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Paul R. Wetzel
Iowa State University

William R. Norris
Iowa State University

Kevin M. Lyles
Iowa State University

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The Vascular Flora of Doolittle Prairie State Preserve— A Prairie Pothole Wetland Complex

PAUL R. WETZEL¹, WILLIAM R. NORRIS¹, and KEVIN M. LYLES²

¹Department of Botany, Iowa State University, Ames, IA 50011-1020

²Department of Landscape Architecture, Iowa State University, Ames, IA 50011-1020

Doolittle Prairie State Preserve is a 10 ha prairie pothole wetland complex located in Story County, central Iowa. A vascular flora of Doolittle Prairie is compiled and the prominent vegetation communities and zones described based on field observations by the authors and several additional investigators from 1982 to 1997. The preserve contains 14 shallow wetlands comprised of low prairie, wet meadow, and shallow emergent plant communities, as well as a disturbed prairie community and fence rows. These communities support a diverse vascular flora of 223 native species, plus 42 non-natives, representing 59 families and 178 genera. The Asteraceae (40), Poaceae (24), and Cyperaceae (22) families contained the greatest number of native plant species. The low prairie community has the highest number of species (104) and the greatest species overlap with the disturbed prairie and wet meadow communities. The fence row/parking area community contains the second highest number of species (101) and the greatest number of non-natives (33), with 78% of the species restricted to that community. Species number decreased in communities with increasing soil moisture. The wet meadow (46 species) and shallow emergent (14 species) communities contained the lowest number of species. A quantitative comparison of floristic composition was made between Doolittle Prairie and three other Iowa state preserves of similar size and vegetation community types. Floristic similarity between Doolittle Prairie and the other preserves ranged from 35–39%.

INDEX DESCRIPTORS: Doolittle Prairie State Preserve, Iowa flora, prairie pothole, plant communities, Story County.

The recently glaciated area of central Iowa known as the Des Moines Lobe is relatively flat, contains extremely rich soils, and is one of the most intensively cultivated areas in the world. Much of this area originally consisted of shallow prairie wetlands or "potholes" that were subsequently drained or ditched for agricultural purposes. Doolittle Prairie State Preserve is one of the few remaining prairie pothole wetland complexes in the Des Moines Lobe, and it retains a diverse assemblage of wet prairie and wetland plants.

Knowledge of native plant diversity and community structure is critical, particularly with increased interest and attempts to restore prairie and wetland habitats. Many of Iowa's state preserves containing prairie vegetation communities lack even a description of the vascular flora. Of the 28 state preserves that contain significant prairie areas (Fleckenstein 1992), only eight (29%) have published floras. Larger, contiguous preserves are expected to contain greater plant diversity, and yet, of the 13 prairie state preserves with an area of 36 ha or greater, only five (38%) have published floras.

In this paper, we present a species list of vascular plants and describe the vegetative communities/vegetation zones of Doolittle Prairie. Data from floristic surveys and plant collections of the authors and previous workers since 1982 were compiled and combined with a comprehensive vegetation survey conducted during the 1997 growing season. Portions of Doolittle Prairie have not been plowed, and thus, the species list and community descriptions provide useful baseline information for pre-European settlement prairie wetland vegetation.

STUDY AREA

Doolittle Prairie State Preserve is a 10 ha prairie pothole complex located in Story County, approximately 11 km north of Ames and 2 km south of Story City (NE 1/4 of section 25 in T85N R24W, La

Fayette Township) (Fig. 1). The preserve occupies the northern half of the Doolittle Prairie conservation area (Fig. 2). The area of the preserve north of the fence row contains plant communities with the greatest diversity and the least number of non-native species. The area of the preserve south of the fence row is disturbed and aerial photographs indicate that about half of the land west of the wetlands was plowed after 1958 and before 1965. Plowing was not evident on successive aerial photographs. The public land south of the preserve is highly disturbed; this area was cultivated for a longer time period and the hydrology of one of the wetlands was modified with a low berm. A narrow strip of land adjacent to the access road is reconstructed prairie (Fig. 2). The preserve and reconstructed prairie area adjacent to the access road are the areas surveyed for this study.

The prairie wetlands at Doolittle Preserve were formed during the Wisconsin glacial episode 14,000 years ago. An intricate array of cavities and tunnels formed in the glacier as it melted. Eventual collapse of these cavities led to the development of shallow upland swales and depressions (prairie wetlands) separated by low, saddle-like ridges formed from glacial debris (Prior 1991).

Doolittle Prairie is on the southern edge of the prairie pothole region in North America and soil maps suggest that at the time of settlement wetlands covered 20–60% of central and northern Iowa, depending on topography and natural drainage patterns (Galatowitsch and van der Valk 1994). Doolittle Prairie contains 14 saucer-like wetlands, interconnected with shallow vegetated drainage channels (Fig. 2). The flat topography and simple, undeveloped natural drainage system of the surrounding area suggest that wetlands covered a large portion of the presettlement landscape surrounding Doolittle Prairie State Preserve. This observation is confirmed by aerial photographs taken in 1939 (Reviewed at Farm Service Agency, Story County).

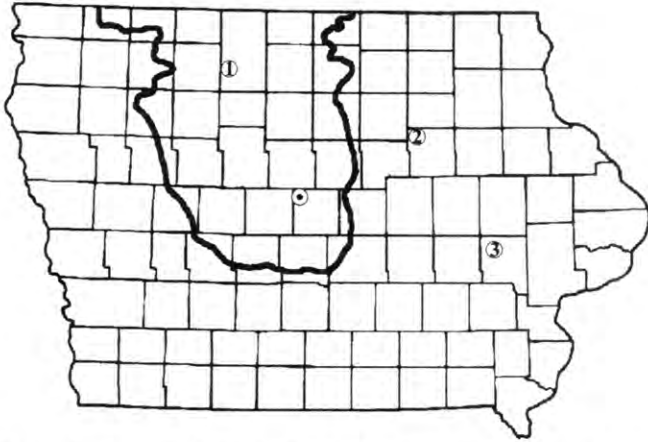


Fig. 1. Location of Doolittle Prairie Preserve (⊙) and three similar preserves (1=Stinson Prairie, 2=Cedar Hills Sand Prairie, 3=Williams Prairie) used for floristic comparison. The boundary of the Des Moines Lobe designates the extent of glacial advances and the prairie pothole region in Iowa.

