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Plant Community Change Following Fifty-years of Management at Kalsow Prairie Preserve, Iowa, U.S.A.

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ABSTRACT.—Over the last 200 y the tallgrass prairie of the Midwestern United States has experienced widespread conversion to agricultural production. Today, the few remaining tracts of unplowed grassland persist as small isolated patches within a landscape of row-crop agriculture. The small size and isolation of these prairie remnants raises concerns over their long-term sustainability. In this study I examined changes in the upland plant community that have occurred since state acquisition of one of Iowa's oldest prairie preserves. I found that 50 y of management has succeeded in reducing the frequency of exotic species and, thus, improved the overall integrity of the native plant community. However, during this same period dramatic changes in the frequency of many native species have also occurred. A general increase by mesic and late flowering species and a decrease by xeric natives was observed. Changes coincided with a documented shift in management from mid-summer haying prior to state ownership to spring burning, suggesting that burning may have exerted selective forces altering the composition of the native community over the past 50 y. My results emphasize the need to merge our current understanding of the processes that help sustain diversity into implemented management practices that will prolong the diversity of our remaining small isolated prairie preserves.

INTRODUCTION

Two hundred y ago, central North America was covered by a vast perennial grassland stretching for an estimated 162 million ha (Samson and Knopf, 1994). From the Rocky Mountains east to Indiana, from Manitoba south into Texas, from the water-limited short grass prairies of the west to the vigorous robust grasses of the east, this great grassland persisted as one large unbroken ecosystem (Kucera, 1992). The uninterrupted form of North America's grassland facilitated the flow of genes, seeds and species necessary to perpetuate diversity, stability and resilience in the face of inevitable climatic shifts and disturbances. This unbroken blanket of grass no longer exists, and no region has experienced greater fragmentation and change than the moist fertile tallgrass prairie of the Midwest (Samson and Knopf, 1994).

The rich fertility of midwestern soils resulted in the widespread conversion of native grassland into agricultural production. Since 1830 native tallgrass prairie has experienced statewide declines ranging from 82.6 to 99.9% (Samson and Knopf, 1994). Iowa lies in the heart of this region, laying claim to 12,500,000 ha of grassland prior to European settlement. Today, Iowa's prairie is reduced to a mere 12,140 ha, only 0.1% of its original extent (Samson and Knopf, 1994). The few unplowed prairies still surviving exist as isolated islands within a matrix of row-crop agriculture (Fig. 1). High rates of plant species loss have been shown from many small remnants in Wisconsin (Leach and Givnish, 1996), casting doubt on the long-term sustainability of their diversity. My study was designed to examine long-term

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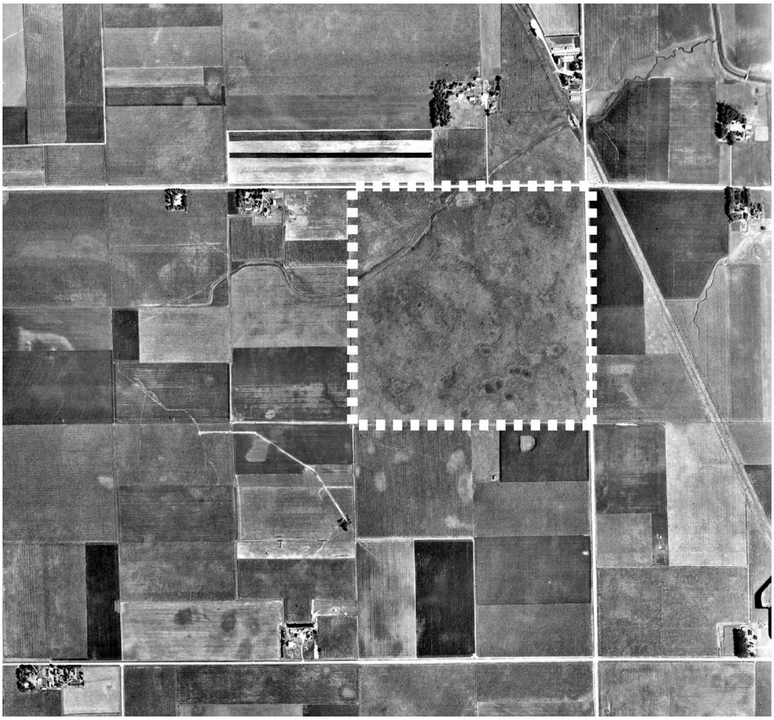

