The Vascular Flora of Clay Prairie State Preserve (Butler County, Iowa): Recommendations to the Iowa State Preserve System

Edwin L. Freese
William R. Norris
Western New Mexico University

Recommended Citation
Freese, Edwin L. and Norris, William R. (2013) "The Vascular Flora of Clay Prairie State Preserve (Butler County, Iowa): Recommendations to the Iowa State Preserve System," Journal of the Iowa Academy of Science: JIAS, 120(1-4), 21-34. Available at: https://scholarworks.uni.edu/jias/vol120/iss1/5

Copyright © Copyright 2013 by the Iowa Academy of Science, Inc.
Follow this and additional works at: https://scholarworks.uni.edu/jias
Part of the Anthropology Commons, Life Sciences Commons, Physical Sciences and Mathematics Commons, and the Science and Mathematics Education Commons

This Research is brought to you for free and open access by the Iowa Academy of Science at UNI ScholarWorks. It has been accepted for inclusion in Journal of the Iowa Academy of Science: JIAS by an authorized editor of UNI ScholarWorks. For more information, please contact scholarworks@uni.edu.
The Vascular Flora of Clay Prairie State Preserve (Butler County, Iowa): Recommendations to the Iowa State Preserve System

EDWIN L. FRESE1 and WILLIAM R. NORRIS2*

133493 S Ave., Adel, Iowa 50003
2Department of Natural Sciences, Western New Mexico University, PO Box 680, 1000 W. College Ave., Silver City, New Mexico 80062

Clay Prairie State Preserve (1.2 ha) is an upland prairie located in Butler County, IA, and represents one of the last remnants of black-soil tallgrass prairie in northeast Iowa. An annotated checklist of the vascular flora of Clay Prairie is presented here, based on a previously published flora of the preserve and recent field work conducted by the authors between 1997 to 2001, and 2008 to 2011. The preserve contains a diverse vascular flora representing 50 families, 145 genera and 214 taxa (174 native to Iowa). In comparison with 26 larger prairies (4 to 121 ha) protected in the Iowa state preserves system, the Clay Prairie flora ranks 10th in total number of native Iowa prairie plant taxa (135 taxa) and 10th in total number of native Iowa prairie plant taxa assigned high (7 to 10) values of the Iowa Conservation Coefficient (55 taxa). As a remnant of formerly much more extensive tallgrass prairie in Iowa, Clay Prairie protects individual plant taxa, plant assemblages, and ecological and evolutionary processes, while providing opportunities for people to experience native prairie. The floristic comparisons presented in this paper suggest that the floras of many other prairies protected in the Iowa State Preserves system are not thoroughly documented. Hence, we recommend that floristic studies of these other prairie preserves be undertaken to include documentation of the entire flora by voucher specimens. We also encourage site managers of prairies in the Iowa State Preserves system to prepare annual reports summarizing management and educational activities that occur in these preserves.

INDEX DESCRIPTORS: Clay Prairie State Preserve, cemetery, floristics, Iowa flora, prairie, Butler County, Iowa.

The loss and fragmentation of historic prairie vegetation, which once covered 85% of the state prior to settlement by Europeans but now occupies less than 0.1% of this state's land area, is well documented (Roosa 1978, Samson and Knopf 1994, Smith 1998). Remnant prairies occur all across the vast agricultural matrix that is Iowa. That small acreages of prairie were spared the plow at all is remarkable, and the circumstances responsible for the preservation of each prairie are unique. However, many prairie remnants in Iowa and elsewhere in the Midwest share a cultural history in that they owe their existence to their proximity to cemeteries (e.g., Betz 1989, Betz and Lamp 1992, Eilers 1966, Foster et al. 2010, Kerr and White 1981, Lantz 1969, Menges-Schaben 1998, Phillipe et al. 2010, Ruch et al. 2010, Schennum 1986, White 1978, 1988). These parcels of native grassland were thus afforded unintended but effective and long-term protection from conversion to crop fields or for other human use.

Clay Prairie State Preserve (Butler Co., IA), adjacent to the east border of Butler Center Cemetery, is one such prairie. Although a mere 1.2 ha in size (Herzberg and Pearson 2001), the vascular flora documented from Clay Prairie is remarkable in both its high diversity of prairie plant taxa and its floristic quality. In this paper, we present a checklist of the vascular flora of the prairie based on a previous study of Clay Prairie (Lantz 1969) as well as our own field work in the preserve (1997 to 2001; 2008 to 2013). Then, we compare the prairie flora of Clay Prairie to that of 26 other prairies which are protected as Iowa state preserves. We proceed to discuss the role of Clay Prairie as a natural vegetation remnant in conservation. Finally, we outline avenues of future research that might be conducted on this and other small prairie remnants in Iowa.

STUDY SITE

Clay Prairie State Preserve (Butler Co., IA), is located at lat 42.69989̊ N and long 92.77171̊ W. It is rectangular in shape, and occupies 1.2 ha (3 ac) (Herzberg and Pearson 2001). The preserve is bounded by the cemetery proper on the west, blacktop on the north, gravel road to the east, and agricultural lands to the south (Fig. 1). Clay Prairie occurs about 0.80 km (0.5 mi) east of the historical town of Butler Center, which was abandoned in the late 19th century (Clay Prairie Preserve…[date unknown]) and today is a cornfield. The prairie was an unused part of Butler Center Cemetery (pers. comm. from W. V. Anthony to Kenneth Madden, Iowa State Preserves Board Ecologist, 1972) until 1961, when it was purchased by the University of Northern Iowa (UNI) with funds provided by the late agricultural equipment maker and UNI alumnus, Joseph B. Clay (Lantz 1969). Clay Prairie was dedicated as a biological state preserve on Dec. 28, 1976 (Roosa 1981), and is currently managed by the Biological Preserves Committee, Department of Biology, UNI (Herzberg and Pearson 2001).

Clay Prairie occurs within a surface landform known as the Iowan Surface, formerly referred to as the Iowa Erosional Surface (Anderson 1998, Prior 1991). This landform is situated between the Des Moines Lobe to the west, noted for its bold landscape features (e.g., kettles, moraines) that mark its recent glacial history, and the Paleozoic Plateau to the east, recognized immediately by its rugged topography, frequently exposed Paleozoic sedimentary bedrock, and the near absence of glacial
deposits (Prior 1991). In contrast, Prior (1991) describes the land surface of the Iowan Surface as “slightly inclined to gently rolling with long slopes, low relief, and open views to the horizon.” The terrain in the vicinity of Clay Prairie conforms to this description, being gently sloping (1 to 9%), and consisting of rolling hills and plains with elevation ranging from about 287 m to 317 m (940 to 1,040 ft) above sea level. The subdued landscape of the Iowan Surface, last visited by glaciers in pre-Illinoian times, reflects subsequent “episodes of weathering and soil development, erosion, and soil deposition” (Prior 1991).

The preserve is found on a north-facing hillside with elevations from 303 m (995 ft) in the northeast corner to 311 m (1,020 ft) in the southwest corner. Soils of this prairie remnant slope gradually down toward the northeast corner. Generally, the eastern edge is lowest and wettest from near the center to the northeast corner. The southwest and western half contain the driest soils. The soils are of the Kenyon-Clyde-Floyd Association (Buckner 1982, Web Soil Survey). About 90% of these soils in the preserve consist of Floyd Loam. The other approximately 10% of the preserve soils is classified as Kenyon Loam (part of northwest corner and a semicircular region in the south-central region of the preserve).

