A Survey of Monarch Butterflies and Bumble Bees at Fort Custer Training Center

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Cover: Monarch butterfly (*Danaus plexippus*) larvae on the leaf of butterfly milkweed (*Asclepias tuberosa*) at Fort Custer Training Center.

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Abstract

Monarch butterflies (*Danaus plexippus*) and bumble bees (*Bombus sp.*) are important pollinators of both natural and managed plant communities. Fort Custer Training Center (FCTC) is located within the range of monarch butterfly migration and is home to many species of bumble bees in Michigan, including multiple state listed species. Due to the recent IUCN listing of the (migratory) monarch as Endangered, it is more important than ever to conduct surveys for their presence and habitat use to create appropriate management plans to inform conservation of the species. In 2022, we conducted 3 rounds of surveys for monarch adults, eggs, and larva, and surveyed for bumble bees and available floral resources, at 8 locations within FCTC. Surveys aimed to establish baseline data on monarch butterflies, continue to monitor bumble bee communities, and document floral resource use by these important pollinators. Surveys documented adult monarch observations, occurrences of monarch eggs and larva, and their associated milkweed host (*Asclepias sp.*). We also documented 3 occurrences of the state special concern Black-and-gold bumble bee (*Bombus auricomus*). In this report, we provide relative abundance of monarch butterflies and bumble bees, bumble bee species richness, and monarch egg/larvae counts on milkweed over the course of the 2022 field season at FCTC. In the discussion, we provide recommendations for habitat management opportunities to support at-risk pollinator communities at FCTC.

Introduction

Monarch butterflies (*Danaus plexippus*) and bumble bees (*Bombus* sp.) play key roles in the pollination of flowering plants across the state of Michigan. Historically, both were a plentiful pollinator within the United States. Currently, these pollinators are experiencing declines, with the monarch now listed as Endangered by the International Union for Conservation of Nature (IUCN), and multiple bumble bee species receiving conservation attention through federal and state conservation strategies. The primary threats to these pollinators include habitat loss and fragmentation, pesticides, pathogens, and climate change (Potts et al., 2010). The loss of such critical pollinators could have profound effects on the ecosystems they inhabit, including decreases in floral abundance, changes in food webs, loss of ecosystem services, and even local extinctions (Allen-Wardell et al., 1998).

Milkweed (*Asclepias* sp.) is a plant genus that plays a vital role in the life cycle of the monarch butterfly. They are the host plant for monarch larva and are the primary plant resource that monarchs will lay their eggs on. Furthermore, monarchs are known to lay their eggs on multiple milkweed species during their migratory path north through their range. During development, monarch larvae feed exclusively on milkweed. It is because of this specialist diet that preserving milkweed abundance and diversity is key to the conservation of this species. Concurrently, bumble bees are very important pollinators of milkweed (Moore & Whitman, 2021). Therefore, by promoting bumble bee conservation through habitat management that includes milkweed resources, landscapes with milkweed habitat can help support both monarch butterflies and bumble bees. Creating a conservation plan that addresses this complex intersection of habitat use is imperative to future ecosystem health.

Fort Custer Training Center (FCTC), located in the southwest portion of Michigan's lower Peninsula, is a federally owned military installation operated by the Michigan Army National Guard (MIARNG) that spans 7570 acres in Kalamazoo and Calhoun Counties (Figure 1). Based on its location and the statewide distributions of bumble bees, FCTC is within the current statewide range of 11 bumble bee species, including 3 species actively tracked in the Michigan Natural Heritage Database (*B. auricomus*, *B. sandersoni*, *B. pensylvanicus*). It also falls within range of north-eastern monarch distribution. While predominately forested, the base has many open locations with ample floral resources that may support both monarchs and bumble bees. While surveys for bumble bees have previously been conducted on base, surveys for monarchs and their behavior, egg and larval presence, and milkweed associations have not been conducted. Surveys to estimate monarch abundance, alongside surveys for bumble bees, could provide valuable information regarding the intersection of habitat use by both insects and allow for informed creation of conservation and habitat management plans to support both bumble bee and monarch populations at FCTC.

In 2022, MNFI conducted 3 rounds of monarch and bumble bee surveys at 8 locations across FCTC to determine monarch adult, egg, and larval abundance, to monitor bumble bee abundance and diversity, and to identify the primary floral resources used by these pollinators on the base. These surveys provide the first characterization of monarch abundance, as well as egg and larval abundance and milkweed associations at FCTC and enable the identification of habitat management strategies to support both monarch butterfly and diverse bumble bee communities at FCTC.

