ERIGENIA

Number 14
November 1995

Journal of the
Illinois Native Plant Society

ERIGENIA

Number 14, November 1995

The Illinois Native Plant Society Journal

The Illinois Native Plant Society is dedicated to the preservation, conservation, and study of the native plants and vegetation of Illinois.

ERIGENIA is named for *Erigenia bulbosa* (Michx.) Nutt. (harbinger of spring), one of our earliest blooming woodland plants. The first issue was published in August 1982.

(ISSN 8755-2000)

COVER ILLUSTRATION

Original drawing of *Isotria medeoloides* (Pursh) Raf. by Nancy Hart Stieber, staff artist at the Morton Arboretum.

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Number 14, November 1995

TABLE OF CONTENTS

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MARK A. BASINGER found his additions to the flora of Illinois as part of his continuing Ph.D. work at Southern Illinois University on the effects of disturbance on native flora. Mark has also developed an interest in Illinois lichens.

ROBERT TODD BITTNER is a restoration biologist with The Nature Conservancy at Nachusa Grasslands. His paper reflects part of his Master's work at Southern Illinois University. His special interest is in quantitative monitoring of the habitat requirements of native plants.

H. DAVID CLARKE received both his M.S. and Ph.D. degrees at the University of Illinois at Urbana-Champaign, working on the tropical American Acacias. His is doing a post-doctoral taxonomic study in Guyana.

BRIAN K. DUNPHY, who is currently a graduate student in plant ecology at Michigan State University, got his undergraduate degree at the University of Illinois at Urbana-Champaign.

JOHN E. EBINGER, a mentor to many Illinois botanists and a frequent contributor to ERIGENIA, will retire in December 1996 as head of the Botany Department at Eastern Illinois University. He will, however, continue his studies of Illinois forests and the Acacias of North and South America. He is also known for his systematic work on the genus *Kalmia*.

DON GARDNER is a retired dentist whose two papers in this volume of Erigenia relate to prairie restorations that he began in 1974 on his family's farm. See also, the winter 1996 issue of THE ILLINOIS STEWARD for his article "A Projectile Point and Prairie Ashes."

DOUGLAS J. HAUG is presently serving in the Peace Corps in Bolivia as an agricultural adviser. His survey on woody vegetation, reported here, was done as part of his Master's thesis at Eastern Illinois University.

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MARK W. SCHWARTZ received his Ph.D. at the University of Minnesota, where he studied the factors involving the rareness of *Torreya*. He was with the Illinois Natural History Survey for five years as a plant ecologist, and is now with the Section of Plant Biology at the University of California at Davis.

JOHN E. SCHWEGMAN has been a frequent contributor to ERIGENIA since its inception. As he moves toward retirement from the Illinois Department of Natural Resources, he expects to continue his prolific writing on Illinois natural history subjects. John has contributed greatly to our knowledge of the Illinois flora, and is a principal architect of the natural divisions map of Illinois and the comprehensive plan for the Illinois nature preserve system.

ERIGENIA, Number 14, November 1995, pp. 3–7

Illinois' Small Whorled Pogonia Orchids

John E. Schwegman[1]

On Saturday afternoon, October 20, 1973, the late Dr. Julius Swayne of Herrin picked up Mike Homoya and Loyal Mehrhoff of Carterville and headed to Randolph County to inspect a tract of land that one of his students had offered for sale. Julius was a botanist who taught biology at Rend Lake College. Mike was a student of botany at Southern Illinois University, and Loyal was a high school student. The goal of the trip was to see if Julius wanted to purchase the land.

They were impressed by the rugged topography of the tract, and after locating a stand of ground cedar (*Lycopodium digitatum*), which was rare in those days, they decided to search for other interesting plants.

Walking about five meters apart, they were easing along a north-facing slope above a sandstone cliff when Mehrhoff called out that he "had something interesting." What he had was a stalk about ten inches tall with two orchid capsules at the top! A check of the area revealed three more such stalks, all of which had shed their leaves.

Their speculation in the field was that perhaps it was a deformed lady's slipper orchid with two capsules together—that is, until they noticed that the leaf scars were in a whorl. Back home with manuals at hand, they readily identified the fruiting specimen as one of North America's rarest native orchids, the small whorled pogonia (*Isotria medeoloides*).

Swayne purchased the land, and the discoverers settled back for a long winter of anticipation over what the spring would bring. As the year's new growth began, the trio began regular visits in search of flowering small whorled pogonias, and in mid May they were rewarded with the discovery of four plants.

Over the remainder of the 1970s, this site received considerable study by its discoverers. First came the research of Mike Homoya, who included it in his Southern Illinois University master's thesis (1977) on the distribution and ecology of the genus *Isotria* in Illinois. This was followed by Loyal Mehrhoff's University of North Carolina thesis (1980) on the reproductive biology of the genus *Isotria* and the ecology of *Isotria medeoloides*. This study included the Illinois locality as one of his ecological study sites.

It is remarkable that the discovery of this rare plant is so closely tied to the careers of two botanists who are prominent in the conservation of native plants today. Homoya is a botanist with the Indiana Division of Nature Preserves and recently published the definitive book *Orchids of Indiana*. Mehrhoff went on to get his doctorate in botany at the University of British Columbia and now works on the conservation of Hawaii's endangered flora.

Julius Swayne visited the site of this orchid population annually from 1974 until his death in November 1994. I joined him for the annual mid-May census visits from 1981 through 1994. Swayne's notes included information on which plants emerged each year and what their flowering status was. In some years he also determined whether seed capsules matured. In 1983 and from 1985 on, I added measurements of stem height to the leaf whorl as a measure of individual plant vigor.

In addition to the spring visits, Swayne made sporadic visits in the fall to check for capsule development and seed set. I established a permanent demographic monitoring plot in 1986 that included plants #5, #7, and #8. It was half of a circular plot with a radius of one meter for 180 degrees containing 1.57 square meters (Schwegman 1986). The plot aided in locating the exact spot where each plant within it should emerge.

Using information Swayne and Homoya had given me, together with my notes, I pieced together what is known about the appearance, disappearance, vigor, fruiting, and fate of the eight individual stems of small whorled pogonia orchid that were observed over the 21-year time span from 1974 to 1994.

This paper documents what we know about the Illinois small whorled pogonia orchids and their habitat, and speculates on the factors responsible for the observed year-to-year variation in population size and vigor.

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Small whorled pogonia orchid and associated vegetation in its Illinois habitat.

The small whorled pogonia in Illinois grows in an area of the Shawnee Hills of the Interior Low Plateaus physiographic province that was covered by the Illinoian glacier. This is a unique situation, as most of the Shawnee Hills are driftless. Schwegman et al. (1973) recognized the distinctive flora and geological history of this region in designating it the Central Section of the Ozark Natural Division of Illinois.

In spite of the past glaciation, the orchid habitat is in a rough ravine and bluff area adjacent to a semi-permanent stream. The plants grow on a slope averaging 31 degrees with an aspect 30 degrees west of north. They are above and about 5 meters south of a 16-meter high cliff of Degonia sandstone of Mississippian age. This same sandstone underlies the entire habitat.

The soil is a silty clay loam with a pH of 4.1 (Mehrhoff 1980). It averages 20 cm or less in depth and measures just 13.5 cm to bedrock in the demographic plot.

Vegetation consists of an open forest of small trees that rarely exceed 30 cm dbh (Homoya 1977). This forest appears to owe its character to soil conditions that restrict tree growth and foster windthrow of trees that reach any great size (Homoya 1977). This open forest, together with the canopy gap associated with the cliff, provides relatively high light levels for an upland forest in southern Illinois.

Mehrhoff (1980) described the vegetation in the orchid's habitat at this site. He found the dominant trees to be *Quercus rubra*, *Quercus alba*, *Amelanchier arborea*, and *Ostrya virginiana*. He listed the most important shrubs as *Amelanchier arborea*, *Ulmus alata*, and *Vaccinium vacillans*, and associated herbs as *Lysimachia lanceolata*, *Polystichum acrostichoides*, and *Solidago buckleyi*. Other associated plants that I feel give an idea of the ecological setting include *Cunila origanoides*, *Luzula multiflora*, *Asplenium platyneuron*, and *Cladonia* sp.

Over the 21 years of observation from 1974 through 1994, a total of eight different orchid stems were observed (table 1). Except for 1976, 1979, and plant #2 in 1974, notes were not made on the flowering condition of individual plants in the 1970s.

Plants #1 through #4, all that were known from 1973 through 1979, grew in one block of habitat measuring 5 meters east to west and 3 meters north to south. In 1980, Julius Swayne discovered plant #5 growing 11 meters west of the others. In 1982 he found plant #6 some 3 meters south (upslope) of plant #2, the most southerly of the original four plants. Plants #7 and #8 eventually appeared near plant #5. The total known habitat block has a length of 16 meters and a width of 6 meters.

In addition to noting flowering condition, beginning in 1985 Swayne and I measured the height of stems from the soil surface up to the leaf whorl and noted the number of flowers, if any, as a measure of individual plant vigor. Some data were obtained on fruiting as well.

Environmental factors that may influence the orchid's vigor and numbers are rainfall, unusually high temperature, and storm damage to the tree canopy within the habitat. Damage by foraging rodents may also have influenced the survival of two plants.

TABLE 1. Annual status of the eight stems of small whorled pogonia orchid found at the Randolph County site from 1974 through 1994.

	Plant number								Total
Year	1	2	3	4	5	6	7	8	plants
1974	?	F	?	?					4
1975	?	?	?						3
1976	F	F	F						3
1977	?	?	?						3
1978	?	?	?						3
1979	F								1
1980	S				F				2
1981					F				1
1982					F	F			2
1983					F				1
1984					F				1
1985					F	S	F		3
1986					F	S			2
1987					F				1
1988					F				1
1989									0
1990									0
1991								S	1
1992									0
1993									0
1994									0

F = flowering; S = sterile; ? = unknown; blank = not found

While there are no climatic data from the immediate area of the population, precipitation data are available from Chester some 14.5 km away (fig. 1), and temperature data exist for Sparta, which is 26 km away. At this writing, data for 1994 are not available.

Average annual precipitation for Chester is 101.7 cm. Over the course of our observations rainfall was above average fourteen years and below average seven. The wettest protracted period was 1982 through 1986. The wettest year was 1990. The driest year was 1976, and the only period of two consecutive below average rainfall years was 1988 and 1989.

Field climatic notes indicate that in spite of above average rainfall at Chester in 1987 there was a severe summer drought at the orchid site. The summer drought at the site in 1988 was also described as severe in these notes.

Temperatures at Sparta exceeded 100°F in six years. These were 1978 (102°F), 1980 (108°F), 1983 (105°F), 1987 (105°F), 1988 (103°F), and 1991 (103°F). Extremely high temperatures and dry conditions occurred together in 1980, 1987, and 1988.

A severe thunderstorm in July of 1980 broke one tree off and uprooted another in the vicinity of the original population. A treetop dropped on some of the orchid's habitat and increased light levels on the rest.

Another disturbance was "rodent" digging that occurred during the flowering season at or near the site of single known plants in 1989 and 1994. From the size of the holes, it appears the digging was done by the eastern chipmunk, which is known from the area.

The appearance and vigor of each plant are discussed below with reference to the various vigor measurements and the environmental variables that may have influenced them.

Plant #1 was one of the original 1974 plants and was seen annually from that year until 1980, after which it disappeared. Its flowering status in the 1970s is unknown except that it flowered in 1976 and 1979. It was sterile in 1980. It probably produced seed in 1973. Its seven years of appearance were second in longevity to plant #5. Its disappearance followed storm damage, which opened the forest canopy in July 1980 and left a treetop on the plant. The year 1980 also had the lowest recorded precipitation and highest summer high temperature (108°F) of any year during the monitoring period. The hot, dry conditions, at the same time much of the shade was removed, may account for its demise.

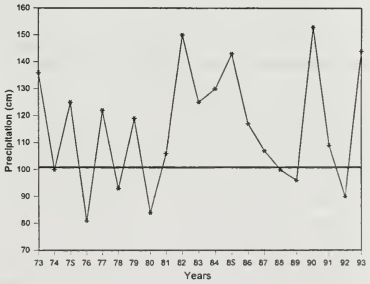

FIG. 1. Total annual precipitation at Chester, Illinois, 1973 to 1993. Average annual precipitation is 100.85 cm, indicated by a heavy line on the graph. Data are from National Oceanographic and Atmospheric Administration Annual Climatological Summaries for Illinois.

Plants #2 and #3 were seen annually from 1974 until they disappeared after the dry and hot year of 1978. Precipitation that year was well below normal, and summer high temperatures reached 102°F. Plant #2 was recorded as flowering in 1974, and both #2 and #3 flowered in 1976. Both may have produced seed in 1973. Their disappearance may have been drought related.

Plant #4 was a second stem that appeared to arise from the same root crown as plant #3 in 1974. Its flowering status was unknown, and it was never seen again. It may have appeared in response to the high moisture levels of 1973 that were not achieved again during the known life of plant #3. This was the only observation we made of two stems apparently arising from the same root crown in the same year.

Plant #5 was first discovered in 1980 some distance from the first known population and may have been present but undetected for some time. It was observed in flower annually from 1980 through 1988. Although it flowered every year, it varied in vigor, as reflected in the number of blossoms produced. In 1984, 1986, and 1988 it had a single flower; in each of the other years it had two. Its average stem height for five measured years was 18.6 cm; it attained a maximum height of 22 cm in 1983. It produced one seed capsule in 1981 and again in 1987. It was not impacted by the forest canopy disruption of 1980.

With nine years of annual observation, plant #5 was the longest lived of the orchids monitored. It disappeared in 1989 after the below normal precipitation and high summer temperatures of 103°F in 1988. It had survived the even higher temperatures and lower rainfall of 1980, but perhaps the two consecutive hot, dry years of 1988–1989 stressed it more than a single very hot, dry year.

On our 1989 visit, we saw a freshly dug 4 cm diameter mammal hole that had been dug about 4 cm upslope from the 1988 orchid stalk. The hole exceeded what we thought was the root level of the plant and probably impacted some of its roots. It was so fresh that we judged it had not caused the failure of the plant to emerge at the site of the previous year's plant. My best guess is that its disappearance was drought related since 1988 was a severe drought year. Rainfall at the site may have been considerably less than at Chester.

Plant #6 was first found as a flowering plant in 1982 upslope from the original population in an area less impacted by the 1980 storm damage. After producing seed in 1982, it disappeared for two years and then reappeared in 1985 and 1986 as sterile plants 7 cm and 8 cm tall respectively. The year 1982 was significantly above average in precipitation, and both 1985 and 1986 followed wet years. There is no drought year to explain the disappearance of this plant in either 1983 or 1987.

Plant #7 appeared as a stem 11.5 cm tall in 1985 and flowered with a single blossom. It had not been seen before and was never seen again. It was just 65 cm from plant #5 and within the demographic plot that was later established in 1986. Its exact location was checked annually through 1994. Its appearance during the longest wet period of our observations indicates that it may have been stimulated to emerge and flower by above average moisture levels.

Plant #8 arose in 1991 as a small sterile plant 5.7 cm tall just 9 cm from the former site of plant #5. This was the third year after plant #5 disappeared. Plant #8 was gone by late July of 1991 when Julius Swayne visited the area and found no evidence of disturbance or what had taken it. Loyal Mehrhoff

Illinois' small whorled pogonia orchid plant #5 as it appeared in 1981.

advised me that small sterile plants arising from the roots of larger small whorled pogonias are not uncommon in the eastern states. These often occur as lines of small plants radiating out as much as 15 cm from the parent plant. Plant #8 may have been a root sprout from plant #5, stimulated to appear by the wettest year of the monitoring period, 1990. In 1994 a small freshly dug hole, the appropriate size for a chipmunk, was found at the exact site where the plant had been in 1991. It is possible that the plant had emerged but was eaten or destroyed a few days before we got there.

Several general conclusions can be drawn from the above information, both about the habitat and ecology of the species in Illinois and about its life history here.

Its Illinois habitat is unique because it is on a rare glaciated, upland, bedrock-controlled surface. The specific site has a rare combination of low forest canopy density typical of drier upland sites and a moderation of xeric conditions due to topographic position. The thin soil depth over bedrock keeps trees small, and the adjacent cliff and canyon provide a canopy gap that allows in more light. The position on a steep north-facing slope and the influence of the adjacent canyon modify what might otherwise be a drier environment. Because the combination of these features is so unique, suitable habitat for this species may be extremely limited in Illinois, and the species is not likely to be found at many other sites.

The appearance and disappearance of individual small whorled pogonia plants in Illinois seem to be related to moisture and possibly high summer temperature. Plants tend to appear after wet years and disappear after dry years, especially dry years with higher than average summer temperatures.

All but one of the plants that appeared in more than one year emerged annually without skipping years until they disappeared. The exception to this was plant #6, which flowered and then had a dormant period of two years before reappearing as a sterile plant two years in a row. Over the 21 years of observation reported here, dormancy was a rare feature of this species.

Most Illinois small whorled pogonia orchids appear for periods of five years or less and then disappear. The two exceptions to this are one plant that appeared seven consecutive years and another that emerged in nine consecutive years.

Seed production occurs at infrequent intervals, usually associated with exceptionally wet years. As far as is known, seeds were produced only in 1973, 1981, 1982, and 1987.

With no live plants of this species having been seen over the past three years, it is possible that this native orchid has disappeared from Illinois. However, lacking information on how long it takes this species to reach flowering condition from seed, we may still be waiting for flowering plants from the big 1973 seed crop to emerge. Only time and careful observation will tell.

This article is dedicated to the memory of the late Dr. Julius Swayne of Herrin, Illinois, who played a major role in the discovery, preservation, and monitoring of the small whorled pogonia orchid in Illinois. I feel honored to have known him and to have been invited to join him in monitoring the population on his land. We spent many enjoyable days in the field. Over the years Julius provided me with his observations of the species, and many of them are included here.

I also want to thank Mr. Michael Homoya for information on the species in the early years of observation and for commenting on aspects of the manuscript. Dr. Loyal Mehrhoff also provided personal observations on the species both in Illinois and elsewhere in its range.

Addendum: searches at the site in 1995, after completion of this manuscript, failed to find any small whorled pogonias.

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ERIGENIA, Number 14, November 1995, pp. 8–14

THISMIA AMERICANA N. E. PFEIFFER, A HISTORY

Linda A. Masters[1]

ABSTRACT: *Thismia americana* N. E. Pfeiffer is one of the most unusual plants ever to have been found in North America. It is a vascular plant discovered in southern Cook County, Illinois, in 1912, observed and studied for five years. It has not been seen in the wild since. Very little is known about the natural history of this plant; therefore a certain amount of mystery surrounds it. Many people have speculated on the continued existence of *T. americana*, the nature of its habitat, the extent of its range, and even its nativity. This paper attempts to bring together what is known about this plant and discusses the possibilities of its rediscovery.

In early August 1912, Norma Etta Pfeiffer, a graduate student in botany at the University of Chicago, and another graduate student took a field trip to a site not far from the city. In a 1985 letter to Robert Mohlenbrock, she wrote that this site was often used by botany students studying the local flora. Dr. Pfeiffer wrote to a former colleague in 1984 that she and her field companion had gotten teaching jobs for the following year and "had made several collecting trips together to have stuff on hand, if our colleges lacked it. This time we were looking for liverworts, low forms that grow flat on the ground. So we were on hands and knees for that when I found *Thismia*. She [Pfeiffer's companion] was on the same ground and never saw it!" Of course Dr. Pfeiffer did not know it was *Thismia* at the time. What she saw was a tiny white plant, which she carefully collected and took back to the university for further study.

In her letter to Mohlenbrock, Pfeiffer also wrote that she consulted her professors Charles Chamberlain and William Land as to the identity of this plant; she even sent a specimen to John Coulter who was vacationing in Indiana. They confessed that they had never seen a plant like it before, but finally determined that the plant belonged in the Burmanniaceae. This was very unusual, since most members of that family are tropical and usually are found in rich-loamed primeval forests that receive great amounts of rainfall (Jonker 1938; Maas et al. 1986; Fernald 1931).

Norma Pfeiffer had discovered not only a new temperate zone species of this family, but a genus new to North America! She named and described this mysterious plant in her dissertation, "Morphology of *Thismia americana*," published in the *Botanical Gazette* (Pfeiffer 1914a). The genus name, *Thismia*, is an anagram commemorating Thomas Smith, an English plant anatomist of the early nineteenth century (Fernald 1931; Gleason 1952). The location and habitat information accompanying Pfeiffer's Latin description of *T. americana* simply reads "Chicago, Ill., in open prairie, N. E. Pfeiffer." Later in the paper, she described the location of the discovery and the habitat:

> . . . in a small space along the margin of a grass field . . . [in] a low prairie, characterized by such plants as *Solidago serotina* [= *S. gigantea*], *S. tenuifolia* [= *S. graminifolia*], *Rudbeckia hirta*, *Eupatorium perfoliatum*, *Asclepias incarnata*, *Iris versicolor* [= *I. virginica* var. *shrevei*], *Acorus calamus*, *Agrostis alba* [var.] *vulgata* [= *A. alba*]; and on the soil itself *Selaginella apus* [= *S. apoda*], *Aneura pinguis*, and *Hypnum*. Usually the *Thismia* grows in spots where the soil is not closely covered by *Aneura* and *Selaginella*, but it may be found occasionally among the moss.[2]

Norma Pfeiffer continued to monitor the plants for the rest of August and into the first half of September, when she obtained fruits. During the winter of 1912–1913, she continued to study the details of the plant's morphology, even trying to germinate the tiny seeds. The attempts, however, were "fruitless" (Pfeiffer 1914a).

In 1913, from the onset of the growing season, Norma Pfeiffer visited the site weekly. On July 1 she found flower buds and hypothesized that the underground parts had overwintered. She wrote in her dissertation that she felt seed germination could have occurred but may have been overlooked. Pfeiffer

[2] Pepoon (1927) credited Pfeiffer and Cowles as describing the habitat as a "sedgy swamp associated with *Selaginella* [*apoda*], near Lake Calumet."

[1] The Morton Arboretum, Lisle, IL 60532

continued to make observations in 1913 and 1914, collecting specimens for study. These specimens were the basis for her dissertation and for a second article also published in the *Botanical Gazette* (Pfeiffer 1918), entitled "The Sporangia of *Thismia americana*," in which she discussed the plant's reproductive process.

As Pfeiffer described in her dissertation, *T. americana* consists of simple floral axes arising from a root system (see fig. 1). The flowers are 0.8–1.5 cm high on an axis 0.3–1.0 cm high. The perianth tube has six conspicuous nerves and six minor nerves and the mouth of the tube is closed by a disk of tissue with a central circular opening surrounded by a raised ring. Three sepals are equal in length to three petals which are connate at their tips. The three to six leaves are reduced to white scalelike bracts, closely appressed to the floral axis. The entire plant, including the root system, is glabrous and white except in the six divisions of the perianth and in the disk closing the perianth mouth. Those areas are a delicate blue green with the raised ring around the opening in the disk somewhat deeper in color. Only this colored portion (5–6 mm in diameter, 4–6 mm in height) is above the level of the soil or of the surrounding moss. The fruit is 3–4 mm in diameter and 2–3 mm high and cup-shaped. The seeds are 0.5 mm long, 0.2 mm in diameter and are hyaline and reticulate (Maas et al. 1986). Pfeiffer believed that, because of the arrangement of the flower parts, insect pollination would be necessary.

The root system lies more or less parallel to the surface at a depth of only a few millimeters. Pfeiffer found no physical connection of the root system to other vascular plants, although the roots often were in close juxtaposition with other roots. The fungi found in the absorptive region of the root (and not found in the stem) seemed to her to have a connection with water and food supply. In the root there is a very large supply of reserve food in the form of oils and fats.

