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Prairie Establishment in Southwestern Ohio

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Abstract. In 1979 a tallgrass prairie was established in southwestern Ohio; a second prairie, adjacent to the first, was established in 1983 (4-year and 8-year sites). These sites differed in time since establishment, seed source, extent of burning, and extent of soil preparation. Six remnant prairies were also selected for comparison with the established sites. The 8-year site was dominated by switchgrass (*Panicum virgatum* L.) and indiangrass [*Sorghastrum nutans* (L.) Nash.], components of the original seed mix, while the 4-year site was dominated by old-field species and big bluestem (*Andropogon gerardii* Vitman). Both 4-year and 8-year sites were equally similar to native Ohio prairies in terms of species presence, but not in terms of species abundance. Most of the vegetational differences between the established sites were attributed to the source of the seed used in prairie establishment. The seed source also accounted for differences between the study sites and native Ohio sites.

Key Words. establishment methods, reconstruction, remnants, tallgrass prairie, Ohio

INTRODUCTION

A peninsula of tallgrass prairie once extended across the midwest covering approximately 1 million square kilometers (Barbour *et al.* 1980). The easternmost extension of this vegetational unit consisted of isolated prairie patches occurring in the state of Ohio (Gleason 1922, Transeau 1935, Wistendahl 1975). Today, 55 of Ohio's 88 counties support remnants of this once vast ecosystem (Gordon 1960, Cusick and Troutman 1978). As in other portions of the midwest, Ohio's prairies have been extensively modified or eliminated through cultivation, overgrazing of domestic stock and fire suppression policies. As the number of native prairies has decreased, interest in reconstruction of tallgrass prairies has increased.

In 1979, a tallgrass prairie was established in southwestern Ohio by the Hamilton County Park District. A second prairie, adjacent to the first, was established in 1983, hereafter these sites will be referred to as the 4-year and 8-year sites. While the sites selected did not presently harbor prairie remnants, there was historical precedence for prairie establishment in southwestern Ohio, as there are many prairie species (Braun 1916 and 1921) and several prairie remnants know from the Cincinnati region (Bryant 1981, Irwin 1929).

The research objectives were to answer the following questions regarding the two established sites: 1) how did differences in establishment techniques affect the vegetational composition of two reconstructed prairies in southwestern Ohio and 2) which reconstruction was most similar in vegetational composition to native Ohio prairies? Answers to these questions were investigated by: a) determining species composition of the 4-year and 8-year established sites and b) comparing established sites with native relic prairies.

METHODS

Study Site

The study site was composed of two adjacent, established prairies in southwestern Ohio (Figure 1). These sites differed in time since establishment, seed course, extent of burning, and extent of soil preparation (Table 1).

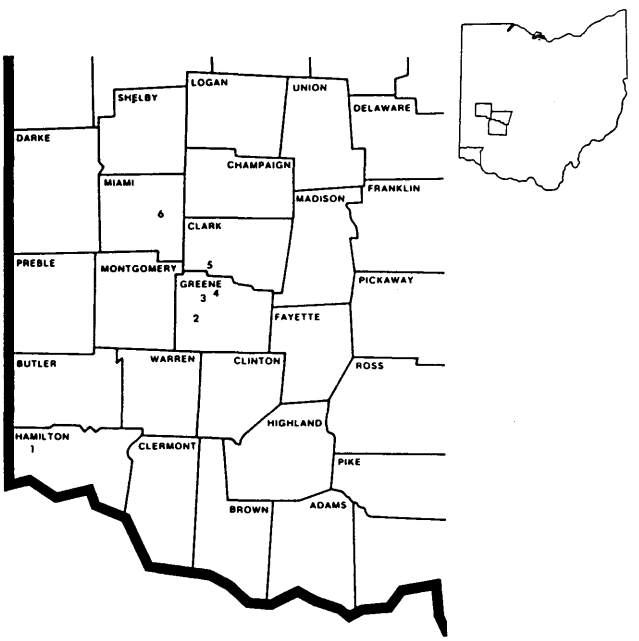

FIG. 1. Location of established sites and remnant prairies.

Table 1. Comparison of two established prairies in southwestern Ohio.

