Effects of a Prescribed Fire on Degraded Forest Vegetation

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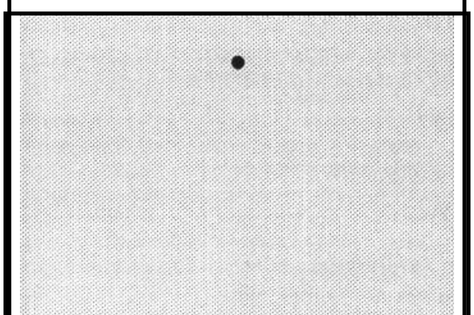

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ABSTRACT: The response of the understory herbaceous flora to fire management was studied in a degraded woodland in northern Illinois. The site contains a rapidly expanding population of *Alliaria petiolata,* a non-indigenous plant that is highly invasive in forests. Three treatment units (March fire, May fire, and unburned) were sampled in 1991, prior to fire treatments. Following prescribed fire, plots were sampled annually from 1992 to 1994, inclusive, to track the response of the vegetation to the fire treatment. The purpose of the experiment was to assess the impact of fire on (1) A. *petiolata* populations, (2) the native herbaceous flora, and (3) shrubs and saplings. The initial impact of fire on A. *petiolata,* understory forbs, shrubs, and saplings was strongly negative in the growing season burn unit and moderate in the dormant season burn unit. After three years, A. *petiolata* had not recovered to preburn densities in the growing season burn unit. Likewise, densities and richness of native herbaceous species remained below preburn values in the growing season burn unit after three years. Dormant season and growing season bums equally and strongly reduced shrub and sapling densities relative to the control unit.

INTRODUCTION

Fire is considered important to the maintenance of dry upland woodlands along the prairie-forest border region of Illinois and elsewhere (Lorimer 1985, Abrams 1986). Descriptions of the historic forest vegetation of Illinois include numerous accounts of fire (White 1994). Postsettlement fire suppression, particularly during the past century (Pyne 1982), has resulted in succession of many vegetation types (e.g., prairies, savannas, and oak-hickory forests) toward forests supporting the growth of mesophytic forest species (Parker et al. 1985, Sharpe et al. 1987, Parker 1989). With increased attention focussed on the natural role of disturbance (e.g., Pickett and White 1985), the dynamic nature of plant communities (e.g., Pickett et al. 1992), and an interest in managing forests for a particular structure and composition, the use of fire has increased in prairies and woodlands in the midwestern prairie-forest border region.

Prescribed fires also may help reduce invasive exotic species. Nuzzo (1991) re-ported that managed fires of moderate in-tensity significantly reduced populations of the exotic weed *Alliaria petiolata.* This eed, while first recorded in Illinois in 1918 (first recorded in North America in 1868), has greatly expanded its distribution with-in Illinois woodlands since the 1960s (Nuzzo 1993). Once established, A. *petiolata* is believed to have the ability to form dense stands that exclude native understory species (e.g., Yost et al. 1991). The continued expansion of A. *petiolata,* its ability to colonize forested sites, and its purported ability to reduce biodiversity have made A. *petiolata* a primary concern in conservation management. Managers are seeking control measures for this exotic species problem. Prescribed fire, cutting, and herbicides have all been recommended (Nuzzo 1991), but mechanical control remains the most popular means of reducing A. *petiolata* populations. The effect of man-aged fire on A. *petiolata,* the associated native herbaceous flora, and woody species regeneration in degraded woodlands requires further study. To address this is-sue we initiated a study of the effect of managed fire, prescribed for woodland restoration, on: (1) A. *petiolata*, (2) native herbaceous species, and (3) understory woody vegetation.

STUDY SITE

A 6-ha upland forest tract of the George B. Fell Nature Preserve (Castle Rock State Park, Ogle County, Illinois) was selected for our study. The forest is located in north-ern Illinois in the Oregon Section of the Rock Hill Country Natural Division (Schwegman et al. 1973). The region is characterized by a rugged topography of St. Peter Sandstone bluffs and ravines that descend nearly 60 m in elevation from the broad uplands to the Rock River Valley. This particular forest stand is located south of Wilderness Road (SW 1/4, sect. 19, T23N, R10E) on the lowest reaches of a broad, gently rolling upland divide between ravine forests. The soils of the study area are moderately thick well-drained silt loam soils developed primarily from loess (Acker et al. 1980). The Public Land Survey in 1839 (Hutchson and Johnson 1980) de-scribed the upper reaches of this rolling upland tract as prairie vegetation with increasing numbers of oaks and hickories as the topography descended to the river basin.

