Assessment of Floral Resource Abundance, Pollinator Networks, and Implications for Bumble Bees in Restored Tallgrass Prairies

2022-2024

A report to the United States Department of Agriculture Natural Resources Conservation Service and Wetland Reserve Easement Landowners

Grant award: # NR205F48XXXXC018


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Executive Summary

- Restoring upland habitat is critical for the Agricultural Conservation Easement Program (ACEP) Wetlands Reserve Easement (WRE) program. Upland habitat restoration prevents erosion, decreases pollution, and provides habitat for plant and animal species.

- Pollinators play a critical role in agricultural lands and are responsible for 35% of global crop pollination. Providing pollinator habitat on easements is, therefore, important for achieving the goals of the ACEP WRE program.

- We used easements that were restored by both adding seeds of native plant species and using prescribed fire, located within a 100-mile radius of Madison, WI. We compared these easements to each other and additional restored prairies found in the region. Within these sites, we assessed whether the type and diversity of floral resources are preferred by one of the most important pollinator groups - bumble bees (*Bombus* spp.). Bumble bees were not commonly found on easements without at least this level of restoration effort.

- We found 1,956 individuals and 10 species of bumble bees and 40,000 stems and 150 species of flowering plants. Bumble bees regularly visited 54 flowering plant species found on easements. Across sampled restored prairies, bumble bees visited 15 plant species more often than expected, demonstrating strong preference for these species.

- High floral resources were present on easements in mid to late summer, but few floral resources were present in spring and early summer.

- Bumble bees foraged more frequently on flowering forb species that are specialists (with high Coefficient of Conservatism scores), which are often species that are difficult to establish in Tallgrass Prairie restorations.

- These results will allow land stewards to make more informed decisions and increase the effectiveness of restoration actions.

- Using seed mixes that contain greater numbers of specialist plant species (species with high Coefficient of Conservatism scores) and spring-blooming species when restoring Tallgrass Prairies on easements will be important for bumble bee conservation.

Introduction

Objectives

The Agricultural Conservation Easement Program (ACEP) Wetlands Reserve Easement (WRE) program, which also includes lands formerly under the Wetlands Reserve Program (WRP), is a voluntary program to conserve, protect and enhance the nation's wetland ecosystems. The program promotes the restoration, enhancement, protection, maintenance, and management of wetland systems and adjacent uplands that contribute to the function and value of wetlands. There are presently over 650 properties, and more than 60,000 acres enrolled in WRE in Wisconsin. To achieve the program's objectives, enrolling and managing both the wetland and adjacent upland habitat is a critical component of WRE restoration. Upland buffers control erosion, remove nutrients and agrichemicals before they reach wetlands, provide habitat for wetland species, and serve as important habitat to plant and animal species, including pollinators.

Pollinators are responsible for 35% of global crop pollination. Upland habitat on NRCS easements, therefore, provides a cost-effective opportunity to provide habitat for a wide array of pollinator species. In addition, NRCS has a long-term responsibility to ensure the easement program objectives are achieved and statutory requirements are met on these lands. Thus, an on-site monitoring policy is in place to ensure that the integrity of the easement is being maintained, that the goals and objectives for which the easement was purchased are being met, to identify actions needed, and to maintain a relationship with the landowner. Experience has shown that the most successful restorations occur when NRCS has an active and engaged relationship with the landowner to ensure the easement is functioning at its full potential.

The objectives of this project are to:

1. Assist NRCS in fulfilling its obligation to periodically monitor easements
2. Evaluate the future trajectory of the upland habitat present on each easement
3. Provide technical recommendations for managing WRE restorations that will maintain and enhance pollinator habitat
4. Evaluate the types of floral resources that may promote diverse pollinator communities on easements

Methods

Study System

This study investigates the impact of floral resource availability and species composition on bumble bee (*Bombus* spp.) foraging patterns in restored Tallgrass Prairies. Restored Tallgrass Prairies vary in the species richness and composition of forb species (i.e., "forb diversity") and, therefore, the resources these plants provide for pollinators. Our research aims to understand bumble bee foraging preferences and determine whether restored prairies with different levels of forb diversity impact bumble bee foraging networks. Study sites primarily occurred on lands managed by Natural Resources Conservation Service (n = 16); seven sites were co-managed with other agencies including the Wisconsin Department of Natural Resources (n = 4), Dane County Parks (n = 1), and non-profit group Southern Wisconsin Birding Alliance (formerly Madison Audubon Society, n = 3). NRCS sites were enrolled in the Agricultural Conservation Easement Program (ACEP) Wetland Reserve Easements (WRE) Program in Wisconsin, USA. We restricted study sites to easements found within a 161 km (100 mi) radius from Madison (Figure 1). All