FIG. 1.—Aerial photograph of Kalsow Prairie Preserve (64.75 ha, located 42°34′N, 94°34′W) in 1953, roughly 4 y after its purchase by the state of Iowa. Note that Kalsow Prairie is already completely surrounded by row crop agriculture and is isolated from any other unplowed grassland parcels. Broken line highlights Kalsow Prairie's boundary

changes that have occurred to the flora of one of Iowa's oldest, largest, and most important prairie preserves by repeating a 1950 survey of the upland plant community.

Kalsow prairie is a 64.75-ha preserve purchased by the state of Iowa in 1949. This preserve posses several unique features that make it an ideal site for evaluating long-term prairie preservation. First, Kalsow is one of the two original prairie preserves purchased by the state. As such, it has been managed for a longer time than most preserves in the Midwest. In addition, Kalsow is an isolated preserve (Fig. 1), representing one of the five largest virgin prairies still remaining within the most recently glaciated region of Iowa (Rosburg, 2001). In fact, Kalsow Prairie's size, although obviously tiny relative to preserves in most parts of the world, is roughly 10 times larger than the largest preserve used by Leach and Givnish (1996). Thus, any changes observed at Kalsow should be conservative indicators of changes that may be occurring to the more common smaller prairie preserves scattered across the Midwest. Finally, Kalsow Prairie has a well-researched and documented history, providing a long-term record of past management (*e.g.,* Moyer, 1953; Brotherson, 1969; Richards, 1969).

METHODS

Kalsow Prairie is located in southern Pocahontas County, Iowa, U.S.A. (42°34′N, 94°34′W) on Iowa's youngest geological landform, experiencing its last glacial event roughly 13,000 y ago (Prior, 1991). Upland areas are dominated by Webster and Clarion soils, characterized as fine-loamy, mixed, mesic Typic Haplaquolls (Finley and Lucassen, 1985). The region averages 208 growing days per year (days with temperatures >0 C), has an average annual rainfall of 77.4 cm, with a mean January temperature of –8.7 C and a mean July temperature of 23.1 C (Carlson and Todey, 2001). Changes in annual precipitation from 1951 to 2000 (Carlson and Todey, 2001) were tested using simple linear regression.

In the summer of 1949 Moyer (1953) initiated a 2-y study of Kalsow Prairie's upland plant community using a systematic survey of 1-m^2 quadrats placed throughout the prairie. Moyer divided the prairie into 64 100-m by 100-m sections and randomly placed one quadrat within each of them. In May, June and August of 1950 Moyer recorded the species present within each quadrat, eliminating all quadrats within lowland or disturbed areas. In total, 40 of the possible 64 quadrats established were sampled, which was sufficiently large to describe Kalsow Prairie's upland community (Moyer, 1953). Moyer (1953) presented his data as frequency of occurrence within quadrats for each species recorded.

In August 1999 I replicated Moyer's experimental design by systematically placing 64 1-m^2 quadrats across the entirety of Kalsow Prairie. I placed one 1-m^2 quadrat in the center of each of the 64 sections established by Moyer (1953). Following placement, all four corners of each quadrat were flagged to allow for exact relocation. Frequency of occurrence was then calculated for each species found within quadrats representative of upland prairie. Moyer (1953) did not specify how he defined "upland" prairie, so I used the definition of Brotherson (1969), "... areas including the major portion of the study area on the ridges and adjacent lower slopes." My final determination of upland prairie was made using the criteria of Brotherson (1969) and by omitting quadrats disturbed by mima mounds and those lying within the successional area in the northwest corner (Moyer, 1953). Forty-two of the 64 quadrats met these criteria and were considered representative of the upland plant community. In August 1999 and June 2000, every species rooted within each quadrat was recorded.

