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# The Conservation Significance of Prairie Remnants in Missouri

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**ABSTRACT** How to conserve the great biodiversity of the prairie resource is a question of continuous debate. In Missouri the estimated 6,070,284 ha (15 million acres) of prairie at the time of Euro-American settlement has been reduced to an estimated 20,234–24,281 ha (50,000–60,000 acres) today, with 8,093 ha (20,000 acres) in conservation ownership. This valuable resource is rare now and is continuing to disappear. The Missouri Prairie Foundation (MPF), a nongovernmental organization celebrating its 50th anniversary in 2016, has acquired and protects 22 tracts that cover more than 1,335 ha (3,300 acres), comprised mostly of original unplowed prairie. These parcels, though limited in size, constitute a system of high quality native remnants. MPF has recently embarked on several surveys to document the biodiversity of these prairies. As funding and opportunity have allowed, surveys were conducted of flora, floristic integrity, bryophytes, soil biota, birds, pollinators, ants, lepidopterans, and odonates. These surveys are demonstrating that even relatively small remnants are supporting and perpetuating high levels of conservative and rare species and providing exciting new discoveries. Protecting remnant prairies, large and not so large, before they disappear is MPF's approach to conserving prairie biodiversity in Missouri and is an essential practice that needs to be included in any state's prairie conservation strategy.

**KEY WORDS** biodiversity, conservation significance, conservative species, floristic integrity, remnant

The fate of original prairie in Missouri parallels what has happened in other midwestern states. Estimates of prairie in Missouri at the time of Euro-American settlement are approximately 6 million ha (15 million acres), with an additional 2.8 million ha (7 million acres) of savanna and glade and 4.45 million ha (11 million acres) of woodlands (Nelson 2005). Today, estimates of remaining prairie remnants of reasonable quality fall within the 20,234–24,281-ha (50,000–60,000-acre) range, based on the state's Natural Heritage Database, of which approximately 8,093 ha (20,000 acres) is in conservation ownership (Missouri Natural Heritage Database 2016). This translates into a loss of 99.6% of the original prairie, and the loss of the remaining 0.4% continues. Most remaining tracts of remnant prairie in Missouri are less than 16 ha (40 acres) in size (Missouri Natural Heritage Database 2016)

Here, I address the status and conservation significance of remnant prairies in Missouri by focusing on those owned and managed by the Missouri Prairie Foundation (MPF), and consider the most vulnerable and irreplaceable elements, the conservative and prairie-dependent species, that MPF targets in conservation efforts. In "Summary of the Surveys of Missouri Prairie Foundation Prairies," I briefly report on the surveys that have occurred on MPF prairies and what they tell us about the conservation significance of the sites, including several examples of significant discoveries on individual prairie remnants. It is hoped that these results stimulate protection of additional remnant prairies for the conservation of biodiversity.

For many years, there was consensus among conservation nongovernmental organizations (NGOs) and agencies to acquire tracts of remnant prairie, even relatively small tracts, for protection. In recent years though, the emphasis seems to have shifted toward large-scale reconstructions with little interest in protecting the extant prairie remnants. An issue of concern is how can the remaining biodiversity, rare species, and healthy natural communities best be conserved? The approach of MPF to answering this question is to concentrate on continuing to acquire and support the conservation ownership of the remaining tracts of remnant prairie. These prairie remnants, regardless of size, possess qualities that are crucial to the understanding and functioning of these natural communities. Many prairie species have so far been found only in remnants, with little or no indication they can be conserved in constructed grasslands (M. Arduser, Missouri Department of Conservation Natural History Biologist (retired), personal communication), or only at great expense. Moreover, with limited financial resources for conservation, we want to make sure our efforts are most efficient for acquisition and for short- and long-term management.

MPF is a membership-driven NGO and land trust, recently celebrating its 50th anniversary. MPF was founded in 1966 to protect prairies by acquisition, education, and advocacy. Currently, MPF owns 22 tracts of land covering 1,338 ha (3,333 acres) and including 706 ha (1,760 acres) of remnant original prairie (see Appendix A for a full list of MPF prairies).