Soils at Doolittle Prairie are classified as a Kossuth-Ottosen association, mineral soils composed of silty clay loam (DeWitt 1984). The swales and depressions contain very poorly drained Okoboji soils (pH 6.6–7.8), surrounded by calcareous Harps soils (pH 7.9–8.4). The wetlands are imbedded in level, poorly drained, upland flats composed of Kossuth soils. Poorly drained Ottosen soils are found on the slight topographic rises (DeWitt 1984).

The climate for central Iowa is midcontinental with hot humid summers and cold dry winters. Winter (December through February) average temperature is -6°C with an average daily minimum of -11°C . Summer (June through August) average temperature is 22°C and average daily maximum is 29°C . The frost-free growing season averages 151 days and the mean annual precipitation is 797 mm, of which 60% falls as rain from May to September (Bair 1992). The prevailing wind is from the northwest. Summer weather is characterized by thunderstorms often associated with high winds and occasional hailstorms and tornados (DeWitt 1984).

Settlement History

William Rochester and Fidelia Electa Doolittle came to Story County in 1855, as some of the area's earliest settlers. They built a farmstead northeast of the preserve area, and eventually the preserve area was part of their 405 ha land holding at the time of William R. Doolittle's death in 1893 (S. Lekwa, personal communication). The site was not plowed, presumably because of its wetness. Merlin and Wesley Doolittle, grandchildren of William R. Doolittle, farmed the land adjacent to the current preserve, but the sentimental value of their grandfather's original homestead prevented them from draining and plowing the area of the preserve. However, hay was harvested from the "wild meadow" until the late 1960s. When the market for "wild hay" declined, the land was sold to the state and became a preserve in 1980. Currently, the Story County Conservation Board manages the preserve and alternately burns half of the prairie every 2–3 years (S. Lekwa, personal communication).

METHODS

Collections of the vascular plants of Doolittle Prairie Preserve are based on field studies conducted by the authors and several additional investigators from 1982 to present. Greg R. Woodley catalogued the vascular flora (excluding the parking area and fence rows) during the

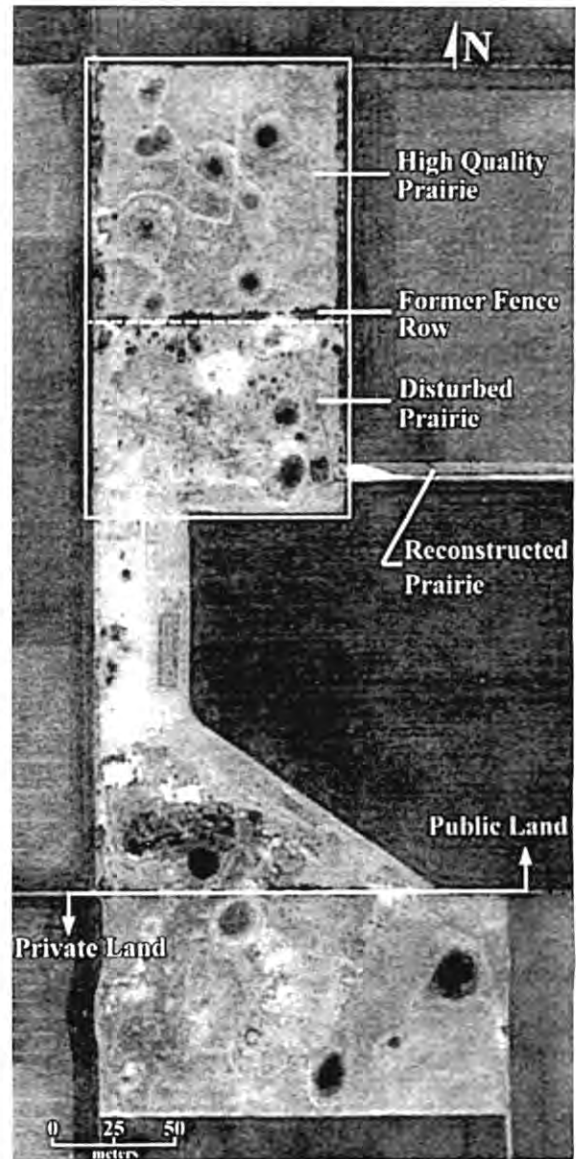


Fig. 2. Aerial view of Doolittle Prairie conservation area indicating prairie potholes, shallow vegetated drainage channels between wetlands, and surrounding land use. The rectangle outlines Doolittle Prairie State Preserve. The preserve and reconstructed prairie area adjacent to the access road are the areas covered by the survey. Prairie plant community diversity ranges from high quality to degraded condition in the conservation area. See text for land use history.

1982 and 1983 growing seasons (Woodley 1983). Lynn Clark collected many of the graminoids found in the preserve during the late 1980s. Further collections were made by the authors on an intermittent basis from 1991 through 1996. During 1997, the authors conducted biweekly surveys of the preserve and land adjacent to the access road from late April to early October. The plant species recorded during the 1997 survey were combined with the previous collections and compiled into an annotated catalogue (Appendix I). The nomenclature of all plant species follows Eilers and Roosa (1994). The plant species were also classified into five communities/vegetation zones: fence rows/parking area, disturbed prairie, low prairie, wet meadow, and shallow emergent wetland community. The

number of species exclusive to each community and species overlap among communities were calculated.