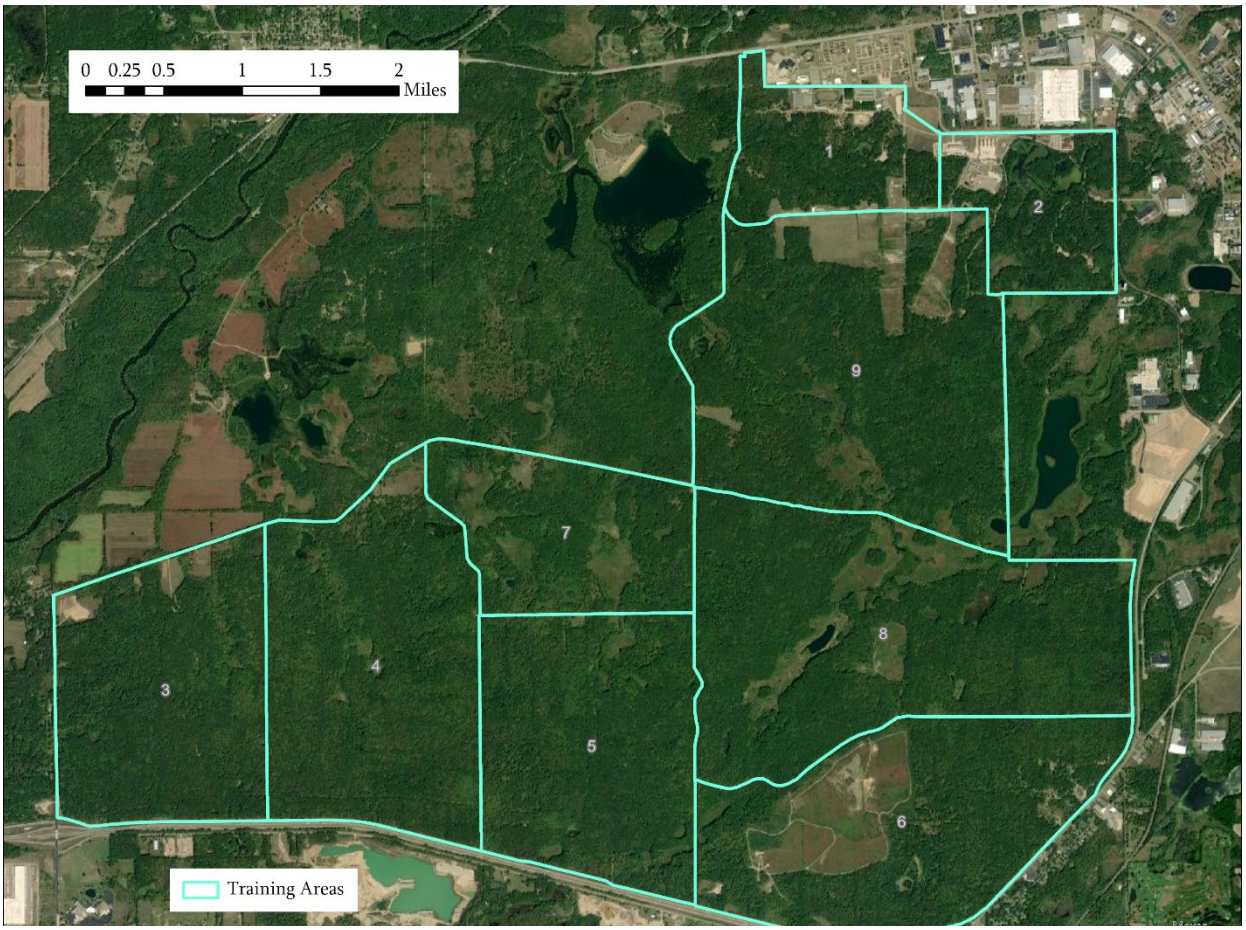

Figure 1. Fort Custer Training Center located in Kalamazoo and Calhoun Counties; the base is divided into 9 training areas.

Methods

Site Selection

Prior to surveys, we used a combination of habitat and landcover data within the Michigan Forest Inventory database, as well as information from previous bumble bee survey work at FCTC (Rowe 2020), to identify potential locations with abundant milkweed. Identified locations were visited in early June 2022 to select the final 8 surveys sites used in this study (Figure 2).