Climate for this region of Iowa is mesothermal moist subhumid (Thorntwaite 1948). Climatic data available for Waterloo, IA (National Oceanic and Atmospheric Administration 1998), the nearest largest city to the preserve, approximate those for Clay Prairie State Preserve. Average yearly precipitation is about 841 mm (33.1 in). The average driest (21 mm [.83 in]) and coldest (<10°C [50°F]) month is January, and the average wettest (119 mm [4.7 in]) and warmest (22.6°C [72.7°F]) month is July. The average frost-free growing season is from April 28 to October 4 (159 days).

Preserve Management

We compiled a partial record of management activities that have occurred at Clay Prairie State Preserve as documented in unpublished reports (Smith 1991, Camarata 1990, 1991, 1996) and personal communications. Although apparently never grazed (Smith 1991), Clay Prairie was hayed annually from an unspecified year through 1958 (Smith 1991) or until its purchase in 1961 (UNI Bio. Dept. website 2013). Smith (1991) reports that Clay Prairie was burned annually between 1976 and 1991, with half of the prairie burned every year, usually in late April. Additional prescribed burns of Clay Prairie occurred in 1996 (Camarata 1996), 2009, and at least twice since 2009 (pers. comm. to author from Greg Houseal, July 27, 2015; unreferenced).

Numerous measures have been implemented to control invasive plants at Clay Prairie. A diversion berm was constructed (1984 to 1985) just outside of the southern boundary fence of the preserve to control incoming silt and weed seeds from adjacent agricultural lands (pers. comm. to author from Paul Whitson, [date unknown] 1999; unreferenced). Cutting, weed-whipping and herbicide treatment have been implemented to control invasive plants including gray dogwood (Cornus foemina P. Miller ssp. racemosa [Lam.] J.S. Wilson), silver poplar (Populus alba L.), smooth sumac (Rhus glabra L.), Canada elderberry (Sambucus canadensis L.), and willow (Salix sp.). Herbicide treatment, hand pulling, cutting of seed heads, and mowing have been variously applied to control invasive grasses such as smooth brome (Bromus inermis Leysser), reed canary grass (Phalaris arundinacea L.) and forbs including giant ragweed (Ambrosia trifida L.), mustard (Brassica sp.), and wild parsnip (Pastinaca sativa L.) (Camarata 1990, 1991).

Several instances of native plant introductions are documented for Clay Prairie and potentially contribute to the current flora.

Fig. 1. Aerial photograph (2011) of Clay Prairie State Preserve and surrounding landscape. Aerial imagery is from the National Agriculture Imagery Program (NAIP).
Unspecified prairie plants were transplanted into the preserve in 1989, with little evidence of subsequent survival. In 1990, porcupine grass (*Hesperostipa spartea* [Trin.] Barkworth) seeds collected just north of the prairie and stratified in the UNI greenhouse were sown into the south side of Clay Prairie. During this same year, additional plant species raised from seed in the UNI greenhouse (seed source unspecified) were plugged into bare spots in the south end of the preserve, including side-oats grama (*Bouteloua curtipendula* Torrey), purple prairie clover (*Dalea purpurea* Vent.), porcupine grass, round-headed bush clover (*Lespedeza capitata* Michx.), and Indian grass (*Sorghastrum nutans* [L.] Nash). In June 1991, Canada wild rye (*Elymus canadensis* L.) and oat (*Avena sp.*) were seeded south of the south border of Clay Prairie to provide an "erosion filter"; the seed source of these plants is likewise unspecified (Camarata 1991).

**PREVIOUS BOTANICAL STUDY OF CLAY PRAIRIE STATE PRESERVE**

Cyrus W. Lantz provided the first established published list of vascular plants for Clay Prairie (Lantz 1969). The checklist includes 98 vascular plant taxa representing 33 families. The most diverse families were Poaceae (11 taxa), Fabaceae (11 taxa) and Asteraceae (20 taxa). Fourteen (14.3%) of these taxa were non-native plant taxa. Lantz (1969) did not indicate that he collected voucher specimens during his study, and we have not encountered specimens collected at Clay Prairie by Lantz in any Iowa herbarium.

The occurrence of several other vascular plant taxa at Clay Prairie prior to this study and not reported by Lantz (1969) are documented by voucher specimens deposited in the Martin L. Grant Herbarium (ISTC) at UNI and the Ada Hayden Herbarium (ISC) at Iowa State University (ISU). Management reports for Clay Prairie (Camarata 1990, 1991, 1994) mention several additional plant taxa not reported by Lantz (1969) as present in the prairie in the late 1980s and early 1990s.

**METHODS**

We inventoried the vascular plants of Clay Prairie State Preserve during the growing seasons between 1997 and 2001 and again between 2008 and 2013, for a total of 29 total visits. We collected voucher specimens of all but eight vascular plant taxa encountered during our field work, and deposited these in the Ada Hayden Herbarium (ISC). Freese also searched the Martin L. Grant Herbarium (ISTC) at UNI for specimens collected in the preserve. From this work, we compiled a checklist of vascular plants known from the preserve. We assigned abundance codes to plants we personally observed at Clay Prairie as follows:

- **Common**: widely distributed and often found growing in large quantities in several different habitats.
- **Frequent**: widespread but not abundant and usually found in only one type of habitat.
- **Infrequent**: not widespread and often not found in places where it might be expected to occur.
- **Sparse**: found in only one or a few places

Family concepts follow Judd et al. 2008. Nomenclature for plant taxa follows Flora of North America Committee (1993+; vols. 2-5, 7-8, and 19-26) and Eilers and Roosa (1994), with the former taking priority. The origin (native, non-native) status of each taxon is likewise based on the above references. Common names follow Eilers and Roosa (1994) and Swink and Wilhelm (1994), with the former taking priority.

We compared the richness and floristic quality of the prairie flora documented from Clay Prairie State Preserve with that documented from 26 other prairies protected in the Iowa State Preserve system (Fig. 2). These represent a broad variety of tallgrass and mid-grass prairie types in Iowa, and range in area from 3.8 ha to 319.7 ha (Table 1) as summarized by Rosburg (2001). All of these prairies comprise a substantial (≥ 38%) portion of the total land area within the state preserve in which they occur (Table 1). We compiled the floras documented from these other 26 prairies from all (48) available sources (e.g., published floras, plant lists, and plot data presented in M.S. theses, Ph.D. dissertations, technical reports to sponsoring conservation agencies, and unpublished checklists) into a spreadsheet. Then, we compared the number of native "Iowa prairie taxa" documented from each of these 27 prairies (including Clay Prairie) protected in the Iowa state preserve system. We determined that a given native vascular plant taxon was an "Iowa prairie plant" if 1) it was stated to occur in prairie habitat in the Iowa checklist of vascular plants (Eilers and Roosa 1994), or 2) if it was included in a list of Iowa prairie plants compiled by Pearson (1991).