In *Round River*, Leopold (1993) eloquently wrote about the need to protect the full array of biota, even if we do not yet understand its role in the ecosystem. In addition, he

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wrote and that “to keep every cog and wheel is the first precaution of intelligent tinkering.”

When considering the conservation significance of the biota, we must remember there is a difference between prairie species and grassland species. Grassland species, as defined here, are those that do not depend on a natural community (and certainly not a high-quality natural community) to survive. These species mainly need an open grassland structure, sometimes requiring native grasses and/or some level of native forbs, but other times not. This category includes grassland birds, non-conservative plants, and many insects considered to be remnant-independent species. Prairie species are those that require an intact remnant native prairie community, and include “conservative” plant species, and insects that are considered “conservative,” “remnant dependent,” or “prairie dependent” by Panzer et al. (1997).

The concept of species conservatism was developed for Missouri flora by Doug Ladd and published by Ladd and Thomas (2015). Ecological conservatism is based on native species responding differently to changes and alterations in the landscape. The two tenants of this concept are as follows: 1) some species can tolerate greater disturbances to their environment, and respond differently than others; and 2) species have varying degrees of fidelity to intact natural communities, ecological processes, and natural disturbance regimes. Thomas (2016a) describes the coefficient of conservatism (CC value) as a 0–10 value assigned to every native species, indicating the likelihood that that species is part of a stable and relatively undisturbed natural community. Species with values of 0–3 show little connection with remnant natural habitats and will opportunistically occupy disturbed areas. The matrix species of intact natural communities are those with values in the 4–6 range. Species with values of 7–10 are the conservative species that show high fidelity to high-quality stable natural communities (Ladd and Thomas 2015). It is intuitive that the conservation significance of species in a world of rare and fragmented natural communities is not the same. Low CC value species are ubiquitous on the landscape and need no special conservation effort; however, the high CC value conservative species largely need native remnant habitats with significant ecological integrity if they are to be conserved in the landscape.

The term “conservative species” is sometimes used by entomologists to refer to species that are restricted to remnants of original prairie; however, other terms such “remnant dependent,” “pollen specialist,” and “prairie specialist” are also used to convey a similar message. The following references provide an indication of how many species of insects may be restricted to original prairie remnants.

Henderson (2015) compiled a partial list of 475 insect species in Wisconsin that are deemed to be tightly

associated with, and even restricted to, areas of native prairie. When the total list of regional insect species is evaluated, the actual number of prairie restricted insects in the region may be 1,900 species or more. Panzer et al. (1995) conducted extensive sampling of insects in prairie remnants and degraded habitats in the Chicago region and found 256 species (23% of the 1,100 species recorded) to be moderately or highly remnant dependent. Metzler et al. (2005) evaluated 347 lepidopteran species in the Midwest for prairie dependence and concluded that 109 species were prairie dependent and an additional 26 species are potentially prairie dependent in the tallgrass prairie region. Arduser (personal communication) reported that more than 200 of the approximately 460 bee species known from Missouri inhabit prairie. Many of these prairie bees are pollen specialists (monolectic and oligolectic), which are often dependent on conservative forbs, and others are conservative species found only in remnant prairies.

Missouri’s Checklist of Species of Conservation Concern lists 18% of the state’s native vascular plants, 14% of the nonvascular plants, 28% of vertebrate animals, and a relatively small number of invertebrates. The checklist does not break the flora and fauna into elements of particular ecosystems, but it includes species that the Missouri Department of Conservation considers vulnerable or experiencing significant population declines, and many of these are prairie species (Missouri Natural Heritage Program 2017).

The list is long of species of flora and fauna that need remnants of original prairie. These are the elements of our biodiversity that are the most irreplaceable and will not be conserved if these prairie remnants disappear.

In an effort to ascertain the true conservation significance and the most irreplaceable elements of the biodiversity of the prairie remnants in its portfolio, MPF encourages, supports, and contracts for numerous inventories, surveys, and studies. The surveys and observations referenced here are the result of contracted professionals, agency biologists, volunteer professionals, and amateur biologists.

