72%	18.60%	15.66%
Prunus serotina	10	5.225	3.53%	5.05%	4.29%
Prunus virginiana	3	2.063	1.06%	2.00%	1.53%
Quercus velutina	10	1.250	3.53%	1.21%	2.37%
Rhus aromatica	16	8.575	5.65%	8.29%	6.97%
Rhus radicans	6	6.050	2.12%	5.85%	3.99%
Ribes missouriense	7	2.263	2.47%	2.19%	2.33%
Rosa caroliniana	3	0.600	1.06%	0.58%	0.82%
Rubus allegheniensis/occidentalis	14	7.025	4.95%	6.80%	5.87%
Sassafras albidum	4	1.837	1.41%	1.78%	1.60%
Smilax hispida	10	1.725	3.53%	1.67%	2.60%
Ulmus americana	1	0.013	0.35%	0.01%	0.18%
Vitis riparia	8	2.950	2.83%	2.85%	2.84%
Xanthoxylum americanum	19	8.350	6.71%	8.08%	7.40%
subtotal woody	**202**	**88.488**	**71.38%**	**85.60%**	**78.49%**
Moss	2	0.112	0.71%	0.11%	0.41%
TOTAL	**283**	**103.377**	**100.00%**	**100.00%**	**100.00%**

SAND RIDGE 1991 **Plot 2 (n=40 1m2 quadrats) Data collected 8-12-91.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Carex pensylvanica	9	0.500	2.08%	0.38%	1.23%
Carex sp.	1	0.013	0.23%	0.01%	0.12%
Elymus canadensis	1	0.013	0.23%	0.01%	0.12%
Graminoid sp.	3	0.038	0.69%	0.03%	0.36%
Panicum sp.	2	0.025	0.46%	0.02%	0.24%
Setaria sp.	1	0.013	0.23%	0.01%	0.12%
subtotal graminoids	**17**	**0.602**	**3.93%**	**0.46%**	**2.19%**
FORBS					
Acalypha rhomboidea	1	0.013	0.23%	0.01%	0.12%
Alliaria petiolata	9	1.475	2.08%	1.12%	1.60%
Ambrosia artemesiifolia	1	0.400	0.23%	0.30%	0.27%
Amphicarpa bracteata	5	0.063	1.15%	0.05%	0.60%
Apocynum sp.	1	0.100	0.23%	0.08%	0.15%
Cerastium sp.	1	0.013	0.23%	0.01%	0.12%
Chenopodium sp.	1	0.013	0.23%	0.01%	0.12%
Chenopodium alba	20	1.550	4.62%	1.18%	2.90%
Cirsium sp.	1	0.013	0.23%	0.01%	0.12%
Erigeron canadensis	9	0.113	2.08%	0.09%	1.08%
Eupatorium rugosum	40	36.250	9.24%	27.59%	18.41%
Fragaria virginiana	4	0.050	0.92%	0.04%	0.48%
Galium circaezens	4	0.525	0.92%	0.40%	0.66%
Geum canadense	5	0.237	1.15%	0.18%	0.67%
Hackelia americana	14	1.650	3.23%	1.26%	2.24%
Helianthus divaricatus	6	0.725	1.39%	0.55%	0.97%
Nepeta cataria	1	0.100	0.23%	0.08%	0.15%
Oenothera beinnis	4	0.225	0.92%	0.17%	0.55%
Phlox bifida	2	0.025	0.46%	0.02%	0.24%
Phyllanthus caroliniensis	20	5.600	4.62%	4.26%	4.44%
Phyrma leptostachia	1	0.100	0.23%	0.08%	0.15%
Phytolacca americana	8	0.962	1.85%	0.73%	1.29%
Polygonum scandens	25	3.037	5.77%	2.31%	4.04%
Potentilla simplex	2	0.025	0.46%	0.02%	0.24%
Sanicula sp.	3	0.213	0.69%	0.16%	0.43%
Smilacina racemosa	6	0.725	1.39%	0.55%	0.97%
Smilax ecchirata	1	0.100	0.23%	0.08%	0.15%
Solanum nigrum	10	1.075	2.31%	0.82%	1.56%
Teucrium canadense	7	1.100	1.62%	0.84%	1.23%
Viola sp.	2	0.112	0.46%	0.09%	0.27%
Unknown Forb	3	0.038	0.69%	0.03%	0.36%
subtotal forbs	**217**	**56.627**	**50.12%**	**43.09%**	**46.60%**
