

Ottawa National Forest Bumble Bee Surveys, 2024 Survey Update



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Cover: *Bombus ternarius* queen nest searching during 2024 surveys. Photo credit: Olivia Franklin

Executive Summary

Michigan Natural Features Inventory (MNFI) received funding from the United States Forest Service (FS) to complete surveys and inventories of bumble bees and associated habitats on the Ottawa National Forest (ONF). The primary objectives of this project are to 1) improve information regarding bumble bee species distributions and locations of rare bumble bees on the ONF, 2) provide a summary of bumble bee forage plants used at bumble bee survey locations on the ONF, and 3) aid future land management decisions made by the ONF. This report details the bumble bee community and habitat survey results from 2023 surveys and queen bumble bee survey results from 2024 at 16 total locations within the ONF. **Information and data collected in 2024 have been combined with 2023 survey efforts in this update.**

During 2023 bumble bee community surveys, a total of 786 bumble bee occurrences were documented. This includes 11 survey locations with *B. terricola* (Yellow banded bumble bee) present. Bumble bees were observed visiting at least 29 plant species in bloom. The most frequently visited bumble bee forage plants include *Hypericum* spp. (St. John's wort, n=125 occurrences) and *Solidago* spp. (goldenrod, n=124 occurrences). *Bombus terricola* was observed foraging from 14 different plant species, including *Asclepias syriaca* (common milkweed), *Spiraea alba* (white meadowsweet), *Hypericum* spp., *Apocynum androsaemifolium* (spreading dogbane), *Melilotus albus* (white sweet clover) and *Plantago* spp. (plantain).

During 2024 targeted queen surveys, a total of 90 bumble bee queens across 13 different sites were documented within the ONF. This included one observation of a *B. terricola* queen observed foraging on *Lorincera* spp. (honeysuckle). At least 5 species of bumble bees were observed during 2024 surveys. Surveys were conducted primarily in adjacent forested landscapes with spring ephemeral ground cover associated with 2023 survey locations to increase the likelihood of bumble bee documentation.

The bumble bee community and queen surveys completed on the ONF in 2023-2024 increase our knowledge of species distribution, relative abundance, and floral resource associations. Continued monitoring of bumble bee populations, particularly for *B. terricola*, is warranted on the ONF, especially during queen flight or at additional locations under active management. Monitoring programs are needed to describe species status and distribution on the ONF and to aid the Forest's management actions for current and future habitat enhancement projects. Improved management actions will benefit long-term conservation and viability for at-risk bumble bees within the Forest.

Acknowledgements

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Bombus terricola queen observed by surveyors in 2024 queen surveys. Queen was released after photo was taken. Photo credit: Summer Eckhardt.

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Introduction

Bumble bees (Hymenoptera: Apidae: *Bombus*) are important pollinators of many naturally occurring and managed flowering plant communities. Multiple species of bumble bees across North America have experienced population declines and range contractions over the last few decades (Colla et al. 2012, Jacobson et al. 2018, Janousek et al. 2023). In Michigan's Upper Peninsula, *Bombus terricola* (Yellow banded bumble bee, State Special Concern) is a species of bumble bee that historically occurred in relatively high abundances but has experienced declines in the last few decades (Husband et al. 1980, Wood et al. 2019, Rowe et al. 2019). Importantly, the declines associated with this species are not limited to Michigan, and it has experienced similar population and range decreases across historic distributions, primarily due to anthropogenic pressures such as increases in pesticide use, parasites and pathogens infections, and habitat loss (Cameron and Sadd, 2020). Based on contemporary survey efforts, the estimated statewide decline in distribution for this species is 71% (Wood et al. 2019). It currently occupies sparse habitats in northern Michigan, north of the floristic tension zone, where Laurentian Mixed Forest becomes increasingly more dominate.

Bumble bee community success is highly dependent on the availability of adequate forage for newly emerged queens in early spring (Watrous et al 2019). Forested areas have been found to be the preferred overwintering habitat for multiple species of queen bumble bees; especially for species like *B. terricola* that are more woodland associated species (Lanterman et al 2019; Mola et al 2021). As newly emerged queens require a great deal of energy to successfully start new nests it becomes critical to preserve early season forage near potential nesting sites (Malfi et al. 2019). Early season flowering plants, such as spring ephemerals and early flowering trees/shrubs, seem to be the most frequently visited flora by early season bumble bees in the forested habitats in Michigan's upper peninsula.

The Ottawa National Forest (ONF) covers approximately 1.5 million acres in the western portion of the upper peninsula in Michigan. Since it is predominately forested, the ONF likely provides ample nesting and foraging opportunities for bumble bee species found in the upper peninsula, including a high potential for woodland early season forage that favors bumble bees. However, there is limited data on species presence and distribution within the ONF, creating challenges for prioritizing bumble bee conservation efforts. To fill this knowledge gap, the Michigan Natural Features Inventory (MNFI) partnered with the ONF to survey 16 locations on the ONF to generate a baseline dataset of species occurrence, relative abundance, frequently visited forage plants, and a summary of flowering vegetation. The data generated will aid the Forest's decision-making processes for managing habitat to support at-risk bumble bee species through the maintenance and creation of high-quality habitat. In this report we outline the data collection methods and results from 2023 and 2024 survey efforts and provide recommendations for future bumble bee survey efforts on the ONF.



Example of areas surveyed for bumble bee queens in 2024. Included forested area and abundant forage of *Claytonia virginica* (Virginia meadow beauty). Photo credits: Olivia Franklin and Summer Eckhardt.