We also compared the number of native Iowa prairie plant taxa of high conservation concern in Clay Prairie with the other 26 prairies. To do this, we utilized Iowa Coefficient of Conservation (ICC) values assigned by a panel of experts to each native vascular plant taxon in the Iowa flora (Drobney et al. 2001). As broadly applied, coefficients of conservation range from 0 to 10, and reflect the likelihood that a given plant taxon will occur in natural habitat (Swink and Wilhelm 1994, Bourdaghs et al. 2006). Following Taft et al. (1997), who state that Illinois plant taxa assigned coefficient of conservation values of 7 to 10 associate mostly with (or are restricted to) natural areas, we tallied the number of Iowa prairie taxa with ICC values equal to 7, 8, 9 or 10 reported for each prairie to allow comparison. Although it was tempting to calculate and compare floristic quality indices and mean ICC values among all 27 prairies (e.g., Swink and Wilhelm 1994, Higgins et al. 2001), we decided against this because of potential effects of area on those metrics (Matthews 2003, Matthews et al. 2005) and especially because of the great range in area of prairie vegetation (1.3 ha to 121.4 ha) represented among the 27 prairies included in this comparison.

Finally, we compared the number of Iowa prairie plant taxa listed as endangered, threatened, or of special concern (Iowa
Table 1. Descriptions of 27 prairies protected in the Iowa State Preserve system. The number of each prairie corresponds to its location presented in Fig. 1. Prairie areas, primary prairie communities and secondary prairie communities are from Rosburg (2001), except for Cedar Hills Sand Prairie and Clay Prairie (pers. comm., Thomas Rosburg, Department of Biology, Drake University). LH = Loess Hills, NE = Northeast, NW = Northwest, TG = Tall Grass. '*' indicates a study for which voucher specimens were collected to document the majority of the flora reported.

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Iowa County</th>
<th>Prairie Area (ha)</th>
<th>Primary Prairie Community</th>
<th>Secondary Prairie Community</th>
<th>Flora(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Anderson Prairie</td>
<td>Emmet</td>
<td>80.9</td>
<td>NW Wet-mesic TG</td>
<td>NW Dry-mesic TG</td>
<td>Moats 1988, 1989, *Bice and James 2013</td>
</tr>
<tr>
<td>1</td>
<td>Cayler Prairie</td>
<td>Dickinson</td>
<td>60.7</td>
<td>NW Wet-mesic TG</td>
<td>NW Dry-mesic TG</td>
<td>*Aikman and Thorne 1956, Smith et al. 1991</td>
</tr>
<tr>
<td>4</td>
<td>Crossman Prairie</td>
<td>Howard</td>
<td>4.0</td>
<td>NE mesic TG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Doolittle Prairie</td>
<td>Story</td>
<td>10.1</td>
<td>Wet-mesic TG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Five Ridge Prairie</td>
<td>Plymouth</td>
<td>121.4</td>
<td>LH Mid-grass</td>
<td>LH Dry-mesic TG</td>
<td>Duxbury 1982</td>
</tr>
<tr>
<td>2</td>
<td>Freda Haffner Kettlehole</td>
<td>Dickinson</td>
<td>30.4</td>
<td>NW Mid-grass</td>
<td>NW Dry-mesic TG</td>
<td>Gerhardt 1940, *Freese and Platt 1991</td>
</tr>
<tr>
<td>5</td>
<td>Hayden Prairie</td>
<td>Howard</td>
<td>97.1</td>
<td>NE Mesic TG</td>
<td>NE Wet-mesic TG</td>
<td>Moyer 1953, Christiansen 1993, Christiansen 1999a</td>
</tr>
<tr>
<td>7</td>
<td>Hoffman Prairie</td>
<td>Cerro Gordo</td>
<td>14.2</td>
<td>Wet-mesic TG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Kish-Ke-Kosh Prairie</td>
<td>Jasper</td>
<td>6.1</td>
<td>Dry-mesic TG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Lisa-Kanek Prairie</td>
<td>Webster</td>
<td>8.1</td>
<td>Mesic TG</td>
<td>Wet-mesic TG</td>
<td>Wilson 1979, Cady 2002</td>
</tr>
<tr>
<td>22</td>
<td>Manikowski Prairie</td>
<td>Clinton</td>
<td>16.2</td>
<td>Dry-mesic lime TG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Mount Talbot, Woodbury</td>
<td>Plymouth</td>
<td>36.4</td>
<td>LH Mid-grass</td>
<td>LH Dry-mesic TG</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Nestor Stiles</td>
<td>Cherokee</td>
<td>4.0</td>
<td>Mesic TG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Rock Island</td>
<td>Linn</td>
<td>4.0</td>
<td>Dry-mesic sand TG</td>
<td></td>
<td>Cady 2003</td>
</tr>
<tr>
<td>27</td>
<td>Rolling Thunder</td>
<td>Warren</td>
<td>24.3</td>
<td>Mesic TG</td>
<td></td>
<td>Mahby 2002</td>
</tr>
<tr>
<td>10</td>
<td>Steele Prairie</td>
<td>Cherokee</td>
<td>80.9</td>
<td>Mesic TG</td>
<td>Wet-mesic TG</td>
<td>Pearson 1996, Rosburg 2003</td>
</tr>
<tr>
<td>6</td>
<td>Stinson Prairie</td>
<td>Kossuth</td>
<td>12.1</td>
<td>NW Wet-mesic TG</td>
<td>NW Dry-mesic TG</td>
<td>Glenn-Lewin 1976, Crist 1978</td>
</tr>
<tr>
<td>16</td>
<td>Sylvan Runkel</td>
<td>Monona</td>
<td>121.4</td>
<td>LH Mid-grass</td>
<td>LH Dry-mesic TG</td>
<td>Pearson 1996, Rosburg 2003</td>
</tr>
<tr>
<td>17</td>
<td>Turin Loess Hills</td>
<td>Monona</td>
<td>80.9</td>
<td>LH Mid-grass</td>
<td>LH Bluff Mid-grass</td>
<td>Novacek-Bates 1989</td>
</tr>
<tr>
<td>26</td>
<td>Williams Prairie</td>
<td>Johnson</td>
<td>8.1</td>
<td>Wet TG</td>
<td>Wet-mesic TG</td>
<td>*Sorenson 1962</td>
</tr>
</tbody>
</table>
A total of 214 vascular plant taxa have been identified at Clay Prairie State Preserve, of which 174 (81%) are native to Iowa (Appendix A). Of the 214 taxa on this list, 162 are eudicots, 50 are monocots, and 2 are fern allies. This list includes representatives of 50 families and 145 genera. A total of 174 taxa (81%) in the Clay Prairie flora are native plant taxa. The most diverse plant families represented in Clay Prairie are Asteraceae (45 taxa), Poaceae (30), Cyperaceae (14), Fabaceae (13), and Rosaceae (11). The most diverse plant genera are Carex (11 taxa), Symphyotrichum (6), Solidago (5), Asclepias (4), Euphorbia (4), and Viola (4). Of these taxa, smooth clustered sedge (Carex aggregata Mack.), is considered to be of special concern in Iowa (Iowa Administrative Code 2002).

We were unable to locate fourteen plant taxa from Lantz’s previously compiled checklist (1969) on the preserve. These include seven native taxa (passion flower [Anemone patens L. var. multifida Fritzell], purple coneflower [Echinacea angustifolia DC.], rockrose [Helianthemum bicknelli Fern.], June grass [Koeleria macrantha (Lede.) Schultes], bunch-flower [Melandrium virginicum L.], sand dropseed [Sporobolus cryptandrus (Torrey) A. Gray], heart-leaved meadow pursnip [Zizia aptera (Gray) Fern.] and seven non-native taxa (Carduus sp., cypress spurge [Euphorbia cyperiatis L.], alfalfa [Medicago sativa L.], red-seeded dandelion [Taraxacum laevigatum (Willdenow) de Candolle var. erythrospermum [Andrzejowski ex Besser] J. Weiss], cultivated red raspberry [Rubus idaeus L.], white clover [Trifolium repens L.], rabbit-foot clover [T. arvense L.]).

