

Assessing species diversity, distribution, and status of the bee genus *Megachile* in Michigan



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Cover: A sample of the *Megachile* spp. collection housed in the Author J. Cook Arthropod Research Collection at Michigan State University.

Contents

Abstract.....	5
Introduction.....	6
Methods	7
Databasing <i>Megachile</i> records in Michigan	7
Mapping distributional changes of <i>Megachile</i> in Michigan.....	8
Assessing spatial changes and changes in relative abundance for <i>Megachile</i> in Michigan	8
Determining Conservation Status ranks (S-ranks) for each species of <i>Megachile</i> in Michigan.	8
Results	9
Summary of species status and trends in Michigan	12
<i>Megachile addenda</i>	12
<i>Megachile albitarsis</i>	13
<i>Megachile apicalis</i>	14
<i>Megachile brevis</i>	15
<i>Megachile campanulae</i>	16
<i>Megachile centuncularis</i>	17
<i>Megachile dakotensis</i>	18
<i>Megachile frigida</i>	19
<i>Megachile frugalis</i>	20
<i>Megachile gemula</i>	21
<i>Megachile inermis</i>	22
<i>Megachile inimica</i>	23
<i>Megachile lapponica</i>	24
<i>Megachile latimanus</i>	25
<i>Megachile lippiae</i>	26
<i>Megachile melanophaea</i>	27
<i>Megachile mendica</i>	28
<i>Megachile montivaga</i>	29
<i>Megachile mucida</i>	30
<i>Megachile perihirta</i>	31
<i>Megachile petulans</i>	32
<i>Megachile pugnata</i>	33
<i>Megachile relativa</i>	34
<i>Megachile rotundata</i>	35

<i>Megachile rugifrons</i>	36
<i>Megachile sculpturalis</i>	37
<i>Megachile texana</i>	38
Discussion	39
Acknowledgements.....	40
Literature Cited	40

List of Tables

Table 1. Data sources for <i>Megachile</i> specimen in Michigan from 1903 to 2021. All records were vetted and combined in a single database of all occurrences.	7
Table 2. Summary of the total historic and contemporary records for each species of <i>Megachile</i> in Michigan. Global and state ranks are provided. Species ranked as ‘SNR’ are exotic species in Michigan and were not ranked using the state rank calculator.....	11

List of Figures

Figure 1. Temporal changes in the total number of <i>Megachile</i> occurrences documented during each 20-year time period in Michigan.	9
Figure 2. Spatial representation of all <i>Megachile</i> occurrences in Michigan between 1903-2021.	10

Abstract

The genus *Megachile* is comprised of a diverse assemblage of solitary bee species found across the United States, including at least 26 species in Michigan. Despite being a relatively recognizable group of native bees, very little is known about individual species' historic and current statewide distributions, and whether populations are currently in decline. This information is needed to document species of concern and to begin the development of conservation initiatives aimed at protecting at-risk species. This project provides species-specific distributional and population level trends for *Megachile* in the state of Michigan by assessing multiple statewide databases on species occurrence, spatial trends, and floral use for each species found in the state. The results here demonstrate that species are currently experiencing varying levels of distributional changes and provide insight on species that may be warranted increased conservation awareness. We recommend continued monitoring of populations of species in the genus *Megachile* to maintain a robust understanding of distributional trends and to better understand habitat needs across the state. Provided this information, we can develop better conservation initiatives that target species at the greatest risk of detrimental population changes.

Introduction

For the last few decades, scientists have been increasingly interested in documenting the population level trends of native bees and other pollinators (Williams et al. 2001, Woodard et al. 2020). These concerns are largely driven by an increasing body of knowledge documenting range contractions and species declines in relation to habitat loss, pathogens, and pesticides, among other anthropogenic stressors (Potts et al. 2010, Colla et al 2012). Most studies documenting native bee population declines have focused on bumble bees (*Bombus* spp.), leading to an impressive level of conservation awareness for declining bumble bee species, and state and federal initiatives to improve populations of species at greatest risk of extinction (Smith et al. 2020). Additional focused research is needed to understand whether less studied native bee species are experiencing similar population level changes. Gaining this knowledge is necessary to determine the conservation status of native bee species and to prioritize future conservation efforts.

The genus *Megachile* (i.e., leafcutter bees) is comprised of a diverse assemblage of solitary bee species found across the United States. Worldwide, there are over 1500 species of leafcutter bees, and in the United States, at least 131 species have been documented. Most of the research concentrated on this group of bees focuses primarily on those species used to assist with agricultural crop production (Pitts-Singer & Cane 2011, Gibbs et al. 2017). Additional studies have documented primary foraging resources, preferred nesting resources, and life-history strategies that seem to be unique to species within the genus. Very few studies have assessed the population level temporal and spatial trends for this genus, which are needed to understand how species' populations may be shifting through time in response to environmental pressures. The primary study which has assessed *Megachile* population trends, focuses on trends on a continental scale, found that 47% of the species in North America may be at-risk of extinction, and 19% of species are represented by historic occurrences only (Young et al. 2016). This effort resulted in updated G-ranks (Global Conservation Species Status Ranks) for each species. While population level changes at a national level are important, many species' distributions can often be better described at the regional scale. More targeted, state level efforts to document temporal trends in species population abundance and spatial occupancy will improve our understanding of species' status within the occupied range. Concurrently, state level status assessments (including conservation status rankings, i.e., S-ranks) for species in the genus *Megachile* are lacking, despite increasing knowledge of species declines at the continental scale. The only state for which these assessments have been completed for the genus *Megachile* is Missouri and for some species in Indiana (NatureServe Explorer, 2022). The results from these efforts highlight differences between ranking values at the continental scale and state scale, suggesting that state level efforts are needed to understand regional trends in species temporal and spatial occupancy. As state-level assessments are completed, a clearer picture is produced, improving the ability to draw broader interpretations regarding population status at the national scale.

Our primary objective with this study is to measure the temporal and spatial trends of species within the genus *Megachile* in Michigan over the past 100+ years. In addition, we provide information regarding species diversity in Michigan and any apparent associations with floral resources in Michigan. Specifically, we use a statewide dataset of *Megachile* occurrences in Michigan to 1) assess temporal trends in species presence within a statewide database, and 2) assess spatial trends in species occurrence between 1903 and 2020 in Michigan, and 3) provide information regarding floral associations for each species of *Megachile* in Michigan.

Methods

Databasing *Megachile* records in Michigan

Data from multiple sources were compiled to develop the *Megachile* spp. of Michigan dataset (Table 1). Contributors included contemporary and historic academic collections, USFWS data sources, personal collections, Global Biodiversity Information Facility (GBIF) collections, Symbiotic Collections of Arthropod Networks (SCAN), Integrated Digitized Biocollections (iDigBio) and research grade occurrence records from iNaturalist. Each data source was vetted, and data was combined using available Source ID fields to create a single database of *Megachile* spp. occurrences. The database schema attempts to adhere to the NatureServe Biodiversity Observation Data Standard and/or Darwin Core without a significant loss of source data information. Occurrence records were assessed and any duplication that was discovered was removed from the final dataset. Duplicates were identified by institution catalog numbers when available or by unique combinations of species, year, and location and surveyor.

Table 1. Data sources for *Megachile* specimen in Michigan from 1903 to 2021. All records were vetted and combined in a single database of all occurrences.