The study area was grazed and logged prior to the 1960s, but there have been no grazing, logging, or managed fire activities within the study area since 1970. The Illinois Natural Areas Inventory classifies the site as a grade "C" (moderately disturbed) dry-mesic upland forest (Illinois Natural Areas Inventory 1978). A. *petiolata* was first observed in the study area in 1989. The study area appears to have been colonized from A. *petiolata* populations that were already well established by the spring of 1988 in the adjacent ravine forests. Precipitation patterns during this study were variable and are likely to have affected plant population sizes. Two of the years (1990 and 1993) were wet years, each with an excess of 40 cm of rain during the spring (April–June). In contrast, 1991, 1992, and 1994 were exceedingly dry, with 20, 18, and 14 cm of rain in April, May, and June, respectively. *Alliaria petiolata* populations on the site were mostly synchronous, with a strong predominance of basal rosettes in 1991, 1992, and 1994 and mostly flowering individuals with few basal rosettes in 1993. The aerial coverage of a second-year flowering stem is less than that of first-year basal rosettes, thus influencing cover estimates in 1993.

METHODS

The study area was divided into three approximately 2-ha units that were randomly assigned to dormant season (March), growing season (May), and control (no fire) burn units. A low- to moderate-intensity fire was conducted on March 4, 1992 under warm (62° F) and moderately dry conditions (70% relative humidity, 8 days since last precipitation). Flame heights varied from 15 cm to 1 m and spread at approximately 1.3 m/minute, burning 75–80% of the unit. A moderate-intensity fire was conducted on May 8, 1992 under warm (78° F) and dry conditions (29% relative humidity, 9 days since last precipitation). Flame heights varied from 10 cm to 75 cm and spread at approximately 1.7 m/minute, burning 75–80% of the second burn unit.

Plant sampling arenas were established in the center of each burn unit to avoid edge effects of roads, forest edges, and fire ignition lines. Preburn herbaceous vegetation was sampled during May 8–21, 1991; preburn woody vegetation was sampled in September 1991. Postburn vegetation was sampled between May 24 and June 4 in 1992, 1993, and 1994. Herbaceous species quadrats were sampled in two ways. In the May (growing season) burn and control units, 0.25-m by 0.25-m (625 cm^2) quadrats were sampled at 2-m intervals along 30-m sample transects (15 quadrats in each transect). The starting points of the six sampling transects were located at 50-m intervals in a 50-m by 100-m sampling arena centered within the treatment unit (one in each corner and one at the mid-point along the long side of the rectangle). The direction of the transect was selected by random number under the constraint that the transect must lie within the sampling arena. Sample transects occasionally crossed over one another, but no two of the 90 quadrats overlapped. In the March (dormant season) burn unit, herbaceous species were sampled in eight randomly chosen sample locations within a 50-m by 100-m sampling arena centered within the treatment unit. Sampling stations were located using a random number table to choose a position along each axis of the sampling arena. One 0.25-m^2 quadrat was located at the center of each sampling station, with additional quadrats located 2.5 m from the center of the sampling station at each of four compass angles (0, 90, 180, 270 degrees), for a total of 40 quadrats. All quadrats were permanently marked for re-sampling. Within each quadrat we sampled cover of *A. petiolata* and the number of stems of all herbaceous species. Cover was estimated following Bailey and Poulton's (1968) modification of the Daubenmire cover class system (Daubenmire 1959). The modified cover classes were: 0, <1%, 1-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100%.

The shrub/sapling stratum (woody species between 50 cm in height and 5 cm dbh) was sampled prior to fire treatments and once following fire treatment for each experimental unit. To sample shrubs and saplings a 25-m^2 circular plot was centered at the 15-m mark along each of six herbaceous species transects in growing season burn and control units. In the dormant season burn unit a 25-m^2 circular plot was centered in each of eight randomly located sample stations. Overstory vegetation was characterized using three parallel and evenly spaced 10-m by 50-m belt transects for each unit in which all trees greater than 5 cm diameter at breast height (dbh) were tallied by species and dbh. Transects within units were separated by 50 m and passed through the ends and middle of the sampling arenas within each unit described above. Large trees (>5 cm dbh) were sampled only once, because fire treatments resulted in no apparent immediate mortality.