To place the flora of Doolittle Prairie State Preserve into context with other wet prairie remnants in Iowa, the percent floristic similarity was calculated between Doolittle Prairie and three other preserves of similar size containing wet prairie. These were Stinson Prairie (Kossuth County; Glenn-Lewin 1976), Cedar Hills Sand Prairie (Black Hawk County; Crum 1972), and Williams Prairie (Johnson County; Sorenson, 1962) (Fig. 1). Wetlands and swales cover at least 50% of the area of each of these preserves. For meaningful comparisons, preserves of similar area were chosen to avoid potential confounding effects of the species-area relationship (number of species increases with increasing area) (Hayek and Buzas 1997). Floristic similarities were calculated using Sorensen's Index of Similarity:

$$\text{Index of Similarity (\%)} = C / (N_1 + N_2 - C) * 100$$

where C = number of native species in common, N_1 = number of native species in the first flora, and N_2 = number of native species in the second flora (Greig-Smith 1964).

RESULTS AND DISCUSSION

An annotated checklist of vascular plants collected from the Doolittle Prairie State Preserve is presented in Appendix I. There are 223 native (218 native species if the reconstructed prairie adjacent to access road is excluded) and 42 non-native species, representing 59 families documented at Doolittle Prairie (Table 1). Doolittle Prairie contains 13% of the species present in the total flora of the State of Iowa (Eilers and Rosa 1994). By major groups, 60 native and 13 non-native species and 35 native genera are monocotyledons and 158 native and 29 non-native species and 111 native genera are dicotyledons. Families with the greatest number of native species are: Asteraceae (40), Poaceae (24), Cyperaceae (22), and Rosaceae (13) (Table 1). Forty-one genera are represented by two or more species, with *Carex* (19), *Asclepias* (5), and *Aster* (5) having the greatest number of native species (Table 1). No federal or state threatened or endangered species were found in Doolittle Prairie.

The plant species list in Appendix I is a compilation of several collection efforts, and the collector history for each species is designated. Woodley surveyed only the northern half of the preserve and the other collectors made sporadic species surveys. Since the effort and aerial coverage of each survey was different, a direct comparison of the efficiency of the surveys is not possible. However, it is possible to determine the presence of plant populations through time. Of the species recorded by Woodley in 1982-83, 94% (134 out of 142) were also found during this study. Many of the species found by Woodley, but not in the current study—*Lactuca ludoviciana*, *L. serriola*, *Stachys tenuifolia*, *Cirsium hillii*, *Ranunculus abortivus*, and *Galium tinctorium*—often resemble other members of their genera, thus making discovery of these plants difficult. In addition, some species simply may not be present under the environmental conditions during which the current survey was conducted.

Vegetation Communities

Five vegetation zones or communities occur in Doolittle Prairie: fence row/parking area, disturbed prairie, low prairie, wet meadow (sedge meadow), and shallow emergent. The community classification of each species is given in Appendix I. Fence rows are found on the perimeter and through the middle of the preserve (the fence row through the middle of the preserve was removed in 1998). The fence rows and parking area are primarily upland. Fence row vegetation is dominated by *Cornus drummondii*. Early successional species occur around the edges of the preserve and in the parking area of the preserve. In the early 1980s, a strip of prairie vegetation was planted

Table 1. Floristic composition of Doolittle Prairie State Preserve.

MAJOR GROUPS	SPECIES		GENERA	
	NATIVE	NON-NATIVE	NATIVE	NON-NATIVE
Pteridophytes	4	0	2	0
Gymnosperms	1	0	1	0
Monocotyledons	60	13	35	8
Dicotyledons	158	29	111	21
Total	223	42	149	29

FAMILY	NON-NATIVE		TOTAL
	NATIVE	NON-NATIVE	
Asteraceae	40	4	44
Poaceae	24	12	36
Cyperaceae	22	0	22
Fabaceae	11	6	17
Rosaceae	13	1	14

GENERA	NON-NATIVE		TOTAL
	NATIVE	NON-NATIVE	
<i>Carex</i>	19	0	19
<i>Polygonum</i>	4	2	6
<i>Asclepias</i>	5	0	5
<i>Aster</i>	5	0	5
<i>Cirsium</i>	3	2	5
<i>Galium</i>	4	0	4
<i>Solidago</i>	4	0	4
<i>Viola</i>	4	0	4

adjacent to the preserve access road on formerly cultivated land (C. Kurtz, personal communication) (Fig. 2). Native plants found only in this area are designated in Appendix I with a '+'.

The southern half of the preserve is a disturbed prairie community (Fig. 2). Approximately half of the southern half of the preserve was plowed around 1965 and contains large populations of *Bromus inermis* and *Pastinaca sativa*. Large populations of *Phalaris arundinacea* are also present in the wetlands.

Wetlands in the preserve contain two or three vegetation zones, which we have loosely designated as communities. The low prairie community is dominated by the grasses *Andropogon gerardii*, *Panicum virgatum*, *Poa pratensis*, *Sporobolus heterolepis*, *Sorghastrum nutans*, and *Spartina pectinata*. Other common plants include *Solidago canadensis*, *Silphium laciniatum*, and *Zizia aurea*. The soil of this vegetation zone is often inundated in the spring with 1-3 cm of standing water, but usually dries completely by mid-summer. During drought periods, the low prairie community remains dry all year, occasionally for several years. Upland plant species may invade at this time, until the water table rises and the wet prairie plants again dominate.