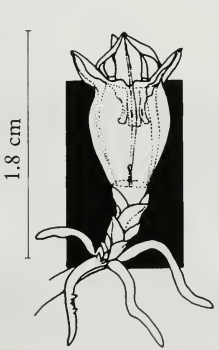

FIG. 1. *Thismia americana* N. E. Pfeiffer. (Drawing by Nancy Hart Stieber.)

The closest relative to *Thismia americana* is *Thismia rodwayi* F. von Müller (fairy lantern). This species is found only in Australia, New Zealand, and Tasmania growing in "gloomy glens on mounds of humus at the base of *Podocarpus dacrydioides* (New Zealand white pine) and other trees" (Campbell 1968). The general habitat of the fairy lantern is damp leaf litter in primeval forests (Maas et al. 1986). *Thismia rodwayi* differs from *T. americana* in the shape and color of the flower and in the root system. *T. rodwayi* can grow to 7.5 cm, the flowers are pale red to yellowish to almost colorless, and the disk closing the perianth mouth is red. Campbell states that "the plant is readily recognized by the small flowers that appear from late October until February, although these are not easily found, since many fail to reach the surface of the forest floor. Only when exposed do they develop to full their very deep salmon-pink color." *T. rodwayi* sometimes lives and flowers completely underground (Maas et al. 1986).

Norma Pfeiffer was 24 years old in 1913, and at the time was the youngest person to have received a Ph.D. from the University of Chicago (fig.2). She left Illinois in 1914 for the University of North Dakota, where she taught botany for ten years. From there she joined the staff at the Boyce Thompson Institute for Plant Research in Yonkers, New York, until she retired in 1959. She died on August 23, 1989, at the age of 100 (New York Times 1989).

Under the *Thismia americana* entry in *Plants of the Chicago Region* (Swink and Wilhelm 1994), a map to the type location, given to the senior author by Norma Pfeiffer, is mentioned. I was curious about the map since nowhere among Pfeiffer's papers had I come across a specific address. I asked Floyd Swink what he knew about this information and he said that in 1948 Norma Pfeiffer had sent him a map on which she gave directions to the site. Soon after Swink received the map, he and his brother went to take a photograph of the area. He said he felt absolutely certain they were in the right spot. "We were at the location on the map, and all the associated plants were there."

FIG. 2. Norma Pfeiffer's graduating class, 1913. (Pfeiffer is in the middle row, third from the right.)

Using the map, Julian Steyermark and Floyd Swink located the area and went on a search for *Thismia americana*. Instead of *T. americana* they found *Ophioglossum vulgatum* L. var. *pseudopodum* (Blake) Farw., which they believed to be new to the Chicago region, and published the find in *Rhodora* (Steyermark and Swink 1952). The authors reported that they found this plant while "on a futile search for *Thismia americana* . . . at its type locality." The collection data for *Ophioglossum vulgatum* var. *pseudopodum* is as follows:

> Bottom prairie swale, on east side of Calumet Lake, between Torrence Avenue and Nickel Plate railroad at about 11900 South, between Ford Plant and Solvay Coke Plant, Chicago, Cook Co., Illinois, June 2, 1949, *Steyermark & Swink 68222.*

The map cannot be located; indeed, Swink believes that he probably had given the map to Steyermark in order to organize forays to the site and that Steyermark may have put it in a file at the Field Museum. In any event, it is now lost to posterity.

On September 19, 1951, a group of Chicago area botanists went on a foray to search for *Thismia americana* at the above location (fig. 3). This foray was reported on in an article published in the *Chicago Sun-Times* (1952). A Chicago acquaintance of Norma Pfeiffer sent her a clipping of the article, which prompted Pfeiffer to write Theodor Just, a participant in the foray, with new information. Until this time it was only known for sure that *T. americana* was seen in the wild from 1912 to 1914. Her letter added two more years based on her collection dates.

> I do not know whether you [Theodor Just] were responsible for the information on which the article was based. But I thought you might be interested in having some data on some of the dates on which I collected plants in flower. You will see it was not nearly so temporary a resident as indicated.
>
> The original collection was made August 5, 1912, and subsequent observation continued that year until mid-September. In 1913, it was again followed through the season (earliest in July) to September 8. For 1914, I have July 29 and 'August', no day specified. In 1915, July 25, and 1916, as late as September 1.

There was no more new material written on *Thismia americana* by Norma Pfeiffer until Mohlenbrock (1985) published in *Erigenia* a letter she had written him in response to the account of *T. americana* in *Where Have All the Wildflowers Gone?* (Mohlenbrock 1983). She wrote that the year following her initial discovery she found *T. americana* on the same site as before but that a year after that a barn had been built on the site. "Good-bye *Thismia*," she wrote. A most interesting piece of new information, however, was her revelation that she had located, about one-third mile away from the original site, a few plants in "the midst of *Typha*" between ancient beach ridges of the post-glacial lake, Lake Chicago.

FIG. 3. Botanists from the 1951 *Thismia* foray. Left to right: Jose Cuatrecasas, Theodor Just, John Thieret, Floyd Swink, Earl Sherff. Not pictured, Julian Steyermark (photographer).

In a 1985 telephone conversation with Bill N. McKnight (pers. comm.), Norma Pfeiffer recalled that although many *Thismia americana* specimens were collected, she did not take all that she saw. She also said that there were no maps made of the plant's location on the site and that no habitat photographs were taken. It is unfortunate that, although Norma Pfeiffer made copious notes on the morphology of *T. americana*, she and others did not realize at the time how important specific habitat, location, and population data would be for future researchers.

This part of southern Cook County, where *Thismia americana* was found, is unique because it is one of the last remnants of an area that was part of the lake plain of the ancient glacial Lake Chicago. The site where it was known to have grown was under the waters of Lake Chicago until a substage, Lake Algoma, began to recede about 2000 years ago (Willman 1971). As Lake Chicago and its substages withdrew, it left behind the swell-and-swale sand deposits that now form well-drained ridges interspersed by wet, calcareous depressions. By 1971, 90 percent of this lake plain had been developed (Willman 1971). It originally was 45 miles long and up to 15 miles wide and it covered approximately 450 square miles. Most of the lake plain was exceptionally flat; the ridges were generally less than ten feet high. What few acres remain of this unique habitat support diverse vegetation, including plants that are disjunct from the Atlantic and Gulf coastal plain and boreal regions of northern Wisconsin and Michigan.

Julian Steyermark and Theodor Just were concerned about the fate of the type location (Tardy 1952). They believed the only way to solve the mystery of *Thismia americana* would be to save the habitat. There are still several areas within a five-mile radius of the type locality that have likely habitat for *Thismia americana*. These would be all of the natural areas still surviving in the lake plain of the lower stage of Lake Chicago: the type location, Powderhorn Marsh and Prairie, Burnham Prairie, Sand Ridge Nature Preserve, Thornton Fractional High School, and the Calumet City Prairie. After Robert Betz discovered Burnham Prairie, owned by Waste Management, in late summer 1974 (pers. comm.), the Illinois Natural Areas Inventory (1976) stated under "significant features" that this prairie would be a likely habitat for *T. americana*. Many of these areas remain unprotected and are still under threat of development (Johnson 1991).

How many hours over the last 80 years have actually been spent in disciplined searches by individuals with good search images for *Thismia*? Although people have been interested in finding this plant over the past 80 years, it would easily be missed, given its size and coloring. The Illinois Native Plant Society has been sponsoring annual *Thismia* hunts since 1991.[3] Searchers gathered at a central location before splitting into five or six groups in order to cover all the potential *Thismia* habitat sites. At the end of the day, they met again to discuss their experiences and make note of any plants they found that were new to the Chicago lake plain. Before the first hunt, 200 small white beads were scattered in what looked like potential *Thismia* habitat at two different search sites. During the hunt, none were found at one site and 36 were recovered at the other, but only after the group was led to the area by a leader who knew where the beads were scattered. The second year 200 more beads were scattered at a third site. None were recovered at the new site, but seven beads from the previous year were discovered. There remain 557 "*Thismia*" yet to be found!

Another by-product of the *Thismia* hunts was a discovery by Bill Zales. While rummaging through a used bookstore, he found a set of reprints of articles by Norma Pfeiffer. He purchased all of them and brought them to a hunt. One of the articles, "The Prothallia of *Ophioglossum vulgatum*" (Pfeiffer 1916), expanded on the description of *Thismia* habitat.

> The situation in which the present growth of *O[phioglossum] vulgatum* occurs is practically the low prairie type previously described for *Thismia americana*. The plants of *Ophioglossum* occur among the prairie plants. Spots have been burned, and here the plants show very distinctly, owing to a partial elimination of the grasses and other plants which ordinarily tend to obscure the smaller *Ophioglossum* plants. Where there is much shade, *Selaginella apus* and *Aneura pinguis* occur, as in the *Thismia* patch, which is close at hand. The habitat is evidently low and wet, inundated in spring. Early in July, *Riccia fluitans* in small amounts was also found, and late in July 1915, after a rather wet month, some of the field was under water. There were, however, hummocks as well as more extensive plots not submerged. Compared with the other situation in

[4] One of the hunts, so widely publicized as it was in the Chicago papers, even brought out relatives of Norma Pfeiffer, and they shared family pictures and memorabilia.

> the Chicago region where *O. vulgatum* has been found, that is, near Gary, the present station in the southeast outskirts of Chicago seems wetter.

In 1993 the Illinois Department of Conservation and the U.S. Fish and Wildlife Service commissioned a systematic search of potential habitat for *Thismia americana* (Bowles et al. 1994). It is the rare botanist who has a search image for such a plant and of the three people asked to search, two are skilled at looking for lichens (Rich Hyerczyk and Michael Jones) and another has a reputation for locating small unusual plants (Ken Klick). Unfortunately, the search did not turn up *Thismia*, but it did produce more information about the sites with potential *Thismia* habitat.

Because there is very little information about this plant, and because it has not been seen for a long time, many botanists have listed it as "almost certainly" or "undoubtedly" extinct (Jones and Fuller 1955; Swink 1974; Mohlenbrock 1970, 1975, 1986; Jones 1971; Swink and Wilhelm 1994). Louis O. Williams, former chairman of the Botany Department at the Field Museum, was more optimistic; he wrote in 1973 that it may still be in areas sharing similar habitat characteristics and "that maybe some day an astute collector may find this tiny little plant again." Fernald wrote in *Gray's Manual of Botany, 8th ed.* (1950) that *Thismia americana* was "a most remarkable species, to be sought again." *T. americana* is listed as an Illinois endangered plant (Sheviak 1981; Illinois Endangered Species Protection Board 1990), which optimistically suggests that the plant remains extant. Extirpated species are not state listed unless they also are federally listed, and *T. americana* is not federally listed. Importantly, in her letter to Dr. Just, Norma Pfeiffer reflected optimism that it could be relocated if similar habitat remained.

> In 1917, I hunted briefly, but did not have adequate time for a thoroughgoing search. Since that time, I have often thought of searching similar locations as well as the original station, but have not done so. With enough time, I am sure I could locate it, if it is still in the region.

Two other examples provide reason for optimism. In 1984, Ken Klick found, for the "first" time, a tiny bladderwort, *Utricularia subulata* L., in the frequently visited and intensely botanized Hoosier Prairie in nearby Lake County, Indiana. Botanists had questioned the plant's nativity, but since then, Gerould Wilhelm and I found a specimen of *U. subulata* from Porter County, misidentified as *U. minor* L., in Father Hebert's herbarium at Notre Dame. This specimen was collected in 1930, giving support to the idea that the plant is native in northwest Indiana. Our present knowledge indicates it had been overlooked for more than 50 years despite intensive floristic work (Wilhelm 1990). Another example is a lichen, *Phaeophyscia leana* Tuck., that was first discovered in 1839 near Cincinnati, Ohio, collected for about ten years, and then not seen since. It was thought to be extinct (Thomson 1963) and was even removed from most lichen flora keys. It was rediscovered 139 years later, in 1978, by Alan Skorepa (1984), 200 miles downstream along the Ohio River in southern Illinois. It has since been found in several more locations in four other states (Wilhelm and Wetstein 1991). It has been a mere 79 years since *Thismia americana* was last seen.

How and where would one begin to look to rediscover *Thismia americana*? Norma Pfeiffer first discovered it east of Lake Calumet and north of the Calumet River, in an area that even then was under threat of industrial development. The plants listed by Norma Pfeiffer would suggest a wet area, but what the actual relationship of *T. americana* to the water table was is not known. She found the plant growing mostly where the soil was not closely covered by *Selaginella* and *Aneura*. Did this mean that the area burned on a regular basis, thereby removing the duff and exposing the soil? Perhaps not enough is known about its flowering phenology. Was it consistent from year to year? Was it dependent on certain temperatures or humidities? Was it ephemeral and easily missed? Like *Thismia rodwayi*, does it also bloom underground from time to time?

One of the great botanical mysteries is how *T. americana*, which is known from nowhere else in the world, came to occupy these low prairies. Some have suggested that this plant was a waif from some tropical area or disjunct from the coastal plain and, not being able to withstand our harsh winters, eventually disappeared; maybe it is native to the temperate zone somewhere in South America and has not yet been discovered there. Because it has been discovered here and nowhere else, I believe we must proceed on the premise that the plant is native to the Chicago region. Many have asserted that the rediscovery of *T. americana* is a long shot. I would answer that it is not nearly such a long shot as its original discovery. In a charming account in a recently rediscovered journal article written when she first arrived in North Dakota (Pfeiffer 1914b), Dr. Pfeiffer speculated on the "slow

finding of forms" that may bridge the geographic space in the distribution of *Thismia* species. She wrote that it was not the lack of fairly intensive botanical work in the Chicago region, but rather, it was the smallness of the plants themselves that made such discoveries so rare. Of *Thismia americana* she wrote the following:

> . . . the dimensions of the plant appear even smaller than in most tropical forms. As a matter of fact, all of the short floral stalk and the basal portion of the flower are underground, with only the delicately colored upper part evident. The young buds are white, developing later a delicate blue-green in the upper part of the flower. The structure of the flower is quite different from that on forms with which most of us are familiar. . . The petals, which are grown together at the top, are distinctly separate 2–3 mm, while the total height of the flower is only 1–1.5 cm at best. It is evident that when not bearing a flower, the organism would defy detection, unless one uncovered the roots.

She went on to discuss how one should search for the plants that may bridge the distribution gap:

> The general characteristics of such a group of plants as this one undoubtedly call for different tactics in hunting them down from those required in enumerating larger, more persistent forms. But the methods are such as are natural to any one. For those of us who have not access to wide displays of fossil forms, with the technical knowledge required to take advantage of them, who have not the opportunity to develop new species in a cultural way, or who are unable to experience the pleasures with the attendant hardships, of the botanical excursion into unexplored country, there remains the regions about us. In these areas, withal they have been cursorily examined, there may exist at the present time, forms as yet undreamed of.

Norma E. Pfeiffer

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ERIGENIA, Number 14, November 1995, pp. 15–17

THE STATUS OF *ASTER SCHREBERI* NEES (SCHREBER'S ASTER) IN ILLINOIS

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ABSTRACT: Populations of *Aster schreberi* Nees were examined at ten sites in the northern one-third of Illinois. Most populations occurred on north-facing, relatively steep slopes in second-growth forests. The overstory above the Schreber's aster populations varied from 232 to 512 stems/ha, and average tree diameters ranged from 22 to 32 cm dbh. Moderate disturbance was evident at most sites, and soil slumping resulted in the loss of some trees. Most aster populations were relatively small, occurring in areas less than 0.5 ha in size. No particular features of the habitat were found to be related to the rare appearances of Schreber's aster in Illinois.

INTRODUCTION

Aster schreberi Nees (Asteraceae) is a common species in dense woods, particularly in the Piedmont and mountains of the eastern and southeastern United States, from Maine to northern Alabama, and west through the Great Lakes region to eastern Wisconsin (Gleason and Cronquist 1991). Illinois populations are disjunct by about 450 km from the nearest populations to the east (Jones 1989). Because of this distribution and the few extant populations in the state, Schreber's aster is presently listed as state threatened (Sheviak and Thom 1981; Herkert 1991). The disjunct Illinois populations have been referred to *Aster chasei* G. N. Jones (Jones and Fuller 1955), but more recently Jones (1989) found no consistent characters for separation of these plants as a distinct species.

Aster schreberi is restricted to the northern one-third of Illinois (Winterringer and Evers 1960; Mohlenbrock and Ladd 1978). It is known from the central part of the Illinois River valley (Bureau, Marshall, Peoria, Putnam, and Tazewell counties) and from northwestern Illinois (Henry, Knox, and Rock Island counties), and it has been reported from Cook and Will counties in northeastern Illinois (Jones 1989). Not only is this species uncommon in Illinois, but flowering individuals are rare. Populations increase in size by rhizomes that form large sterile colonies in which the basal rosettes produce a dense ground cover. The present study was undertaken to determine the size and structure of Schreber's aster populations in Illinois and to characterize the habitat in which these populations occur.

MATERIALS AND METHODS

Location data for all known populations of *Aster schreberi* in Illinois were obtained from Illinois herbaria, and attempts were made to relocate each population. At sites where *Aster schreberi* populations were found, general site and population data were gathered, and at ten sites a detailed site evaluation was undertaken. The woody overstory density (stems/ha), basal area (m^2/ha), relative values, importance values, and average diameters were determined, as was the density (stems/ha) of the saplings. The woody overstory composition was tabulated by using two quadrats, each 25 × 25 m, centered over the *Aster schreberi* population. In these quadrats all trees 10 cm dbh and larger were identified and their diameters recorded. The density of small saplings (> 40 cm tall and < 2.5 cm dbh) and large saplings (2.5 to 9.9 cm dbh) was determined using nested circular plots of 1 m^2 (for small saplings) and 10 m^2 (for large saplings), centrally located in each quarter of each 25 × 25 m quadrat.

RESULTS AND DISCUSSION

Most of the Schreber's aster populations were located on north-facing hillsides that had a slope of 10 to 30 degrees. A few populations were in steep-sided ravines, and one was located on a terrace at the base of a steep slope. Occasionally colonies were found on the flat uplands above the hillsides (table 1).

In the 10 sites studied, there were dense colonies of *Aster schreberi* 4 to 12 m across that grew to the exclusion of most other species. Between these dense colonies were many smaller colonies as well as scattered individuals (table 1). Generally, *Aster schreberi*

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individuals were confined to an area of less than 0.5 ha. Two populations, however, were much more extensive. At Thorn Creek Woods Nature Preserve (Will #1) much of the forest had extensive colonies, some as large as 35 m across, located mostly on the slopes of Thorn Creek and the adjacent uplands. The largest *Aster schreberi* population found in Illinois was at Loud Thunder Forest Preserve (Rock Island #1), where it extended for more than 1.5 km along the wooded, north-facing hillside adjacent to the Mississippi River. Numerous dense colonies, some 45 m across, were scattered along this hillside, along with many smaller colonies and scattered individuals.

Few flowering plants were observed at most study sites; six sites contained fewer than 40 flowering individuals during the 1991 survey (table 1); however, at two different sites in the Marshall County State Fish and Wildlife Area (Marshall #3 and #4), nearly 100 flowering individuals were observed. In the largest populations (Rock Island #1 and Will #1) no attempt was made to count the number of flowering individuals because of the size of the areas, but very few were observed. Most flowering individuals were growing in the more open parts of the sites.

The woody overstory at the Schreber's aster colonies was dominated by species typically associated with mesic hillsides and terrace forests. On the steep hillsides *Acer saccharum* Marsh. (sugar maple) was usually the most common species with an importance value (IV) close to 100 (out of a possible 200). *Quercus rubra* L. (red oak), *Q. alba* L. (white oak), and *Tilia americana* L. (American linden) usually followed in importance, though on two sites red oak had the highest IV, and on one white oak dominated. The terrace population overstory was dominated by *Ulmus americana* L. (American elm) with an IV of 80, followed by *Populus deltoides* Marsh. (cottonwood) and American linden. The forests showed indications of past disturbance. Usually a few cut stumps were present, and soil slumping on steep slopes resulted in the loss of some trees. Tree densities varied from 232 to 512 stems/ha, averaging 340 stems/ha for the 10 sites; the basal area varied from 13.9 to 38.3 m^2/ha, averaging 25.7 m^2/ha. Trees were relatively mature with average diameters of 22.4 to 31.8 cm for the 10 sites.

The understory was relatively open and generally dominated by sugar maple, which accounted for nearly 50% of the individuals present. The understory tree *Ostrya virginiana* (Mill.) K. Koch (hop hornbeam) was also common, along with *Fraxinus* spp. (ash) and *Carya cordiformis* (Wang.) K. Koch (bitternut hickory). Common shrubs included *Corylus americana* Walt. (hazelnut), *Staphylea trifolia* L. (bladdernut), *Viburnum prunifolium* L. (black haw), and *Hydrangea arborescens* L. (hydrangea). Shrub and small sapling densities ranged from 2,100 to 9,625 stems/ha, averaging 5,538 stems/ha for the 10 sites; large saplings averaged 770 stems/ha.

During late summer when the study was undertaken, the common herbaceous species found associated with the Schreber's aster populations were *Asarum canadense* L., *Carex albursina* Sheldon, *Cystopteris protrusa* (Weatherby) Blasd., *Eupatorium rugosum* Houtt., *Hepatica nobilis* Mill. var. *acuta* (Pursh) Steyerm., *Polystichum acrostichoides* (Michx.) Schott, *Solidago flexicaulis* L., and *S. ulmifolia* Muhl.

In addition to the 10 sites studied, 12 other populations of *Aster schreberi* were located. All were in the Illinois River valley in the general vicinity of Peoria. Both Robinson Park and Forest Park have extensive north-facing hillsides, and some of these had extensive populations of Schreber's aster. A few additional populations were found at the Marshall County State Fish and Wildlife Area; others occurred in and near the Miller-Anderson Woods Nature Preserve. One population was located in a steep-sided ravine in northwestern Tazewell County (S12 T26N R4W). The majority of the *Aster schreberi* populations were in state and city parks; others were in a university natural area, a nature preserve, and a state fish and wildlife area. Since these areas are protected to some degree, it appears that the survival of *Aster schreberi* in Illinois is relatively secure.

In the Illinois River valley there are many areas with habitats similar to those in which *Aster schreberi* was found, in some cases within a few hundred meters of a population. These areas have the same associated species, but lack Schreber's aster. It appears that the rarity of this taxon in Illinois is probably not related to a specialized habitat, but is most likely the result of the small number of flowering individuals, or possibly poor seed reproduction, poor seedling survival, or low genetic variability.

ACKNOWLEDGMENTS

This work was supported, in part, by a grant from the Illinois Department of Conservation's Wildlife Preservation Fund.

TABLE 1. Colonies of *Aster schreberi* examined in Illinois.