In contrast, we encountered 117 plant taxa (including 91 native taxa) during the current study that were not reported by Lantz (1969). Among these are three taxa planted in the preserve in the early 1990s (Camarata 1990, 1991): side-oats grama, Canada wild rye, and Indian grass. The seed sources of these taxa are not specified in these reports. Although not reported as occurring at Clay Prairie by Lantz (1969), Indian grass was apparently present in the preserve prior to its introduction reported by Camarata because it is listed as an associate of tall nut-rush (Scleria triglomerata Michx.) on the specimen label (ISC 365127) of the latter taxon collected in the preserve in mid-1980s. Finally, our observation of hairy blue violet (Viola sororia Willd.) at Clay Prairie during the current study is probably due to its mid-1980s introduction in soil brought in to create the diversion berm just outside the southern edge of the preserve (pers. comm., Paul Whitson, fall 1999; unreferenced). Whitson noted subsequent hybridization of hairy blue violet with other violet taxa in the preserve.

Additional vascular plant taxa reported anecdotally by preserve workday managers (Smith 1991, Camarata 1990, 1991, 1994) were not reported by Lantz (1969) nor relocated by us at Clay Prairie. These include six native taxa (northern reed grass [Calamagrostis stricta (Timm) Koeler], downy painted cup [Castilleja sessiliflora Pursh], purple coneflower [Echinacea purpurea (L.) Moench], Maximillian’s sunflower [Helianthus maximiliani Schrader], blazing star [Liatris aspera Michx.], Solomon’s seal [Polygonatum biflorum (Walter Ell.)] and five non-native taxa (velvet leaf [Abutilon theophrasti Medicus], tickseed coreopsis [Coreopsis lanceolata L.], canary grass [Phalaris canariensis L.], silver poplar, hedgerow rose [Rosa rugosa Thunb.]). Given the anecdotal nature of these reports, we did not include these taxa in the checklist (Appendix A).

The total number of Iowa prairie plant taxa ranked from 69 to 182 among the 27 Iowa state preserves considered in this study. Of these, Clay Prairie ranked 10th with 135 prairie plant taxa (Fig. 3). The total number of Iowa prairie plant taxa with ICC values $= 7, 8, 9, 10$ ranged from 15 to 83 among these same 27 Iowa state preserve prairies. In this comparison, Clay Prairie ranked 10th among all of these prairies with 55 Iowa prairie plant taxa assigned high (7 to 10) ICC values (Fig. 4). No Iowa prairie plant in the Clay Prairie flora is currently considered to be endangered, threatened, or of special concern in the State of Iowa (note: Iowa special concern taxon smooth clustered sedge, mentioned above as occurring at Clay Prairie, is not an Iowa prairie plant). In this regard, the Clay Prairie flora is tied for last place along with four other prairies included in this comparison.

**DISCUSSION**

To truly comprehend how small Clay Prairie State Preserve is, consider that the next largest prairies featured in the Iowa state preserves system (Ames High Prairie, Crossman Prairie, Nestor Stiles Prairie, Rock Island) are more than three times larger (Table 1). The Iowa state preserve containing the largest amount of prairie, Five Ridge Prairie, contains more than 250 times as many plant taxa versus total prairie area for 27 prairies protected in the Iowa state preserve system. Clay Prairie State Preserve is identified by an arrow. Each of the 27 prairies is characterized in Table 1.
much prairie as Clay Prairie. More than 200 prairies the size of Clay Prairie would fit inside one square mile (the common unit into which much of the Iowa landscape is subdivided by intersecting county roads).

Thus, it is remarkable that the Clay Prairie flora ranks so highly in floristic comparisons with other prairies in the Iowa state preserve system (Figs. 3, 4). One likely explanation for this result is that the Clay Prairie flora has been studied more comprehensively and for a longer period of time than many of the other prairies in the Iowa state preserve system. We strongly suspect that the floras of many of the other 26 prairies, if thoroughly inventoried, would be discovered to contain more plant taxa with prairie affinity and/or more prairie plant taxa with high ICC values (i.e., ICC = 7, 8, 9, or 10) than are currently documented from Clay Prairie.

Role of Clay Prairie State Preserve as Vegetation Remnant in Conservation

What is the conservation value of Clay Prairie State Preserve, a mere speck on the Iowa landscape? Saunders et al. (1991) described four reasons that natural vegetation remnants should be preserved. These include: a) species oriented reasons, in which individual species and their gene pools are preserved; b) example oriented reasons, in which remnants preserve particular ecosystems, communities, habitats and vegetation assemblages; c) process oriented reasons, by which remnants preserve important ecological and evolutionary processes; and d) social oriented reasons, in which remnants provide opportunities for people to experience nature in a variety of ways. We summarize how Clay Prairie fulfills the above four criteria below.

Clay Prairie possesses a diverse flora of prairie plants (Fig. 3) including many taxa of high conservation concern (Fig. 4). Populations of some of these plants have provided seed for prairie restoration projects elsewhere (Camarata 1991). What of other biota? Studies of insect diversity and biology conducted in prairie remnants in Iowa and adjacent states have focused on ants (Foster et al. 2010), bees (Slagle and Hendrix 2009), beetles (St. Pierre and Hendrix 2003, Larson and Work 2003, Larsen et al. 2003), butterflies (Debinski and Kelly 1998, Selsor and Schramm 1992), grasshoppers (Bomar 2001, Bomar and Secrist 2002), leafhoppers (Hamilton 1995), moths (Summerville 2008, Summerville et al. 2006), and thrips (Gerdes 1982). Bryophytes (van der Linden and Farrar 1981) and fungi (Liberta and Anderson 1986, Tiffany and Knaphus 1995) have also been the focus of biotic inventories conducted on prairie remnants in the Midwest. To our knowledge, Clay Prairie State Preserve has not been the focus of any inventory of insects, fungi, or bryophytes. Scientists and conservation managers of Clay Prairie would benefit from such information.

In preserving an example of tallgrass prairie in Iowa, Clay Prairie satisfies criterion b. Shafer (1995) argues that although conservation strategies should focus on large vegetation conservation reserves, these large reserves should be augmented with smaller ones because the latter may be the only available representative of a given vegetation type. This justification for preservation of small preserves certainly applies in Iowa, where the majority (> 99.9 %) of historic tallgrass prairie vegetation no longer exists (Smith 1998).

Certainly ecological and evolutionary processes (criterion c) continue at Clay Prairie, though highly modified through the lens of human impacts on this prairie and surrounding landscape. Dozens of studies have appeared in the scientific literature that focus on various biological processes occurring in prairie remnants. Clay Prairie was included in at least one of these studies (Wilsey et al. 2005) that focused on prediction of plant extinction rates in prairie remnants based on species-area curves. The results of this study indicated that many more native prairie plant species were present in small prairie remnants than were predicted based on island biogeography theory (MacArthur and Wilson 1967).