	8-year site	*4-year site*
Date of establishment	1979	1983
Soil composition (in ppm)	N = 6, P = 3, K = 113, pH = 4.7	N = 7, P = 3, K = 131, pH = 4.7
Original vegetation	Old field species including sasafrass, goldenrod, and blackberry	Old field species including sasafrass, goldenrod and blackberry
Seed source	Sharp Bros., Healy, Kansas equal amounts of big bluestem, little bluestem, indiangrass, and switchgrass. 6.8 PLS kg per ha native seed added in 1983.	Collected from native prairies within a 160 km radius of the established site. 2.3-3.2 kg seed and chaff per ha.
Fire management	1983, 95% burn	1983, prior to planting
Soil preparation	Disc harrowed prior to planting.	Shallow plowing

Table 2. Summary of community comparisons.

Prairie	*Size*	*Aspect*	*PS (4-yr)*[1]	*PS (8-yr)*[2]	*Dominants*
4-year site	1.5 ha	Flat, mesic	——	49.71	goldenrod, big bluestem broomsedge
8-year site	1.5 ha	Flat, mesic	49.71	——	switchgrass, indiangrass
Herr Rd.	4 ha	Hillside, xeric	30.24	29.43	little bluestem, goldenrod
Stillwater #1	4 ha	Moderate slope, mesic	27.05	30.05	little bluestem, big bluestem, asters
Stillwater #2	1 ha	Moderate slope, mesic	16.69	31.49	goldenrod, Queen Anne's lace, grey-headed coneflower
Selma Rd.	10 ha	Flat-lowland, wet mesic	28.45	28.06	big bluestem, indiangrass, grey-headed coneflower
Zimmerman	5 ha	Flat, lowland, hydric	12.03	20.79	prairie dock, Queen Anne's lace, Virginia mountain mint
Doorley	3 ha	Rolling, river-bottom, hydric	17.22	17.28	big bluestem, orange coneflower, marsh bedstraw

[1]PS (4-year) = percent similarity between remnant sites and the 4-year site.
[2]PS (8-year) = percent similarity between remnant sites and the 8-year site.

Six remnant prairies (Table 2) were selected for comparison with the established sites. All sites were within a 160 km radius of the established prairies, occurring in glaciated western Ohio. None of these prairies were extensively disturbed or managed.

Sampling Methods

The vegetation of the 8-year and 4-year prairies was sampled using a randomized grid design (Greig-Smith 1983). Fifty quadrats (1 m^2) were sampled from the 4-year site and 50 from the 8-year site. Each quadrat was sampled monthly from 1 July 1986 through 6 September 1986. Frequency and percent cover were recorded for each species observed. The six native prairie sites were sampled during the month of August 1986. Sampling was completed for each of the two established sites. The number of samples taken per site varied, however, all were in excess of 25 quadrats.

RESULTS

Vegetational Composition of Established Sites

A total of 121 species of vascular plants belonging to 41 families were identified at the study site. Nineteen species were unique to the 8-year site, and 35 were unique to the 4-year site. Sixty-five species were common to both sites. The Compositae comprised 28% of the flora followed in decreasing order by the Gramineae (14%), the Fabaceae (8%), and the Rosaceae (5%) on both the 4- and 8-year sites. These families, along with the Labiatae, were the dominant families of plants in native tallgrass prairies (Weaver 1968).

Composition of the 8-Year Site

Switchgrass (*Panicum virgatum* L.) and indiangrass [*Sorghastrum nutans* (L.) Nash] were found to have the highest values for percent frequency, percent cover, and importance values (percent frequency + percent cover/2) on the 8-year site. Little bluestem (*Andropogon scoparius* Michx.) and big bluestem (*Andropogon gerardii* Vitman) were among the ten species with the highest importance values, ranking fifth and seventh, respectively.

Many weedy species were also found to be dominant in the 8-year prairie community. Goldenrod (*Solidago* L. spp.) was frequently encountered and contributed greatly to overall cover. Bush clover (*Lespedeza procumbens* Michx.), Korean bush clover (*Lespedeza stipulacea* Maxim.), woolly panicgrass (*Panicum lanuginosum* Ell.), cinquefoil (*Potentilla reptans* L.) and blackberry (*Rubus allegheniensis* Porter) also had high frequencies but had lower percent cover.