County and site	Extent of *Aster schreberi* population	Flowering individuals
Bureau #1 S36 T15N R9E	110 × 45 m along slope, six colonies 5–18 m in diameter, along with numerous smaller colonies and scattered individuals	3
Knox #1 S6 T11N R4E	45 × 24 m along slope, one colony 8 m in diameter and another 10 × 20 m, along with scattered individuals	20
Marshall #1 S23 T12N R9E	85 × 22 m along slope and terrace, four colonies 5–8 m in diameter, along with numerous smaller colonies and scattered individuals	0
Marshall #2 S34 T12N R9E	75 × 45 m along slope, two colonies 6–12 m in diameter, along with numerous smaller colonies and scattered individuals	10
Marshall #3 S23 T29N R3W	110 × 30 m along slope, seven colonies 4–9 m in diameter, along with scattered individuals	110
Marshall #4 S23 T29N R3W	70 × 15 m along ravine, three colonies about 5 m in diameter and one 20 × 5 m, along with scattered individuals	98
Peoria #1 S22 T9N R8E	45 m along terrace and 35 m up slope, one colony 11 m in diameter, along with numerous scattered individuals	15
Peoria #2 S22 T9N R8E	65 × 35 m along slope, four colonies 2–6 m in diameter, along with scattered individuals and a few smaller colonies	33
Rock Island #1 S26 T17N R4W	1,500 × 125 m along a north-facing hillside at Loud Thunder Forest Preserve, numerous dense colonies and scattered individuals	?
Will #1 S11 T34N R13E	Extensive colonies and scattered individuals throughout much of Thorn Creek Woods Nature Preserve	?

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ERIGENIA, Number 14, November 1995, pp. 18–31

Prairie Restoration on an East-Central Illinois Field

Don Gardner[1]

ABSTRACT: A prairie restoration project was initiated in 1974 on mesic soil pasture land. Restoration of adjacent plots within the field continued annually; the final plot was seeded in 1990. Geological, climatological, and settlement histories are described briefly. Methods of soil preparation, seed treatment, nursery propagation, weed control, and the use of fire are discussed. The floristic composition and observations of successional changes are recorded. An inventory yielded 189 species of native and alien vascular plants. Voucher specimens were collected and placed in a herbarium.

Introduction

This is a report concerning a continuing prairie restoration project on a former pasture in northern Ford County. In the natural divisions of Illinois, it lies within the Grand Prairie Section of the Grand Prairie Division (Schwegman et al. 1973). It is located on the southeast side of the village of Kempton (in part of SW NW NE and SE NE NW S6) in Mona Township. The field shape is roughly trapezoidal, containing over seven acres. The long axis is east-west and is about 1000 feet. Width averages about 325 feet. Intense grazing for many years contributed to the extirpation of many native prairie species. The goal of the project has been to increase populations of remaining desirable native species and to introduce other native species that continue to survive on prairie remnants in central Illinois.

The project began in 1974. The years following provided time for comparisons of restoration methods and observations of species population changes. Although this represents more than twenty growing seasons, it is only a moment in the time span necessary for successional development of climax prairie. This report describes the brief and generally satisfying progress in what is anticipated to be a much longer-term project.

A survey of species established on the restoration was conducted, and voucher specimens were placed on file in the Illinois Natural History Survey herbarium (ILLS) at Champaign. All collections were made from 1991 to 1994.

Glaciation and Topography

Bedrock under this area is the Carbondale formation of the Pennsylvanian system. It consists of thick shaly mudstones interbedded with thin coals, limestones, and sandstones. Above this bedrock are more than 200 feet of glacial till, a generally unstratified mixture of silt, clay, and sand, with inclusions ranging from pebbles to large boulders. It accounts for the principal features of the present topography of the region (Piskin and Bergstrom 1975). The project site lies near the south margin of the Ransom moraine. It has about 80 feet of elevation above a glacial lacustrine region to the southeast.

Rapid plant invasion followed the recession of the most recent glaciation, the Woodfordian phase of the Wisconsinan. Tundra vegetation with scattered spruce and fir forests was followed by a transition to deciduous tree species about 12,000 B.P. Beginning about 6500 B.P., grassland intruded from the west in response to a period of warm, dry climate (Geis and Boggess 1968; King 1981).

The variation of elevation within the restoration field reflects the gently rolling topography. From about 730 feet above sea level at the southwest corner, there is a gradual slope downward to a shallow watercourse passing diagonally through the central part of the field. Water is present in the ditch only during seasonal runoff. There is a difference of about 15 feet from the highest location to where the ditch exits the field (U.S.G.S. 1986).

The watershed draining through the restoration includes a major part of the village of Kempton and fields extending about one-half mile north of the village. Water flow is to the southeast where, in about three miles, it enters what was locally known as the Vermilion Swamp, a wetland that was drained early in the twentieth century. Water then enters the North Fork of the Vermilion River, which flows west and north, eventually entering the Illinois River near LaSalle.

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Soils

Soil types in the restoration are Swygert 91B2, particularly on the higher parts of the field, and Bryce 235 (fig. 1). Both are poorly drained fine-textured silty clay loam soils formed in loess, local outwash, and underlying glacial till. The surface layer is black to dark gray, friable, firm, and about 12 inches thick. Both soils are classified in hydrologic soil groups that have slow infiltration rates when wet, which causes potentially high runoff. These soils are used for cultivated crops, primarily corn and soybeans in the local area. Problems they present for cultivation are ponding in low areas and water erosion on slopes. Contributing to these effects is slow permeability and moderate available water capacity (Fehrenbacher 1990). The compact surface layer and low permeability of these soils cause severe and persistent clodding if cultivated when too wet. Thus, during springs of above average rainfall, timing of cultivation is critical.

A buried drainage tile passes through the restoration, causing localized alterations in soil hydrology. An 18-inch diameter drainage tile from the village enters the restoration site from the north and parallels the ditch to its exit from the restoration. This tile is nonperforated plastic and thus hydrologic modification of the soil is reduced. A 10-inch diameter perforated plastic tile connects to the larger tile after entering the site from the west. A 5-inch diameter clay tile line crosses the site from the southwest and connects to the 10-inch line (fig. 2).

Climatic factors

Marked year-to-year variations in climatic conditions significantly affect the accuracy of any characterization of a typical weather year over the short duration of the study, and the following statistics can be misleading for any brief period of years.

Ford County has a continental climate with cold winters and hot, humid summers. Precipitation is generally adequate. Data recorded in the period 1951–80 at Kankakee established that total annual precipitation averaged about 35 inches. Approximately 65 percent of this fell from April through September. Snowfall averaged 24.8 inches annually. Snow cover can be a protective factor on a restoration, especially for young plants. It provides insulation from the often intense subzero Fahrenheit temperatures and prevents the displacement of recently established plants that results from intermittent freezing and thawing of exposed soil. The number of winter days with a covering of snow varies greatly from year to year (Fehrenbacher 1990).

Established prairie forbs are well adapted to short-term moisture variations and use several protective mechanisms. During stressfully dry growing seasons leaf curling is apparent, growth is curtailed, and anthesis may not occur. During the drought years of 1988 and 1991 the tall warm-season native grasses grew to only about one-third of their usual height, and viable seed was not produced. Rainfall of 11.6 inches in July 1992 established a monthly high record;

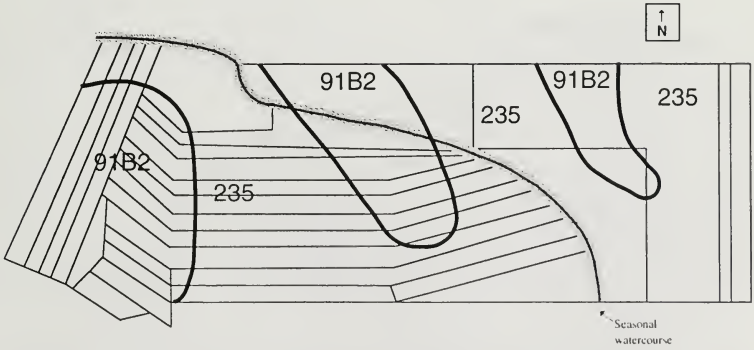

Fig. 1. Restoration site with designations of soil types, Swygert 91B2 and Bryce 235.

however, this was preceded by drought conditions during the spring, with 2.7 inches of precipitation from early April until 2 July. In spite of the wet summer, seed production by the tall native grasses was reduced. This suggests that anthesis is determined early, probably in June. In 1981, a year in which there was above average rainfall (39.7 inches from April through September), some plants of *Andropogon gerardii* (big bluestem) exceeded ten feet in height.

The growing season extends from about mid April until mid October. Two years in ten, killing frost (28°F or lower) occurs later than 20 April or earlier than 18 October (Fehrenbacher 1990). Early or late frost rarely was cause for problems on the restoration. Soon after freezing in the fall, seed falls readily from some grasses; prompt seed harvest is required. The remarkably prolonged resilience of the culms of these grasses was noted. Occasionally ice storms prostrated entire stands of previous season growth of the tall grasses, but following the melting of the ice, the culms rapidly regained their erect stature.

Settlement History

The first written records found for the immediate area in which the restoration is located are dated 27 April 1834. It was then that the United States public lands survey was conducted. The survey indicates that all of what is now Mona Township was prairie, with the marshland in the southeast portion described as the "Vermilion Swamp" (Illinois presettlement atlas 1840). Field notes (Ewing 1834) for the survey of Section 6, in which the restoration is located, describe it as "rich first rate prairie." The survey record notes that prairie covered all of Sullivan Township, adjacent on the west. Mona Township was organized in 1870, with a population of 342; major settlement had occurred from 1867 to 1870. Population growth was encouraged by construction of the Bloomington-Kankakee branch line of the Illinois Central Railroad, and the village of Kempton was developed on this newly established line in 1878.

Wright Kemp, who was instrumental in forming the village and owned land including the present prairie restoration, came from Morris in Grundy County to "Grand Prairie, Ford Co." in 1866. He described that journey, by way of Dwight, as traveling "across the unbroken prairie." The 1884 *Historical Atlas of Ford County, Illinois*, in which these comments appear, also describes northern Mona Township as "a fine body of undulating prairie land."

The two subsequent owners of the restoration site used the pasture land to graze dairy cattle throughout the early and mid portions of the twentieth century. Grazing ceased in 1965, and the pasture remained an old field with annual mowing until the start of the restoration work in 1974.

In past years, during conversations with the author, older residents of the community stated that the restoration had been permanent pastureland from at least 1900. It was their opinion that the field had never been tilled, but this could not be documented.

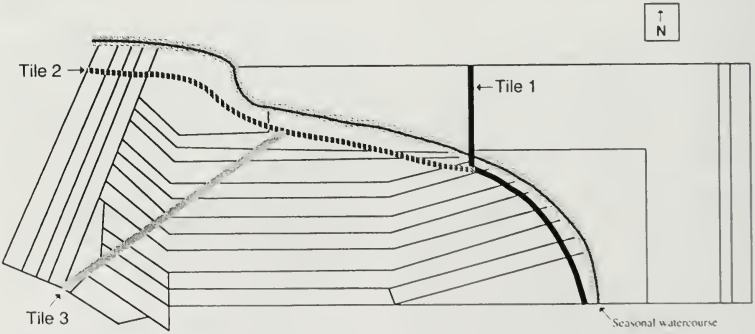

Fig. 2. Drainage tile locations. Tile 1, nonperforated plastic, 18-inch diameter. Tile 2, perforated plastic, 10-inch diameter. Tile 3, clay, 5-inch diameter.

METHODS

Plots

From 1974 through 1990, 28 plots were established in the approximately 7.3-acre restoration field (fig. 3). Plot size varied from about 0.044 acre to 1.375 acre (table 1) and was determined by the amount of hand-collected seed available each year. In some years two plots were delineated to test different soil preparation methods and different seed mixes, or to expand restoration into another part of the field. Generally the restoration started at the south side of the field and progressed northward in parallel plots. Most of the longer plots were curved in the hope of minimizing erosion of exposed soil on the slope and reducing the generally artificial appearance that is inevitable in the early years when adjacent restorations or reconstructions are being established. Pathway strips between most plots provided undisturbed areas for existing native species.

Plots were permanently marked using 1-inch diameter reinforcing bars cut to 24-inch lengths. A 1-inch brass tag with the plot number was bolted near the top end of each rebar. The rebar with the appropriate number was driven into the ground at the southwest corner of each plot (fig. 3). The tops of the steel markers were driven to ground level. Individual plots can be located using the prepared map and, if necessary, a metal detector.

Plot 19 remains as a control; there was no disturbance or direct seeding of this plot. Some native species from other plots are appearing there because of natural dispersal. Plot 20 is the part of the field containing the shallow ditch, and it remains largely undisturbed as well, although several wet-mesic species have been introduced. Nomenclature follows Mohlenbrock (1986).

Soil Preparation

Before restoration work started, the principal grasses in the field were *Poa pratensis* (Kentucky bluegrass), *Bromus inermis* (Hungarian brome), *Phleum pratense* (timothy), and *Agropyron repens* (quack grass). Frequent adventive forbs were *Daucus carota* (wild carrot), *Leucanthemum vulgare* (ox-eye daisy), *Asclepias syriaca* (common milkweed), *Aster pilosus* (hairy aster), *Achillea millefolium* (yarrow), and *Cirsium arvense* (Canada thistle). Surviving native species were often found in scattered, low-density populations.

Several preparation techniques were used, ranging from no soil disturbance to moldboard plowing. In the fall of 1973, Plot 1 (about 24 × 90 feet) was prepared by hand spading 48 3-foot square quadrats. Existing sod strips between the tilled quadrats were not disturbed. The following spring these quadrats were hand tilled several times and seeded on 20 June. The results were not satisfactory. Although germination was fair, the surrounding alien grasses, especially *Agropyron repens* and *Bromus inermis*, rapidly encroached. The introduced native species, including *Andropogon gerardii*, *Monarda fistulosa* (bergamot), and *Silphium*

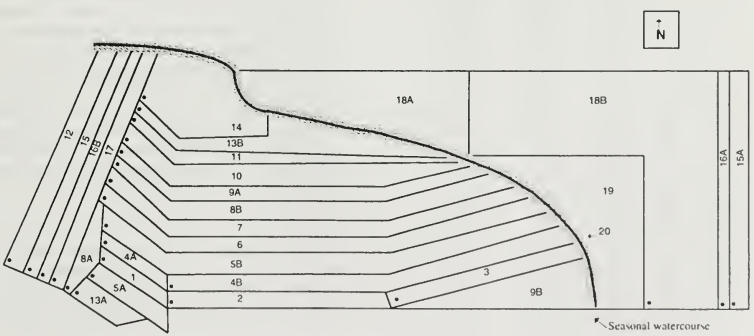

FIG. 3. Map of restoration area with individually numbered plots. • = Locations of buried steel identification markers.

terebinthinaceum (prairie dock), have gradually increased. However, even now, Plot 1 continues to have significant populations of alien species.

This method of soil preparation was not repeated, and for several years a moldboard plow was used. In the fall, the next plot would be plowed to a depth of seven to ten inches. During the following spring the plot was tilled several times with a disk and a spring-toothed harrow. Thus a fine particulate seedbed was prepared and the existing vegetation removed. Seeding was followed by light harrowing. A roller was then used to create a firm seedbed. Seeding dates ranged from 18 May to 20 June. In thirteen of the seventeen years in which new plots were established the planting date fell within the last ten days of May or the first ten days of June. In spite of repeated tillage and late planting, competition from annual weeds was invariably severe. Typical weed growth the first year included *Amaranthus hybridus* (green amaranth), *Chenopodium album* (lamb's quarters), *Erigeron annuus* (annual fleabane), and *Panicum capillare* (witch grass). One method of attempting to reduce competition was to leave a plot fallow for an extra growing season. It was fall plowed and then disked several times the following year. The second spring following plowing it was disked, harrowed, and seeded. This procedure was followed on two plots, 7 and 14. Weed competition continued to be intense. Although each tillage operation destroyed growing weeds, it also created conditions that encouraged germination of additional existing seed. Leaving the soil without a cover for an additional year increased the already existing risk of erosion associated with moldboard plowing. That is what occurred, especially on the 1980 Plot 7 where movement of soil was significant. With weed competition seemingly not diminished and erosion increased, this method of leaving a plot fallow was rejected.

TABLE 1. Planting years and individual plot sizes.

Plot #	Year	Area (sq. ft.)	Area (acres)
1	1974	1,925	0.044
2	1975	8,026	0.184
3	1976	6,256	0.144
4A	1977	2,230	0.051
4B	1977	12,166	0.279
5A	1978	3,384	0.078
5B	1978	18,222	0.418
6	1979	13,164	0.302
7	1980	12,520	0.287
8A	1981	3,524	0.081
8B	1981	13,678	0.314
9A	1981	10,194	0.234
9B	1981	1,243	0.258
10	1982	11,660	0.268
11	1983	7,266	0.167
12	1984	7,366	0.169
13A	1985	2,486	0.057
13B	1985	8,784	0.202
14	1986	2,729	0.292
15A	1987	9,415	0.216
15B	1987	6,311	0.145
16A	1988	4,519	0.104
16B	1988	6,095	0.140
17	1989	6,748	0.155
18A	1990	20,548	0.472
18B	1990	59,904	1.375
19	control	20,301	0.466
20	control	17,672	0.406
Total		318,338	7.308

Use of the moldboard plow was discontinued after 1982. Fall tillage on Plot 12 was with a Soil Saver farm implement, which is a combination of disk blades and chisel plow. This thoroughly agitates the soil but does not invert a layer as with the moldboard plow. The additional plant material remaining on the surface over the winter reduced soil erosion. Before spring seeding began, the plot was disked and harrowed. Weed competition was similar to previous years, but reduced erosion and other satisfactory results encouraged continued use of this procedure.

In 1986 another system was tried. There was no fall tillage and in May a 2% solution of the glyphosate herbicide Roundup was sprayed on the plot. Use of a hand sprayer permitted directing the spray to avoid any existing native species. Approximately two weeks later this procedure was repeated to destroy vegetation previously missed. Immediately before and after hand seeding, the plot was lightly harrowed and then rolled. This method delayed and seemed to reduce weed competition, and erosion was virtually eliminated. Germination and growth of native species occurred, with results similar to those achieved with other procedures. Although this method required application of a herbicide, it proved useful for establishing prairie.

Seed

Seed was used for plant propagation, with a few recorded exceptions. Collection sites were all Illinois locations within approximately 120 miles of the restoration field. Seed was sown on the restoration site by hand broadcasting.

Freshly collected seed was dried indoors by spreading it in a shallow layer that was regularly turned. No artificial heat or forced air drying was used. Storage of the dried seed was in a cool, dry basement. Seed of species for which there were small collections was frequently stored in refrigerators. Also, damp stratification was occasionally used, but insufficient refrigerated storage made this procedure impractical on any large scale.

Seed from spring-flowering taxa was often planted in late summer. After drying, the seed of species such as *Dodecatheon meadia* (shooting star), *Pedicularis canadensis* (wood betony), *Phlox pilosa* (prairie phlox), and *Sisyrinchium albidum* (common blue-eyed grass) was planted in established restoration plots. Small open areas were selected, and the soil was agitated with a pronged hand cultivator. Seed was scattered on the surface, the soil was agitated again, and then compressed. It was felt that this method was more conserving of seed than broadcast application when establishing a new plot in which heavy weed competition was assured. However, spring seeding on new sites with *D. meadia* proved successful on Plots 2, 3, 4A, and 5B. The same was true for *Pedicularis canadensis* on Plot 12.

For about the first ten years of the project, legume seeds of the genera *Amorpha*, *Baptisia*, and *Dalea* were treated immediately before planting with an appropriate *Rhizobium* inoculant from Nitragin Corp. Before inoculation, *Amorpha canescens* (lead plant), *Baptisia lactea* (white wild indigo), and *Baptisia leucophaea* (cream wild indigo) were scarified using a vibrating bench sander.

Dalea candida (white prairie clover), *Dalea purpurea* (purple prairie clover), and *Baptisia lactea* germinated well, usually appearing the first or second year after planting. *Amorpha canescens* often, though not always, required several years to appear. In Plot 12, established in 1984, *A. canescens* emerged the first year; seedlings also appeared in 1990.

In recent years scarification was continued, but legume seed was no longer treated with inoculant. The appearance of increasing numbers of native legumes may suggest that the required strains of *Rhizobium* are established in the soil. Other legumes such as *Astragalus canadensis* (Canadian milk vetch) and *Lespedeza capitata* (round-headed bush clover) were planted without inoculation or scarification. They have become established in several locations within the restoration.

Nursery

Cultivated nursery plots were in continuous use for the duration of the restoration project. They provided a source of additional seed and transplants for species for which small amounts of seed were collected or for species that proved difficult or slow to establish by direct seeding in the field. Short nursery rows were seeded, and resulting plants were increased primarily by division.

A typical example is *Dodecatheon meadia*. Although seed germination was often satisfactory, this plant required four or more years to reach anthesis in the restoration field. Plot 3 first produced flowering individuals in 1984, eight years after seeding. A nursery row was seeded to hasten the process. After about three years, the nursery plants were lifted in late summer. The root system of *D. meadia* consists of a central root crown from which project numerous radiating roots. These roots, each of which has a bud, may be detached separately from the central crown. These single roots were planted in additional rows. This reduced the time necessary to produce mature plants, saving probably two years over starting from seed.

With an increase in the length and number of nursery rows, some divided roots and mature plants were transplanted to the restoration. This provided older plants for recently established plots, and thus the opportunity for earlier appearance of seedling plants surrounding the parents. A useful indication of success on a restoration is the appearance of second-generation plants. This has occurred on several plots with *Dodecatheon meadia*. In addition, the nursery rows produced increasing amounts of readily collected seed. In 1991, 12 ounces of *D. meadia* seed were harvested from 147 feet of nursery rows.

Sporobolus heterolepis (prairie dropseed) is an example of a species for which only small amounts of hand-collected seed were available initially, and there was no success in establishing the species on the restoration by direct seeding. Seed planted in a nursery row in 1981 had poor germination, but did provide a few plants. After two years these plants were lifted before the start of spring growth. Tillers were divided and immediately planted in an extension of that row. This was repeated in subsequent years, and after several rows were established the tufts were divided, and some were planted in the field in early spring. Except in excessively dry years, these transplants grew well. During the same time, the rows of *S. heterolepis*

in the nursery provided increasing amounts of seed. In 1986 the collection was 1.25 pounds, but by 1990, 13.5 pounds were harvested from 410 feet of nursery rows. This seed was sown on the restoration, and *S. heterolepis* is now appearing on the most recent restoration plots. Previous lack of substantial amounts of seed may have been the principal reason for the early failure to establish this grass by direct seeding.

Asclepias tuberosa ssp. *interior* (butterfly milkweed) is an example where, after establishment in the nursery, it became possible to collect more seed and at an optimal time of maturity. In earlier years there were only isolated instances of success from direct seeding. However, many young plants are appearing in recent plots on which the greater amounts of fully ripened seed were applied from the nursery.

When moisture conditions were adequate, transplanting most species from the nursery was successful, and anthesis was achieved in the first or second year. With some species, though, the transplants had a shortened life span. This was true of at least some transplants of *Echinacea pallida* (pale purple coneflower), *Liatris pycnostachya* (prairie blazing star), and *Liatris spicata* (marsh blazing star). The transplants grew and produced seed, and seedling plants were often found in the area. However, the parent plants frequently diminished in size and disappeared after three to five years. Determination was not made whether this was due to the transplantation.

Since 1981 the nursery has been located in part of the restoration field (Plot 8A). When it is no longer required, tillage of rows will cease, and existing plants will remain as a part of the restoration.

Fire

Annual late winter burning of the restoration site is a principal management technique. The ground cover retained over winter aids in prevention of erosion and provides shelter for wildlife. Prescribed burning usually has taken place in March. However, the dates have ranged from 25 February to 19 April. The April dates were due to prolonged snow cover in 1978 and wet field conditions in 1979. In the latter year there was some damage to emerging *Dodecatheon meadia*.

Fire lanes are mowed in late summer on the east, southeast, and southwest sides of the restoration where there is a risk of escape. When possible, the burn takes place when there is a westerly wind. This diverts the considerable amount of smoke away from the village. Backfires are started on the east side. Then the fire is permitted to run downwind from the west. Following these precautions, problems were never encountered. However, the startling height of flames and noise of the fire caused local citizens to notify the fire department on three occasions.