Methods

Site Selection

Michigan Natural Features Inventory worked with the ONF to select survey locations on the ONF for bumble bee and habitat surveys in 2023. A total of 15 survey sites were selected for 2023 bumble bee surveys (Figure 1). Based on previous survey work completed through the Great Lakes Restoration Initiative survey program, these sites were deemed to have stable bumble bee population numbers and represent a mostly even distribution across the forest. These sites were surveyed again in 2024 to document queen bumble bee occurrences and foraging preferences. However, one site (Blackspur) was replaced with a different location (RL Rd/3616; see Figure 1) due to the site being inaccessible due to a flooded access road during survey windows.

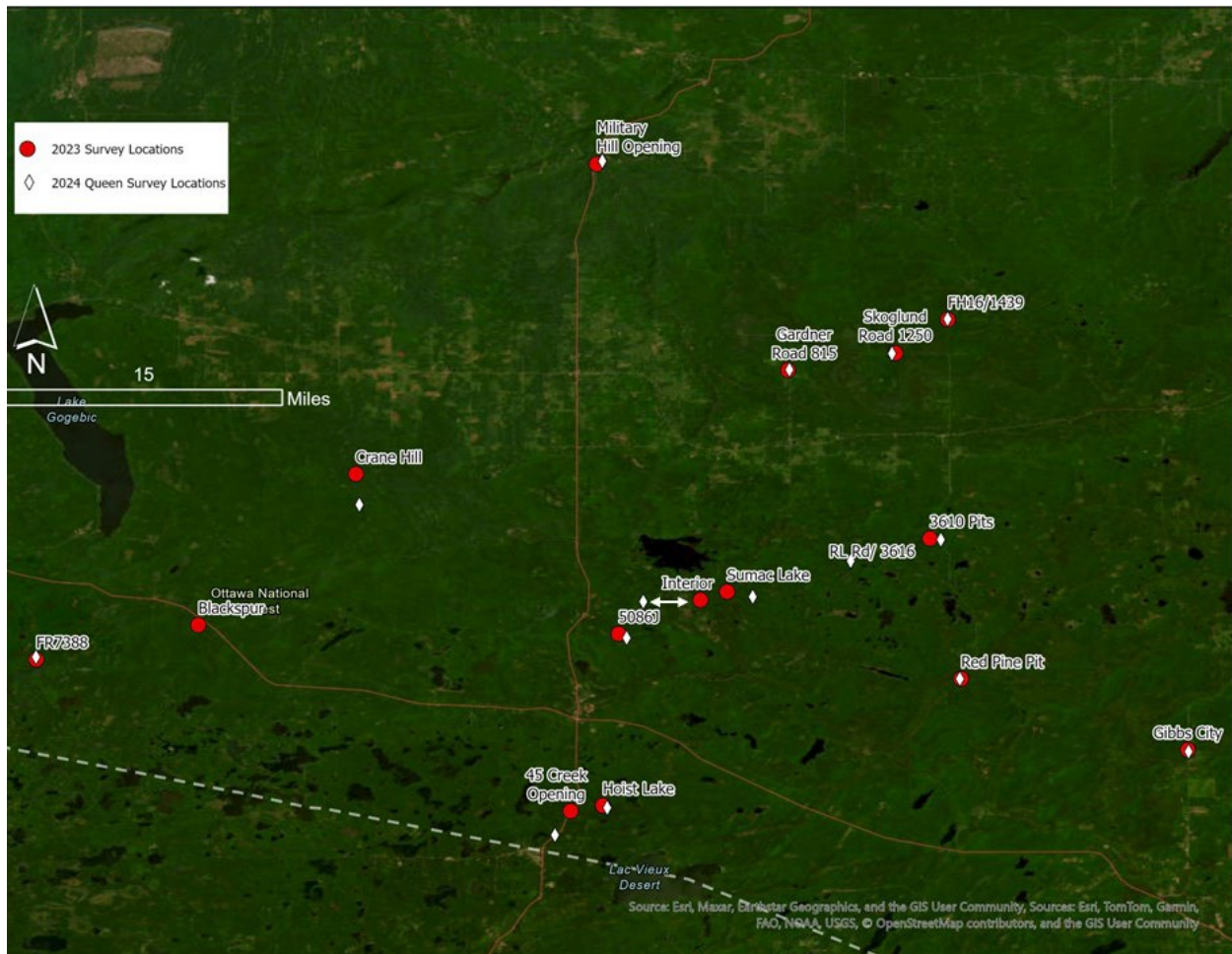


Figure 1. Map of bumble bee community and associated queen survey locations across 2023-2024 in the ONF.

Bumble Bee and Habitat Surveys

We used a modified version of the USFWS bumble bee survey protocol for unoccupied zones (USFWS Survey Protocols for the Rusty Patched Bumble Bee Version 2.2) to complete bumble bee community surveys at each survey location in the ONF in 2023. Each survey consisted of a 1–2-person hour bumble bee community survey (individual survey lengths depended on size of survey habitat and the availability of foraging resources). Surveyors walked meander paths through potential habitat, focusing survey efforts in areas of high concentrations of available flowering resources. We generally used non-lethal techniques, but when identification confirmations were needed, we collected the specimen and completed identifications in the laboratory. The purpose of this methodology was to document the relative abundance of each bumble bee species encountered. Therefore, for each bumble bee occurrence, we recorded the site, date, species (if known), GPS location, and floral resource association. In some instances, we were unable to identify the visited plant species, and so we recorded the lowest taxonomic level with high certainty. Bumble bee voucher specimens from each site were placed in vials with the same information and stored in a cooler for processing post-hoc. All bumble bee community surveys were conducted on days that had no rain, temperatures above 15°C (60°F), and when winds were ≤ 25 kph (15 mph). Bumble bee community surveys were completed between July 28th and August

2nd in 2023. We used ArcGIS Survey123 (ESRI 2020) to record all bumble bees and associated data during field surveys.