## **SUMMARY OF THE SURVEYS OF MISSOURI PRAIRIE FOUNDATION PRAIRIES**

A comprehensive botanical inventory of all MPF remnant prairies was conducted in 1997 and 1998 (Ladd and Churchwell 1999), with notes on important floristic elements and management recommendations. Of the nine remnant prairies inventoried, the number of native species ranged from 220 to 337 and the mean CC value ranged from 3.6 to 4.2. The report establishes the quality of MPF remnant prairies and the conservative elements of the flora. Using this same methodology in northern Illinois to identify natural areas, a mean CC value for a site of at least 3.5 is

Table 1. MPF remnant prairies with the number of known native vascular plant species, the number of conservative plant species ( $CC \geq 7$ ), and the mean CC value of the native species.

Prairie Name	No. of Native Species	No. of Species $CC \geq 7$	Native Mean CC
Snowball Hill	152	41	5.43
Brown	131	34	5.10
Linden's	198	39	4.69
Carver	206	36	4.54
Coyne	174	27	4.54
La Petite Gemme	335	53	4.28
Stark	207	23	4.27
Pleasant Run Creek	253	33	4.20
Penn-Sylvania	289	40	4.20
Gay Feather	288	37	4.17
Friendly	305	37	4.11
Golden	320	35	4.06
Denison/Lattner	299	33	4.05
Schwartz	351	35	4.04
Drover's	252	28	3.83
Stilwell	325	36	3.81

considered to have natural area potential (Swink and Wilhelm 1994).

A plant list database is being used to keep a comprehensive, updated list of the flora for each MPF remnant prairie. The list includes the Ladd and Churchwell (1999) survey and all subsequent surveys and observations. MPF prairies support up to 350 native vascular plant species, with a range of 23–53 conservative species per site. Looking at the mean native CC value is perhaps a better indicator for comparison because of differences in size and physical characteristics of each site. In Missouri today, most of the landscape has a mean native CC value below 3.0 (Ladd and Thomas 2015), and in such a highly fragmented landscape a site with a mean native CC value of near 4.0 or more is considered to hold a level of natural integrity that is missing in most areas. Currently, MPF prairies have a mean native CC value of 3.8–5.4. It is also encouraging how even the smaller remnants that MPF owns, including the newest acquisitions, have maintained their diversity and conservative flora for many decades despite being isolated remnants (Table 1).

MPF has contracted with the Institute of Botanical Training for floristic integrity surveys since 2012. These surveys are designed “as the most practical way to collect statistically meaningful data regarding three interrelated variables: species richness, floristic quality and species

Table 2. Prairies sampled to date, the mean native CC/plot, the average number native species per plot, and the number of plots sampled in the prairie.

Prairie Name	Mean CC/Plot	Mean native Species/Plot	No. of Plots
Penn-Sylvania	4.7	89	3
Golden	4.4	79	6
Coyne	4.2	88	4
La Petite Gemme	4.4	100	3
Linden's	4.8	79	3
Carver	4.7	72	3
Pleasant Run Creek	4.3	71	3

diversity” (Thomas 2015). To date, these surveys have been conducted on MPF's Coyne Prairie (2012), Golden Prairie (2013), Penn-Sylvania Prairie (2014), La Petite Gemme Prairie (2015), Linden's Prairie (2015), Pleasant Run Creek Prairie (2015), and Carver Prairie (2016). There are three to six sampling plots per prairie, and each plot consists of 25 one-quarter square meter quadrats (a total of 6.25 square meters). The quadrats are randomly spaced along five parallel transects. For each of the prairies sampled the average number of species per plot ranges between 67 and 100, with mean native CC values from 4.2 to 4.8. Four of the individual quadrats (two at La Petite Gemme Prairie and two at Penn-Sylvania Prairie) contained more than 30 species each. The floristic integrity surveys are not designed to only document the current state of the flora but also to compare with future sampling to determine changes in flora over time, which will have implications for management (Thomas 2015, 2016a, 2016b) (Table 2).

