Transactions of the Illinois State Academy of Science
(2008), Volume 101, #3&4, pp. 157-165
received 1/3/08
accepted 8/16/08

Windfall Glacial Drift Hill Prairie, Vermilion County, Illinois: Present Vegetation and Changes Since 1977

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ABSTRACT

The vascular flora of the glacial drift hill prairie at Windfall Prairie Nature Preserve, Vermilion County, Illinois, was studied during the 2005 and 2006 growing seasons. This prairie is located on a steep south- to southwest-facing hillside overlooking the Middle Fork of the Vermilion River. The composition and structure of the flora was determined using m^2 plots placed along line transects. Frequency, mean cover, relative values, and Importance Value of each species were determined from these data. The site supported 107 vascular plant species of which 50 were encountered in the plots. *Schizachyrium scoparium* (little bluestem) had the highest importance value (IV of 24.6), followed by *Sorghastrum nutans* (Indian grass) and *Bouteloua curtipendula* (side-oats grama) with IVs of 22.9 and 20.3, respectively. Common forbs included *Aster laevis* (smooth aster), *Silphium terebinthinaceum* (prairie dock), *Solidago nemoralis* (gray goldenrod), and *Coreopsis tripteris* (tall tickseed). Exotic species were represented by 10 taxa, 9.3% of the flora. The community had a Floristic Quality Index of 41.86, indicating a site of statewide significance. Since a previous study in 1977 there have been a few changes in the importance of the common species.

Key Words: glacial drift hill prairie, Illinois, *Sorghastrum nutans, Schizachyrium scoparium*.

INTRODUCTION

In pre-settlement Illinois small prairie openings were common in the forests on glacial moraines and steep hillsides of river valleys (Vestal 1918, Hanson 1922, Transeau 1935). Many of the prairie openings were associated with loess soil, and most of these were located on steep hillsides of the Illinois and Mississippi river valleys. Many of these loess hill prairies still exist and have been intensely studied during the past 75 years (Evers 1955, McClain and Anderson 1990, Robertson et al. 1995, Swartz, et al. 1997).

Others prairie inclusions on steep hillsides, known as glacial drift hill prairies, were associated with heavy clay soils. They were first studied in 1916 in the vicinity of Charleston, Coles County, Illinois by Arthur G. Vestal (1918) while he taught at Eastern Illinois State

Normal School. These glacial drift hill prairies were associated with glacial deposits that were heavily eroded, and no longer had a loess covering. Many were associated with river systems in east-central Illinois, particularly the Kaskaskia, Embarras, and the Middle Fork of the Vermilion Rivers and their tributaries (Ebinger 1981; Evers 1955; Vestal 1918). A few glacial drift hill prairies are found along the Illinois River, with a concentration around Peoria (McFall and Karnes 1995).

Glacial drift hill prairies developed on glacial till of Wisconsin and Illinoian age that have lost the loess overburden due to soil slumping and erosion. These low-nutrient, rocky and clay soils contain little organic material and allow for rapid water runoff, creating droughty conditions (McClain et al. 2002, Robertson et al. 1995). In addition to the soils, a combination of factors including south- to southwest-facing slope aspect, steep slope angle, and dry prevailing west winds contributes to the maintenance of the prairie vegetation on these sites. These environmental conditions, however, do not prevent woody plant encroachment. Of the nine small prairie inclusions reported by Vestal (1918) from a steep-sided valley near Charleston, Illinois, just three were re-located by Reeves et al. (1978). Behnke and Ebinger (1989) reported only one inclusion that contained typical prairie vegetation, and three others degraded by woody species encroachment. Owens and Cole (2003) reported only one remaining prairie opening.

The present study was undertaken to determine the vascular plant species composition, vegetation structure, and floristic quality of a small glacial drift hill prairie located at Windfall Prairie Nature Preserve in east-central Illinois, and to compare results with a previous study of the site in 1977 (Ebinger 1981).

