Video Surveillance of Bumble Bee- and Lepidopteran-Plant Interactions on a Reconstructed Missouri Prairie

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Abstract–Pollinator biodiversity is important for the health of ecosystems. Many pollinator species, including bumble bees and butterflies, are experiencing population declines and reduced habitat availability. To better manage land for at-risk pollinator communities, it is becoming increasingly important to be able to identify pollinators at the species taxonomic level. Here, we assessed the use of inexpensive video monitoring equipment to gather information about bumble bees and Lepidoptera on a recently reconstructed prairie. We identified 6 *Bombus* and 17 lepidopteran species with information about plant visitation and plant visit durations. Our findings indicate that video surveillance can be used as a management or research tool to identify large pollinators and study their plant interactions.

Introduction

Pollinators are essential for the reproductive success of many flowering plants, including dozens of crops worldwide (Kevan et al. 2003, Klein et al. 2007). High pollinator species richness is important for the health of an ecosystem (Peterson et al. 1998). Pollinator diversity also positively correlates with fruit production (Albrecht et al. 2012), benefiting frugivores. Among pollinators, bumble bees (*Bombus* spp.)—which comprise approximately 260 species worldwide (Cameron et al. 2020)—are relatively effective, partly due to the differential placement of interspecific pollen on their bodies (Huang et al. 2015) and their ability to buzz pollinate certain flowers (Buchmann 1985). Other well-known pollinators are the butterflies and moths (order Lepidoptera), the most speciose group of pollinators (Ollerton 2017, Wardhaugh 2015). Though generally not considered as effective at pollinating as bumble bees (Barrios et al. 2015), these conspicuous insects are often viewed by the general public as important symbols of healthy ecosystems (Ghazanfar et al. 2016).

Pollinator species are facing population declines in many areas, including the Midwestern United States. Several *Bombus* species native to the Midwest have faced a reduction in habitat over the past 100 years (Cameron et al. 2011, Colla 2012, Grixti et al. 2009). In 2017 *Bombus affinis* Cresson, the Rusty patched bumble bee, was listed as endangered by the U.S. Fish and Wildlife Service (USFWS 2017), and the International Union for Conservation of Nature (IUCN) listed *Bombus fraternus* Smith, the Southern Plains bumble bee, as endangered in 2014 (Hatfield et al. 2014). Other bumble bees, such as *B. pensylvanicus* De Geer and *B. auricomus* Robertson, have been reported to be declining in population (Cameron et al. 2011, Wood et al. 2019). Within Lepidoptera, the migratory Monarch butterfly, *Danaus plexippus* spp. *plexippus* (L.), is listed as vulnerable by the IUCN (Normile 2023), and many other lepidopterans native to the Midwest have been reported to be in decline, including the Black swallowtail (*Papilio polyxenes* Fabricius) and the Common sootywing (*Pholisora catullus* Fabricius, Wepprich et al. 2019).

A contributing factor to pollinator declines is habitat loss, such as the loss of prairie systems (Hanberry et al. 2021, Spiesman et al. 2013). Prairies once dominated the Midwest and were a vast supply of grasses and forbs (herbaceous flowering plants) for pollinators and other

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animals. In Missouri and nearby states, less than 1% of prairie ecosystems remain (Samson et al. 1994), highlighting a need for prairie restorations and reconstructions as a land management tool to preserve declining pollinators. An important aspect of habitat reconstruction is identifying realistic goals that can be measured (Ehrenfeld 2000). For example, if a goal is to provide habitat for declining bumble bee species, then a survey of bumble bee species would be an appropriate assessment tool. Additional reconstruction goals could include removal and monitoring of invasive species. Management goals could also include behavioral analysis of at-risk pollinators to better understand their behaviors such as plant visitation and flower visit duration, both of which are positively correlated with the amount of pollen picked up by bumble bees (Thøstesen et al. 1996). In controlled experimental setups, visit duration can indicate a preference for a certain flower (Vaudo et al. 2014).

Monitoring pollinators can be challenging for a number of reasons. Accurate identification of morphologically similar insects can be difficult in the field, leading to aggregation of species such as *B. pensylvanicus* and *B. auricomus* (Novotny et al. 2023). Time constraints and lack of manpower can influence the quality of field surveys. Human observation is also confined to the time in which the observer is present, which may not coincide with a pollinator's visitation patterns (Majetic 2015). Additionally, some species may be more likely to avoid human observers, resulting in data bias.

In response to these and other challenges, the use of video surveillance for observing insects has been increasing. Video monitoring can be beneficial for understanding pollinator ecology for several reasons. For example, the experimental setup can easily be performed by non-experts. Surveillance videos can also be used in the training of novices because animal identity can be verified later by experts. Another advantage of video surveillance is that it allows for repeated reviewing and the potential for in-depth behavioral analysis (Steen 2017). Video monitoring can also help eliminate biases caused by human interference in the field. Video surveillance methods range from continuous video to motion-activated recordings (Pegoraro et al. 2020, Weinstein 2015). The small size of insects and wind-driven motion of prairie plants can create issues when using motion-activation. A recent study compared motion-activated cameras with scheduled 60-s-long videos and determined that the scheduled cameras detected more insects because the insects were too small to consistently activate the motion sensor (Naqvi et al. 2022). Pairing continuous or scheduled recording with deep learning systems may prove to be the most powerful combination for pollinator ecology, as it enables specific and automated filtering of vast amounts of data (Weinstein 2018).