The wet meadow vegetation community is dominated by sedges such as *Carex haydenii*, *C. lanuginosa*, and *C. sartwellii*, and also includes *Calamagrostis canadensis*, *Stachys palustris*, and *Lycopus americanus*. Sedge meadows generally have a temporary water regime, with 5-30 cm of standing water that recedes by mid-summer. During the wet summer of 1993, these zones remained flooded with a water

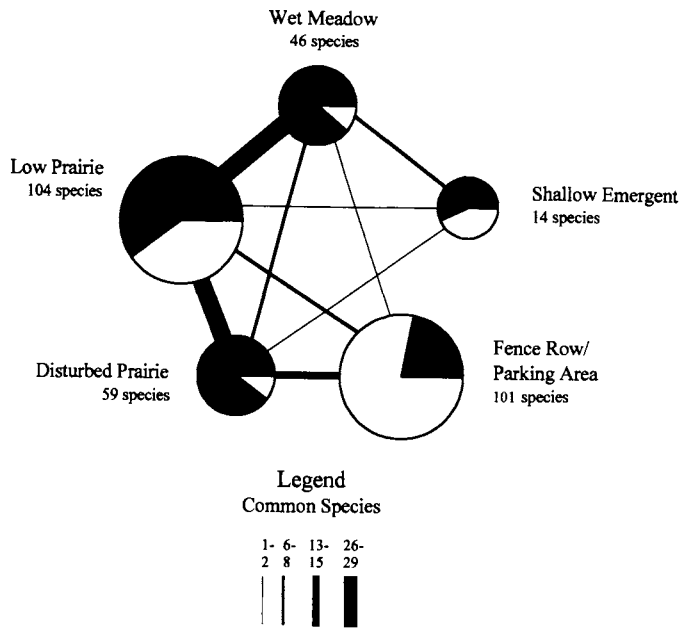


Fig. 3. Total number of species per community/vegetation zone (circles) and overlap with other communities (connecting lines). The proportion of species exclusive to a community is left white, proportion of species shared with other communities is shaded black.

depth of 5 to 16 cm throughout the growing season (Wetzel and van der Valk 1996).

The shallow emergent community has standing water up to 40 cm throughout most of the summer (seasonal wetlands). Only four of the potholes at Doolittle Prairie have small shallow emergent communities (or zones). In 1996, the shallow emergent zone in all four wetlands was completely dry during July, August, and September. Typical vegetation in this zone includes: *Scirpus heterochaetus*, *Alisma plantago-aquatica*, *Polygonum amphibium*, *Sagittaria brevirostra*, *Carex vesicaria*, and *C. atherodes*. During wet years, this zone also contains submergent species such as *Ranunculus flabellaris*, *Utricularia vulgaris*, and a liverwort, *Riccia fluitans*.

Species organization among communities is illustrated in Figure 3. The low prairie community has the highest number of species (104) and the greatest species overlap with the disturbed prairie and wet meadow communities. Forty-two percent of the species were exclusive to the low prairie community.

The fence row/parking area community contains the second highest number of species (101) and the greatest number of non-natives (33) (Fig. 3). Seventy-eight percent of the species in the fence rows and parking area community are restricted to that community, and species overlap is moderate with the disturbed prairie community, small with the low prairie and wet meadow, and non-existent with the shallow emergent community (Fig. 3). The fence rows and parking area tend to be drier than the other communities, resulting in a higher number of species found exclusively in this community.

Species number decreases in communities with increased soil moisture. The wet meadow (46 species) and shallow emergent (14 species) communities contained the lowest number of species. The wet meadow community is clearly a transition community between low prairie and shallow emergent, containing only five exclusive species and having a large overlap with the low prairie (Fig. 3). When present, species overlap between the shallow emergent community and all other communities is minimal.

Hydrology is the major factor that determines the plant species distribution and vegetation zonation in the wetlands of the preserve. In response to annual and multiple year water fluctuations, plant species form concentric vegetation zones or communities along the hydrologic gradient (Stewart and Kantrud 1971, van der Valk and Welling 1988). During high water periods, flooding drowns the emergent vegetation, creating gaps in the vegetation. Periods of low water expose the gaps as mud flats, providing an opportunity for seeds in the seed bank to germinate, thus assuring long-term survival of these emergent species (van der Valk and Davis 1980).

Invasion by non-native (*Bromus inermis*) and aggressive native species (*Typha latifolia* and *Phalaris arundinacea*) are the greatest management challenge at Doolittle Prairie Preserve. Control of weedy species is difficult because intensive agriculture surrounding the preserve and disturbed prairie and fence row/parking area vegetation communities provide high levels of nutrients and seed sources into the preserve. Direct herbicide application on *Typha* and *Phalaris* populations and planting native species in the disturbed prairie area combined with a frequent burn schedule are recommended to control these species populations. The removal of fence rows would eliminate woody vegetation seed sources, although it should be noted that fence rows provide important habitat for a variety of uncommon bird species that are summer residents at Doolittle, including Bell's Vireo (*Vireo bellii*) and Willow Flycatcher (*Empidonax traillii*) (W. Norris, personal observation).

Expanding the preserve 10–12 ha would also improve the vegetation communities. Currently, four prairie potholes straddle the preserve boundaries while three cultivated wetlands immediately to the east of the preserve flood nearly every year. Increasing the boundaries

Table 2. Size, location, and species composition of four wet prairies used in the floristic analysis.

NAME	SIZE (ha)	LOCATION (county)	TOTAL NATIVE SPECIES	NO. OF NATIVE SPECIES IN COMMON (Floristic Similarity, %)
Doolittle Prairie	10	Story	223	—
Stinson Prairie ^a	12.5	Kossuth	153	103 (39)
Cedar Hills Sand Prairie ^b	14.6	Black Hawk	257	128 (35)
Williams Prairie ^c	12	Johnson	213	106 (37)

^aGlenn-Lewin 1976

^bCrum 1972

^cSorensen 1962

of the preserve and restoring native vegetation would save the existing wetlands and reduce the invasion of weedy species into the high quality prairie.

Floristic Analysis

The floristic composition of Doolittle Prairie was compared to the published surveys of three other wet prairie preserves: Stinson Prairie (Glenn-Lewin 1976), Cedar Hills Sand Prairie (Crum 1972), and Williams Prairie (Sorenson 1962) (Table 2). Stinson Prairie is located in northern central Iowa on the Des Moines Lobe (Fig. 1). In addition to swales and potholes, the preserve contains dry and mesic prairie vegetation types. Both Cedar Hills Sand Prairie and Williams Prairie are located in the east central portion of the state, outside of the Des Moines Lobe on the Iowan Surface (Fig. 1). In addition to potholes and swales, Cedar Hills Sand Prairie contains a ridge of excessively drained eolian sand that supports dry and mesic prairie vegetation. Williams Prairie is a wet meadow dominated by sedges located on the Iowa River floodplain.

