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

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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, Phillippe 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 42.69989° N and long 92.77171° 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

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Fig. 1. Aerial photograph (2011) of Clay Prairie State Preserve and surrounding landscape. Aerial imagery is from the National Agriculture Imagery Program (NAIP).

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 (Thornwaite 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 [14°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 woody plants including gray dogwood (*Cornus foenina* 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.

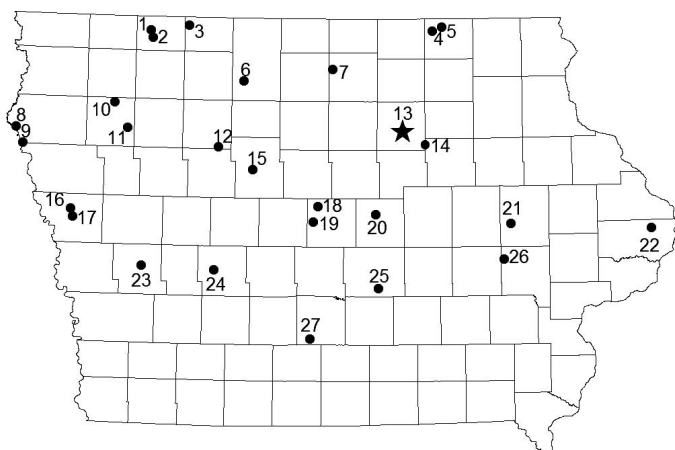


Fig. 2. Location of 27 Iowa state preserves with significant (> 30% of total area) prairie vegetation. See Table 1 for information about each preserve. Clay Prairie State Preserve indicated with a star.

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 ($\geq 38\%$) 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.

Number	Name	Iowa County	Prairie Area (ha)	Primary Prairie Community	Secondary Prairie Community	Flora(s)
3	Anderson Prairie	Emmet	80.9	NW Wet-mesic TG	NW Dry-mesic TG	Moats 1988, 1989, *Bice and James 2013
19	Richard W. Pohl Memorial Preserve at Ames High Prairie	Story	4.0	Mesic TG	Dry-mesic TG	*Freckmann 1966, Norris 1995, *Thompson 2013
1	Cayler Prairie	Dickinson	60.7	NW Wet-mesic TG	NW Dry-mesic TG	*Aikman and Thorne 1956, Smith et al. 1991
14	Cedar Hills Sand Prairie	Black Hawk	10.2	Dry-mesic sand TG		*Crum 1972, Glenn-Lewin 1981b, *Freese 2012
13	Clay Prairie	Butler	1.2	Wet-mesic TG	Mesic TG	Lantz 1969
4	Crossman Prairie	Howard	4.0	NE mesic TG		Glenn-Lewin 1981a, Bockenstedt 2004
23	Dinesen Prairie	Shelby	8.1	Mesic TG		Rosburg 2005a
18	Doolittle Prairie	Story	10.1	Wet-mesic TG		*Woodley 1983, *Wetzel et al. 1999
8	Five Ridge Prairie	Plymouth	121.4	LH Mid-grass	LH Dry-mesic TG	Duxbury 1982
2	Freda Haffner Kettlehole	Dickinson	30.4	NW Mid-grass	NW Dry-mesic TG	Gerhardt 1940, *Freese and Platt 1991
5	Hayden Prairie	Howard	97.1	NE Mesic TG	NE Wet-mesic TG	Moyer 1953, Christiansen 1993
7	Hoffman Prairie	Cerro Gordo	14.2	Wet-mesic TG		Christiansen 1999a
12	Kalsow Prairie	Pocahontas	48.6	Mesic TG	Wet-mesic TG	Moyer 1953, Richards 1970 based on Brotherson 1969, Dornbush 2004
25	Kish-Ke-Kosh Prairie	Jasper	6.1	Dry-mesic TG		Kurtz 1976, Wagner 1980, *Kessler 2002
15	Liska-Stanek Prairie	Webster	8.1	Mesic TG	Wet-mesic TG	Wilson 1979
22	Manikowski Prairie	Clinton	16.2	Dry-mesic lime TG		Cady 2002
20	Marietta Sand Prairie	Marshall	6.1	Dry-mesic sand TG	Mesic TG	Leoschke 1982, Christiansen 1999b
9	Mount Talbot	Plymouth, Woodbury	36.4	LH Mid-grass	LH Dry-mesic TG	Pearson and Fleckenstein 1989, *Hazlett 2003
11	Nestor Stiles	Cherokee	4.0	Mesic TG		Schennum and Dudley 1983, Pearson and Leoschke 1987
21	Rock Island	Linn	4.0	Dry-mesic sand TG		Cady 2003
27	Rolling Thunder	Warren	24.3	Mesic TG		Mabry 2002
24	Sheeder Prairie	Guthrie	10.1	Mesic TG	Dry-mesic TG	Kennedy 1969, Roosa 1989, Rosburg 1996
10	Steele Prairie	Cherokee	80.9	Mesic TG	Wet-mesic TG	Pearson and Fleckenstein 1987
6	Stinson Prairie	Kossuth	12.1	NW Wet-mesic TG	NW Dry-mesic TG	Glenn-Lewin 1976, Crist 1978
16	Sylvan Runkel	Monona	121.4	LH Mid-grass	LH Dry-mesic TG	Pearson 1996, Rosburg 2005b
17	Turin Loess Hills	Monona	80.9	LH Mid-grass	LH Bluff Mid-grass	Novacek-Bates 1989
26	Williams Prairie	Johnson	8.1	Wet TG	Wet-mesic TG	*Sorenson 1962