Bumble Bee Queen Surveys

Targeted surveys for queen bumble bees were conducted using 1-person hour meander-based surveys at sites within the ONF in 2024. Surveys focused on identifying queen bumble bees and the foraging/nesting resources available to them. Therefore, we prioritized habitats with close proximity to 2023 survey locations but contained higher densities of blooming spring ephemerals. These locations were often directly adjacent to the 2023 survey locations and determined through an initial assessment of available habitat prior to surveying. Observations of queen bumble bees were categorized into three main behaviors: nest searching, foraging, or flying. If a queen's nesting site was observed, information on the nest was collected, including if nest under or above ground and nearby available nest building materials. Foraging resources available at each site were also documented with flowering plant species either identified or were photographed and later identified by MNFI staff to most specific taxonomic level. All queen surveys were conducted between May 6th and May 15th, 2024.

Data Summary and Analysis

We summarized all bumble bee occurrence data by survey site and provide the abundance of each bumble bee species documented during survey events at each site. To assess floral use by state listed bumble bees in Michigan, we generated a rank abundance of plant species floral visits by these species. Floral resources were also ranked by abundance within the site using the DAFOR (D- Dominate plant species, A- Abundant, F- Frequent, O- Occasional, R- Rare) system to determine relative cover forage within sites surveyed. Similarly, we summarized all floral abundance data to identify primary floral resources visited by bumble bees during both years of surveys.

Results

Bumble Bee Community Surveys

We completed a total of 15 bumble bee and habitat surveys on the ONF in 2023. These surveys documented 9 bumble bee species and a total of 786 bumble bee occurrences (Table 1). The most frequently encountered species during these surveys was *B. ternarius* (Tri-colored bumble bee, n=489), followed by *B. vagans* (Half black bumble bee, n=137) and *B. borealis* (Northern amber bumble bee, n=52). We documented a total of 46 occurrences of *B. terricola* at 11 survey sites.

Table 1. Summary of the bumble bee community documented at each survey site on the Ottawa National Forest in 2023. All surveys were conducted between July 28th and August 2nd, 2023.

Site	Lat	Long	Bumble Bee Species									Grand Total
			<i>Bombus bimaculatus</i>	<i>Bombus borealis</i>	<i>Bombus flavidus</i>	<i>Bombus griseocollis</i>	<i>Bombus impatiens</i>	<i>Bombus perplexus</i>	<i>Bombus ternarius</i>	<i>Bombus terricola</i>	<i>Bombus vagans</i>	
Gibbs City	46.23968	-88.7008	0	10	0	0	1	0	0	6	3	20
Red Pine Pit	46.29514	-88.8781	1	9	0	0	0	0	25	4	13	52
3610 Pits	46.4048	-88.9025	0	0	0	0	0	0	76	4	0	80
Skoglund Road 1250	46.54977	-88.9296	0	1	0	1	2	0	26	1	2	33
FH16/1439	46.57608	-88.8885	0	0	0	1	3	0	10	0	1	15
Gardner Road 815	46.53652	-89.0135	0	4	0	2	10	0	12	0	4	32
FR7388	46.31032	-89.6017	0	0	0	2	0	2	30	3	4	41
Blackspur	46.3373	-89.4749	0	11	0	8	0	0	44	2	8	73
Hoist Lake	46.19608	-89.1584	0	2	3	0	0	0	66	4	4	79
45 Creek Opening	46.19172	-89.1836	0	0	1	0	0	1	0	0	2	4
Military Hill Opening	46.69765	-89.1631	0	1	0	2	4	1	4	4	51	67
Crane Hill	46.45527	-89.3516	0	6	0	8	2	1	32	8	34	91
Sumac Lake	46.36323	-89.0612	0	3	1	0	1	0	57	0	5	67
Interior	46.35679	-89.0821	0	3	0	0	0	1	62	1	3	70
5086J	46.3303	-89.1461	0	2	2	1	0	0	45	9	3	62

Bumble bees were documented visiting at least 29 plant species in bloom (Table 2). The most frequently visited forage plants included species within the genera *Hypericum* (St. John’s wort, n=125 occurrences) and *Solidago* (goldenrod, n=124 occurrences). Four additional plant species were visited at least 40 times during survey events (*Apocynum androsaemifolium*, n=43; *Asclepias syriaca*, n=42; *Clinopodium vulgare*, n=53; *Melilotus albus*, n=53). *Bombus terricola* was documented visiting at least 14 different plant species, and most frequently visited *A. syriaca* (n=11), *Solidago* spp. (n=9), *Hypericum* spp. (n=4).



Foraging habitat surveyed at Military Hill Opening on the Ottawa National Forest. *Bombus terricola* (top left) and *B. borealis* (top right) observed foraging on *Solidago* sp. during this survey.

Table 2. The number of bumble bee occurrences to each forage resource used by bumble bees during surveys in the ONF in 2023. Forage resources associated with *Bombus terricola* are shown.

