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Survey of the critically endangered Rusty Patched Bumble bee (*Bombus affinis*) at Midewin National Tallgrass Prairie, (USDA-FS) Ill.

Anne Hughes

Olivet Nazarene University, anne.c.hughes@att.net

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**Survey of the critically endangered Rusty Patched
Bumble bee (*Bombus affinis*) at Midewin National
Tallgrass Prairie, (USDA-FS) III.**

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Student: Anne Hughes-Wagner, Zoology undergrad

Faculty: Derek W. Rosenberger, M.A., PhD

Abstract:

Bumble bees (*Bombus spp.*) are important pollinators of many plants around the world. Recent declines in populations and range(s) of *Bombus spp.* are attributed to habitat loss, pesticide use and invasive pathogens. Four species have undergone notable declines in Illinois, with one, the rusty patched bumble bee (*B. affinis*), recently being listed as endangered under the Endangered Species Act. Prairie restoration over the past 20 years at Midewin National Tallgrass Prairie, a 20,000 acre preserve near Wilmington, IL, has resulted in much florally rich prairie habitat, yet no comprehensive survey for *B. affinis* has been conducted, despite known populations in several surrounding counties. In this study we recorded the presence of all bumble bee species in Midewin across 12 transects in June-August 2018. Nearly 800 bumble bees, representing a total of 9 species were recorded during this survey. *B. affinis* was observed just once during our transect surveys, the first known record in Will county, comprising just 0.13% of all bumble bees captured. Three other bumble bee species of conservation concern, *B. vagans*, *B. pensylvanicus* and *B. fervidus* were also found, representing 10% of all captured bumble bees. The results of this study show that Midewin currently supports bumble bee species of conservation concern and efforts should be made to support these populations.

Introduction:

Bombus species populations are on the decline worldwide with several species in Illinois at historic lows (Cameron et al. 2001). *B. fervidus*, *B. pensylvanicus* and *B. affinis* are all species whose populations have declined from historical numbers (Cameron et al. 2011, Grixti et al. 2009, USFWS 2017). Indeed, for the first time in North America, a bumble bee that was historically found in Illinois, *B. affinis*, has been listed under the Federal Endangered Species Act (Grixti 2009, USFWS 2017). There are many factors at play that have led to the decline in *Bombus* species including pesticide use, invasive pathogens being introduced and habitat loss (Colla & Packer 2008, Clark et al. 1973, Gels et al. 2002, Szabo et al. 2012).

The details of the life cycle of *B. affinis* are not completely known but are generally as follows. The queens emerge from hibernation in the spring, earlier than many other *Bombus* species, and that same queen stays alive deep into the fall (Williams et al. 2014). Based on the short length of the tongue, the food sources required for *B. affinis* are more limited than some of the other *Bombus* species also found foraging in the same territories (Colla & Packer 2008, Gels 2002). The underground nest sites are theorized to be in forested areas where the spring floral resources are located. *B. affinis* will forage along the edge of forest areas in late spring and can be found feeding on such flowers as *Mondarda fistulosa* (Wild Bergamot) and *Eutrochium maculatum* (Spotted Joe Pye Weed) in prairies during the summer (Dramstad 2003, Hines & Hendrix 2005, Jordan et. al. 2017, USFWS 2017).

Museum collections indicate that *B. affinis* range once comprised most of the Midwest and East coast of the United States (Grixti 2009). Over the last few decades the range of *B. affinis* has shrunk considerably however, leaving isolated islands scantily in only 5 remaining states. The current highest densities of *B. affinis* are found in southern Wisconsin and northern Illinois (USFWS 2017, Szymanski 2016).

The grassland ecosystem that once covered 3.6 million km² used to include the “prairie peninsula” of Iowa, Illinois and Indiana. However, today prairie comprises less than 1% of its historical area (Cagle 2008). Midewin National Tallgrass Prairie (MNTP) was the first national grassland established by the U.S. Congress, under the U.S. Department of Agriculture Forest Service, in 1997 when the land was no longer going to be used by the U.S. Army for an ammunition plant (Fornes 2004, Herkert & Glass 2016, Vitt 2009). The land was over 18,180

acres (7357 ha) of bunkers, railroad tracks, landfills, contaminated sites, wetlands, agricultural fields and fragmented prairies (Fornes 2004, Herkert & Glass 2016, Vitt 2009). The prairie plans that MNTP is following will include management of two tracts of 3000 acres (1214 ha) unfragmented grasslands of differing heights to maintain populations of native and endangered plant, mammal, reptile and invertebrate species of concern, including *B. affinis* (Herkert & Glass 2016).