Removal of surface plant material from the previous season is especially helpful when attempting to establish early spring forbs. Rotational burning of nearby railroad prairie remnants has repeatedly shown reduced flowering of species such as *Dodecatheon meadia* and *Pedicularis canadensis* in years when burning did not occur. The only year when burning of the restoration field did not take place was 1989, because of the stress of the previous drought year and the reduced amount of thatch. There followed a marked decrease in flowering of early spring species.

Burning was often incomplete on plots during the first two or three years because of the difficulty of starting the fire in the coarse annual weeds. *Chenopodium album*, *Erigeron annuus*, *Amaranthus hybridus*, *Ambrosia artemisiifolia* (common ragweed), and *Ambrosia trifida* (giant ragweed) produced heavy stems and small amounts of leaf material, which prevented clean burns. Some plots had a heavy first-year growth of *Panicum capillare* and *Panicum dichotomiflorum* (fall panicum), which provided excellent fuel. In these plots prairie species seemed to establish themselves more quickly.

Weed Control

Annual weedy species grew vigorously on all plots during their first year of restoration. Removal of existing vegetation, combined with soil disturbance, permitted pioneering taxa to thrive. Considering that perennial sod cover had been in place, one could not fail to be impressed with the opportunistic character of these species. Their seed was necessarily present in the soil for an extended time, remaining dormant until proper conditions for germination occurred. The predominant pioneering species varied with location. Plots toward the south side of the field had more *Chenopodium album*, *Amaranthus hybridus*, *Ambrosia* spp., and *Erigeron annuus*. Farther north the overwhelmingly dominant species the first year was *Panicum capillare*.

In some years a weed mower was used on new plots in midsummer, cutting to about six inches high. However, if growth was heavy, this could cause accumulation of cut plant material on the native

seedlings, with resultant losses. Unless the growth was light or raking was possible, mowing was counterproductive.

In spite of their rapid coverage of a new restoration plot, these annual weeds never proved to be an enduring problem. Another wave of unwanted taxa replaced them during the second and third years. These included *Daucus carota* (wild carrot). This biennial had invaded the entire field before restoration, and by midsummer it was the dominant forb cover. It was expected to be the cause of substantial difficulty in restoration management. At times it became so pervasive that intervention seemed necessary. After flowering, the plants were mowed. This was largely ineffective since secondary umbels developed and additional mowing was contraindicated because of the presence of young prairie taxa. However, the concern proved unnecessary. *D. carota* remains present in the field, in greatest numbers on more recently planted plots. In established areas only small scattered specimens can be found, and these do not flower. Given enough time, *D. carota* will probably be virtually extirpated from the site through successional replacement.

Other biennial aliens in this second wave of succession were *Melilotus alba* (white sweet clover) and *Melilotus officinalis* (yellow sweet clover). Their growth appears to respond favorably to burning, and they continue to persist even in some older plots. Their populations vary from year to year, but have not shown a significant increase. If they are not succeeded, some form of intervention will be required. Hand removal by hoeing before anthesis is one choice. Another possible treatment is use of a sponge or wick applicator to apply concentrated (50%) glyphosate herbicide.

The aggressive rhizomatous growth of *Agropyron repens* makes it a tenacious invader from border areas. There have been instances of it overwhelming and replacing seedling prairie forbs, and it continues to be a problem in limited areas. However, native species replace *A. repens* in the long term. This process could be hastened by using more native tall grasses in the seed mix in a problem area. *Andropogon gerardii* has shown that it will displace *Agropyron repens*.

Cirsium arvense has a long history as an aggressive and persistent perennial weed in our agricultural areas, and it was expected to be a continuing problem on the restoration. Herbicide was used on denser stands, but as the prairie grasses became established, *C. arvense* was displaced. None has been observed in the restoration for several years.

A neighboring field provides a continuing seed source for *Rosa multiflora* (multiflora rose). Fire is only a partially effective control. Spot treatment with a 2% Roundup spray in early summer or midsummer will destroy existing plants; however, an annual sweep of the field is necessary to treat newly established individuals.

The tree seedlings that occur are *Fraxinus* sp. (ash), *Crataegus* sp. (hawthorn), *Ulmus pumila* (Siberian elm), and *Morus alba* (white mulberry). They are primarily in evidence in recently established plots. Once the prairie develops to the extent that adequate fuel is produced, fire becomes an effective control. Although the nearby village and a wood lot act as continuing seed sources, these trees have not presented a problem on the restoration.

SUCCESSIONAL CHANGES

Lack of understanding of species succession has caused unnecessary concern for the long-term species content of several plots. In 1975 the central portion of Plot 2 received a generous application of *Elymus canadensis* (Canada wild rye) in the seed mix. It flourished, and many individuals achieved anthesis the first year. For three years it continued to expand and dominate its range. Although it is a desirable prairie species, it is not a dominant in native prairie; thus, control of its range seemed necessary. Collection of *E. canadensis* seed was sharply curtailed and only small amounts were applied to subsequent plots. In Plot 2, thinly scattered *Andropogon gerardii* became more vigorous. By 1980 it had, to a large extent, displaced the *E. canadensis*. By 1990 only occasional plants of *E. canadensis* remained in the plot, which now also contains *Dodecatheon meadia*, *Eupatorium altissimum* (tall boneset), *Monarda fistulosa*, *Pycnanthemum pilosum* (hairy mountain mint), *Silphium laciniatum* (compass plant), and *Solidago juncea* (early goldenrod). *Elymus canadensis* proved to be a pioneering prairie species that creates a useful early cover and does not prevent later establishment of a diverse prairie community.

Rudbeckia hirta (black-eyed Susan) becomes established rapidly and often flowers the year it is seeded. Frequently it is used to provide some readily visible sense of success in otherwise weedy restorations or reconstructions. It also is an active participant in the mechanism of plant succession among prairie species. One of several examples where it became quickly dominant in the restoration was on the west end of Plot 2. It was replaced by even greater numbers of

Ratibida pinnata (yellow coneflower), another readily established species. By 1989 the *R. pinnata* population had decreased in that area, having been replaced by *Andropogon gerardii* and other native forbs.

Problems in establishing some species were predictable. *Lithospermum incisum* (fringed puccoon) and *Coreopsis lanceolata* (sand coreopsis) were readily grown in a nursery setting; however, after transplantation to the field, they disappeared within two years. These dry species were unable to survive the vigorous competition in a mesic soil environment. The same may be true of *Bouteloua curtipendula* (side-oats grama). Although it grows well when directly seeded onto plots, sometimes reaching anthesis the first year, it has disappeared in earlier plots, and population numbers are decreasing in recent seedings.

The drought of 1988 had prolonged effects on certain species. *Pedicularis canadensis* flowered normally that spring, but was decimated by the ensuing heat and drought. In 1989 there was no flowering, and no mature plants could be found. However, many seedling plants did appear. They increased in number and size the following year, but it was not until 1991 that flowering resumed in numbers comparable to those before the drought. A similar effect was noted with *Gentianella quinquefolia* ssp. *occidentalis* (stiff gentian), which did not flower between the years 1987 and 1993.

A warm-season grass that quickly became predominant in some plots was *Sorghastrum nutans* (Indian grass). One of several examples was in Plot 6, planted in 1979. In 1981 it was the dominant grass in that plot with only occasional *Andropogon gerardii* observed. Gradually there has been a population shift, so that ten years later the frequency of appearance of the two species has reversed. This may be a normal succession for this locality. Nearby railroad and cemetery prairie remnants have *A. gerardii* as the dominant tall grass with *S. nutans* scattered or absent. In high-quality prairie remnants, native forbs can partially displace *A. gerardii*. There are preliminary indications of that process occurring, and continued change in that direction is anticipated over time on the restoration.

Floristic Composition and Evaluation

In 1991 and 1992, a survey of the flowering plants growing on the site yielded 189 species. Of these, 138 species are considered native to central Illinois. The remaining 51 species are alien plants, generally common in the region. The native species comprise 71 previously existing on the site and 67 established during the restoration project. The total number of families recorded was 37. Those with the greatest native representations are Compositae with 35 species, Gramineae 19, Cyperaceae 14, and Leguminosae 12.

A plant list is included at the end of this paper, containing the following information: whether the species is considered native or alien; plots where the species has been observed growing (although not necessarily limited to those plots); whether the species existed on the site or was introduced as part of the restoration; and seed source locations.

An attempt was made to evaluate the restoration inventory. The Swink-Wilhelm method of floristic quality assessment revised by Swink and Wilhelm (1994) was used with revised numerical ratings (Taft et al. 1993).

A combination of recent species introductions and rapid successional change contributes to an artificiality of community structure in a restoration of short duration, and in such a diverse assemblage, some taxa negate the effects of others on the index. Thus high-quality marginally established prairie species are, to some extent, negated by alien species that are merely transitional. With a floristic quality index of 44, the restoration presents significant native character; however, the primary use of the evaluation here is to act as a guide for future species improvement of the site.

The last plots were added to the restoration in 1990. Further plans include enrichment of existing plots, a quantitative vegetation analysis, and continued observation of successional changes. In the past, lack of seed was a deterrent to increasing the size of the restoration. With an established seed source now on the site, the opportunity for enlargement is enhanced.

In September 1995 the restoration qualified for and was included in the Illinois Natural Areas Inventory as a Category V (natural community restoration site).

Acknowledgments

I thank Kenneth Robertson for several years of important advice, the review of this paper, and assistance in producing the mapping. Appreciation is also given to Edward Collins for his review, which contained many useful corrections and suggestions. I also acknowledge the suggestions and encouragement given me, especially in early years of the project, by Robert

Betz and Corliss Ingels. Appreciation is expressed to Nathan Fletcher, Howard Haley, and Carol Haley for assistance at various times with seed collecting, planting, and burning. I especially wish to express appreciation to my mother, Ila Gardner, on whose land the restoration has been developed and whose generosity, interest, and patience have never waned.

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GARDNER PRAIRIE RESTORATION KEMPTON, ILLINOIS (FORD COUNTY)

Native /Alien	Scientific name	Common name	Plots where species observed	Species added to restoration	Seed source locations[1]
A	Achillea millefolium	yarrow	various	N	
A	Agropyron repens	quack grass	various	N	
A	Agrostis alba	red top	18B,19,20	N	
N	Allium canadense	wild onion	20	N	
N	Allium cernuum	nodding wild onion	18A	Y	T,9
A	Amaranthus hybridus	green amaranth	8A,13A	N	
N	Ambrosia artemisiifolia	common ragweed	most	N	
N	Ambrosia trifida	giant ragweed	most	N	
N	Amorpha canescens	lead plant	3,4,5B,7,8B–12	Y	3,6,11,16
N	Andropogon gerardii	big bluestem	most	Y	2,6,11,12
N	Anemone canadensis	meadow anemone	1	Y	12
N	Anemone cylindrica	thimbleweed	613	Y	6,12,13
N	Antennaria neglecta	pussytoes	18B,19	N	
N	Apios americana	groundnut	8A	Y	T,6
A	Arctium minus	common burdock	20	N	
N	Aristida oligantha	prairie three-awn	19	N	
N	Asclepias sullivantii	prairie milkweed	16A,18B,19	N	
N	Asclepias syriaca	common milkweed	various	N	
N	Asclepias tuberosa ssp. interior	butterfly milkweed	2,6,8A,10–14	Y	1
N	Asclepias verticillata	whorled milkweed	various	N	
A	Asparagus officinalis	asparagus	12,19,20	N	
N	Aster ericoides	heath aster	various	N	
N	Aster laevis	smooth blue aster	10,12,17	Y	3
N	Aster novae-angliae	New England aster	7,9,8B,12,18B	Y	6,12
N	Aster pilosus	hairy aster	most	N	
N	Aster praealtus	willow aster	20	N	
N	Astragalus canadensis	Canadian milk vetch	10,13A,15	Y	14
N	Baptisia lactea	white wild indigo	various	Y	14
N	Baptisia leucophaea	cream wild indigo	8A	Y	1
N	Bidens frondosa	common beggar's ticks	20	N	
N	Bouteloua curtipendula	side-oats grama	15	Y	11
A	Brassica rapa	field mustard	various	N	
A	Bromus inermis	Hungarian brome	various	N	
N	Calamagrostis canadensis	blue joint grass	20	Y	6
N	Calystegia sepium	hedge bindweed	10,11,20	N	
N	Carex bebbii		15A	N	
N	Carex bicknellii	prairie sedge	16B	Y	T,9
N	Carex blanda		15A	N	
N	Carex brevior		17,20	N	
N	Carex gravida		15A	N	
A	Carex hirta *		12	N	
N	Carex meadii	Mead's sedge	1,12	N	
N	Carex molesta		15	N	
N	Carex muhlenbergii		15	N	
N	Carex vulpinoidea		15A	N	
N	Cassia fasciculata	partridge pea	18B,19	N	
A	Cerastium vulgatum	mouse-ear chickweed	20	N	
A	Chenopodium album	lamb's quarters	8A,13A	N	
A	Cichorium intybus	chicory	12,19,18B	N	
N	Cirsium discolor	pasture thistle	12,19,20	N	

[1] Listed at the end of this table.

Native /Alien	Scientific name	Common name	Plots where species observed	Species added to restoration	Seed source locations
N	Coreopsis palmata	prairie coreopsis	5B,6,11,12	Y	6,11,13
N	Coreopsis tripteris	tall coreopsis	8A,18A,18B	Y	13,16
N	Cyperus esculentus	nut grass	20	N	
A	Dactylis glomerata	orchard grass	various	N	
N	Dalea candida	white prairie clover	3,4,6,7,11–15	Y	3,6
N	Dalea purpurea	purple prairie clover	3,6–8,10–15	Y	3,6,12–14
A	Daucus carota	wild carrot	most	N	
N	Desmanthes illinoensis	Illinois mimosa	8A	Y	17
N	Desmodium canadense	showy tick trefoil	16A	Y	
N	Dichanthelium acuminatum	panic grass	19	N	
N	Dodecatheon meadia	shooting star	2–7,12	Y	6,11
N	Echinacea pallida	pale purple coneflower	7,10–13	Y	6,10,11
N	Echinacea purpurea	purple coneflower	11	Y	7
A	Echinochloa crus-galli	barnyard grass	15A,20	N	
N	Eleocharis elliptica compressa	flat-stemmed spike rush	19,20	N	
N	Eleocharis verrucosa	slender spike rush	18B,19	N	
N	Elymus canadensis	Canada wild rye	various	Y	Several
N	Elymus virginicus	Virginia wild rye	20	N	
N	Erigeron annuus	annual fleabane	various	N	
N	Eryngium yuccifolium	rattlesnake master	various	Y	6,12,13
A	Erysimum cheiranthoides	wormseed mustard	20	N	
N	Eupatorium altissimum	tall boneset	various	N	
A	Festuca pratensis	meadow fescue	20	N	
N	Filipendula rubra	queen-of-the-prairie	8A,20	Y	T,15
N	Fragaria virginiana	wild strawberry	various	N	
N	Galium aparine	cleavers	20	N	
N	Galium boreale	northern bedstraw	8A	Y	T,9
N	Gentiana andrewsii	closed gentian	8A,8B	Y	5
N	Gentiana puberulenta	downy gentian	10	Y	6,16
N	Gentianella quinquefolia ssp. occidentalis	stiff gentian	11	Y	6,11
N	Geum laciniatum	rough avens	20	N	
N	Helianthus grosseserratus	sawtooth sunflower	20	N	
N	Helianthus rigidus	prairie sunflower	10	N	
N	Heliopsis helianthoides	false sunflower	7	N	
N	Heuchera richardsonii var. grayana	prairie alum root	8A	Y	11
N	Hierochloë odorata	vanilla grass	8A,16B	Y	T,9
A	Hordeum jubatum	squirrel-tail grass	20	N	
A	Ipomoea hederacea	ivy-leaved morning glory	15A	N	
N	Iris shrevei	blue flag	20	Y	T,5
N	Juncus dudleyi	Dudley's rush	17	N	
N	Juncus interior	interior rush	19	N	
N	Koeleria macrantha	June grass	8A	Y	T,9
A	Lactuca serriola	prickly lettuce	19	N	
N	Leersia oryzoides	rice cutgrass	15A,20	N	
A	Leonurus cardiaca	motherwort	20	N	
A	Lepidium campestre	field cress	20	N	
N	Lespedeza capitata	round-headed bush clover	3,4,6,13A,14	Y	1,3,6,12
A	Leucanthemum vulgare	ox-eye daisy	various	N	
N	Liatris aspera	rough blazing star	9–14,19	Y	6,10–13
N	Liatris pycnostachya	prairie blazing star	10,13	Y	2,6,12,13
N	Liatris spicata	marsh blazing star	10,11,13A,19	Y	7
N	Lithospermum canescens	hoary puccoon	1,5A,8A	Y	6
A	Lychnis alba	white campion	15A	N	
N	Lysimachia lanceolata	lance-leaved loosestrife	8A	Y	T,6
A	Medicago lupulina	black medick	20	N	

Native /Alien	Scientific name	Common name	Plots where species observed	Species added to restoration	Seed source locations
A	Melilotus alba	white sweet clover	5B,6,12,18B,19	N	
A	Melilotus officinalis	yellow sweet clover	14	N	
A	Mollugo verticillatus	carpet weed	8A,13A	N	
N	Monarda fistulosa	wild bergamot	various	N	
N	Oenothera biennis	common evening primrose	various	N	
N	Oenothera pilosella	prairie sundrops	8A,12	Y	T,6
A	Ornithogalum umbellatum	star of Bethlehem	20	N	
N	Oxalis stricta	yellow wood sorrel	various	N	
N	Oxalis violacea	violet wood sorrel	16B	Y	T,14
N	Panicum capillare	witch grass	8A,18A	N	
N	Panicum dichotomiflorum	fall panicum	15A	N	
N	Panicum virgatum	switch grass	4A	Y	6
N	Parthenium integrifolium	wild quinine	various	Y	3,6,12,13
N	Parthenocissus inserta	Virginia creeper	19	N	
A	Pastinaca sativa	wild parsnip	various	N	
N	Pedicularis canadensis	wood betony	7,8,10–13	Y	6,11
N	Perideridia americana	perideridia	5B	N	
A	Phleum pratense	timothy	most	N	
N	Phlox pilosa	prairie phlox	12	Y	6
N	Physalis heterophylla	clammy ground cherry	11	N	
N	Physalis subglabrata	smooth ground cherry	18A	N	
N	Physostegia virginiana	false dragonhead	9,12,13A	Y	6,11,13
A	Plantago lanceolata	buckhorn	various	N	
A	Plantago rugelii	red-stalked plantain	various	N	
A	Poa compressa	Canada bluegrass	15A,20	N	
A	Poa pratensis	Kentucky bluegrass	most	N	
N	Polygala sanguinea	field milkwort	19	N	
N	Polygala verticillata	whorled milkwort	19	N	
A	Polygonum persicaria	lady's thumb	20	N	
A	Portulaca oleracea	purslane	8A	N	
A	Potentilla recta	sulfur cinquefoil	most	N	
N	Potentilla simplex	common cinquefoil	various	N	
N	Prunella vulgaris var. elongata	self-heal	18B,19	N	
N	Psoralea onobrychis	French grass	8A,20	Y	14
N	Pycnanthemum pilosum	hairy mountain mint	2,4B,10,11	Y	12
N	Pycnanthemum tenuifolium	slender mountain mint	18B	Y	
N	Pycnanthemum virginianum	common mountain mint	10	Y	3,6,11,12
N	Ranunculus abortivus	small-flowered buttercup	20	N	
N	Ratibida pinnata	yellow coneflower	various	N	
N	Rorippa islandica	marsh yellow cress	15A,20	N	
N	Rosa carolina	pasture rose	19	N	
A	Rosa multiflora	multiflora rose	16A,18B,19,20	N	
N	Rudbeckia hirta	black-eyed Susan	various	Y	6,12,13
N	Rudbeckia subtomentosa	fragrant coneflower	15A	N	
A	Rumex crispus	curly dock	various	N	
N	Schizachyrium scoparium	little bluestem	7,8B,9A,10,12	Y	3,6,10,12
N	Scirpus atrovirens	dark green rush	15A,20	N	
N	Scirpus pendulus	red bulrush	20	N	
N	Senecio plattensis	prairie ragwort	16B	N	
N	Silphium integrifolium	rosin weed	13	N	
N	Silphium laciniatum	compass plant	2,12,14–17	N	
N	Silphium perfoliatum	cup plant	8A,20	Y	T,4
N	Silphium terebinthinaceum	prairie dock	1,4A,4B	Y	12
N	Sisyrinchium albidum	common blue-eyed grass	8,10–13	Y	6,11
N	Smilacina stellata	starry false Solomon's seal	8A,20	Y	T,8
A	Solanum carolinense	horse nettle	various	N	

Native /Alien	Scientific name	Common name	Plots where species observed	Species added to restoration	Seed source locations
A	Solanum dulcamara	bittersweet nightshade	20	N	
N	Solidago canadensis	tall goldenrod	2,4B,6	N	
N	Solidago juncea	early goldenrod	2,15A	N	
N	Solidago ptarmicoides	stiff aster	10	Y	
N	Solidago rigida	rigid goldenrod	2,7,8B,9,10	N	
A	Sonchus oleraceus	common sow thistle	8A,20	N	
N	Sorghastrum nutans	Indian grass	various	Y	12,14
N	Spartina pectinata	prairie cord grass	220	Y	6
N	Sporobolus asper	rough dropseed	16A	N	
N	Sporobolus heterolepis	prairie dropseed	8A,16A,16B	Y	3
A	Stellaria media	common chickweed	20	N	
N	Stipa spartea	porcupine grass	16A	Y	6,12,13
A	Taraxacum officinale	common dandelion	various	N	
N	Thalictrum dasycarpum	purple meadowrue	8A,20	Y	T,6
A	Thlaspi arvense	penny cress	20	N	
N	Tradescantia ohiensis	common spiderwort	4A,12,20	N	
A	Tragopogon pratensis	common goat's beard	12	N	
A	Tridens flavus	purple-top	19	N	
A	Trifolium hybridum	alsike clover	17,20	N	
A	Trifolium pratense	red clover	various	N	
A	Trifolium repens	white clover	17	N	
N	Typha latifolia	common cat-tail	20	N	
N	Verbena urticifolia	white vervain	15A	N	
N	Veronicastrum virginicum	Culver's root	6,7,12,13A	Y	6,11,13
N	Viola pedatifida	prairie violet	6,8A	Y	6
N	Viola pratincola	common blue violet	20	N	
N	Vitis aestivalis	summer grape	12,18B,19,20	N	
N	Zizia aurea	golden Alexanders	8A,17	Y	6,13

* Gardner (1992)

SEED SOURCE LOCATIONS

Location #	Site	County
1	Bath Township, central part Section 14	Mason
2	Bath Township, central part Section 4	Mason
3	Broughton Township Cemetery, Section 14 Broughton Township	Livingston
4	Broughton Township, ditch, Section 14	Livingston
5	Havana Township, roadside ditch, Section 26	Mason
6	Kempton, railroad 2 miles north to 2 miles south	Ford, Livingston
7	Lincoln Memorial Garden, Springfield, probable Lee County source	Sangamon
8	Mona Township, north roadside, Section 9	Ford
9	Natural Garden Nursery, St. Charles	Kane
10	North Quiver Township, Section 6	Mason
11	Crane Creek Township, Sections 26 and 36	Mason
12	Railroads and roadsides	Mason
13	Sheldon to Donovan, railroad	Iroquois
14	Swing Grove Cemetery, Section 6 Mason City Township South	Mason
15	Lafayette Home Nursery, Lee County source	Lee
16	Weston Cemetery, Yates Township, Section 2	McLean
17	Illinois State Tree Nursery, Quiver Township SE Section 33	Mason
T	Indicates introduction was by transplant rather than seeding	

Erigenia, Number 14, November 1995, pp. 32–36

Vegetation Analysis of a Prairie Restoration Ford County, Illinois

Don Gardner[1]

Abstract: A floristic survey was conducted on a 2.8 ha prairie restoration in northern Ford County, Illinois, from 1991 to 1994. This inventory yielded 138 native and 51 alien species in 37 vascular plant families (Gardner 1995). In 1993 a vegetation analysis of the site was initiated using the point-intercept technique, yielding 71 species of vascular plants. The three principal families recorded were Gramineae, Compositae, and Leguminosae. Taxa with the highest importance values were *Andropogon gerardii* (big bluestem) and *Aster pilosus* (hairy aster). Comparisons were made with an unrestored control area in which *Poa pratensis* (Kentucky bluegrass) and *Daucus carota* (wild carrot) had the highest importance values.