Insect surveys are frequently limited by the lack of authorities to conduct the surveys and/or identify specimens to the species level. MPF is continually looking for opportunities to support research activities on insects that use or are restricted to prairies. In 2013, MPF contracted with Richard Day to survey eight of its prairies for adult odonates. The survey listed 31 species found on those prairies, ranging from 8 to 19 species per site (Day 2013). James Trager has surveyed ants during the annual bioblitz for 3 yr, recording 11–13 species at each prairie (Trager 2010, 2013, 2014). These surveys are adding valuable information to the known biodiversity of these sites for two important groups of insects, although to date the species found are generalist grassland species and are not considered to be prairie specialists, which is consistent with findings from other studies on prairie specialist insect species (Panzer et al. 1995).

MPF contracted with bee expert Michael Arduer to survey several of its properties. Surveys were completed for

Golden, Stilwell, and Pleasant Run Creek prairies and are in progress for Linden's, Carver, and Snowball Hill prairies. At Golden Prairie, 44 species of bees were observed, including 9 species considered to be conservative species and 17 species that are pollen specialists. For two of these 44 species, this record was only the second in the state. On Stilwell Prairie, there were 50 species, four conservative species and 12 pollen specialists with one being a state record (Arduser 2014). Pleasant Run Creek Prairie had 25 species, 4 conservative and 9 pollen specialists (Arduser 2015a); and this prairie was just acquired and was hayed annually until the year before the survey. Many species of bees, such as bumble bees, are grassland generalists that do not rely strictly on natural prairie communities, yet native prairies provide important habitats for many of them. Many other bees, though, are pollen specialists and are completely dependent on particular species or genera of prairie plants to survive (Arduser 2015b; see Appendix B). Some species are found only on actual remnants and apparently are not able to survive in reconstructed prairies, even if their required plant species are established in the planting. For some of these bees, the remnant prairie can be as small as a few acres. As an example, MPF's Joplin tract has a tiny remnant of less than 0.5 ha (1.2 acre) with a population of the state-listed pollen specialist *Andrena beameri* persisting on a population of bigflower coreopsis (*Coreopsis grandiflora*) (M. Arduser, personal communication).

Surveys for Lepidoptera have occurred on many MPF prairies, although no comprehensive studies have been conducted to date. Diurnal surveys show that at least 11 MPF prairies support the regal fritillary (*Speyeria idalia*), a prairie specialist and Missouri species of conservation concern. The golden byssus skipper (*Problema byssus*), also a prairie specialist, has been found at Schwartz and Snowball Hill prairies (Koenig 2016, Williams 2017). Moths have provided some very notable recent discoveries. The olivaceous phaneta moth (*Phaneta olivaceana*) found in 2015 at La Petite Gemme Prairie was only the second record for the state and the first in 35 yr (Koenig 2016). In 2016, *Amphipoea erepta*, a probable prairie specialist, was collected at Linden's Prairie, representing only the eighth Missouri record (Koenig 2016). At Carver Prairie in 2016, the rare prairie specialist noctuid moth *Dichagyris reliqua* was found for only the fourth time in the state and the first time in 17 yr (Koenig 2016). Friendly and Drover's prairies were among the sites where a 2015 survey recorded the rattlesnake master stem borer (*Papaipema eryngii*), a very rare prairie specialist, for the first time in the state (Wiker 2016). Lepidoptera are similar to bees with many generalist grassland species but also a number of prairie specialists. Additional and more thorough surveys are likely to find other prairie-restricted species.

A breeding bird survey was conducted on nine MPF prairies in 2011, 2012, and 2014 (Cantrell 2011, 2012,

2014). Eight of the target grassland bird species used by the Missouri River Bird Observatory (2016) were regularly found on these nine prairies. Of these target grassland birds, northern bobwhite (*Colinus virginianus*), dickcissel (*Spiza americana*), eastern meadowlark (*Sturnella magna*), and grasshopper sparrow (*Ammodramus savannarum*) were found at all MPF prairies surveyed; Henslow's sparrow (*Ammodramus henslowii*) at eight of the nine prairies; field sparrow (*Spizella pusilla*) at seven; Bell's vireo (*Vireo bellii*) at five; and yellow-breasted chat (*Icteria virens*) at four. Surveys on MPF and other prairies indicate that grassland birds do well on native prairies managed for their ecological integrity. These grassland birds are not prairie-dependent species that require original remnant prairie, and they can do very well in prairie plantings, warm-season grass fields, and even in some non-native grasslands (Jacobs and Wilson 1997, Helzer 2011). They have however suffered among the steepest population declines of any suite of birds in North America (North American Bird Conservation Initiative, U.S. Committee 2014) and are part of the prairie community; therefore, we still consider them to be conservation targets. Surveys on MPF prairies show that indeed these prairies, even some of the smaller prairies such as Gay Feather and La Petite Gemme, continue to benefit the conservation of these target grassland species.