Species richness, stem density, and A. *petiolata* cover were analyzed using Repeated Measures Analysis of Variance (RMANOVA). The RMANOVA examines for differences in response variables between replicates and among years. For species richness and stern density, individual quadrats were used as replicates. A Principal Components Analysis (PCA, SYSTAT 2.1) of stem density data was used to examine the community level effects of fire on herbaceous species composition.

RESULTS

Vegetation Description

Ulmus rubra was the most abundant tree (Table 1). Smaller size classes (5–20 cm dbh) were dominated by it, *Celtis occidentalis, Fraxinus americana,* and *Prunus* ***serotina*** (Figure la). ***Quercus alba,*** *Q. rubra,* and *Juglans nigra* dominated in terms of basal area (Table 1), and these species also dominated in terms of abundance in the >20 cm size classes (Figure lb). *Fraxinus americana* and *U. rubra* dominated among saplings, while *Prunus*

Table 1. Density, basal area, and importance values (IV = relative density + relative basal area) for overstory trees of the study region within the George B. Fell Nature Preserve.

Species	Density (trees/ha)	Basal Area (cm^2/ha)	IV
Ulmus rubra	304.5	47,810	59.7
Quercus alba	81.1	116,569	49.5
Q. ***rubra***	59.5	62,333	**28.8**
Juglans nigra	52.3	42,929	21.5
Carya ovata	41.4	19,013	12.2
Fraxinus americana	34.2	5,955	6.9
Celtis occidentalis	41.4	3,752	7.2
Prunus serotina	23.4	3,327	4.5
Ostrya virginiana	12.6	425	2.0
Cornus alternifolia	10.8	276	1.7
Carya cordiformis	9.0	829	1.6
U. americana	9.0	540	1.5
Q. nigra	1.8	2,828	1.2
Populus grandidentata	1.8	2,008	0.9
Tilia americana	1.8	176	0.3
Carpinus caroliniana	1.8	42	0.3
Acer negundo	1.8	36	0.3

virginiana, Viburnum prunifolium, **and** *Cornus racemosa* were the most abundant small trees/small **shrubs,** and ***Ribes missouriense*** **and** ***Rubus occidentalis*** **dominated** among small shrubs (Table 2). In 1991, before the experiemental burn, *Alliaria petiolata* dominated the understory vegetation, being present with a median cover of 15% in 194 (88%) herb plots and at greater than 50% cover in 88 (40%) of the herb plots. Common native species in the herbaceous layer included *Circaea lutetiana* in 124 (56.4%) plots, ***Parthenocissus quinquefolia*** in 98 (44.5%) plots, *Arisaema triphyllum* in 79 (35.9%) plots, *Galium aparine* in 71 (32.3%) plots, and *Geranium maculatum* in 53 (24.1%) plots. No other species was found in more than 22 (10%) plots. A complete species list for the site is presented in Appendix A; nomenclature follows Mohlenbrock (1986).

Table 2. Estimated density and pre- and post-treatment abundances of sapling trees, shrubs, and woody vines In the George B. Fell Nature Preserve. Data are presented for all stems greater than 50 cm tall and less than 5 cm dbh from three treatment units (unburned control, dormant season burn, and growing season burn).

		Number Sampled											
	Estimated	Dormant				Growing season				Control			
	Density	<2 cm		2-5 cm		<2 cm		2-5 cm		<2 cm		2-5 cm	
Species	(per ha)	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post
SAPLINGS (<5CM **DBH**) OF OVERSTORY TREES													
Fraxinus americana	3,060	70	35	29	25	45	7	5	0	4	7	0	0
Ulmus rubra	1,220	1	1	16	7	9	0	5	4	24	3	**6**	6
Celtis occidentalis	580	15	8	9	7	2	1	1	1	12	12	0	0
Carya cordiformis	260	0	0	0	0	5	0	1	1	7	7	0	0
Prunus serotina	220	3	0	3	2	5	5	0	0	3	3	0	0
Quercus rubra	160	2	0	0	0	1	0	0	0	4	0	1	1
Carya ovata	160	1	0	2	1	2	0	0	0	3	0	0	0
Other species	660	4	0	4	2	8	0	3	3	12	9	2	2
SMALL TREES AND TALL **SHRUBS**													
Prunus virginiana	10,380	461	10	6	6	7	0	0	0	15	7	0	0
Viburnum prunifolium	1,620	17	1	3	3	48	0	0	0	69	22	1	0
Cornus racemosa	1,420	21	0	1	0	0	0	0	0	14	14	0	0
Cornus alternifolia	720	14	0	10	10	13	0	0	0	0	0	0	0
Corylus americana	600	13	0	0	0	16	0	0	0	2	0	0	0
Zanthoxylum americanum	140	5	1	0	0	1	0	0	0	0	0	0	0
Other species	180	2	0	2	2	4	0	0	0	1	3	0	0
SMALL SHRUBS AND VINES													
Ribes missouriensis	4,900	0	0	-	-	113	0	-	-	28	23	-	-
Rubus occidentalis	1,000	0	0	-	-	0	0	-	-	17	24	-	-
Rubus allegheniensis	230	0	0	-	-	5	0	-	-	2	1	-	-
Other species	60	1	0	-	-	1	0	-	-	1	1	-	-