Monarch Butterfly Surveys

During the summer of 2022, 8 sites were surveyed once a month for three survey periods: survey period one was in June, survey period two was in July, and survey period three was in August. Monarch surveys were conducted when temperatures were above 70ºF and wind was below 10mph. Two monarch surveys were completed simultaneously: an adult monarch survey and a monarch egg and larval survey. Weather conditions were recorded at the start of each survey.

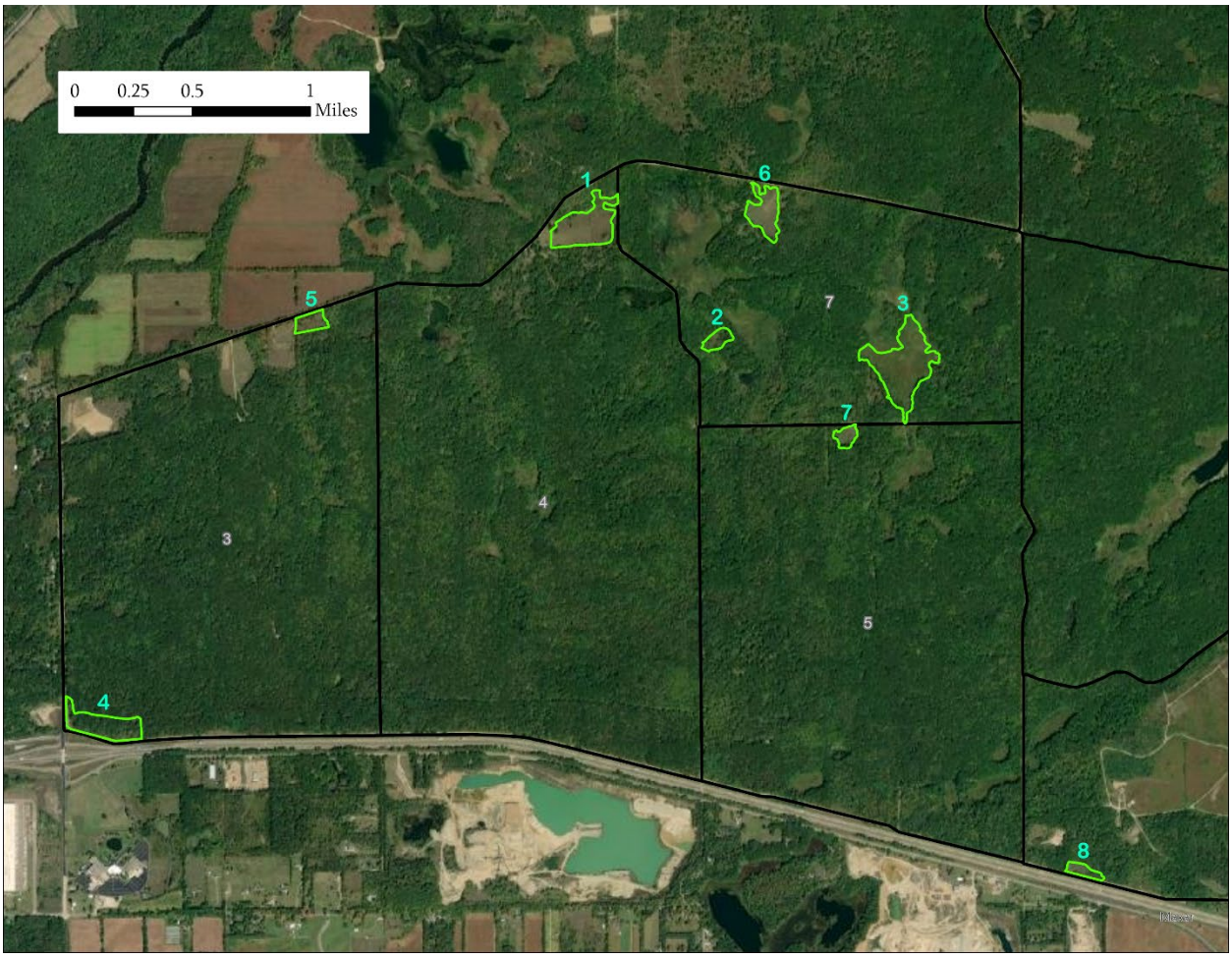

Figure 2. Monarch butterfly and bumble bee survey sites at Fort Custer Training Center.