Plant identification often varies between authors, potentially suggesting changes in community structure and composition, when in fact only species identification or taxonomic classification differs. I took two steps to assure that my findings reflect true changes, not plant-identification differences. First, taxonomic changes and synonyms were updated to nomenclature found in Eilers and Roosa (1994). Second, only species easily identified were used for statistical comparisons. Species easily misidentified, such as those in the genera *Carex*, *Dichanthelium* and *Equisetum*, prevented their use as indicators of change. There were discrepancies in Moyer's identification of *Fragaria* and *Physalis* species that prevented comparison at the species level to my 1999/2000 data. In each of the above cases all species in both the 1950 and 1999/2000 surveys were combined to the genera level prior to statistical comparisons. Moyer (1953) only presented frequency data and, thus, combination was not possible for *Dichanthelium* species. As a result, this genus was only recorded as being present in both survey years. Based on these precautions, I feel confident that the results reported are both robust and real.

I compared my 1999/2000 data with Moyer's 1950 data at two distinct levels of organization. Overall changes in plant community composition were detected using Sorensen's Community Similarity Index, $S_s = 2a/(2a + b + c)$, where a = the number of species identified in 1999/2000 and 1950, b = the number of species identified in 1950 but not in 1999/2000 and c = the number of species identified in 1999/2000 but not 1950 (Legendre and Legendre, 1998). This index produces values ranging from 0, where the two communities examined share no similar species, to 1, where both communities contain identical species. Although this index does not allow for the determination of statistical significance, its use of species presence/absence data results in a very robust means of community comparison (Legendre and Legendre, 1998). At the species level, changes in species frequency between 1950 and 1999/2000 surveys were tested for statistically significant differences using an adjusted chi-squared test ($P \leq 0.05$). The adjusted Chi Squared test accounts for empty cells, thereby providing a more robust means of determining real changes (Ott, 1993).

RESULTS

I found 81 vascular plant species representing 64 genera in 23 families (Table 1). Four species were of non-native origin, or roughly 5.0% of species recorded (Table 1). These values are quite similar to Moyer's 1950 survey results (*i.e.,* 78 species from 23 families, including 6 non-natives, Table 1). In 1999/2000 the upland prairie community had a mean richness of 17.8 species per m^2 with a standard error of 0.5 ($n = 42$). The maximum species richness recorded for any quadrat was 26, while the minimum was 10. Moyer (1953) did not present species richness data at the quadrat level ($1\text{-}m^2$).

No significant change ($P > 0.3$) in annual precipitation was detected between 1951 and 2000. Precipitation records prior to 1951 were not available (Carlson and Todey, 2001). The possibility that drier conditions existed previous to state purchase in 1949 cannot, therefore, be excluded.

Species composition of Kalsow Prairie's upland prairie has changed over the past 50 y. Based on Sorensen's Community Similarity Index, the similarity between 1950 Kalsow Prairie and 1999/2000 Kalsow Prairie was 0.61. At the level of individual species, 35 species significantly changed in frequency (or a total of 33.7% of 104 species compared statistically) (Table 2). Of those, 19.2% increased in frequency, while 14.4% decreased. In total, there were 9 non-native species included on either species list (Table 1), of which 22.2% showed significant decreases and none showed significant increases in frequency since the original 1950 survey (Table 2).

DISCUSSION

The similarity between the 1950 and 1999/2000 upland plant communities at Kalsow Prairie was only 0.61, and ⅓ of all species compared ($n = 104$) changed significantly in frequency since 1950. Ecosystems are not static and continuous change is expected with time (Watt, 1947; van der Valk and Davis, 1978; Howe, 1994a). However, the specific nature of these changes can provide insight into the long-term consequences of management at Kalsow Prairie.

Prior to purchase of the prairie in 1949 the land had been, "... owned by one family for over a generation during which Kalsow was mowed closely ..." (Moyer, 1953). This land use is reflected in Kalsow Prairie's 1950 community composition; introduced cool season forage grasses such as *Phleum pratense* and *Agrostis gigantea* were present in 85% and 25% of surveyed quadrats, respectively. Additionally, *Trifolium pratense,* a common pasture legume, was present in 13% of surveyed quadrats. The presence of these introduced species likely reflects the combined effects of intentional seeding and mowing on species composition. For example, Gibson *et al.* (1993) found that mowing in tallgrass prairies increased the frequency of many exotic pasture species. Since 1950 the frequency of these three introduced species has decreased dramatically; none were found within sampled quadrats in 1999/2000. *Poa pratensis* provides a notable exception, as it was present in 90% of quadrats in both 1950 and 1999/2000. Overall however, 50 y of management at Kalsow Prairie has succeeded in decreasing the frequency of most non-native plants.