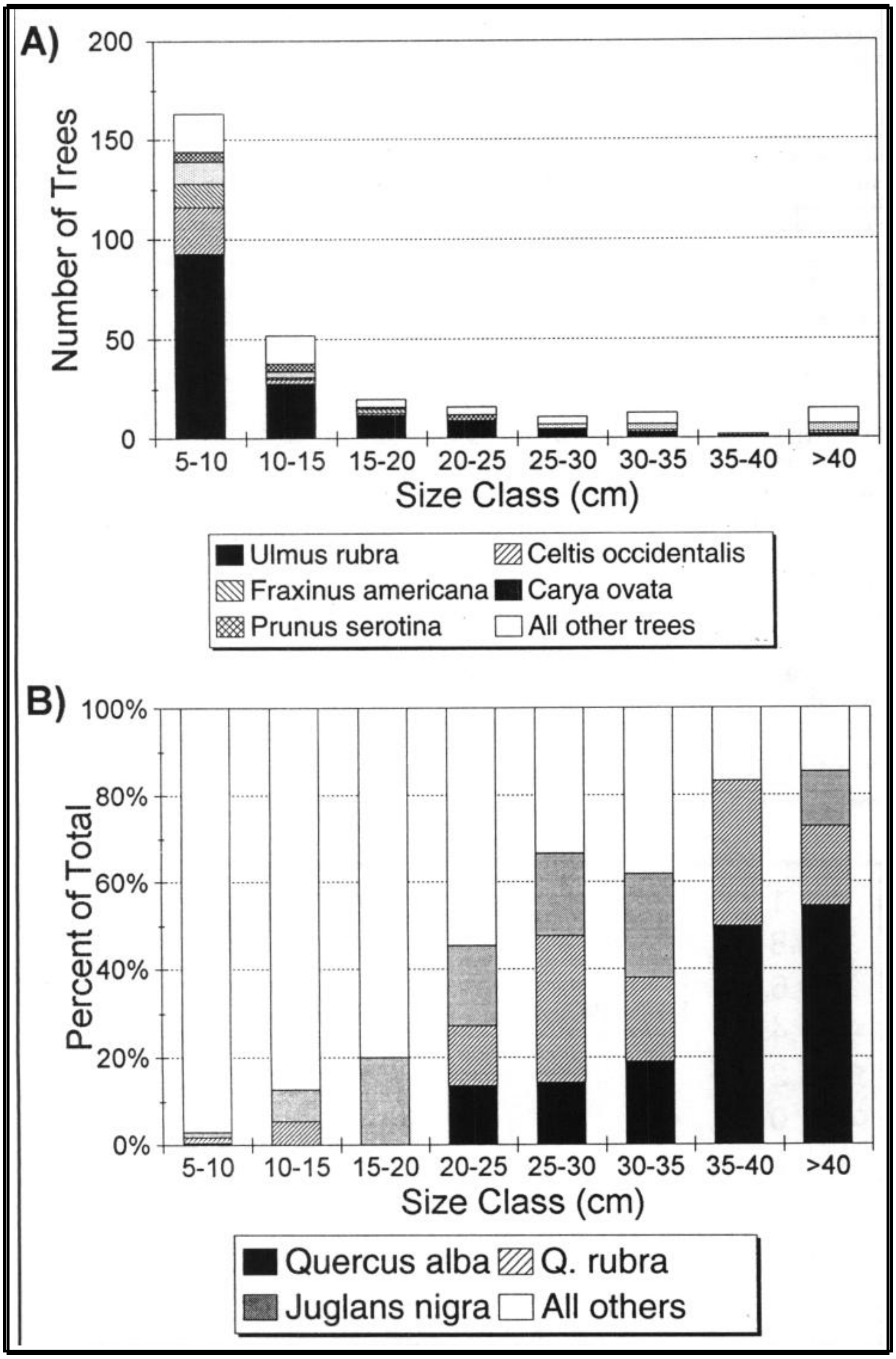

Figure 1. Relative abundances of major tree species of the study site in the George B. Fell Nature Preserve. Data are presented to highlight (A) numerical dominance of five tree species In small size categories using the numbers of trees sampled In nine 10-m by 50-m belt transects, and (B) the proportional dominance of three different tree species in the larger size classes.