WOODY					
Carya texana/tomentosa	16	8.037	3.70%	6.12%	4.91%
Celastrus scandens	26	7.100	6.00%	5.40%	5.70%
Celtis occidentalis	3	0.213	0.69%	0.16%	0.43%
Cornus racemosa	16	5.825	3.70%	4.43%	4.06%
Morus alba	1	0.013	0.23%	0.01%	0.12%
Parthenocissus quinquefolia	27	7.537	6.24%	5.74%	5.99%
Prunus serotina	8	4.537	1.85%	3.45%	2.65%
Quercus marylandica	1	0.100	0.23%	0.08%	0.15%
Quercus velutina	4	0.700	0.92%	0.53%	0.73%
Rhus aromatica	11	7.050	2.54%	5.37%	3.95%
Rhus radicans	5	6.037	1.15%	4.59%	2.87%
Ribes missouriense	14	1.563	3.23%	1.19%	2.21%
Robinia pseudo-acacia	11	5.050	2.54%	3.84%	3.19%
Rosa caroliniana	2	0.200	0.46%	0.15%	0.31%
Rubus allegheniensis/occidentalis	19	8.788	4.39%	6.69%	5.54%
Sassafras albidum	5	1.763	1.15%	1.34%	1.25%
Smilax hispida	5	0.625	1.15%	0.48%	0.82%
Vitis riparia	5	2.150	1.15%	1.64%	1.40%
Xanthoxylum americanum	19	6.875	4.39%	5.23%	4.81%
Unknown woody	1	0.013	0.23%	0.01%	0.12%
subtotal woody	**199**	**74.176**	**45.96%**	**56.45%**	**51.20%**
TOTAL	**433**	**131.405**	**100.00%**	**100.00%**	**100.00%**

SAND RIDGE 1992 **Plot 2 (n=40 1m2 quadrats) Data collected 8-6-92.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Carex pensylvanica	1	0.013	0.29%	0.01%	0.15%
Carex sp.	6	0.463	1.77%	0.34%	1.06%
Graminoid sp.	5	0.063	1.47%	0.05%	0.76%
Panicum sp.	4	0.225	1.18%	0.17%	0.67%
subtotal graminoids	**16**	**0.764**	**4.72%**	**0.56%**	**2.64%**
FORBS					
Acalypha rhomboidea	7	0.475	2.06%	0.35%	1.21%
Alliaria petiolata	4	0.525	1.18%	0.39%	0.78%
Ambrosia artemesiifolia	6	0.25	1.77%	0.18%	0.98%
Amphicarpa bracteata	5	0.325	1.47%	0.24%	0.86%
Anemone cylindrica	1	0.013	0.29%	0.01%	0.15%
Apocynum sp.	2	0.500	0.59%	0.37%	0.48%
Cacalia atriplicifolia	1	0.013	0.29%	0.01%	0.15%
Cassia fasciculata	1	0.013	0.29%	0.01%	0.15%
Chenopodium sp.	5	0.150	1.47%	0.11%	0.79%
Chenopodium alba	2	0.025	0.59%	0.02%	0.30%
Circaea quadrisulcata	1	0.938	0.29%	0.69%	0.49%
Commelina erecta	1	0.013	0.29%	0.01%	0.15%
Erigeron canadensis	1	0.100	0.29%	0.07%	0.18%
Eupatorium rugosum	40	54.585	11.80%	40.13%	25.96%
Fragaria virginiana	3	0.038	0.88%	0.03%	0.46%
Galium circaezens	10	0.775	2.95%	0.57%	1.76%
Geum canadense	2	0.025	0.59%	0.02%	0.30%
Hackelia americana	2	0.025	0.59%	0.02%	0.30%
Helianthus divaricatus	7	1.837	2.06%	1.35%	1.71%
Oenothera biennis	3	0.213	0.88%	0.16%	0.52%
Phlox bifida	2	0.025	0.59%	0.02%	0.30%
Phyllanthus caroliniensis	5	0.237	1.47%	0.17%	0.82%
Phytolacca americana	9	0.587	2.65%	0.43%	1.54%
Polygonum scandens	3	0.125	0.88%	0.09%	0.49%
Potentilla simplex	4	0.138	1.18%	0.10%	0.64%
Sanicula sp.	2	0.025	0.59%	0.02%	0.30%
Senecio plattensis	1	0.013	0.29%	0.01%	0.15%