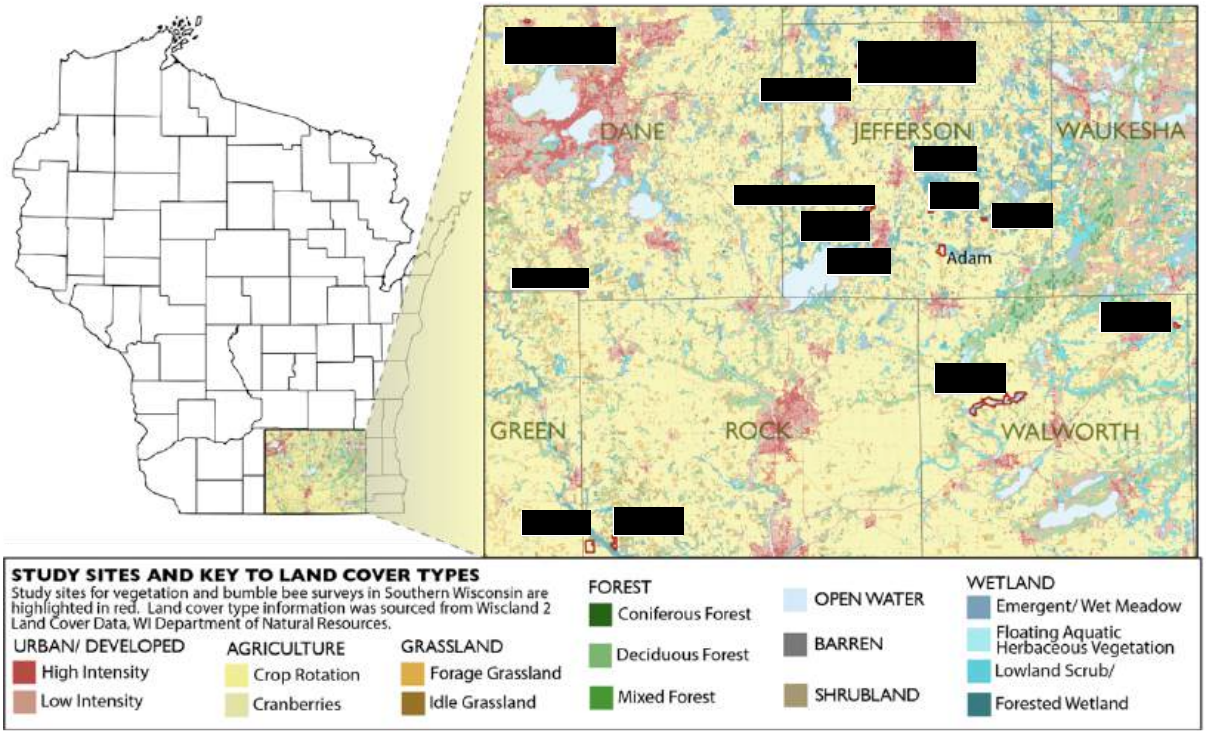

Figure 1. A land use-landcover map showing the 16 easements included in this final report throughout south-central Wisconsin.A land use-landcover map showing the 16 easements included in this final report throughout South Central Wisconsin.

study sites are restored Tallgrass Prairies that have been seeded with native plant species and that are managed with prescribed fire. The age of restoration varied, with sites ranging from 10 to 15 years old. Bumble bees were not abundant at sites that were not seeded and burned.

Plot location

At each site, we haphazardly placed a 55 × 55 m plot (Figure 2) in a restored section of the easement that had upland habitat using ArcGIS Desktop 10.5. Plots were not placed in areas with saturated soil or standing water and restricted to a single burn management unit. Study plot placement was verified in the field to ensure the plot met the above criteria.

Floral-resource abundance and quality

To characterize the available floral resources for bumble bees at each site, we collected floral-resource data in 50 1 X 1 m quadrats along the perimeter and through the center of each plot (Figure 2). We recorded all flowering forb species (i.e., species that were flowering) and recorded the number of stems for each species in each quadrat. In cases where species are difficult to distinguish, flowers were identified to the genus level.

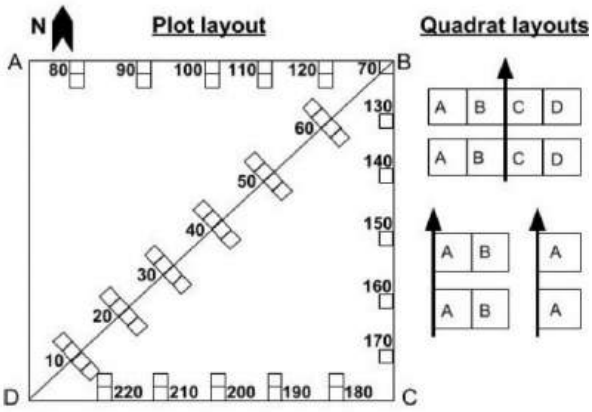

Figure 2. Plot layout showing floral resource quadrats. Bumble bee transect was conducted on the diagonal.

Bumble bee surveys

To understand whether restored Tallgrass Prairie forb diversity influences bumble bee foraging patterns, two different non-lethal bumble bee surveys were employed at each visit (transect and meander). For the transect surveys, an observer alternated walking and stationary observations along the diagonal of the 55 x 55 m bumble bee plot using a standardized slow pace, for a total transect length of 77.8 m in 10 minutes (Figure 2). For meander surveys, an observer haphazardly walked throughout the entire plot for a 30-minute survey. Bumble bees were hand netted using an aerial insect net and put on ice for accurate identification. Behavior, species, caste/sex, and flower used for foraging (when applicable) were recorded for each bee. All bees were released after processing. Data were collected at times of day when the temperature was at least 22 °C, with minimal wind, and no dense cloud cover/precipitation to avoid weather related impacts on bee abundance. Surveys were conducted following conditions under U.S. Fish and Wildlife Service Permit Numbers TE06130D and ES06130D.

Analyses

In order to understand how to optimize restoration efforts for declining bumble bee populations, we used the collected data to assess easement pollinator habitat and to investigate bumble bee foraging patterns. We did the following analyses: 1) bumble bee foraging preferences, 2) floristic

quality of bumble bee-preferred forb species, 3) floral resource phenology, 4) easement forb diversity and quality assessments, and 5) ran network analyses for all bumble bees and the flowering species they visited.

Bumble bee foraging preferences

We categorized flowering species at each easement into three groups, rarely visited (i.e., forb species that were either never visited or abundant species that were only visited once), bumble bee-visited forbs (visited at least two times during the course of our study), or bumble bee-preferred forbs. We calculated the strength of their preference based on the proportion of flowering stems observed and the total number of bumble bee floral visits. We assigned the strength of bumble bee preference based on how much greater their observed visits were to the number of expected visits based on floral availability. All forb species that were visited at least twice as frequently as expected were placed into the bumble bee-preferred category. We further categorized bumble bee-preferred forb species into strongly preferred, moderately preferred, and slightly preferred. We designated forb species to be strongly preferred if they were visited 10 or more times more frequently than expected, moderately preferred if visited 5-10 times more than expected, and slightly preferred visited 2-5 times more than expected. We included all NRCS visitation data, plus data collected from an additional ten non-NRCS restored prairies to determine these categories.

Floristic quality of bumble bee-visited species

To assess the floristic quality of bumble bee forb species preferences, we averaged the Coefficient of Conservatism (C) scores for not-visited forbs, bumble-bee visited forbs, and bumble-bee preferred forbs. Coefficient of Conservatism scores were assigned by regional botanical experts (Watermolen 2003), where 0 represents species of low conservation value that are widely distributed and grow readily in degraded habitats, and 10 represents species of high conservation value that are restricted to undegraded habitat. We use R Studio (version 4.4.2; R Core Team 2024) to determine if floristic quality is significantly different between these groups.

Floral resource phenology

To determine the degree to which individual easements have floral resources available throughout the summer, we collected South Central Wisconsin's flowering phenology data for each bumble bee-visited species on iNaturalist (www.inaturalist.org). We then estimated each species peak bloom date, and converted this into its Julian day, which is a continuous day count starting on the first of January each year. This data was used to make a figure for each easement that shows the floral resource phenology.

Easement forb diversity and quality assessments

We calculated mean C score of the forb community, forb richness, native richness, bumble bee-visited forb richness, and bumble bee-preferred forb richness for each easement.