STUDY AREA

Windfall glacial drift hill prairie, about 1 ha in size, is located in east-central Illinois, about 10 km northwest of Danville, Illinois in Kennekuk Cove County Park (NE1/4 NW1/4 S8 T20N R12W; 40.2164° N, 87.7468° W). Situated at the top of a south- to southwest-facing bluff overlooking the Middle Fork of the Vermilion River the hill prairie is at an elevation above sea level of about 200 m and is located on Wisconsin glacial till in the Vermilion River Section of the Wabash Border Division (Schwegman 1973). The hill prairie is surrounded by dry, immature upland oak-hickory forests on the ridges and in shallow ravines just behind the exposed bluff (Anderson 1991; Ebinger and McClain 1991).

The heavily eroded prairie soils lacked much of an A horizon, were well drained, low in organic content, and slightly acidic. Extensive soil slumping has occurred on the steeper slopes with the clay subsoil commonly exposed, while continued cutting by the Middle Fork of the Vermilion River caused continued soil loss from the bluff face and base of the prairie. Many gravel-sized pebbles and a few stones were imbedded in the soils. The climate is continental and characterized by hot, humid summers and cold winters. Precipitation averages 104.0 cm, with June having the highest rainfall (11.9 cm). Mean annual temperature is 11.4° C, the hottest month being July (average of 24.1° C), the coldest being January (average of –3.4° C). The average number of frost-free days is 169 (Midwestern Regional Climate Center 2007).

MATERIALS AND METHODS

Windfall hill prairie was visited every 3-4 weeks during the 2005 and 2006 growing seasons. During each trip, all flowering or fruiting species encountered were collected and voucher specimens were deposited in the Stover-Ebinger Herbarium of Eastern Illinois University, Charleston, Illinois (EIU). Nomenclature follows Mohlenbrock (2002) and the assignment of non-native status was determined using Taft et al. (1997) and Mohlenbrock (2002).

Ground-layer species were analyzed in early September 2005 using m^2 plots located at 1 m intervals along two randomly placed 25 m transects oriented perpendicular to the slope (n=25/transect). Even-numbered plots were placed to the right, odd-numbered to the left. Herbaceous species, shrubs, and tree seedlings to 0.4 m in height were included in the sampling. Percent cover for each species, as well as for bare ground and litter, were determined by using the Daubenmire (1959) cover class system as modified by Bailey and Poulton (1968) (class 1 = 0-1%, class 2 = 2-5%, class 3 = 6-25%, class 4 = 26-50%, class 5 = 51-75%, class 6 = 76-95%, and class 7 = 96-100%). Mean cover, relative cover, frequency (%), relative frequency, and importance value (IV) were determined for each species. As used here, IV is the sum of the relative frequency and relative cover.

Floristic Quality Index (FQI) of the site was determined using the coefficient of conservatism (CC) assigned to each species by Taft et al. (1997). For each species in the Illinois flora, the CC was determined by subjectively assigning an integer from 0 to 10, based on its tolerance to disturbance and its fidelity to habitat integrity. FQI is a weighted index of species richness (N = number of species present), and is the arithmetic product of average coefficient of conservatism (C-Value = the average of all species CCs) multiplied by square root of the species richness (ÖN): FQI = C-Value (ÖN). Therefore, FQI indicates level of habitat degradation and provides an assessment of the quality of each tract based on taxa present. It is particularly useful when combined with quadrat-based sampling methods and provides a way of making quantitative comparisons among sites.

RESULTS

A total of 107 species representing 41 families and 85 genera was documented for Windfall hill prairie (Appendix I). Fern-allies and gymnosperms were represented by three species. Of the remainder, 85 were dicots in 33 families and 67 genera, and 20 were monocots in 6 families and 16 genera. Of these totals, 16 were woody species while 10 were exotic. Predominant plant families were Asteraceae with 28 species and Poaceae with 11 species. FQI for this site, when non-native species were included, was 41.86 with a mean C-value of 4.03; with non-native species excluded from the calculations FQI was 43.94 with a mean C-value of 4.44, indicating a site of statewide significance (Taft et al. 1997). No state endangered or threatened species were found (Herkert and Ebinger 2002).