During the adult monarch survey, we counted the number of adult occurrences within the survey area and noted any behavioral information pertaining to each observation. During the egg and larval survey, we counted the number of eggs and larvae per individual milkweed plant. Each survey lasted a total of 1 hour per site. The egg and larval survey was completed simultaneously with the adult survey due to the low number of adult occurrences during each survey event. The egg and larval survey was completed when 50 milkweed plants were assessed for both eggs and larvae. If a survey site did not have 50 milkweed plants, we completed the survey on all milkweed resources available. For sites with greater than 50 milkweed plants, we selected a total of 50 plants at random using a meander walk at the site to complete the survey. All species of milkweed present were assessed, and ideally, a representative mix of milkweed species was surveyed at each site. Each milkweed plant was thoroughly looked over, taking care to look at the underside of each leaf and around flowers.

Bumble Bee Surveys

After concluding the monarch surveys, a 30-minute bumble bee survey was conducted at each site. This included a meander walk around the site, with efforts focused on areas with higher densities of floral resources. Bees encountered were either identified on plant or caught with a net and vialed. Vialed bees were identified and then released, with a few specimen from each

survey site being kept as vouchers. For each bee, the species identity and behavior were recorded. Behaviors included flying, resting, foraging, and the plant the bee was foraging on if this behavior was observed. When all three surveys were fully complete, end weather and plant data were recorded.

Data Analysis

Monarch Egg and Larva Analysis

During some survey periods, sites did not have 50 milkweed stems. To standardize the data and be able to compare egg and larval counts among sites, an egg per stem value and larvae per stem value were calculated for each site, during each survey period. We assessed standardized values for eggs and larvae over time and compared between sites during each survey round.

Bumble Bee Analysis

We assessed the total number of bumble bees recorded from each site during the 3 survey periods, primarily looking for peak bumble bee abundance time frames at FCTC. Additionally, we determined the total number of bumble bees collected from each flowering plant species. Documented occurrences of state listed species were incorporated into the Michigan Natural Heritage database, where Elemental Occurrences (EOs) were updated to reflect the most recent survey information.

Figure 3. Site 2 full of floral bloom at Fort Custer Training Center.

Results

Monarch Results

During the summer of 2022, 24 adult monarch surveys and egg/larval surveys were conducted within the 8 survey sites at Fort Custer Training Center. Eighteen adult monarchs were observed over the three survey periods, with 1 observed in survey period 1 (S1), 13 observed in survey period 2 (S2), and 4 adults observed in survey period 3 (S3) (Figure 4). Similarly, egg per stem (EPS) values also peaked in the second survey period (Figure 5). In S1, eggs were found on three sites: site 1, site 5, and site 7. Site 5 had a moderate EPS value (0.2), while 1 and 7 had very low EPS values (1 = 0.02, 7 = 0.036). In S2, eggs were found on seven of the eight sites, with Site 2 being the only site without eggs found during the survey. Sites 1, 3, 5, and 7 had high EPS values (1 = 0.26, 3 = 0.42, 5 = 0.32, 7 = 0.46), site 6 had a moderate EPS value (0.22), and sites 4 and 8 had low EPS values (4 = 0.06, 8 = 0.1). In S3, only one site had eggs found during surveys (site 8). Though eggs were present, the EPS value was very low (0.02). No eggs were found at site 2 during the three rounds of surveys. No larvae were present in S1. However, larvae were found on sites in S2 and S3 (Figure 6). Detectability of larva and therefore larva per stem (LPS) values were much lower than eggs. In S2, larvae were found on sites 2, 6, and 8. Site 2 saw a lower LPS value (0.02), whereas sites 6 and 8 had higher values (6 = 0.06 , 8 = 0.04). In S3, four sites contained larvae: 1, 3, 7, and 8. Site 1 had the lowest LPS value (0.04), while sites 7 and 8 shared the same LPS value (0.02), and site 3 had the highest value (0.083).