Here, we investigated whether a relatively inexpensive videography surveillance method could be used to classify large insect pollinators to the species taxonomic level on a reconstructed prairie in northwest Missouri. Our goal was to identify bumble bee and Lepidoptera species and their behaviors. We conducted our studies using inexpensive portable video camera setups that were arranged near flowering plants, most of which were native and one that is a noxious invasive weed, Musk thistle (*Carduus nutans* Linnaeus), which appeared to be attracting numerous pollinators. We wanted to determine if the cameras would allow us to confidently identify lepidopterans and bumble bees to the species taxonomic level. We measured visit duration on various prairie plants and Musk thistle to determine if any differences could be detected between plant species. We investigated whether differences in visit duration could be observed between *Bombus* species or Lepidoptera families. Finally, we used our camera setups to calculate visitation rates between plant species. Such video surveillance methodology can be useful towards monitoring pollinators and pollinator-plant interactions to address a variety of conservation-related questions.

Materials and Methods

Site description

The John Rushin Teaching and Research Prairie (Fig. 1A) is a 36-acre (14.4 ha) urban prairie-savanna located on Missouri Western State University's campus in St. Joseph, Missouri. It is located east of most of the university buildings. It is comprised primarily of prairie habitat reconstruction with a connecting 5-acre (2 ha) savanna habitat. The area of land that comprises actively growing prairie vegetation totals approximately 25 acres (10 ha). The prairie reconstruction began in 2019 with two rounds of herbicide application followed by seeding in 2020 with over 200 species of forbs, grasses, sedges, and rushes that were collected as part of a partnership with the Missouri Department of Conservation and The Nature Conservancy (Supplemental Table 1, available online at https://eaglehill.us/prnaonline/suppl-files/prna-036-Newton-s1.pdf).

Figure 1. (A) The John Rushin Teaching and Research Prairie totals 36 acres (14.4 ha) and is located on the eastern side of Missouri Western State University's campus within the city limits of St. Joseph, Missouri 39.760833, -94.775556 (Google Earth Pro 7.3 July 2022). B) Examples of the camera surveillance setup to record Goldenrod (left, *Solidago* spp.) and native thistle (right, *Cirsium* spp.).

Video collection

We used Polaroid Cube HD 1080p cameras to capture footage of different plants in the prairie from June to October 2022. Each camera contains a magnetic bottom which was used to attach it to a 2.5 cm x 3.8 cm piece of 1.25 cm welded wire mesh after the mesh was slipped over and attached to a 1.2 m metal fence post with a binder paper clip (Fig. 1B). The pole was placed ~15–20 cm away from a flower of interest and the height of the wire mesh was adjusted to match the height of the flower. The camera was then placed on top of the wire mesh. In the case of tall plants, two metal fence posts were often attached with hose clamps to add height. Occasionally, a nearby tall plant was used as an attachment point. Cameras were always oriented in the same direction as the sun to maximize light exposure; pointing the camera into the sun yielded dark videos that made identification very difficult.

Twice weekly (weather permitting), we deployed 5 cameras for approximately 50 min. Recordings began in the morning between 10 AM to noon on summer days and later in the afternoon on autumn days when temperatures were favorable for insect sightings. Each day, we aimed to record visitations at 3 different floral species with observed pollinator activity. Once the filming was complete, the cameras were collected, and the files were downloaded for analysis. Videos of poor quality and those that had technical difficulties (for example, a plant that was blown over by the wind) were excluded from the analysis. All plants were native to the Midwest with the exception of Musk thistle because we wanted to compare its pollinator demographic with that of surrounding native plants.

Video analysis

All videos were manually analyzed using VLC media player, version 3.0.17. Pollinators and corresponding timestamps were documented in a spreadsheet from each video. An insect was manually documented when it physically touched a flower of interest. Next, we identified each animal to the appropriate taxonomic level for which we were confident. For this study, we report *Bombus* and Lepidoptera data only. The subset of bumble bees and lepidopterans that were confidently identified to the species taxonomic level were included in our analysis. We used identification guides for areas that included the state of Missouri (Cameron 2009, Cameron et al. 2016) and online resources including iNaturalist (2022-2023, www.inaturalist.org) and Insect Identification (Missouri Insects 2022-2023, www.insectidentification.org). *Bombus auricomus* and *B. pensylvanicus* females were distinguished from each other based on the presence or absence of yellow on the head. Flower visit duration (in seconds) was defined as the time from which a pollinator touched a flower head until it moved off, except in the case Common milkweed (*Asclepias syriaca* Linnaeus) and Bee balm (*Monarda fistulosa* Linnaeus), which were measured by inflorescence and Goldenrod (*Solidago* spp.), which was measured by branch (Fig. 2B). If an insect flew out of the camera's field of view and then flew back into view, it was counted as a new observation.