Introduction

Prairie restoration was started in 1974, and continued with annual preparation and seeding of successive small plots in a former pasture located in northern Ford County on the south margin of the village of Kempton, Illinois. The final plots were added to the restoration in 1990. The site lies within the Grand Prairie Section of the Grand Prairie Division in the natural divisions of Illinois (Schwegman et al. 1973). The soils are Swygert and Bryce, somewhat poorly drained, fine-textured silty clay loams (Fehrenbacher 1990). The topography is gently rolling with an elevation difference of about 4.5 meters between the high and low portions of the field. Most of the land in the immediate area is cultivated. Principal crops are corn and soybeans. Because of the presence of indigenous native species, the project is described as a restoration rather than a reconstruction. A floristic survey of the field was made from 1991 to 1994, and a plant list of 189 vascular species was compiled. This list comprises 67 native species introduced during the period of restoration, 71 native species indigenous to the site, and 51 alien species. Plant specimen vouchers were filed at the Illinois Natural History Survey herbarium (ILLS) in Champaign. A report was prepared that included the plant list. Certain details of restoration methods employed and results achieved during the prolonged restoration period were discussed by Gardner (1995).

As the next step in the study, a vascular vegetation analysis was conducted in June 1993. The purpose was to quantify the species' density, frequency, and cover in the restoration field. More significantly, a baseline was established for comparison with vegetation analyses to be performed in future years.

Methods

Five line transects totaling 315 meters were established in the restoration area in June 1993 (fig. 1). Vegetation along these transects was identified and recorded using a point-intercept method (Mueller-Dombois and Ellenberg 1974). This method was modified by using five holes spaced at 20 cm intervals in the horizontal portion of the point-intercept frame, which was supported about one meter above ground level by four folding legs. A pointed steel rod, 3.4 mm in diameter, was passed successively through each hole. Each plant contacted by the point during descent of the rod was recorded by species. Upon completion of the five intercept readings, the frame was moved along the line transect and the process repeated at 1.5 meter intervals. The total number of point-intercept locations was 1,050.

The measurement of cover by point-intercept has been considered to be the most accurate quantitative analysis of nonforest communities for description purposes (Becker and Crockett 1973; Mueller-Dombois and Ellenberg 1974). A disadvantage is that this method is difficult to implement under windy conditions. Wind moves the vegetation and prevents accurate readings beneath the descending point. Early mornings and evenings are often the best times for the work. Heavy accumulations of old vegetation can present another hindrance. Ease of sampling is enhanced by conducting the analysis in a year when the site has been burned during late winter, although this can limit the scope of the study.

A control area, Plot 19 (fig. 1), of 0.18 ha was reserved where no taxa were introduced. The same management techniques were used on the control and

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the restoration area. Annual burning was done in late winter or early spring. In the control area, readings were made at 110 point-intercept locations.

Determinations were made of relative density, relative frequency, and relative cover as described by Mueller-Dombois and Ellenberg (1974) and further clarified by Cox (1990). Relative density (*RD*) is computed by dividing the number of intercepted individual stems of a species (*I*) by the total number of individual stems intercepted of all species (*TI*) and multiplying by 100, $RD = (I/TI) \times 100$. Relative frequency (*RF*) is an expression of the number of points at which a species occurs (*F*), divided by the points of occurrence for all species (*TF*), and then converted to a percentage, $RF = (F/TF) \times 100$. Thus density is a count of the individual stems intercepted by the descending point. Frequency is an expression of the distribution of the species over the extent of the transects. For example, a high density number indicates only that many individual stems of that species are present. There is no indication from this of how evenly they are distributed. A low frequency number for that species would suggest that the species is concentrated in one or more clusters and is not evenly distributed over the site.

Relative cover (*RC*) is sometimes described as relative dominance. In this analysis, it is a proportional measure of species present at the highest stratum of areal vegetation cover and reflects the visual aspect of the unit. It is determined by recording the first intercept encountered at each point. The total of these intercepts (*FI*) for each species is divided by the total intercept points (*TIP*) and is expressed as a percentage, $RC = (FI/TIP) \times 100$. Species ranking high in *RC* would be the most apparent species when scanning the site under survey.

The sum of relative density and relative frequency gives the importance value (*IV*) for each species out of a total of 200, $IV = RD + RF$. Relative cover, as measured by this point-intercept method, gives a bias against species positioned at lower strata. For this study, cover is recorded to provide information about the aspect and appearance of the site. Thus only relative density and relative frequency are used to compute *IV*. Importance value is useful in providing a means for combining the recorded counts for purposes of ranking. Absolute values provide the most important quantitative measures. With relative values, a species can appear to increase or decrease without actually changing in recorded numbers. Nomenclature follows Mohlenbrock (1986).

RESULTS AND DISCUSSION

Readings were taken at 940 intercept points on the restoration portion of the study site. The total number of individual plants intercepted was 1,888 (table 1). These represented 71 species, of which 66.2% were natives. The three principal families encountered were Compositae, Gramineae, and Leguminosae. Of the species encountered on the control, 48.5% were natives (table 2). Several native species not previously observed on the control site are now appearing there. It is reasonable to assume that there has been a natural

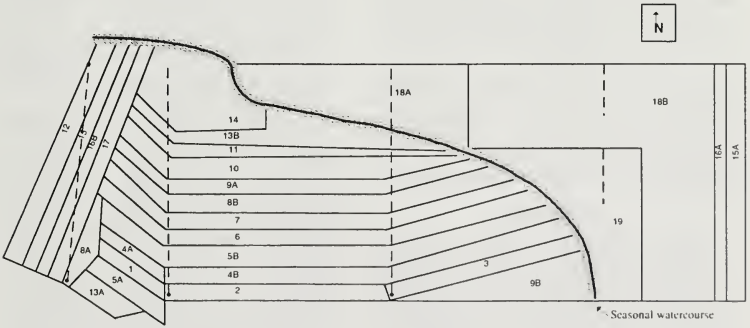

Fig. 1. Restoration field (2.8 ha), Kempton, Illinois. Numbered areas indicate consecutively restored plots (1974–1990). Unrestored control is Plot 19 (shaded). Locations of point-intercept transects (---).

dispersion of native species from the restored area. These species are not found on land adjacent to the restoration site, and they were not artificially introduced into the control. They include *Andropogon gerardii, Elymus canadensis* (Canada wild rye), *Liatris aspera* (rough blazing star), *Liatris pycnostachya* (prairie blazing star), and *Sorghastrum nutans* (Indian grass).

Of all the species in the restored plots, *Andropogon gerardii* ranked highest, with a relative density of 27.9%, relative frequency of 23.5%, and relative cover of 35.5%. Three of the six most important species were native grasses that were added to the restoration by seeding; their combined *IV* was 71.8 (table 1). This reinforces personal observation of disturbed prairie sites where native grasses tend to dominate during middle stages of prairie development.

The second-ranking species on the restoration transects was *Aster pilosus*, a weedy native forb previously established on the site. *Daucus carota* and *Achillea millefolium* (Yarrow) also ranked among the top six species. These aliens were also well established on the field before the start of restoration work. The difference in abundance on the restoration and control for the two species is readily observable and is confirmed by a comparison of relative cover values. In the control, *D. carota* has a 10.9% relative cover and *A. millefolium* 3.6%. On the restoration these values are 2.7% and 2.8% respectively.

Although lower in rank, planted native prairie forbs appeared among the highest thirty species in *IV* on the restoration transects. Among these are *Pedicularis canadensis* (wood betony), *Amorpha canescens* (lead plant), *Zizia aurea* (golden Alexanders), and *Baptisia lactea* (white wild indigo). Changes in their ranking in future vegetation analyses of the site will be of particular interest.

On the pre-restoration field two of the principal grasses were *Poa pratensis* and *Phleum pratense* (timothy). This is reflected on the control, where they have high importance values of 33.3 and 16.9 respectively. On the restoration they are being displaced and have *IV*s of 6.2 and 3.8 (tables 1 and 2).

CONCLUSION

When working with a restoration there is justifiable satisfaction in observing the establishment and increase of native species. However, this is often accompanied by a subjectivity that assigns a greater prevalence to these species than they merit. A quantitative survey counters this tendency. There has been encouraging progress in establishing this restoration with a diversity of species. On the restoration there was a 69.3% rate of encounter of individual native plants, while on the control the rate was only 35.8% (tables 1 and 2). This analysis, however, provides an emphatic reminder that restoration of prairie is, even with some degree of management, a ponderously slow process. Of the ten species ranking highest in *IV* on the restoration, five are alien in origin.

Empirical observation indicates that plants in recently established prairies are in a state of rapid species population change. By performing periodic vegetation analyses, these changes can be quantified. Numerous prairies are being restored or reconstructed throughout the Midwest. If these survive, there is the hope that on many of them, plant surveys and vegetation analyses will be conducted. Such information can provide valuable base line records for use by succeeding generations of botanists, ecologists, and prairie enthusiasts.

ACKNOWLEDGMENTS

I wish to express appreciation to John Taft for generously discussing the project and offering criticism. I also thank both him and Roger Anderson for their thoughtful reviews of a draft of this manuscript.

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TABLE 1. Point-intercept Data, Restoration Area.

Family	Species	Importance value (IV 200)	Intercept count individuals	Relative density (%)	Total intercept points	Relative frequency (%)	First intercept	Relative cover (%)
GRAMINEAE	Andropogon gerardii	51.4	526	27.9	380	23.5	334	35.5
COMPOSITAE	Aster pilosus	16.5	148	7.8	140	8.7	76	8.1
UMBELLIFERAE	Daucus carota	11.7	103	5.5	101	6.3	25	2.7
COMPOSITAE	Achillea millefolium	11.5	102	5.4	98	6.1	26	2.8
GRAMINEAE	Sorghastrum nutans	10.6	103	5.5	83	5.1	65	6.9
GRAMINEAE	Schizachyrium scoparium	9.8	97	5.1	76	4.7	42	4.5
GRAMINEAE	Poa pratensis	6.2	55	2.9	53	3.3	27	2.9
COMPOSITAE	Ambrosia artemisiifolia	6.0	52	2.8	52	3.2	13	1.4
LEGUMINOSAE	Trifolium pratense	5.7	53	2.8	46	2.8	21	2.2
ROSACEAE	Potentilla recta	4.6	41	2.2	39	2.4	17	1.8
COMPOSITAE	Ratibida pinnata	4.6	43	2.3	37	2.3	17	1.8
LEGUMINOSAE	Medicago lupulina	4.4	39	2.1	38	2.4	7	0.7
LABIATAE	Monarda fistulosa	3.9	40	2.1	28	1.7	25	2.7
GRAMINEAE	Phleum pratense	3.8	35	1.9	31	1.9	19	2.0
COMPOSITAE	Aster ericoides	3.5	33	1.7	29	1.8	20	2.1
COMPOSITAE	Helianthus rigidus	2.8	27	1.4	22	1.4	18	1.9
SCROPHULARIACEAE	Pedicularis canadensis	2.7	25	1.3	23	1.4	4	0.4
GRAMINEAE	Bromus inermis	2.6	24	1.3	22	1.4	12	1.3
LEGUMINOSAE	Melilotus alba	2.6	24	1.3	22	1.4	11	1.2
JUNCACEAE	Juncus interior	2.0	17	0.9	17	1.1	8	0.9
GRAMINEAE	Elymus canadensis	1.9	17	0.9	16	1.0	13	1.4
GRAMINEAE	Agropyron repens	1.8	16	0.8	16	1.0	8	0.9
ROSACEAE	Fragaria virginiana	1.8	16	0.8	16	1.0	3	0.3
CYPERACEAE	Carex hirta *	1.8	18	1.0	14	0.9	2	0.2
LEGUMINOSAE	Amorpha canescens	1.5	15	0.8	12	0.7	6	0.6
UMBELLIFERAE	Zizia aurea	1.5	15	0.8	12	0.7	7	0.7
CYPERACEAE	Carex brevior	1.5	13	0.7	13	0.8	3	0.3
LEGUMINOSAE	Baptisia lactea	1.4	12	0.6	12	0.7	8	0.9
COMPOSITAE	Taraxacum officinale	1.4	12	0.6	12	0.7	2	0.2
UMBELLIFERAE	Pastinaca sativa	1.3	11	0.6	11	0.7	3	0.3
CONVOLVULACEAE	Calystegia sepium	1.0	9	0.5	9	0.6	5	0.5
COMPOSITAE	Leucanthemum vulgare	0.9	8	0.4	8	0.5	5	0.5
PLANTAGINACEAE	Plantago lanceolata	0.9	8	0.4	8	0.5	5	0.5
COMPOSITAE	Echinacea pallida	0.9	9	0.5	7	0.4	4	0.4
LEGUMINOSAE	Dalea candida	0.9	8	0.4	7	0.4	6	0.6
GRAMINEAE	Agrostis alba	0.8	7	0.4	7	0.4	5	0.5
UMBELLIFERAE	Eryngium yuccifolium	0.8	7	0.4	7	0.4	3	0.3
COMPOSITAE	Parthenium integrifolium	0.8	7	0.4	7	0.4	4	0.4
COMPOSITAE	Silphium laciniatum	0.7	7	0.4	5	0.3	5	0.5
GRAMINEAE	Poa compressa	0.6	6	0.3	5	0.3	4	0.4
LABIATAE	Prunella vulgaris var. elongata	0.6	6	0.3	5	0.3	2	0.2
LEGUMINOSAE	Dalea purpurea	0.6	5	0.3	5	0.3	3	0.3
PLANTAGINACEAE	Plantago rugelii	0.6	5	0.3	5	0.3	0	0.0
ASCLEPIADACEAE	Asclepias verticillata	0.5	5	0.3	4	0.2	2	0.2
COMPOSITAE	Solidago rigida	0.5	5	0.3	4	0.2	4	0.4
ASCLEPIADACEAE	Asclepias tuberosa ssp. interior	0.5	4	0.2	4	0.2	0	0.0
COMPOSITAE	Erigeron annuus	0.5	4	0.2	4	0.2	3	0.3
PRIMULACEAE	Dodecatheon meadia	0.3	3	0.2	3	0.2	0	0.0
COMPOSITAE	Eupatorium altissimum	0.3	3	0.2	3	0.2	1	0.1
SOLANACEAE	Solanum carolinense	0.3	3	0.2	3	0.2	0	0.0
GRAMINEAE	Dactylis glomerata	0.3	3	0.2	2	0.1	2	0.2
ONAGRACEAE	Oenothera biennis	0.3	3	0.2	2	0.1	1	0.1
COMPOSITAE	Rudbeckia hirta	0.3	3	0.2	2	0.1	1	0.1
COMPOSITAE	Ambrosia trifida	0.2	2	0.1	2	0.1	1	0.1
ASCLEPIADACEAE	Asclepias syriaca	0.2	2	0.1	2	0.1	1	0.1
LILIACEAE	Asparagus officinalis	0.2	2	0.1	2	0.1	1	0.1
CYPERACEAE	Carex vulpinoidea	0.2	2	0.1	2	0.1	1	0.1
COMPOSITAE	Coreopsis palmata	0.2	2	0.1	2	0.1	2	0.2
COMPOSITAE	Echinacea purpurea	0.2	2	0.1	2	0.1	2	0.2
OXALIDACEAE	Oxalis stricta	0.2	2	0.1	2	0.1	1	0.1
COMPOSITAE	Sonchus oleraceus	0.2	2	0.1	2	0.1	1	0.1
LEGUMINOSAE	Trifolium repens	0.2	2	0.1	2	0.1	0	0.0
VIOLACEAE	Viola pratincola	0.2	2	0.1	2	0.1	0	0.0
COMPOSITAE	Aster novae-angliae	0.1	1	0.1	1	0.1	0	0.0
LEGUMINOSAE	Lespedeza capitata	0.1	1	0.1	1	0.1	1	0.1

Family	Species	Importance value (IV 200)	Intercept count individuals	Relative density (%)	Total intercept points	Relative frequency (%)	First intercept	Relative cover (%)
COMPOSITAE	Liatris pycnostachya	0.1	1	0.1	1	0.1	1	0.1
LEGUMINOSAE	Melilotus officinalis	0.1	1	0.1	1	0.1	1	0.1
ONAGRACEAE	Oenothera pilosella	0.1	1	0.1	1	0.1	0	0.0
LABIATAE	Physostegia virginiana	0.1	1	0.1	1	0.1	1	0.1
ROSACEAE	Potentilla simplex	0.1	1	0.1	1	0.1	0	0.0
SCROPHULARIACEAE	Veronicastrum virginicum	0.1	1	0.1	1	0.1	1	0.1
	Absence of cover	0.0					18	1.9
	Total	200	1888	100.0	1615	100.0	940	100.0
	SUMMARY							
	Species count	71						
	Native species	66.2%						
	Individual native intercepts	1308						
	Native species intercepts	69.3%						

* Gardner (1992)

TABLE 2. Point-intercept Data, Control Plot.

Family	Species	Importance value (IV 200)	Intercept count individuals	Relative density (%)	Total intercept points	Relative frequency (%)	First intercept	Relative Cover (%)
GRAMINEAE	Poa pratensis	33.3	31	16.6	30	16.8	24	21.8
UMBELLIFERAE	Daucus carota	29.5	28	15	26	14.5	12	10.9
GRAMINEAE	Phleum pratense	16.9	16	8.6	15	8.4	8	7.3
COMPOSITAE	Aster pilosus	16.4	15	8.0	15	8.4	10	9.1
COMPOSITAE	Achillea millefolium	10.9	10	5.3	10	5.6	4	3.6
GRAMINEAE	Dichanthelium acuminatum	10.9	10	5.3	10	5.6	9	8.2
CRUCIFERAE	Brassica rapa	8.7	8	4.3	8	4.5	4	3.6
COMPOSITAE	Antennaria neglecta	7.7	7	3.7	7	3.9	1	0.9
COMPOSITAE	Ambrosia artemisiifolia	6.6	6	3.2	6	3.4	3	2.7
ROSACEAE	Potentilla recta	5.5	5	2.7	5	2.8	4	3.6
PLANTAGINACEAE	Plantago lanceolata	4.9	5	2.7	4	2.2	3	2.7
GRAMINEAE	Andropogon gerardii	4.4	4	2.1	4	2.2	4	3.6
ROSACEAE	Fragaria virginiana	4.4	4	2.1	4	2.2	2	1.8
GRAMINEAE	Agropyron repens	3.8	4	2.1	3	1.7	1	0.9
COMPOSITAE	Ratibida pinnata	3.8	4	2.1	3	1.7	1	0.9
GRAMINEAE	Sorghastrum nutans	3.8	4	2.1	3	1.7	1	0.9
CYPERACEAE	Carex brevior	3.3	3	1.6	3	1.7	3	2.7
UMBELLIFERAE	Pastinaca sativa	3.3	3	1.6	3	1.7	2	1.8
COMPOSITAE	Aster ericoides	2.2	2	1.1	2	1.1	2	1.8
GRAMINEAE	Bromus inermis	2.2	2	1.1	2	1.1	1	0.9
CYPERACEAE	Carex vulpinoidea	2.2	2	1.1	2	1.1	2	1.8
GRAMINEAE	Elymus canadensis	2.2	2	1.1	2	1.1	2	1.8
LEGUMINOSAE	Medicago lupulina	2.2	2	1.1	2	1.1	0	0.0
AMARANTHACEAE	Amaranthus hybridus	1.1	1	0.5	1	0.6	0	0.0
ASCLEPIADACEAE	Asclepias syriaca	1.1	1	0.5	1	0.6	1	0.9
CHENOPODIACEAE	Chenopodium album	1.1	1	0.5	1	0.6	1	0.9
COMPOSITAE	Eupatorium altissimum	1.1	1	0.5	1	0.6	1	0.9
JUNCACEAE	Juncus interior	1.1	1	0.5	1	0.6	1	0.9
LEGUMINOSAE	Melilotus officinalis	1.1	1	0.5	1	0.6	1	0.9
GRAMINEAE	Poa compressa	1.1	1	0.5	1	0.6	1	0.9
POLYGONACEAE	Polygonum persicaria	1.1	1	0.5	1	0.6	0	0.0
LABIATAE	Prunella vulgaris var. elongata	1.1	1	0.5	1	0.6	0	0.0
POLYGONACEAE	Rumex crispus	1.1	1	0.5	1	0.6	1	0.9
	Total	200	187	100.0	179	100.0	110	100.0
	SUMMARY							
	Species count	33						
	Native species	48.5%						
	Individual native intercepts	67						

Erigenia, Number 14, November 1995, pp. 37–40

Effects of Different Fire Regimes on the Ground Layer Vegetation of a Dry Sand Savanna, Hooper Branch Nature Preserve, Iroquois County, Illinois

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Abstract: A ground layer vegetation study was undertaken in the fall of 1989 in a dry sand savanna at the Hooper Branch Nature Preserve. Sections of this sand savanna had been subjected to different fire regimes, one site burned every spring from 1987 through 1989, the other site burned only in the spring of 1987. At both sites *Carex pensylvanica* Lam. (common oak sedge) had the highest relative frequency. The site with the three-year burn regime had a higher density of woody stems, in particular *Rhus copallina* L. var. *latifolia* Engl. (winged sumac) and *Rosa carolina* L. (pasture rose); however, the less frequent burning regime allowed for the presence of woody species not found at the site with three consecutive burns, in particular, seedlings of *Quercus velutina* Lam. (black oak). The less frequent burning may also have contributed to a higher relative frequency of some herbaceous species.

Introduction

Savannas occurred across much of Midwestern North America at the time of European settlement (Nuzzo 1986). These communities consisted of open-grown trees, mostly oaks, in small groves or as scattered individuals with a herbaceous, primarily graminoid, understory. These savannas were found throughout much of what is now Illinois, forming broad to narrow ecotones separating forest from prairie, or appearing as isolated communities within the prairie. These oak savannas in Illinois are separated into three subclasses: black soil savannas on the fine-textured soils of glacial till plains; sand savannas on sandy, acidic soils; and barrens on excessively drained, acidic soils (Madany 1981; Packard 1991).

We believe that black soil savannas were once extremely common in Illinois. Most have been destroyed, the majority having been converted to farmland, the remainder degraded by fire suppression. In contrast, sand savannas, though restricted to localized areas of sand outwash plains and old lake deposits, are still relatively common. Two major sand areas occur in Illinois (Schwegman et al. 1973). One is the Illinois River and Mississippi River Sand Area Division with extensive sand deposits in Mason County and scattered smaller deposits along the rivers. The presettlement forests in this division were studied by Rodgers and Anderson (1979); Adams and Anderson (1980) and later Jenkins et al. (1991) examined the present forest structure and composition. The second sand area is the Kankakee Sand Area Section of the Grand Prairie Division in Kankakee and Iroquois counties in the northeastern part of the state. Hedborn (1984) reported on the presettlement vegetation of parts of this section, and McDowell et al. (1983) and later Johnson and Ebinger (1992) studied the present-day forests.