RECOMMENDATIONS

The high floristic quality of Clay Prairie State Preserve is clear, and its future preservation is ensured due to its status as an Iowa state preserve. To date, comprehensive floristic studies are published in the scientific literature for only eight prairies in the Iowa state preserves system: Ames High School Prairie (Freckmann 1966), Cayler Prairie (Aikman and Thorne 1956), Cedar Hills Sand Prairie (Crum 1972), Clay Prairie (Lantz 1969), Doolittle Prairie (Wetzel et al. 1998), Freda Haffner Kettlehole (Freese and Platt 1991), Stinson Prairie (Glenn-Lewin 1976), and Williams Prairie (Sorenson 1962). Floristic data for the other 19 prairie preserves (Table 1) are available as technical reports to several conservation agencies, university masters theses and PhD dissertations, and in a few cases as private plant lists compiled by citizen scientists with expertise in plant identification.

It took us more than two years to locate and obtain all of the floras and reports cited in Table 1. These vary widely in duration (multiple years versus several days), intensity (plants of high conservation priority versus entire flora), and extent (entire preserve versus plot data collected along a transect line). Obviously, the conservation management agencies who oversee prairies protected in the Iowa state preserve system should sponsor comprehensive floristic inventories of prairie remnants that they manage which span several years and focus on the entire flora. These agencies should then encourage publication of these floristic studies in peer-reviewed journals. Such careful characterization of the floras of prairie remnants in the Iowa state preserve system would provide data for sophisticated ecological studies of plant community and population dynamics (e.g., Wilsey et al. 2005). Likewise, we recommend that establishment and survey of permanent plots surveyed at multiple points in time (e.g., Rosburg 1996, Dornbush 2004) be undertaken to inform preserve managers of vegetation change in these prairie remnants, especially increasing or decreasing trends of exotic plant populations.

Only 12 of the 49 studies cited in Table 1 indicate that vouchers were collected to thoroughly document the featured floras. Thus, it is impossible to verify the occurrence of plant taxa reported for the majority of prairie remnants in the Iowa State Preserve system. To illustrate this problem, Lantz (1969) reported one species of purple coneflower (Echinacea angustifolia) from Clay Prairie in the 1960s, Camarata (1990) anecdotally noted the occurrence of another species of purple coneflower (Echinacea purpurea) in the preserve during the late 1980s and early 1990s, and Lammers vouchered pale coneflower (Echinacea pallida) from the preserve in 1980 (subsequently encountered by us during the current study). Future floristic studies should adhere to rigorous standards, especially comprehensive documentation of the flora via voucher specimens and/or digital photographs with subsequent deposit in university herbaria, as outlined by Palmer and Richardson (2012).
Recent ecological studies have explored how prairie vegetation influences the insects that reside within it. For example, Panzer and Schwartz (1998) showed that native plant species richness explained a significant proportion of variation in conservative insect species richness in 50 prairie remnants near Chicago, IL. Other studies (e.g., Panzer 2002) have investigated how prairie management (i.e., burning) influences insect communities. Published studies of insect diversity in Iowa state prairie preserves (e.g., Larson and Work 2003, Larson et al. 2003, Slagle and Hendrix 2009) are limited. We recommend that, concurrent with increased effort to characterize the floras of prairie remnants in the Iowa state preserve system, an increased focus on insect inventory in these prairie remnants be undertaken by academicians, conservation agency biologists, and citizen scientists with expertise in insect identification.

Finally, the numerous management reports by Smith (1991) and Camarata (1990, 1991, 1994, 1996, 1997, 1998) provide extremely useful historical information about Clay Prairie, including a record of seed collection and reintroduction of native plants in the preserve, accounts of visits by school groups to the prairie, and a vegetation map locating regions of problematic woody plant occurrence. We encourage a resumption of annual reporting of activities at Clay Prairie to inform future generations of prairie enthusiasts about this prairie jewel.

ACKNOWLEDGEMENTS

Lawrence J. Eilers, Martin L. Grant, Thomas G. Lammers, and Mark Leoschke each collected important voucher specimens of plant taxa at Clay Prairie independent of this and the prior floristic study of this preserve. Ron Camarata, Greg Houseal, Daryl Smith, and Paul Whitson documented management history of Clay Prairie through written reports and personal communications to us. Cyrus W. Lantz introduced Freese to Clay Prairie on a field trip he led there during the summer of 1966. John Pearson provided us with numerous Iowa prairie floras and prepared several figures for use in this paper. Tom Rosburg compiled information about Iowa prairies that we utilized in this paper. Michael Palmer and three anonymous reviewers provided many helpful suggestions that have helped us to improve the quality of this paper. Mary E. Brown, Billie Hemmer, Mark Leoschke, Brian Hazlett, Steve Hendrix, Greg Houseal, Daryl Howell, Kelly Kindscher, Deb Lewis, Jean Prior, Tom Rosburg, Daryl Smith, Arnold Webster, Paul Whitson, Mark Widrlechner, Gerould Wilhelm, Tre Wilson, and Scott Zager all assisted us with various other aspects of this project. We thank all of the above for their contributions to this study.

The floristic comparisons presented in this paper were possible because of the 49 botanical studies conducted in Iowa prairies by the authors and the following 43 individuals: John Aikman, Philip Bice, Paul Bockenstedt, Jack Brotherson, Tom Cady, Allen Crist, Paul Christiansen, Glenn Crum, Kathryn Davis, Matt Dornbush, R. Dudley, Alexis Duxbury, John Fleckenstein, Robert Freckmann, Charles Gerhardt, Brian Hazlett, Aubrie James, Carol Kern, Carl Kurzt, Cyrus Lantz, Mark Leoschke, David Glenn-Lewin, Brian Hazlett, Robert Kennedy, Jim Kessler, Cathy Mabry, Bob Moats, John Moyer, Jean Novacek-Bates, John Pearson, William Platt, Mary Richards, Dean Roosa, Tom Rosburg, Wayne Schennum, Daryl Smith, Paul Sorenson, Jimmie Thompson, Robert Thorne, Mark Wagner, Paul Wetzel, Tre Wilson, and Greg Woodley. We thank all of the above for their efforts to document historic prairie vegetation in Iowa.

This research was funded in part by a research grant from the Iowa State Preserves Board, Iowa Department of Natural Resources for the 1999-2000 field season.

LITERATURE CITED


BICE, P. M. and A. R. M. JAMES. 2013. The vascular flora of Anderson Prairie State Preserve, Emmet County. Unpublished report, State Preserve Advisory Board, Iowa Department of Natural Resources, Des Moines, IA.


ROOSA, D. M. 1981. Directory of state preserves. Iowa State Preserves Board (State Preserves Advisory Board), Iowa Conservation Commission (Division of Natural Resources), Des Moines, IA.


ROSBURG, T. R. 1996. A quantitative plant inventory of Sheeder Prairie State Preserve, Guthrie County, Iowa. A report to the Iowa State Preserves Advisory Board, Parks, Preserves and Recreation Division, Iowa Department of Natural Resources, Des Moines, IA.


ROSBURG, T. R. 2005a. Floristic and plant community inventories on Sylvan Runkel State Preserve, Monona County, IA. Unpublished report, State Preserves Advisory Board, Iowa Department of Natural Resources, Des Moines, IA.


APPENDIX

Checklist of Clay Prairie State Preserve flora. Voucher specimens collected by E.L. Freese, M.J. Leoschke and W.R. Norris are deposited in the Ada Hayden Herbarium (ISC) at Iowa State University, and those collected by L.J. Eilers, M.L. Grant and T.G. Lammers are deposited in the Martin L. Grant Herbarium (ISTC) Herbarium at the University of Northern Iowa.