Of 107 species encountered, 50 were recorded in the plots (Table 1). Of these, *Schizachyrium scoparium* (little bluestem) was the most plentiful, having a frequency of 100% and an IV of 24.6. *Sorghastrum nutans* (Indian grass) and *Bouteloua curtipendula* (side-oats grama) were second and third in importance with IVs of 22.9 and 20.3 respectively. These three prairie grasses were followed in importance by four common prairie forbs of

the Asteraceae: *Aster laevis* (smooth aster), *Silphium terebinthinaceum* (prairie dock), *Solidago nemoralis* (gray goldenrod), and *Coreopsis tripteris* (tall tickseed), all with IVs greater than 7.0 (Table 1). Nearly all herbaceous species encountered in the plots were prairie grasses and forbs that would be expected in a high quality hill prairie. As is typical of most glacial drift hill prairies, the extent of bare ground and litter was relatively high with a mean cover of 27.3% (Table 1).

Though 10 exotic species were found during the present study, only *Melilotus alba* (white sweet clover) and *Medicago lupulina* (black medic) were encountered in the plots, both with low IVs (Table 1). The remaining exotic species were restricted to disturbed habitats mostly at the forest edge. No exotic shrubs or trees were encountered in the plots, but *Elaeagnus umbellata* (autumn olive), *Rhamnus cathartica* (common buckthorn), and *Rosa multiflora* (multiflora rose) were occasionally encountered at the edges of the prairie. Other woody plants observed were mostly seedlings of native forest species, some being found in the plots (Table 1).

DISCUSSION

Windfall prairie is similar in species composition to other glacial drift hill prairies in east-central Illinois. Ebinger (1981) found many of the same prairie species in four small hill prairie remnants in Coles County. One of these hill prairies was recently studied by Owens and Cole (2003) with similar results but the size of the hill prairie had been greatly reduced by woody encroachment. More recently, Owens et al. (2006) reported a similar species composition for Coneflower glacial drift hill prairie in Moultrie County. In these studies generally two to four species of prairie grasses were among the dominants along with a number of common prairie forbs, including many members of the Asteraceae. Generally a few exotic herbaceous species were also encountered, usually in low numbers, as well as scattered shrubs and tree seedlings and saplings.

While sampling the glacial drift hill prairies in east-central Illinois, Ebinger (1981) also studied the flora of Windfall glacial drift hill prairie. In that study (Ebinger 1981) prairie grasses found were the same as in the present study, with *Sorghastum nutans* the dominant, followed by *Bouteloua curtipendula* and *Schizachyrium scoparium*. The common prairie forbs were similar, but differed in importance. *Silphium terebinthinaceum, Solidago nemoralis, and Aster laevis* were dominant species, *Coreopsis tripteris* was present, but not found in the plots during the original study. Other forbs that were commonly encountered in both studies were *Lithospermum canescens, Pedicularis canadensis, Phlox pilosa, Thaspium barbinode, Comandra umbellata, Blephilia ciliata, Liatris cylindracea, Linum sulcatum*, and *Chamaecrista fasciculata*. Ebinger (1981) reported the exotic *Melilotus alba* as being common (IV of 7.1) in 1977. This species is difficult to eradicate since the best management procedure is pulling the plants before fruit development. Presently *M. alba* is not common (IV of 1.2), the results of ongoing management.