B. affinis requires a high floral diversity and abundance over a greater time to sustain a viable colony (Griffin 2015, Hines & Hendrix 2005, USFWS 2017). The floral diversity and abundance that can be attained through proper prairie restoration practices may help to sustain populations of *B. affinis* at Midewin (Cameron et al. 2011). Analysis of GBIF distribution data and other citizen science sites such as *Beespotter.org* and *Bumblebeewatch.org* indicate the existence of *B. affinis* in recent years in the counties that surround Midewin, but not in Will County itself.

Our research objective was to determine presence and abundance of *B. affinis* and other *Bombus* species of conservation concern at Midewin National Tallgrass Prairie. We hypothesized that *B. affinis* would be located on the premises at Midewin due to the confirmed sightings in neighboring counties but that the occurrence of *B. affinis* would be low.

Methods:

USFWS protocol was used to establish 12 sampling locations. This protocol evaluated the floral abundance, nearby tall tree cover and disturbance levels (Clark 1973). Sampling locations were established in late May. The choice of optimal transects was based on a combination of aerial photographs, maps supplied by officials at Midewin along with driving and bike riding throughout the facility. To standardize the procedure, we used the USFWS methods for determining the best locations (Jordan et al. 2017, Rowe 2010, USFWS 2017).

Once the twelve optimal locations were located, we proceeded to conduct 30-minute surveys along the 100 meter transects (USFWS 2017). *Bombus* species were captured using non-lethal sweeping methods within the transects. Bees were transferred to vials inside an ice cooler for positive identification using field guides at the completion of the 30 minutes, and then released (Grixti 2008, Williams 2014).

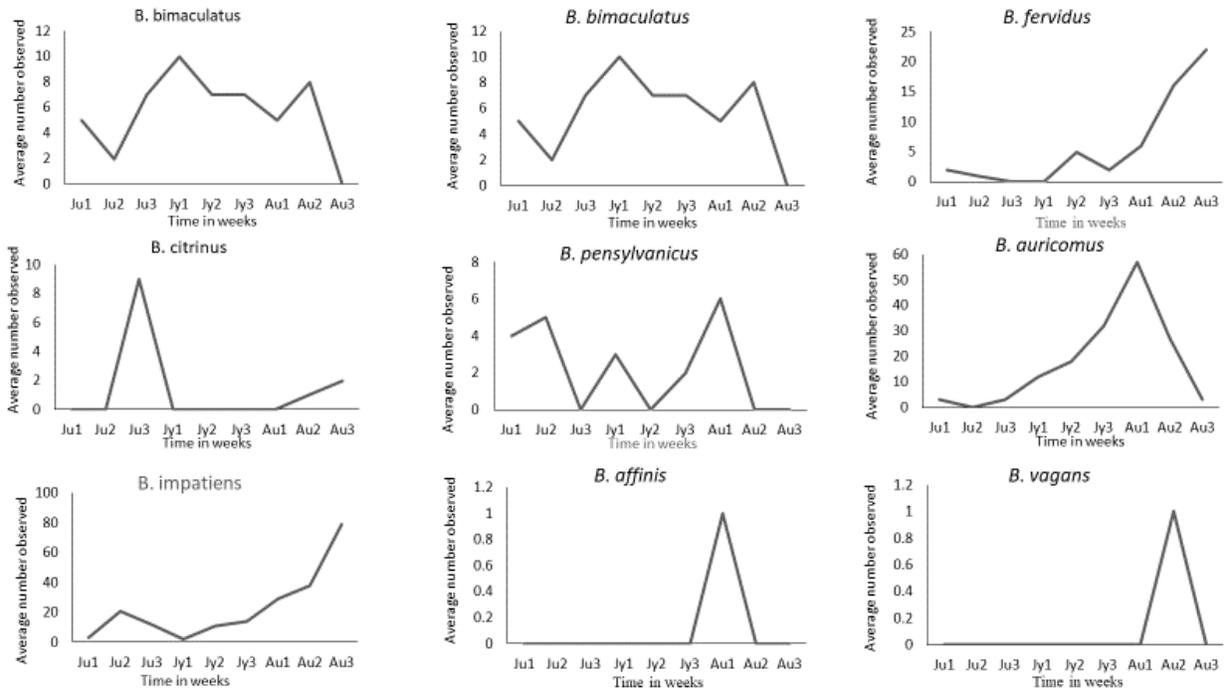
Results:

The results from this survey did confirm the presence as predicted, of the critically endangered *B. affinis*, along with 8 other species of bumble bees (Table 1). The levels were low for *B. affinis*, *B. vagans*, *B. citrinus* and *B. pensylvanicus* (Table 1). Over the entire survey time the presence of *B. auricomus*, *B. impatiens* and *B. griseocollis* were the more numerous and consistently found (Table 1).

A total of 9 *Bombus spp.* were noted over 9 weeks of sampling (Fig. 1). The highest abundance present were *B. griseocollis*, followed by *B. impatiens* then *B. auricomus* (Fig. 1). The end of July showed the highest *Bombus spp.* diversity present over the entire sample period (Fig. 1). *Bombus spp.* were located at every sample site throughout Midewin with the levels varying at each location (Fig. 2).

Table 1: The relative abundance per species over 9 sample dates, through 3 summer months at 12 transect locations.

Species	Conservation Status	n	Relative Abundance
<i>B. affinis</i>	CR	1	0.13%
<i>B. vagans</i>	LC	1	0.13%
<i>B. citrinus</i>	LC	12	1.50%
<i>B. pensylvanicus</i>	VU	20	2.50%
<i>B. bimaculatus</i>	LC	51	6.39%
<i>B. fervidus</i>	VU	54	6.77%
<i>B. auricomus</i>	LC	155	19.42%
<i>B. impatiens</i>	LC	209	26.19%
<i>B. griseocollis</i>	LC	295	36.97%
Total		798	100.00%



Figures 1: The relative abundance by species over the 9 weeks of sampling.



Figure 2: Relative abundance of total *Bombus* species found per transect, at Midewin National Tallgrass Prairie during June, July and August 2018. Yellow denotes the relative abundance of *Bombus* species found in each transect. Figure 2: Relative abundance of total *Bombus* species

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Discussion:

We present the first known recording of the endangered *B. affinis* in Will County, Illinois at Midewin National Tallgrass Prairie. Until this year, *B. affinis* had not been observed at this location or within Will County. While the bee's presence has now been confirmed, it was exceedingly rare, comprising just 0.13% of all bumble bees found in the 12 transects over the entire 9 weeks sampled, only a single male *B. affinis* was found one time, in a single transect (Fig 1, Table 1). While little is known about the behavior of *B. affinis*, male bumble bees, once they leave the nest, do not return, and it is unclear how far they will go in search of an unmated queen. Thus, it is unclear where exactly *B. affinis* nest may have been, or if the male originated on the site at all, though it is likely within several kilometers of the capture site.

Of the 16 *Bombus* spp. that were historically found in Illinois (Grixti et al. 2009), we found a total of 9 species during this survey. Three other bumble bees of conservation concern, *B. vagans*, *B. fervidus* and *B. pensylvanicus* were also found to be present at Midewin, though also in very low numbers (Figures 1-10, Table 1). *B. pensylvanicus* and *B. fervidus* are two of the species, along with *B. affinis*, that have had the largest declines in populations in recent years throughout North America (Cameron et al. 2011, Grixti et al. 2009). These data indicate that Midewin is indeed providing valuable habitat for *Bombus* species since approximately 10% of the total *Bombus* species captured at Midewin were of conservation concern (Table 1).

Our results also indicate that bumble bees are not evenly distributed throughout the site, but that there are some areas that support greater numbers than others (Fig 2). Differences in abundance indicates that some sites are more suitable than others and that habitat characteristics and management may play a role in bumble bee populations, as has been noted by others (Hines & Hendrix 2005). Further research should investigate what these site characteristics may be.