Silene stellata	1	0.400	0.29%	0.29%	0.29%
Smilacina racemosa	7	0.913	2.06%	0.67%	1.37%
Solanum nigrum	2	0.025	0.59%	0.02%	0.30%
Teucrium canadense	5	1.400	1.47%	1.03%	1.25%
Tradescantia ohiensis	1	0.013	0.29%	0.01%	0.15%
Unknown Forb	1	0.013	0.29%	0.01%	0.15%
subtotal forbs	**147**	**64.752**	**43.36%**	**47.60%**	**45.48%**
WOODY					
Carya texana/tomentosa	15	5.037	4.42%	3.70%	4.06%
Celastrus scandens	22	6.400	6.49%	4.70%	5.60%
Celtis occidentalis	1	0.400	0.29%	0.29%	0.29%
Cornus racemosa	12	5.300	3.54%	3.90%	3.72%
Parthenocissus quinquefolia	17	5.475	5.01%	4.02%	4.52%
Prunus serotina	5	1.612	1.47%	1.19%	1.33%
Prunus virginiana	2	0.200	0.59%	0.15%	0.37%
Quercus marylandica	1	0.013	0.29%	0.01%	0.15%
Quercus velutina	4	0.613	1.18%	0.45%	0.82%
Rhus aromatica	12	9.450	3.54%	6.95%	5.24%
Rhus radicans	5	5.325	1.47%	3.91%	2.69%
Ribes missouriense	5	1.400	1.47%	1.03%	1.25%
Robinia pseudo-acacia	7	2.200	2.06%	1.62%	1.84%
Rosa caroliniana	1	0.100	0.29%	0.07%	0.18%
Rubus allegheniensis/occidentalis	24	14.813	7.08%	10.89%	8.98%
Sassafras albidum	7	4.200	2.06%	3.09%	2.58%
Smilax hispida	6	0.162	1.77%	0.12%	0.94%
Vitis riparia	7	1.425	2.06%	1.05%	1.56%
Xanthoxylum americanum	23	6.387	6.78%	4.70%	5.74%
subtotal woody	**176**	**70.512**	**51.92%**	**51.84%**	**51.88%**
TOTAL	339	136.028	100.00%	100.00%	100.00%

SAND RIDGE 1993 Plot 2 (n=40 1m2 quadrats) Data collected 7-19-93.

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Andropogon scoparius	1	0.4	0.24%	0.28%	0.26%
Carex pensylvanica	12	1.725	2.92%	1.19%	2.06%
Carex sp. 1	1	0.013	0.24%	0.01%	0.13%
Carex sp. 2	1	0.013	0.24%	0.01%	0.13%
Cyperus sp.	6	1.475	1.46%	1.02%	1.24%
Panicum sp.	4	0.525	0.97%	0.36%	0.67%
Panicum virgatum	1	0.1	0.24%	0.07%	0.16%
subtotal graminoids	26	4.251	6.33%	2.93%	4.63%
FORBS					
Acalypha rhomboidea	4	0.050	0.97%	0.03%	0.50%
Alliaria petiolata	11	2.425	2.68%	1.67%	2.17%
Ambrosia artemisiifolia	3	0.3	0.73%	0.21%	0.47%
Ambrosia psilostachya	3	0.9	0.73%	0.62%	0.68%
Amphicarpa bracteata	7	0.913	1.70%	0.63%	1.17%
Anemone cylindrica	5	0.925	1.22%	0.64%	0.93%
Apocynum sp.	3	1.200	0.73%	0.83%	0.78%
Aster oblongifolius	1	0.400	0.24%	0.28%	0.26%
fasciculata	4	1.063	0.97%	0.73%	0.85%
Chenopodium alba	14	0.738	3.41%	0.51%	1.96%
Circaea quadrisulcata	1	0.1	0.24%	0.07%	0.16%
Commelina erecta	3	0.038	0.73%	0.03%	0.38%
Erigeron canadensis	5	0.063	1.22%	0.04%	0.63%
Eupatorium rugosum	33	40.500	8.03%	27.95%	17.99%
Fragaria virginiana	2	0.025	0.49%	0.02%	0.25%
Galium circaezans	16	4.125	3.89%	2.85%	3.37%
Geum canadense	4	0.225	0.97%	0.16%	0.56%
Hackelia americana	2	0.025	0.49%	0.02%	0.25%