Declining vs stable species designation

A pollinator species was designated as "declining" in our study if it had USFWS or IUCN status as endangered or vulnerable, or if populations have been reported to be declining in scientific studies. An absence of such information led to a species to be labeled as "stable".

Statistical analysis

All data were calculated as mean ± standard error of the mean. For visit duration, plants containing fewer than 10 bumble bee or Lepidoptera visitors were removed from analysis. For visitors per hour analysis, plants that consisted of one observational video and plants for which no bumble bee or Lepidoptera pollinators were observed were removed from analysis. Statistical analyses were conducted using R, version 4.3.0 (R Core Team 2023). Mean visit duration and mean visitors per hour were analyzed using a Kruskal-Wallis test because the data were not normally distributed. Post-hoc Dunn's test was completed using the *FSA* and *rcompanion* packages with a Bonferroni adjustment (Mangiafico 2023, Ogle et al. 2023). We accepted significant differences at $p < 0.05$.

Results

We accumulated 123 hours of video footage from 3 June 2022 to 28 October 2022. Most of our footage (78.1%) was comprised of native plant flowers (Fig. 2A) and approximately 21.9% came from flowers of Musk thistle, a noxious invasive weed that was located on the prairie and appeared to be attracting numerous visitors. The plants with the lowest number of footage hours were Prairie rosinweed (*Silphium integrifolium* Michx) with 0.98 hr, Bee balm with 1.03 hr, and Ironweed (*Vernonia fasciculata* Michx) with 1.29 hr. Some plants were not recorded as much because they were not in bloom for very long during our analysis window (for example, Bee balm) compared with other plants, such as Purple coneflower (*Echinacea purpurea* [L.] Moench). A few morphologically similar species were categorized by genus, such as *Coreopsis* and Goldenrod. Similarly, white asters were grouped by genus and collectively labeled *Symphyotrichum* spp. to distinguish them from New England aster (*Symphyotrichum novae-angliae* [L.] G.L. Nesom). Field

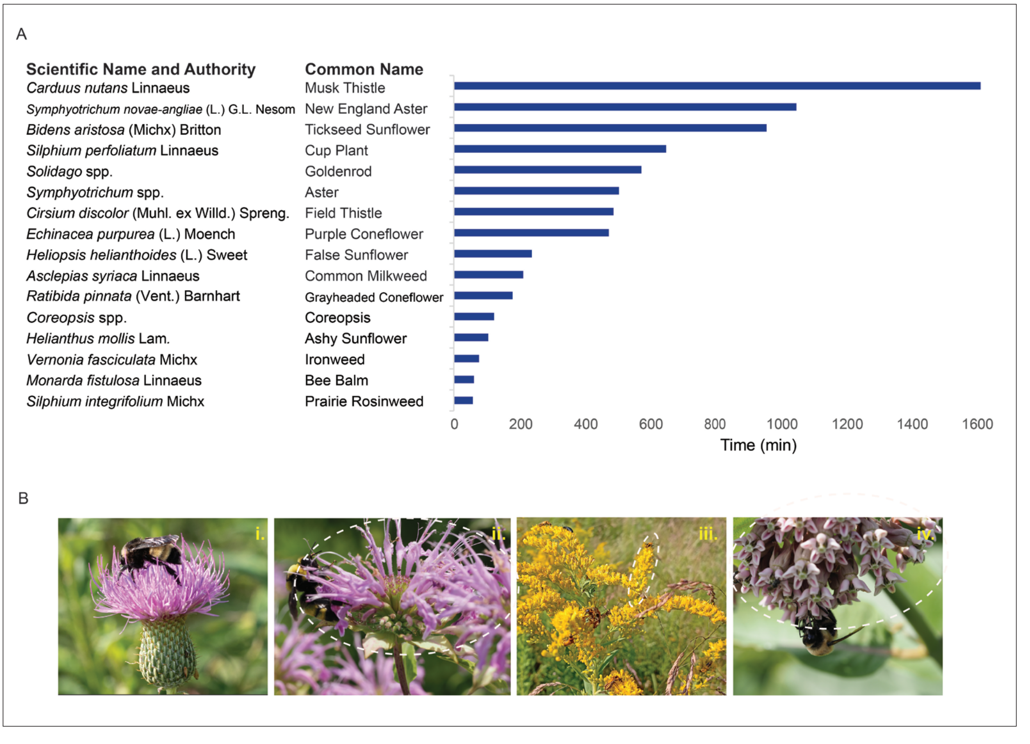

Figure 2. (A) Total amount of time that each plant was recorded. A total of 123 hours of footage was collected. (B) Examples of different plants analyzed in this study: i. Flowering head of a Field Thistle (*Cirsium discolor*), ii. Bee Balm (*Monarda fistulosa*) with inflorescence circled, iii. Goldenrod (*Solidago*) spp. with branch circled, and iv. Common Milkweed (*Asclepias syriaca*) with inflorescence circled.

thistle (*Cirsium discolor* [Muhl. ex Willd.] Spreng.) was the sole native species in our study that was not part of the seed mix used in the reconstruction process. Examples of flowers that were recorded are shown in Figure 2B.