Glacial drift hill prairies are created by soil slumping on steep slopes that exposes bare ground. This bare ground rapidly succeeds to prairie grasses and forbs. Steep slope, clay soil, and xeric conditions, particularly on south- and southwest-facing slopes, initially prevented the establishment of woody species. *Schizachyrium scoparium* is one of the early invaders on these sites (Vestal 1918). As soil organic material and soil stability

increases over time, other xeric prairie species are established. Later, woody encroachment occurs along the edges of the hill prairie and rapidly increases in extent and diversity, slowly eliminating transient hill prairie species. This woody encroachment proceeds relatively slowly at first, but rapidly increases as the hill prairie decreases in size (McClain and Anderson 1990, Robertson et al. 1995, Schwartz et al. 1997).

Removing woody and exotic forbs will be necessary to maintain Windfall hill prairie, which could rapidly disappear due to woody encroachment. McClain and Anderson (1990) found loess hill prairies were decreasing in size due to woody encroachment and that many had disappeared. Later, Schwartz et al. (1997) found that most hill prairies have diminished in size by more than 50% since 1940, with many of the smaller ones being eliminated. At Windfall hill prairie numerous large individuals of *Juniperus virginiana*, along with understory native and exotic trees and shrubs are common at the prairie/forest interface along with some woody individuals on the hill prairie. Periodically some of these woody species have been removed by the Illinois Department of Natural Resources and volunteers. Continued maintenance will be necessary to prevent the loss of this hill prairie.

ACKNOWLEDGEMENTS

We thank the Illinois Department of Natural Resources for permission to study the Windfall glacial drift hill prairie, and Dr. Gordon Tucker for his help in species identification, particularly members of the genus *Carex*.

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Table 1. Frequency (%), mean cover (% of total area), relative frequency, relative cover, and importance value (I. V.) of ground layer species at Windfall Prairie Nature Preserve, Vermilion County, Illinois. Also given is the I.V. of the species encountered during the earlier study during the growing season of 1977 (Ebinger 1981). (*exotic species)

Species	Freq.	Mean Cover	Rel. Freq.	Rel. Cover	I. V. 2006	I. V. 1977*
Schizachyrium scoparium	100	13.19	7.1	17.5	24.6	7.0
Sorghastrum nutans	90	12.43	6.4	16.5	22.9	29.6
Bouteloua curtipendula	94	10.36	6.6	13.7	20.3	10.4
Aster laevis	94	8.28	6.6	11.0	17.6	4.5
Silphium terebinthinaceum	64	7.82	4.5	10.4	14.9	16.0
Solidago nemoralis	70	2.75	5.0	3.6	8.6	13.0
Coreopsis tripteris	46	3.05	3.3	4.0	7.3	--
Lithospermum canescens	76	1.03	5.4	1.4	6.8	5.4
Pedicularis canadensis	32	3.31	2.3	4.4	6.7	6.6
Phlox pilosa	74	1.06	5.2	1.4	6.6	4.0
Carex spp.	50	2.20	3.5	2.9	6.4	--
Thaspium barbinode	62	1.20	4.4	1.6	6.0	10.6
Comandra umbellata	44	1.10	3.1	1.5	4.6	10.7
Liatris cylindracea	58	0.39	4.1	0.5	4.6	15.6
Blephelia ciliata	44	0.77	3.1	1.0	4.1	6.8
Linum sulcatum	48	0.24	3.4	0.3	3.7	8.1
Rudbeckia hirta	28	1.12	2.0	1.5	3.5	--
Rosa carolina	34	0.42	2.4	0.6	3.0	5.0
Dichanthelium acuminatum	28	0.49	2.0	0.6	2.6	--
Chamaecrista fasciculata	22	0.60	1.6	0.8	2.4	6.5
Lobelia spicata	28	0.19	2.0	0.3	2.3	2.7
Juniperus virginiana	26	0.13	1.8	0.2	2.0	5.5
Equisetum hyemale	22	0.16	1.6	0.2	1.8	7.0
Sisyrinchium albidum	18	0.09	1.3	0.1	1.4	1.0
Ostrya virginiana	10	0.44	0.7	0.6	1.3	--
Silphium integrifolium	10	0.49	0.7	0.6	1.3	--
Lactuca floridana	8	0.48	0.6	0.6	1.2	--
Lysimachia quadriflora	14	0.12	1.0	0.2	1.2	--
**Melilotus alba*	16	0.08	1.1	0.1	1.2	7.1
Parthenium integrifolium	8	0.48	0.6	0.6	1.2	1.8
Lespedeza virginica	12	0.16	0.8	0.2	1.0	2.2
Euphorbia corollata	12	0.11	0.8	0.1	0.9	1.9
Agalinis tenuifolia	10	0.05	0.7	0.1	0.8	3.7
Polygala verticillata	10	0.05	0.7	0.1	0.8	2.3
Antennaria plantaginifolia	8	0.09	0.6	0.1	0.7	--
Others **		0.62	3.4	0.7	4.1	5.0
Totals		75.52	100.0	100.0	200.0	200.0
Average bare ground and litter		27.31				