Helianthus divaricatus	6	1.950	1.46%	1.35%	1.40%
Lespedeza capitata	1	0.1	0.24%	0.07%	0.16%
Oenothera biennis	4	0.138	0.97%	0.10%	0.53%
Opuntia humifusa	1	0.013	0.24%	0.01%	0.13%
Phlox bifida	3	0.213	0.73%	0.15%	0.44%
Phyllanthus caroliniensis	18	7.938	4.38%	5.48%	4.93%
Physalis sp.	1	0.013	0.24%	0.01%	0.13%
Phytolacca americana	4	1.688	0.97%	1.16%	1.07%
Polygonum scandens	8	0.188	1.95%	0.13%	1.04%
Rudbeckia hirta	1	0.100	0.24%	0.07%	0.16%
Scrophularia marilandica	7	0.913	1.70%	0.63%	1.17%
Silene stellata	1	0.400	0.24%	0.28%	0.26%
Smilacina racemosa	5	0.500	1.22%	0.35%	0.78%
Solanum nigrum	1	0.100	0.24%	0.07%	0.16%
Sonchus sp.	1	0.100	0.24%	0.07%	0.16%
Teucrium canadense	12	3.037	2.92%	2.10%	2.51%
Tradescantia ohiensis	3	0.125	0.73%	0.09%	0.41%
subtotal forbs	198	71.531	48.18%	49.36%	48.77%
WOODY					
Carya texana/tomentosa	19	5.713	4.62%	3.94%	4.28%
Celastrus scandens	17	2.813	4.14%	1.94%	3.04%
Celtis occidentalis	3	0.213	0.73%	0.15%	0.44%
Cornus racemosa	14	5.412	3.41%	3.73%	3.57%
Parthenocissus quinquefolia	23	4.525	5.60%	3.12%	4.36%
Prunus serotina	7	1.212	1.70%	0.84%	1.27%
Ptelea trifoliata	2	0.800	0.49%	0.55%	0.52%
Quercus marylandica	8	0.625	1.95%	0.43%	1.19%
Rhus aromatica	10	3.725	2.43%	2.57%	2.50%
Rhus radicans	5	4.875	1.22%	3.36%	2.29%
Ribes missouriense	6	0.725	1.46%	0.50%	0.98%
Robinia pseudo-acacia	15	10.587	3.65%	7.31%	5.48%
Rosa caroliniana	3	0.213	0.73%	0.15%	0.44%
Rubus allegheniensis/occidentalis	24	17.563	5.84%	12.12%	8.98%
Sassafras albidum	5	4.262	1.22%	2.94%	2.08%
Smilax hispida	5	1.013	1.22%	0.70%	0.96%
Vitis riparia	4	1.150	0.97%	0.79%	0.88%
Xanthoxylum americanum	16	3.700	3.89%	2.55%	3.22%
subtotal woody	186	69.126	45.26%	47.70%	46.48%
Moss	1	0.013	0.24%	0.01%	0.13%
TOTAL	411	144.921	100.00%	100.00%	100.00%

SAND RIDGE 1994 **Plot 2 (n=40 1m2 quadrats) Data collected 7-16-94.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Carex pensylvanica	4	0.613	1.13%	0.49%	0.81%
Carex sp.	3	0.425	0.85%	0.34%	0.59%
Graminoid sp. 1	3	0.125	0.85%	0.10%	0.47%
Graminoid sp. 2	1	0.013	0.28%	0.01%	0.15%
Panicum villosissimum	1	0.013	0.28%	0.01%	0.15%
subtotal graminoids	**12**	**1.189**	**3.38%**	**0.96%**	**2.17%**
FORBS					
Acalypha rhomboidea	2	0.112	0.56%	0.09%	0.33%
Alliaria petiolata	10	1.038	2.82%	0.83%	1.83%
Amphicarpa bracteata	11	1.850	3.10%	1.49%	2.29%
Anemone cylyndirca	1	0.100	0.28%	0.08%	0.18%
Apocynum sp.	3	0.600	0.85%	0.48%	0.66%
Aster sp.	1	0.100	0.28%	0.08%	0.18%
Cacalia atriplicifolia	1	0.400	0.28%	0.32%	0.30%
Chenopodium alba	1	0.100	0.28%	0.08%	0.18%
Circaea quadrisulcata	1	0.400	0.28%	0.32%	0.30%
Erigeron canadensis	3	0.038	0.85%	0.03%	0.44%