Effects of Prescribed Fire

The effects of our March and May fires on *Alliaria petiolata* were difficult to assess owing to the fact that temporal changes in cover in all three units were similar (Table 3) and significant (RMANOVA, $P<0.001$). The primary difference between treatments was that cover was far more severely reduced in the May bum unit than either the March burn unit or the control unit (Table 3). Changes observed in *A. petiolata* cover in control plots are interpreted to be a result of climatic patterns. It is impossible to distinguish fire and climatic effects in the March burn unit. By 1994, A. *petiolata* cover was increasing in all plots.

Fire effects on individual herbaceous species were, in general, complex (Table 3). *Geranium maculatum* and *Parthenocissus quinquefolia* appeared to be unaffected by either fire treatment. *Geum canadense, Podophyllum peltatum,* and *Trillium recurvatum* were low in density and responded unpredictably to fire. *Galium aparine* decreased throughout the site in 1992, even in control plots. *Circaea lutetiana* and *Arisaema triphyllum* appeared to be more strongly impacted by growing season fire but were rebounding by 1994. *Prunus virginiana* decreased in density in both burn plots, while ***Ribes missouriense, Rubus*** *occidentalis,* and *R. allegheniensis* decreased in the May burn unit relative to the March bum and control unit responses. Overall, stem densities increased through the study period in control plots (RMANOVA, $F3\ 264 = 6.38$, $P < 0.001$), remained stable in the March burn unit (RMANOVA, $^{F}31114 = 1.73$, $P = 0.165$), and remained depressed in the May burn unit (RMANOVA, $F3\ 264 = 5.15$, $P = 0.002$) (Table 3). Species richness decreased in 1992 in the March (RMANOVA, $^{F}31114 = 18.70$, $P < 0.001$) and May (RMANOVA, $F3\ 264 = 13.24$, $P < 0.001$) burn units but increased in control plots (RMANOVA, $F3\ 264 = 16.99$, $P < 0.001$) (Table 3).

These species-level effects were summarized at the community level through an ordination of the species densities for the 14 dominant herbs in each experimental unit through the fours years of this experiment (Figure 2). This ordination described 79% of the variation in herb densities in the first two axes (62.4% and 16.6%, respectively). *Arisaema triphyllum* and *Circaea lutetiana* dominated PCA axis I. ***Galium aparine, Geranium maculatum,* and** *Geum canadense* (loading positively) and ***Rubus occidentalis*** (loading negatively) dominated PCA axis II (Table 4). This ordination suggests that by 1994, control

Table 3. Stem densities (per m^2) of major herbs and small shrubs in two fire treatment plots and one control plot in the George B. Fell Nature Preserve, Ogle County, Illinois. Fire treatments were applied between the 1991 and 1992 growing season samples. Percent cover is reported for A. *petiolata* only.

	Stem Density											
	Dormant Season Burn Plots (40)				Spring Burn Plots (90)				Unburned (control) Plots (90)			
Species	**1991**	**1992**	**1993**	**1994**	**1991**	**1992**	**1993**	**1994**	**1991**	**1992**	**1993**	**1994**
Parthenocissus quinquefolia	14.75	4.45	7.65	9.4	10.3	9.8	8.2	6.6	12.3	11.7	13.5	10.8
Circaea lutetiana	13.15	11.9	16.5	11.4	16.5	10.0	10.7	13.7	21.5	28.8	26.0	23.8
Arisaema triphyllum	7.65	4.05	7.0	9.05	6.0	2.3	3.4	3.7	**12.1**	14.2	18.3	8.2
Geranium maculatum	6.0	3.1	7.8	10.4	14.8	12.3	10.1	9.2	7.5	6.0	8.2	13.5
Galium aparine	4.55	0.1	1.2	0.8	8.4	0.2	0.7	2.7	8.4	1.4	2.0	9.6
Trillium recurvatum	0.8	0.15	1.15	0.8	0.18	0	2.84	0.53	0.36	0.88	5.69	7.11
Podophyllum peltatum	1.75	0.9	1.45	1.0	1.24	0.71	1.96	1.42	0.89	1.07	1.07	0.89
Geum canadense	0.1	0.6	0.95	0.7	0.53	0.18	0.36	0.89	0.71	1.07	1.96	3.56
Prunus virginiana	2.95	1.65	3.25	3.2	1.96	1.42	2.13	1.42	2.84	1.96	1.6	2.13
Ribes missouriensis	3.0	1.05	1.95	0.8	3.91	1.42	0.36	0.18	2.13	1.6	4.08	1.6
***Rubus** occidentalis*	0.85	0.40	1.55	1.9	0.53	0.36	0.53	0.00	0.53	0.53	0.71	2.49
Species per plot	5.13	3.85	5.93	5.45	2.43	1.58	1.83	2.19	2.47	2.57	2.88	3.11
Total stem density	59.7	31.9	58.2	55.2	80.2	54.2	55.6	65.2	76.3	86.0	99.9	104.9
Alliaria petiolata (% cover)	40.8	32.1	15.9	41.0	29.4	2.3	5.0	17.3	38.2	16.8	6.6	25.5