MPF remnant prairies support 59 populations of 28 species of conservation concern, including two federally threatened species and two federal candidate species (see Appendix C for a full list of species of conservation concern on MPF prairies). These prairies were acquired to protect the remnant prairie natural communities, not specific species of conservation concern, and most of these species were discovered well after acquisition. Protecting the remnant prairie natural community, even on our smallest remnants, has resulted in conservation of many of the state's most vulnerable species.

Since 2010, MPF has conducted its annual prairie bioblitz on one of its prairies. The bioblitz, conducted in early June, combines authorities in numerous natural history fields with interested participants. Each bioblitz has added more information to the known resources of that prairie. Discoveries of the Arkansas darter (*Etheostoma cragini*), a candidate for federal listing, in a headwater stream at Golden Prairie; the state-listed pale green orchid (*Plantanthera flava*) at Schwartz Prairie; and the second state record of the olivaceous phaneta moth at La Petite Gemme Prairie are among the notable discoveries to date on the prairie bioblitzes.

The following four MPF prairies provide examples of what we have learned on a site-by-site basis. These examples demonstrate the overall conservation significance of these remnant prairies, including the smaller prairies such as La Petite Gemme and Snowball Hill. They also show that remnants, isolated for many decades continue to support

their conservative flora, prairie-dependent fauna, and rare species.

**La Petite Gemme Prairie** is a 15-ha (37-acre) prairie in Polk County. It was protected by MPF in 1969. A 1999 botanical inventory of MPF prairies (Ladd and Churchwell 1999) listed 277 native taxa, with a native mean CC value of 4.2. The prairie is also known to support the state-listed prairie mole cricket (*Gryllotalpa major*) and bullsnake (*Pituophis catenifer*) as well as a compliment of grassland birds including Henslow's sparrow and northern bobwhite. In 2015, this "little gem" prairie demonstrated that after 40 yr of conservation ownership, the quality of the conservative vegetation is still doing well, and additional floral and faunal discoveries are there to be made. During MPF's annual prairie bioblitz, 18 species of bryophytes were recorded, including *Trematodon longicollis*, an S1 species in Missouri (Holmberg 2015). The olivaceous phaneta moth was documented for only the second time in Missouri. Fourteen native vascular plants were added to the species list, and these newly discovered species had a mean native CC of 5.4, indicating that many of these new additions are conservative species. Later in 2015, the Institute of Botanical Training, during sampling for a Floristic Integrity Report, found 38 and 37 plant species in two of the one-quarter square meter quadrats, the highest species diversity in that size quadrat they have ever encountered in Missouri (Thomas 2016a). However, not only was the species richness extremely high but also the mean native CC value of the first quadrat was 4.9, indicating a very conservative floristic component.

**Linden's Prairie** is a 69-ha (171-acre) isolated remnant prairie in Lawrence County. The prairie was acquired in 2014. Currently, 198 native plant taxa have been recorded for the prairie, with a mean native CC value of 4.7 and 39 conservative species. The Institute of Botanical Training survey in 2015 yielded mean native CC values for the plots of 4.6, 4.8, and 5.0, indicating a floristically significant prairie very worthy of protection (Thomas 2016a). In addition, several state-listed species have been found: the regal fritillary, the moss *T. longicollis* (Holmberg 2016), and the bee *A. beameri* (M. Arduser, personal communication). There is a large population of royal catchfly (*Silene regia*), which has been regarded as perhaps the largest known for this conservative species (Menges and Dolan 1998). In 2016, the moth *A. erepta*, potentially a prairie specialist, was discovered here as only the eighth Missouri record.