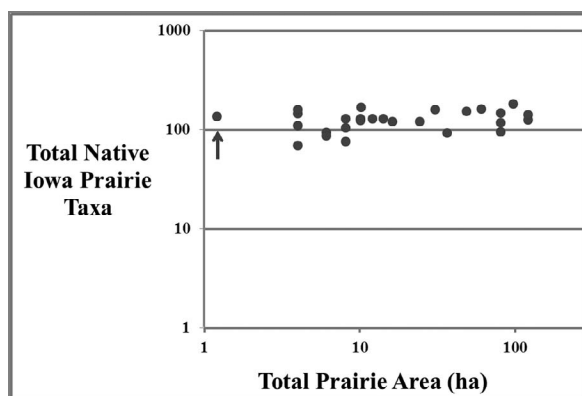


Fig. 3. Relationship between total number of native Iowa prairie plant taxa versus total prairie area for 27 prairies protected in the Iowa state preserve system. Clay Prairie State Preserve is identified by an arrow. Each of the 27 prairies is characterized in Table 1.

Administrative Code 2002) in Clay Prairie with those documented from the other 26 preserves.

RESULTS

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), *Symphotrichum* (6), *Solidago* (5), *Asclepias* (4), *Euphorbia* (4), and *Viola* (4). One 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 (pasque flower [*Anemone patens* L. var. *multifida* Fritzell], purple coneflower [*Echinacea angustifolia* DC.], rockrose [*Helianthemum bicknellii* Fern.], June grass [*Koeleria macrantha* {Ledeb.} Schultes], bunch-flower [*Melanthium virginicum* L.], sand dropseed [*Sporobolus cryptandrus* {Torrey} A. Gray], heart-leaved meadow parsnip [*Zizia aptera* {Gray} Fern.] and seven non-native taxa (cypress spurge [*Euphorbia cyparissias* 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 the mid-1980s. Finally, our observation of hairy

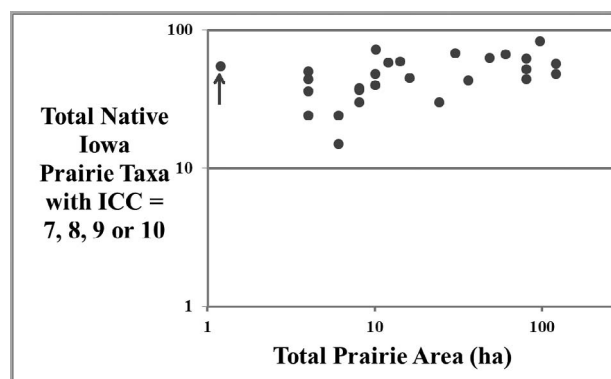


Fig. 4. Relationship between total number of native Iowa prairie plant taxa assigned high (7, 8, 9 or 10) values of the Iowa Coefficient of Conservation (ICC) versus total prairie area for 27 prairies protected in the Iowa state preserve system. Clay Prairie State Preserve is identified by an arrow. Each of the 27 prairies is characterized in Table 1.