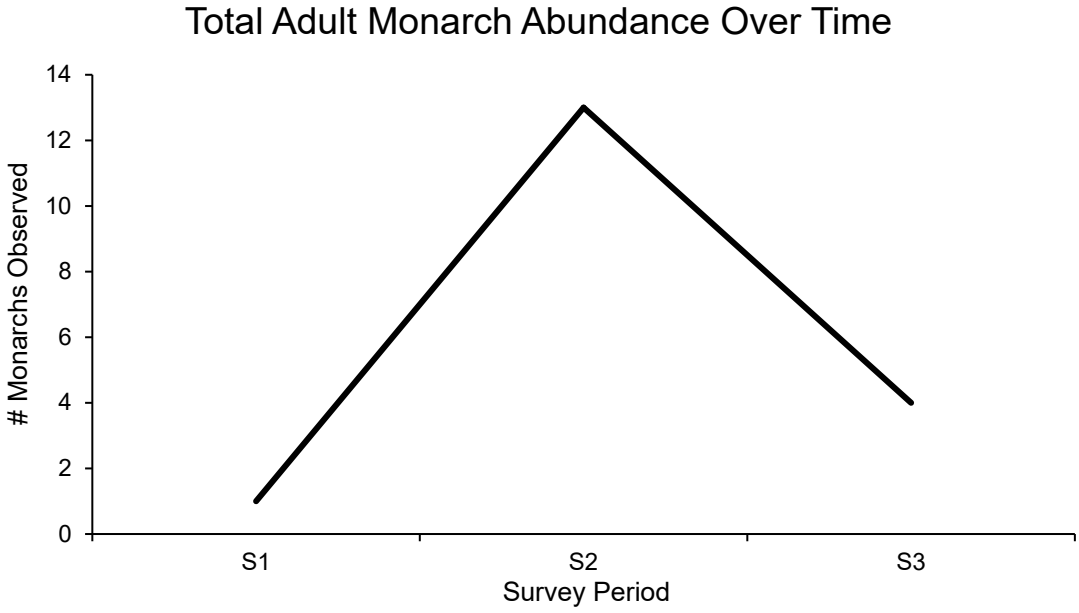

Figure 4. Total monarch abundance over time at Fort Custer Training Center.

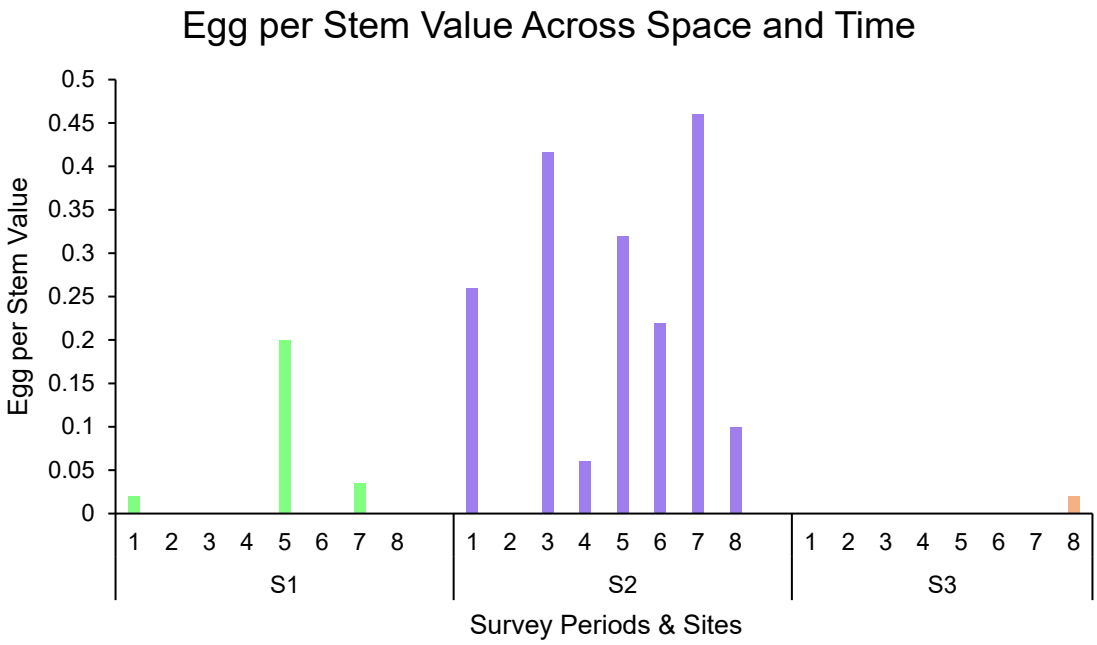

Figure 5. Egg per stem values across space and time at Fort Custer Training Center.