The floristic similarity of Doolittle Prairie to the other three prairies was similar, ranging from 35–39% reflecting a low level of floristic commonness among any of these prairie preserves (Table 2). Such a low level of common native plants suggests that these prairie preserves together contain a tremendous amount of plant diversity, despite their small size. The floristic analysis indicates that single preserves do not possess the entire realm of prairie species diversity and that multiple preserves or conservation areas are needed to encompass the complete prairie flora. Iowa's state preserves and conservation areas form the foundation of native plant diversity preservation in a state that is almost completely privately owned and dominated by agricultural land use. For this reason, the state preserves are a valuable resource and deserve continued protection, maintenance, and study.

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APPENDIX I. ANNOTATED CATALOGUE

Common names are given in parentheses after the binomial. Voucher specimens of each species are deposited in the Ada Hayden Herbarium (ISC) at Iowa State University, Ames, unless otherwise noted.

Key

- ! Introduced species
 + Native species found only in planted area along access road
 * Not vouchered
 C = current study (1991–1997)
 W = Woodley (1982–1983)
 O = other recent collectors (1987–1997)

Plant Community Codes

- 1 = Fence row/parking area
 2 = Disturbed prairie
 3 = Low prairie
 4 = Wet meadow
 5 = Shallow emergent

PTERIDOPHYTES

EQUISETACEAE (Horsetail Family)

- Equisetum arvense* L. (common horsetail) O *
Equisetum X ferrissii Clute (hybrid-scouring rush) C, W [3]
Equisetum laevigatum A. Br. (smooth-scouring rush) C, W [2, 3]

OPHIIOGLOSSACEAE (Adder's Tongue Family)

- Botrychium virginianum* (L.) Sw. (rattlesnake fern) C * [1]

GYMNOSPERMS

CUPRESSACEAE (Cypress Family)

- Juniperus virginiana* L. (red cedar) C, W * [1]

ANGIOSPERMS

(DICOTYLEDONS)

ACERACEAE (Maple Family)

- Acer negundo* L. (box elder) C * [1]
Acer saccharinum L. (silver maple) C, W * [1]

AMARANTHACEAE (Amaranth Family)

- Amaranthus rudis* Sauer (amaranth) C [1]

ANACARDIACEAE (Cashew Family)

Toxicodendron radicans (L.) Kuntze (poison ivy) C [1, 2]

APIACEAE (Parsley Family)

Cicuta maculata L. (water hemlock) C, W [3, 4]
Eryngium yuccifolium Michx. (rattlesnake master) C, W * [3]
Osmorbiza longistylis (Torrey) DC. (anise root) C * [1]
Oxypolis rigidior (L.) Raf. (cowbane) C, W [4]
 !*Pastinaca sativa* L. (wild parsnip) C, W [2, 3]
Sanicula canadensis L. (black snakeroot) C [1]
Sanicula gregaria Bickn. (common snakeroot) C [1]
Sium suave Walter (water parsnip) C, W * [4]
Zizia aurea (L.) Koch (golden alexander) C, W [2, 3]

APOCYNACEAE (Dogbane Family)

Apocynum cannabinum L. (Indian hemp) C, W [2, 3, 4, 5]
Apocynum sibiricum Jacq. C [2, 3]

ASCLEPIADACEAE (Milkweed Family)

Asclepias incarnata L. (marsh milkweed) C, W [2, 3, 4]
Asclepias sullivantii Engelm. ex Gray (Sullivant's milkweed) C, W [2]
Asclepias syriaca L. (common milkweed) C, W [2, 3]
Asclepias tuberosus L. ssp. *interior* Woodson (butterfly milkweed) C, W [3]
Asclepias verticillata Raf. (whorled milkweed) C, W [2]

ASTERACEAE (Aster Family)

Achillea millefolium L. ssp. *lanulosa* (Nutt.) Piper (yarrow) C, W [2, 3]
Ambrosia artemisiifolia L. (common ragweed) C, W * [1, 2]
Ambrosia trifida L. (giant ragweed) C, W * [1, 2]
 !*Antennaria neglecta* Greene (pussy toes) C [3]
Artemisia ludoviciana Nutt. (prairie sage) C, W [3]
Aster ericoides L. (heath aster) C, W [2, 3]
Aster laevis L. (smooth aster) C, W [3]
Aster lanceolatus Willd. var. *simplex* (Willd.) A.G. Jones (panicked aster) C, W [3, 4]
 +*Aster novae-angliae* L. (New England aster) C, W
Aster pilosus Willd. (frost aster) C [2, 3]
Bidens vulgata Greene (tall beggar ticks) C [2]
 +*Brickellia eupatorioides* (L.) Shinners (false boneset) C
Cacalia plantaginea (Raf.) Shinners (Indian plantain) C, W [3]
Cirsium altissimum (L.) Sprengel (tall thistle) C, W [2]
 !*Cirsium arvense* (L.) Scop. (Canada thistle) C * [2]
Cirsium discolor (Muhl. ex Willd.) Sprengel (field thistle) C, W * [2]
Cirsium hillii (Canby) Fern. (Hill's thistle) W
 !*Cirsium vulgare* (Savi) Tenore (bull thistle) C, O * [2, 3]
Echinacea pallida Nutt. (pale purple coneflower) C, W [3]
Erechtites hieracifolia (L.) Raf. ex DC. (fireweed) C [1]
Erigeron annuus (L.) Pers. (daisy fleabane) C [1]
Erigeron strigosus Muhl. ex Willd. (rough fleabane) C, W [1, 2, 3]
 +*Eupatorium altissimum* L. (tall boneset) C
Helenium autumnale L. (sneezeweed) C, W [3, 4]
Helianthus grosseserratus Martens (saw-toothed sunflower) C, W [3]
Helianthus rigidus (Cass.) Desf. (stiff sunflower) C, W [3, 4]
Heliopsis helianthoides (L.) Sweet (ox-eye) C, W, O [3]
Lactuca canadensis L. (wild lettuce) C [2]
Lactuca ludoviciana (Nutt.) Riddell (prairie lettuce) W *
 !*Lactuca serriola* L. (prickly lettuce) W *