Because Midewin is an actively managed landscape, knowing when these bees are most abundant can be helpful in timing management that may cause disturbance to their habitat. Our phenology data suggests that species of conservation concern are most abundant in late July and August, although *B. pensylvanicus* was identified throughout the summer (Fig 1). Because further monitoring is important for understanding population trends, efficient monitoring could

focus efforts in late July and August. Late summer appears to be the best time for monitoring in general as most species showed a spike at this time (Fig 1). These results do follow the trends seen in other studies and publications (Cameron et. al. 2011, Williams et. al. 2014).

The restoration of the prairie system at Midewin has shown that the *Bombus* species seasonal trends are like those seen in the Midwest in general (Griffin 2017, Hines & Hendrix 2005, USFWS 2017). Ongoing restoration of prairie at Midewin will continue to increase floral species richness for *Bombus* species to utilize. This study is a useful baseline for those managing this and other tallgrass prairie sites. Ongoing and increased research needs to be conducted in the coming years to assure healthy levels of *Bombus* species at Midewin National Tallgrass Prairie.

Acknowledgements:

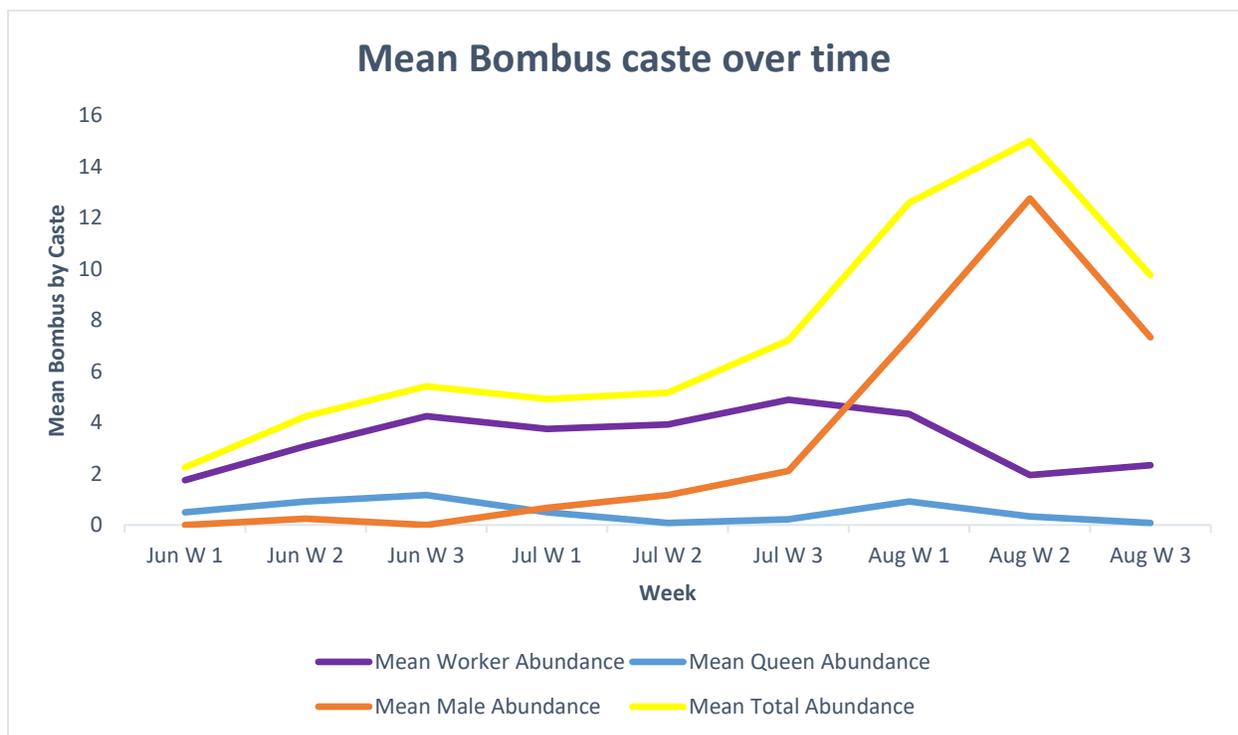
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Appendix:



Supplemental Figure 1: The mean caste of the 9 *Bombus* spp. collected over the 9 sample dates and from the entire research area.