Percent frequency, percent cover, and importance of values of prairie species increased gradually throughout the growing season while seasonal variation was observed among the weedy species. For example, Korean bush clover, a Eurasian perennial, peaked in August with an importance value of 4.01, followed by a decline (IV = 1.99) in September. Increasing importance values were noted for prairie grasses which gradually developed throughout the summer (e.g. indiangrass July IV = 12.8, August IV = 14.54, September IV = 19.04). The percent cover, across all species, remained constant throughout the sampling period. Mean percent cover for all species: July = 80.8, August = 76.9, September = 76.9. The average number of species per quadrat was 6.1.

Vegetational Composition of the 4-Year Site

The 4-year site was dominated by weedy vegetation. Goldenrods ranked first in all measures (average IV = 15.6). Other weedy dominants included ragweed (*Ambrosia artemisiifolia* L.), woolly panicgrass, blackberry, broom sedge (*Andropogon virginicus* L.) and cinquefoil. Only one prairie species, big bluestem, had a high importance value (maximum IV = 8.45).

Many species exhibited seasonal dominance. Purple milkwort (*Polygala sanguinea* L.) had an importance value of 3.80 for July dropping to 1.15 in August and 0.51 in September. Other seasonal changes were noted for green foxtail [*Setaria viridis* (L.) Beauv.] which peaked in June, tick trefoil [*Desmondium canadense* (L.) DC.] which peaked in mid-summer, and asters which peaked in September. Percent cover, across all species, remained relatively constant throughout the growing season. Mean percent cover for all species was as follows: July = 70.9, August = 65.4, September = 69.87. The average number of species per quadrat was 9.6.

The 4-year site had greater species richness with 98 total species, while the 8-year site had a total of only 84 species. The 4-year site also had greater diversity (H' = 1.49). Diversity for the 8-year site was H' = 1.31. The Shannon-Wiener Index was used to determine diversity (H'). The formula used was:

$$\text{Shannon-Wiener Index: } H' = \Sigma P_i \log P_i$$

where Σ = the number of species and P_i = the proportion belonging to the *i*th species.

Community Comparisons

The Percent Similarity Index (PS), weighted for percent frequency, was used to compare community samples (Mueller-Dombois and Ellenberg 1974).

Community Coefficient: $CCj = 2(FC)/FA + FB + 2(FC)$
FA = the % frequency of species unique to community A, FB = the % frequency of species unique to community B, FC = the % frequency of species in both community A and B.

Vegetation at the 4-year and 8-year sites was compared to the vegetation at each of the six remnant prairie communities (Figure 2). The 4- and 8-year sites were also compared. The adjacent established sites had greater similarity to each other than to the remnant prairies (PS = 49.7%). The 4-year and 8-year sites were equally similar to all remnant prairies with the exception of Stillwater Prairie #2 and Zimmerman Prairie. The 4-year site was considerably more similar to these prairie remnants since they were both dominated by forbs. The prairie most similar to the 8-year site was Herr Road Prairie (PS = 30.24). Both sites were dominated by little bluestem and lesser amounts of indiangrass with dicots such as goldenrod, cinquefoil, and poison ivy (*Toxicoderdron* P. Mill. sp.) prominent in the species composition. Stillwater Prairie #2 was found to be most similar to the 4-year site (PS = 31.5). Both sites are for dominated with an abundance of Queen Anne's lace (*Daucus carota* L.), goldenrod, and grey-headed coneflower [*Ratibida pinnata* (Vent.) Barnh.].

The communities were re-analyzed, separating prairie species from weedy vegetation (Figure 3). Determination of prairie species classification follows Cusick and Troutman (1978). The similarity of the 4- and 8-year sites to Herr Road, Stillwater #2, and Selma Road is primarily due to those weedy species these sites have in common. Zimmerman and Doorley's Prairie Fen increased dramatically in similarity to the 4- and 8-year sites when considering only prairie species.

DISCUSSION

Vegetational Data

The flora of the 8-year site was dominated by switchgrass and indiangrass with goldenrod, blackberry, and little bluestem as subdominants. The four grasses originally planted in the 8-year site are among those with the highest percent frequency, percent cover, and importance values. These grasses, however, were not typically found as dominants in Ohio prairies (Sears 1926, Jones 1944, Cusick and Troutman 1978, Nolan and Runkle 1985). Switchgrass was found primarily in the prairies of north-central Ohio (Cusick and Troutman 1978), and in these it is not dominant. Likewise, indiangrass, while found in many prairies in southwestern Ohio, is rarely a dominant species.