Eupatorium rugosum	34	18.587	9.58%	14.95%	12.26%
Fragaria virginiana	3	1.050	0.85%	0.84%	0.84%
Galium circaezens	14	2.188	3.94%	1.76%	2.85%
Geum canadense	2	0.112	0.56%	0.09%	0.33%
Hackelia americana	1	0.013	0.28%	0.01%	0.15%
Helianthus divaricatus	9	3.237	2.54%	2.60%	2.57%
Oenothera biennis	2	0.500	0.56%	0.40%	0.48%
Penstemon sp.	1	0.013	0.28%	0.01%	0.15%
Phlox bifida	3	0.213	0.85%	0.17%	0.51%
Phyrma leptostachya	1	0.013	0.28%	0.01%	0.15%
Phyllanthus caroliniensis	1	0.013	0.28%	0.01%	0.15%
Phytolacca americana	1	0.400	0.28%	0.32%	0.30%
Polygonum scandens	1	0.013	0.28%	0.01%	0.15%
Potentilla simplex	3	0.512	0.85%	0.41%	0.63%
Sanicula sp.	1	0.100	0.28%	0.08%	0.18%
Scrophularia marilandica	6	1.438	1.69%	1.16%	1.42%
Senecio sp.	1	0.013	0.28%	0.01%	0.15%
Smilacina racemosa	6	4.662	1.69%	3.75%	2.72%
Solanum nigrum	1	0.013	0.28%	0.01%	0.15%
Solidago sp.	1	0.100	0.28%	0.08%	0.18%
Teucrium canadense	11	2.188	3.10%	1.76%	2.43%
Unknown Forb	1	0.013	0.28%	0.01%	0.15%
subtotal forbs	**138**	**40.129**	**38.87%**	**32.28%**	**35.57%**
WOODY					
Carya texana/tomentosa	15	7.487	4.23%	6.02%	5.12%
Celastrus scandens	18	2.912	5.07%	2.34%	3.71%
Celtis occidentalis	6	1.200	1.69%	0.97%	1.33%
Cornus racemosa	22	9.925	6.20%	7.98%	7.09%
Morus alba	1	0.100	0.28%	0.08%	0.18%
Parthenocissus quinquefolia	26	10.775	7.32%	8.67%	8.00%
Prunus serotina	7	3.813	1.97%	3.07%	2.52%
Prunus virginiana	5	2.563	1.41%	2.06%	1.73%
Ptelea trifoliata	1	0.400	0.28%	0.32%	0.30%
Quercus marylandica	2	0.025	0.56%	0.02%	0.29%
Quercus velutina	6	0.813	1.69%	0.65%	1.17%
Rhus aromatica	10	5.338	2.82%	4.29%	3.56%
Rhus radicans	4	2.463	1.13%	1.98%	1.55%
Ribes missouriense	3	0.213	0.85%	0.17%	0.51%
Robinia pseudo-acacia	11	3.438	3.10%	2.77%	2.93%
Rosa caroliniense	1	0.100	0.28%	0.08%	0.18%
Rubus allegheniensis/occidentalis	32	22.800	9.01%	18.34%	13.68%
Sassafrass albidum	2	1.337	0.56%	1.08%	0.82%
Smilax hispida	9	1.837	2.54%	1.48%	2.01%
Tilia americana	2	0.100	0.56%	0.08%	0.32%
Vitis riparia	7	0.100	1.97%	0.08%	1.03%
Xanthoxylum americanum	15	5.275	4.23%	4.24%	4.23%
subtotal woody	**205**	**83.014**	**57.75%**	**66.77%**	**62.26%**
TOTAL	**355**	**124.332**	**100.00%**	**100.00%**	**100.00%**

SAND RIDGE 1990 **Plot 3 (n=40 1m2 quadrats) Data collected 8-8-90.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Carex sp.	2	0.025	0.73%	0.03%	0.38%
subtotal graminoids	**2**	**0.025**	**0.73%**	**0.03%**	**0.38%**
FORBS					
Alliaria petiolata	18	4.600	6.59%	5.00%	5.80%
Amphicarpa bracteata	2	0.112	0.73%	0.12%	0.43%
Apocynum sp.	1	0.100	0.37%	0.11%	0.24%
Chenopodium alba	1	0.013	0.37%	0.01%	0.19%
Circaea quadrisulcata	3	2.600	1.10%	2.83%	1.96%