**Carver Prairie** is a 26-ha (65-acre) remnant prairie in Newton County, acquired by MPF in 2015. Currently, the flora of the prairie includes 206 native species, with a mean native CC of 4.5 and 36 conservative species. The state-listed Barbara's buttons (*Marshallia caespitosa*) occurs here. During a floristic integrity survey in 2016, two notable species were discovered: *Lysimachia linearis*, which is the first naturally occurring record for the state, and bushy bluestem (*Andropogon hirsuitior*), also a state record

(Thomas 2016b). A state-listed rare noctuid moth, *D. reliqua*, was rediscovered in the state after 17 yr at this site in 2016.

**Snowball Hill Prairie** is a 9-ha (23-acre) isolated remnant in Cass County. The prairie was acquired in 2015 by the MPF and the Platte Land Trust. Since acquisition, MPF has compiled a plant list of 152 native species, with a mean native CC of 5.4 and 41 conservative species. The 5.4 mean native CC value is the highest for any MPF site. Besides retaining such a high overall floristic quality for many decades as a small, isolated remnant, the state-listed interior bluegrass (*Poa interior*) was recorded from this site in 1987. Recent additions to the flora have included the state-listed auriculate false foxglove (*Agalinis auriculata*), small-headed rush (*Juncus brachyphyllus*), *Panicum leibergerii*, and the federally threatened Mead's milkweed (*Asclepias meadii*). Williams (2017) reported the prairie specialist butterfly, the golden byssus skipper, in 2016 and 2017.

## DISCUSSION

MPF is devoted to protecting the full array of prairie biodiversity and maintaining healthy, functional examples of prairie natural communities on its land. To do so requires knowing what species are present and what species possess the greatest conservation significance. For example, the native partridge pea (*Chamaecrista fasciculata*) is ubiquitous in the landscape, and its continuing existence does not depend on having ecologically significant remnant prairies to survive in the wild. However, the prairie grass pink orchid (*Calopogon oklahomensis*) is a rare conservative species that is basically irreplaceable if lost to the system and is, therefore, a target of great conservation significance.

Soil biota and microbial communities are still poorly known; therefore, we lack specifics even though some soil sampling has been conducted on MPF prairies. However, Kremer and Veum (2015) emphasized that floristically diverse remnant prairies support the greatest diversity of soil microbiota of any terrestrial ecosystem globally, and this soil microbiota is responsible for major ecological functions of the prairie. At this time, it would seem that conserving this crucial, although still largely unknown, element of prairie biodiversity is best, or maybe only accomplished by protecting remaining remnant prairies that possess high floristic integrity.

Currently, however, there is a trend among conservation agencies and many NGOs to work on large-scale prairie reconstructions, which often means passing on opportunities to protect smaller-scale examples of remnant original prairies. Perhaps this trend is partly due to concerns about the long-term viability of flora and fauna in scattered small prairie remnants (Helzer 2012). However, recent surveys of MPF prairies and data from other sites in the Midwest would seem to make a good case for the continuing conservation

significance of these remnants, even relatively small remnants. After many decades of isolation, MPF prairies are still showing a high level of native floristic diversity, conservatism, and floristic integrity as well as supporting many species of conservation concern, prairie-restricted, and conservative insects, and a full array of more generalist grassland species of flora, insects, and birds. These results are consistent with other reports. Gnaedinger (2013) noted that the size of a remnant prairie was not that important for insect conservation and that small sites are valuable. Arduser (personal communication) stated that small prairie remnants are important for pollen specialist bees. J. Thomas of the Institute of Botanical Training and NatureCITE (personal communication) described small cemetery prairie remnants known to support a high-quality conservative flora after 150 yr of isolation. Similarly, Helzer (2012) reported there were many cases of very small prairies maintaining their plant and insect species after being isolated from other prairies for more than a century.

Above and beyond the values of planted grassland, the true conservation significance of prairie remnants rests in the irreplaceable elements of the biota they support. Missouri's original prairies have been reduced to less than 0.4% of their original extent. There are still an estimated 12,140–16,187 ha (30,000–40,000 acres) of extant remnant prairie not in conservation ownership, but the loss of these prairies continues. What are the most irreplaceable resources of prairie? The soil biota, the rare species, the conservative species, the prairie specialists, these are the things that can be most easily lost when the remnants disappear and are least likely to be conserved.