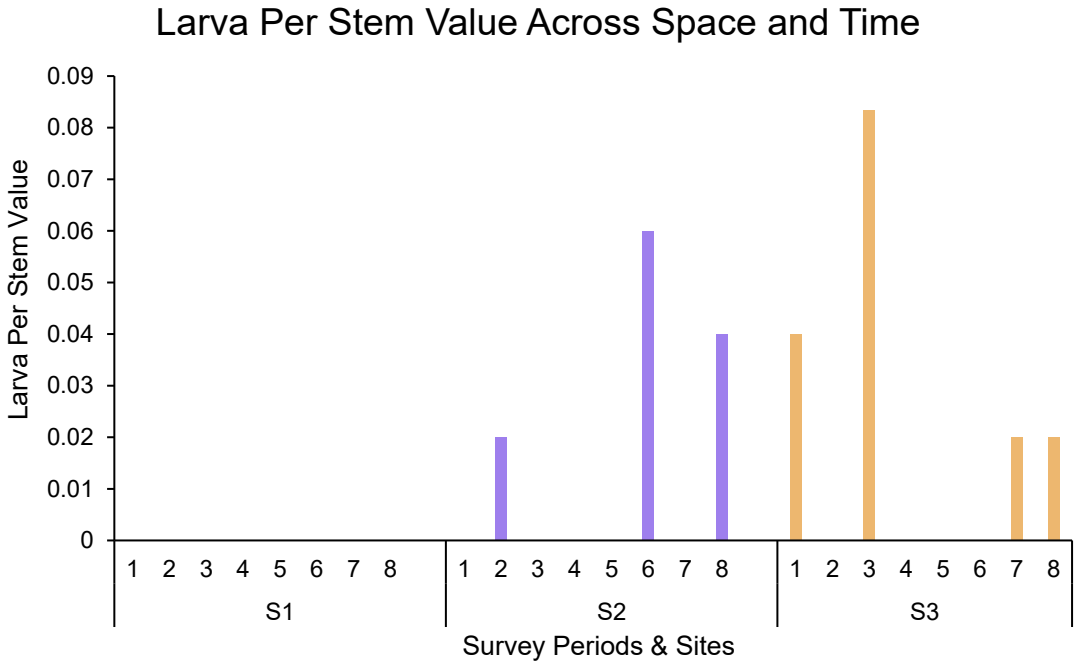

Figure 6. Larva per stem values across space and time at Fort Custer Training Center.

Figure 7. Brown-belted bumble bee (*Bombus griseocollis*) foraging on Lupine (*Lupinus perennis*) at Fort Custer Training Center.

Bumble Bee Results

A total of 24 bumble bee surveys were conducted through the summer at all 8 survey sites. A total of 749 bees were observed during the surveys (S1: n = 22, S2: n = 324, S3: = 403) (Figure 8), with eight species represented (Table 1). The common eastern bumble bee (*Bombus impatiens*) was the most common species of bumble bee found during surveys (n = 553), followed by the two-spotted bumble bee (*Bombus bimaculatus*) (n = 79) and the brown-belted bumble bee (*Bombus griseocollis*) (n = 61). The least encountered species included the black and gold bumble bee (*Bombus auricomus*, State Special Concern) (n = 3) and the confusing bumble bee (*Bombus perplexus*) (n = 1). Associated floral species for each bumble bee occurrence is provided in Table 2. Bumble bees were most frequently collected from spotted knapweed (*Centaurea stoebe*; n = 398*)* followed by wild bergamot (*Monarda fistulosa;* n = 112) and butterfly milkweed (*Asclepias tuberosa;* n = 78).