Forb-bumble bee network analyses

We created a bipartite network matrix to visualize all bumble bee species foraging visits in Tallgrass Prairie restorations, using the bipartite package (version 2.18; Dormann et al., 2008, 2009) in R Studio (version 4.4.2; R Core Team 2024). This analysis investigates the frequency with which bumble bee species and flowering forbs are associated. Restoration practitioners commonly include flowering species that readily establish in restoration seed mixes. These same species are also commonly the most abundant species at our study sites. To gain a better understanding of bumble bee foraging preferences, we weighted the number of bumble bee foraging visits by the abundance of the flowering species are our study sites, using the *sweep* function in the bipartite package. To do this, we took the inverse of each species' floral resource abundance (1/floral abundance). This allowed us to determine whether bumble bees have flowering species preferences by giving less common flowering species a higher weight. This analysis highlights if bees preferentially visit rarer (or less abundant) flower species.

Figure 3. *Bombus bimaculatus* (two-spotted bumble bee) foraging on *Hypericum perfoliatum* in the left panel. The right panel shows *Bombus* species visiting *Veronicastrum virginicum* (Culver's root)

Results & Discussion

During 2023 and 2024, we visited 15 NRCS WRP easements, with the number of plots and visits varying for each easement (Table 1). We collected data at 24 plots for a total of 157 unique plot-date combinations. Plot-level floral resource abundance varied greatly between easements, with average stem counts ranging from 24 flowering stems to 411 flowering stems.

Across easements, we observed 10 species of bumble bees (1,956 individuals) foraging on floral resources. We recorded nearly 150 forb species (~40,000 stems). Of these, bumble bees regularly visited 54 species (Table 2). Incorporating bumble bee foraging patterns in restored Tallgrass Prairie from the larger data set that included non-NRCS sites, we found that bumble

Table 1. List of easements included in this report. Number of 55m X 55m plots varied per easement, as did the total number of unique date-plot visits. Average plot-level floral resource abundance varied greatly, with the Adam easement having the greatest average abundance of flowering stems and the [redacted] easement having the fewest flowering stems.

Landowner	Legacy #	number of plots	total plot visits	average stem count
David Adam	665F480900WKB	1	7	411
[redacted]	[redacted]	1	8	364
[redacted]	[redacted]	1	8	349
Wisconsin DNR	665F480900WV0	1	8	286
Dane County	665F480800MBG	1	7	232
Wisconsin DNR	65F48000074F	3	4	219
[redacted]	[redacted]	1	4	216
Wisconsin DNR	665F480900MJC	1	9	205
[redacted]	[redacted]	1	3	192
[redacted]	[redacted]	1	5	187
[redacted]	[redacted]	2	11	169
[redacted]	[redacted]	1	4	156
Jefferson Co	665F4805007JL	2	11	83
Wisconsin DNR	665F480900MJ9	2	17	69
Wisconsin DNR	665F480900MJ8	2	9	48
[redacted]	[redacted]	1	2	24

bees visited 15 species more often than expected (Table 3), which indicated that bumble bees likely prefer these floral species over other visited species. We assigned the strength of bumble bee preference based on how much greater their observed visits were to their expected visits. We designated forb species to be strongly preferred if they were visited 10 or more times more frequently than expected, moderately preferred if visited 5-10 times more than expected, and slightly preferred if visited 2-5 times more than expected.

Table 2. The 54 flowering forb species regularly visited by bumble bees on NRCS WRP easements. Plant family and Latin binomial scientific names are provided. Some species are difficult to distinguish and were only identified to the genus level (indicated by "spp.").

family	scientific name	family	scientific name
Amaryllidaceae	*Allium cernuum*	Asteraceae	*Taraxacum officinale*
Apiaceae	*Daucus carota*	Brassicaceae	*Berteroa incana*
Apiaceae	*Eryngium yuccifolium*	Caprifoliaceae	*Lonicera* spp.
Apiaceae	*Zizia aurea*	Commelinaceae	*Tradescantia ohiensis*
Apocynaceae	*Apocynum androsaemifolium*	Convolvulaceae	*Convolvulus arvensis*
Apocynaceae	*Asclepias syriaca*	Fabaceae	*Amorpha canescens*
Asteraceae	*Cirsium arvense*	Fabaceae	*Baptisia alba*
Asteraceae	*Cirsium discolor*	Fabaceae	*Dalea candida*
Asteraceae	*Cirsium muticum*	Fabaceae	*Dalea purpurea*
Asteraceae	*Echinacea pallida*	Fabaceae	*Desmodium canadense*
Asteraceae	*Euthamia graminifolia*	Fabaceae	*Lathyrus palustris*
Asteraceae	*Helianthus divaricatus*	Fabaceae	*Lespedeza capitata*
Asteraceae	*Heliopsis helianthoides*	Fabaceae	*Lotus corniculatus*
Asteraceae	*Liatris pycnostachya*	Fabaceae	*Melilotus albus*
Asteraceae	*Liatris spicata*	Fabaceae	*Melilotus officinalis*
Asteraceae	*Parthenium integrifolium*	Fabaceae	*Securigera varia*
Asteraceae	*Ratibida pinnata*	Fabaceae	*Trifolium hybridum*
Asteraceae	*Rudbeckia hirta*	Fabaceae	*Trifolium pratense*
Asteraceae	*Rudbeckia subtomentosa*	Hypericaceae	*Hypericum perforatum*
Asteraceae	*Silphium integrifolium*	Lamiaceae	*Agastache foeniculum*
Asteraceae	*Silphium laciniatum*	Lamiaceae	*Monarda fistulosa*
Asteraceae	*Silphium perfoliatum*	Lamiaceae	*Monarda punctata*
Asteraceae	*Silphium terebinthinaceum*	Lamiaceae	*Pycnanthemum virginianum*
Asteraceae	*Solidago* spp.	Plantaginaceae	*Penstemon digitalis*
Asteraceae	*Sonchus arvensis*	Plantaginaceae	*Veronicastrum virginicum*
Asteraceae	*Symphyotrichum lateriflorum*	Rosaceae	*Rosa carolina* complex
Asteraceae	*Symphyotrichum* spp.	Rosaceae	*Rubus* spp.