Cypripedium candidum	1	0.938	0.37%	1.02%	0.69%
Desmodium glutinosa	1	0.100	0.37%	0.11%	0.24%
Eupatorium rugosum	17	3.987	6.23%	4.33%	5.28%
Fragaria virginiana	1	0.100	0.37%	0.11%	0.24%
Galium circaezens	7	1.425	2.56%	1.55%	2.06%
Geum canadense	1	0.100	0.37%	0.11%	0.24%
Hackelia americana	1	0.100	0.37%	0.11%	0.24%
Phyrma leptostachya	11	0.400	4.03%	0.43%	2.23%
Polygonum scandens	5	1.400	1.83%	1.52%	1.68%
Potentilla simplex	2	0.200	0.73%	0.22%	0.47%
Sanicula sp.	1	0.100	0.37%	0.11%	0.24%
Smilacina racemosa	9	1.337	3.30%	1.45%	2.37%
Smilax ecchirata	1	0.400	0.37%	0.43%	0.40%
subtotal forbs	**83**	**18.012**	**30.40%**	**19.58%**	**24.99%**
WOODY					
Carya texana/tomentosa	9	1.800	3.30%	1.96%	2.63%
Celastrus scandens	15	3.800	5.49%	4.13%	4.81%
Celtis occidentalis	3	0.213	1.10%	0.23%	0.67%
Cornus racemosa	21	10.400	7.69%	11.30%	9.50%
Eleagnus angustifolia	1	0.100	0.37%	0.11%	0.24%
Parthenocissus quinquefolia	30	13.038	10.99%	14.17%	12.58%
Prunus serotina	8	2.987	2.93%	3.25%	3.09%
Prunus virginiana	2	1.337	0.73%	1.45%	1.09%
Quercus velutina	8	0.275	2.93%	0.30%	1.61%
Rhus aromatica	6	2.400	2.20%	2.61%	2.40%
Rhus radicans	16	15.137	5.86%	16.45%	11.16%
Ribes missouriense	4	0.825	1.47%	0.90%	1.18%
Rosa caroliniana	7	2.438	2.56%	2.65%	2.61%
Rosa multiflora	1	0.400	0.37%	0.43%	0.40%
Rubus allegheniensis/occidentalis	15	8.387	5.49%	9.12%	7.31%
Smilax hispida	11	1.438	4.03%	1.56%	2.80%
Ulmus americana	16	1.413	5.86%	1.54%	3.70%
Vitis riparia	7	3.600	2.56%	3.91%	3.24%
Xanthoxylum americanum	8	3.975	2.93%	4.32%	3.63%
subtotal woody	**188**	**73.963**	**68.86%**	**80.39%**	**74.63%**
TOTAL	**273**	**92.000**	**100.00%**	**100.00%**	**100.00%**

SAND RIDGE 1992 **Plot 3 (n=40 1m2 quadrats) Data collected 8-6-92.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Carex sp.	1	0.013	0.39%	0.02%	0.39%
subtotal graminoids	**1**	**0.013**	**0.39%**	**0.02%**	**0.39%**
FORBS					
Acalypha rhomboidea	2	0.025	0.78%	0.03%	0.78%
Alliaria petiolata	25	8.637	9.80%	10.53%	9.80%
Amphicarpa bracteata	1	0.100	0.39%	0.12%	0.39%
Circaea quadrisulcata	3	0.900	1.18%	1.10%	1.18%
Eupatorium rugosum	16	3.438	6.27%	4.19%	6.27%
Galium circaezens	10	0.950	3.92%	1.16%	3.92%
Geum canadense	1	0.013	0.39%	0.02%	0.39%
Hackelia americana	4	0.138	1.57%	0.17%	1.57%
Phryma leptostachya	7	1.125	2.75%	1.37%	2.75%
Polygonum scandens	3	0.125	1.18%	0.15%	1.18%
Potentilla simplex	1	0.100	0.39%	0.12%	0.39%
Sanicula sp.	1	1.038	0.39%	1.27%	0.39%
Silene stellata	1	0.013	0.39%	0.02%	0.39%
Smilacina racemosa	10	3.100	3.92%	3.78%	3.92%
Teucrium canadense	1	0.013	0.39%	0.02%	0.39%
Tovara virginiana	1	0.100	0.39%	0.12%	0.39%
