# Monitoring butterfly species of greatest conservation need in Michigan grasslands and savannas


Prepared By:

M.J. Monfils, L.M. Rowe, A.A. Cole-Wick, and D.L. Cuthrell
Michigan Natural Features Inventory, Michigan State University Extension
P.O. Box 13036
Lansing, MI 48901-3036


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Cover: Karner blue butterfly (*Lycaeides melissa samuelis*) resting on lupine (*Lupinus perennis*) during May surveys, Allegan State Game Area, Allegan County, MI. Photo by L.M. Rowe.

# Table of Contents



# List of Tables



# List of Figures

# Executive Summary

The Michigan Department of Natural Resources (DNR) obtained a Competitive State Wildlife Grant (CSWG) to implement habitat conservation and monitoring activities for imperiled prairie and savanna ecosystems and associated species of greatest conservation need (SGCN). Focal SGCN for the project include rare and declining grassland bird and butterfly species. Project partners are working toward two objectives: 1) restore and enhance 1,000 acres of grassland and savanna habitat in Michigan and Ohio; and 2) develop and implement long-term monitoring programs under an adaptive management framework to better assess population level impacts on SGCN relative to ongoing and historical management activities. As a partner on the CSWG project, the Michigan Natural Features Inventory (MNFI) is working with the DNR to achieve the second project objective by conducting surveys to evaluate the status of SGCN populations and their response to management actions. Our objective for the first year of monitoring was to design and implement surveys for frosted elfin (*Incisalia irus*), Karner blue butterfly (*Lycaeides melissa samuelis*), and monarch butterfly (*Danaus plexippus*).

We built upon an existing occupancy-based sample design and survey methodology developed by MNFI for Karner blue. The original protocol consisted of two visits to all sites during the second Karner blue flight. We added two additional visits in May to target the frosted elfin flight. Any observations of monarch were recorded during the four surveys. During each visit, a modified Pollard-Yates (Pollard and Yates 1993) survey was conducted at each site in which surveyors followed a series of transects paralleling the outer boundary of the identified patch of potential habitat. We collected geographic locations for all frosted elfin and Karner blue observations, whereas monarch detections were recorded at the survey area (i.e., patch) level due to their high mobility.

We completed 215 surveys in 2021 across the four survey periods and 62 habitat patches. All 62 sites were visited at least twice, with 34 (54.8%) being surveyed four times and 23 (37.1%) having three surveys completed. We found 69% of the sites had at least one target species present and only five sites (8%) had all three target species detected; four of these five sites were in Allegan SGA and the fifth was on private land (Gamez Property). Karner blue was detected at 29 (49%) of the 59 sites surveyed, with 2,587 Karners recorded across all sites and the two second-flight visits, and a maximum season count of 1,808 Karner blues after taking the greatest one-day count from each site. We observed frosted elfin at 10 (17%) of the 59 sites, with 51 elfins recorded across all sites and visits and a maximum season count of 40 (sum of greatest one-day count from each site). Monarchs were detected at 35 (56%) of the 62 sites surveyed. We observed 326 monarchs across all sites and visits recorded a maximum season count of 238.

This project produced valuable data for three butterfly species of high conservation concern. The 2021 Karner blue surveys represent the fifth year of data gathered in the last seven years using a consistent sample frame and protocol. The data collected on frosted elfin and monarch will serve as an important baseline information if surveys are continued in the future. Our 2021 results indicated Karner occupancy and relative abundance declined since 2018 and were similar to estimates from 2015. A variety of factors could influence changes in Karner blue abundance and occupancy, such as habitat conditions and weather conditions. Additional surveys are needed to assess whether our 2021 results represent normal variation in occupancy and abundance or a downward trend in the populations at these sites. Augmenting the current protocol with surveys during the first flight could help us assess if the changes in abundance are related to conditions occurring between the second flight and the first

flight in the following year, such as lack of snow cover, winter thaw-freeze events, or extreme spring weather.

The surveys supported by this project will help address information gaps regarding the status of frosted elfin and monarch in Michigan. The low abundance and proportion of sites occupied by frosted elfin indicate concern about this species is warranted and continued monitoring is needed. Although our maximum monarch count was only 238, none were detected during the first two surveys, which occurred prior to the arrival of most migrant monarchs. A survey designed specifically for monarch, instead of the multispecies approach used in the project, may have resulted in greater abundance and occupancy estimates. Despite the survey's limitations, our 2021 results provide useful baseline data that, if replicated over space and time, could allow assessment of population trends and possible associations with habitat covariates.