Several possible explanations exist for the dominance of these two species in the 8-year site. Both switchgrass and indiangrass produce tillers rapidly, within five to seven weeks after germination. Thus, germination and tillering of these species may occur several weeks in advance of such prairie grasses as big bluestem and little bluestem (Weaver 1954).

Most prairie grasses require aerated soils for optimum growth (Weaver 1954). Switchgrass and indiangrass, typically found in wetter lowlands with more poorly aerated soils, may indeed be better suited to the heavy clay soils characteristic of the 8-year site. Indiangrass is also known to invade open space more quickly

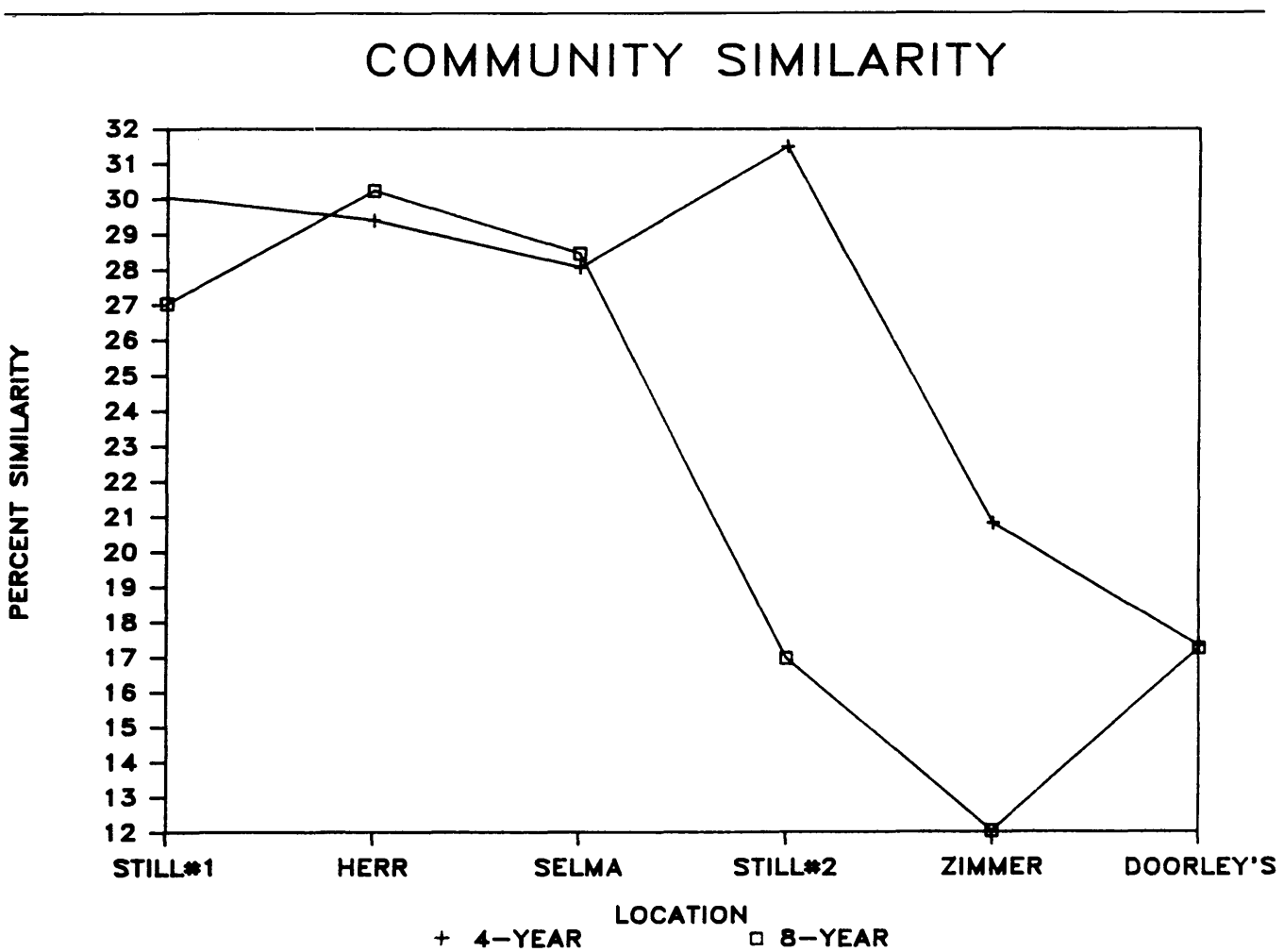

FIG. 2. Percent similarity of remnant prairies with the 4-year and 8-year established sites.