The regular fires that swept across the prairie peninsula restricted the encroachment of woodlands and were a major factor in the maintenance of prairie and savanna communities (McClain and Elzinga 1994). The suppression of fire in the postsettlement period has changed many oak savanna communities into closed forests, often with a dense understory of shade-tolerant species and a depauperate ground layer (Gleason 1912, 1913; Transeau 1935; Curtis 1959; Vogl 1974; Ebinger and McClain 1991; Ladd 1991; Wilhelm 1991). Controlled burning is an integral part of the management to restore these savanna communities to their presettlement character. The present study was undertaken to determine the composition of the ground layer vegetation in a dry sand savanna community and to examine the effects of recent controlled burns on this community.

Study Area

Hooper Branch Nature Preserve is located in the northeast corner of Iroquois County, Illinois (NW S13 T29N R11W), in the Kankakee Sand Area Section (Schwegman et al. 1973; Hedborn 1984). This 230 ha

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tract of forest, savanna, prairie, and old-field communities was recognized as containing good quality dry sand savanna (White and Madany 1978). The land was acquired by the state of Illinois in 1984, and a 195 ha area was dedicated as a nature preserve in 1985. The area is situated at the edge of former glacial Lake Watseka, which was formed approximately 14,000 years ago (Willman and Frye 1970). With the incising of the Illinois River valley, this glacial lake was eventually drained, leaving sandy beaches and near-shore sand deposits. Wind action created the sand dunes and swales, upon which characteristic sand savanna and sand prairie vegetation was established (Glass 1985). The soil is classified as Plainfield fine sand, which is a light-colored, acidic sand derived from windblown sand deposits (Wascher et al. 1951). The study area, located within the sand savanna community at Hooper Branch Nature Preserve, is traversed by an east-west access road that divides it into two parts. Land management south of this access road (Site A) included annual controlled burns in the springs of 1987, 1988, and 1989; the land north of the access road (Site B) was subjected to a controlled burn only once, in the spring of 1987 (Glass, pers. comm.).

MATERIALS AND METHODS

The ground layer vegetation was sampled in September 1989, using five north-south transects 20 m long, located randomly, in both Site A and Site B. Along each transect, 0.25 m^2 quadrats were placed randomly at 1 m intervals, yielding a total of 100 plots for each site. A random-numbers table was used to determine the number of meters the quadrats were placed to the west (odd-numbered quadrats) or to the east (even-numbered quadrats) of the transect. All herbaceous species within the quadrats were identified, and their relative frequencies were calculated. In addition, the stems of all woody seedlings in the plots were counted, and their densities (stems/m^2), relative frequencies, relative densities, and importance values were calculated. A chi-square statistical procedure was used (2 × 2 contingency table using the Yates correction factor) to determine if the relative frequencies of the dominant species found at both sites were significantly different (Sokal and Rohlf 1981). Nomenclature follows Swink and Wilhelm (1994).

RESULTS AND DISCUSSION

Forty species were recorded in the plots, 26 from Site A and 33 from Site B, 19 of them common to both sites (table 1). *Carex pensylvanica* dominated both sites, in many areas forming a continuous groundcover under an open canopy of *Quercus velutina*. Of the 10 common species encountered (those with a combined relative frequency of ≥ 5.0 for the two sites), 4 species showed no significant difference in relative frequency between the two sites, and 6 species showed a significant difference (table 1).

TABLE 1. Relative frequencies of ground layer species sampled from Site A (3 burns) and Site B (1 burn) at the Hooper Branch Nature Preserve. χ^2 values are shown for the dominant species.

	Relative frequency		
Species	Site A	Site B	χ^2
Carex pensylvanica Lam.	35.1	23.7	16.25***
Rosa carolina L.	6.9	8.0	1.25
Euphorbia corollata L.	6.9	4.9	0.60
Rhus copallina L. var. *latifolia* Engl.	6.2	0.7	12.03***
Panicum villosissimum Nash var. *pseudopubescens* (Nash) Fern.	5.8	4.2	0.39
Eragrostis spectabilis (Pursh) Steud.	4.6	5.2	0.39
Koeleria cristata (L.) Pers.	3.9	7.8	4.17*
Andropogon scoparius Michx.	2.6	9.1	11.53***
Cassia fasciculata Michx.	1.2	6.6	11.48***
Quercus velutina Lam.	1.2	4.2	4.60*
Rumex acetosella L.	4.6	-	
Panicum virgatum L.	3.9	-	
Cassia nictitans L.	3.1	0.3	
Tephrosia virginiana (L.) Pers.	2.6	1.0	
Sporobolus cryptandrus (Torr.) A. Gray	2.3	-	
Liatris aspera Michx.	1.5	-	
Asclepias verticillata L.	1.2	2.8	
Lithospermum canescens (Michx.) Lehm.	1.2	0.8	
Commelina erecta L. var. *deamiana* Fern.	1.2	0.4	
Cyperus filiculmis Vahl	0.8	2.8	
Erigeron canadensis L.	0.8	0.3	
Monarda punctata L.	0.8	-	
Helianthemum canadense (L.) Michx.	0.4	1.8	
Rhus glabra L.	0.4	1.4	
Panicum oligosanthes Schult. var. *scribnerianum* (Nash) Fern.	-	5.6	
Andropogon gerardii Vitman	-	1.4	
Corylus americana Walter	-	1.0	
Achillea millefolium L.	-	1.0	
Prunus serotina Ehrh.	-	0.7	
Smilacina stellata (L.) Desf.	-	0.7	
Lespedeza capitata Michx.	-	0.7	
Rubus allegheniensis Porter	-	0.7	
Rubus flagellaris Willd.	-	0.7	
Amorpha canescens Pursh	-	0.3	
Others	0.8	1.2	
Total	100.0	100.0	

* $P < .05$., ** $P < .01$., *** $P < .001$.

The woody species encountered in the quadrats are listed in table 2, along with their densities, relative values, and importance values. Four species were recorded for Site A, with a total density of 3.58 stems/m^2. Nine species were encountered at Site B, with a total density of 2.64 stems/m^2. The stem densities of *Rhus copallina* var. *latifolia* and *Rosa carolina* were higher at Site A than at Site B. Kraege (1978) concluded that regular burning in a northern Illinois prairie stimulated the growth of *Rubus flagellaris* Willd. (common dewberry). Similarly, this may account for the higher stem density of *Rosa carolina* and *Rhus copallina* var. *latifolia* at Site A in the sand savanna. The more frequent burning is also probably responsible for the low seedling density of *Quercus velutina*. Similar results were obtained by Henderson and Long (1984) for seedling densities in black oak woodlands in northwestern Indiana.

Initially, there was some concern over any possible negative effects of prescribed burning at the Hooper Branch Nature Preserve. The savanna communities there have retained much of their natural character, yet have received only sporadic fires during the postsettlement period. In this short-term study it may be concluded that these recent prescribed burns have not adversely affected this sand savanna, except for the vigorous resprouting in some shrub species. It would be interesting to study the effects of this phenomenon on the ground layer species composition and the community structure over a longer time period. This sand savanna is an example of an intact and stable plant community that contains a diverse assemblage of native plant species. Short-term comparative studies at such high quality natural areas are unlikely to reveal any conclusive findings or patterns in land use practices. It is probable that only through long-term studies or monitoring can land management practices such as prescribed burning be accurately assessed.

The authors would like to thank the reviewers for their helpful comments and suggestions.

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Table 2. Densities (stems/m^2), relative frequencies, relative densities, and importance values of the ground layer woody species sampled from Site A (3 burns) and Site B (1 burn) at the Hooper Branch Nature Preserve.

	Stems/m^2		Relative frequency		Relative density		Importance value	
Species	A	B	A	B	A	B	A	B
Rosa carolina	2.52	1.44	47.4	46.0	70.0	53.7	117.4	99.7
Rhus copallina latifolia	0.92	0.08	42.1	4.0	25.6	3.0	67.7	7.0
Quercus velutina	0.12	0.52	7.9	24.0	3.3	19.4	11.2	43.4
Rhus glabra	0.02	0.20	2.6	8.0	1.1	7.5	3.7	15.5
Corylus americana	-	0.12	-	4.0	-	4.5	-	8.5
Prunus serotina	-	0.12	-	4.0	-	4.5	-	8.5
Rubus allegheniensis	-	0.08	-	4.0	-	3.0	-	7.0
Rubus flagellaris	-	0.04	-	4.0	-	2.9	-	6.9
Amorpha canescens	-	0.04	-	2.0	-	1.5	-	3.5
Total	3.58	2.64	100.0	100.0	100.0	100.0	200.0	200.0

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ERIGENIA, Number 14, November 1995, pp. 41–52

FIFTY YEARS OF CHANGE IN ILLINOIS HILL PRAIRIES[1]

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ABSTRACT: Hill prairies are islandlike patches of prairie vegetation occurring on otherwise wooded steep slopes that face south or southwest. In Illinois, hill prairies appear intermittently along most of the western border of the state formed by the Mississippi River and along the Illinois River from north of Peoria south to its junction with the Mississippi, with a few in east-central Illinois and other scattered localities. Illinois has four types of hill prairies: loess (by far the most abundant), glacial drift, gravel, and sand. The floras found on hill prairies are combinations of species that also occur in other types of prairies—dry, black soil, sand, and gravel. Only a few species are largely restricted to hill prairies. Hill prairies appear to be decreasing in size from the encroachment of woody species. Rates of area change for nine hill prairies were examined using a series of aerial photographs from approximately 1940 to 1988. On average, these hill prairies lost 63% of their area, became fragmented into smaller units, and experienced an increase in the ratio of edge to center. Field studies showed that there was a correlation between the proportion of area lost and lowered species richness.

INTRODUCTION

For nearly 30 years, Dr. Robert A. Evers of the Illinois Natural History Survey studied the hill prairies of Illinois. His landmark treatise *Hill Prairies of Illinois* was published in 1955. During the early 1970s, Dr. Evers revisited many of his earlier sites and took extensive notes with the aim of updating the 1955 publication. The update was never published, although the notes remain in files at the Illinois Natural History Survey. The senior author of the current paper was fortunate to accompany Dr. Evers during the late 1970s on several trips to Bland Hill Prairie in Greene County and Cap au Gris Hill Prairie in Calhoun County; this first sparked his interest in hill prairies.

Hill prairies are islandlike prairie openings occurring on steep slopes that are (or were) otherwise forested. This prairie vegetation usually occurs only on the slopes, not on the tops of hills, where a combination of factors results in droughty conditions, such as the south- to west-facing slope aspect, steep slope angle, dry prevailing winds, and well-drained soil. Measurements made of slopes at six hill prairies in Jersey County, Illinois, showed average slopes of 17.3% to 56.3% (Kilburn and Warren 1963).

According to Evers (1955), the term "hill prairies" was first used by A. G. Vestal in 1943 during his ecology classes and seminars at the University of Illinois; they have also been called bluff prairies, goat prairies, and prairie openings. Prior to European settlement, hill prairies likely never formed large continuous belts in Illinois, but were fragmented by forested ravines that dissect the river bluffs and slopes.

METHODS

As part of a project to investigate critical trends in the changing Illinois environment (Robertson and Schwartz 1994), aerial photos from 1938 to 1988 were used for nine loess hill prairies in Illinois to ascertain the loss of hill prairies during the last 50 years (table 1, fig. 1). The aerial extent of each hill prairie was digitized at three to five time periods into a Geographical Information System (GIS - ARC/INFO version 6.0, 1992, as implemented on SUN workstations). Aerial photographs were obtained from the archives of

[1] This paper is a refinement of "A synopsis of hill prairies in Illinois: 50 years of change" published in: Proceedings of the Fourth Central Illinois Prairie Conference, T. E. Rice, editor. Sponsored by Grand Prairie Friends of Illinois in cooperation with Millikin University, Biology Department, and the Macon County Conservation District, September 17–18, 1994. (Published in 1995.)

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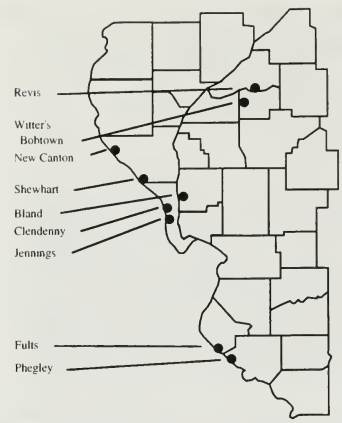

FIG. 1. Locations of the nine hill prairies sampled.

the University of Illinois Map Library. Photographs prior to 1988 were taken at a 1:20,000 scale by the U.S. Department of Agriculture Soil Conservation Service. The 1988 photographs had lower resolution than previous series, but the poorer resolution did not systematically bias the results. The Bobtown Hill Prairie photo coverage for 1988 was partially obscured by late afternoon shadows, making habitat identification very difficult; this photo was eliminated from the analysis.

To assess the relative amount of edge through which woody species may encroach upon each prairie, the perimeter to area (p/a) ratio was used. This value should be related to how fast areas may be invaded, other factors being equal. A simple geometric relationship is expected in the p/a ratio over time if the area is decreasing. To determine if the p/a ratio is increasing at rates faster than expected, a p/a ratio index was used, which is a measure of the p/a ratio relative to a circle of equal size. Since a circle has the minimum p/a ratio of any two-dimensional shape, this index will always be greater than 1.0. There is no maximum to the p/a ratio index; higher values indicate a more complex shape with increasing amounts of edge for a given area.

Each of the nine sites was also sampled for vegetation characteristics. Between one and ten permanent sampling transects were established at each site to sample for prairie species richness and woody species invasion (table 2). Transect ends were located at random intervals along the crests of hilltops, with each transect set out downslope from the crest at the steepest angle possible. Sampling stations were established at 5-meter intervals along transects from the crest to the lower edge of each hill prairie. At each sampling station a 25 m^2 plot was sampled for woody species. All woody stems within this plot were identified to species and counted. At the center of each 25 m^2 plot, a 1 m^2 quadrat was sampled for cover of all vegetation. Cover was estimated to the nearest percent. Summary data for sites were generated by the mean of all plots sampled at each hill prairie.

Distribution of Hill Prairies

Hill prairies are found along certain river systems in the central United States. The largest number of hill prairies occur along the Mississippi River, or tributaries near their junctions with the Mississippi, from near St. Paul, Minnesota, and adjacent Wisconsin southward to Iowa and southern Illinois. In Minnesota, hill prairies occur in Fillmore, Goodhue, Houston, Wabasha, and Winona counties, south of Minneapolis. They are found mostly along tributaries that flow into the Mississippi River from the west, and they can be up to 8 miles from the Mississippi (Olson 1989). In most instances, hill prairies in Minnesota occur on southwest-facing slopes in thin soil atop bluffs that have a northwest to southeast orientation.

In Wisconsin, hill prairies are mostly found on steep south- to west-facing slopes above limestone, sandstone, or dolomite bluffs on the eastern side of the Mississippi River from Polk County southward to Grant County. There are Wisconsin state natural areas for hill prairies in Crawford, Grant, Pierce, and Vernon counties. Five-Mile Bluff Prairie Natural Area occurs on slopes above bluff tops in Pepin County along the Chippewa River approximately three miles from its junction with the Mississippi River (pers. comm. from Kelly Kearns and Eric Epstein, Wisconsin Department of Natural Resources). See Shimek (1924) for early photographs of hill prairies near Prairie du Chien, Wisconsin.

Hill prairies in Iowa can be found in both the eastern and western parts of the state (Cooper and Hunt 1982; White and Glenn-Lewin 1984; Rosburg et al. 1994). There are only a few in the northeastern "Driftless Area" of the state (Shimek 1910, 1924). More

TABLE 1. Changes in size and shape for nine Illinois hill prairies between about 1940 and 1988.

Site (county)	Ownership	Grazing and burning history	Date of photo	Area (ha^2)	P/A ratio	P/A ratio index	No. of units	Proportion of original area
Bland (Greene)	Private	moderately grazed, not burned	1938	2.04	0.0351	1.42	1	1.000
			1968	1.12	0.0626	1.87	1	0.550
			1988	0.65	0.1211	2.76	1	0.319
Clendenny (Calhoun)	Private	moderately grazed, not burned	1940	3.97	0.0574	3.22	1	1.000
			1950	3.77	0.0689	3.77	1	0.949
			1968	3.45	0.0741	3.88	1	0.868
			1988	2.52	0.0807	3.61	1	0.633
Fults (Monroe)	State, Nature Preserve	not grazed, burned regularly since 1970s	1940	7.20	0.0625	4.73	2	1.000
			1950	7.22	0.0633	4.80	2	1.000
			1962	5.73	0.0785	5.30	6	0.797
			1988	3.35	0.1169	6.04	9	0.466
Jennings (Calhoun)	Private, Natural Heritage Landmark	no grazing for ca. 25 years, burning began in 1990s	1940	2.16	0.1081	4.48	1	1.000
			1950	1.65	0.1301	4.71	2	0.764
			1968	1.65	0.1068	3.87	3	0.765
			1988	0.99	0.1509	4.24	3	0.458
New Canton (Pike)	Private	probably not grazed, burning began in 1990s	1936	1.71	0.0944	3.48	3	1.000
			1939	1.83	0.1045	3.99	3	1.070
			1950	0.96	0.1270	3.51	8	0.563
			1968	1.53	0.1250	4.36	8	0.897
			1988	0.32	0.1246	1.99	2	0.212
Phegley (Randolph)	Private	intensively grazed, not burned	1940	2.65	0.0543	2.49	1	1.000
			1952	2.21	0.0615	2.58	2	0.834
			1959	2.04	0.0693	2.79	2	0.770
			1971	0.97	0.1455	4.04	8	0.365
			1988	0.46	0.1907	3.65	5	0.175
Shewhart (Pike)	Private	not recently grazed, not burned since at least 1928	1936	3.10	0.0665	3.30	3	1.000
			1939	1.61	0.0898	3.21	3	0.516
			1950	2.05	0.0840	3.39	4	0.662
			1968	2.22	0.0928	3.90	5	0.714
			1988	0.79	0.1572	3.94	7	0.254
Witter's Bobtown* (Menard)	Private, Nature Preserve	not grazed recently, burned regularly now, brush removed	1939	1.99	0.0300	1.19	1	1.000
			1950	1.17	0.0400	1.22	1	0.588
			1957	1.50	0.0346	1.20	1	0.752
			1969	1.31	0.0421	1.36	1	0.658
Revis (Mason)	State, Nature Preserve	not grazed recently, long history of fall burning, brush removed	1939	39.16	0.0410	7.24	15	1.000
			1950	34.26	0.0474	7.83	14	0.875
			1957	32.06	0.0558	8.91	16	0.819
			1969	32.51	0.0414	6.66	14	0.830
			1988	17.37	0.0813	9.56	22	0.444

*1988 photo obscured by evening shadows and eliminated from this analysis.

Table 2. Most frequently sampled plant species in nine Illinois hill prairies.

Species	Percent of plots	Average cover (% total area)
Schizachyrium scoparium	64.6	30.49
Bouteloua curtipendula	62.4	13.50
Petalostemum purpureum	37.1	3.41
Panicum spp.	29.8	2.68
Aster azureus	29.2	5.29
Andropogon gerardii	27.5	25.90
Psoralea tenuiflora	27.5	12.24
Solidago nemoralis	22.5	3.14
Melilotus alba	18.0	9.05
Aster ericoides	16.3	9.81
Senecio plattensis	16.3	0.37
Rhus glabra	15.7	27.60
Cornus drummondii	15.2	14.38
Euphorbia corollata	15.2	1.47
Ambrosia artemisiifolia	14.6	12.55
Cassia fasciculata	14.0	4.48
Eupatorium altissimum	13.5	2.74
Aster patens	12.9	2.47
Ruellia humilis	12.9	0.96
Juniperus virginiana	11.2	20.60
Kuhnia eupatorioides	10.7	2.57
Asclepias verticillata	10.7	2.12

than a dozen hill prairie remnants have been catalogued as "element occurrences" by the Iowa Department of Natural Resources (pers. comm. to J. Olson) in Allamakee, Clayton, Dubuque, Fayette, and Jackson counties; these are called "alkaline high prairies: Midwestern type." Some of these occur along the Mississippi River; others are along the Iowa River. At least one is found in Fayette County above a creek that flows into the Volga River.

Hill prairies also occur in the "Loess Hills" region along the Missouri River in northwestern Missouri, western Iowa, and southeastern South Dakota (Novacek 1985). In Missouri, Steyermark (1963) says that these prairies are best developed in Atchison and Holt counties, but extend southward into Jackson County, below Kansas City. Floristically, these prairies are quite different from hill prairies along the Mississippi River and nearby tributaries; many plant species from the Great Plains reach their easternmost limits of distribution in the loess hills.

In Illinois, hill prairies are scattered along the Mississippi River from near the Wisconsin border southward to the southern part of the state (Evers 1955); those currently listed on the Illinois Natural Areas Inventory (INAI) are shown in figure 2. In southern Illinois, there is some gradation from hill prairies to barrens and glades; see Heikens and Robertson (1994), Heikens, West, and Robertson (1994), and Robertson and Heikens (1994) for discussions of barrens in Illinois. Hill prairies also occur along the Illinois River from north of Peoria southward to its junction with the Mississippi River; additional hill prairies appear along the Sangamon River, a tributary of the Illinois River (Evers 1955). A few small hill prairies can be found in east-central Illinois along the Embarras River in Coles County; these were described by Vestal (1918), Reeves et al. (1978), and Ebinger (1981).

Field work conducted for the INAI during 1976–1977 located 446 hill prairies; only 127, many less than one acre in size, were relatively undisturbed by grazing (Nyboer 1981) (fig. 3). A total of 534.4 acres of

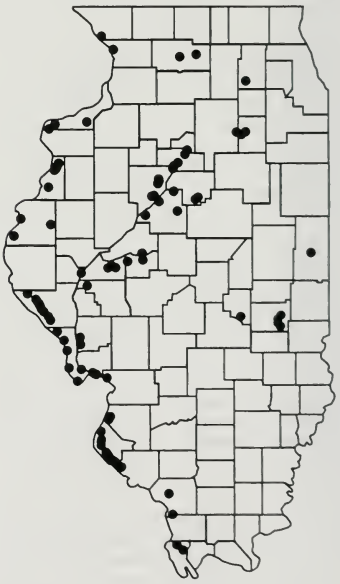

Fig. 2. Hill prairies on the Illinois Natural Areas Inventory as of November 1994

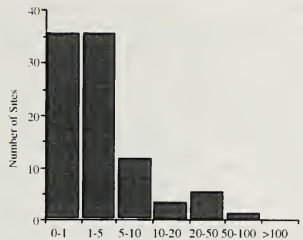

FIG. 3. Number of Grades A and B hill prairies, by acreage categories, as identified by the INAI (White 1978).

Grades A and B hill prairies were included in the inventory, representing four types of hill prairies: loess (463 acres), glacial drift (51.5 acres), gravel (14.7 acres), and sand (5.2 acres). Because of their steep slopes and relative inaccessibility, many hill prairies have not been plowed and converted to row crops. It is likely that a higher proportion of original hill prairie remains in Illinois than other prairie types. Thus, hill prairies represent some of the last living windows into the ecology of the prairie biome that dominated Illinois for 8,000 years.