# Introduction

Historically, native grasslands (e.g., prairies and savannas) were found primarily in the southern Lower Peninsula of Michigan. Estimates based on surveys conducted by the General Land Office in Michigan from 1816 to 1856 suggest these grasslands occupied approximately 7% of the state (Comer et al. 1995). Most of our native grasslands and savannas have been lost or fragmented due to development, conversion to agriculture, and lack of disturbance leading to vegetative succession. Grassland and savannas remaining in the southern Lower Peninsula are considered degraded or highly degraded and are generally disjunct and smaller in size than in the past. Many of these grassland natural communities are ranked as imperiled or critically imperiled within Michigan or globally. Not surprisingly, many species reliant on these grasslands and savannas are now in decline or in danger of extinction. With our remaining native grasslands being degraded, fragmented, and more isolated, insect species requiring these habitats, or the host plants supported by these ecosystems, are more vulnerable to an array of threats, such as climate change, invasive species, and human development.

To address the conservation needs of imperiled grassland ecosystems and associated species of greatest conservation need (SGCN), the Michigan Department of Natural Resources (DNR) applied for and obtained a Competitive State Wildlife Grant (CSWG) to implement habitat conservation and monitoring activities. The project focuses on implementing conservation actions to benefit several SGCN affected by grassland loss and degradation, including dickcissel (*Spiza americana*), grasshopper sparrow (*Ammodramus savannarum*), Henslow's sparrow (*Ammodramus henslowii*), frosted elfin (*Incisalia irus*), Karner blue butterfly (*Lycaeides melissa samuelis*), and monarch butterfly (*Danaus plexippus*). In addition to habitat conservation, monitoring of these SGCN is an important part of the project to facilitate assessment of success and adaptation of management strategies as needed to achieve project goals. Two objectives were identified for the project: 1) restore and enhance 1,000 acres of grassland and savanna habitat in Michigan and Ohio; and 2) develop and implement long-term monitoring programs under an adaptive management framework to better assess population level impacts on SGCN species relative to ongoing and historical management activities. The Michigan Natural Features Inventory (MNFI) is a partner on the CSWG project and working with the DNR to achieve the second project objective by conducting surveys to evaluate the status of SGCN populations and their response to management actions. Our objective for the first year of monitoring was to design and implement surveys for Karner blue, frosted elfin, and monarch butterfly.

# Methods

**Sample Design**

We built upon an existing occupancy-based sample design and survey methodology developed by MNFI for Karner blue and previously implemented during 2015-2018 (Monfils and Cuthrell 2015, 2018). We used the same sample frame of potential survey sites used for surveys conducted during 2016-2018, which consisted of areas occupied by KBB during pilot occupancy surveys conducted in 2015, unoccupied sites connected to or within 200 m of sites occupied in 2015, four previously occupied sites surveyed using distance sampling in the past, and occupied sites located on private lands for which the MDNR has provided management assistance. The sample frame consists of 64 sites totaling approximately 413 hectares (1,021 acres) of potential habitat for Karner blue, frosted elfin, and monarch (Figure 1).