and dormant season burn plots had re-turned to a composition similar to that of the initial conditions, and that the growing season burn resulted in a different and longer lasting effect than the dormant sea-son burn. Further, the trajectories of the control and dormant season burn units are similar to one another and distinct from that of the growing season burn unit (Figure 2). Finally, both burn units are similar along PCA axis I but not PCA axis II in 1991, but appear similar to one another on both axes after one fire treatment and three years of recovery.

The effects of fire on herbaceous community structure were most pronounced in the May burn unit, demonstrated most effectively by the unique trajectory in the herb species PCA, where stem density was markedly reduced in 1992. This observation is, in part, a result of the fact that the plant samples were collected approximately one month following the fire, when the herbaceous flora had had a minimal time to recover from the fire treatment. What isn't well documented in these data is that

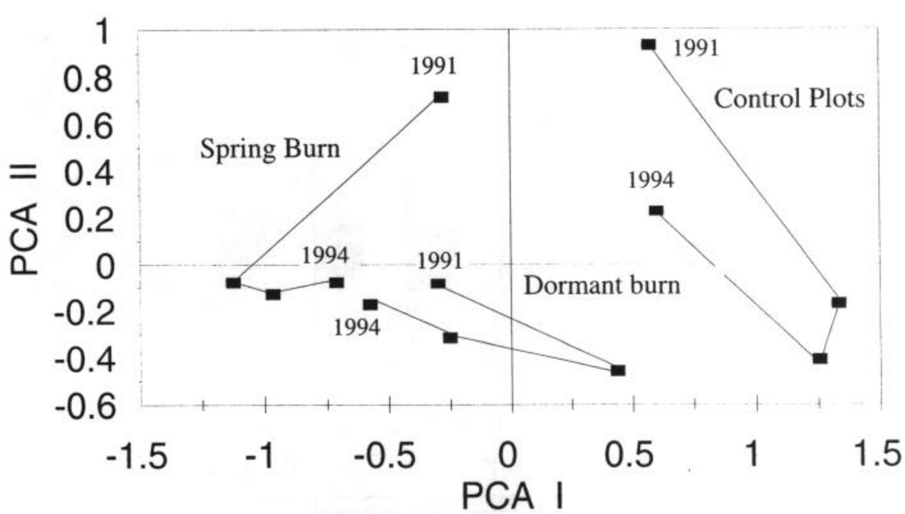

Figure 2. Principal Components Analysis of herbaceous species data from the study site, summarized by burn treatment for each year. Trajectories track changes In herb communities through time for dormant and growing season burn plots and control plot.

the increase in open ground following the growing season burn appeared to persist, in terms of burn mosaic pattern, into the 1994 growing season. Total stem density in 1994 was still lower than prior to the fire treatment (1991). In addition, plants within the growing season burn unit were also noticeably smaller than in either other unit, although the magnitude of this effect was not measured.

Both dormant and growing season fires resulted in top-kill of approximately 95% of small saplings and shrubs (>50 cm tall, <2 cm dbh [Table 2]). Most top-killed small saplings appeared to resprout, resulting in very little outright mortality as a direct effect of the fire. In the larger size class of saplings (2-5 cm dbh), the March bum unit lost 29% (25 of 82) of its saplings and the May burn unit lost 40% (6 of 15) of its saplings, whereas the control plot lost just 1 of 10 saplings (Table 2).