Plant Species	All Bombus Species	<i>Bombus terricola</i> only
<i>Apocynum androsaemifolium</i>	43	3
<i>Asclepias syriaca</i>	42	11
<i>Centaurea stoebe</i>	39	1
<i>Chamaenerion angustifolium</i>	5	0
<i>Cirsium arvense</i>	19	2
<i>Cirsium palustre</i>	10	2
<i>Clinopodium vulgare</i>	53	0
<i>Daucus carota</i>	5	0
<i>Helianthus spp.</i>	34	1
<i>Hypericum spp.</i>	125	4
<i>Leucanthemum vulgare</i>	6	1
<i>Lotus corniculatus</i>	96	2

Plant Species	All Bombus Species	<i>Bombus terricola</i> only
<i>Melilotus albus</i>	53	3
<i>Monarda fistulosa</i>	33	0
<i>Oenothera parviflora</i>	3	0
<i>Pastinaca sativa</i>	3	2
<i>Plantago spp.</i>	3	3
<i>Plantago major</i>	2	0
<i>Rosa blanda</i>	3	0
<i>Rubus strigosus</i>	1	0
<i>Rudbeckia hirta</i>	2	0
<i>Securigera varia</i>	24	0
<i>Solidago spp.</i>	124	9
<i>Spirea alba</i>	1	0
<i>Tanacetum vulgare</i>	1	0
<i>Trifolium hybridum</i>	33	0
<i>Trifolium pratense</i>	12	1
<i>Verbascum thapsus</i>	1	0
<i>Vicia spp.</i>	5	0
Grand Total	786	46

We documented a total of at least 42 plant species in bloom during bumble bee surveys in 2023. There was an average of 14.4 plant species in bloom per site. The most frequently blooming species include *Trifolium pratense* (n=14 sites), *Achillea millefolium* (n=13 sites), and *Leucanthemum vulgare* (n=13 sites). Species in the genera *Hypericum* and *Solidago* were found at 13 sites and 11 sites, respectively. A full summary of the flowering plant species documented at each survey site, and the number of bumble bees that visited them, is provided in Table 3.

Table 3. Summary of plant species observed at each bumble bee survey site on Ottawa National Forest in 2023. Plant species abundance and the number of bumble bees documented from each plant species is shown.

Site	Plant Species	Abundance	Number of Bumble Bees Documented
3610 Pits	<i>Lotus corniculatus</i>	Frequent	0
3610 Pits	<i>Achillea millefolium</i>	Occasional	0
3610 Pits	<i>Centaurea stoebe</i>	Occasional	0
3610 Pits	<i>Hypericum spp.</i>	Occasional	74
3610 Pits	<i>Leucanthemum vulgare</i>	Occasional	0
3610 Pits	<i>Rudbeckia hirta</i>	Occasional	0
3610 Pits	<i>Clinopodium vulgare</i>	Rare	6
3610 Pits	<i>Daucus carota</i>	Rare	0
3610 Pits	<i>Erigeron annuus</i>	Rare	0

Site	Plant Species	Abundance	Number of Bumble Bees Documented
3610 Pits	<i>Hieracium aurantiacum</i>	Rare	0
3610 Pits	<i>Monarda fistulosa</i>	Rare	0
3610 Pits	<i>Oenothera parviflora</i>	Rare	0
3610 Pits	<i>Silene vulgaris</i>	Rare	0
3610 Pits	<i>Solidago spp.</i>	Rare	0
3610 Pits	<i>Trifolium pratense</i>	Rare	0
3610 Pits	<i>Verbascum thapsus</i>	Rare	0
45 Creek Opening	<i>Achillea millefolium</i>	Occasional	0
45 Creek Opening	<i>Apocynum androsaemifolium</i>	Occasional	0
45 Creek Opening	<i>Asclepias syriaca</i>	Occasional	3
45 Creek Opening	<i>Centaurea stoebe</i>	Occasional	0
45 Creek Opening	<i>Leucanthemum vulgare</i>	Occasional	0
45 Creek Opening	<i>Cirsium palustre</i>	Rare	1
45 Creek Opening	<i>Euthamia graminifolia</i>	Rare	0
45 Creek Opening	<i>Solidago spp.</i>	Rare	0
45 Creek Opening	<i>Verbascum thapsus</i>	Rare	0
5086J	<i>Apocynum androsaemifolium</i>	Frequent	16
5086J	<i>Helianthus spp.</i>	Frequent	24
5086J	<i>Asclepias syriaca</i>	Occasional	15
5086J	<i>Clinopodium vulgare</i>	Occasional	2
5086J	<i>Erigeron annuus</i>	Occasional	0
5086J	<i>Leucanthemum vulgare</i>	Occasional	4
5086J	<i>Trifolium pratense</i>	Occasional	0
5086J	<i>Cirsium spp.</i>	Rare	0
5086J	<i>Cirsium arvense</i>	Rare	1
5086J	<i>Symphyotrichum sp.</i>	Rare	0
Blackspur	<i>Lotus corniculatus</i>	Frequent	12
Blackspur	<i>Verbena hastata</i>	Frequent	0
Blackspur	<i>Apocynum androsaemifolium</i>	Occasional	0
Blackspur	<i>Asclepias syriaca</i>	Occasional	7
Blackspur	<i>Centaurea stoebe</i>	Occasional	0
Blackspur	<i>Cirsium arvense</i>	Occasional	4
Blackspur	<i>Clinopodium vulgare</i>	Occasional	1
Blackspur	<i>Daucus carota</i>	Occasional	0
Blackspur	<i>Hypericum spp.</i>	Occasional	28
Blackspur	<i>Leucanthemum vulgare</i>	Occasional	0
Blackspur	<i>Plantago major</i>	Occasional	1
Blackspur	<i>Spirea alba</i>	Occasional	1
Blackspur	<i>Tanacetum vulgare</i>	Occasional	0
Blackspur	<i>Achillea millefolium</i>	Rare	0