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], Maximilian's sunflower [*Helianthus maximilliani* 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 ranged 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, or 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

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, Selser 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).

Finally, Clay Prairie State Preserve fulfills criterion d, justifying preservation of vegetation remnants in providing opportunities for people to experience prairie. Smith (1991), Camarata (1990, 1991, 1994, 1996, 1997, 1998) and Houseal (pers. comm. to author, July 27, 2015; unreferenced) describe numerous field trips and prairie management work days that took place at Clay Prairie in the early 1970s and through the late 2000s.

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* Nutt.) 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.

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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 officinale* 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 gravida* 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 wooly sedge) [F] Infrequent *Freese 17 July 1998-2*
- Carex pennsylvanica* 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]

- Hypoxis hirsuta* (L.) Cov. (yellow stargrass) [L, F] Frequent *Lammers 3345*

IRIDACEAE

- Iris srebveii* 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 6550*
- 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*

- **Dactylis glomerata* L. (orchard grass) [F] Sparse *Norris 2011-8-11-36*
Dichanthelium leibergii (Vasey) Freckm. (Leiberg's panic grass) [F] Infrequent *Freese 8 July 2000-1*
Dichanthelium ovale (Elliott) ssp. *praecocious* (Hitch. & Chase) Freckmann & Lelong [*Dichanthelium acuminatum* (Sw.) Gould & Clark var. *villosum* (Gray) Gould & Clark] (long-haired panic grass) [F] Infrequent *Freese 6 July 2009-17*
Dichanthelium oligosanthes (Schultes) Gould var. *scribnerianum* (Nash) Gould (Scribner's panic grass) [F] Infrequent *Freese 8 Aug 2000-1*
Elymus canadensis L. (Canada wild rye) [F] Infrequent *Freese 20 Sept 2008-30*
 **Elymus repens* (L.) Gould (*Agropyron repens* (L.) Beauv.) (quack grass) [F] Sparse *Freese 11 Aug 2009-32*
Elymus virginicus L. (Virginia wild rye) [F] Sparse *Freese 8 Aug 2000-2*
Hesperostipa spartea (Trin.) Barkworth [*Stipa spartea* Trin.] (porcupine grass) [L, F] Infrequent *Freese 6 July 2009-21*
Hordeum jubatum L. (squirrel-tail barley) [L, F] Sparse *Freese 6 July 2009-25*
Koeleria macrantha (Ledeb.) Schultes (June grass) [L]
Muhlenbergia mexicana (L.) Trin. (leafy satin grass) [F] Infrequent *Freese 20 Sept 2008-44*
Muhlenbergia racemosa (Michx.) BSP. (marsh muhly) [F] Infrequent *Freese 20 Sept 2008-45*
Panicum dichotomiflorum Michx. (knee grass) [F] Sparse
Phalaris arundinacea L. (reed canary grass) [F] Sparse *Freese 6 July 2009-22*
 **Pbleum pratense* L. (timothy) [L, F] Sparse
 **Poa pratensis* L. (Kentucky bluegrass) [L, F] Frequent *Freese 8 July 2000-2*
Schizachyrium scoparium (Michx.) Nash (little bluestem) [L, F] Infrequent *Freese 20 Sept 2008-46*
 **Setaria faberi* Herrm. (giant foxtail) [F] Sparse *Freese Sept 2008-18*
 **Setaria pumila* (Poiret) Roemer & Schultes ssp. *pumila* [*Setaria glauca* (L.) Beauv.] (yellow foxtail) [F] Sparse *Norris 2011-8-15-2*
 **Setaria viridis* (L.) Beauv. (green foxtail) [F] Sparse *Norris 2011-8-15-5*
Sorghastrum nutans (L.) Nash (Indian grass) [F] Infrequent *Loeschke 1 July 1983 - ISC 365127*
Spartina pectinata Link (slough grass) [L, F] Infrequent *Freese 8 Aug 2009-3*
Sporobolus cryptandrus (Torrey) A. Gray (sand dropseed) [L]
Sporobolus heterolepis (Gray) Gray (prairie dropseed) [F] Infrequent *Freese 20 Sept 2008-16*