DISCUSSION

Conclusions derived from our research support other research (e.g., Nuzzo 1991) examining the control of A. *petiolata* using fire. First, it appears to be difficult to use fire as the sole method for control of A. *petiolata,* although fire may be a useful tool in combination with other control methods such as herbicides and mechanical removal (Nuzzo 1991). Our experiment suggested that timing is critical in the use of fire to control A. *petiolata.* Our growing season (May) fire, while effective at reducing A. *petiolata* and reducing shrub and sapling growth, also adversely affected **populations** of native understory forbs. This opening of the herbaceous layer in our May burn unit was discernible for three growing seasons following fire, at which time A. *petiolata* was increasing to pre-burn densities. Thus, a managed fire applied after the growing season has begun for the summer herbaceous flora (in this case May 8) can have a lasting impact on native forbs that may not be desirable. In contrast, A. *petiolata* was not adversely affected by a light dormant season fire. These results suggest that the predominant management regime of fall fires, occur-ring during the dormant season, might not best achieve the management objective of *A. petiolata* control. *Alliaria petiolata, a* winter biennial, begins spring growth be-fore nearly all of the other understory forbs do (personal observation). As such, a single fire applied in the narrow window between the dormant season and the full growing season (in this case, between March 5 and May) has the potential to significantly reduce A. *petiolata* while not adversely affecting the native herbaceous flora. Unfortunately, we can only infer this conclusion, since neither fire treatment imposed in this study fell within this target window.

Differences in composition between small trees and large overstory trees suggest that an ongoing process of vegetation change occurs in this stand. This apparent shift makes the George B. Fell Preserve an ideal candidate for fire management to facilitate regeneration among the less shade tolerant trees. Implementation of such fire management, however, is problematic. In Illinois, both natural and anthropogenic (initiated by Native Americans) fires apparently were most frequent in the fall, particularly in late October (McClain and Elzinga 1994). If the management objective is to simply remove small woody biomass, then our research suggests that light to moderate fires in either the dormant or growing season achieve that objective. Our dormant season burn, however, had less of an impact on the A. *petiolata* population. Paralleling this observation, the native understory flora was also less affected by the dormant season burn.

A management problem suggested by this research is that this window during which *A. petiolata* control may be most effective (i.e., early spring) is short in duration and unpredictable with respect to appropriate fire weather. Thus, widespread application of fire to control A. *petiolata* may be challenging. In addition, implementation of a fire program to control A. *petiolata* may be problematic in areas where A. *petiolata* is widespread, because well-timed spring fire is most effective but repeated burns are required to exhaust the seed bank. It would be difficult to simultaneously use fire for a broad array of sites because of the constraints on the number of appropriate burn days available each year.

ACKNOWLEDGMENTS

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Table 4. Species scores for the dominant species in a Principal Components Analysis of herb layer species data, summarized by burn treatment plot for the study site in the George B. Fell Nature Preserve for years 1991-1994. Boldface numbers highlight species that are most strongly related to (i.e., explain the most variance in) each PCA axis (subjectively set at loading 1.00).

	I	II	III	**IV**
Proportion of Variance Explained by Principal Components Analysis				
By Axis	62.4	16.7	**8.8**	5.7
Cumulative	62.4	79.1	87.8	93.6
Species Scores				
Circaea lutetiana	**1.26**	0.05	-0.78	-0.36
Arisaema triphyllum	**1.15**	-0.36	**1.00**	0.80
Galium aparine	0.30	**2.20**	0.69	**-1.16**
Geranium maculatum	-0.49	**1.87**	-0.74	**1.33**
Geum canadense	0.73	**1.10**	**-1.36**	**1.44**
Rubus allegheniensis	-0.17	**-1.00**	**1.00**	-0.84
Parthenocissus quinquefolia	0.69	0.36	**2.44**	0.09
Ribes missouriensis	0.62	0.55	**1.43**	0.05
Alliaria petiolata	0.44	0.52	**1.20**	**-1.92**
Trillium recurvatum	0.54	0.99	-0.48	**2.79**
Prunus virginiana	0.04	-0.60	0.76	**-1.52**
Rubus occidentalis	0.18	0.84	-0.19	**1.27**
Toxicodendron radicans	0.58	-0.80	0.90	0.58
Podophyllum peltatum	-0.31	-0.90	-0.25	-0.88

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James R. Heim is a Natural Heritage Biologist with the Illinois Department of Natural Resources. He specializes in the preservation, restoration, and management of Illinois natural areas and endangered species habitats and has over ten years of experience in natural resources management in northern Illinois.

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APPENDIX. A partial flora of the George B. Fell Nature Preserve, Castle Rock State Park, Ogle County, Illinois.