Of the bumble bees that were observed in our footage and landed on a flower, we were able to confidently identify 76.1% (648 of 852) to the species taxonomic level, which included 6 different species (Table 1). The stable species *B. impatiens* Cresson was the most frequently observed bumble bee (n = 447). Likewise, the second and third most observed

Table 1. Counts of Bombus and Lepidoptera species identified in the recordings.

***Bombus* Species**	**Common Name**	**Count**
B. auricomus Robertson	Black and Gold Bumble Bee	23
B. bimaculatus Cresson	Two-Spotted Bumble Bee	72
B. fraternus Smith	Southern Plains Bumble Bee	1
B. griseocollis De Geer	Brown-Belted Bumble Bee	76
B. impatiens Cresson	Common Eastern Bumble Bee	447
B. pensylvanicus De Geer	American Bumble Bee	29
Total identified		**648**
Total *Bombus* count (identified and unidentified species)		852

Lepidoptera Species	**Common Name**	**Count**
Atalopedes campestris Boisduval	Sachem Skipper	55
Danaus plexippus Linnaeus	Monarch	28
Epargyreus clarus Cramer	Silver-Spotted Skipper	17
Erynnis horatius Scudder and Burgess	Horace's Duskywing	3
Euphyes vestris Boisduval	Dun Skipper	1
Euptoieta claudia Cramer	Variegated Fritillary	1
Hemaris diffinis Boisduval	Snowberry Clearwing	27
Hylephila phyleus Drury	Fiery Skipper	1
Junonia coenia Hübner	Common Buckeye	4
Lerema accius Smith	Clouded Skipper	2
Papilio glaucus Linnaeus	Eastern Tiger Swallowtail	4
Papilio polyxenes Fabricius	Black Swallowtail	5
Phoebis sennae Linnaeus	Cloudless Sulphur	2
Pholisora catullus Fabricius	Common Sootywing	1
Polites peckius Kirby	Peck's Skipper	8
Speyeria cybele Fabricius	Great Spangled Fritillary	5
Vanessa cardui Linnaeus	Painted Lady	13
Total identified		**177**
Total Lepidoptera count (identified and unidentified species)		267

species, *B. griseocollis* De Geer (n = 76) and *B. bimaculatus* Cresson (n = 72), are stable species as well. We observed 3 declining *Bombus* species: *B. auricomus* (n = 23), *B. pensylvanicus* (n = 29), and *B. fraternus* (n = 1).

We were able to confidently identify 66.3% (177 of 267) of lepidopterans to the species taxonomic level. A total of 17 different species were recorded, including 9 skippers (Hesperiidae) and the Snowberry clearwing sphinx moth (*Hemaris diffinis* Boisduval). The Sachem skipper (*Atalopedes campestris* Boisduval) was the most frequently observed lepidopteran (n = 55). The Monarch butterfly was the second most observed (n = 28) and the Snowberry clearwing was third (n = 27). Four species were identified once: the Dun skipper (*Euphyes vestris* Boisduval), the Variegated fritillary (*Euptoieta claudia* Cramer), the Fiery skipper (*Hylephila phyleus* Drury), and the Common sootywing. Of the Lepidoptera observed, 3 have been reported to be declining in population: the Monarch, the Black swallowtail, and the Common sootywing (Wepprich et al. 2019). Because the Monarch butterfly is a species of concern, we documented the plants on which it was observed (Supplemental Table 2, available online at https://eaglehill.us/prnaonline/suppl-files/prna-036-Newton-s2.pdf). Monarchs were seen from June 6 through October 10, peaking in September. They were observed predominantly on Tickseed sunflower, *Bidens aristosa* (Michx) Britton, and New England aster but also seen on Field thistle, Common milkweed, Musk thistle, Cup plant (*Silphium perfoliatum* L.), Goldenrod, and *Symphyotrichum* spp.

We first wanted to determine if flower visit duration by pollinators differed between plants and began by evaluating bumble bee visit durations (Fig. 3A). A Kruskal-Wallis analysis revealed significant differences between samples (H[8] = 135.19, $p < 0.001$). Mean visit durations were highest on Common milkweed (36.4 ± 5.88 s), Musk thistle (40.1 ± 6.08 s), and Field thistle (44.4 ± 10.1 s). On these plants, bees had a significantly longer mean visitation time ($p < 0.05$) than on Tickseed sunflower, Bee balm, Goldenrod spp., New England aster, and *Symphyotrichum* spp. Within Lepidoptera, a Kruskal-Wallis analysis also revealed significant differences in visit duration between plants (H[4] = 30.605, $p < 0.001$) The longest mean visitation was seen on Field thistle (Fig. 3B, 100.0 ± 35.6 s), which had a significantly longer visit duration than Tickseed sunflower (15.1 ± 5.20 s) and New England aster (17.6 ± 2.50 s, $p < 0.05$).