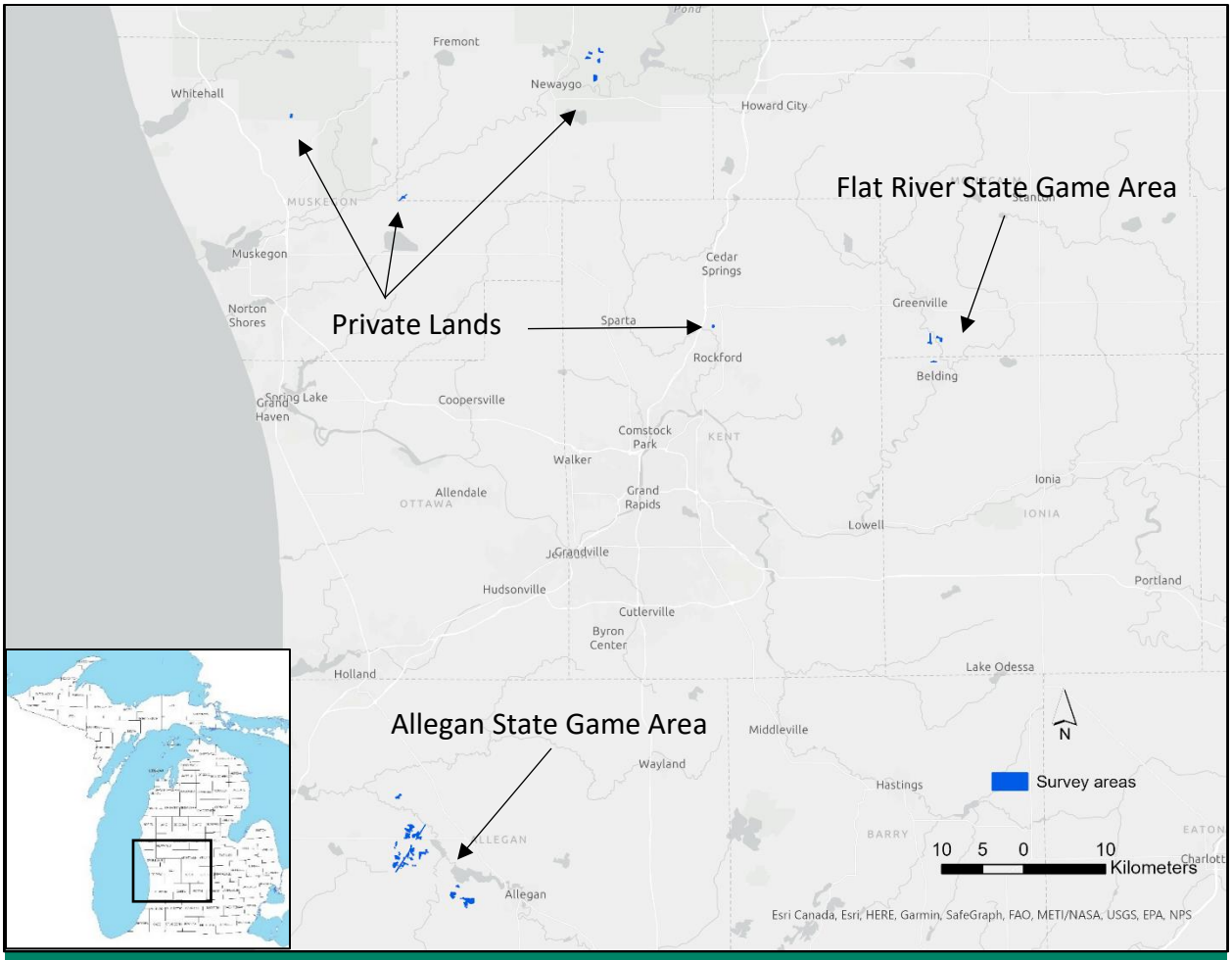


**Figure 1.** Butterfly survey locations (blue shading) in southwestern Lower Michigan visited during 2021.

**Butterfly Surveys**

Polygons defining the survey sites were uploaded to smart devices (i.e., tablet computers, smartphones) to assist surveyors as they navigated among and within sites using a GPS application. We focused surveys on areas having ≤ 60% tree canopy cover (Grundel et al. 1998). Areas within the polygons having one or more of the following conditions were excluded from the survey: 1) > 60% tree canopy cover; 2) > 75% bare soil and no lupine; and 3) planted crops or ground cover (e.g., grassland, lawn) lacking lupine and nectar sources. Areas of potential habitat (i.e., ≤ 60% canopy cover with lupine/nectar sources) located immediately outside of the identified polygons were added to the survey.

The occupancy-based survey methodology used for Karner blue since 2015 requires two visits during the second Karner flight (approximately mid-July to early August). For this project, we added two additional visits to this protocol during the frosted elfin flight period (early to late May), resulting in a total of four surveys at each site. Observations of monarchs were recorded during all four visits. As much as possible, we limited surveys to periods when the temperature was above 15° C (60° F), there was no rain, and when winds were ≤ 25 km/h (15 mph). If temperatures were 15 - 21° C (60 - 70° F), surveys were only conducted when cloud cover was

≤ 50% of the sky. There was no cloud cover restriction if the temperature was above 21° C (70° F). Because of cold temperatures experienced in 2021 during the first survey of the frosted elfin flight period, 23 of the 57 surveys were done with temperatures at 10 - 15° C (50 - 59° F). If weather conditions deteriorated during a visit, observers terminated the survey and resurveyed the entire site on a suitable day. Surveys were conducted between 9 AM and 6 PM (EDT).

We conducted modified Pollard-Yates (Pollard and Yates 1993) surveys in which surveyors followed a series of transects paralleling the outer boundary of the identified patch of potential habitat (e.g., savanna, grassland). The first transect began 5 m inward from the outer edge of the patch, with one surveyor slowly walking along the first transect until the entire periphery of the site was surveyed. A second transect was located 10 m inward from the first transect and was surveyed in the same manner. Additional transects were added until the entire patch of suitable habitat was surveyed. For long narrow sites (e.g., utility corridors), surveyors used short transects traversing the width of the corridor (i.e., perpendicular to longest axis) and surveyed the transects back and forth, moving from one end of the corridor to the other, to avoid repeat counts of butterflies. At some large sites, two to five people conducted the survey together, with transects spaced 10 m apart. Observers looked for and counted butterflies (i.e., frosted elfin, Karner blue, and monarch) within an area 5 m to either side of the transect, 5 m forward along the transect, and 5 m above the transect (10 m x 5 m x 5 m, rectangular survey area). Surveyors walked at a steady, slow speed of approximately 35 m/min. If butterflies flew ahead of an observer, they were ignored if the surveyor was certain the individual was already counted. When an observer was uncertain as to whether an individual was tallied, it was counted and considered a new individual.