Dataset Name	Total Records Contributed
GBIF <i>Megachile</i> Occurrence (accessed 2021-07-12)	910
iDigBio <i>Megachile</i> Occurrence (accessed 2021-07-28)	5
iNaturalist Research Grade <i>Megachile</i> (accessed 2021-08-04)	51
Isaacs Lab <i>Megachile</i> Records (Michigan State University)	1861
Jamieson Lab <i>Megachile</i> Records 2017-2021 (Oakland University)	97
<i>Megachile</i> MSU Museum SCAN	266
Michigan State University Bee Health Historic <i>Megachile</i>	3744
ScanBugs (accessed 2021-07-28)	209
Tom Wood Michigan Bee Records	214
University of Michigan <i>Megachile</i>	34
United States Forest Service GLRI <i>Megachile</i>	60
Grand Total	7451

Mapping distributional changes of *Megachile* in Michigan

The Michigan *Megachile* database was used to develop a geodatabase of all occurrence records in Michigan from 1903-2021, and included the XY coordinates, using Latitude and Longitude fields, and was exported as a point feature layer (ESRI 2022). Data were visually assessed for points outside of the Michigan boundary, including points in the Great Lakes. Any outlying points were removed, and minor mapping errors were assigned to the county level. A Michigan County centroid coordinate (latitude and longitude in decimal degrees) table was created from the Michigan Framework 1:24,000 County geospatial dataset, forcing the centroid to be placed inside the polygon(s). For example, the Keweenaw County point is within the mainland polygon, whereas a geometric centroid would have been placed in Lake Superior somewhere between Isle Royale and the mainland county polygon. The primary mapping objective of this project was to view occurrence data at the county level. For this reason, two attribute fields were added to the specimen record table, “countyLatitude” and “countyLongitude”. Attribute indexes were created on the county attribute field in both tables. The Michigan County centroid coordinate table was then joined to the specimen table by the common county name fields. The Lat/Long fields in the specimen record table were calculated from the joined county centroid latitude and longitude. The join was then removed, and the records were mapped as above. Appropriate notes were added to the georeferenced fields to indicate that records were mapped to the county scale.

For each species of *Megachile* in Michigan, we create statewide distribution maps using county level occurrence data using the time periods *pre-1940*, *1940-1959*, *1960-1979*, *1980-1999*, and *2000-current*. These time periods were used to accurately capture the temporal spread of data within the Michigan database. Using these time periods allowed for a temporal comparison of species occurrence, and to visualize any spatial changes in species occupancy across Michigan.

Assessing spatial changes and changes in relative abundance for *Megachile* in Michigan

To measure the change in spatial occupancy for a species, we calculated the proportion of re-sampled historical counties (pre-1940 -1999) for a species occupied by that species in the most recent time period (2000-2021), using a methodology similar to that developed by Colla et al. 2012 for bumble bees. We included only re-sampled counties in this analysis due to the rarity of many species of *Megachile* in Michigan and similarly, the current time period (2020-2021) includes fewer re-sampled counties. Therefore, our analysis describes spatial change in county level occurrence based on historic and contemporary sampling efforts. To assess temporal changes in species abundance we calculated the relative abundance of occurrence records for each species within time periods *pre- 1940*, *1940-1959*, *1960-1979*, *1980-1999*, and *2000-current*. Each species was assessed independently by comparing the number of occurrence records within the database for that species against all species combined within each time period.

Determining Conservation Status ranks (S-ranks) for each species of *Megachile* in Michigan

We used NatureServe’s Conservation Rank Calculator to determine the conservation status for each species of *Megachile* in Michigan (NatureServe 2020). This tool determines species status ranks and assesses the extinction risk of species by requiring knowledge of the distribution,

population size and trends, and critical threats for a species of concern. The calculator was built to accommodate missing data and to accept a great deal of uncertainty, which is important when assessing groups such as invertebrates that may have low survey effort and/or a shortage of occurrence data historically. The strengths of the calculator are that it standardizes the assessment process, is easily replicated, and records all the assessment fields (including author and date). For a more detailed description of the process and metrics please refer to Master et al. (2012) and Faber-Langendoen et al. (2012). Each species receives an S-rank as follows: S1- Critically Imperiled, S2- Imperiled, S3- Vulnerable, S4- Apparently Secure, S5- Secure, SX- Presumed Extirpated, SH- Possibly Extirpated, and SU- Status Unknow. We used information on the spatial occupancy and relative abundance trends for each species in Michigan to inform the model. Critical threats were determined using available information in the database regarding species life history and biology, specific habitat needs, and rarity. Recommendations for species based on current S-ranks are provided in the discussion.

Results

We compiled a total of 7451 occurrences of 26 species of *Megachile* collected in Michigan between 1901 and 2021. The dataset contains a wide spatial representation of species across the state; however, representation tends to be greater during the contemporary time period compared to earlier periods (Figure 1, Figure 2). The species that were assessed in this project show varying levels of range contraction and range expansion in Michigan. Most notably, the species that have experienced the greatest range contraction in Michigan include *M. melanophaea* (60% decrease, S3), *M. relativa* (55% decrease, S2S3), *M. gemula* (54% decrease, S2) and *M. lippiae* (50% decrease, S1S2). We identified a single species (*Megachile dakotensis*) that is currently only represented by historic occurrences and is likely extirpated in Michigan. One species was ranked as Critically Imperiled to Imperiled (S1) (*M. lippiae*). This species was presumed to be extirpated from Michigan until it was rediscovered in 2015 in Berrien County. Three species were determined to be Imperiled (S2) in Michigan and include *M. frugalis*, *M. petulans*, and *M. rugifrons* (Table 2). Due to a limited amount of long-term occurrence data, we were unable to complete s-ranks for 3 species (*M. albitarsis*, *M. lapponica*, and *M. perihirta*).



Figure 1. Temporal changes in the total number of *Megachile* occurrences documented during each 20-year time period in Michigan.