Tree Species

Acer negundo	**boxelder**
Carpinus caroliniana	**blue beech**
Carya ovata	**shagbark hickory**
Carya ***cordiformis***	**bittemut hickory**
Celtis occidentalis	**hackberry**
Cornus alternifolia	**alternate-leaved dogwood**
Fraxinus americana	**white ash**
Fraxinus pennsylvanica	**green ash**
Gleditsia tricanthos	**honeylocust**
Juglans nigra	**black walnut**
Ostrya virginiana	**hop hornbeam**
Populus grandidentata	**large-toothed aspen**
Prunus serotina	**wild black cherry**
Quercus alba	**white oak**
Quercus rubra	**red oak**
Quercus velutina	**black oak**
Tilia americana	**basswood**
Ulmus americana	**American elm**
Ulmus rubra	**slippery elm**

Small Tree, Shrub, and Woody Vine Species

Cornus racemosa	grey dogwood
Corylus americana	hazelnut
Crataegus mollis	red hawthorn
Lonicera prolifera	grape honeysuckle
Parthenocissus ***quinquefolia***	Virginia creeper
Prunus virginiana	common chokecherry
Ribes missouriense	Missouri gooseberry
Rosa carolina	pasture rose
Rosa multiflora	multiflora rose
Rubus allegheniensis	**common blackberry**
Rubus *occidentalis*	black raspberry
Sambucus canadensis	elderberry
Smilax hispida	bristly catbrier
Smilax lasioneuron	carrion flower
Smilax ecirrhata	carrion flower
Toxicodendron radicans	posion ivy
Viburnum prunifolium	**blackhaw**
Vitis aestivalis	summer grape
Vitis riparia	riverbank grape
Zanthoxylum americanum	**prickly-ash**

Herbaceous Species

Actaea pachypoda	doll's-eye
Adiantum pedatum	maidenhair fern
Agrimonia pubescens	soft agrimony
Alliaria petiolata	garlic mustard
Allium tricoccum	wild leek
Amphicarpa bracteata	hog peanut
Anemone quinquefolia	wood anemone
Arisaema ***triphyllum***	Jack-in-the-pulpit

Athyrium angustum	lady fern
Botrychium *virginianum*	rattlesnake fern
Brachyelytrum *erectrum*	woodland awn grass
Campanula americana	American bellflower
Caulophyllum *thalictroides*	**blue cohosh**
Carex blanda	sedge
Carex convoluta	sedge
Carex hirtifolia	sedge
Carex grisea	sedge
Chenopodium album	lamb's quarters
Circaea lutetiana	enchanters nightshade
Cirsium vulgare	bull thistle
Cypripideum pubescens	yellow lady's-slipper orchid
Cryptotaenia canadensis	honewort
Desmodium glutinosum	pointed tick trefoil
Elymus hystrix	bottlebrush grass
Elymus villosus	slender wild rye daisy
Erigeron annuus	fleabane purple
Eupatorium *purpureum*	Joe-pye-weed
Eupatorium rugosum	white snakeroot
Festuca ***obtusa***	nodding fescue
Galium aparine	goosegrass
Galium concinnium	shining bedstraw
Geranium maculatum	wild geranium
Geum canadense	white avens
Hackelia virginiana	stickseed
Laportea canadensis	wood nettle
Leersia virginica	white grass
Lobelia inflata	Indian tobacco
Lilium michiganense	Turk's cap lily
Menispermum canadense	moonseed
Mertensia virginica	bluebells
Onoclea sensibilis	sensitive fern yellow
Oxalis stricta	wood sorrel
Phryma leptostachya	lopseed
Pilea pumila	clearweed
Podophyllum peltatum	mayapple
Polygonum virginianum	Virginia knotweed
Polygonatum commutatum	Solomon's seal common
Potentilla simplex	cinquefoil small-flowered
Ranunculus abortivus	crowfoot hooked crowfoot
Ranunculus recurvatus	swamp buttercup late
Ranunculus septentrionalis	figwort
Scrophularia marilandica	false Solomon's seal
Smilacina racemosa Stachys	hedge nettle common
tenuifolia	dandelion
Taraxacum officinale	red trillium
Trillium recurvatum	common horse gentian
Triosteum perfoliatum	stinging nettle yellow
Urtica dioeca	bellwort smooth yellow
Uvularia grandiflora	violet woolly blue violet
Viola pubescens var. *eriocarpa*	common blue violet
Viola sororia	
Viola pratincola	