To facilitate an accurate count of the Karner blue and frosted elfin, and understand their distributions within and among sites, we collected geospatial information using GPS units or smart devices. In most cases, a waypoint was collected for each butterfly observed. For example, if five butterflies were seen on one nectar source, five waypoints were collected at the same location. However, at a few of the most densely populated sites, surveyors recorded locations at the periphery of observations and documented the number of individuals detected. Observers tried to avoid flushing butterflies when collecting waypoints as much as possible. For monarchs, we recorded the total number of butterflies detected during each survey of a site (i.e., polygon) but did not take GPS point data. Other butterfly species detected during surveys were recorded on a checklist for each site. However, to avoid distracting surveyors from detecting the three target species, we did not attempt to estimate relative abundance for non-target species.

**Site Characterization**

Observers characterized environmental and habitat characteristics at each site during each visit. We collected information on variables that may influence Karner blue detection and occupancy and could be included in models used to estimate population parameters. At the start and end of a survey, surveyors recorded the temperature (°C), percent relative humidity, cloud cover (expressed as the % of sky occluded), and maximum wind speed (km/h). Surveyors collected general information about potential threats to target species and their habitats and ranked the relative abundance of lupine, nectar sources, and invasive plant species. We used the DAFOR scale to rank the relative abundance of lupine, potential nectar sources, and invasive species as dominant (D), abundant (A), frequent (F), occasional (O), or rare (R).

# Results

During 2021, we conducted 215 surveys total across four survey periods and 62 habitat patches (Figure 1); two surveys were done during the frosted elfin flight and two during the second Karner blue flight. All 62 sites surveyed were visited at least twice, with 34 (54.8%) being surveyed four times and 23 (37.1%) having three surveys completed. We found 69% of the sites had at least one target species present and only five sites (8%) had all three target species detected; four of these five sites were in Allegan SGA and the fifth was on private land (Gamez Property).

**Karner Blue**

We surveyed 59 sites during the second Karner blue flight, with 73% of them being surveyed twice. Karner blue was detected at 29 (49%) of the 59 sites surveyed, with 2,587 Karners recorded across all sites and the two second-flight visits. Thirty Karners were detected during May surveys targeting frosted elfin. Our maximum season count for 2021 was 1,808 Karner blues after taking the greatest one-day count from each site. We detected Karner blue at 22 of the 48 sites surveyed within Allegan SGA (Figure 2) and two of the four areas surveyed within Flat River SGA (Figure 3). Five of the seven sites on private lands contained Karner blue (Figure 4).

We employed the same sample frame and protocol used to survey Karner blue during 2015-2018, which allowed us to compare our 2021 results to past surveys. Forty-two sites were surveyed in all five years during which surveys were conducted (2015-2018 and 2021). At these 42 sites, our total abundance, naïve occupancy (i.e., observed proportion of sites occupied by Karner blue), and raw density (butterflies per hectare) were lower than 2016-2018 and similar to 2015 (Figure 5, Table 1). In 2021, total abundance, naïve occupancy, and raw density across all sites surveyed were the second lowest of the five years. When comparing the 51 sites surveyed in both 2018 and 2021, 26 (50%) had lower abundance in 2021, whereas only 10 sites (20%) had an increase in abundance. Mean density of the 51 sites decreased by 15.0 (SE = 13.9). The most dramatic declines in abundance were recorded at the Megasite (-2,419 individuals) in Flat River SGA and Horseman's Camp (-683 individuals) and 42$^{nd}$ Street (-321 individuals) sites in Allegan SGA. The greatest increase in abundance was observed at the private Gamez Property (+612 individuals). We used data from 2021 surveys to update 15 existing Karner blue EOs in the Natural Heritage Database.