* The Importance Value obtained in 1977 was based on the sum of relative density and relative frequency (Ebinger 1981).

** 15 additional species were encountered in 2006 while 7 were tallied in 1977.

APPENDIX I.

Vascular plant species encountered at Windfall Prairie Nature Preserve, Vermilion, Illinois, are listed alphabetically by family under major plant groups. An asterisk indicates exotic (non-native) species. Collecting numbers preceded by an E were collected by John E. Ebinger those preceded by an O were collected by Nick Owens. Both are deposited in the Stover-Ebinger Herbarium, Eastern Illinois University, Charleston, Illinois (EIU). Six species were observed but not collected. (*exotic species)

FERN AND FERN-ALLIES
Equisteaceae
Equisetum arvense L.: O93
Equisetum hyemale L.: E16453

GYMNOSPERMS
Cupressaaceae
Juniperus virginiana L.: E32178

MONOCOTS
Amaryllidaceae
Hypoxis hirsuta (L.) Coville: O131

Cyperaceae
Carex blanda Dewey: E32134
Carex glaucodea Tuckerm.: E32131
Carex hirsutella Mack.: E16381
Carex pensylvanica Lam.: O175

Iridaceae
Sisyrinchium albidum Raf.: O136

Liliaceae
Allium canadense L.: O145
Polygonatum biflorum (Walt.) Ell.: E32128

Orchidaceae
Spiranthes cernua (L.) Rich: O110

Poaceae
Agrostis hyemalis (Walt.) BSP.: O105
Andropogon gerardii Vitman: O149
Bouteloua curtipendula (Michx.) Torr.: E16449
Brachyelytrum erectum (Roth.) P. Beauv.: O102
Danthonia spicata (L.) Roem. & Schultes: E32129
Dichanthelium acuminatum (Sw.) Gould & Clark: observed
Muhlenbergia tenuiflora (Willd.) BSP.: O101
**Poa compressa* L.: O107
**Poa pratensis* L.: E32130
Schizachyrium scoparium (Michx.) Nash: O87
Sorghastrum nutans (L.) Nash: O127

DICOTS
Aceraceae
Acer saccharum Marsh.: E32182

Apiaceae
Oxypolis rigidior (L.) Raf.: O100
Sanicula odorata Pryer & Phillippe: O133
Thaspium barbinode (Michx.) Nutt.: O92

Apocynaceae
Apocynum androsaemifolium L.: E16383

Asclepiadaceae
Asclepias tuberosa L.: E16368
Asclepias verticillata L.: E32184
Asclepias viridiflora Raf.: E16369