Individual *Bombus* species showed no significant differences in visit duration within a plant species (Fig. 4A). Notably, Musk thistle, Cup plant, and Field thistle were visited by a higher proportion of declining bumble bee species compared to other plant species that we observed. *Symphyotrichum* spp., including New England aster, Goldenrod spp., and Tickseed sunflower were predominantly visited by *B. impatiens*. A Kruskal-Wallis analysis for each plant revealed no significant differences in visit duration between *Bombus* species. Evaluating the 5 Lepidoptera families in our study (Fig. 4B), Kruskal-Wallis analysis revealed significant differences between families for Musk thistle (H[3] = 13.799, p = 0.003) and New England Aster (H[1] = 6.924, p = 0.009). On Musk thistle, Hesperiidae had significantly longer visit durations (67.4 ± 19.1 s) compared with the Snowberry clearwing (Sphingidae, 17.8±4.77 s). On New England aster, Nymphalidae displayed significantly longer visit durations (22.0 ± 3.39 s) compared with Hesperiidae (9.9 ± 2.10 s).

Bombus plant visitation rates differed significantly by Kruskal-Wallis analysis (H[10] = 46.81, $p < 0.001$; Fig. 5A). New England aster was visited significantly more often (21.1 ± 3.49 bees/hr) than Tickseed sunflower (3.02 ± 1.14 bees/hr), Musk thistle (2.52 ± 0.66 bees/hr), and Purple coneflower (0.67 ± 0.56 bees/hr) at $p < 0.001$; Field thistle (2.41 ± 1.51 bees/hr), False sunflower (*Heliopsis helianthoides* (L.) Sweet; 0.52 ±0.33 bees/hr), and Goldenrod spp. (2.61 ± 1.43 bees/hr) at $p < 0.01$; and *Symphyotrichum* spp. (2.16 ± 0.74 bees/hr) at $p < 0.05$. All identified bumble bees on New England aster were *B. impatiens*, and it was also the sole or most frequently observed bumble bee on Tickseed sunflower (100%), Goldenrod (95.7%), and *Symphyotrichum* spp. (100%). *B. griseocollis* was the most frequent visitor on Common milkweed (89.2%) and Cup plant (46%). Cup plant was visited by the greatest number of different bumble bee species (n = 5). The most frequent visitor of Musk thistle (47.8%) and False sunflower (100%) was *B. bimaculatus*. *Bombus pensylvanicus* was identified as the most common visitor of Field thistle (68.2%) and the sole visitor of Ironweed.