+*Liatris aspera* Michx. (rough blazing-star) C, W
Liatris pycnostachya Michx. (prairie blazing star) C, W [3, 4]
Prenanthes racemosa Michx. (glaucous white lettuce) C, W [4]
Ratibida pinnata (Vent.) Barnh. (grey-headed coneflower) C, W [2, 3]
Rudbeckia hirta L. (black-eyed Susan) C, W [2, 3]
Senecio plattensis Nutt. (prairie ragwort) C, W [3]
Silphium laciniatum L. (compass plant) C, W [3]
Solidago canadensis L. (Canada goldenrod) C, W [2, 3]
Solidago gigantea Aiton (tall goldenrod) C, W [2, 3]
Solidago riddellii Frank ex Riddell (Riddell's goldenrod) C * [3, 4]
Solidago rigida L. (stiff goldenrod) C, W [3]
 !*Taraxacum officinale* Weber (dandelion) C, W [1]
 !*Tragopogon dubius* Scop. (goat's beard) C, W [1]
Vernonia fasciculata Michx. (western ironweed) C, W [3, 4]

BORAGINACEAE (Borage Family)

Hackelia virginiana (L.) I.M. Johnston (stickseed) C [1]
Lithospermum canescens (Michx.) Lehm. (hoary puccoon) C, W [3]

BRASSICACEAE (Mustard Family)

Arabis hirsuta (L.) Scop. (rock cress) C, W [1,3]
 !*Capsella bursa-pastoris* (L.) Medicus (shepard's purse) C [1]
Cardamine bulbosa (Schreber) BSP. (spring cress) C, W * [1]
 !*Lepidium densiflorum* Schrader (pepper grass) C [1]
Rorippa palustris (L.) Besser (marsh cress) C [4]

CAMPANULACEAE (Bluebell Family)

Lobelia spicata Lam. (pale spike lobelia) C, W [3]

CAPRIFOLIACEAE (Honeysuckle Family)

!*Lonicera maackii* Maxim. C [1]
Sambucus canadensis L. (elderberry) C, O * [1]

CARYOPHYLLACEAE (Pink Family)

!*Silene pratensis* (Raf.) Gren. & Godron (white campion) O [1]

CELASTRACEAE (Wahoo Family)

Euonymus atropurpureus Jacq. (wahoo) C [1]

CHENOPODIACEAE (Goosefoot Family)

!*Chenopodium album* L. (lamb's quarters) C [1]

CONVOLVULACEAE (Morning Glory Family)

Calystegia sepium (L.) R. Br. (bindweed) C, W [1]

CORNACEAE (Dogwood Family)

Cornus drummondii C.A. Meyer (rough-leaved dogwood) C, O [1, 2]

EUPHORBIACEAE (Spurge Family)

Acalypha virginica L. C [1]
Euphorbia nutans Lag. (nodding spurge) C [1]

FABACEAE (Bean Family)

Amorpha canescens Pursh (lead plant) C, W [3]
Baptisia bracteata Muhl. ex Ell. var. *glabrescens* (Larisey) Isely (cream wild indigo) W [3]
 +*Baptisia lactea* (Raf.) Thieret (white wild indigo) C
Dalea purpurea Vent. (purple prairie clover) C * [3]
Desmodium canadense (L.) DC. (showy tick-trefoil) C, W [3]
Gleditsia triacanthos L. (honey locust) C * [1]
Glycyrrhiza lepidota Pursh (wild licorice) O *
Lathyrus palustris L. (marsh vetchling) C, W [3]
Lespedeza capitata Michx. (round-headed bush clover) C, W [3]
 !*Medicago lupulina* L. (black medic) C [1]

¹ Discovered just prior to publication and not included in floristic similarity analysis.