Since 1950 there has also been a significant decrease in the frequency of many native xeric species (based on Reed, 1988), including *Schizachyrium scoparium* (85 to 2%), *Koeleria*

TABLE 1.—Number of plant families, genera and species recorded in upland quadrats from Kalsow Prairie, Iowa. Counts for 1950 are from Moyer (1953) and are based on 40 quadrats, while 1999/2000 counts are from this study and based on 42 quadrats. For *Carex*, *Fragaria* and *Physalis* in 1950 and *Melilotus* in 1999/2000 identification was only to the genera level, so each genus was also counted as one species for their respective survey years

Classification	1950	1999/2000	Total
Families	23	23	27
Genera	65	64	83
Species	78	81	113
Non-native species	6	4	9

macrantha (25 to 0%), *Cirsium hillii* (18 to 0%), *Antennaria neglecta* (68 to 0%), *Baptisia bracteata* (15 to 0%), *Dalea purpurea* (33 to 7%) and *Anemone cylindrica* (35 to 7%). During the same time there was no change in annual precipitation, suggesting that factors other than climatic are responsible for observed trends. I hypothesize that the decreased frequency of xeric species likely resulted from cessation of mid-summer haying following Kalsow Prairie's purchase. Mowing influences many aspects of vegetative structure; reducing canopy height (Parr and Way, 1988; Schacht *et al.*, 1998), plant cover (Gilley *et al.*, 1996; Gibson *et al.*, 1993), standing biomass (Titlyanova *et al.*, 1990; Gilley *et al.*, 1996), litter thickness (Schacht *et al.*, 1998) and sub-canopy microclimate. Moyer (1950) reported that Kalsow Prairie's litter thickness was only half as thick as that measured at the unhayed Hayden Prairie, the second of the two original Iowa prairie preserves. Midsummer haying of Kalsow Prairie may have influenced litter accumulation and site microclimatic conditions (*see* Facelli and Pickett, 1991) prior to 1950 when the prairie supported a more xeric upland plant community.

Since establishment of Kalsow Prairie, the primary management tool for the preserve gradually changed to spring burning. The first controlled burn occurred in the spring of 1959 (unpubl. data), with the second conducted in the spring of 1968 (Richards, 1969). Subsequent burns continued periodically through the 1970s and into the mid-1980s. Since 1986, ¼ to ½ of the prairie has been burnt on an average of every 2.3 y. All controlled burns occurred in April, with no fires occurring after May. Spring burning increases production and flowering by warm-season grasses (Collins, 1987; Glenn-Lewin *et al.*, 1990; Kucera, 1992; Collins *et al.*, 1995) and late flowering species in general (those species flowering post mid-July) (Howe, 1994b). In contrast, mid-season biomass removal, such as haying or mid-summer burns, favors growth by cool-season and early flowering species (Hover and Bragg, 1981; Howe, 1994b). I found that the frequencies of cool-season grasses, both native and introduced, have decreased since 1950, while the frequencies of many late flowering forbs have increased (Table 2). For example, *Agrostis gigantean*, *Koeleria macrantha* and *Poa pratense* have significantly decreased in frequency, while *Aster ericoides*, *A. laevis*, *A. lanceolatus*, *Helianthus grosseserratus*, *Solidago canadensis* and *S. rigida* all have increased (Table 2). These changes were accompanied by an increased frequency in many native sub-canopy species (*e.g.*, *Calystegia sepium*, *Fragaria* spp., *Galium obtusum* and *Phlox pilosa*, Table 2). Although burning and mowing can result in similar responses from prairie vegetation (Rice and Parenti, 1978; Hover and Bragg, 1981), haying at Kalsow occurred during the summer, whereas current management consists of spring burns. Altering the timing of biomass removal can strongly influence community composition (Conrad, 1954; Hover and Bragg, 1981; Hirsch *et al.*, 1986; Howe, 1994b) and appears to have done so at Kalsow Prairie during the last 50 y.