Table 3. Fifteen forb species were identified as preferred by bumble bees. We calculated the strength of their preference based on the proportion of flowering stems observed and the total number of bumble bee floral visits. We assigned the strength of bumble bee preference based on how much greater their observed visits were to the number of expected visits based on floral availability. We designated forb species to be strongly preferred if they were visited 10 or more times more frequently than expected, moderately preferred if visited 5-10 times more than expected, and slightly preferred if visited 2-5 times more than expected.

degree of preference	scientific name	common name	family	C	Wisconsin status
strong	*Rosa carolina complex*	Rose species	Rosaceae	-	Native
strong	*Cirsium muticum*	swamp thistle	Asteraceae	8	Native
strong	*Dalea purpurea*	purple prairie-clover	Fabaceae	7	Native
moderate	*Apocynum androsaemifolium*	spreading dogbane	Apocynaceae	2	Native
moderate	*Baptisia alba*	White wild indigo	Fabaceae	8	Native
moderate	*Amorpha canescens*	lead-plant	Fabaceae	7	Native
moderate	*Hypericum perforatum*	St. John's-wort	Hypericaceae	0	Introduced
slight	*Silphium perfoliatum*	cup-plant	Asteraceae	4	Native
slight	*Dalea candida*	white prairie-clover	Fabaceae	8	Native
slight	*Monarda fistulosa*	bee balm	Lamiaceae	3	Native
slight	*Veronicastrum virginicum*	Culver's root	Plantaginaceae	6	Native
slight	*Allium cernuum*	nodding wild onion	Amaryllidaceae	7	Native
slight	*Lonicera*	honeysuckle	Caprifoliaceae	0	Introduced
slight	*Monarda punctata*	horsemint	Lamiaceae	3	Native
slight	*Silphium integrifolium*	prairie rosinweed	Asteraceae	6	Native

Figure 4. Images of bee-preferred flowering forb species. Shown from left to right: *Rosa* spp. (strongly preferred), *Hypericum perforatum* (moderately preferred), *Lonicera* spp. (moderately preferred), and *Monarda fistulosa* (moderately preferred).

Floristic quality of bumble bee-visited and -preferred species is significantly higher than species unvisited by bumble bees (Figure 5). The average C score of forb species that were rarely/never visited by bees was 1.85, visited forbs had as mean C of 3.7, and preferred forb species have a C score of 4.5. Plant species with a high C score tend to be specialist species with a narrow habitat niche, that can be difficult to establish in Tallgrass Prairie restoration. These results suggest that incorporating these specialist plant species into seed mixes is important for bumble bee conservation.

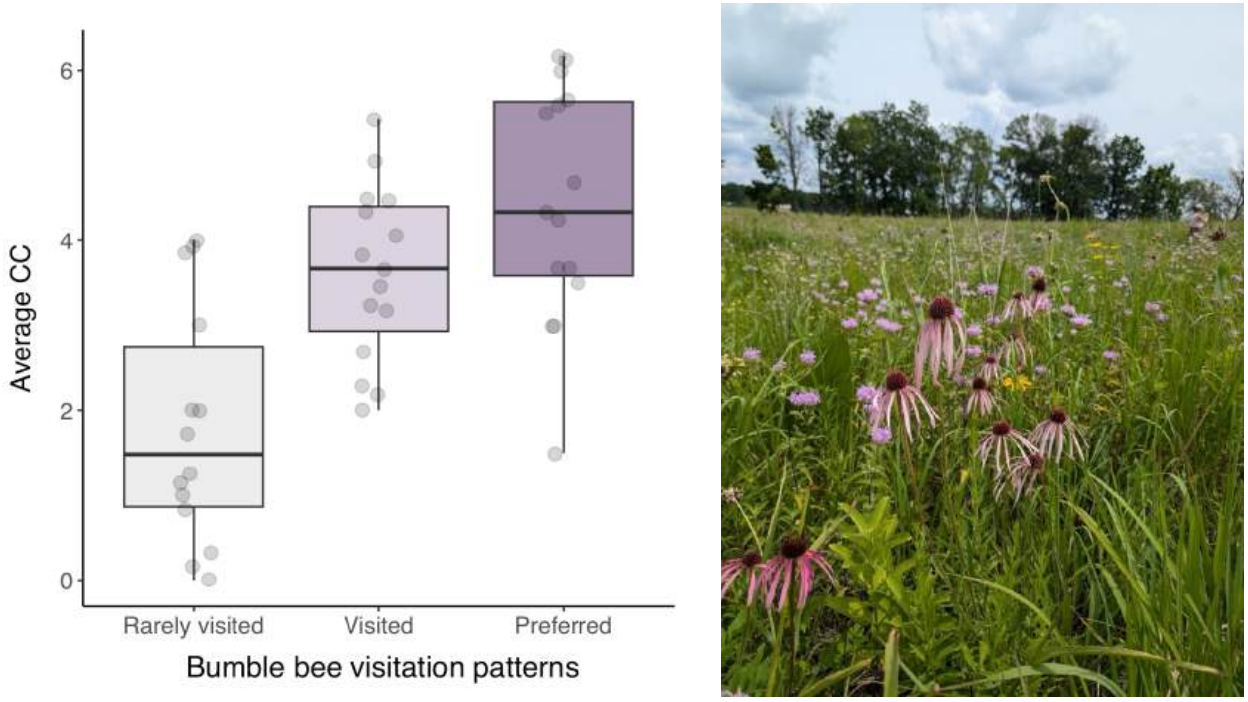

Figure 5. The left panel illustrates that the mean C score of rarely visited species is significantly less than the visited species ($p < 0.001$) and preferred forb species ($p < 0.001$). The panel on the right is a picture of the [redacted] easement, which is an extremely high quality site with a mean C of 4.1 and 36 native flowering forbs.

We assessed forb quality across all easements using several metrics, including a weighted C score, forb richness, native forb richness, bumble-bee visited forb richness, and bumble bee-preferred forb richness (Table 4). Quality varied greatly across easements. Floristic quality, measured by weighted C scores, ranged from 4.98 at the [redacted] property to 1.26 at the [redacted] property. Native forb richness was highest at the easement co-owned by [redacted] with 30 native forbs, while the [redacted] easement only had 4 native forbs present. The Turtle Valley Wildlife area easement managed by the WI DNR had the highest number of bumble bee visited plants (n=27), while the [redacted] easement had the fewest (n=3). Finally, both the [redacted] easement and [redacted] easement had the most bumble bee-preferred forbs (n=6).

Network analyses were conducted to look at the foraging interactions across easements (Figure 6) and within easements (see individual easement summaries). The weighted network highlights bumble bee foraging preferences while accounting for the rarity of forb species (Figure 7).

Table 4. Quality of floral resources varied greatly among the easements included in this report, with the [redacted] easement having the highest weighted C score for the forb community. The three easements managed by [redacted] have the overall highest quality when incorporating both weighted C score, native richness, and bumble bee-preferred richness. For each easement, we provided the landowner's name and NEST identification number. Weighted Coefficient of Conservatism (C) score, and number of species (richness) for all forbs, native forbs, forbs visited by bumble bees, and forbs preferred by bumble bees.