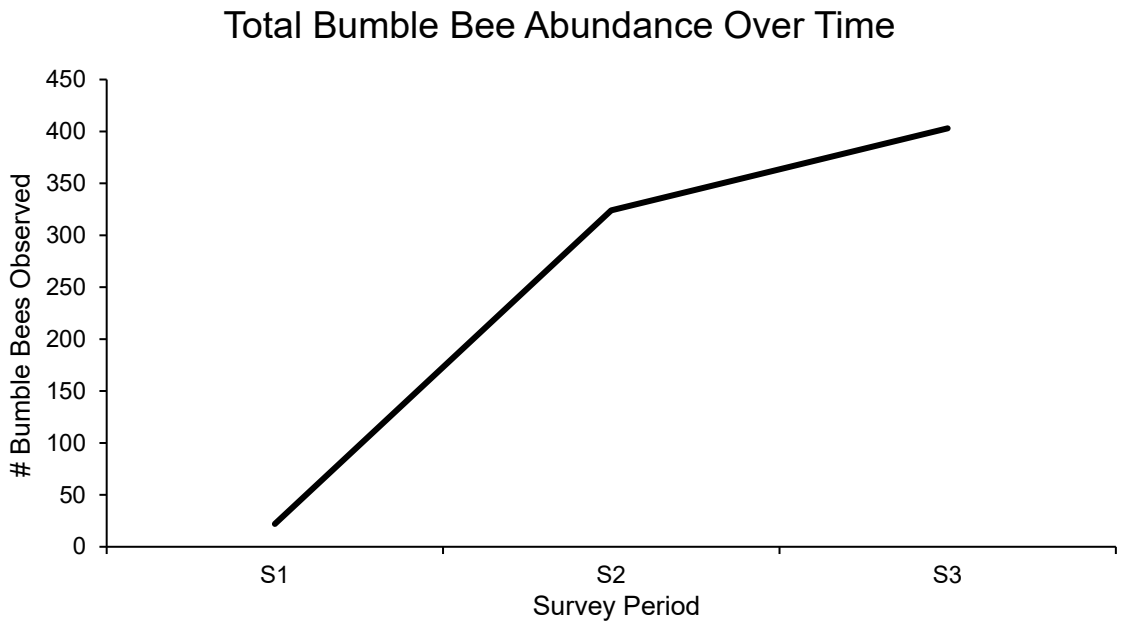

Figure 8. Total bumble bee abundance over time at Fort Custer Training Center.

Table 1. Bumble bee abundance by species over each survey period at Fort Custer Training Center.

	Survey Period			
Species	**S1**	**S2**	**S3**	**Grand Total**
B. auricomus	1	2	0	3
B. bimaculatus	10	69	0	79
B. citrinus	0	2	22	24
B. fervidus	0	1	4	5
B. griseocollis	4	46	11	61
B. impatiens	4	191	358	553
B. perplexus	0	1	0	1
B. vagans	0	6	8	14
Unknown	3	6	0	9
Grand Total	**22**	**324**	**403**	**749**

Table 2. Relative abundance of each bumble bee species collected from associated floral species at Fort Custer Training Center.

	Bumble Bee Species								
Plant Species	*B. auricomus*	*B. bimaculatus*	*B. citrinus*	*B. fervidus*	*B. griseocollis*	*B. impatiens*	*B. perplexus*	*B. vagans*	**Grand Total**
Angelica atropurpurea	-	1	-	-	-	-	-	-	1
Asclepias tuberosa	-	1	1	1	2	73	-	-	78
Asclepias viridiflora	-	-	-	-	3	1	-	-	4
Berteroa incana	-	2	-	-	-	12	-	-	14
Centaurea stoebe	-	14	10	1	37	327	1	8	398
Cirsium vulgare	-	-	2	-	2	14	-	1	19
Coreopsis lanceolata	-	5	-	-	1	3	-	-	9
Daucus carota	-	-	-	1	-	1	-	-	2
Desmodium paniculatum	-	-	-	-	-	1	-	-	1
Eupatorium perfoliatum	-	-	-	-	-	1	-	-	1
Eutrochium purpureum	-	-	1	-	2	14	-	-	17
Lathyrus latifolius	2	1	-	-	-	-	-	-	3
Lespedeza capitata	-	-	-	-	-	1	-	-	1
Lespedeza hirta	-	-	-	-	-	17	-	-	17
Leucanthemum vulgare	-	-	-	-	-	1	-	-	1
Liatris aspera	-	-	3	-	-	-	-	-	3
Lythrum salicaria	-	3	4	-	1	14	-	-	22
Melilotus alba	-	-	-	-	-	1	-	-	1
Monarda fistulosa	-	48	-	1	9	50	-	4	112
Potentilla recta	-	-	-	-	1	-	-	-	1
Pycnanthemum virginianum	-	-	-	-	-	6	-	-	6
Ratibida pinnata	-	-	1	-	-	-	-	-	1
Rosa multiflora	-	-	-	-	1	-	-	-	1
Solanum carolinense	-	-	-	-	-	1	-	1	2
Solidago sp.	-	-	1	-	-	6	-	-	7
Trifolium pratense	-	-	-	1	-	1	-	-	2
Vicia villosa	1	2	-	-	1	1	-	-	5
Grand Total	**3**	**77**	**23**	**5**	**60**	**546**	**1**	**14**	**729**

Figure 9. Bombus auricomus caught at Fort Custer Training Center.