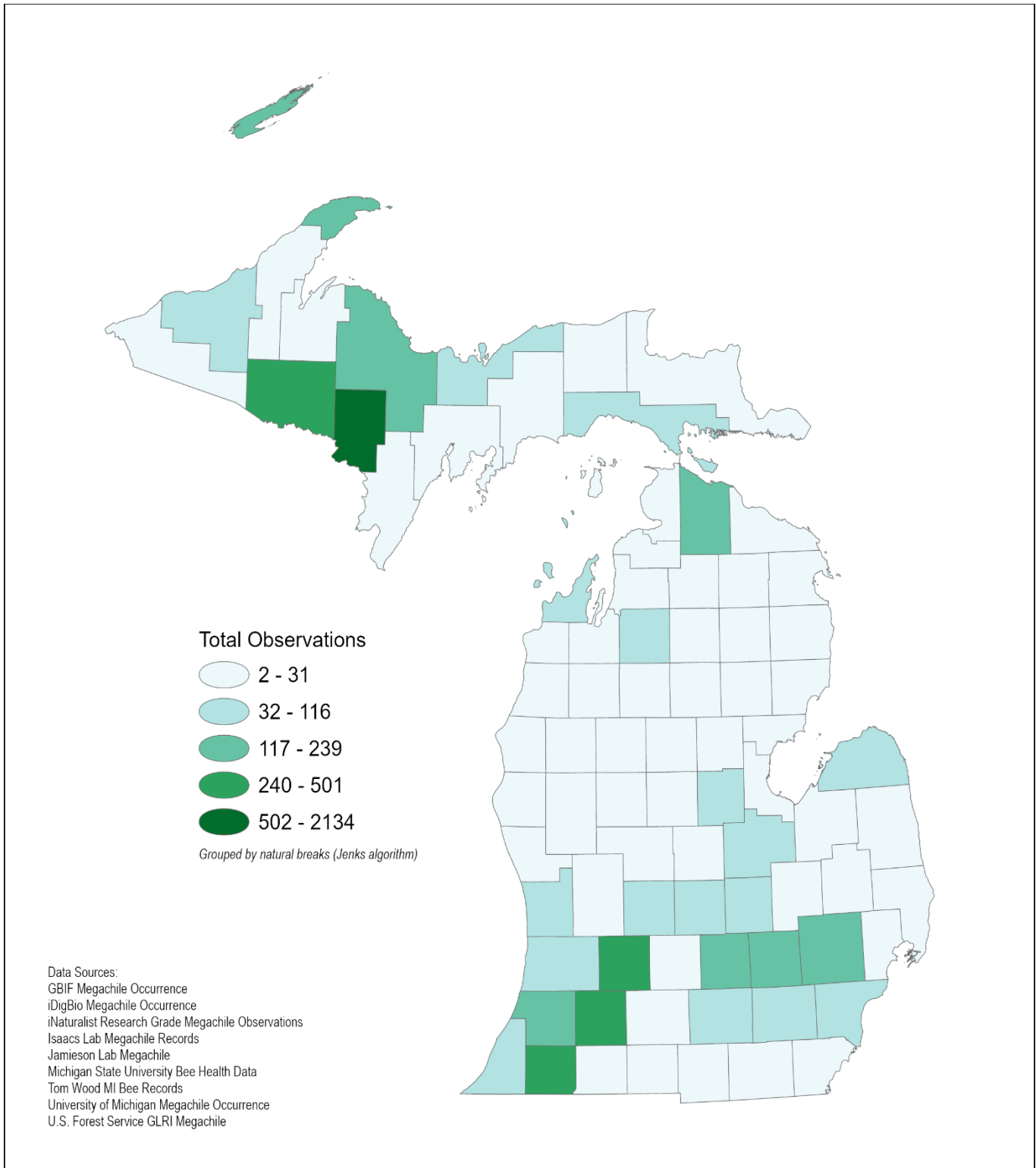


Figure 2. Spatial representation of all *Megachile* occurrences in Michigan between 1903-2021.

Table 2. Summary of the total historic and contemporary records for each species of *Megachile* in Michigan. Global and state ranks are provided. Species ranked as 'SNR' are exotic species in Michigan and were not ranked using the state rank calculator.

Scientific Name	Historic (pre-1999)	Contemporary (2000-2021)	Global Rank	State Rank
<i>Megachile addenda</i>	14	10	G5	S4
<i>Megachile albitarsis</i>	0	16	G4	SU
<i>Megachile apicalis</i>	0	1	G4	SNR
<i>Megachile brevis</i>	85	36	G5	S4
<i>Megachile campanulae</i>	17	46	G5	S5
<i>Megachile centuncularis</i>	25	86	G5	S5
<i>Megachile dakotensis</i>	25	0	G2	SH
<i>Megachile frigida</i>	104	24	G5	S3
<i>Megachile frugalis</i>	4	9	G4	S2
<i>Megachile gemula</i>	178	45	G5	S2
<i>Megachile inermis</i>	1368	182	G5	S3S4
<i>Megachile inimica</i>	1	1	G5	S2S3
<i>Megachile lapponica</i>	0	2	G5	SU
<i>Megachile latimanus</i>	636	212	G5	S4
<i>Megachile lippiae</i>	9	1	G5	S1S2
<i>Megachile melanophaea</i>	309	31	G5	S3
<i>Megachile mendica</i>	206	142	G5	S4
<i>Megachile montivaga</i>	47	34	G5	S3
<i>Megachile mucida</i>	0	19	G4	S4
<i>Megachile perihirta</i>	0	1	G5	SU
<i>Megachile petulans</i>	8	2	G5	S2
<i>Megachile pugnata</i>	191	1351	G5	S5
<i>Megachile relativa</i>	1481	75	G5	S2S3
<i>Megachile rotundata</i>	30	93	G5	SNR
<i>Megachile rugifrons</i>	1	2	G2	S2
<i>Megachile sculpturalis</i>	0	57	G5	SNR
<i>Megachile texana</i>	75	34	G5	S3S4

Summary of species status and trends in Michigan

Megachile addenda

Species Common Name: Cranberry Leafcutter bee

NatureServe Global and State

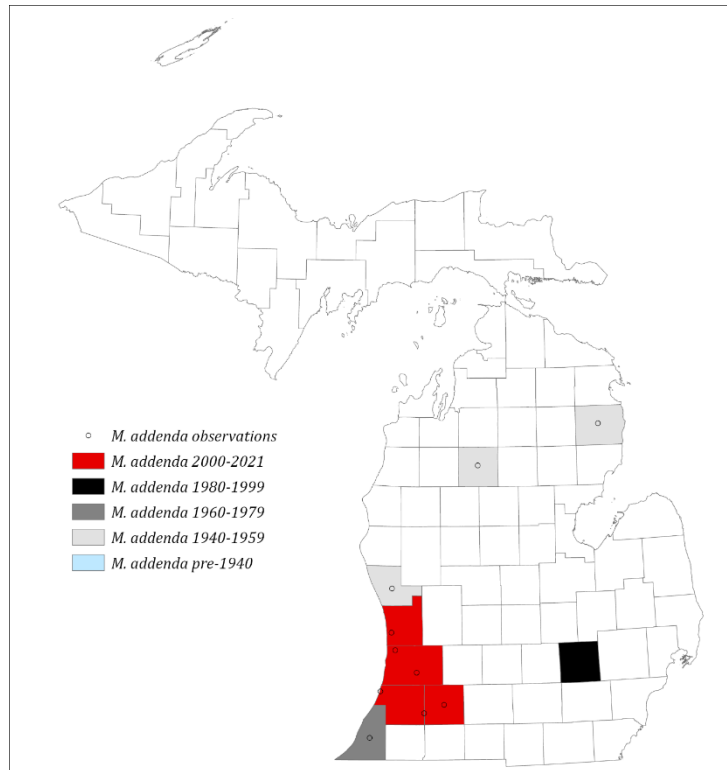
Ranks: G5- Secure, S4- Apparently Secure

Last Observed in Michigan: 2018

Estimated Spatial Increase/Decline (Historic – Current): -33%

Conservation Information: A ground nesting species known as a pollinator for cranberry production. Primarily an eastern species in the United States.

Associated Plant Species in Michigan: *Asclepias* sp., *Hieracium* sp., *Opuntia* sp., *Rubus* sp.