Landowner	weighted C	forb richness	native forb richness	visited-forb richness	preferred forb richness
[redacted]	4.98	22	13	15	4
[redacted]	4.09	36	30	21	6
[redacted]	3.86	34	29	21	6
[redacted]	3.81	24	21	16	5
Wisconsin DNR 665F480900MJ8	3.71	25	17	18	2
Wisconsin DNR 65F48000074F	3.45	36	22	27	5
[redacted]	3.37	15	12	11	2
Wisconsin DNR 665F480900MJ9	3.32	29	19	19	3
Jefferson Co 665F4805007JL	3.00	26	17	16	3
[redacted]	2.98	4	4	3	1
Dane County 665F480800MBG	2.64	17	10	14	3
[redacted]	2.29	19	14	11	2
Wisconsin DNR 665F480900WV0	2.27	26	15	17	4
David Adam 665F480900WKB	1.95	21	11	16	3
Wisconsin DNR 665F480900MJC	1.49	31	13	18	3
[redacted]	1.26	7	4	4	1

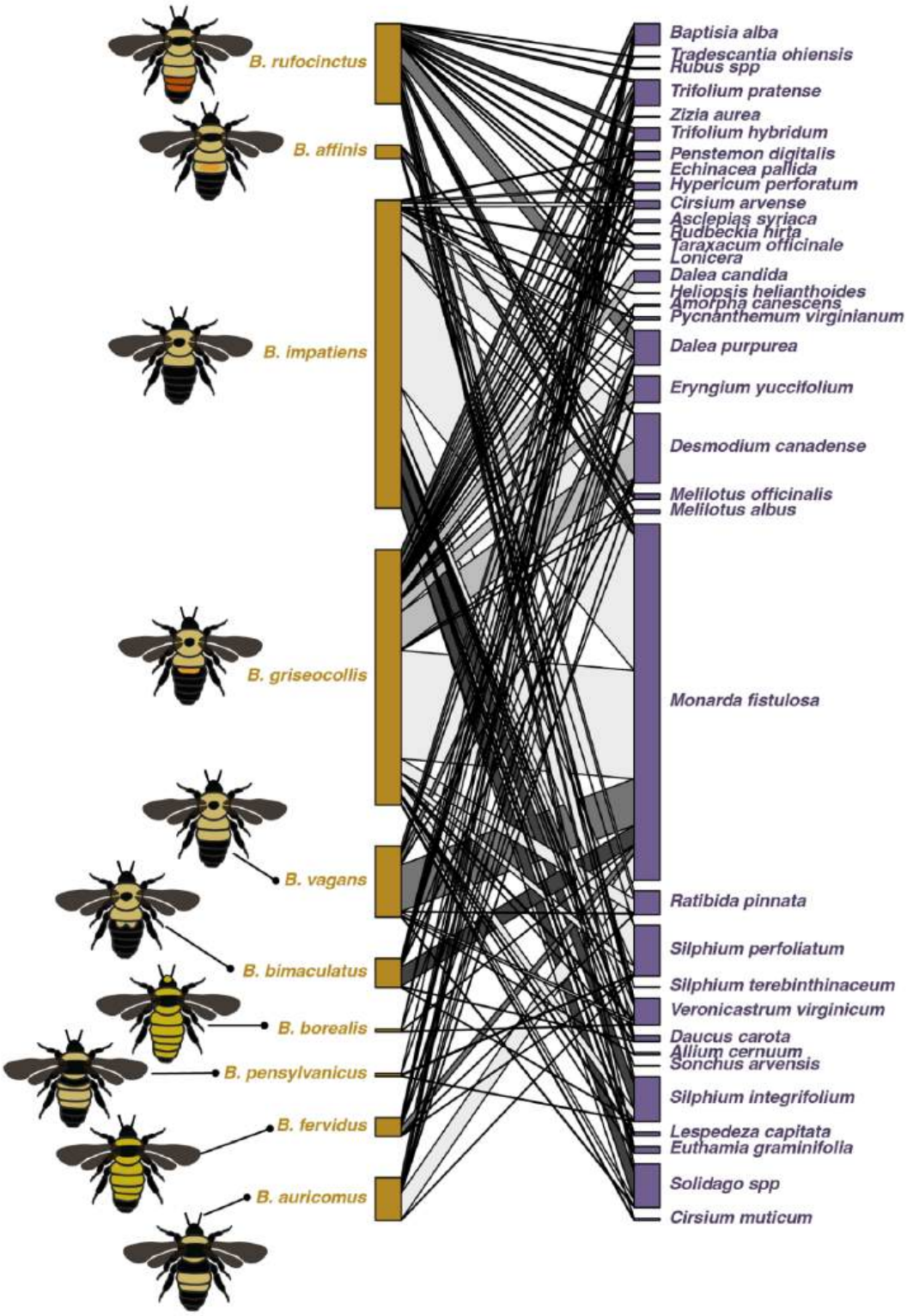

Figure 6. Unweighted network analysis of bumble bee-forb species interactions. The gold bars represent the proportion of bumble bee species observed in this study, and the purple bars represent the frequency of visitation for each of the listed forb species. The most frequently visited flower species was *M. fistulosa*. The most commonly observed bumble bee species include *Bombus impatiens* and *B. griseocollis*.