Key
No symbol = Taxa native to Iowa
* = Taxa not native to Iowa
Boldface = Native Iowa Prairie Plant (defined in text)
Nomenclatural synonyms, alternate family names as presented in Eilers and Roosa (1993)
F = Taxa reported by Freese and Norris
L = Taxa reported by Lantz
Abundance codes defined in text
Collection number of voucher specimens in italics

FERNS AND FERN ALLIES
(formerly Pteridophytes)

EQUISETACEAE
Equisetum arvense L. (common horsetail) [L, F] Frequent Freese 12 May 2009-7
Equisetum laevigatum A. Br. (smooth scouring-rush) [L, F] Infrequent Freese 11 Aug 2009-6

ANGIOSPERMS: MONOCOTYLEDONS

ASPARAGACEAE [formerly LILIACEAE, in part]
*Asparagus officinalis L. (garden asparagus) [F] Sparse Freese 11 Aug 2009-41

CONVALLARIACEAE [formerly LILIACEAE, in part]
Polygonatum biflorum (Walter) Ell. (Solomon’s seal) [F] Sparse Freese 11 Aug 2009-7

CYPERACEAE
Carex aggregata Mack. (smooth clustered sedge) [F] Infrequent Freese 6 June 2000-1
Carex bicknellii Britton (copper-shouldered oval sedge) [L, F] Infrequent Freese 2 June 2001-3
Carex brevior (Dewey) Mack. ex Lunell (plains oval sedge) [F] Infrequent Freese 2 June 2001-1
Carex buxbaumii Wahl. (dark-scaled sedge) [L, F] Infrequent Freese 21 June 1997-1
Carex gratisda Bailey (long-awned bracted sedge) [F] Infrequent Freese 2 June 2001-2

Carex haydenii Dewey (long-scaled tussock sedge) [F] Infrequent Freese 21 June 1997-3
Carex meadii Dewey (Mead’s stiff sedge) [F] Infrequent Freese 2 June 2001-4
Carex normalis Mack. (spreading oval sedge) [F] Infrequent Freese 2 June 2001-5
Carex pellita Willd. [Carex lanuginosa Michx.] (broad-leaved woolly sedge) [F] Infrequent Freese 17 July 1998-2
Carex pensylvanica Lam. (common oak sedge) [F] Infrequent Freese 12 May 2009-15
Carex sartwellii Dewey (running marsh sedge) [F] Infrequent Freese 17 July 1998-1
Eleocharis compressa Sulliv. (spike-rush) [F] Infrequent Freese 21 June 1997-2
Scirpus atrovirens Willd. (dark green bulrush) [F] Sparse Freese 17 July 1998-3
Scleria triglomerata Michx. (tall nut-rush) [F] Sparse Leoschke 1 July 1983 - ISC 365127

HYPOXIDACEAE [formerly AMARYLLIDACEAE, in part]
Hyposis bursata (L.) Gov. (yellow stargrass) [L, F] Frequent Lammers 3345

IRIDACEAE
Iris sibreei Small (blue flag) [F] Sparse Norris 2013-6-2-8.5
Sisyrinchium campestre Bickn. (prairie blue-eyed grass) [L, F] Frequent Freese 12 May 2009-3

JUNCACEAE
Juncus dudleyi Weig. (Dudley’s rush) [F] Infrequent Freese 6 July 2009-4

LILIACEAE
Lilium philadelphicum L. [Lilium philadelphicum L. var. andinum (Nutt.) Ker-Gawl] (wood lily) [L, F] Sparse Freese 6 July 2009-8

MELANTHIACEAE [formerly, LILIACEAE, in part]
Melanthium virginicum L. (bunch-flower) [L]

POACEAE
*Agrostis gigantea Roth (redtop) [L, F] Infrequent Freese 6 July 2009-1
Andropogon gerardii Vitman (big bluestem) [L, F] Frequent Eilers 6500
Bouteloua curtipendula (Michx.) Torrey (side-oats grama) [F] Sparse Freese 6 July 2009-23
Bromus ciliatus L. (Canada brome grass) [L, F] Sparse
*Bromus inermis Leysser (smooth brome) [F] Sparse Freese 6 July 2009-24
Calamagrostis canadensis (Michx.) Beauv. (bluejoint) [F] Infrequent Freese 20 Sept 2008-43
Angiosperms: Eudicotyledons
(formerly, Dicotyledons)

Adoxaceae [includes, Caprifoliaceae, in part]
Sambucus canadensis L. (Canada elderberry) [F] Sparse Freese 11 Aug 2009-32

Amaranthaceae [includes Chenopodiaceae]
Amaranthus tuberculatus (Moquin-Tandon) J.D. Sauer [Amaranthus rudis Sauer] (western water hemp) [F] Sparse Freese 16 Sept 2000-4
* Chenopodium album L. (lamb’s quarters) [F] Sparse Freese 16 Sept 2000-3

ANACARDIACEAE
Rhus glabra L. (smooth sumac) [L, F] Infrequent Freese 20 Sept 2008-32

Apiales
Cicuta maculata L. (water hemlock) [L, F] Infrequent Freese 6 July 2009-18
* Daucus carota L. (Queen Anne’s lace) [F] Sparse Freese 20 Sept 2008-31
Eryngium yuccifolium Michx. (rattlesnake master) [L, F] Infrequent Freese 20 Sept 2008-33
* Pastinaca sativa L. (wild parsnip) [L, F] Sparse Freese 11 Aug 2009-1
Sanicula canadensis L. (black snakeroot) [F] Sparse Freese 11 Aug 2009-2
Sium suave Walter (water parsnip) [L, F] Infrequent Freese 11 Aug 2009-5
Zizia aptera (Gray) Fern. (heart-leafed golden alexander) [L] Zizia aurea (L.) Koch (golden alexander) [L, F] Common Freese 20 Sept 2008-41

ApoCynaceae [includes Asclepiadaceae]
Apocynum andricum Jacq. (dogbane) [F] Infrequent Freese 11 Aug 2009-3
Asclepias birtella (Pennell) Woodson (tall green milkweed) [F] Sparse
Asclepias syriaca L. (common milkweed) [L, F] Infrequent Freese 11 Aug 2009-4
Asclepias tuberosa L. ssp. interior Woodson (butterfly weed) [F] Sparse Freese 11 Aug 2009-10
Asclepias viridiflora Raf. (green milkweed) [L, F] Sparse