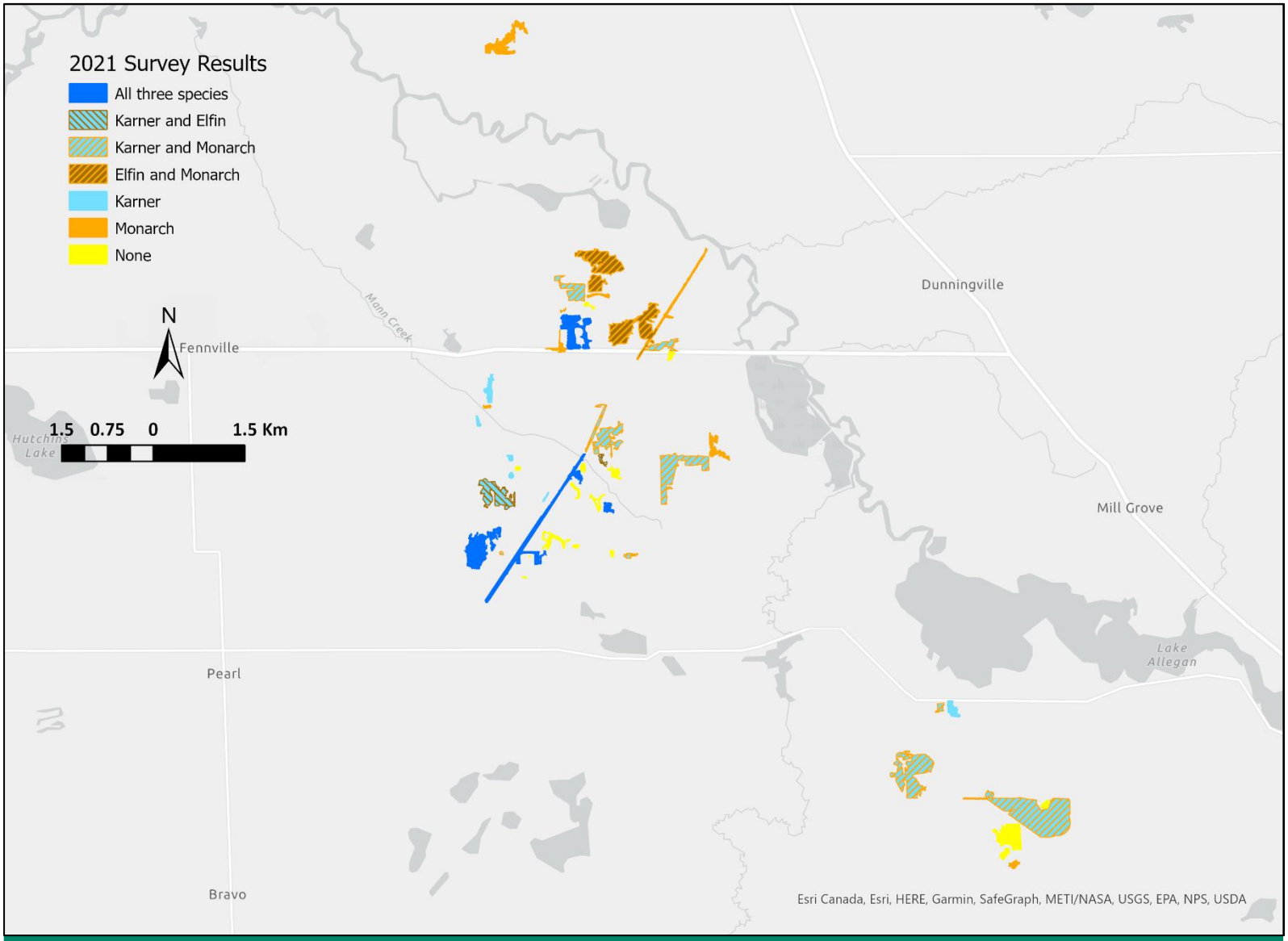


**Figure 2.** Results of surveys conducted in 2021 at Allegan State Game Area in southwestern Lower Michigan. Sites are shaded according to target species detected.