TABLE 2.—Frequency of occurrence of upland prairie species in 1-m^2 quadrats in Kalsow Prairie State Preserve, Iowa. Data from 1950 were collected by Moyer (1953) (n = 40 quadrats); 1999/2000 data were collected in the present study (n = 42 quadrats). NA under frequency columns indicates that taxa were not identified to the species level. Frequency data for 1999/2000 differing significantly from 1950 values at $P \leq 0.05$ (Adj. Chi Squared) are indicated by *. Non-native species are indicated by ^{E} preceding the species name

Family	Species	Frequency	
		1950 (%)	1999/2000 (%)
Apiaceae	*Cicuta maculata* L.	10.0	0.0
Apiaceae	*Eryngium yuccifolium* Michx.	2.5	14.3
Apiaceae	*Zizia aptera* (Gray) Fern.	10.0	0.0
Apiaceae	*Zizia aurea* (L.) Koch	67.5	81.0
Apocynaceae	*Apocynum sibiricum* Jacq.	0.0	2.4
Asclepiadaceae	*Asclepias sullivantii* Engelm. ex Gray	5.0	9.5
Asclepiadaceae	*Asclepias syriaca* L.	0.0	7.1
Asclepiadaceae	*Asclepias tuberosa* L.	2.5	7.1
Asclepiadaceae	*Asclepias verticillata* L.	5.0	0.0
Asteraceae	*Achillea millefolium* L.	45.0	21.4*
Asteraceae	*Ambrosia artemisiifolia* L.	0.0	2.4
Asteraceae	*Ambrosia trifida* L.	0.0	2.4
Asteraceae	*Antennaria neglecta* Greene	67.5	0.0*
Asteraceae	*Artemisia ludoviciana* Nutt.	2.5	9.5
Asteraceae	*Aster ericoides* L.	37.5	73.8*
Asteraceae	*Aster laevis* L.	7.5	35.7*
Asteraceae	*Aster lanceolatus* Willd.	0.0	40.5*
Asteraceae	*Cirsium altissimum* (L.) Sprengel	0.0	14.3*
Asteraceae	*Cirsium discolor* (Muhl. ex Willd.) Sprengel	5.0	0.0
Asteraceae	*Cirsium hillii* (Canby) Fern.	17.5	0.0*
Asteraceae	*Coreopsis palmata* Nutt.	7.5	0.0
Asteraceae	*Echinacea pallida* Nutt.	10.0	0.0
Asteraceae	*Erigeron strigosus* Muhl. ex Willd.	7.5	0.0
Asteraceae	*Euthamia graminifolia* (L.) Nutt. ex Cass.	5.0	19.1
Asteraceae	*Helianthus grosseserratus* Martens	10.0	76.2*
Asteraceae	*Helianthus maximiliani* Schrader	0.0	7.1
Asteraceae	*Helianthus rigidus* (Cass.) Desf.	7.5	23.8
Asteraceae	*Heliopsis helianthoides* (L.) Sweet	17.5	11.9
Asteraceae	*Liatris pycnostachya* Michx.	27.5	9.5
Asteraceae	*Liatris scariosa* (L.) Willd.	25.0	0.0*
Asteraceae	*Prenanthes racemosa* Michx.	0.0	2.4
Asteraceae	*Ratibida pinnata* (Vent.) Barnh.	10.0	40.5*
Asteraceae	*Rudbeckia hirta* L.	0.0	2.4
Asteraceae	*Silphium laciniatum* L.	15.0	19.1
Asteraceae	*Solidago canadensis* L.	0.0	76.2*
Asteraceae	*Solidago gigantea* Aiton	15.0	0.0*
Asteraceae	*Solidago missouriensis* Nutt.	5.0	0.0
Asteraceae	*Solidago nemoralis* Aiton	2.5	11.9
Asteraceae	*Solidago rigida* L.	5.0	28.6*
Asteraceae	^{E}*Taraxacum officinale* Weber	0.0	2.4
Boraginaceae	*Lithospermum canescens* (Michx.) Lehm.	17.5	2.4
Convolvulaceae	*Calystegia sepium* (L.) R. Br.	2.5	47.6*
Convolvulaceae	^{E}*Ipomoea purpurea* (L.) Roth	2.5	0.0
Cyperaceae	*Carex bicknellii* Britton	NA	4.8