asteraceae
Ambrosia artemisiifolia L. (common ragweed) [F] Sparse Freese 11 Aug 2009-9
Ambrosia trifida L. (giant ragweed) [L, F] Sparse Freese 16 Sept 2000-1
Antennaria neglecta Greene (pussytoes) [F] Sparse Freese 6 June 1998-3
Antennaria plantaginifolia (L.) Hooker (ladies’-toacco) [L, F] Sparse Freese 6 June 1998-8
Arnoglossum plantagineum Raf. (Cacalia plantaginea) (Raf.) Shinners) (prairie Indian plantain) [L, F] Infrequent Freese 6 July 2009-7
Artemisia ludoviciana Nutt. (white sage) [F] Sparse Freese 11 Aug 2009-11
* Carduus sp. (musk thistle) [L]
* Cirsium arvense (L.) Scop. (Canada thistle) [F] Sparse Freese 11 Aug 2009-34
Cirsium floridum (Ryd.) Arthur (Flodman’s thistle) [L, F] Infrequent Freese 11 Aug 2009-33
* Cirsium vulgare (Savi) Tenore (bull thistle) [F] Sparse Freese 11 Aug 2009-35
Coreopsis palmata Nutt. (prairie coreopsis) [L, F] Frequent Freese 20 Sept 2008-28
Doellingeria umbellata (Miller) Nees var. umbellata (P. Miller) Nees (Aster umbellatus Miller) (flat-topped aster) [F] Infrequent Freese 8 Sept 2010-1
Echinacea angustifolia DC. (purple coneflower) [L]
Echinacea pallida Nutt. (pale coneflower) [F] Sparse Lammers 3726
Erigeron annuus (L.) Pers. (annual fleabane) [F] Sparse Freese 6 July 2009-20
Erigeron strigosus Muhl. ex Willd. (daisy fleabane) [L, F] Infrequent Freese 6 July 2009-11
Euthamia graminifolia (L.) Nutt. (common grass-leaved goldenrod) [F] Infrequent Freese 20 Sept 2008-34
Helianthus grosseserratus Martens (saw-tooth sunflower) [F] Frequent Freese 11 Aug 2009-12
Helianthus pauciflorus Nuttall [Helianthus rigidus (Cass.) Desf.] (prairie sunflower) [F] Frequent Freese 11 Aug 2009-13
Helianthus tuberosus L. (Jerusalem artichoke) [F] Frequent Freese 20 Sept 2008-12
Krigia biflora (Walter) Blake (false dandelion) [L, F] Infrequent Freese 6 June 2009-29
Lactuca canadensis L. (wild lettuce) [F] Sparse Freese 11 Aug 2009-14
Liatris pycnostachya Michx. (prairie blazing star) [L, F] Infrequent Freese 11 Aug 2009-20
Packera aurea (L.) A. Love & D. Love [Senecio aureus L.] (golden ragwort) [L, F] Sparse Norris 2013-6-2-1
Parthenium integrifolium L. (wild quinine) [L, F] Infrequent Freese 20 Sept 2008-20
Prenanthes racemosa Michx. (glaucous white lettuce) [F] Infrequent Freese 20 Sept 2008-29
Ratibida pinnata (Vent.) Barnh. (gray-headed coneflower) [L, F] Frequent Freese 20 Sept 2008-23
Rudbeckia hirta (Vent.) Barnh. (gray-headed coneflower) [L, F] Frequent Freese 20 Sept 2008-47
Solidago canadensis L. (tall goldenrod) [L, F] Frequent Freese 20 Sept 2008-47
Solidago gigantea Aiton (smooth goldenrod) [F] Frequent Norris 2013-6-1-2
Solidago missouriensis Nutt. (Missouri goldenrod) [F] Infrequent Freese 11 Aug 2009-15
Solidago nemoralis Aiton (field goldenrod) [F] Infrequent Freese 11 Aug 2009-17
Solidago rigidula L. (stiff goldenrod) [F] Infrequent Freese 20 Sept 2008-7
Solidago speciosa Nutt. (showy goldenrod) [F] Infrequent Freese 20 Sept 2008-8
Symphyotrichum leaven (L.) A. Love & D. Love [Aster laevis L.] (smooth blue aster) [F] Frequent Lammers 4007
Symphyotrichum lanceolatum (Willld.) G. L. Nesom [Aster lanceolatus Willld.] (painted aster) [F] Frequent Freese 20 Sept 2008-26
Symphyotrichum olsentangiense (Riddell) G. L. Nesom [Aster azureus Lindley] (sky-blue aster) [F] Infrequent Grant 14966
*Taraxacum laevigatum (Willdenow) de Candolle var. erythrospermum (Andrzejowski ex Besse) J. Weiss [Taraxacum laevigatum (Willd.) DC.] (red-seeded dandelion) [L]
*Taraxacum officinale Weber (common dandelion) [F] Sparse Freese 12 May 2009-12
*Tragopogon dubius Scop. (goat’s-beard) [L, F] Sparse Freese 11 Aug 2009-16
BORAGINACEAE

Hackelia virginiana (L.) I.M. Johnston (stickseed) [F] Sparse Freese 11 Aug 2009-22
Lithospermum canescens (Michx.) Lehnn. (hoary puccoon) [L, F] Infrequent Freese 12 May 2009-1

BRASSICACEAE

*Barbara vulgaris R. Br. (yellow rocket) [F] Sparse Freese 6 June 2000-19
*Capsella bursa-pastoris (L.) Medicus (shepherd’s purse) [F] Sparse Freese 8 Sept 2010-3
Cardamine bulbosa (Schreber) BSP. (spring cress) [L, F] Infrequent Freese 6 June 2000-4

CAMPANULACEAE

Campanula paradinoides Pursh (marsh bellflower) [F] Infrequent Freese 8 July 2000-1
Lobelia spicata Lam. (spiked lobelia) [L, F] Infrequent Freese 6 July 2009-26
Tridax perfoliatus (L.) Nieuw. (Venus’s looking-glass) [F] Sparse Freese 6 June 1998-10

CARYOPHYLLACEAE

*Centaurium erythraea R.Br. (European bindweed) [F] Sparse Freese 6 June 1998-7
*Silene latifolia Poiret [Silene pratensis (Rafn.) Gren. & Godron] (white campion) [F] Sparse Freese 6 July 2009-27

CISTACEAE

Helianthemum bicknellii Fern. (hoary frostweed) [L]

CONVOLVULACEAE

Calystegia sepium (L.) R.Br. (bindweed) [F] Sparse Freese 17 June 1998-6
*Convolvulus arvensis L. (European bindweed) [L, F] Sparse Freese 11 Aug 2009-21

CORNACEAE

Corpus foemina P. Miller ssp. racemosa (Lam.) J.S. Wilson (gray dogwood) [F] Common Freese 11 August 2009-18

EUPHORBIACEAE

Enphorbia corollata L. (flowering spurge) [L, F] Infrequent Freese 11 August 2009-17
*Euphorbia cyparissias L. (cypress spurge) [L]
Euphorbia maculata L. (carpet spurge) [F] Sparse Freese 16 Sept 2000-3
Euphorbia nutans Lag. (noding spurge) [F] Sparse Freese 16 Sept 2000-4

FABACEAE

Amorpha canescens Pursh (leadplant) [L, F] Frequent Freese 20 Sept 2008-19
Baptisia bracteata Muhl. ex Ell. var. glabrescens (Larisey) Isley (cream wild indigo) [L, F] Infrequent Freese 20 Sept 2008-15
Baptisia lactea (Raf.) Thieret (white wild indigo) [L, F] Infrequent Freese 20 Sept 2008-14
Dalea candida Willd. (white prairie clover) [L, F] Sparse Lammers 3733
Dalea purpurea Vent. (purple prairie clover) [L, F] Infrequent Freese 6 July 2009-28
Desmodium canadense (L.) DC. (showy tick-trefoil) [L, F] Infrequent Freese 11 Aug 2009-23
Latibyus palustris L. (marsh vetchling) [L, F] Infrequent Freese 6 July 2009-31
Lespedeza capitata Michx. (round-headed bush clover) [L, F] Infrequent Freese 20 Sept 2008-48
*Melica sativa L. (alfalfa) [L]
*Melilotus alba Medicus (white sweet clover) [F] Sparse Freese 6 July 2009-32
*Trifolium arvense L. (rabbit foot clover) [L]
*Trifolium repens L. (white clover) [F]

FAGACEAE
Quercus rubra L. [Quercus borealis Michx. f. var. maxima (Marsh.) Ashe] (northern red oak) [L, F] Sparse