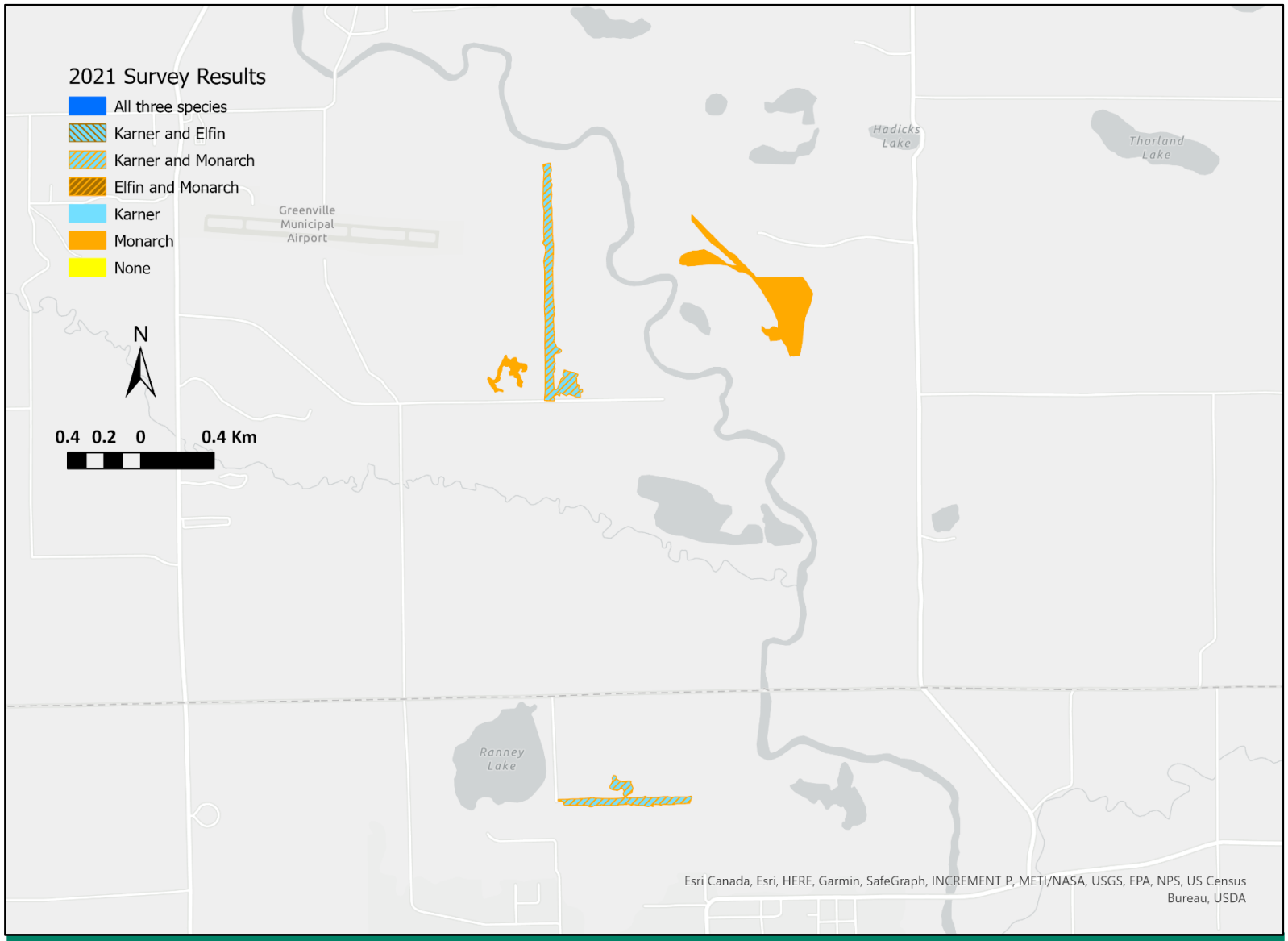


**Figure 3.** Results of surveys conducted in 2021 at Flat River State Game Area in southwestern Lower Michigan. Sites are shaded according to target species detected.