Site	Plant Species	Abundance	Number of Bumble Bees Documented
Blackspur	<i>Chamaenerion angustifolium</i>	Rare	0
Blackspur	<i>Erigeron annuus</i>	Rare	0
Blackspur	<i>Helenium autumnale</i>	Rare	0
Blackspur	<i>Melilotus albus</i>	Rare	16
Blackspur	<i>Rudbeckia hirta</i>	Rare	0
Blackspur	<i>Trifolium pratense</i>	Rare	1
Blackspur	<i>Verbascum thapsus</i>	Rare	0
Crane Hill	<i>Daucus carota</i>	Frequent	0
Crane Hill	<i>Lotus corniculatus</i>	Frequent	8
Crane Hill	<i>Solidago spp.</i>	Frequent	53
Crane Hill	<i>Cirsium arvense</i>	Occasional	5
Crane Hill	<i>Clinopodium vulgare</i>	Occasional	11
Crane Hill	<i>Helianthus spp.</i>	Occasional	10
Crane Hill	<i>Trifolium pratense</i>	Occasional	0
Crane Hill	<i>Achillea millefolium</i>	Rare	0
Crane Hill	<i>Asclepias syriaca</i>	Rare	1
Crane Hill	<i>Centaurea stoebe</i>	Rare	0
Crane Hill	<i>Cirsium palustre</i>	Rare	0
Crane Hill	<i>Erigeron annuus</i>	Rare	0
Crane Hill	<i>Euthamia graminifolia</i>	Rare	0
Crane Hill	<i>Hypericum spp.</i>	Rare	0
Crane Hill	<i>Leucanthemum vulgare</i>	Rare	0
Crane Hill	<i>Monarda fistulosa</i>	Rare	3
Crane Hill	<i>Spirea alba</i>	Rare	0
Crane Hill	<i>Verbena hastata</i>	Rare	0
Crane Hill	<i>Vicia spp.</i>	Rare	0
FH16/1439	<i>Centaurea stoebe</i>	Frequent	0
FH16/1439	<i>Apocynum androsaemifolium</i>	Occasional	5
FH16/1439	<i>Erigeron annuus</i>	Occasional	0
FH16/1439	<i>Hypericum spp.</i>	Occasional	7
FH16/1439	<i>Solidago spp.</i>	Occasional	1
FH16/1439	<i>Achillea millefolium</i>	Rare	0
FH16/1439	<i>Clinopodium vulgare</i>	Rare	1
FH16/1439	<i>Monarda fistulosa</i>	Rare	0
FH16/1439	<i>Potentilla argentea</i>	Rare	0
FH16/1439	<i>Plantago major</i>	Rare	1
FH16/1439	<i>Rudbeckia hirta</i>	Rare	0
FH16/1439	<i>Trifolium pratense</i>	Rare	0
FH16/1439	<i>Verbascum thapsus</i>	Rare	0
FR7388	<i>Apocynum androsaemifolium</i>	Abundant	16

Site	Plant Species	Abundance	Number of Bumble Bees Documented
FR7388	<i>Clinopodium vulgare</i>	Abundant	11
FR7388	<i>Asclepias syriaca</i>	Frequent	5
FR7388	<i>Centaurea stoebe</i>	Occasional	0
FR7388	<i>Erigeron annuus</i>	Occasional	0
FR7388	<i>Helianthus spp.</i>	Occasional	0
FR7388	<i>Hypericum spp.</i>	Occasional	6
FR7388	<i>Leucanthemum vulgare</i>	Occasional	0
FR7388	<i>Lotus corniculatus</i>	Occasional	0
FR7388	<i>Plantago major</i>	Occasional	0
FR7388	<i>Achillea millefolium</i>	Rare	0
FR7388	<i>Oenothera parviflora</i>	Rare	0
FR7388	<i>Rubus strigosus</i>	Rare	1
FR7388	<i>Rudbeckia hirta</i>	Rare	0
FR7388	<i>Trifolium pratense</i>	Rare	0
FR7388	<i>Verbascum thapsus</i>	Rare	0
Gardner Road 815	<i>Achillea millefolium</i>	Occasional	0
Gardner Road 815	<i>Clinopodium vulgare</i>	Occasional	6
Gardner Road 815	<i>Lotus corniculatus</i>	Occasional	11
Gardner Road 815	<i>Arctium minus</i>	Rare	0
Gardner Road 815	<i>Cirsium arvense</i>	Rare	8
Gardner Road 815	<i>Daucus carota</i>	Rare	0
Gardner Road 815	<i>Hypericum spp.</i>	Rare	0
Gardner Road 815	<i>Plantago major</i>	Rare	0
Gardner Road 815	<i>Potentilla argentea</i>	Rare	0
Gardner Road 815	<i>Rudbeckia hirta</i>	Rare	0
Gardner Road 815	<i>Securigera varia</i>	Rare	1
Gardner Road 815	<i>Solidago spp.</i>	Rare	0
Gardner Road 815	<i>Tanacetum vulgare</i>	Rare	1
Gardner Road 815	<i>Trifolium pratense</i>	Rare	0
Gardner Road 815	<i>Verbena hastata</i>	Rare	0
Gardner Road 815	<i>Vicia spp.</i>	Rare	5
Gibbs City	<i>Asclepias syriaca</i>	Frequent	11
Gibbs City	<i>Cirsium arvense</i>	Frequent	1
Gibbs City	<i>Hieracium aurantiacum</i>	Frequent	0
Gibbs City	<i>Linaria vulgaris</i>	Frequent	0
Gibbs City	<i>Clinopodium vulgare</i>	Occasional	0
Gibbs City	<i>Leucanthemum vulgare</i>	Occasional	0
Gibbs City	<i>Oenothera parviflora</i>	Occasional	0
Gibbs City	<i>Solidago spp.</i>	Occasional	0
Gibbs City	<i>Achillea millefolium</i>	Rare	0