Discussion

In this project, we monitored monarch butterflies and bumble bees at Fort Custer Training Center, focusing surveys at sites known to have both floral resources and milkweed present. While monarch butterflies were present during each survey period, monarch abundance strongly peaked during the second survey period (July). Coinciding with this peak in adult monarchs, July had the greatest number of sites with eggs present, as well as the strongest egg per stem values. Monarch eggs take 3-5 days to hatch. Therefore, larvae presence in mid-August shows egg-laying occurs through at least early-mid August at the base. We found that some sites were more frequently utilized for monarch egg-laying than others, with sites 7, 3, and 5 having the highest egg per stem values. We recommend prioritizing these locations for on the ground habitat efforts that target monarch butterflies. Sites 1 and 6 had slightly lower egg per stem values. These sites were more open fields with relatively high milkweed counts, but overall, had lower floral diversity. Improving the floral diversity of these sites may be key in increasing habitat suitability for the monarchs. Sites 4 and 8 had little or no egg presence, depending on the survey round. Interestingly, site 2 had no eggs found during all three rounds of survey, although being the most buffered by forest. Because of this data, monarch butterflies seem to be more closely associated with some areas of the base compared to other potential landscapes.

It is important to note that there were some sections of site 3 that were inaccessible to survey. Site 3 (Mott Rd fen) was a diverse fen with both native and non-native floral species. Although the terrain was difficult to navigate, this site had one of the highest eggs per stem values and the highest larva per stem value, alongside having the most adult monarch observations. Considering this, the site is likely heavily utilized by monarchs. One concern that would need to be addressed within this site is the increasing pressure of purple loosestrife (*Lythrum salicaria*). Managing this site for this invasive species is imperative to maintaining the diversity and suitability of this site for both monarch and bumble bee habitat utilization. Purple loosestrife can take over a site quite fast, so management for this plant should begin immediately.

Bumble bee abundance at FCTC was higher in the second half of the summer (July and August), with the peak being in August. Interestingly, when bumble bees were at this peak abundance is when they were seen to be utilizing butterfly milkweed (*Asclepias tuberosa*), an important plant for the monarch life cycle. Monarch egg and larvae were still being found on stem while the bumble bees were simultaneously using this plant for forage, an important intersection of habitat use between bumble bees and monarch butterflies. Plantings of butterfly milkweed across all of the surveyed sites, with an initial focus on priority sites 7 and 5, would benefit both monarchs and bumble bees, and is highly recommended. With higher milkweed diversity, monarchs overall lay more eggs (Pocius et al., 2018). A planting would promote and facilitate monarch egg-laying, while also promoting larval growth due to decreased larval competition. At the same time, bumble bees will also be provided with a reliable native floral resource for foraging through late summer. Furthermore, it is recommended that swamp milkweed (*Asclepias incarnata*) plantings occur in Site 3. Together, these milkweed plantings would promote increased pollinator abundance in occupied habitats.

Figure 10. Site 1 full of blooming butterfly milkweed (*Asclepias tuberosa*) during final survey round at Fort Custer Training Center.

Importantly, spotted knapweed (*Centaurea stoebe*) was found on every site except site 3. Furthermore, over half of all of the bees that were observed foraging were caught on the flower of this plant. This plant is very detrimental to the environments it invades and can kill other plants around it, creating a floral monoculture where only knapweed survives. If this plant is allowed to persist in these habitats, it will continue to choke out other native species and drastically decrease plant biodiversity. In some areas of FCTC, it is already beginning to dominate the landscape. This leaves the bumble bees (and other pollinators) with very little foraging options, and therefore spotted knapweed comprises a major portion of their diet, leaving pollinators in this habitat with overall poor nutrition. Additionally, when the spotted knapweed is no longer in bloom, the bees are left with limited to no floral resources. It is important that there are diverse floral resources available across the entire flight period (spring-fall) of all pollinators if populations are to be supported and sustained. Management of this invasive species in surveyed sites is recommended to promote healthy and diverse habitats for pollinators at FCTC.

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