- ! *Medicago sativa* L. (alfalfa) C [1, 2]
 ! *Melilotus alba* Medicus (white sweet clover) C, W [1, 2]
 ! *Melilotus officinalis* (L.) Pallas (yellow sweet clover) C, W [1, 2]
 ! *Pedimelum argophylla* (Pursh) Grimes (silvery scurf pea) C, W [3]
 ! *Trifolium pratense* L. (red clover) C, W [1, 2]
 ! *Trifolium repens* L. (white clover) C * [1, 2]
Vicia americana Muhl. ex Willd. (vetch) C, W [3]
- GENTIANACEAE** (Gentian Family)
Gentiana andrewsii Griseb. (bottle gentian) C, W [3, 4]
Gentiana puberulenta J. Pringle (downy gentian) C * [3]
- LAMIACEAE** (Mint Family)
Lycopus americanus Muhl. ex Barton (water horehound) C, W [2, 4]
Monarda fistulosa L. (horsemint) C, W [1, 3]
 ! *Nepeta cataria* L. (catnip) C * [1]
 ! *Prunella vulgaris* L. (self heal) C, W [1]
Pycnanthemum virginianum (L.) Dur. & Jackson (Virginia mountain mint) C, W [3, 4]
Scutellaria leonardii Epling (skullcap) C, W [3]
Stachys palustris L. (woundwort) C, W [4]
Stachys tenuifolia Willd. var. *hispida* (Pursh) Fern. (hedge nettle) W
Teucrium canadense L. (American germander) C, W [1]
- LENTIBULARIACEAE** (Bladderwort Family)
Utricularia vulgaris L. (common bladderwort) C * [5]
- LYTHRACEAE** (Loosestrife Family)
Ammannia coccinea Rottb. (toothcup) C [1]
Lytbrum alatum Pursh (winged loosestrife) C, W, O [3, 4]
- MALVACEAE** (Cheese Family)
 ! *Abutilon theophrasti* Medicus (velvet leaf) C [1]
- MORACEAE** (Mulberry Family)
 ! *Cannabis sativa* L. (hemp) C, W [2]
 ! *Morus alba* L. (white mulberry) C [1]
- ONAGRACEAE** (Evening Primrose Family)
Epilobium coloratum Biehler (cinnamon willow herb) C, W [3, 4]
Ludwigia polycarpa Short & Peter (false loosestrife) C [5]
- OXALIDACEAE** (Wood-sorrel Family)
Oxalis stricta L. (yellow wood sorrel) C, W [2]
Oxalis violacea L. (violet wood sorrel) C [3]
- PHRYMACEAE** (Lopseed Family)
Phryma leptostachya L. (lopseed) C * [1]
- PLANTAGINACEAE** (Plantain Family)
Plantago rugelii Dcne. (common plantain) C [1, 2]
- POLEMONIACEAE** (Phlox Family)
Phlox pilosa L. (prairie phlox) C, W [3, 4]
- POLYGONACEAE** (Smartweed Family)
Polygonum achoreum Blake C [1]
Polygonum amphibium L. var. *emersum* Michx. (water smartweed) C, W, O [4, 5]
 ! *Polygonum aviculare* L. (knotweed) C [1]
Polygonum hydropiper L. (water pepper) C [1]
Polygonum pensylvanicum L. var. *laevigatum* Fern. C [1]
 ! *Polygonum persicaria* L. (lady's thumb) C [1]
Rumex altissimus Wood C [2]
- ! *Rumex crispus* L. (curly dock) C [2]
- PRIMULACEAE** (Primrose Family)
Lysimachia ciliata L. O [3]
Lysimachia quadriflora Sims C, W [3]
Lysimachia thyrsoflora L. C, W [4]
- RANUNCULACEAE** (Buttercup Family)
Anemone canadensis L. (Canada anemone) C, W [1, 3]
Anemone cylindrica Gray (thimbleweed) C, W [3]
Ranunculus abortivus L. (small-flowered crowfoot) W * [1]
Ranunculus flabellaris Raf. (yellow water crowfoot) C [5]
Thalictrum dasycarpum Fischer & Ave-Lall. (tall meadow-rue) C, O, W [2, 3]
- RHAMNACEAE** (Buckthorn Family)
 ! *Rhamnus cathartica* L. (common buckthorn) C * [3]
- ROSACEAE** (Rose Family)
Agrimonia gryposepala Wallr. (tall agrimony) C [1]
Crataegus sp. L. (hawthorn) C [1]
Fragaria virginiana Duchesne (wild strawberry) C, W [2, 3]
Geum canadense Jacq. (white avens) C, W [1]
 ! *Malus sylvestris* (apple) C [1]
Potentilla arguta Pursh (tall cinquefoil) C, W [3]
Potentilla norvegica L. (rough-leaved cinquefoil) C [1]
Potentilla simplex Michx. (common cinquefoil) C, W [3]
Prunus americana Marsh. (wild plum) C * [1]
Prunus serotina Ehrh. (black cherry) C * [1]
Prunus virginiana L. (choke cherry) C * [1]
Rosa arkansana Porter var. *suffulta* (Greene) Cockerell (sunshine rose) O
Rosa carolina L. (pasture rose) C, W [2, 3]
Rubus occidentalis L. (black raspberry) C * [1]
- RUBIACEAE** (Madder Family)
Galium aparine L. (cleavers) O [1]
Galium obtusum Bigelow (wild madder) C, W [3, 4]
Galium tinctorium L. (stiff bedstraw) W
Galium triflorum Michx. (sweet-scented bedstraw) C [1]
- RUTACEAE** (Citrus Family)
Zanthoxylum americanum P. Miller (prickly ash) C * [1]
- SALICACEAE** (Willow Family)
 ! *Populus nigra* L. (Lombardy poplar) C [2]
Salix petiolaris Smith (meadow willow) C [3]
- SANTALACEAE** (Sandalwood Family)
Comandra umbellata (L.) Nutt. (bastard toadflax) C, W [3]
- SAXIFRAGACEAE** (Saxifrage Family)
Penthorum sedoides L. (ditch stonecrop) C [4]
Ribes americanum P. Miller (wild black currant) C [1]
Ribes missouriense Nutt. ex T. & G. (Missouri gooseberry) C * [1]
- SCROPHULARIACEAE** (Figwort Family)
Lindernia dubia (L.) Pennell (false pimpernel) C, W [1]
Pedicularis canadensis L. (lousewort) C, W [3]
Veronica peregrina L. (speedwell) C * [1]
Veronicastrum virginicum (L.) Farw. (Culver's root) C, W [3]
- SOLANACEAE** (Nightshade Family)
Physalis heterophylla Nees (clammy ground cherry) C [3]
Physalis virginiana P. Miller (ground cherry) C, W [3]

Solanum americanum P. Miller (black nightshade) C [1]

ULMACEAE (Elm Family)

Celtis occidentalis L. (hackberry) C, W [1]
Ulmus americana L. (American elm) C * [1]
 !*Ulmus pumila* L. (Siberian elm) C [1]

URTICACEAE (Nettle Family)

Laportea canadensis (L.) Wedd. (wood nettle) C * [1]
Parietaria pensylvanica Muhl. ex Willd. (pellitory) C * [1]
Urtica dioica L. (stinging nettle) C * [1]

VERBENACEAE (Vervain Family)

Verbena hastata L. (blue vervain) C, W [3]
Verbena stricta Vent. (hoary vervain) C, W [3, 4]

VIOLACEAE (Violet Family)

Viola pedatifida G. Don (prairie violet) C, W [2, 3]
Viola pubescens Aiton (downy yellow violet) C, W * [1]
Viola pratensis Greene (common blue violet) C * [3]
Viola sororia Willd. (hairy blue violet) C, W [1]

VITACEAE (Grape Family)

Parthenocissus quinquefolia (L.) Planchon (Virginia creeper) C * [1]
Parthenocissus vitacea (Kner) A.S. Hitchc. (woodbine) C * [1]
Vitis riparia Michx. (riverbank grape) C * [1, 2]