ANGIOSPERMS: EUDICOTYLEDONS (formerly, Dicotyledons)

- ADOXACEAE [includes, CAPRIFOLIACEAE, in part]
Sambucus canadensis L. (Canada elderberry) [F] Sparse *Freese 8 Sept 2010-2*
 AMARANTHACEAE [includes CHENOPODIACEAE]
 **Amaranthus retroflexus* L. (pigweed) [F] Sparse *Freese 16 Sept 2000-2*
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*

APIACEAE

- 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 ASCLEPIACEAE]

- Apocynum sibiricum* 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

- Achillea millefolium* L. [*Achillea millefolium* L. ssp. *lanulosa* (Nutt.) Piper] (western yarrow) [L, F] Sparse *Freese 6 July 2009-14*
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'-tobacco) [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 flodmanii (Rydb.) 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] Infrequent Freese 20 Sept 2008-12
- Heliopsis helianthoides* (L.) Sweet (ox-eye) [L, F] Frequent Freese 20 Sept 2008-13
- Krigia biflora* (Walter) Blake (false dandelion) [L, F] Infrequent Freese 6 July 2009-6
- 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* L. (black-eyed Susan) [L, F] Sparse Freese 6 July 2009-12
- Silphium laciniatum* L. (compass plant) [L, F] Frequent Freese 20 Sept 2008-11
- Silphium perfoliatum* L. (cup plant) [F] Sparse Norris 2013-6-2-13
- 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 rigida* L. (stiff goldenrod) [F] Infrequent Freese 20 Sept 2008-7
- Solidago speciosa* Nutt. (showy goldenrod) [F] Infrequent Freese 20 Sept 2008-8
- Symphotrichum ericoides* (L.) G. L. Nesom [*Aster ericoides* L.] (heath aster) [F] Sparse Freese 20 Sept 2008-25
- Symphotrichum leave* (L.) A. Love & D. Love [*Aster laevis* L.] (smooth blue aster) [F] Frequent Lammers 4007
- Symphotrichum lanceolatum* (Willd.) G. L. Nesom [*Aster lanceolatus* Willd.] (panicled aster) [F] Frequent Freese 20 Sept 2008-26
- Symphotrichum novae-angliae* (L.) G. L. Nesom [*Aster novae-angliae* L.] (New England aster) [F] Infrequent Freese 20 Sept 2008-42
- Symphotrichum oolentangiense* (Riddell) G. L. Nesom [*Aster azureus* Lindley] (sky-blue aster) [F] Infrequent Grant 14966
- Symphotrichum pilosum* (Willd.) G. L. Nesom [*Aster pilosus* Willd.] (hairy aster) [F] Sparse Freese 20 Sept 2008-40
- **Taraxacum laevigatum* (Willdenow) de Candolle var. *erythrospermum* (Andrzejowski ex Besser) 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.) Lehm. (hoary puccoon) [L, F] Infrequent Freese 12 May 2009-1
- BRASSICACEAE**
- **Barbarea vulgaris* R. Br. (yellow rocket) [F] Sparse Freese 6 June 2000-19
- **Brassica rapa* L. [*Brassica campestris* L.] (field mustard) [L, F] Sparse Freese 6 June 2000-20
- **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 aparinoides* Pursh (marsh bellflower) [F] Infrequent Freese 8 July 2000-1
- Lobelia spicata* Lam. (spiked lobelia) [L, F] Infrequent Freese 6 July 2009-26
- Triodanis perfoliata* (L.) Nieuw. (Venus's looking-glass) [F] Sparse Freese 6 June 1998-10
- CARYOPHYLLACEAE**
- **Cerastium fontanum* Baumgarten [*Cerastium vulgatum* L.] (mouse-eared chickweed) [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**