MPFs strong interest in inventory, research, and monitoring of its sites will continue to help identify the most significant conservation elements at each site and provide benchmarks for future conservation planning and management. Protecting these examples of the true prairie provides the best way to save as much as possible of the complete biodiversity of the prairie and all of Leopold's "cogs and wheels." MPF has continued to, and even increased, efforts to acquire and protect these remaining priceless gems and hopes other conservation entities will, too.

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have worked to protect and manage these remnant prairies for their natural biodiversity, providing sites to study these natural communities. I also thank two anonymous reviewers and the editor for numerous comments and suggestions that greatly improved this manuscript.

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Appendix A. MPF properties: the year(s) acquired, tract name, hectares (acres) of the site, hectares (acres) of the remnant prairie portion, and the county in which the prairie is located.

Year(s) Acquired	Tract Name	ha (Acres) of Site	ha (Acres) of Remnant	County
1969	Friendly	16 (40)	16 (40)	Pettis
1970, 1975	Golden	254 (630)	129 (320)	Barton
1971	Penn-Sylvania	64 (160)	64 (160)	Dade
1974	La Petite Gemme	15 (37)	15 (37)	Polk
1976	Gay Feather	30 (76)	30 (76)	Vernon
1981	Drover's	32 (80)	32 (80)	Pettis
1991	Schwartz	97 (240)	80 (200)	St. Clair
1993	Lattner	48 (120)	32 (80)	Vernon
1993	Denison	129 (320)	64 (160)	Barton
1995	Stilwell	152 (376)	52 (130)	Vernon
2001	Bruns tract	64 (160)		Pettis
2002	Prairie Fork	80 (200)		Callaway
2006	Coyne	32 (80)	32 (80)	Dade
2006	Runge	16 (40)		Adair
2010	Welsch tract	32 (80)		Dade
2013	Stark	14 (34)	14 (34)	Hickory
2014	Joplin tract	3 (8)	0.5 (1)	Jasper
2014	Linden's	69 (171)	69 (171)	Lawrence
2014	Pleasant Run Creek	72 (180)	33 (84)	Vernon
2015	Snowball Hill	29 (74)	9 (23)	Cass
2015	Carver	65 (163)	26 (65)	Newton
2016	Brown	25 (64)	8 (19)	Newton
Total		1,338 (3,333)	706 (1,760)	

Appendix B. Notable plant pollen specialist bees reported from MPF prairies (Arduser 2015b).

Bee Species	Plant Associate	Prairie	State Record
<i>Andrena helianthiformis</i>	<i>Echinacea pallida</i> , <i>Echinacea simulata</i>	Linden's	
<i>Tetraloniella cressoniana</i>	<i>Salvia azurea</i>	Golden	2nd record
<i>Colletes robertsonii</i>	<i>Amorpha canescens</i> , <i>Dalea</i> spp.	Golden	
<i>Andrena quintilus</i>	<i>Amorpha canescens</i>	Golden	
<i>Tetraloniella albata</i>	<i>Dalea</i> spp.	Golden	
<i>Melissodes intorta</i>	<i>Callirhoe</i> spp.	Golden	2nd record
<i>Osmia distincta</i>	<i>Penstemon</i> spp.	Pleasant Run Creek	
<i>Adrena beameri</i>	<i>Coreopsis</i> spp.	Friendly, Drover's Linden's Prairie, Joplin tract	
<i>Nomia universitatis</i>	<i>Psoralea tenuiflora</i>	Pleasant Run Creek	
<i>Tetraloniella spissa</i>	<i>Helianthus</i> spp.	Stilwell	State record

Appendix C. Missouri species of conservation concern found on MPF prairies. Listed by taxonomic group. Ranking (S1, S2, S3, and SU) of Missouri species of concern is described at the end of the appendix.