TABLE 2.—Continued

Family	Species	Frequency 1950 (%)	Frequency 1999/2000 (%)
Cyperaceae	*Carex brevior* (Dewey) Mack. ex Lunell	NA	11.9
Cyperaceae	*Carex buxbaumii* Wahl.	NA	2.4
Cyperaceae	*Carex crawei* Dewey	NA	2.4
Cyperaceae	*Carex meadii* Dewey	NA	2.4
Cyperaceae	*Carex sartwellii* Dewey	NA	2.4
Cyperaceae	*Carex* spp.	5.0	50.0
Cyperaceae	*Carex* Total spp.	5.0	69.1*
Cyperaceae	*Eleocharis compressa* Sulliv.	0.0	19.1*
Equisetaceae	*Equisetum arvense* L.	0.0	2.4
Equisetaceae	*Equisetum laevigatum* A. Br.	42.5	23.8
Equisetaceae	*Equisetum* Total spp.	42.5	26.2
Fabaceae	*Amorpha canescens* Pursh	27.5	19.1
Fabaceae	*Amphicarpaea bracteata* (L.) Fern.	0.0	14.3*
Fabaceae	*Astragalus canadensis* L.	0.0	4.8
Fabaceae	*Baptisia bracteata* Muhl. ex Ell.	15.0	0.0*
Fabaceae	*Dalea candida* Willd.	7.5	0.0
Fabaceae	*Dalea purpurea* Vent.	32.5	7.1*
Fabaceae	*Desmodium canadense* (L.) DC.	5.0	26.2*
Fabaceae	*Lathyrus palustris* L.	0.0	19.1*
Fabaceae	*Lathyrus venosus* Muhl. ex Willd.	5.0	0.0
Fabaceae	*Lespedeza capitata* Michx.	2.5	2.4
Fabaceae	[E]*Melilotus* spp.	0.0	4.8
Fabaceae	*Pediomelum argophyllum* (Pursh) Grimes	5.0	4.8
Fabaceae	[E]*Trifolium pratense* L.	12.5	0.0
Fabaceae	*Vicia americana* Muhl. ex Willd.	7.5	31.0*
Gentianaceae	*Gentianopsis crinita* (Froel.) Ma.	2.5	0.0
Iridaceae	*Sisyrinchium campestre* Bickn.	0.0	14.3*
Liliaceae	*Allium canadense* L.	0.0	4.8
Liliaceae	*Hypoxis hirsuta* (L.) Cov.	0.0	2.4
Lamiaceae	*Lycopus americanus* Muhl. ex Willd.	0.0	2.4
Lamiaceae	*Monarda punctata* L.	2.5	0.0
Lamiaceae	*Pycnanthemum virginianum* (L.) Dur & Jackson	5.0	4.8
Lamiaceae	*Scutellaria parvula* Michx.	0.0	2.4
Lamiaceae	*Teucrium canadense* L.	0.0	9.5
Nyctaginaceae	*Mirabilis hirsuta* (Pursh) MacM.	2.5	0.0
Oxalidaceae	*Oxalis stricta* L.	0.0	9.5
Poaceae	*Agropyron trachycaulum* (Link) Malte	2.5	0.0
Poaceae	[E]*Agrostis gigantea* Roth	25.0	0.0*
Poaceae	*Andropogon gerardii* Vitman	87.5	88.1
Poaceae	*Bouteloua curtipendula* (Michx.) Torrey	7.5	0.0
Poaceae	[E]*Bromus inermis* Lesser	0.0	4.8
Poaceae	*Dichanthelium oligosanthes* (Schultes) var. *scribneriamum* Gould	25.0	0.0
Poaceae	*Dichanthelium acuminatum* (Sw.) var. *villosum* (Gray) Gould & Clark	12.0	0.0
Poaceae	*Dichanthelium leibergii* (Vasey) Freckm.	0.0	71.4
Poaceae	*Dichanthelium* spp.	0.0	9.5
Poaceae	*Elymus canadensis* L.	12.5	21.4
Poaceae	*Koeleria macrantha* (Ledeb.) Schultes	25.0	0.0*