Megachile albitarsis

Species Common Name: White-footed Leafcutter bee

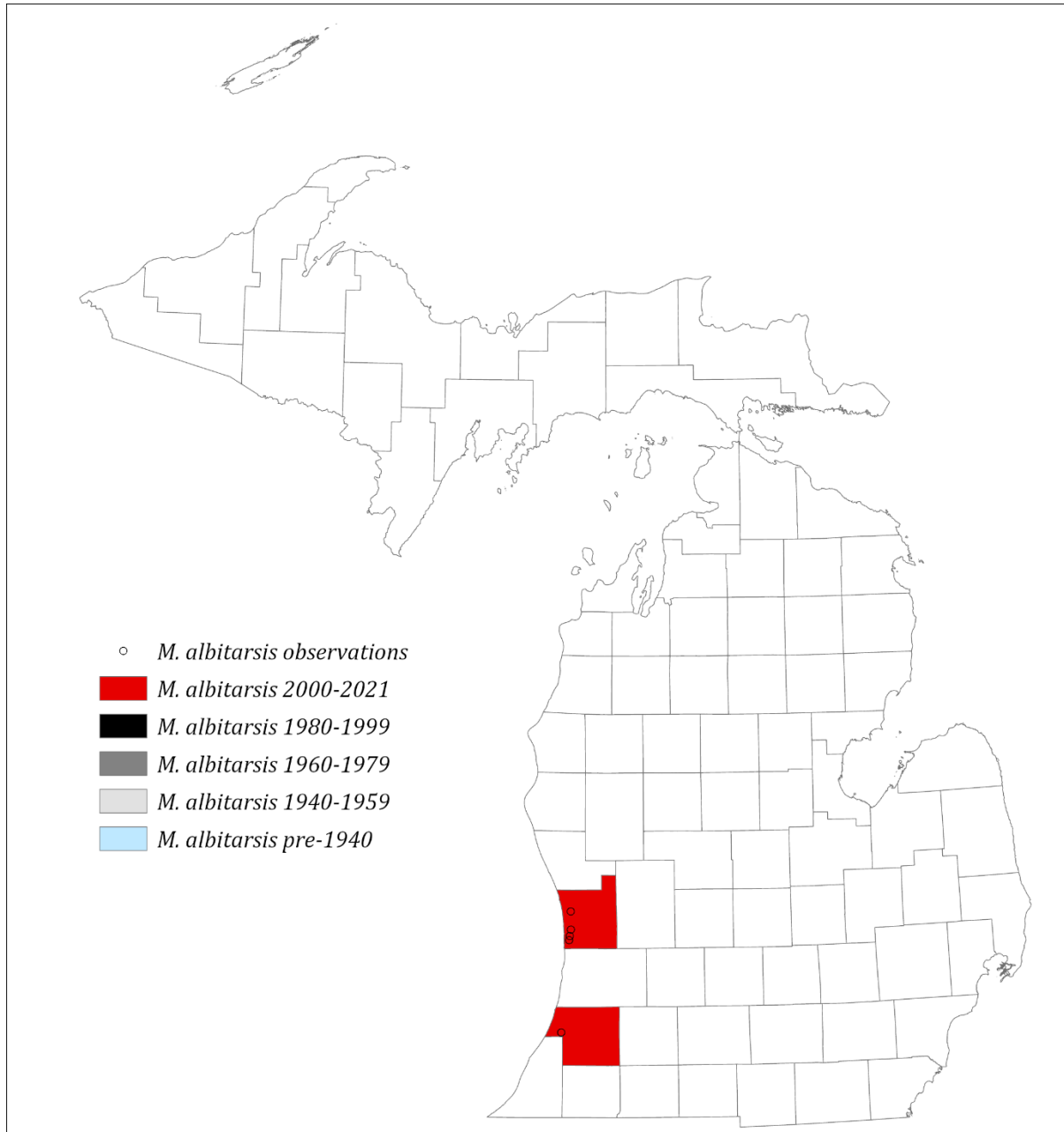
NatureServe Global and State Ranks: G4- Apparently Secure, SU- Species Status Unknown

Last Observed in Michigan: 2006

Estimated Spatial Increase/Decline (Historic – Current): +100% (No historic records)

Conservation Information: Primarily a southern United States species. Michigan is in the northern range of this species. Blueberry pollinator in Southwest Michigan.

Associated Plant Species in Michigan: NA



Megachile apicalis

Species Common Name: Apical Leafcutter bee

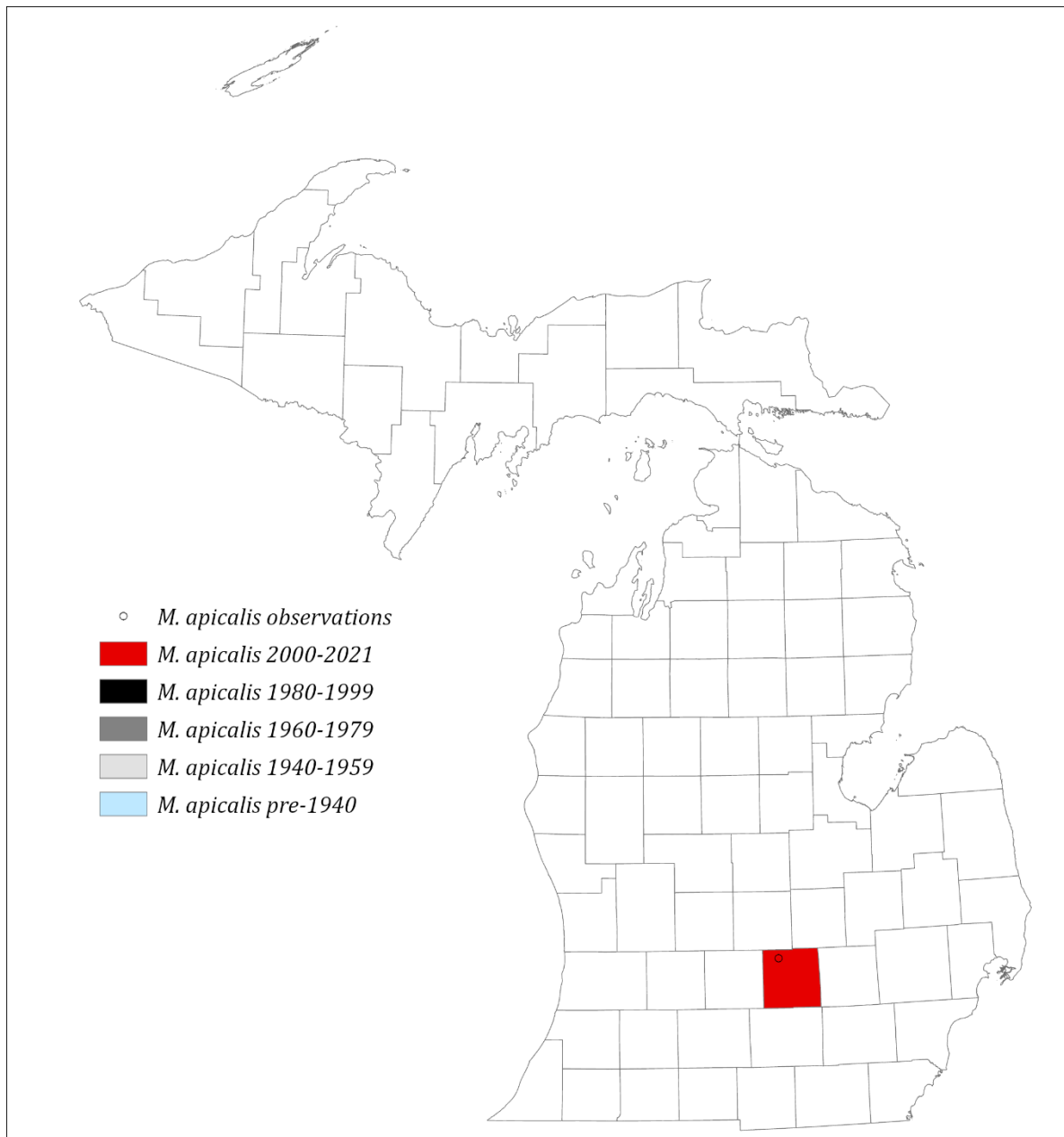
NatureServe Global and State Ranks: G4- Apparently Secure, SNR- Species Not Ranked (Exotic Species)

Last Observed in Michigan: 2013

Estimated Spatial Increase/Decline (Historic – Current): +100% (No historic records)

Conservation Information: Commonly found in Europe. Considered an exotic species in Michigan.