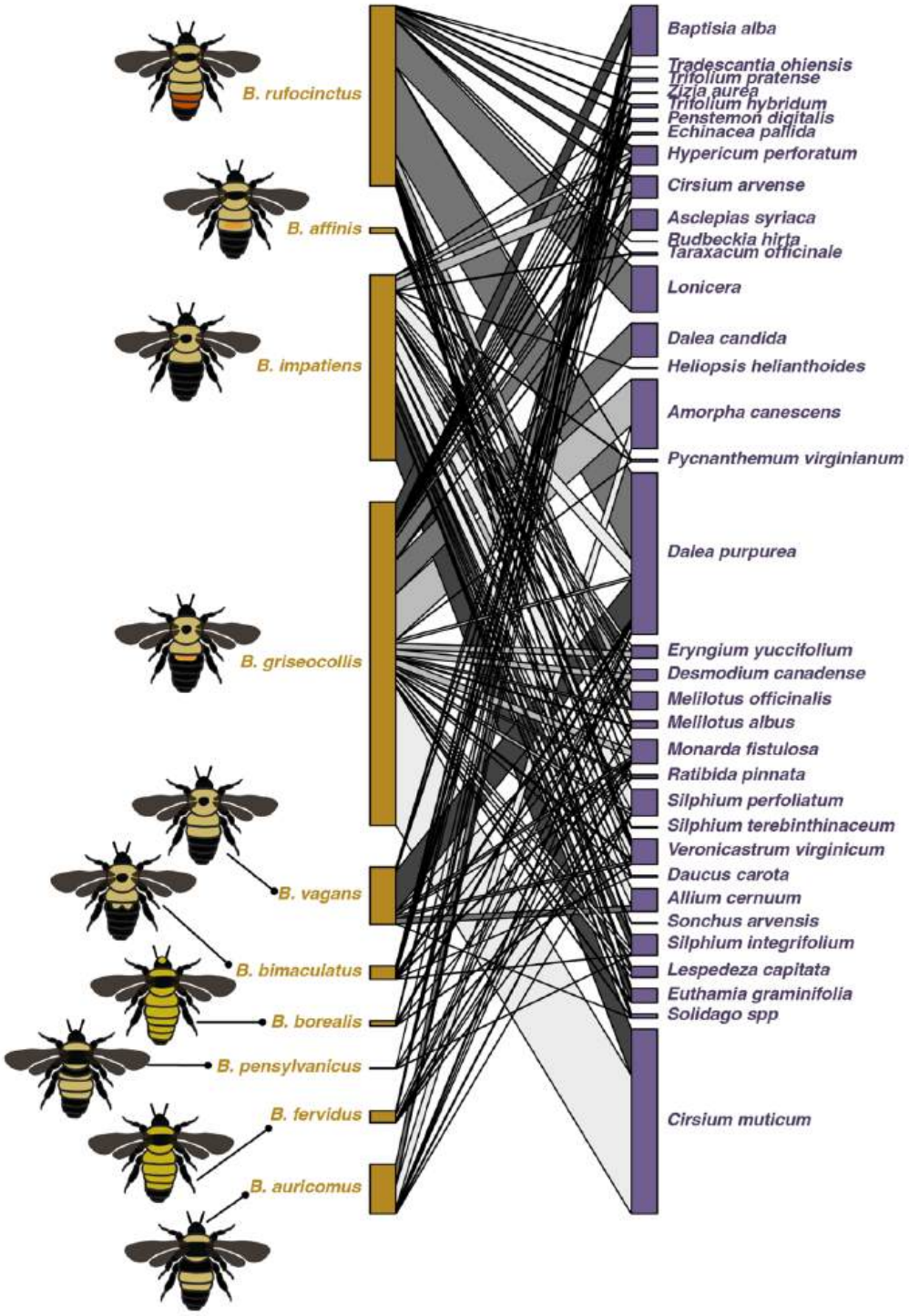

Figure 7. Weighted network analysis of bumble bee-forb species interactions. In this network analysis, the proportion of bumble bees are represented in gold, and the frequency of visits to forb species, weighted by abundance, are represented in purple. With abundance taken into account, the forb species with the highest visitation frequency include *Dale purpurea* and *Cirsium muticum.*

Table 5. Ten bumble bee (*Bombus*) species were observed on NRCS ACEP Wetland Reserve Easements. The maximum number of bee species observed at an individual easement was eight species. All three bumble bee species of concern were observed during our surveys (Federally Endangered *B. affinis*; state species of concern *B. fervidus* and *B. pensylvanicus*). All three species of concern were present at Turtle Valley Wildlife Area (65F48000074F) and Dorothy Carnes County Park (665F4805007JL).

WRP Easement	*B. griseocollis*	*B. impatiens*	*B. affinis*	*Bombus* spp.	*B. pensylvanicus*	*B. bimaculatus*	*B. auricomus*	*B. rufocinctus*	*B. fervidus*	*B. vagans*	*B. borealis*
Wisconsin DNR 65F48000074F	121	116	4	5	2	5	12	2	1	0	0
[redacted]	3	5	2	0	0	6	0	1	0	26	0
[redacted]	41	51	0	2	0	3	0	9	1	14	1
[redacted]	27	14	0	1	0	2	8	0	6	3	0
Jefferson Co 665F4805007JL	3	22	2	0	1	0	0	2	1	0	0
[redacted]	4	10	1	0	0	1	0	9	1	7	0
Dane County 665F480800MBG	29	41	0	0	0	4	6	4	0	2	1
Wisconsin DNR 665F480900MJ8	4	3	0	0	0	1	0	9	0	0	0
Wisconsin DNR 665F480900MJ9	7	13	0	0	0	0	3	4	0	1	0
Wisconsin DNR 665F480900MJC	14	14	0	1	0	4	4	5	2	2	0
David Adam 665F480900WKB	26	7	0	3	0	5	8	23	8	3	1
[redacted]	5	20	0	3	0	2	9	2	4	15	0
Wisconsin DNR 665F480900WV0	30	70	1	2	0	6	6	27	3	14	0
[redacted]	14	50	3	0	1	2	6	30	0	10	0
[redacted]	3	0	1	0	0	0	0	1	0	2	1
[redacted]	13	13	0	0	0	0	0	0	0	2	0

Implications for species of concern

Rusty-patched bumble bee
Bombus affinis

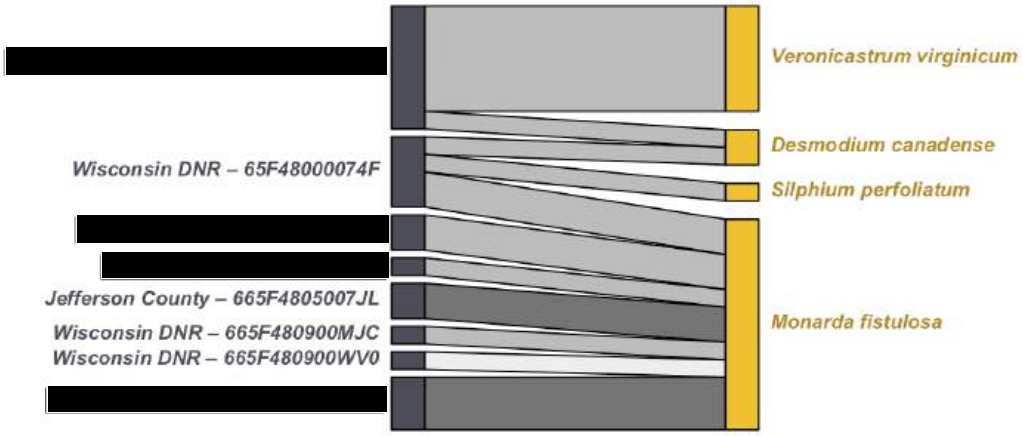

Figure 8. The rusty-patched bumble bee (*Bombus affinis)* was observed at 8 easements in 2023 and 2024, as shown on the left side of this network figure. On the right side, the diagram highlights that *B. affinis* foraged most frequently on *Monarda fistulosa*, followed by *Veronicastrum virginicum*. Rusty-patched bumble bees also foraged on *Silphium terebinthinaceaum*, and *Desmodium canadense*.