Types of Hill Prairies

In Illinois, there are four basic types of hill prairies recognized by the INAI (White 1978): loess hill prairies, sand hill prairies, glacial drift hill prairies, and gravel hill prairies. The first, loess hill prairies, is the most abundant type in the state and occur primarily along the Mississippi and Illinois rivers. These prairies are named for their characteristic windblown loam soil, which was deposited as the glaciers receded (Pielou 1991). Two subclasses of loess hill prairies can be recognized—one occurring on loess deposited above bluffs and the other where the loess is deposited just above the floodplains of rivers, mostly on top of mounds of glacial till. Two examples of loess hill prairies above bluffs in the Illinois nature preserves system are Fults Hill Prairie and Pere Marquette nature preserves (only one small hill prairie is actually in the latter, but larger hill prairies are in the nearby Pere Marquette State Park). Examples of loess hill prairie nature preserves over glacial till include Meredosia Hill Prairie, Revis Hill Prairie, and Witter's Bobtown Hill Prairie. Large amounts of the latter type of loess hill prairie, most of it severely grazed, also occur at Site M in Cass County, recently purchased by the Illinois Department of Conservation.

Varying amounts of windblown sand can be mixed in with the loess, and pockets of sand can also be deposited on top of loess. Areas with extensive amounts of sand that support some characteristic sand prairie plants are considered to be sand hill prairies. Some examples are Hanover Bluff Nature Preserve, the Principia College Prairies (see Kilburn and Ford 1963; Kilburn and Warren 1963; Bland and Kilburn 1966; Ranft and Kilburn 1969), and French Woods Hill Prairie. Sand is also found to varying degrees at loess hill prairies, such as Revis Hill Prairie.

Glacial drift hill prairies occur on steeply sloping glacial till that does not have a mantle of loess. These are widely scattered in Illinois. Several occur along the Illinois River from just south of Peoria, north to Putnam, LaSalle, and Grundy counties. Examples in the nature preserve system include Crevecoeur, Ridgetop Hill Prairie, Robinson Park Hill Prairies, and Wier Hill Prairie. A few glacial drift hill prairies also occur in the extreme eastern part of Illinois. Windfall Prairie Nature Preserve in Vermilion County occurs on steep southwest-facing slopes above the Middle Fork of the Vermilion River. Calcareous seeps occur on the lower slopes of the prairie. Several small hill prairies are found in Coles County. These were first described by Vestal (1918) and subsequently studied by Reeves et al. (1978) and Ebinger (1981). Recently, Behnke and Ebinger (1989) described the invasion of one of these hill prairies by the non-native *Euonymus alatus* (winged wahoo, burning bush). According to J. E. Ebinger (pers. comm.), some plants frequently seen on these Coles County hill prairies, but not mentioned on the lists given below, are *Calystegia spithamaea* (dwarf bindweed), *Galium circaezans* var. *hypomalacum* (wild licorice), *Helianthus divaricatus* (woodland sunflower), *Lespedeza virginica* (slender bush clover), *Monarda bradburiana* (Bradbury beebalm), *Silphium terebinthinaceum* (prairie-dock), and *Thaspium barbinode* (hairy meadow parsnip). *Melilotus alba* (white sweet clover) is a common non-native species. None of these Coles County hill prairies are dedicated as an Illinois nature preserve; the poorest quality one is located in a city park, and the others are privately owned.

There are only a few gravel hill prairies in Illinois. There is some intergradation between "gravel hill prairies" and "gravel prairies" as recognized by the INAI. There are two nature preserves considered gravel hill prairies by the INAI. Beach Cemetery

Prairie in Ogle County is located on a gravel kame, and Manito Prairie in Tazewell County is located on a gravel and sand terrace above the floodplain of the Illinois River. Numerous other dry prairies occur on gravel kames and eskers in northern Illinois.

Hill Prairie Plants

On 36 mostly loess Illinois hill prairies, Evers (1955) reported 252 taxa (248 species) of vascular plants. Most of these are native prairie species, but these figures also include a few native forest species and non-native species found in 18 or more sites. Of these 252 taxa, 123 occurred in 3 or fewer sites, while only 53 were found in 12 or more prairies. This relatively large number of species is due to the considerable ecological diversity that occurs on hill prairies in Illinois and the latitudinal difference of nearly 400 miles from the northernmost to the southernmost locations.

The most frequently occurring vascular plant species in hill prairies include *Schizachyrium scoparium* (little bluestem), *Bouteloua curtipendula* (side-oats grama), and *Erigeron strigosus* (daisy fleabane) (Anderson 1972; Evers 1955; Kilburn and Ford 1963). At Fults Hill Prairie, *Sorghastrum nutans* (Indian grass) and *Bouteloua curtipendula* had the highest percent of cover (Dziadyk 1978). The INAI lists the first two species plus *Sorghastrum nutans* as dominant plants on loess hill prairies, with the following listed as characteristic plants: *Asclepias viridiflora* (green milkweed), *Kuhnia eupatorioides* (false boneset), *Linum sulcatum* (wild flax), *Lithospermum incisum* (fringed puccoon), *Penstemon pallidus* (pale beardtongue), *Psoralea tenuiflora* (scurfy pea), *Sisyrinchium campestre* (blue-eyed-grass), and *Spiranthes magnicamporum* (scented ladies' tresses) (White 1978). Data are presented above (table 2) of our own sampling of nine loess hill prairies. The three most frequently occurring species were *Schizachyrium scoparium*, *Bouteloua curtipendula*, and *Petalostemum purpureum* (purple prairie clover); the three species with the largest percent cover were *Schizachyrium scoparium*, *Andropogon gerardii*, and *Rhus glabra* (smooth sumac).

Non-native plant species are generally less of a problem in hill prairies than in other types of prairies in Illinois. *Melilotus alba* is a serious problem in many hill prairies, as is *Robinia pseudoacacia* (black locust). Bush honeysuckles (*Lonicera maackii*, members of the *L. tatarica* complex, and *L.* × *bella*) are found on some hill prairies and have the potential to become serious woody invaders. *Belamcanda chinensis* (blackberry-lily), native to China and Japan, is a fairly frequent herbaceous plant on hill prairies, as are *Lespedeza stipulacea* (Korean clover) and *Verbascum thapsus* (woolly mullein). Some non-native grasses frequently observed on hill prairies include *Poa pratensis* (Kentucky bluegrass), *P. compressa* (Canadian bluegrass), *Bromus tectorum* (downy brome), *B. inermis* (smooth brome), and *Festuca elatior* (tall fescue). Woody non-native species sometimes seen on hill prairies are *Rosa multiflora* (multiflora rose), *Elaeagnus umbellata* (autumn olive), *Rhamnus cathartica* (common buckthorn), and *Maclura pomifera* (Osage orange). Behnke and Ebinger (1989) suggest that *Euonymus alatus* could be a major woody invader of hill prairies when a seed source occurs in the immediate area.

The floras of these islandlike xeric habitats are combinations of plant species that also occur in other types of dry prairies, black soil prairies, sand prairies, and gravel prairies, with only a few species largely restricted to hill prairies. It is always difficult to place individual species into categories, as there are nearly always exceptions to generalizations. The following groupings of plant species found on loess hill prairies are based on the authors' experiences in Illinois, taking into account discussions with John E. Ebinger, William E. McClain, Loy R. Phillippe, and John B. Taft (errors are ours, not theirs). We also compared species lists from Evers (1955) with species lists in Betz and Lamp (1989, 1992) and several unpublished species lists in the files of the Illinois Natural History Survey. The senior author would greatly appreciate any additions, corrections, or other comments from readers. Information on endangered and threatened species is from the Illinois Endangered Species Protection Board (1994).

Common on loess hill prairies, also frequent in various dry and mesic prairies:[6]

Amorpha canescens (lead plant)
Andropogon gerardii (big bluestem)
Anemone cylindrica (thimbleweed)
Asclepias verticillata (horsetail milkweed)

[6] Conspicuous by their general absence on hill prairies are these mesic prairie species: *Asclepias sullivantii* (Sullivant's milkweed), *A. tuberosa* (butterfly weed), *Baptisia leucantha* (white wild indigo), *B. leucophaea* (cream wild indigo), *Desmodium canadense* (showy tick trefoil), *Eryngium yuccifolium* (rattlesnake master), *Hypoxis hirsuta* (yellow star-grass), *Liatris pycnostachya* (prairie blazing star), *Parthenium integrifolium* (wild quinine), *Prenanthes aspera* (rough white lettuce), *Viola pedatifida* (prairie violet), and *Zizia aurea* (golden Alexanders). Three common mesic prairie grasses, *Panicum virgatum* (switch grass), *Sporobolus heterolepis* (prairie dropseed), and *Stipa spartea* (needle grass) rarely occur on hill prairies.

Aster azureus (sky-blue aster)
Aster ericoides (heath aster)
Bouteloua curtipendula (side-oats grama)
Cassia fasciculata (partridge pea)
Ceanothus americanus (New Jersey tea)
Comandra umbellata (false toadflax)
Coreopsis palmata (prairie coreopsis)
Coreopsis tripteris (tall tickseed)
Echinacea pallida (pale coneflower)
Elymus canadensis (nodding wild rye)
Erigeron strigosus (daisy fleabane)
Eupatorium altissimum (tall boneset)
Euphorbia corollata (flowering spurge)
Heuchera richardsonii (prairie alumroot)
Koeleria macrantha (June grass)
Kuhnia eupatorioides (false boneset)
Lespedeza capitata (round-headed bush clover)
Liatris aspera (rough blazing-star)
Linum sulcatum (wild flax)
Lithospermum canescens (hoary puccoon)
Lobelia spicata (spiked lobelia)
Monarda fistulosa (wild bergamot)
Oxalis violacea (purple oxalis)
Penstemon pallidus (pale beardtongue)
Petalostemum candidum (white prairie clover)
Petalostemum purpureum (purple prairie clover)
Physostegia virginiana (false dragonhead)
Pycnanthemum pilosum (hairy mountain mint)
Rosa carolina (pasture rose)
Ruellia humilis (wild petunia)
Schizachyrium scoparium (little bluestem)
Scutellaria parvula (small skullcap)
Silphium integrifolium (rosinweed)
Solidago nemoralis (field goldenrod)
Solidago rigida (rigid goldenrod)
Solidago speciosa (showy goldenrod)
Sorghastrum nutans (Indian grass)
Tradescantia ohiensis (spiderwort)
Verbena stricta (hoary vervain)

Mostly found on loess hill prairies and sand prairies:[7]
Agalinis skinneriana (pale false foxglove)
STATE THREATENED
Anemone caroliniana (Carolina anemone)
Asclepias amplexicaulis (sand milkweed)
Asclepias viridiflora (green milkweed), also gravel prairies
Aster oblongifolius (aromatic aster)
Aster sericeus (silky aster), also gravel prairies
Coreopsis lanceolata (tickseed coreopsis)
Desmodium sessilifolium (sessile-leaved tick trefoil)
Draba reptans (whitlow grass), also gravel prairies
Helianthus occidentalis (western sunflower), also gravel prairies
Heterotheca camporum (golden aster)
Liatris cylindracea (blazing-star), also gravel prairies
Opuntia macrorhiza (prickly-pear)
Panicum villosissimum (hairy panic grass)
Phlox bifida (cleft phlox)
Polygala incarnata (pink milkwort), also glades
STATE ENDANGERED
Polygala verticillata var. *isocycla* (whorled milkwort)
Sisyrinchium campestre (blue-eyed grass)
Solidago ptarmicoides (white goldenrod)

Mostly found on loess hill prairies and gravel prairies:
Lithospermum incisum (fringed puccoon)
Microseris cuspidata (prairie dandelion)
STATE ENDANGERED

Largely restricted to loess hill prairies in Illinois, although they can occur in different habitats in other states:
Asclepias stenophylla (narrow-leaved green milkweed)
STATE THREATENED
Buchnera americana (blue hearts)
Hedyotis nigricans (narrow-leaved bluets), also glades
Onosmodium occidentale (marbleseed)
Psoralea tenuiflora (scurfy pea)
Rudbeckia missouriensis (Missouri coneflower), also glades
STATE ENDANGERED
Solidago radula (rough goldenrod), also glades
Spiranthes magnicamporum (Great Plains ladies' tresses)

[7]A few other typical sand prairie plants can occasionally be found in sand pockets on hill prairies, such as *Aster linariifolius* (flax-leaved aster), *Helianthemum bicknellii* (frostweed), *Monarda punctata* (horsemint), *Plantago purshii* (salt-and-pepper plant), *Selaginella rupestris* (rock spikemoss), *Talinum rugospermum* (flower-of-an-hour), *Tephrosia virginiana* (goat's-rue), and *Viola pedata* (bird's-foot violet).

Loss of Area

People have observed that hill prairies in Illinois have been decreasing in area, primarily because of the encroachment of woody species (Anderson 1972, 1991; Behnke and Ebinger 1989; Ebinger 1981; Kilburn and Warren 1963; McClain and Anderson 1990; Reeves et al. 1978; Werner 1994; White 1978). This observation was quantified at Pere Marquette State Park by McClain (1983), who found from an analysis of aerial photographs that five hill prairies had been reduced in size by an average of 62% between 1937 and 1974.

Robert A. Evers resurveyed most of the sites described in his 1955 publication *Hill Prairies of Illinois* during the early 1970s. In his unpublished notes in files at the Illinois Natural History Survey, Evers frequently commented that hill prairies seen in the 1950s were being invaded by woody species by the 1970s. For example, in 1955, Evers noted that prairie vegetation dominated Seehorn Cemetery Hill Prairie in Adams County. Notes made by Evers on 9 June 1970 said, "On this visit, prairie no longer occupied the cemetery. The cemetery has some large red cedars (6 dm dbh), a few other large trees, and a host of

saplings of *Ulmus*, *Quercus muhlenbergii*, *Carya* sp., *Morus rubra*, *Fraxinus americana* etc. The herb layer was also practically all forest species."

Several points can be observed by comparing figure 1 of Evers (1955), a map of the 100 hill prairies described or observed in the early 1950s, with figure 2 in the present publication, a map showing the locations of the 91 hill prairies currently on the Illinois Natural Areas Inventory. (1) Many of Evers' sites are still extant and are now on the INAI. (2) There are a number of sites now on the INAI that were not recorded by Evers. Loess hill prairies were the primary focus of Evers, and he did not visit many glacial till hill prairies. Also, some hill prairies have been discovered since Evers' work. (3) Many sites on Evers' map are not on the INAI. Some have been completely filled by forest species, as in the example of Seehorn Cemetery given above. Evers described nine hill prairies in Adams County, but none from this county are currently on the INAI. A few sites have been destroyed by quarrying. Other Evers' sites are probably still extant but are too small to include on the INAI. Lastly, Evers mentions that many of the hill prairies he visited were grazed, and even if those were still extant, they may not be of high enough quality to include on the INAI.

It is a matter for conjecture why hill prairies have not completely disappeared in the past 100 years. Prior to European settlement, Native Americans likely burned the hill prairies, perhaps to function as lookout points. Because hill prairies are high above the surrounding terrain, lightning is frequent, and it probably started natural wildfires. The first generations of European settlers probably burned hill prairies periodically; at any rate they did not stop wildfires. However, with the advent of the "Smokey the Bear" philosophy in the 1930s, hill prairies were no longer burned, and woody vegetation began encroaching upon the prairies.

Although the steep slopes of hill prairies precluded their conversion to row crops, hill prairies were likely used extensively for grazing domestic livestock. Both Evers (1955) and Nÿboer (1981) commented that grazing has deleterious effects on species composition in hill prairies. However, grazing probably kept many hill prairies open that would have otherwise reverted to forest. Hill prairies that have been grazed, such as Revis Hill Prairie Nature Preserve, have shown remarkable resiliency in eventually recovering much of their original quality. Perhaps 50 or more acres of hill prairies at Site M in Cass County, recently purchased by the Illinois Department of Conservation, have the potential of increasing in natural quality with proper management.

Results

Over the approximately 50-year study interval, hill prairies were reduced in size by an average of 63.0% (table 1, fig. 4), ranging from 36.7% at Clendenny to 82.5% at Phegley. A careful examination of figure 4 shows that the rate of loss has not been uniform over time. Fults has been managed as a nature preserve with regular burning since the early 1970s, yet it still lost 33.1% of its 1940 area between 1962 and 1988. Revis, the largest unit in our study, has a history of intermittent fall burns since the early 1970s (Schwegman and McClain 1985), yet it decreased in size from 32.51 hectares in 1969 to 17.37 in 1988. Perimeter maps showing the loss of area over the study period for Bland and Phegley hill prairies are shown in figure 5. Although our sites do not evenly sample sites of varying size, there was no indication of a relationship between the size of a site at the beginning of the study interval and rate of habitat loss.

In addition to losing significant area, our results show that hill prairies are becoming more fragmented; two-thirds of the sites increased the number of units or patches of hill prairie at some point during the study interval (table 1). This is graphically demonstrated for Phegley in figure 5. In the case of New Canton and Phegley, the number of patches is currently decreasing as small isolated units are completely filled in by woody vegetation (table 1).

The perimeter to area *ratio* shows an average increase of over 100% during the study interval (fig. 6). Not only are our hill prairies declining from woody invasion at an alarming rate, but the propensity for this woody invasion is accelerating because of an increased ratio of edge to center of the habitat. As any two-dimensional object shrinks in size, the ratio of edge to center will increase. The p/a ratio *index* assesses the amount of edge present in a hill prairie patch relative to a circle of equal area. This p/a ratio index does not show dramatic increases over the study interval at most sites (fig. 7), although the p/a ratio index was higher in 1988 than at the beginning of the series in seven of the nine sites (table 1). Clendenny, one of the two sites where the p/a ratio index ended lower than it began, is an exception in that it lost

numerous patches in 1988. Prior to 1988, this site also had an increasing p/a ratio index.

In our field sampling of these nine hill prairies, we found *Schizachyrium scoparium* and *Bouteloua curtipendula* to be by far the most frequent in occurrence (table 2), as in previous studies (Anderson 1972; Evers 1955; Kilburn and Ford 1963). Other species occurring in at least 25% of the sites are *Petalostemum purpureum*, *Panicum* spp. (panic grass), *Aster azureus* (sky-blue aster), *Andropogon gerardii*, and *Psoralea tenuiflora*. A total of 22 species were found in more than 10% of the 1 m^2 plots (table 2). The most frequent woody species were *Cornus drummondii* (rough-leaved dogwood), *Juniperus virginiana* (red cedar), and *Rhus glabra*. These woody species, however, are not necessarily indicative of hill prairie loss. These species persist in low abundance and low stature in many hill prairie sites. The woody species rank much higher in percent of total area (table 2), *Rhus glabra* ranking second, *Juniperus virginiana* fourth, and *Cornus drummondii* fifth. The only non-native species observed in more than 10% of our plots was *Melilotus alba*.

Our sampling data also show that the higher the proportion of 1940 area remaining in 1988, the larger the number of species observed in our 1 m^2 sample plots (fig. 8). Conversely, the lower the proportion of 1940 area remaining in 1988, the larger the number of sample plots that contained woody species (fig. 9).

Discussion

The results of this study suggest that hill prairies have, on average, been more than halved in size since 1940. This estimate includes only those sites that have managed to remain hill prairies during this period, and is thus a conservative estimate of the total rate of habitat loss. Much of this hill prairie loss is from woody encroachment around the borders of sites, especially by *Juniperus virginiana*, *Rhus glabra*, and *Cornus drummondii*. There is a natural propensity for habitat patches or units to increase in edge perimeter as the total size declines. Hill prairies are shown to be no exception to this rule, as most sites increased the amount of edge relative to a uniform shape of the size during each sample period, indicating increasing complexity of habitat patch shape. This increasing amount of edge is an important trend as woody invasion takes place mostly along edges, and therefore the rates of conversion of hill prairie to woody vegetation also increase. It is likely that what we observed at the nine sample hill prairies represents what is happening at hill prairies throughout Illinois, and thus it appears that many of the hill prairies in Illinois could disappear in the next 10 to 20 years.

The results of this study point to the single clear trend toward loss of the already rare hill prairie habitats in Illinois. The Illinois Department of Conservation and the Illinois Nature Preserves Commission are currently taking measures to protect hill prairie sites through active fire management. These measures, however, may be inadequate. Of the nine sites studied, only Revis and Fults have a history of fire management since the 1970s. While these two sites have relatively high species diversity values (fig. 8), they do not have particularly low levels of woody species invasions (fig. 9). In addition, sites acquired by the state of Illinois and managed by fire, such as Revis and Fults, have still declined in size since the 1970s. This may be a result of long intervals between fire treatments on these habitats. There is much debate on the natural fire frequency for hill prairies—estimates range from 5 to 30 years. When combating advanced woody encroachment, managed fire frequencies may need to exceed natural levels until woody invasion is suppressed. In addition, it is necessary in some cases to manually cut and remove the woody plants.

Acknowledgments

The authors wish to thank the following for sharing their knowledge of hill prairies: John E. Ebinger, Don Gardner, William E. McClain, John Schwegman, John Taft, and Stan Tyson. Celine D'Onofrio and Liane Suloway provided us with data from the Illinois Natural Areas Inventory database. Katherine J. Hunter prepared figure 2, Jennifer Tate obtained literature, and Ann Marie Trame and Ann Kirts helped compile data from species lists. Loy R. Phillippe, John K. Bouseman, William E. McClain, and Gerould Wilhelm provided critical reviews. Careful readings by Scott C. McKay, Amanda S. Robertson, and Charles Warwick greatly improved readability. Funding was provided by the Illinois Department of Energy and Natural Resources.

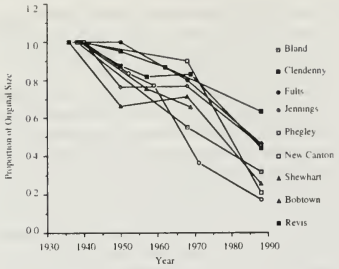

FIG. 4. The change in size of nine Illinois hill prairies between about 1940 and 1988 as measured by the proportion of the size measured in the earliest aerial photograph (see table 1).

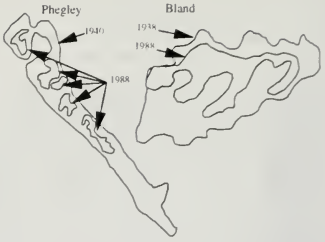

FIG. 5. Graphical depiction of the areas for Phegley (left) and Bland (right) hill prairies at the beginning and the end of the study period as digitized from aerial photographs; the inner unit(s) are from the 1988 photographs.

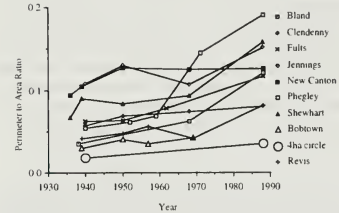

FIG. 6. The change in perimeter to area ratio for nine Illinois hill prairies between about 1940 and 1988. For reference, the change in the perimeter to area ratio for a circle that is halved in size is plotted between the 1940 and 1988 markers.

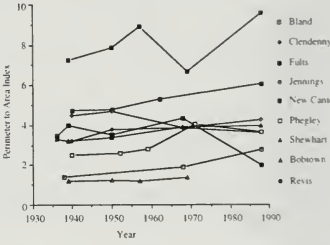

FIG. 7. The change in perimeter to area ratio index for nine Illinois hill prairies between about 1940 and 1988. This index is the perimeter to area ratio divided by the perimeter to area ratio for a circle of the same area; it is a measure of the complexity of the shape of each hill prairie.

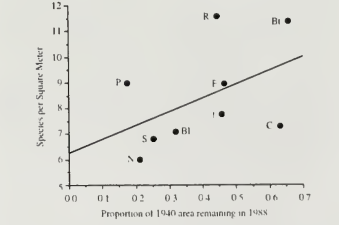

FIG. 8. Scatterplot of the average number of species sampled per square meter and the rate of recent habitat loss for nine Illinois hill prairies.