Associated Plant Species in Michigan: NA



Megachile brevis

Species Common Name: Short Leafcutter bee

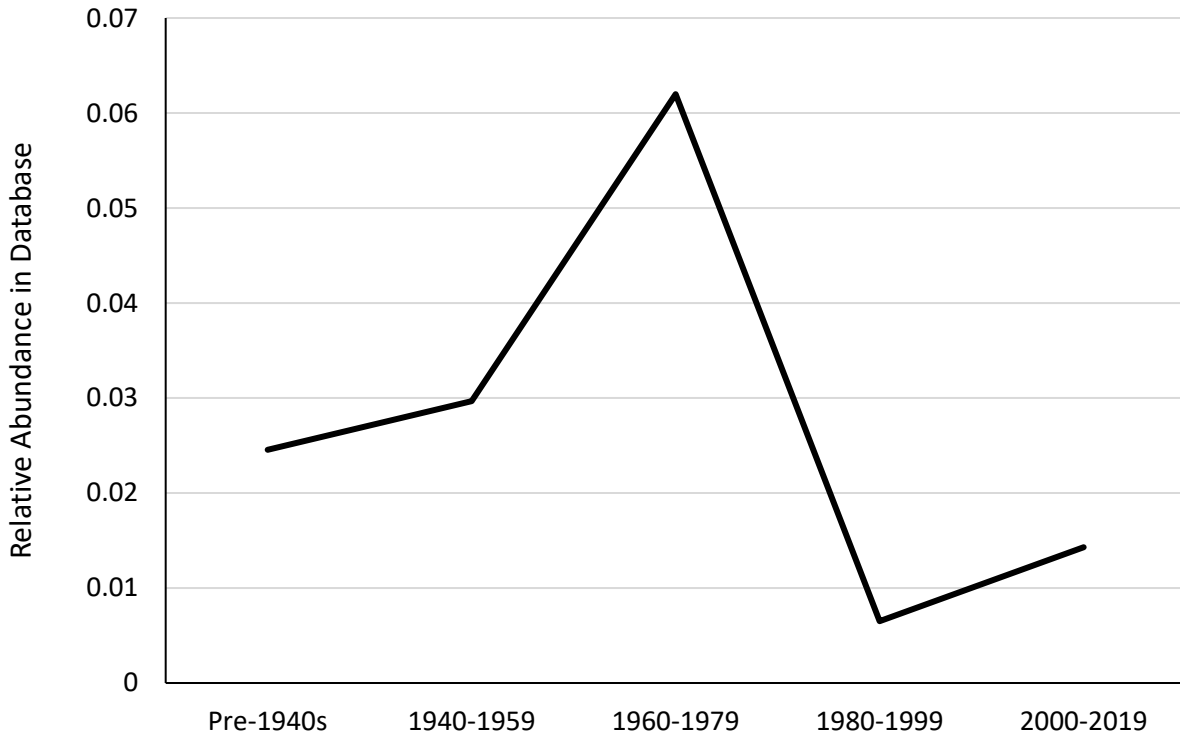
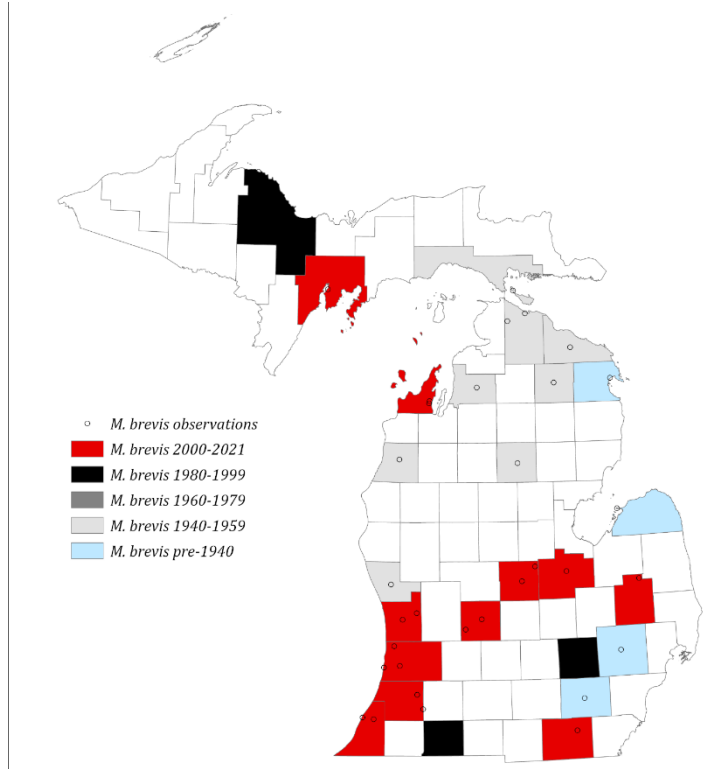
NatureServe Global and State

Ranks: G5- Secure, S4- Apparently Secure

Last Observed in Michigan: 2020
Estimated Spatial Increase/Decline (Historic – Current): -39%

Conservation Information: A cavity or stem-nesting species found across the United States.

Associated Plant Species in Michigan: *Achillea* sp., *Asclepias* sp., *Centaurea* sp., *Desmodium* sp., *Rudbeckia* sp.



Megachile campanulae

Species Common Name: Bellflower Leafcutter bee

NatureServe Global and State

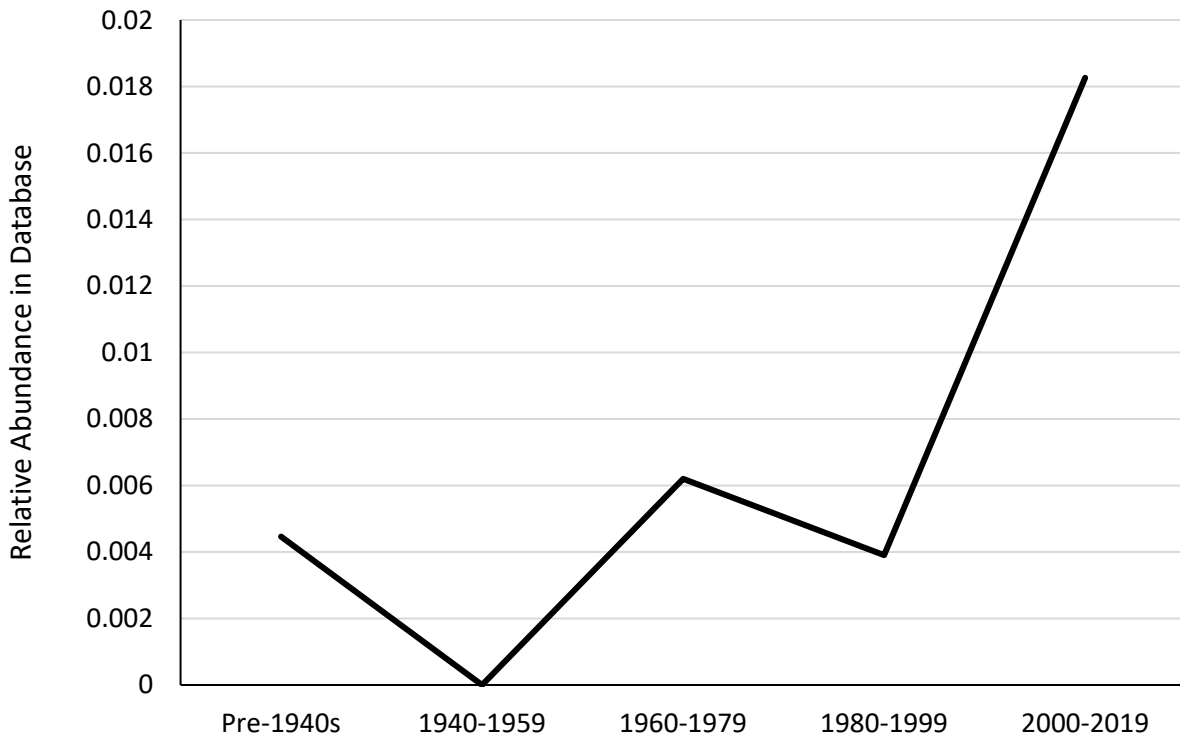
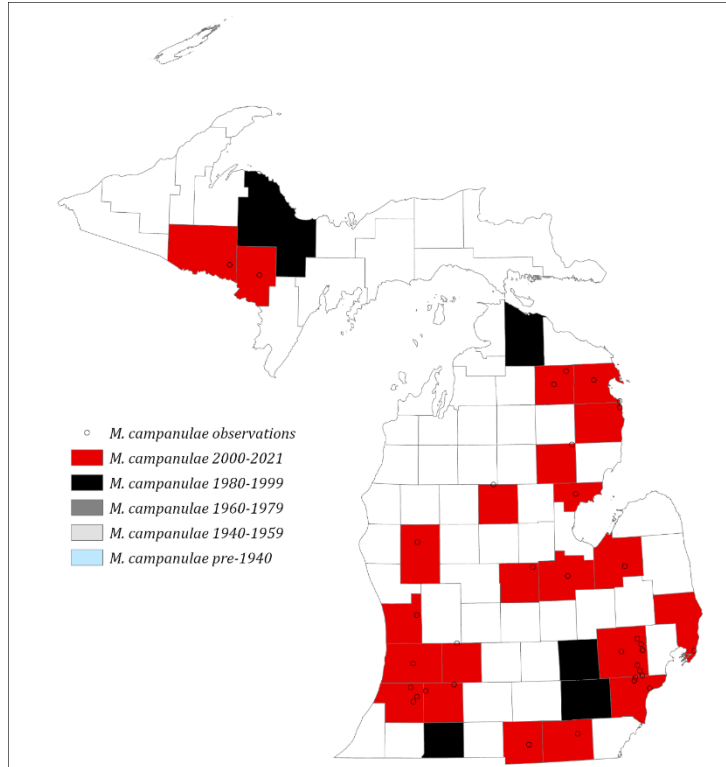
Ranks: G5- Secure, S5- Secure