GENTIANACEAE
Gentiana andrewsii Griseb. (bottle gentian) [F] Infrequent Freese 20 Sept 2008-10
Gentiana x billingtonii Farw. (soapwort gentian) [F] Sparse Freese 20 Sept 2008-50

HYDROPHYLLACEAE
Ellisia nyctela L. (wild tomato) [F] Sparse Freese 6 July 2009-29

LAMIACEAE
*Glehoma baderica L. (creeping Charlie) [F] Sparse Freese 6 June 1998-1
*Neptea cataria L. (catnip) [F] Sparse Freese 16 Sept 2000-5
Stachys palustris L. (woundwort) [F] Infrequent Freese 11 Aug 2009-30

MALVACEAE
*Malva sp. (mallow) [F] Sparse Freese 16 Sept 2000-6

MORACEAE
*Morus alba L. (white mulberry) [F] Sparse Freese 11 Aug 2009-27

NYCTAGINACEAE
Mirabilis nyctaginea (Michx.) MacM. (wild four-o’clock) [F] Sparse

ONAGRACEAE
Oenothera biennis L. ssp. centralis Munz (evening primrose) [F] Sparse Freese 11 Aug 2009-24

OROBLANCHACEAE [formerly SCrophulariaceae, in part]
Castilleja coccinea (L.) Sprengel (Indian paintbrush) [L, F] Infrequent Lammers 2560
Pedicularis canadensis L. (lousewort) [L, F] Infrequent Freese 12 May 2009-4

OXALIDACEAE
Oxalis stricta L. (yellow wood sorrel) [F] Sparse Freese 17 July 2013-2

PLANTAGINACEAE [formerly SCrophulariaceae, in part]
Veronicastrum virginicum (L.) Farwell (Culver’s root) [L, F] Frequent Freese 6 July 2009-3

POLEMONIACEAE
Phlox pilosa L. (prairie phlox) [L, F] Infrequent Freese 6 July 2009-33

POLYGONACEAE
Persicaria penstemonica (L.) M. Gomez [Polygonum pensylvanicum L. var. laevigatum Fern.] (pinkweed) [F] Sparse Norris 2011-8-11-21
Rumex acetosella L. (red sorrel) [F] Sparse Norris 2013-6-25-4
*Rumex altilissimus Wood (pale dock) [F] Sparse Norris 2013-6-1-9

PRIMULACEAE
Dodecatheon meadia L. (shooting star) [L, F] Common Lammers 3338

RANUNCULACEAE
Anemone cylindrica Gray (thimbleweed) [F] Sparse Freese 20 Sept 2008-36
Anemone patens L. var. multifida Pritzel [Pulsatilla patens (L.) P. Mill.] (pasque flower) [L]
Tallicium dasycarpum Fischer & Ave-Lall. (purple meadow-rue) [L, F] Infrequent Freese 20 Sept 2008-57

RHAMNACEAE

ROSACEAE
Fragaria virginiana Duchesne (wild strawberry) [L, F] Frequent Freese 12 May 2009-11
Geum triflorum Pursh (prairie smoke) [L, F] Frequent Lammers 3561

Potentilla arguta Pursh (prairie cinquefoil) [F] Infrequent Lammers 3730
*Potentilla recta L. (sulphur cinquefoil) [F] Sparse Freese 6 June 1998-4

Potentilla simplex Michx. (common cinquefoil) [F] Sparse Norris 2-13-6-2-10
Prunus americana Marsh. (wild plum) [F] Sparse Norris 2013-6-1-6
Prunus serotina Ehrh. (wild black cherry) [F] Sparse Norris 2011-8-11-31
Rosa arkansana Porter var. suffulta (Greene) Cockerell (sunshine rose) [L, F] Infrequent Freese 20 Sept 2008-31
Rosa blanda Aiton (meadow rose) [F] Infrequent Freese 20 Sept 2008-39
*Rubus idaeus L. (cultivated red raspberry) [L]
**Rubiaceae**

*Rubus occidentalis* L. (black raspberry) [F] Infrequent *Freese 17 July 1998-4*

*Spiraea alba* Du Roi (meadowsweet) [L, F] Infrequent *Freese 11 Aug 2009-36*

**Rubiaceae**

*Galium aparine* L. (cleavers) [F] Sparse *Norris 2013-6-2-7*

*Galium boreale* L. (northern bedstraw) [L, F] Frequent *Lammers 3565*

*Galium obtusum* Bigelow (wild madder) [F] Sparse *Freese 17 June 1998-2*

**Salicaceae**

*Populus deltoides* Bartram ex Marsh. (cottonwood) [F] Frequent *Freese 20 Sept 2008-5*

*Populus tremuloides* Michx. (quaking aspen) [L, F] Frequent *Freese 20 Sept 2008-4*

*Salix discolor* Muhl. (pussy willow) [L, F] Infrequent *Lammers 3724*

*Salix humilis* Marsh. (prairie willow) [L, F] Infrequent *Lammers 3336*

*Salix petiolaris* Smith (meadow willow) [F] Infrequent *Freese 20 Sept 2008-3*

**Sapindaceae** (formerly Aceraceae)

*Acer saccharinum* L. (silver maple) [F] Sparse

**Santalaceae**

*Comandra umbellata* (L.) Nutt. (bastard toadflax) [L, F] Infrequent *Freese 12 May 2009-6*

**Saxifragaceae**

*Heuchera richardsonii* R. Br. (alumroot) [L, F] Infrequent *Freese 6 July 2009-34*

*Micranthes pensylvanica* (L.) Haworth [Saxifraga pensylvanica L.] (swamp saxifrage) [L, F] Infrequent *Lammers 3333*

**Scrophulariaceae**

*Scrophularia lanceolata* Pursh (early figwort) [F] Sparse *Freese 17 June 1998-5*

**Solanaceae**

*Physalis heterophylla* Nees (ground cherry) [F] Sparse *Freese 11 Aug 2009-25*

*Physalis virginiana* P. Miller (ground cherry) Sparse [F] *Norris 2011-8-11-15*

*Solanum americanum* P. Miller (black nightshade) [F] Sparse *Freese 16 Sept 2000-7*

**Ulmaceae**

*Ulmus pumila* L. (Siberian elm) [F] Sparse *Freese 11 Aug 2009-30*

*Ulmus rubra* Muhl. (red elm) [F] Sparse *Norris 2011-8-11-34*

**Urticaceae**

*Parietaria pensylvanica* Muhl. ex Willd. (pellitory) [F] Sparse *Norris 2011-8-11-23*

*Urtica dioica* L. (stinging nettle) [F] Sparse *Norris 2013-6-1-4*

**Verbenaceae**

*Verbena urticifolia* L. (white vervain) [F] Sparse *Norris 2011-8-11-16*

**Violaeeae**

*Viola neprophylla* Greene (northern bog violet) [F] Frequent *Freese 11 Aug 2009-31*

*Viola pedata* L. (bird’s-foot violet) [L, F] Frequent *Lammers 3341*

*Viola pedatifida* G. Don. (prairie violet) [L, F] Frequent *Lammers 3342*

*Viola sororia* Willd. (hairy blue violet) [F] Sparse *Freese 6 June 1998-9*

**Vitaceae**

*Parthenocissus* sp. [F] Sparse *Norris 2013-6-1-1*

*Vitis riparia* Michx. (riverbank grape) [F] Sparse *Norris 2011-8-11-27*