Group	Species	Common Name	Ranking	Prairie Name
Bryophyte	<i>Riccia hirta</i>	Liverwort	S2	Schwartz
Bryophyte	<i>Pohlia annotina</i>	Moss	S2	Schwartz
Bryophyte	<i>Trematodon longicollis</i>	Moss	S2	La Petite Gemme Linden's
Vascular plant	<i>Juncus brachyphyllus</i>	Small-headed rush	S1	La Petite Gemme Snowball Hill
Vascular plant	<i>Juncus debilis</i>	Weak rush	S1	Penn-Sylvania
Vascular plant	<i>Rhynchospora macrostachya</i>	Horned rush	S1	Drover's
Vascular plant	<i>Rhynchospora harveyi</i>	Harvey's beak rush	S1	Pleasant Run Creek Schwartz
Vascular plant	<i>Poa interior</i>	Inland bluegrass	S1	Snowball Hill
Vascular plant	<i>Perideridia americana</i>	Wild dill	S2	Stark Stilwell Stilwell
Vascular plant	<i>Marshallia caespitosa</i>	Barbara's buttons	S3	Brown Carver
Vascular plant	<i>Calopogon oklahomensis</i>	Prairie grass pink orchid	S2	Brown Gay Feather Penn-Sylvania Pleasant Run Creek Schwartz
Vascular plant	<i>Xyris torta</i>	Yellow-eyed grass	S1	Gay Feather
Vascular plant	<i>Plantanthera flava</i>	Pale green orchid	S2	Schwartz
Vascular plant	<i>Panicum leibergii</i>	Leiberg's panic grass	SU	Snowball Hill
Vascular plant	<i>Opuntia macrorhiza</i>	Low prickly pear	S2	Stilwell
Vascular plant	<i>Bouteloua gracilis</i>	Blue grama	S1	Stilwell
Vascular plant	<i>Agalinis auriculata</i>	Auriculate false foxglove	S3	Snowball Hill
Vascular plant	<i>Eleocharis lanceolata</i>	Lance-like spike rush	S2	Schwartz
Vascular plant	<i>Asclepias meadii</i>	Mead's milkweed	S2	Fed-thr Friendly Gay Feather La Petite Gemme Snowball Hill Stilwell
Vascular plant	<i>Geocarpon minimum</i>	Geocarpon	S2	Fed-thr Schwartz
Insect	<i>Gryllotalpa major</i>	Prairie mole cricket	S3	Friendly Golden La Petite Gemme Penn-Sylvania Schwartz
Insect	<i>Andrena beameri</i>	Andrenid bee	S3	Friendly Drover's Linden's Joplin tract

## Appendix C. Continued.

Group	Species	Common Name	Ranking	Prairie Name
Insect	<i>Dichagyris reliqua</i>	Noctuid moth	S1	Carver
Insect	<i>Speyeria idalia</i>	Regal fritillary	S3	Carver Drover's Friendly Gay Feather Golden Linden's Penn-Sylvania Pleasant Run Creek Schwartz Stilwell
Insect	<i>Papaipema eryngii</i>	Rattlesnake master borer moth	Fed-candidate	Friendly Drover's
Fish	<i>Etheostoma cragini</i>	Arkansas darter	Fed-candidate	Golden
Amphibian	<i>Lithobates areolatus circulosus</i>	Northern crawfish frog	S3	Penn-Sylvania Schwartz
Reptile	<i>Pituophis catenifer sayi</i>	Bullsnake	SU	La Petite Gemme

Definition of ranking species of concern in the Missouri species and communities. "STATE RANK Assigning national and subnational conservation status ranks for species and ecosystems (ecological communities and systems) follows the same general principles as used in assigning global status ranks. Subnational ranks are assigned and maintained by the Missouri Natural Heritage Program (MONHP). S1: Critically Imperiled: Critically imperiled in the state because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state. S2: Imperiled: Imperiled in the state because of rarity due to very restricted range, very few populations or occurrences, steep declines, or other factors making it very vulnerable to extirpation from the state. S3: Vulnerable: Vulnerable in the state due to a restricted range, relatively few populations or occurrences, recent and widespread declines, or other factors making it vulnerable to extirpation. S4: Apparently Secure: Uncommon but not rare; some cause for long-term concern due to declines or other factors. S5: Secure: Common, widespread, and abundant in the state. S#S#: Range Rank: A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4). SU: Unrankable: Currently unrankable due to lack of information or due to substantially conflicting information about status or trends." (Missouri Natural Heritage Program 2017).