Last Observed in Michigan: 2020

Estimated Spatial Increase/Decline (Historic – Current): +214%

Conservation Information: A stem-nesting, resin collection species found across Michigan. Full range includes much of the eastern United States.

Associated Plant Species in Michigan: *Asclepias* sp., *Campanula* sp., *Centaurea* sp., *Desmodium* sp., *Lespedeza* sp., *Rudbeckia* sp.



Megachile centuncularis

Species Common Name: Common Leafcutter bee

NatureServe Global and State

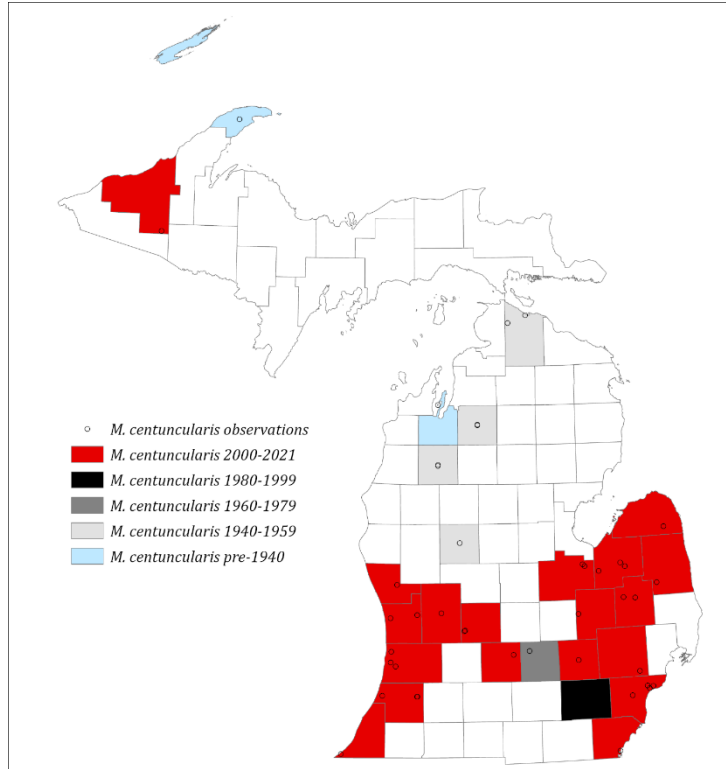
Ranks: G5- Secure, S5- Secure

Last Observed in Michigan: 2018

Estimated Spatial Increase/Decline (Historic – Current): +90%

Conservation Information: A cavity-nesting species that is possibly exotic to Michigan.

Associated Plant Species in Michigan: *Cirsium* sp., *Coreopsis* sp., *Erigeron* sp.



Megachile dakotensis

Species Common Name: A Leafcutter bee

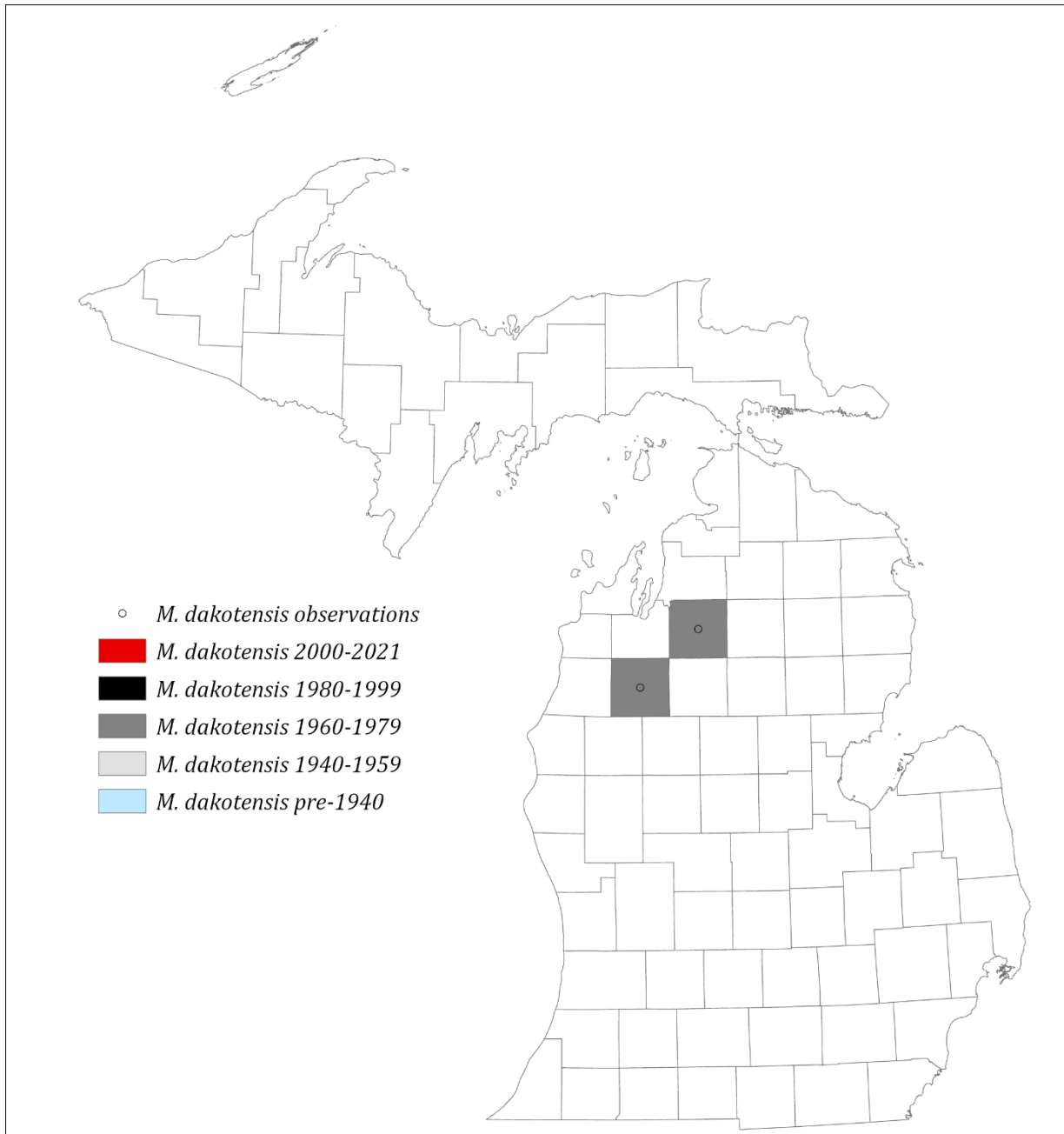
NatureServe Global and State Ranks: G2- Imperiled, SH- Possibly Extirpated

Last Observed in Michigan: 1966

Estimated Spatial Increase/Decline (Historic – Current): -100%

Conservation Information: A prairie associated species presumed to be extirpated in Michigan.