Unknown Forb	1	0.100	0.39%	0.12%	0.39%
subtotal forbs	**88**	**19.915**	**34.51%**	**24.29%**	**29.40%**
WOODY					
Carya texana/tomentosa	2	0.200	0.78%	0.24%	0.78%
Celastrus scandens	13	2.625	5.10%	3.20%	5.10%
Celtis occidentalis	2	0.500	0.78%	0.61%	0.78%
Cornus racemosa	17	5.238	6.67%	6.39%	6.67%
Parthenocissus quinquefolia	32	13.012	12.55%	15.87%	12.55%
Prunus serotina	4	0.913	1.57%	1.11%	1.57%
Prunus virginiana	4	1.150	1.57%	1.40%	1.57%
Quercus velutina	6	0.550	2.35%	0.67%	2.35%
Rhus aromatica	5	1.612	1.96%	1.97%	1.96%
Rhus radicans	23	19.837	9.02%	24.19%	9.02%
Ribes missouriense	10	2.200	3.92%	2.68%	3.92%
Robinia pseudo-acacia	1	0.400	0.39%	0.49%	0.39%
Rosa caroliniana	6	0.600	2.35%	0.73%	2.35%
Rubus allegheniensis/occidentalis	16	7.025	6.27%	8.57%	6.27%
Smilax hispida	4	0.913	1.57%	1.11%	1.57%
Ulmus americana	12	2.975	4.71%	3.63%	4.71%
Xanthoxylum americanum	9	2.313	3.53%	2.82%	3.53%
subtotal woody	**166**	**62.063**	**65.10%**	**75.69%**	**70.40%**
TOTAL	**255**	**81.991**	**100.00%**	**100.00%**	**100.19%**

SAND RIDGE 1993 **Plot 3 (n=40 1m2 quadrats) Data collected 7-19-93.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
subtotal graminoids	**0**	**0.000**	**0.00%**	**0.00%**	**0.00%**
FORBS					
Alliaria petiolata	28	1.225	11.02%	1.60%	6.31%
Amphicarpa bracteata	2	0.200	0.79%	0.26%	0.52%
Asclepias sp.	1	0.100	0.39%	0.13%	0.26%
Chenopodium alba	1	0.013	0.39%	0.02%	0.21%
Circaea quadrisulcata	5	2.475	1.97%	3.23%	2.60%
Cypripedium candidum	1	0.400	0.39%	0.52%	0.46%
Desmodium glutinosa	1	0.100	0.39%	0.13%	0.26%
Eupatorium rugosum	8	2.450	3.15%	3.20%	3.17%
Fragaria virginiana	1	0.013	0.39%	0.02%	0.21%
Galium circaezens	8	0.837	3.15%	1.09%	2.12%
Hackelia americana	2	0.025	0.79%	0.03%	0.41%
Phryma leptostachya	4	0.438	1.57%	0.57%	1.07%
Phytolacca americana	1	0.100	0.39%	0.13%	0.26%
Polygonum scandens	2	0.112	0.79%	0.15%	0.47%
Potentilla simplex	2	0.200	0.79%	0.26%	0.52%
Sanicula sp.	2	0.112	0.79%	0.15%	0.47%
Smilacina racemosa	20	5.088	7.87%	6.64%	7.26%
Smilax ecchirata	1	0.100	0.39%	0.13%	0.26%
Tovara virginiana	2	1.038	0.79%	1.36%	1.07%
Unknown Forb	1	0.013	0.39%	0.02%	0.21%
subtotal forbs	**93**	**15.039**	**36.61%**	**19.64%**	**28.13%**
WOODY					
Carya texana/tomentosa	10	1.850	3.94%	2.42%	3.18%
Celastrus scandens	12	1.150	4.72%	1.50%	3.11%
Cornus racemosa	13	3.850	5.12%	5.03%	5.07%
Parthenocissus quinquefolia	33	14.350	12.99%	18.74%	15.87%
Prunus serotina	5	0.712	1.97%	0.93%	1.45%
Prunus virginiana	3	0.900	1.18%	1.18%	1.18%
Quercus marylandica	2	0.112	0.79%	0.15%	0.47%
Quercus velutina	1	0.100	0.39%	0.13%	0.26%
Rhus aromatica	4	2.138	1.57%	2.79%	2.18%