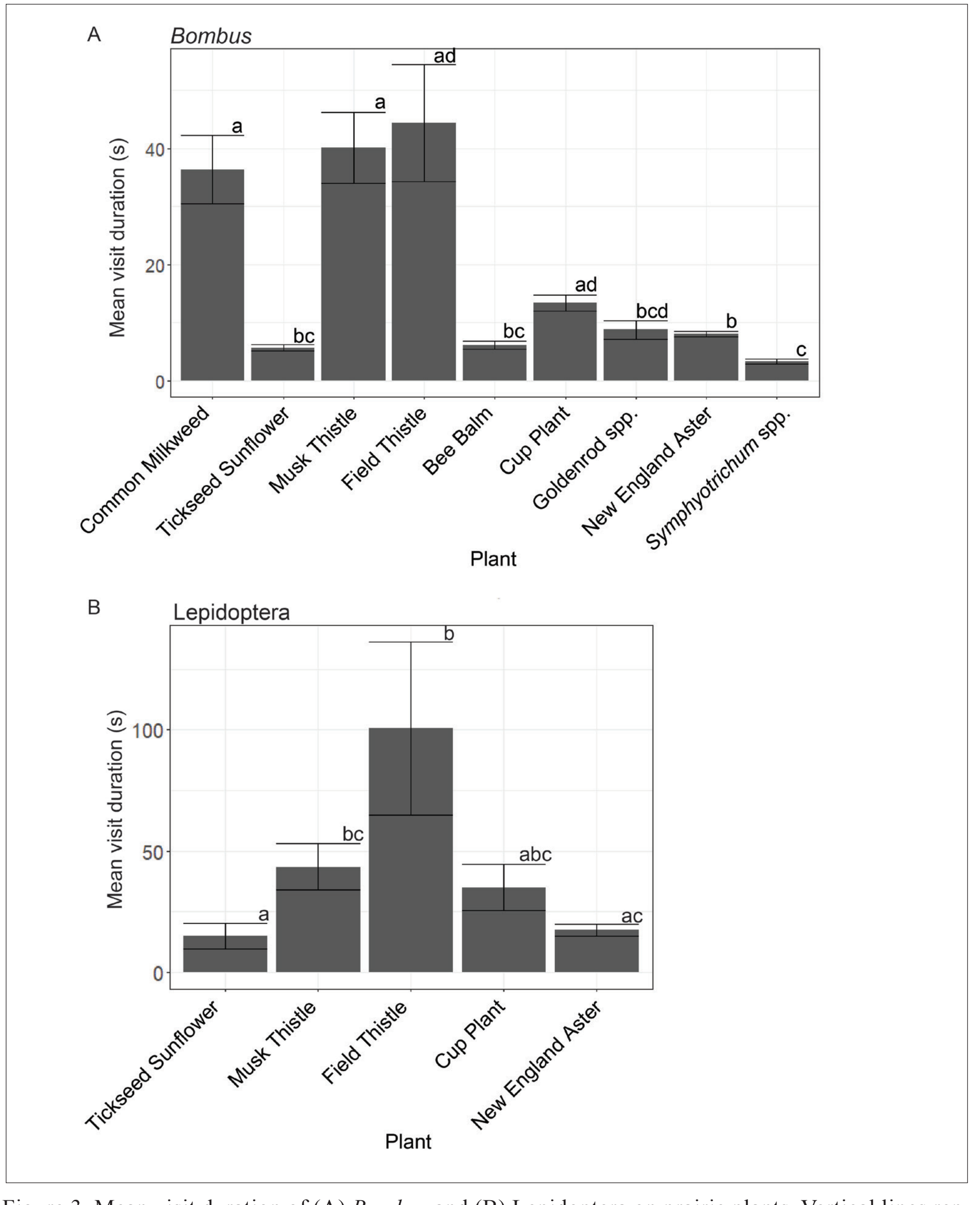

Figure 3. Mean visit duration of (A) *Bombus* and (B) Lepidoptera on prairie plants. Vertical lines represent SE. A Kruskal-Wallis analysis revealed significant differences between plant species. Samples containing different letters were statistically different from each other ($p < 0.05$) using Dunn's test.

A Kruskal-Wallis test revealed no significant differences in Lepidoptera visitors per hour (± standard error, SE) between different plant species (H[10] = 15.14, $p = 0.127$; Fig. 5B). Hesperiidae was the most frequent visitor to Tickseed sunflower (52.8%), Musk