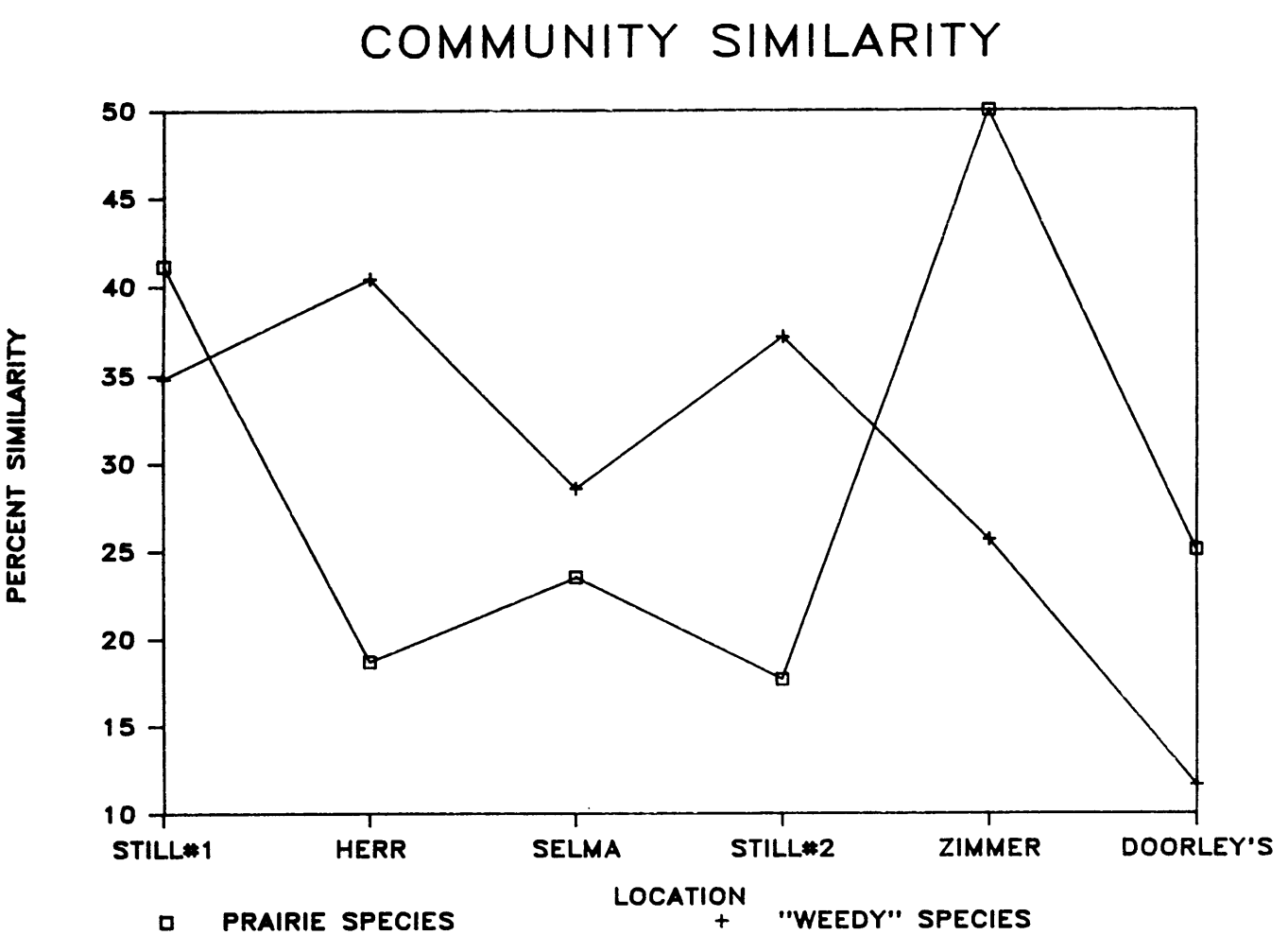

FIG. 3. Percent similarity of remnant prairies with the 8-year established site, comparing numbers of weedy and prairie species.

than other prairie species, as it has an extremely high rate of seed germination (Weaver 1954).