Rhus radicans	21	20.200	8.27%	26.38%	17.32%
Ribes missouriense	2	0.112	0.79%	0.15%	0.47%
Rosa caroliniana	4	0.525	1.57%	0.69%	1.13%
Rubus allegheniensis/occidentalis	18	8.475	7.09%	11.07%	9.08%
Smilax hispida	8	1.138	3.15%	1.49%	2.32%
Ulmus americana	5	1.400	1.97%	1.83%	1.90%
Vitis riparia	6	0.725	2.36%	0.95%	1.65%
Xanthoxylum americanum	14	3.800	5.51%	4.96%	5.24%
subtotal woody	**161**	**61.537**	**63.39%**	**80.36%**	**71.87%**
TOTAL	**254**	**76.576**	**100.00%**	**100.00%**	**100.00%**

SAND RIDGE 1994 **Plot 3 (n=40 1m2 quadrats) Data collected 7-16-94.**

SPECIES	FREQ. OCCU	MEAN% COVER	REL. FREQ.	REL. COVER	IMP. VALUE
GRAMINOIDS					
Carex sp.	1	0.013	0.36%	0.01%	0.19%
subtotal graminoids	**1**	**0.013**	**0.36%**	**0.01%**	**0.19%**
FORBS					
Acalypha rhomboidea	1	0.013	0.36%	0.01%	0.19%
Alliaria petiolata	34	16.950	12.27%	18.51%	15.39%
Amphicarpa bracteata	6	0.162	2.17%	0.18%	1.17%
Botrychium virginianum	3	0.125	1.08%	0.14%	0.61%
Circaea quadrisulcata	9	2.550	3.25%	2.79%	3.02%
Eupatorium rugosum	5	1.013	1.81%	1.11%	1.46%
Fragaria virginiana	1	0.100	0.36%	0.11%	0.24%
Galium circaezens	6	0.162	2.17%	0.18%	1.17%
Hackelia americana	7	0.438	2.53%	0.48%	1.50%
Helianthus divaricatus	1	0.100	0.36%	0.11%	0.24%
Phryma leptostachya	5	0.712	1.81%	0.78%	1.29%
Polygonum scandens	6	0.250	2.17%	0.27%	1.22%
Potentilla simplex	3	0.512	1.08%	0.56%	0.82%
Sanicula sp.	3	0.213	1.08%	0.23%	0.66%
Smilacina racemosa	19	7.350	6.86%	8.03%	7.44%
Smilax ecchirata	1	0.013	0.36%	0.01%	0.19%
Taraxacum officinale	1	0.013	0.36%	0.01%	0.19%
Teucrium canadense	2	0.112	0.72%	0.12%	0.42%
Unknown Forb	1	0.013	0.36%	0.01%	0.19%
subtotal forbs	**114**	**30.801**	**41.16%**	**33.64%**	**37.40%**
WOODY					
Carya texana/tomentosa	6	0.637	2.17%	0.70%	1.43%
Celastrus scandens	8	0.837	2.89%	0.91%	1.90%
Celtis occidentalis	4	1.600	1.44%	1.75%	1.60%
Cornus racemosa	17	5.363	6.14%	5.86%	6.00%
Parthenocissus quinquefolia	32	17.138	11.55%	18.72%	15.14%
Prunus serotina	3	0.125	1.08%	0.14%	0.61%
Prunus virginiana	5	1.700	1.81%	1.86%	1.83%
Quercus velutina	1	0.013	0.36%	0.01%	0.19%
Rhus aromatica	4	1.538	1.44%	1.68%	1.56%
Rhus radicans	19	17.825	6.86%	19.47%	13.16%
Ribes missouriense	10	3.638	3.61%	3.97%	3.79%
Rosa caroliniense	3	0.213	1.08%	0.23%	0.66%
Rubus allegheniensis/occidentalis	17	5.238	6.14%	5.72%	5.93%
Smilax hispida	9	1.413	3.25%	1.54%	2.40%
Ulmus americana	14	2.037	5.05%	2.22%	3.64%
Vitis riparia	3	0.125	1.08%	0.14%	0.61%
Xanthoxylum americanum	7	1.300	2.53%	1.42%	1.97%
subtotal woody	**162**	**60.740**	**58.48%**	**66.34%**	**62.41%**
TOTAL	**277**	**91.554**	**100.00%**	**100.00%**	**100.00%**