Site	Plant Species	Abundance	Number of Bumble Bees Documented
Gibbs City	<i>Centaurea stoebe</i>	Rare	0
Gibbs City	<i>Hypericum spp.</i>	Rare	1
Gibbs City	<i>Lotus corniculatus</i>	Rare	4
Gibbs City	<i>Plantago spp.</i>	Rare	3
Gibbs City	<i>Rudbeckia hirta</i>	Rare	0
Gibbs City	<i>Trifolium pratense</i>	Rare	0
Hoist Lake	<i>Apocynum androsaemifolium</i>	Occasional	0
Hoist Lake	<i>Cirsium palustre</i>	Occasional	1
Hoist Lake	<i>Clinopodium vulgare</i>	Occasional	1
Hoist Lake	<i>Leucanthemum vulgare</i>	Occasional	1
Hoist Lake	<i>Trifolium pratense</i>	Occasional	4
Hoist Lake	<i>Achillea millefolium</i>	Rare	0
Hoist Lake	<i>Chamaenerion angustifolium</i>	Rare	1
Hoist Lake	<i>Cirsium spp.</i>	Rare	0
Hoist Lake	<i>Hieracium aurantiacum</i>	Rare	0
Hoist Lake	<i>Melilotus albus</i>	Rare	36
Hoist Lake	<i>Oenothera parviflora</i>	Rare	0
Hoist Lake	<i>Solidago spp.</i>	Rare	0
Hoist Lake	<i>Trifolium hybridum</i>	Rare	33
Hoist Lake	<i>Verbascum thapsus</i>	Rare	0
Interior	<i>Solidago spp.</i>	Abundant	16
Interior	<i>Centaurea stoebe</i>	Frequent	37
Interior	<i>Achillea millefolium</i>	Occasional	0
Interior	<i>Clinopodium vulgare</i>	Occasional	9
Interior	<i>Hypericum spp.</i>	Occasional	0
Interior	<i>Leucanthemum vulgare</i>	Occasional	1
Interior	<i>Rudbeckia hirta</i>	Occasional	0
Interior	<i>Trifolium pratense</i>	Occasional	3
Interior	<i>Asclepias syriaca</i>	Rare	0
Interior	<i>Chamaenerion angustifolium</i>	Rare	0
Interior	<i>Hieracium aurantiacum</i>	Rare	0
Interior	<i>Monarda fistulosa</i>	Rare	0
Interior	<i>Oenothera parviflora</i>	Rare	1
Interior	<i>Rosa blanda</i>	Rare	3
Military Hill Opening	<i>Monarda fistulosa</i>	Frequent	28
Military Hill Opening	<i>Centaurea stoebe</i>	Occasional	1
Military Hill Opening	<i>Cirsium arvense</i>	Occasional	0
Military Hill Opening	<i>Daucus carota</i>	Occasional	5
Military Hill Opening	<i>Hypericum spp.</i>	Occasional	2
Military Hill Opening	<i>Leucanthemum vulgare</i>	Occasional	0

Site	Plant Species	Abundance	Number of Bumble Bees Documented
Military Hill Opening	<i>Rudbeckia hirta</i>	Occasional	1
Military Hill Opening	<i>Solidago spp.</i>	Occasional	20
Military Hill Opening	<i>Trifolium pratense</i>	Occasional	1
Military Hill Opening	<i>Achillea millefolium</i>	Rare	0
Military Hill Opening	<i>Helianthus spp.</i>	Rare	0
Military Hill Opening	<i>Lotus corniculatus</i>	Rare	5
Military Hill Opening	<i>Medicago sativa</i>	Rare	0
Red Pine Pit	<i>Lotus corniculatus</i>	Abundant	37
Red Pine Pit	<i>Apocynum androsaemifolium</i>	Frequent	6
Red Pine Pit	<i>Centaurea stoebe</i>	Occasional	0
Red Pine Pit	<i>Hypericum spp.</i>	Occasional	0
Red Pine Pit	<i>Leucanthemum vulgare</i>	Occasional	0
Red Pine Pit	<i>Trifolium pratense</i>	Occasional	0
Red Pine Pit	<i>Cirsium palustre</i>	Rare	6
Red Pine Pit	<i>Erigeron annuus</i>	Rare	0
Red Pine Pit	<i>Monarda fistulosa</i>	Rare	1
Red Pine Pit	<i>Solidago spp.</i>	Rare	2
Skoglund Road 1250	<i>Leucanthemum vulgare</i>	Occasional	0
Skoglund Road 1250	<i>Trifolium pratense</i>	Occasional	1
Skoglund Road 1250	<i>Achillea millefolium</i>	Rare	0
Skoglund Road 1250	<i>Chamaenerion angustifolium</i>	Rare	4
Skoglund Road 1250	<i>Clinopodium vulgare</i>	Rare	1
Skoglund Road 1250	<i>Erigeron annuus</i>	Rare	0
Skoglund Road 1250	<i>Hieracium aurantiacum</i>	Rare	0
Skoglund Road 1250	<i>Hypericum spp.</i>	Rare	1
Skoglund Road 1250	<i>Lotus corniculatus</i>	Rare	0
Skoglund Road 1250	<i>Melilotus albus</i>	Rare	1
Skoglund Road 1250	<i>Oenothera parviflora</i>	Rare	1
Skoglund Road 1250	<i>Potentilla argentea</i>	Rare	0
Skoglund Road 1250	<i>Rosa blanda</i>	Rare	0
Skoglund Road 1250	<i>Rudbeckia hirta</i>	Rare	0
Skoglund Road 1250	<i>Securigera varia</i>	Rare	23
Skoglund Road 1250	<i>Trifolium hybridus</i>	Rare	0
Skoglund Road 1250	<i>Verbena hastata</i>	Rare	0
Sumac Lake	<i>Centaurea stoebe</i>	Frequent	1
Sumac Lake	<i>Lotus corniculatus</i>	Frequent	19
Sumac Lake	<i>Achillea millefolium</i>	Occasional	0
Sumac Lake	<i>Clinopodium vulgare</i>	Occasional	4
Sumac Lake	<i>Erigeron annuus</i>	Occasional	0
Sumac Lake	<i>Hypericum spp.</i>	Occasional	6