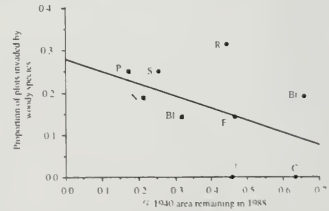

FIG. 9. Scatterplot of the proportion of 25 m^2 plots invaded by woody plant species and the rate of recent habitat loss for nine Illinois hill prairies.

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Erigenia, Number 14, November 1995, pp. 53-56

Woody Vegetation Survey of Bois du Sangamon Nature Preserve, an Upland Forest in Macon County, Illinois

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Abstract: A survey was made of the woody vegetation at Bois du Sangamon Nature Preserve, an upland forest in Macon County, Illinois. *Quercus alba* L. (white oak) ranked first with an importance value of 68.2 (IV 200), followed by *Acer saccharum* Marsh. (sugar maple) with an importance value of 26.6. Associated species included *Carya cordiformis* (Wang.) K. Koch, *Carya ovata* (Mill.) K. Koch, and *Ulmus americana* L. The larger diameter classes were dominated by white oak, whereas sugar maple dominated the 10-20 cm diameter class. Tree density averaged 324.4 stems/ha, and average basal area was 26.4 m^2/ha. Although only 16% of the individuals (10 cm dbh and above) were white oak, they accounted for more than 50% of the basal area.

Introduction

The upland forests of the prairie peninsula of Illinois have undergone significant changes since presettlement time (Ebinger and McClain 1991). Those not destroyed have been extensively modified by logging, grazing, and fire suppression (Rodgers and Anderson 1979). According to the historical information available, most upland forests were relatively open (Ebinger 1986a, 1987) and could be characterized as open forests or savannas, a transition between the extensive prairie found throughout much of the upland area of the prairie peninsula and the closed forests of the dissected terrain usually associated with river valleys.

The forest at Bois du Sangamon Nature Preserve is typical of the relatively mature upland forests of the Grand Prairie Natural Division (Schwegman et al 1973). Though more open and probably lacking many of our mesophytic woody species in presettlement times, the forest canopy is now closed, and like other central Illinois forests (Boggess and Geis 1966; Newman and Ebinger 1985; Ebinger 1986b), it has developed a more mesophytic woody flora, probably because of fire suppression (Rodgers and Anderson 1979; Ebinger 1986b). A detailed study of this nature preserve was undertaken to determine its woody composition and structure.

Study Area

Bois du Sangamon Nature Preserve is located on the east shore of Lake Decatur, Macon County, Illinois (S4 T16N R3E). The lake forms the northwestern border of the preserve and the Norfolk & Western Railroad the southern border. The preserve is about 13 ha in size with a topographic relief of about 20 m. It is located in the midst of what was described by the Public Land Survey field notes of 1822 as land rolling and rich, dominated by oak, hickory, and elm (Hutchison 1985). Since settlement the area has undergone many changes. Major excavations occurred in the early 1900s along the eastern edge of the preserve, the Wabash Railroad was built along the southern edge, and a dam on the Sangamon River raised Lake Decatur to its present level in the early 1920s. Other past disturbances included selective logging, grazing, and the clearing of a small portion of land in the southwest corner. Hutchison (1985) reported that the owners had protected the woods from logging for fifty years prior to formal protection. The soils of the study area are Xenia silt loam on the nearly level uplands and Miami loam on the steep slopes (Dole 1990). Both are calcareous, moderately to well-drained soils with a dark grayish brown surface layer about 15 cm thick.

Materials and Methods

During the summer of 1993, a 2.5 ha section of the upland forest was divided into 40 25 × 25 m quadrats. In each quadrat all living and dead-standing woody individuals over 10 cm dbh were identified, and their diameters recorded. From these data the density (stems/ha), basal area (m^2/ha), relative density, relative

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dominance, importance value (IV), and average diameter (cm) were calculated for each species. The determination of the IV follows the procedure used by McIntosh (1957), and is the sum of the relative density and relative dominance of a given species.

Woody understory composition and density (stems/ha) were determined using nested circular plots 1 m^2, 10 m^2, and 100 m^2 in size, randomly located in each quadrat by blind- throwing a marker from a corner of the plot. Two additional 1 m^2 circular plots were located 5 meters to the east and west of each center. In the 1 m^2 circular plots seedlings (< 40 cm tall) and all shrubs were counted, in the 10 m^2 circular plots small saplings (> 40 cm tall and < 2.5 cm dbh) were recorded, and in the 100 m^2 circular plots large saplings (2.5–10.0 cm dbh) were tallied. Saplings were divided into 2.5 cm diameter classes. Nomenclature follows Mohlenbrock (1986).

RESULTS AND DISCUSSION

Sixteen canopy and four understory tree species were encountered in the woods. *Quercus alba* (white oak) ranked highest with an IV of 68.2 out of a possible 200 (table 1). It had the highest basal area (13.8 m^2/ha), the largest average diameter (55.7 cm), and the highest relative dominance (52.3%). It occurred in all diameter classes, but 67% of the individuals were 50 cm dbh or greater. Many of these larger individuals have an open-grown appearance with low branches or branch scars within five meters of the ground and broad, open crowns, indicative of a forest that was more open in the past. *Quercus velutina* Lam. (black oak) and *Q. rubra* L. (red oak) were occasionally encountered, but were not important forest components, ranking eighth and eleventh respectively. Very few oak seedlings and saplings were found (table 2).

A few mesic, shade-tolerant species were common components of the woods. For the most part these species were common in the seedling and sapling layer, and were usually well represented in the smaller diameter classes. *Acer saccharum* (sugar maple) ranked second in importance (IV of 26.6); it had the highest relative density (17.8) and an average diameter of 18.3 cm (table 1). This species had the highest density in the understory: counts were 5833 seedlings/ha, 4825 small saplings/ha and 599 large saplings/ha (table 2). *Carya cordiformis* (bitternut hickory) ranked third (IV of 15.5) and was well represented in the seedling and sapling layers. *Ulmus americana* (American elm) and *U. rubra* Muhl. (slippery elm) were common understory species represented by many smaller diameter individuals.

Both *Carya ovata* (shagbark hickory) and *C. tomentosa* (Poir.) Nutt. (mockernut hickory) were common in the lower diameter classes. Few individuals exceeded 40 cm dbh, and average diameters for these two species were 19.3 and 23.2 cm respectively. A few seedlings and saplings were encountered, but far fewer than for the mesic species.

Tree mortality, which was relatively low in the woods, averaged 14 dead-standing stems/ha with an average basal area of 0.7 m^2/ha. American elm had the highest mortality, averaging 4.4 stems/ha, followed by slippery elm, mockernut hickory, and white oak. Mockernut hickory accounted for the highest average

TABLE 1. Densities (stems/ha), diameter classes, basal areas (m^2/ha), relative values, importance values, and average diameters of the woody species in an upland forest at Bois du Sangamon Nature Preserve, Macon County, Illinois.

Species	Stems/ha by diameter class (cm)							Total stems/ ha	Basal area (m^2/ha)	Rel. den.	Rel. dom.	IV	Avg. diam. (cm)
	10–20	20–30	30–40	40–50	50–60	60–70	70+						
Quercus alba L.	2.0	3.2	4.4	7.6	8.8	15.6	10.0	51.6	13.8	15.9	52.3	68.2	55.7
Acer saccharum Marsh.	45.6	6.8	2.4	–	0.8	0.8	1.2	57.6	2.3	17.8	8.8	26.6	18.3
Carya cordiformis (Wang.) K .Koch	21.6	10.4	2.8	0.4	–	–	–	35.2	1.2	10.9	4.6	15.5	19.5
Carya ovata (Mill.) K. Koch	20.4	10.4	3.6	0.4	–	–	–	34.8	1.2	10.8	4.5	15.3	19.3
Ulmus americana L.	29.6	3.6	0.8	0.8	–	–	–	34.8	0.9	10.7	3.3	14.0	16.4
Carya tomentosa (Poir.) Nutt.	12.4	4.4	2.0	0.4	2.0	–	–	21.2	1.2	6.5	4.4	10.9	23.2
Ulmus rubra Muhl.	10.8	6.8	3.2	1.2	–	–	–	22.0	1.0	6.8	3.6	10.4	21.5
Quercus velutina Lam.	0.4	0.8	2.0	2.4	0.8	2.0	0.8	9.2	1.8	2.8	6.9	9.7	47.0
Ostrya virginiana (Mill.) K. Koch	23.2	–	–	–	–	–	–	23.2	0.3	7.2	1.2	8.4	12.9
Juglans nigra L.	4.0	6.0	4.0	0.8	–	–	–	14.8	0.9	4.6	3.3	7.9	25.9
Quercus rubra L.	0.8	0.8	1.2	0.8	–	0.4	1.2	5.2	1.2	1.6	4 4	6.0	46.9
Prunus serotina Ehrh.	3.2	1.6	1.6	0.8	–	–	–	7.2	0.4	2.2	1.5	3.7	23.9
Others	4.4	1.6	1.6	–	–	–	–	7.6	0.2	2.2	1.2	3.4	
Total	178.4	56.4	29.6	15.6	12.4	18.8	13.2	324.4	26.4	100.0	100.0	200.0	

Table 2. Density (stems/ha) of shrubs, woody seedlings, and saplings in an upland forest at Bois du Sangamon Nature Preserve, Macon County, Illinois.

Species	Seedlings (diameter <40 cm)	Saplings diameter class (cm)			
		<2.5	2.5–5.0	5.1–7.5	7.6–10.0
Trees					
Acer saccharum Marsh.	5833	4825	448	113	38
Ulmus spp.	250	175	75	35	23
Carya spp.	583	250	35	18	5
Quercus spp.	83	–	–	–	3
Sassafras albidum (Nutt.) Nees	332	–	5	3	–
Other trees	250	275	28	8	15
Shrubs					
Ribes missouriense Nutt.	417	–	–	–	–
Symphoricarpos orbiculatus Moench	250	–	–	–	–
Cornus drummondii C. A. Mey.	83	–	–	–	–
Total	8081	5525	591	177	84

dead-standing basal area (0.4 m^2/ha), followed by slippery elm. No cut stumps were found during the study. Coppice stems were also uncommon, averaging 6.8 individuals/ha. The understory tree *Ostrya virginiana* (Mill.) K.Koch (hop hornbeam) accounted for nearly 60% of the coppice individuals.

Of the understory trees on the site, only hop hornbeam was common; it was well represented in the 10–20 cm diameter class, averaging 23.2 stems/ha. *Viburnum prunifolium* L. (black haw) was also occasionally encountered, as was *Cercis canadensis* L. (redbud). Shrubs averaged 750 individuals/ha, with *Ribes missouriense* Nutt. (Missouri gooseberry) and *Symphoricarpos orbiculatus* Moench (coralberry) the most common (table 2).

Presently Bois du Sangamon Nature Preserve is an oak/maple/hickory forest. Sugar maple accounts for the highest number of stems/ha in the seedling, sapling, and 10–20 cm diameter classes. Observations indicate that the hickories and elms are increasing in importance. These data suggest that as the canopy continues to close and the forest becomes more mesic, shade-tolerant species will continue to increase in importance. In particular, sugar maple, because of its high gap-phase-replacement potential, will dominate the forest as the veteran oaks die (Runkle 1984; Pallardy et al. 1991). This eventual shift in canopy composition is a widespread phenomenon, occurring throughout much of the oak/hickory forest region (Braun 1950) of the Midwest. These changes largely reflect the elimination of disturbance regimes, particularly fires, that had maintained these forests in early successional stages (Curtis 1959). With the reduction in fire frequency, fire-sensitive, shade-tolerant species such as sugar maple, elm, and bitternut hickory are able to invade and become established.

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ERIGENIA, Number 14, November 1995, pp. 57–58

Additions to the Vascular Flora of Illinois

Mark A. Basinger[1]

ABSTRACT: Seven vascular plant species are reported new to Illinois: *Brachiaria platyphylla* (Grisebach) Nash, *Eupatorium hyssopifolium* L., *Ipomoea quamoclit* L., *Pennisetum americanum* (L.) Leeke, *Spiraea* × *vanhouttei* (Briot) Zabel, *Sporobolus pyramidatus* (Lam.) Hitchcock, and *Tagetes patula* L.

Introduction

Field work in southern Illinois from 1993 through 1995 has led to the discovery of seven vascular plant species new to the state. This paper describes each of these plants and provides collection information. A voucher specimen has been deposited in the Illinois Natural History Survey Herbarium (ILLS) to voucher each taxon reported here, except for *Eupatorium hyssopifolium* L., which is deposited in the herbarium at the Shawnee National Forest Headquarters in Harrisburg, Illinois. Nomenclature follows Gleason and Cronquist (1991).

Taxa New to Illinois

Brachiaria platyphylla (Grisebach) Nash (POACEAE) is an annual grass native to the southeastern United States, from North Carolina south to Florida, west to Texas, and north to Kentucky and Missouri (Correll and Johnston 1970; Hitchcock 1951; Radford et al. 1968). A member of the tribe Paniceae, this species is recognized by racemes that have a broadly winged rachis bearing glabrous spikelets up to 5 mm in length, and by its decumbent, stoloniferous habit (Hitchcock 1951).

COLLECTION DATA: locally abundant in a fallow field east of the dam at Horseshoe Lake Conservation Area, S15 T16S R2W, Alexander County, 14 October 1993, Basinger & Ketzner #7759; associated with *Bidens cernua*, *B. frondosa*, *Cyperus aristatus*, *C. erythrorhizos*, *Panicum dichotomiflorum*, *Polygonum lapathifolium*, and *P. pensylvanicum*. It was persisting at this station and in roadside ditches and fallow fields on the refuge in 1994.

Eupatorium hyssopifolium L. var. ***hyssopifolium*** (ASTERACEAE) is a perennial, native to open forests, pine savannas, sandy fields, and roadsides from Massachusetts south to Florida, west to Louisiana, and north to Ohio and Kentucky (Radford et al. 1968; Cronquist 1980; Gleason and Cronquist 1991). This species is distinguished from any other *Eupatorium* in the Illinois flora by its whorled, linear primary stem leaves, which are in 3s or 4s, are 6–40 times longer than broad, and are glandular-punctate beneath. The upper stem leaves usually have axillary fascicles of reduced leaves, and the corollas are white. Given the associated native flora and current management of the area, this population of *E. hyssopifolium* is probably native. However, a recent collection by Eric Ulaszek (2 August 1994, #2156) from Johnson County, along Interstate 24 approximately 5 miles south of Ill. 146, is probably adventive. At the Johnson County station, approximately 200 plants were found associated with *Coronilla varia*, *Festuca pratensis*, *Lespedeza cuneata*, *Rhus copallina*, and *Vernonia* sp.

COLLECTION DATA: local in sandy soil at Dean Cemetery East Barrens Ecological Area, S14 T15S R6E, Pope County, 24 October 1993, Basinger #7839; associated with *Agalinis tenuifolia*, *Lobelia puberula*, *Schizachyrium scoparium*, *Scleria pauciflora*, *Solidago juncea*, and *S. nemoralis*. It persisted at this station in 1994.

Ipomoea quamoclit L. (CONVOLVULACEAE) is an annual vine native to tropical America that readily escapes from cultivation into fields and roadsides (Radford et al. 1968; Gleason and Cronquist 1991). This species is similar to *I. coccinea* L. in the Illinois flora, but is distinguished by its pinnately divided leaves.

COLLECTION DATA: persistent in a field at the War Bluff Valley Sanctuary about 6 miles north of Golconda near the intersection of Bushwhack Road and Ill. 146, S25 T13S R6E, Pope County, 14 August 1993, Basinger #6528; associated with *Asclepias syriaca*, *Festuca elatior*, *Cirsium discolor*, and *Solidago canadensis*. It was persisting at this station in 1994.

Pennisetum americanum (L.) Leeke (POACEAE) is an annual grass native to the Old World that is planted as forage for wildlife in the southeastern United States (Clewell 1985). It is recognized by its large culms up to

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2 m tall and its large cylindrical panicles up to 50 cm long (Hitchcock 1951; Radford et al. 1968). This species has been known as either *P. glaucum* (L.) R. Brown, or *P. typhoides* (Burm.) Stapf & C. E. Hubb. in some manuals (e.g., Bor 1960), but collections at Southern Illinois University (SIU) have been determined by Michael Stieber (Morton Arboretum, Lisle, Illinois), as *P. americanum*.

COLLECTION DATA: local along the roadside of Ill. 13 north of a wetland mitigation pond approximately 75 meters west of the Saline County line, S13 T9S R4E, Williamson County, 30 September 1993, Basinger #7590; associated with *Ambrosia artemisiifolia*, *Eragrostis pectinacea*, *Oenothera biennis*, *Panicum dichotomiflorum*, and *P. virgatum*. It was not observed at this station in 1994, but new stations along Ill. 13 approximately 1 to 3 miles west of the original location were noted.

Spiraea × *vanhouttei* (Briot) Zabel (ROSACEAE) is a shrub native to Asia that has been widely planted as an ornamental around homesites in North America (Rehder 1940). Rehder (1940) reported this plant as a hybrid between *S. cantoniensis* Lour. and *S. trilobata* L. It is distinguished from other members of section Chamaedryon by its umbelliform inflorescence with leafy bracts, its arching branching habit, and its slightly 3- to 5-lobed leaves with cuneate bases that are toothed only near the apex (Rehder 1940; Gleason and Cronquist 1991).

COLLECTION DATA: persistent and spreading vegetatively at the old Weaver homesite approximately 3.7 miles south of Jonesboro along Ill. 127, SW S13 T13S R2W, Union County, 7 May 1995, Basinger #9466; associated with *Euonymus fortunei*, *Hemerocallis fulva*, *Hibiscus syriacus*, *Juglans nigra*, *Lonicera japonica*, *Prunus serotina*, and *Vinca minor*.

Sporobolus pyramidatus (Lam.) Hitchcock (POACEAE) is a perennial grass that ranges from tropical America north to Kansas and Missouri, with an adventive population in New York (Hitchcock 1950; Gleason and Cronquist 1991). It is distinguished from other species of *Sporobolus* in Illinois by its whorled lower panicle branches that are gradually reduced in length upward in pyramid fashion (Hitchcock 1951; Correll and Johnston 1970; Long and Lakela 1971).

COLLECTION DATA: locally abundant along the roadside of Ill. 3 at Horseshoe Lake Conservation Area, SE SE NE S10 T16S R2W, Alexander County, 19 August 1993, Basinger #6568; local along the roadside of Ill. 3 at the intersection with Ill. 149 about 8 miles west of Murphysboro, S8 T9S R3W, Jackson County, 6 September 1993, Basinger & Ketzner #6720; at both stations, this species was associated with *Eragrostis pectinacea*. It persisted at these stations in 1994.

Tagetes patula L. (ASTERACEAE) is an annual species, native to Mexico, that occasionally escapes from cultivation, primarily in the southern United States (Radford et al. 1968; Gleason and Cronquist 1991). The genus *Tagetes* can be distinguished from other members of the tribe Heliantheae by the presence of a cylindrical involucre of phyllaries that are united to the apex (Cronquist 1980). This species is distinguished from *T. erecta* L. by its deep red orange heads surrounded by involucral bracts no more than 1.5 cm long (Bailey 1949; Radford et al. 1968).

COLLECTION DATA: persistent along a crop field-successional forest margin at Horseshoe Lake Conservation Area, NE SW S17 T16S R2W, Alexander County, 5 July 1993, Basinger #6031; associated with *Ambrosia trifida*, *Artemisia annua*, *Festuca elatior*, *Polygonum pensylvanicum*, and *Prunus persica*. It was persisting at this station in 1994.

ACKNOWLEDGMENTS

The author expresses deep appreciation to Gerould Wilhelm and Eric Ulaszek, who reviewed the manuscript and offered many helpful suggestions. Field assistance by David Ketzner is also appreciated.

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Erigenia, Number 14, November 1995, pp. 59–60

New Populations of Rare Species in Southern Illinois

Robert Todd Bittner

Populations of *Calamagrostis porteri* Gray ssp. *insperata* (Swallen) C. Greene (reed bent grass) and *Carex willdenowii* Schkuhr (Willdenow's sedge) were recently discovered in Pope County in southern Illinois at Bell Smith Springs Ecological Area and at Lusk Creek Canyon Wilderness Area. Both Bell Smith Springs and Lusk Creek are floristically diverse areas that support a wide variety of community types and contain several other threatened and endangered species (U.S.D.A. 1992).

Calamagrostis porteri ssp. *insperata* was originally described from Jackson County, Ohio, in 1934 (Van Schaack 1954). In the 1930s, another Ohio population was discovered from Vinton County (Braun 1967), and three populations were discovered in Ozark ((Steyermark 20043 MO), Douglas (Steyermark 23350 MO), and Texas (Steyermark 16620 MO) counties, Missouri, by Julian Steyermark (1963) although the last collection was mistakenly not included in *The Flora of Missouri*. Recently, the historic Missouri populations were relocated, along with over 60 additional populations from six Missouri counties (Summers 1993; Ellshoff 1993). The two historical populations in Ohio have also been relocated, along with new populations within the Vinton County site (Spooner 1981). An additional six populations have been reported from two sites in Kentucky (Cambell et al. 1992).

Calamagrostis porteri ssp. *insperata*, an Illinois threatened species (Herkert 1994) and a federal candidate for listing as an endangered or threatened species (Federal Register 1993), was first discovered in Illinois in 1991 at Bell Smith Springs by Bill Summers of St. Louis, Missouri. In 1992, a second Pope County population was discovered in the Lusk Creek Canyon Wilderness Area by John Schwegman. During 1993, three additional populations were located, two at Bell Smith Springs and one at Lusk Creek Canyon. This grass grows rhizomatously, forming clonal populations on cool, mesic, north-facing bluff edges and under tree falls in high-quality oak-hickory forests. The populations of *C. porteri* ssp. *insperata* vary from 500 to over 18,000 tillers, but flowering individuals are extremely rare; only one was observed in 1993 (Bittner 1995).

Three new Illinois populations of *Carex willdenowii*, a state endangered species (Herkert 1991), were discovered in 1993, two at Bell Smith Springs and one at Lusk Creek Canyon. At all three sites *C. willdenowii* was found growing in association with *Calamagrostis porteri* ssp. *insperata*. Other *C. willdenowii* populations in Illinois are located in Gallatin and Union counties and other portions of Pope County. *Carex wildenowii* is superficially similar to many common sedges and may often be overlooked; it may be more common than present records suggest.

Specimens of both species have been deposited in the Illinois Natural History Survey Herbarium, Urbana, Illinois.

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Braun (1950) or Parks et al. (1968) or (Mohlenbrock 1970, 1990) or (Swink and Wilhelm 1994; Young 1994).

In Literature Cited:

Braun, E. L. 1950. Deciduous forests of eastern North America. Blakiston, Philadelphia.

Mohlenbrock, R. H. 1990. Forest trees of Illinois. 6th ed. Illinois Department of Conservation, Springfield.

Parks, W. D., J. B. Fehrenbacher, C. C. Miles, J. M. Paden and J. Weiss. 1968. Soil survey of Pulaski and Alexander counties, Illinois. U.S.D.A. Soil Report 85.

Greenberg, R. 1992. Forest migrants in nonforest habitats on the Yucatan Peninsula. Pages 273-286 *in* J. M. Hagan III and D. W. Johnson, eds. Ecology and conservation of neotropical migrant landbirds. Smithsonian Institution Press, Washington, D.C.

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CONTENTS

ERIGENIA 14 NOVEMBER 1995