Associated Plant Species in Michigan: NA



Megachile frigida

Species Common Name: Frigid Leafcutter bee

NatureServe Global and State

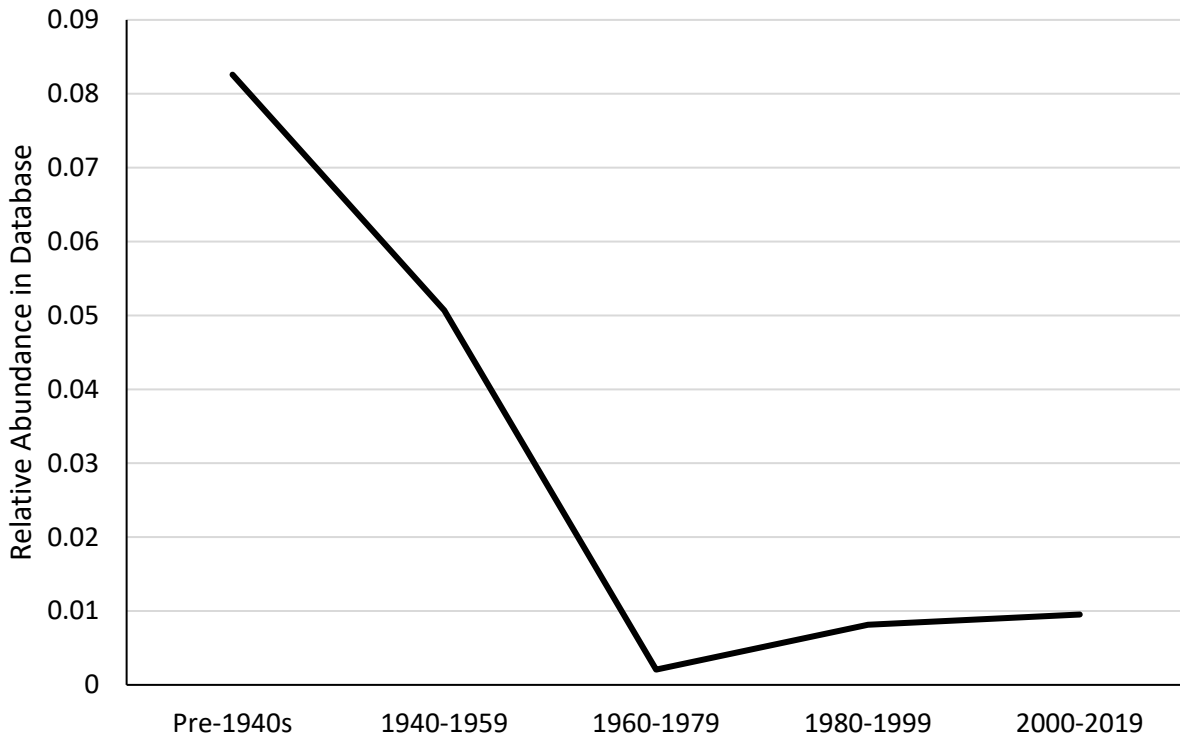
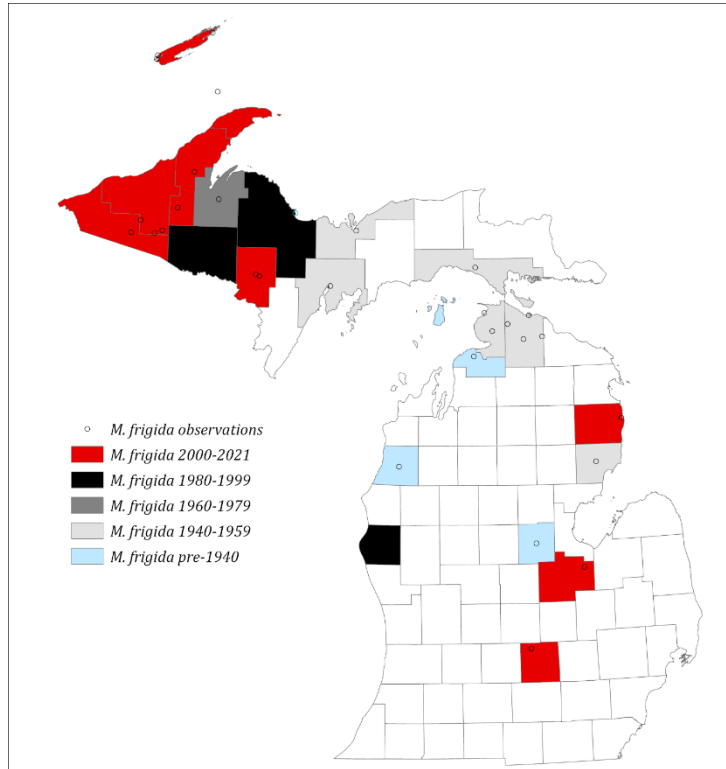
Ranks: G5- Secure, S3- Vulnerable

Last Observed in Michigan: 2018

Estimated Spatial Increase/Decline (Historic – Current): -47%

Conservation Information: Species seems to be a cavity nester, primarily nesting in logs. Range extends across northern United States and into Canada.