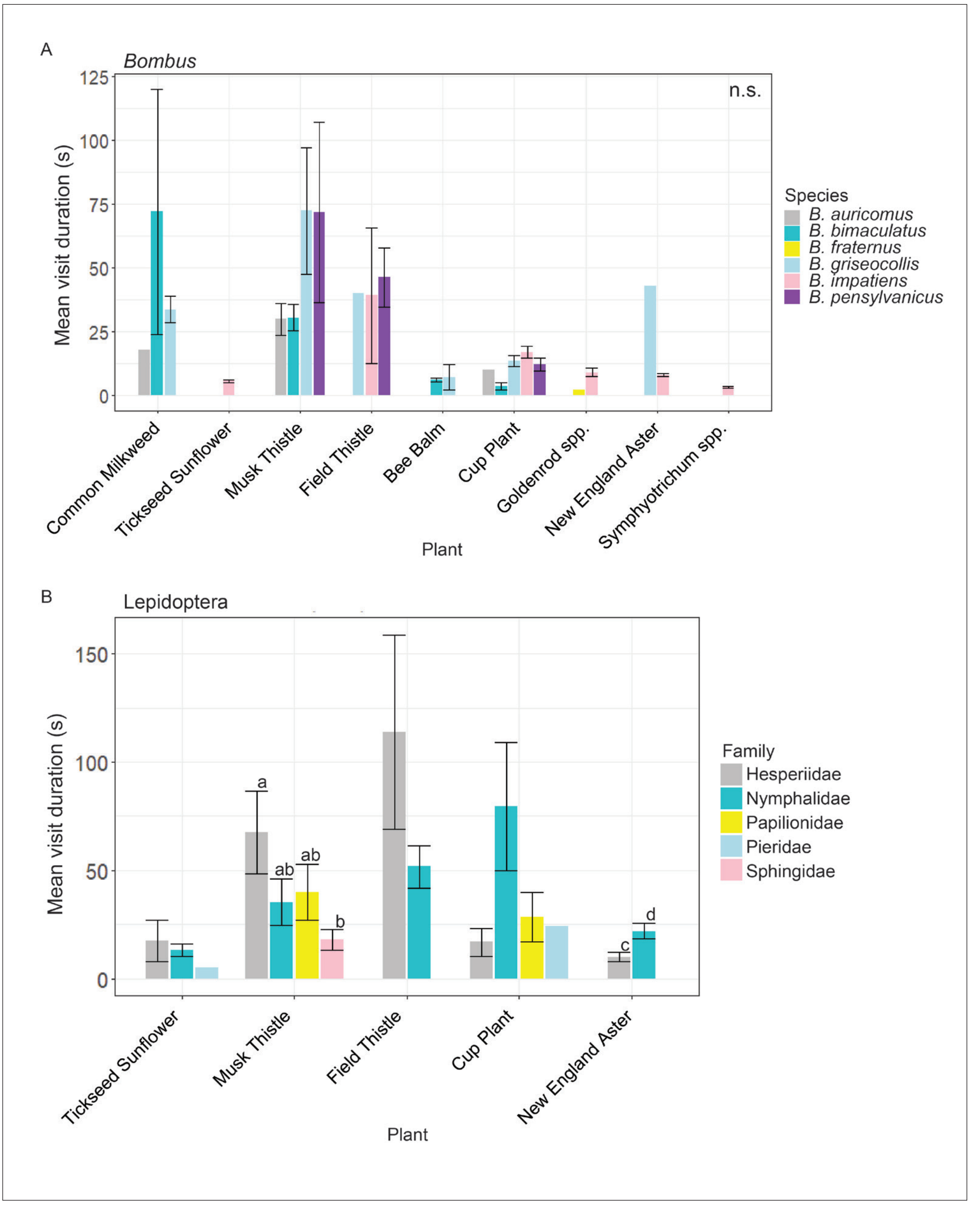

Figure 4. Mean flower visit duration on prairie plants by (A) *Bombus* species and (B) Lepidoptera families. Vertical lines represent SE. A Kruskal-Wallis analysis revealed no significant differences between *Bombus* species within each plant. In Lepidoptera, a Kruskal-Wallis analysis revealed significant differences within plant species. Families containing different letters within Musk Thistle (*Carduus nutans*) and New England Aster (*Symphyotrichum novae-angliae*) were statistically different from each other ($p < 0.05$) using Dunn's test.

thistle (46.3%), Field thistle (75%), Purple coneflower (83.3%), and False sunflower (100%). The Snowberry clearwing (family Sphingidae) was the most frequent visitor to Common milkweed (75%), and Sphingidae and Hesperiidae visited Ironweed equally (50%). The plants with visitors from the greatest number of families were Musk thistle (Hesperiidae, Nymphalidae, Papilionidae, and Sphingidae) and Cup plant (Hesperiidae, Nymphalidae, Papilionidae, and Pieridae).

Discussion

We demonstrate that bumble bee and Lepidoptera species can be identified at the species taxonomic level using inexpensive video cameras. Video surveillance provides advantages compared with in-person surveys. The videos allow us to revisit and slow footage to distinguish between morphologically similar species such as *B. pensylvanicus* and *B. auricomus*. Videos also add flexibility; if time is limited, identifications can be done at a later date. Video monitoring also allowed us to easily assess other behaviors such as flower visits and flower visit durations, which can serve as a proxy for pollen pickup in bumble bees (Thøstesen et al. 1996).

Our cameras allowed us to identify 6 different *Bombus* species on a reconstructed prairie. We recorded a single observation of *B. fraternus*, listed as endangered by the IUCN (Hatfield et al. 2014), on Goldenrod spp., indicating that at least one colony is located on or near the prairie. Other observed *Bombus* species were consistent with those reported in the region (Cameron et al. 2011, Larose et al. 2020). In our study the declining species *B. pensylvanicus* and *B. auricomus* visited Field thistle (a native plant) and the closely related noxious weed Musk thistle (Fig. 4A). This is consistent with Wood et al. (2019), who described pollen found on the hind legs of *B. pensylvanicus* and *B. auricomus* museum specimens dating as far back as 1912 and reported that both species carried a higher proportion of *Cirsium*-type pollen than any other analyzed species. The declining Common sootywing was also seen on Musk thistle. In our study, both native and non-native thistles appear to be an important food source for declining pollinators. It has been proposed that non-native plants can serve as important resources to native wildlife (Gleditsch et al. 2011). Therefore, careful planning may be necessary when removing these plants to ensure that sufficient native plants are in bloom to serve as food for declining pollinators.

Of the plants analyzed, New England aster had a significantly higher total *Bombus* visitation rate than Tickseed sunflower, both thistles, Purple coneflower, False sunflower, Goldenrod, and white *Symphyotrichum* spp. This is likely because it was visited primarily by *B. impatiens*, which was the most frequently recorded bumble bee and the only *Bombus* visitor that we detected on the aster. In fact, *B. impatiens* was the only bumble bee observed from September 26 until the end of our analysis period on October 28. New England aster began blooming on approximately October 3. This is consistent with Novotny et al. (2023) who saw a decrease in non-*B. impatiens* species, starting in August. Though no other bumble bees were observed on New England aster, we noted that it is a food source for other pollinators, such as butterflies (Fig. 3B) and other native bees, flies, and beetles (data not shown). The abundance of *B. impatiens* on New England aster may be due to the fact that the aster was one of the only remaining food sources in October. *Bombus impatiens* has been reported to have a relatively wide dietary niche and has been regarded as a generalist feeder (Novotny et al. 2023, Wood et al. 2019).

Overall, the advantages of video monitoring place it as a valuable complement to other survey methods. The cameras we used were continuous-use cameras as opposed to motion-activated camera traps. This was intentional, as the movement of the prairie plants due to wind would have activated the camera traps and generated false positive data. However, modifications of this technique can be applied to better suit different research needs, such as scheduled recordings to prolong camera life, connection to an external power source, or anchoring of the plant to prevent its movement (Steen 2017). In the near future, the incorporation of deep learning and automation in video monitoring research will greatly accelerate the field (Pegoraro et al. 2020), which is fortuitous as it is becoming increasingly urgent to identify at-risk species as part of land management goals.