Figure 9. The rusty-patch bumble bee (*Bombus affinis)* visiting goldenrod *(Solidago* spp.*)* on the left and bee balm *(Monarda fistulosa)* on the right

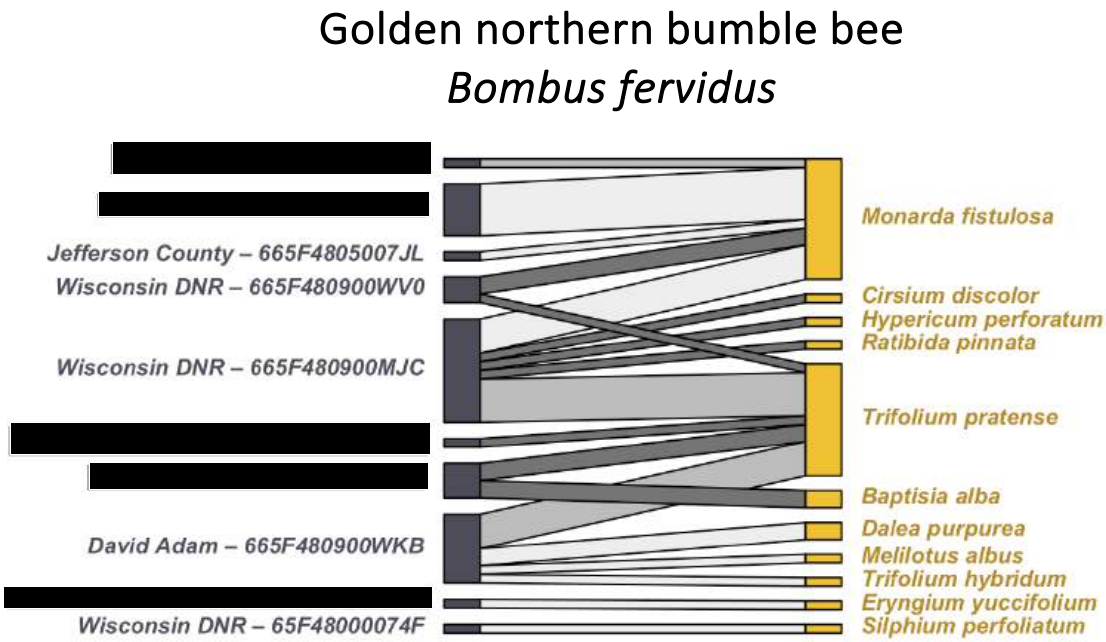

Figure 10. The golden northern bumble bee (*Bombus fervidus)* was observed at 10 easements in 2023 and 2024. The left side of this network figure shows each site where *B. fervidus* observed. The right side, the diagram highlights which forb species *B. fervidus* foraged on at each easement. The diagram also shows that *Trifolium pratense* and *Monarda fistulosa* were most frequently forbs by *B. fervidus*.

Figure 11. The golden northern bumble bee (*Bombus fervidus)* on musk thistle (*Carudus nutans).*

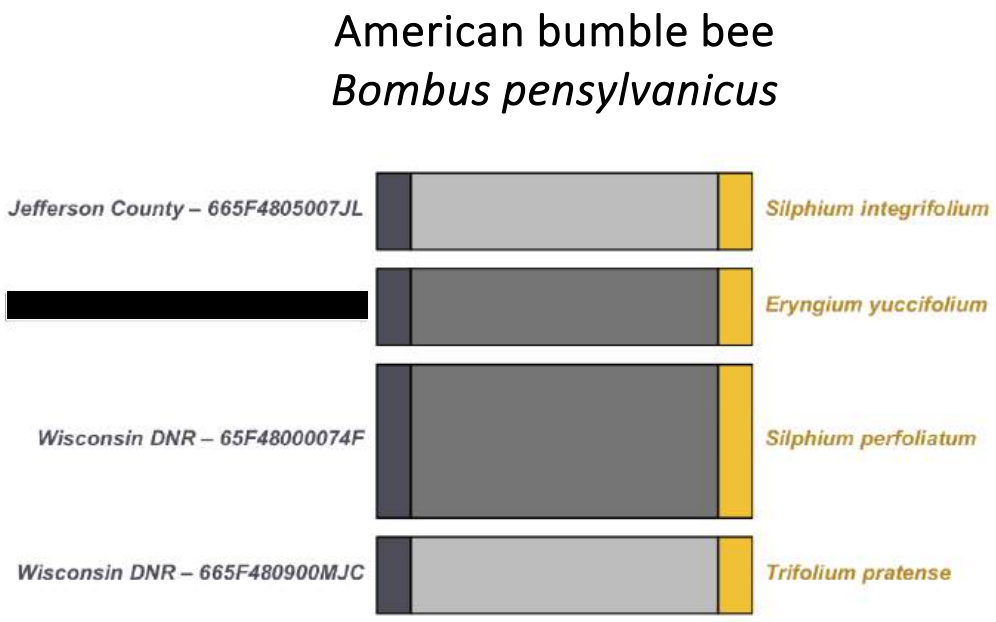

Figure 12. The American bumble bee (*Bombus pensylvanicus)* was only observed at 4 easements in 2023 and 2024, as shown on the left side of this network figure. On the right side, the diagram highlights that *B. pensylvanicus* foraged most frequently on *Monarda fistulosa*, followed by *Veronicastrum virginicum*. American bumble bees also foraged on *Silphium terebinthinaceaum*, and *Desmodium canadense*.

Figure 13. The American bumble bee (*Bombus pensylvanicus)* foraging on purple prairie clover (*Dalea purpurea)*.

David Adam – 665F480900WKB

The Adam Birding Conservancy (ABC) is an easement stewarded by David Adam in Jefferson County. Restoration of this 36.88-acre easement began in 2011. The ABC is regularly managed with prescribed fire, and management of invasive species using mowing and spot herbicide treatments. Floral resource and bumble bee assessments occurred in one plot, which was visited seven times. This easement had the highest floral resource availability, with an average of 411 stems per visit.

This site had relatively low vegetation quality (weighted C score = 1.95). This site had 21 flowering plant species (Table 11A), 11 of which are native to Wisconsin. Three of the 16 bee-visited flowering species were preferred by bumble bees. Eight bumble bee species were observed at this site (Figure 11B), one of which is a species of conservation concern: The northern golden bumble bee (*B. fervidus*).

Figure 11A. Easement and study site map for the Adam Birding Conservancy in Jefferson County. Plot location is indicated with the white star.