TABLE 2.—Continued

Family	Species	Frequency 1950 (%)	1999/2000 (%)
Poaceae	*Muhlenbergia racemosa* (Michx.) BSP.	0.0	7.1
Poaceae	*Panicum virgatum* L.	75.0	28.6*
Poaceae	[E]*Phleum pratense* L.	85.0	0.0*
Poaceae	[E]*Poa compressa* L.	12.5	0.0
Poaceae	[E]*Poa pratensis* L.	90.0	90.5
Poaceae	*Schizachyrium scoparium* (Michx.) Nash	85.0	2.4*
Poaceae	*Sorghastrum nutans* (L.) Nash	42.5	52.4
Poaceae	*Spartina pectinata* Link	17.5	19.1
Poaceae	*Sporobolus heterolepis* (Gray) Gray	85.0	69.1
Poaceae	*Stipa spartea* Trin.	20.0	7.1
Polemoniaceae	*Phlox pilosa* L.	10.0	47.6*
Polygonaceae	*Polygonum amphibium* L. var. *emersum* Michx.	5.0	0.0
Primulaceae	*Lysimachia hybrida* Michx.	5.0	0.0
Primulaceae	*Lysimachia quadriflora* Sims	0.0	2.4
Ranunculaceae	*Anemone canadensis* L.	0.0	2.4
Ranunculaceae	*Anemone cylindrica* Gray	35.0	7.1*
Ranunculaceae	*Thalictrum dasycarpum* Fisher & Ave-Lall.	7.5	0.0
Rhamnaceae	*Ceanothus herbaceus* Raf.	2.5	0.0
Roseaceae	*Fragaria* spp.	7.5	0.0
Roseaceae	*Fragaria virginiana* Duschesne	0.0	54.8
Roseaceae	*Fragaria* Total spp.	7.5	54.8*
Roseaceae	*Rosa arkansana* Porter	45.0	73.8*
Rubiaceae	*Galium obtusum* Bigelow	5.0	64.3*
Santalaceae	*Comandra umbellata* (L.) Nutt.	45.0	16.7*
Scrophulariaceae	*Pedicularis canadensis* L.	22.5	2.4*
Solanaceae	*Physalis* spp.	7.5	NA
Solanaceae	*Physalis heterophylla* Nees	0.0	14.3
Solanaceae	*Physalis* Total spp.	7.5	14.3
Violaceae	*Viola pedatifida* G. Don	5.0	11.9
Violaceae	*Viola sororia* Willd.	0.0	2.4

Notes: Total frequency was reported for *Carex*, *Equisetum*, *Fragaria* and *Physalis* spp. when taxonomic classification was only to the genus level, or when species identification was uncertain for at least one of the survey years. This precaution assures that all statistical differences are real and not the result of differences in identification. Difficulties in identifying *Dichanthelium* species, coupled with an inability to combine 1950 frequency values prevented statistical comparisons for this genus

Kalsow Prairie's age, size, isolation and documented history make this study an important indicator for the long-term sustainability of prairie preserves in general. Leach and Givnish (1996) documented dramatic losses of species richness from small, isolated tallgrass prairie remnants in Wisconsin following fire elimination. In my study, 50 y of prairie management, with a documented shift from agricultural haying to spring burning, has reduced the frequency of non-native species at Kalsow Prairie (Tables 1, 2). However, during this same time the frequencies of ~30% of all native species' have changed. Thirteen native species had frequency changes greater than 30%, and changes greater than 75% were found for four native species (Table 2). Although the nature of this study prevents determination of definitive cause and effect relationships, taken together my results suggest that while implementation of a uniform management practice has increased and maintained native dominance, this practice may have also exerted strong selection pressures upon the native community. Prolonged implementation of uniform management may have inadvertently decreased the frequency of some native xeric species, potentially undermining attempts at maintaining maximum species diversity. Collins *et al.* (1998) have shown experimentally that maximum local diversity in a Kansas tallgrass prairie was maintained only when multiple selective forces were allowed to operate in combination. The results of this 50 y case study appear to support their results, emphasizing the need to address this issue in practice if we hope to maintain maximum native species diversity on our few remaining prairie preserves.

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