We demonstrate that bumble bee and Lepidoptera species and their pollinator-plant interactions can be evaluated using an inexpensive camera setup and free video software (VLC media player). Reconstruction and restoration goals may include surveying wild-

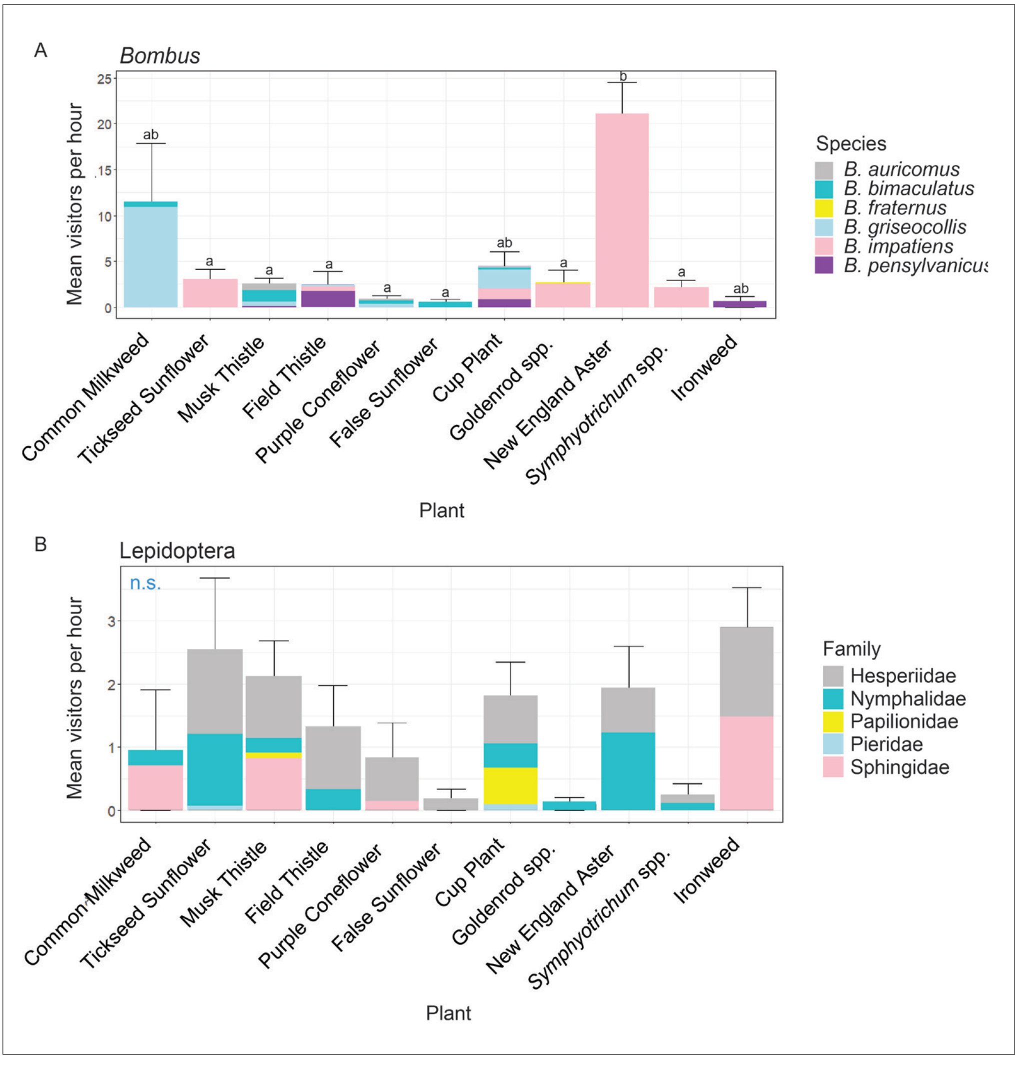

Figure 5. (A) Mean *Bombus* visits per hour. Vertical lines represent SE. A Kruskal-Wallis analysis revealed significant differences between plant species. Samples containing different letters were statistically different from each other ($p < 0.05$) using Dunn's test. (B) Mean Lepidoptera visits per hour. Vertical lines represent SE. No significant differences were found between plant species using a Kruskal-Wallis analysis.

life, including pollinators. Traditional pollinator surveys can be time-constraining and difficult and may require the capture of animals to correctly identify the species. The videography method we described is a simple way to gather information about pollinator-plant interactions, ranging from general, "What types of pollinators are present?" to specific information, "Is species *X* found in our habitat?" It can inform management efforts regarding noxious invasive weeds to determine if the plants are being used by declining species. It could also help identify deficits in forb composition. For example, our study emphasized the importance of late-blooming plants such as New England aster and Goldenrod for at-risk species, including Monarchs and *B. fraternus*. However, the addition of other late-blooming species to the reconstructed prairie would provide additional nectar and pollen sources. Video surveillance as a management tool can be easily adapted to suit the needs of land managers, as it can provide valuable information about the current status of a habitat as well as implications for improvement.

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