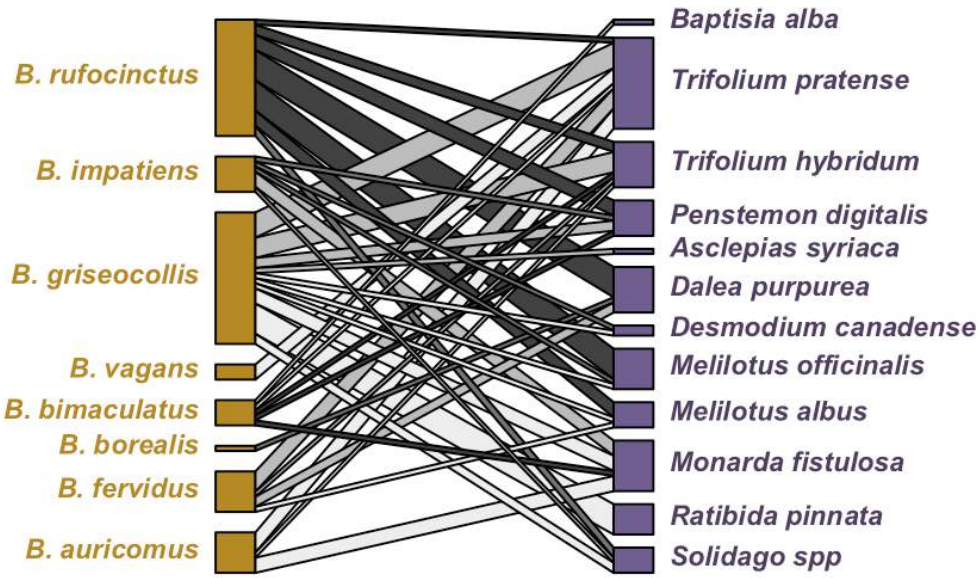

Figure 11B. Network figure of bumble bee foraging interactions at the Adam Birding Conservancy (Legacy # 665F480900WKB). This property has a robust network that supports eight bumble bee species. The bumble bees (gold) were observed visiting 12 flowering forbs. The size of the gold bars represents the proportion of each bumble bee species at this easement, while the size of the purple bars represents the visitation frequency for each forb.

Table 11A. Flowering forb species found within the study plot at the Adam Birding Conservancy. Forb species were assigned one of three categories: species rarely or never visited by bumble bees (gray), species visited by bumble bees (light purple) and species preferred by bumble bees (darker purple). For each forb species, the scientific name, common name, and plant family are provided. We indicate whether the species is visited by bumble bees and, if so, whether it is preferred (Y or N). The Coefficient of Conservatism (C) and native status are provided as measures of floral resource quality for bees. The (%) column represents the proportion of all flowering stems at the site.

scientific name	common name	family	bee-visited	bee-preferred	C	native status	%
Penstemon digitalis	false foxglove	Plantaginaceae	Y	N	4	Introduced	26%
Trifolium hybridum	alsike clover	Fabaceae	Y	N	0	Introduced	19%
Trifolium pratense	red clover	Fabaceae	Y	N	0	Introduced	14%
Ratibida pinnata	gray coneflower	Asteraceae	Y	N	4	Native	12%
Medicago lupulina	black medick	Fabaceae	N	N	0	Introduced	12%
Monarda fistulosa	**bee balm**	**Lamiaceae**	**Y**	**Y**	**3**	**Native**	**5%**
Melilotus albus	white sweet-clover	Fabaceae	Y	N	0	Introduced	4%
Zizia aurea	golden alexanders	Apiaceae	Y	N	7	Native	2%
Desmodium canadense	Canadian tick-trefoil	Fabaceae	Y	N	4	Native	1%
Rudbeckia hirta	black-eyed Susan	Asteraceae	Y	N	4	Native	0.01
Melilotus officinalis	yellow sweet-clover	Fabaceae	Y	N	0	Introduced	<1%
Solidago spp.	goldenrod	Asteraceae	Y	N	-	Native	<1%
Dalea purpurea	**purple prairie-clover**	**Fabaceae**	**Y**	**Y**	**7**	**Native**	**<1%**
Medicago sativa	alfalfa	Fabaceae	N	N	0	Introduced	<1%
Tradescantia ohiensis	common spiderwort	Commelinaceae	Y	N	5	Native	<1%
Oenothera biennis	common evening-primrose	Onagraceae	N	N	1	Native	<1%
Trifolium repens	white clover	Fabaceae	N	N	0	Introduced	<1%
Rudbeckia triloba	brown-eyed Susan	Asteraceae	N	N	4	Native	<1%
Silphium perfoliatum	**cup-plant**	**Asteraceae**	**Y**	**Y**	**4**	**Native**	**<1%**
Sonchus arvensis	field sow-thistle	Asteraceae	Y	N	0	Introduced	<1%
Cirsium arvense	Canada thistle	Asteraceae	Y	N	0	Introduced	<1%

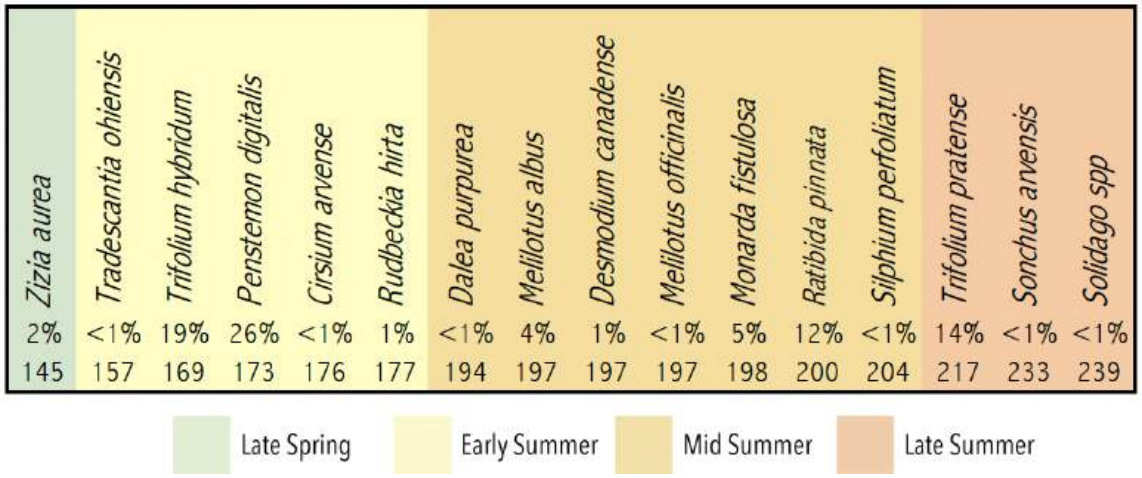

Figure 11C. Flowering phenology for bee-visited forbs at the Adam Birding Conservancy. Floral resources are available for bumble bee foraging throughout the growing season, but the Adams easement does not have many flowering stems in late spring. The proportion of stems and estimated peak-bloom Julian day are listed below each species. Peak-bloom Julian days were estimated using iNaturalist data from South Central Wisconsin.

Figure 11D. Pictures of flowering plants on this easement: *Silphium perfoliatum* (cup plant, left), *Monarda fistulosa (*bee balm, left), and *Ratibida pinnata* (gray coneflower, left and right).