ANGIOSPERMS

(MONOCOTYLEDONS)

ALISMACEAE (Water Plantain Family)

Alisma plantago-aquatica L. (water plantain) C, W * [5]
Sagittaria brevirostra Mack. & Bush (arrowhead) C, W [5]

COMMELINACEAE (Spiderwort Family)

Tradescantia bracteata Small (spiderwort) C, W, O [3]

CYPERACEAE (Sedge Family)

Carex amphibola Steudel var. *turgida* Fern C [1]
Carex annectens (Bickn.) Bickn. var. *xanthocarpa* (Bickn.) Wieg. C, O [3]
Carex atherodes Sprengel C, W [4, 5]
Carex bicknellii Britton C, W [3]
Carex blanda Dewey C [1]
Carex brevior (Dewey) Mack. ex. Lunell C, O [3]
Carex buxbaumii Wahl. C, W, O [3, 4]
Carex cristatella Britt. C, O [4]
Carex davisii Schwein. & Torrey C [1]
Carex gravida Bailey C, W [1]
Carex haydenii Dewey C, W, O [4]
Carex lanuginosa Michx. C [2, 3, 4]
Carex meadii Dewey C, O [2, 3]
Carex rostrata Stokes ex Willd. var. *utriculata* (Boott) Bailey C, O [5]
Carex sartwellii Dewey C, W, O [2, 3, 4]
Carex scoparia Schkuhr ex Willd. C, O [4]
Carex tribuloides Wahl. C, O [4]
Carex vesicaria L. C, W [4, 5]
Carex vulpinoidea Michx. C, W, O [2]
Cyperus acuminatus Torrey & Hooker C [1]
Eleocharis macrostachya (spike-rush) C, O [2, 3, 4]
Scirpus heterochaetus Chase (prairie bulrush) C, W, O [5]

IRIDACEAE (Iris Family)

Iris shrevei Small (blue flag) C, W, O [4, 5]
Sisyrinchium campestre Bickn. (blue-eyed grass) C, W [3]

JUNCACEAE (Rush Family)

Juncus dudleyi Wieg. C, O [1, 3]
Juncus tenuis Willd. C [2]
Juncus torreyi Cov. C [4]

LEMNACEAE (Duckweed Family)

Lemna minor L. (duckweed) C * [5]

LILIACEAE (Lily Family)

Allium canadense L. (wild onion) C, W, O [3]
 !*Convallaria majalis* L. (lily-of-the-valley) C [1]
Hypoxis hirsuta (L.) Cov. (yellow stargrass) C * [2, 3]
Polygonatum biflorum (Walter) Ell. (Solomon's seal) C * [1]
Smilax hispida Munl. (green briar) C [1]

ORCHIDACEAE (Orchid Family)

Spiranthes cernua (L.) L.C. Rich. (nodding lady's tresses) C, W [3, 4]

POACEAE (Grass Family)

!*Agrostis gigantea* Roth (redtop) C [1, 2]
Andropogon gerardii Vitman (big bluestem) C, W [3]
Bouteloua curtipendula (Michx.) Torrey (side-oats grama) C, W [3]
 !*Bromus inermis* Leysser (smooth brome) C, W [1, 2]
 !*Bromus japonicus* Thunb. ex Murray (Japanese brome) C [1]
 !*Bromus tectorum* L. (downy chess) C * [1]
Calamagrostis canadensis (Michx.) Beauv. (bluejoint) C, W [4]
 !*Dactylis glomerata* L. (orchard grass) C [1, 2]
Dichanthelium acuminatum (Sw.) Gould & Clark var. *implicatum* (Scribner) Gould & Clark C [3]
Dichanthelium acuminatum (Sw.) Gould & Clark var. *villosum* (Gray) Gould & Clark C [3]
Dichanthelium leibergii (Vasey) Freckm. (Leiberg's panic grass) C [3]
Dichanthelium oligosanthos (Schultes) Gould var. *scribnerianum* (Nash) Gould C, W [3]
 !*Digitaria ischaemum* (Schreber ex Schweigger) Schreber ex Muhl. (smooth crabgrass) C [1]
 !*Echinochloa crus-galli* (L.) Beauv. (barnyard grass) C [1]
Elymus canadensis L. (Canada rye) C, W [3]
Elymus virginicus L. (Virginia rye) C * [1]
Eragrostis pectinacea (Michx.) Nees O [1]
Glyceria striata (Lam.) A.S. Hitchc. C, O
Hordeum jubatum L. (squirrel-tail barley) C * [1]
Koeleria macrantha (Ledeb.) Schultes (June grass) C, W [3]
Leersia oryzoides (L.) Sw. (rice cut-grass) C, W [4]
Muhlenbergia frondosa (Poir.) Fern. (wirestem muhly) C [2]
Panicum dichotomiflorum Michx. (knee grass) C [1]
Panicum virgatum L. (switch grass) C, W [3, 4]
Phalaris arundinacea L. (reed canary grass) C, W [2, 3, 4]
 !*Phleum pratense* L. (timothy) C, W [2]
 !*Poa compressa* L. (Canada bluegrass) C, O [2, 3]
 !*Poa pratensis* L. (Kentucky bluegrass) C, W [1, 2, 3, 4]
Schizachyrium scoparium (Michx.) Nash (little bluestem) C, W [3]
 !*Setaria faberi* Herrm. (giant foxtail) C, W [1]
 !*Setaria glauca* (L.) Beauv. (yellow foxtail) C [1]
Sorghastrum nutans (L.) Nash (Indian grass) C, W [3]
Spartina pectinata Link (slough grass) C, W [3, 4]
Sphenopholis obtusata (Michx.) Scribner (wedge grass) O
Sporobolus heterolepis (Gray) Gray (prairie dropseed) C * [3, 4]
Stipa spartea Trin. (porcupine grass) C, W [3]

TYPHACEAE (Cattail Family)

Typha latifolia L. (common cattail) C * [4, 5]