Site	Plant Species	Abundance	Number of Bumble Bees Documented
Sumac Lake	<i>Leucanthemum vulgare</i>	Occasional	0
Sumac Lake	<i>Rudbeckia hirta</i>	Occasional	1
Sumac Lake	<i>Solidago spp.</i>	Occasional	32
Sumac Lake	<i>Trifolium pratense</i>	Occasional	1
Sumac Lake	<i>Verbascum thapsus</i>	Occasional	1
Sumac Lake	<i>Asclepias syriaca</i>	Rare	0
Sumac Lake	<i>Chamaenerion angustifolium</i>	Rare	4
Sumac Lake	<i>Cichorium intybus</i>	Rare	0
Sumac Lake	<i>Helianthus spp.</i>	Rare	0
Sumac Lake	<i>Monarda fistulosa</i>	Rare	1
Sumac Lake	<i>Tragopogon dubius</i>	Rare	0

2024 Bumble Bee Queen Surveys

We completed bumble bee queen surveys at 15 sites across the ONF in 2024 (see Figure 1). Survey sites were generally adjacent to 2023 survey locations, but based on available foraging habitat, may have been separated by distances of over 1 mile. From these, 90 individual queen bumble bees were observed from at least 5 different species at 13 of the sites (Table 4). Only one occurrence of a state-listed species was observed, with one *B. terricola* queen being observed at site 5086J. The most observed bumble bee queen was *B. ternarius* (Tri-color bumble bee; n=57).

Queens were rarely observed foraging with most individuals being observed in flight (n=38) or nest searching (n=27). When queens were observed foraging most were observed on *Lorincera* spp. (n=11); which was only documented at one site. The sole observation of a *B. terricola* queen was observed foraging on *Lorincera* spp. No active bumble bee nests were documented. A summary of queen bumble bee activity/foraging is provided in Table 5.

At least 14 flowering species were observed during queen bumble bee surveys (Table 6). No flowering resource was the dominant cover at any site. The most observed flowering resource was *Claytonia virginica* (Virginia meadow beauty, n=11) and it was abundant (n=4) or frequent (n=3) at more sites than any other floral resource.

Table 4. Summary of queen bumble bee observations at 2024 survey sites.

Site	Lat	Long	<i>B. borealis</i>	<i>B. impatiens</i>	<i>B. ternarius</i>	<i>B. terricola</i>	<i>B. vagans</i>	Unknown	Total
Gibbs City	46.238246	-88.700187	-	-	1	-	-	-	1
Red Pine Pit	46.295157	-88.879112	-	-	7	-	1	4	12
3610 Pits	46.403953	-88.893955	-	-	20	-	-	2	22
Skoglund Road 1250	46.549497	-88.932261	-	-	4	-	-	1	5
FH16/1439	46.576415	-88.888865	-	-	1	-	-	1	2
Gardner Road 815	46.536918	-89.012394	-	-	-	-	-	5	5
FR7388	46.312228	-89.601882	-	-	-	-	-	-	0
RL Rd/3616	46.387289	-88.964518	-	-	-	-	-	3	3
Hoist Lake	46.194318	-89.154954	-	-	-	-	1	1	2
45 Creek Opening	46.173001	-89.195878	-	-	3	-	-	1	4
Military Hill Opening	46.699999	-89.158795	1	2	-	-	3	-	6
Crane Hill	46.43126	-89.348899	-	-	-	-	-	-	0
Sumac Lake	46.359297	-89.041178	-	-	3	-	-	1	4
Interior	46.35552	-89.12677	-	-	5	-	-	1	6
5086J	46.32716	-89.139795	-	-	13	1	3	1	18
Total	-	-	1	2	57	1	8	21	90

Table 5. Table of behaviors and foraging sources utilized by queen bumble bees during 2024 surveys.