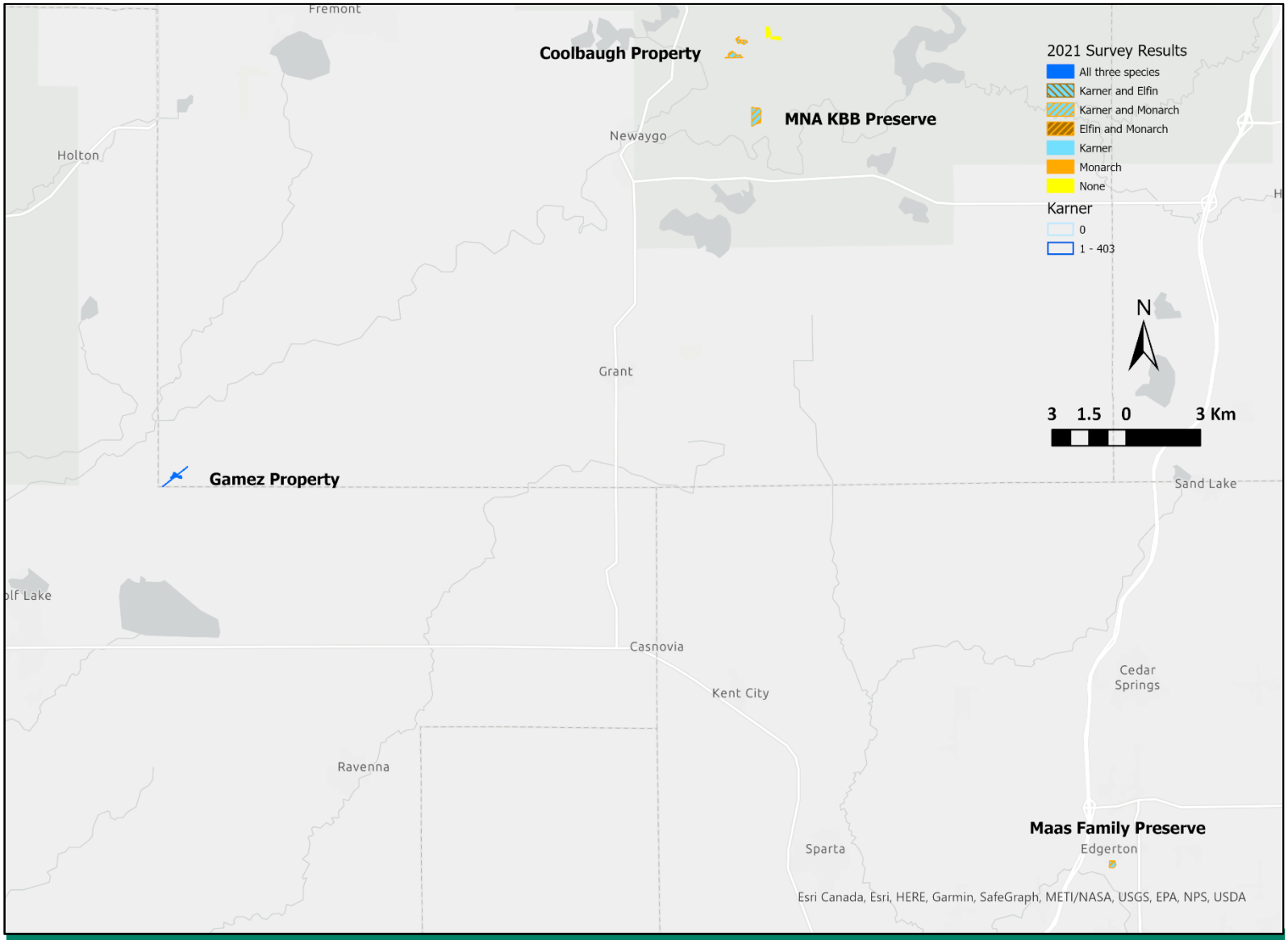


**Figure 4.** Results of surveys conducted in 2021 at private land sites in southwestern Lower Michigan. Sites are shaded according to target species detected.

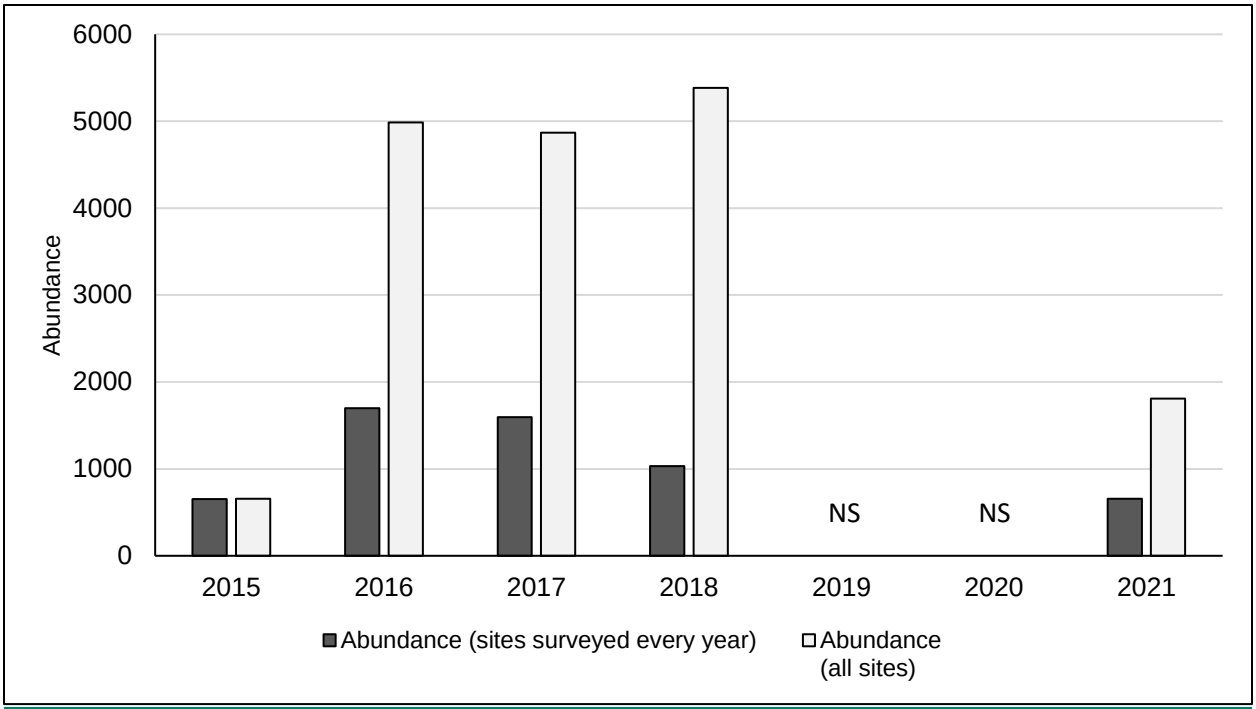


**Figure 5.** Total maximum second flight Karner blue abundance observed at 42 habitat patches surveyed during 2015-2018 and 2021. Surveys were not conducted in 2019-2020 (NS).

**Table 1.** Proportion of sites occupied (i.e., naïve occupancy) and raw densities (butterflies per hectare) of Karner blue in southwestern Lower Michigan by year for all sites surveyed and a subset of sites visited every year (n = 42).

| Year | Naïve Occupancy | | Raw Density | |
|---|---|---|---|---|
| | All sites | Sites surveyed every year | All sites | Sites surveyed every year |
| 2015 | 0.471 | 0.548 | 4.2 | 5.3 |
| 2016 | 0.672 | 0.690 | 25.4 | 20.4 |
| 2017 | 0.672 | 0.738 | 19.6 | 15.5 |
| 2018 | 0.690 | 0.714 | 24.2 | 10.4 |
| 2021 | 0.492 | 0.476 | 8.9 | 8.0 |

**Frosted Elfin**
We surveyed 59 sites during the frosted elfin flight; 37 sites (63%) were visited twice and 22 sites (37%) were surveyed once. We detected frosted elfin at 10 (17%) of the 59 sites surveyed, with 51 elfins recorded across all sites and visits. When taking the greatest one-day count from each site, we had a total of 40 elfins for the 10 occupied habitat patches. Nine of the 10 sites with elfin detections were within Allegan SGA (Figure 2) and the final site was on private land (Gamez Property, Figure 4). Data gathered during surveys produced nine new element occurrences (EOs) and updated one existing occurrence within the Natural Heritage Database.