Asteraceae
Ageratina altissima (L.) King & Robins.: O89
Antennaria plantaginifolia (L.) Hook.: E32137
Aster laevis L.: E16944
Aster novae-angliae L.: O95
Aster oolentangiensis Riddell: O121
Aster pilosus Willd.: O98
Bidens aristosa (Michx.) Britt.: O152
Coreopsis tripteris L.: E16459
Echinacea pallida (Nutt.) Nutt.: E16367
Erigeron strigosus Muhl.: E16364
Eupatorium altissimum L.: O114
Heliopsis helianthoides (L.) Sweet: O153
Krigia biflora (Walt.) Blake: E32139
Lactuca floridana (L.) Gaertn.: observed
**Leucanthemum vulgare* Lam.: E32140
Liatris cylindracea Michx.: O128
Liatris pycnostachya Michx.: E32180
Oligoneuron riddellii (Frank) Rydb.: O88
Parthenium integrifolium L.: O111
Prenanthes alba L.: O115
Ratibida pinnata (Vent.) Barnh.: O146

Rudbeckia hirta L.: O120
Silphium integrifolium Michx.: O126
Silphium terebinthinaceum Jacq.: observed
Solidago caesia L.: O104
Solidago nemoralis Ait.: O119
Solidago ulmifolia Muhl.: O103

Boraginaceae
Lithospermum canescens (Michx.) Lehm.: O132

Brassicaceae
**Barbarea vulgaris* R. Br.: O144

Caesalpiniaceae
Cercis canadensis L.: O109
Chamaecrista fasciculata (Michx.) Greene: O117

Campanulaceae
Lobelia spicata Lam.: O116

Celastraceae
Celastrus scandens L.: E32141

Convolvulaceae
Calystegia spithamaea (L.) Pursh: E32142

Cornaceae
Cornus florida L.: O90

Corylaceae
Ostrya virginiana (Mill.) K. Koch: E32181

Elaeagnaceae
**Elaeagnus umbellata* Thunb.: O112

Euphorbiaceae
Euphorbia corollata L.: E16372

Fabaceae
Amorpha canescens Pursh: E16371
Dalea purpurea Vent.: E16451
Lespedeza virginica (L.) Britt.: E16452
**Medicago lupulina* L.: O150
**Melilotus alba* Medic.: O129
**Melilotus officinalis* (L.) Pallas.: E16370

Fagaceae
Quercus imbricaria Michx.: E32179
Quercus velutina Lam.: observed

Gentianaceae
Gentianella quinquefolia (L.) Small: O148

Grossulariaceae
Ribes missouriense Nutt.: E32144

Lamiaceae
Blephelia ciliata (L.) Bernh.: E16379
Prunella vulgaris L.: O99
Pycnanthemum tenuifolium Schrad.: O147
Pycnanthemum virginianum (L.) Dur. & B.D. Jacks.: O96

Linaceae
Linum sulcatum Riddell: E16454

Plantaginaceae
Plantago rugelii Decne.: O106

Polemoniaceae
Phlox divaricata L.: O134
Phlox pilosa L.: E16378

Polygalaceae
Polygala verticillata L.: observed

Portulacaceae
Claytonia virginica L.: O130

Primulaceae
Lysimachia quadriflora Sims: O94

Ranunculaceae
Aquilegia canadensis L.: O139

Rhamnaceae
**Rhamnus cathartica* L.: E32146

Rosaceae
Fragaria virginiana Duchesne: observed
Potentilla simplex Michx.: O142
Rosa carolina L.: O125
**Rosa multiflora* Thunb.: E32147
Rubus flagellaris Willd.: E32149
Rubus pensilvanicus Poir.: E32148
Rubus occidentalis L.: E32150

Rubiaceae
Galium aparine L.: O151
Galium circaezans Michx.: E16376

Santalaceae
Comandra umbellata (L.) Nutt.: O122

Scrophulariaceae
Agalinis tenuifolia (Vahl) Raf.: E16455
Castilleja coccinea (L.) Spreng.: E16374
Pedicularis canadensis L.: O141
Penstemon digitalis Nutt.: E32151

Violaceae
Viola sororia L.: O135