Species	<i>Claytonia virginica</i>	<i>Epigea repens</i>	<i>Lorincera</i> spp.	<i>Viola</i> spp.	Flying	Nest Searching	Resting
<i>B. borealis</i>	-	-	-	-	1	-	-
<i>B. impatiens</i>	-	-	-	-	1	1	-
<i>B. ternarius</i>	10	2	8	-	14	23	-
<i>B. terricola</i>	-	-	1	-	-	-	-
<i>B. vagans</i>	-	-	2	1	2	3	-
Unknown	-	-	-	-	20	-	1
Total	10	2	11	1	38	27	1

Table 6. Table of 2024 queen bumble bee survey sites and floral resources present at each site.

Site	Abundant	Frequent	Occasional	Rare
Gibbs City	-	-	-	<i>Trillium grandiflorum</i> ; <i>Taraxacum officinale</i> ; <i>Claytonia virginica</i> ; <i>Anemonoides nemorosa</i>
Red Pine Pit	-	-	<i>Viola</i> spp; <i>Taraxacum officinale</i> ; <i>Waldsteinia fragarioides</i>	<i>Epigaea repens</i> ; <i>Fragaria virginiana</i>
3610 Pits	<i>Claytonia virginica</i>	-	-	-
Skoglund Road 1250	-	<i>Claytonia virginica</i>	-	-
FH16/1439	<i>Claytonia virginica</i>	-	-	-
Gardner Road 815	-	<i>Waldsteinia fragarioides</i>	<i>Viola</i> spp.	<i>Trillium grandiflorum</i> ; <i>Taraxacum officinale</i>
FR7388	<i>Erythronium americanum</i>	<i>Claytonia virginica</i>	<i>Dicentra cucullaria</i>	<i>Sambucus racemosa</i>
RL Rd/3616	<i>Claytonia virginica</i>	-	-	<i>Trillium grandiflorum</i>
Hoist Lake	-	-	-	<i>Claytonia virginica</i>
45 Creek Opening	-	-	-	<i>Waldsteinia fragarioides</i>
Military Hill Opening	<i>Trillium grandiflorum</i>	-	-	<i>Viola</i> spp.; <i>Claytonia virginica</i> ; <i>Erythronium americanum</i> ; <i>Caulophyllum thalictroides</i>
Crane Hill	<i>Claytonia virginica</i>	<i>Panax trifolius</i>	-	<i>Waldsteinia fragarioides</i> ; <i>Taraxacum officinale</i>
Sumac Lake	-	-	-	<i>Sambucus racemosa</i>
Interior	<i>Erythronium americanum</i>	<i>Claytonia virginica</i>	-	-
5086J	-	<i>Lonicera</i> spp.	-	<i>Claytonia virginica</i>

Discussion

In 2023, MNFI completed bumble bee community and floral surveys at 15 locations within the ONF. At each survey location we documented the local bumble bee community, primary foraging resources, and all flowering plants available during the survey. *Bombus terricola* was documented at 11 of the 15 survey sites, demonstrating that this species seems to persist throughout the ONF. Bumble bees visited at least 29 plant species, but a few species tended to receive the bulk of visitations, including *A.*

androsaemifolium, *A. syriaca*, *C. vulgare*, and *M. albus*. Most flowering plant species were recorded as Occasionally to Rare, suggesting that flowering resource abundance may be a limiting factor in supporting robust bumble bee communities at the surveyed sites. Increasing the abundance of native flowering plants known to support bumble bee populations will be the best method to increase bumble bee abundance and diversity at these sites. Special attention should be given to locations with *B. terricola*, as this species is considered a Species of Greatest Conservation Need (SGCN) in Michigan's Wildlife Action Plan (WAP) and known to be decreasing in numbers across the historic range.

In 2024 we expanded upon these bumble bee community surveys by conducting targeted surveys for early season queen bumble bees on the ONF at 15 locations. Bumble bee queens were documented at 13 of the 15 sites, including one observation of the state listed *B. terricola*. Bumble bee queens were most frequently observed flying or nest searching and were infrequently observed foraging. While most survey sites in 2024 did contain some degree of potential forage, early season forage may be a limiting factor in surveyed habitats. At many sites, floral resources were sparsely available with less than half of the sites containing a foraging resource as a dominant or abundant landcover. In these habitats, bumble bees may have been foraging on trees/shrubs above where MNFI researchers could document them. To support this species, improving spring and fall flowering resource abundance may be crucial. Promoting flowering species like the spring forb *Claytonia virginica*, the flowering shrub *Vaccinium angustifolium*, and spring flowering trees, can help support *B. terricola* during queen foraging and early colony development. In the fall, species in the genera *Solidago*, *Symphotrichum*, and *Eutrochium* are the most frequently visited flowering plants by *B. terricola* (Rowe et al. 2023). Additionally, forest management at sites within the ONF that have populations of bumble bee species should be managed in such a way that nesting habitat is supported. This includes taking into account how logging may affect available bumble bee habitat and floral resources; and practices such as clear-cutting areas may have a negative impact on bumble bee populations (Catar 2005).

We recommend continued surveys for bumble bees that align with the ONF's management and treatment plans to 1) continue locating populations of *B. terricola*, 2) Identify habitats which would benefit from habitat enhancement or conservation, 3) Continual monitoring of sites where *B. terricola* has been observed to document yearly differences and 4) inform the bumble bee databases of the ONF and MNFI. 2023 was the first year of bumble bee focused surveys on the ONF and 2024 the first targeted effort to document locations of bumble bee queens. Additional years may be warranted to meet conservation and management goals. This should include monitoring additional locations for queen bumble bees and targeted surveys to document what resources are available for bumble bee communities across the ONF. Conducting these surveys in relation to ongoing management within the ONF will improve the conservation potential for at-risk species of bumble bees on ONF.

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