**Monarch**
We detected monarchs at 35 (56%) of the 62 sites surveyed, with a total of 326 observed across all sites and visits. None were observed during the two early surveys targeting frosted elfin. Taking the greatest one-day count from each site, we had a maximum season count of 238. Monarchs were detected at 26 of the 51 Allegan SGA sites (Figure 2), all four Flat River SGA sites (Figure 3), and five of the seven private lands sites (Figure 4).

# Discussion

In 2021, we gathered important data for three butterfly SGCN: Karner blue, frosted elfin, and monarch. Our sampling approach built upon an existing design and protocol used to survey Karner blue on state and nearby private lands in southwestern Lower Michigan. With the surveys completed in 2021, we now have five years of data under this protocol for Karner blue since 2015, which highlights the value of long-term monitoring using a standardized sample design and protocol. Not only can these data be used to assess the status of Karner blue and progress toward recovery goals, but they are available for more in-depth analyses, such as occupancy modeling to estimate population parameters and evaluate associations with management and other factors. By building on this existing monitoring program, we now have baseline information for frosted elfin (state threatened) and monarch (candidate for federal listing). Repeating surveys in future years will allow better assessments of the status of the elfin and monarch on state lands, similar to information we have for Karner blue. These data could also inform recovery planning and assessment if these species become listed at the federal level.

Although analysis conducted in 2018 suggested an increasing trend in Karner blue occupancy at our survey sites during 2015-2018 (Monfils and Cuthrell 2018), the 2021 survey results indicate occupancy and relative abundance have declined since 2018. Researchers have found a variety of factors associated with Karner blue occupancy, including patch size, microclimate, resource availability, and matrix quality (Grundel and Pavlovic 2007, Walsh 2017). Additional surveys are needed to assess whether our 2021 results represent normal variation in occupancy and abundance or downward trend in the populations at these sites monitored. We recommend conducting surveys as often as resources allow and reanalysis of the data using occupancy modeling to produce population parameter estimates (i.e., occupancy, extinction, colonization). Augmenting the current protocol with surveys during the first flight could help us assess if the changes in abundance are a result of normal population fluctuations or related to conditions during the time between the second flight and the first flight in the following year, such as lack of snow cover, winter thaw-freeze events, or extreme spring weather (e.g., high temperatures, late-season frosts).

Lower mean Karner blue occupancy, abundance, and raw density estimates recorded in 2021 could also be associated with changes in habitat availability. We observed some survey polygons now containing patches of unsuitable habitat, such as oak (*Quercus* spp.) regeneration or ground cover dominated by *Carex pensylvanica*, thus reducing the area of suitable habitat within the survey site. We suggest detailed mapping of the survey areas be done periodically (e.g., every 2-3 years) to track habitat availability, lupine populations, and locations of management actions. Having more accurate habitat area estimates for the survey sites would allow us to examine trends in habitat concurrent with population abundance and occupancy and explore relationships between habitat variables and population parameters. For example, quantitative covariates on habitat availability and management would be available for occupancy modeling and other analyses, rather than categorical variables gathered during butterfly surveys.

In the recent species status assessment conducted for frosted elfin, the condition of 86% of the populations was unknown due to the lack of recent surveys providing information about abundance and habitat conditions (U.S. Fish and Wildlife Service 2018). The surveys supported by this project will help address the significant information gaps regarding this species present across much of its range. With only about 40 frosted elfins being detected at 17% of the sites surveyed in 2021, concern about its status at these areas appears warranted and continued monitoring is needed.

We estimated a maximum monarch count of 238 individuals, which were detected at just over half the survey sites. Mean raw density based on the maximum count per sites was 0.87 monarchs per hectare (SE = 0.20). Little information is available for monarch density on breeding grounds, but our raw estimate is lower than those of a study conducted in Iowa, which produced density estimates of 5.80 and 9.40 monarchs per hectare at random and non-random transects, respectively (Kinkead et al. 2019). Our lower density could be due to differences in habitats (barrens in MI vs. more productive grasslands in IA) and sampling techniques (whole patch surveys in MI vs. transects in IA). Because we took a multispecies approach to surveys, a survey designed specifically for monarch would likely be needed if accurate population estimates (e.g., abundance, occupancy) are needed. Despite its limitations, our 2021 surveys do provide important baseline information that, if repeated over time and replicated in other areas, could provide for assessment of population trends and investigation of covariates related to monarch abundance or occupancy.

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Frosted elfin (*Incisalia irus*). Photo by L.M. Rowe.