The dominant grasses of most Ohio prairies are big bluestem and little bluestem (Sears 1926, Jones 1944, Cusick and Troutman 1978). The lack of big bluestem on the 8-year site may be both a function of competition and time. Four aggressive prairie dominants were planted on the 8-year site. As previously discussed, switchgrass and indiangrass may have had an advantage both in the percentage of seeds that germinate and the speed with which tillers developed, allowing these species to invade open space rapidly. While big bluestem was found only along the edges of the 8-year site, it became successfully established in the 4-year site. Big bluestem would have been the primary grass collected for seed on the 4-year site, as it was the dominant grass in nearby prairies which were used as a seed source (Braun 1921, Cusick and Troutman 1978). Without competition from indiangrass and switchgrass, big bluestem became established on the 4-year site. In addition to the lack of competition, these seeds were gathered from native Ohio prairies and, therefore, the seeds were genetically suited to the site.

Seasonal fluctuations in percent cover and importance values which were more pronounced on the 4-year site, suggest vegetational affinities to a successional old-field (Bazzaz 1968). The majority of prairie species increased in percent cover throughout the growing season, while old-fields, populated by cool- and warm-season species, fluctuated throughout the year.

The 4-year site also has a higher species diversity than did the 8-year site. In successional seres, a point in time occurs where both pioneer and mature species are present in a community, creating a peak in species diversity. After time species diversity decreased slightly to a steady value (Bazzaz 1968). Therefore, the 4-year site had a greater species diversity because it contained both prairie and old-field species.

Seasonal fluctuations and species diversity can be attributed, in part, to the differences in the ages of the two sites. Over time, both the 4-year and 8-year will become less weedy in species composition and these differences will be damped. These results, however, are again ultimately influenced by the seed source. The dominance of switchgrass and indiangrass has effectively excluded many weedy species from this site.

The effect of burning has long been documented as a means of removing woody vegetation from prairies. As both sites still have a high percentage of blackberry and sasafrass [*Sasafrass albidum* (Nutt.) Nees.], it is unlikely the effect on one fire (1983, 8-year site) had an affect on the present vegetation. A regular burn cycle should curtail the growth of these species, unfortunately it is unlikely to eliminate them completely.

Tilling prior to planting may in part account for the weedy composition of the 4-year site. However, of the differences between the sites, this variable probably accounts for the fewest differences between sites.

Community Data

The 4-year and 8-year sites were equally similar to all remnant prairies with the exception of Stillwater Prairie #2 and Zimmerman Prairie. The 4-year site was considerably more similar to these prairie remnants since they were both dominated by forbs. The grasses made up less than 10% of the species composition of Stillwater Prairie #2 and Zimmerman. They were all dominated by goldenrod species, Queen Anne's lace, and cinquefoil.

Additional observations were made concerning the types of prairie species and weedy species the sites had in common. The remnant prairie sites had an equal number of prairie and weedy species in their flora. The same weedy species were invading natural and established prairies alike. This was also found by Cusick and Troutman (1978) in their survey of Ohio prairies, as well as by Cottam and Wilson (1966) on the Curtis Prairie. Schwartzmeier (1970) examined the possibilities of planting companion crops with prairie weeds to decrease the weedy vegetation that invades nearly established prairies. Similar weeds were found to invade this Wisconsin tallgrass prairie reconstruction as well. With the exception of Stillwater Prairie #1, none of the native sites surveyed had been maintained by fire, mowing, or other management techniques. Therefore, it would be expected that these prairies would have a high incidence of weedy species. These remnants of the prairie ecosystem have remained as they occur in places too steep, too rocky, or with soils too poor to support other vegetation. As a result these sites may not require fire as frequently as larger black soil prairies.

In terms of presence only, the established prairies resemble Ohio's remnant prairies. When abundances of species were considered, the similarities begin to disappear. If possible, additional prairie species should be added to established sites to approximate remnant prairie vegetation. The 4-year and 8-year reconstructions, although not a perfect reflection of native prairies, are a valuable attempt at recreating a once rich and varied ecosystem. Further study of these established communities will provide valuable information in preserving endangered ecosystems for the future.

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