- Cornus foemina* P. Miller ssp. *racemosa* (Lam.) J.S. Wilson (gray dogwood) [F] Common Freese 11 August 2009-18
- EUPHORBIACEAE**
- Euphorbia 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. (nodding 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*
- Lathyrus 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*
- **Medicago 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 pratense* L. (red clover) [F] Sparse *Freese 11 Aug 2009-39*
- **Trifolium repens* L. (white clover) [L]
- 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*
- Gentiana puberulenta* J. Pringle (downy gentian) [L, F] Sparse *Freese 20 Sept 2008-51*
- HYDROPHYLLACEAE
- Ellisia nyctelea* L. (wild tomato) [F] Sparse *Freese 6 July 2009-29*
- LAMIACEAE
- **Glechoma hederacea* L. (creeping Charlie) [F] Sparse *Freese 6 June 1998-1*
- Monarda fistulosa* L. (horsemint) [F] Frequent *Freese 6 Aug 1997-2*
- **Nepeta cataria* L. (catnip) [F] Sparse *Freese 16 Sept 2000-5*
- Pycnanthemum virginianum* (L.) Dur. & Jackson (common mountain mint) [L, F] Infrequent *Freese 20 Sept 2008-35*
- 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*
- OROBANCHACEAE [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*
- Oxalis violacea* L. (violet wood sorrel) [L, F] Frequent *Freese 12 May 2009-2*
- PLANTAGINACEAE [formerly SCROPHULARIACEAE, in part]
- Veronicastrum virginicum* (L.) Farwell (Culver's root) [L, F] Frequent *Freese 6 July 2009-3*
- POLEMONIACEAE
- Pblox pilosa* L. (prairie phlox) [L, F] Infrequent *Freese 6 July 2009-33*
- POLYGONACEAE
- Persicaria pensylvanica* (L.) M. Gomez [*Polygonum pensylvanicum* L. var. *laevigatum* Fern.] (pinkweed) [F] Sparse *Norris 2011-8-11-21*
- **Rumex crispus* L. (curly dock) [L, F] Sparse *Freese 11 Aug 2009-37*
- Rumex acetosella* L. (red sorrel) [F] Sparse *Norris 2013-6-25-4*
- **Rumex altissimus* Wood (pale dock) [F] Sparse *Norris 2013-6-1-9*
- PRIMULACEAE
- Dodecatheon meadia* L. (shooting star) [L, F] Common *Lammers 3338*
- Lysimachia ciliata* L. (fringed loosestrife) [L, F] Infrequent *Freese 20 Sept 2008-21*
- Lysimachia quadriflora* Sims (whorled loosestrife) [F] Infrequent *Freese 6 July 2009-5*
- RANUNCULACEAE
- Anemone canadensis* L. (Canada anemone) [L, F] Frequent *Freese 20 Sept 2008-35*
- Anemone cylindrica* Gray (thimbleweed) [F] Sparse *Freese 20 Sept 2008-36*
- Anemone patens* L. var. *multifida* Pritzell [*Pulsatilla patens* (L.) P. Mill.] (pasque flower) [L]
- Thalictrum dasyacarpum* Fischer & Ave-Lall. (purple meadow-rue) [L, F] Infrequent *Freese 20 Sept 2008-37*
- RHAMNACEAE
- Ceanothus americanus* L. var. *pitcheri* T. & G. (New Jersey tea) [L, F] Frequent *Freese 20 Sept 2008-27*
- 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*
- Prunus virginiana* L. (choke cherry) [L, F] Sparse *Freese 11 Aug 2009-25*
- 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]

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

VIOLACEAE

Viola nephrophylla 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