Associated Plant Species in Michigan: NA



Megachile frugalis

Species Common Name: A
Leafcutter bee

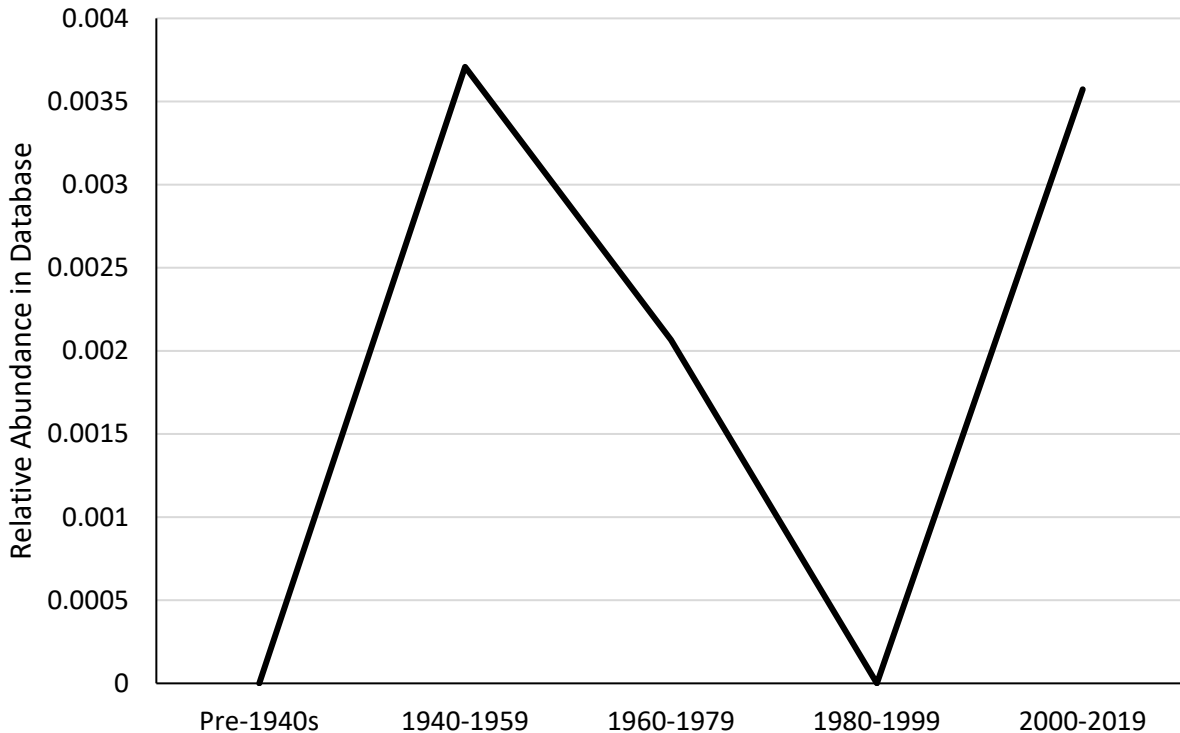
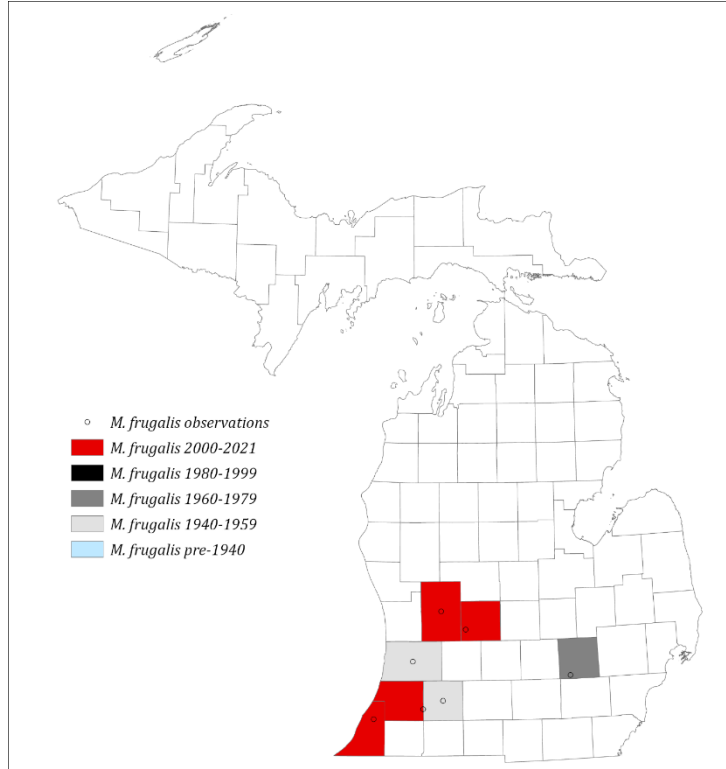
NatureServe Global and State

Ranks: G4- Apparently Secure, S2-
Imperiled

Last Observed in Michigan: 2016
**Estimated Spatial Increase/Decline
(Historic – Current):** +33%

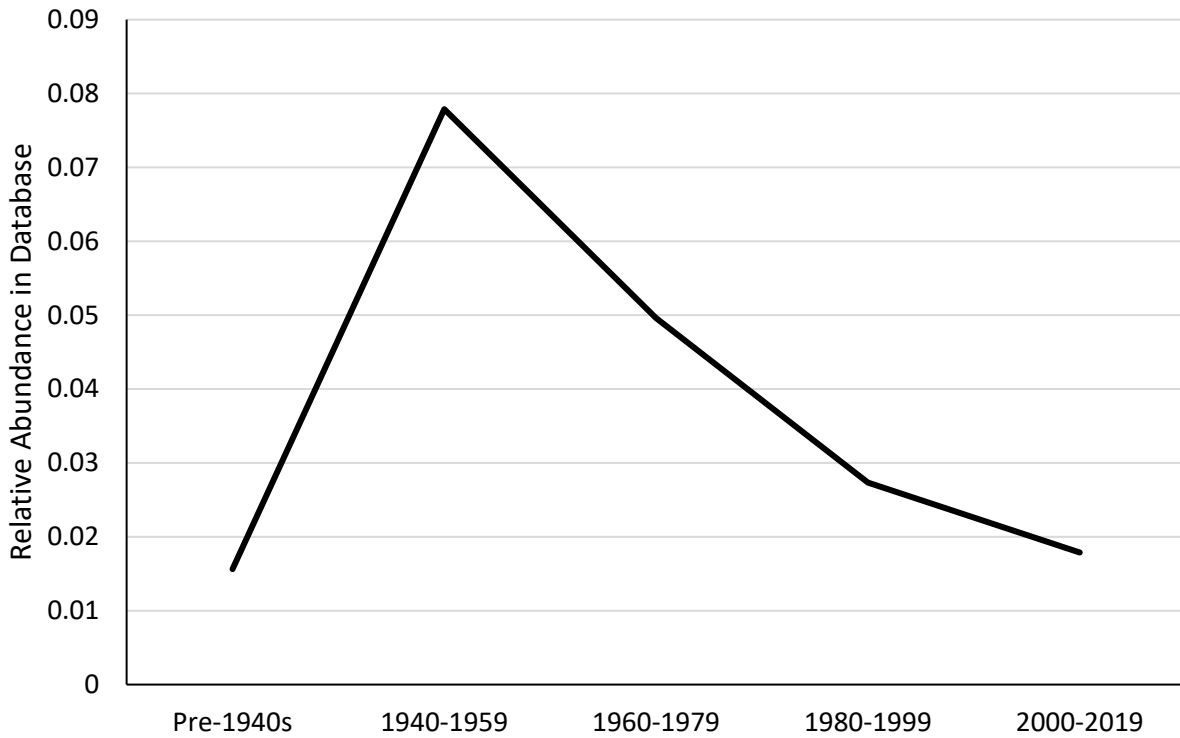
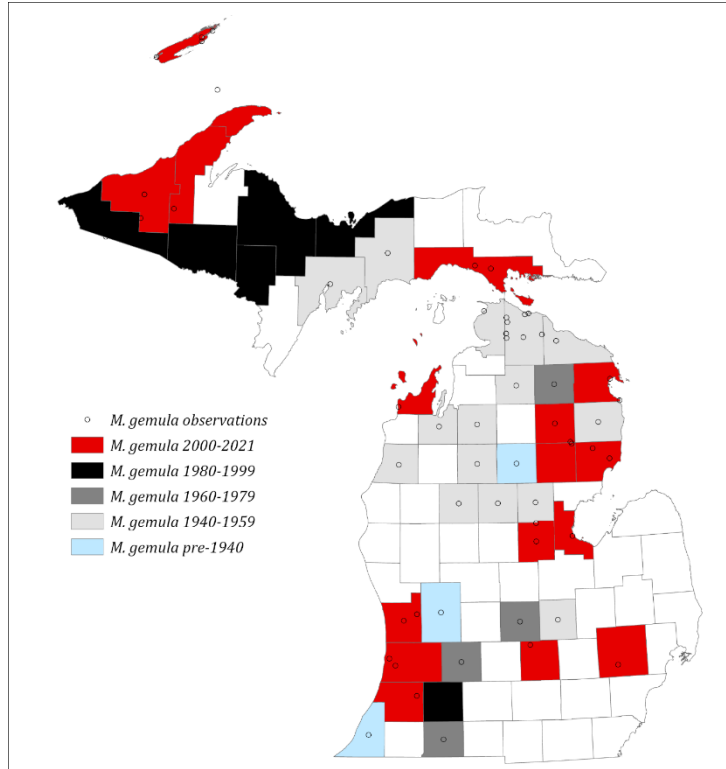
Conservation Information: Species
thought to be extirpated until recent
occurrence in 2019. Primarily a
southern United States Species with
northern Range extending into
Michigan. Likely a ground nesting
species.

**Associated Plant Species in
Michigan:** *Asclepias* sp., *Coreopsis*
sp., *Dalea* sp., *Rudbeckia* sp.,
Verbena sp.



Megachile gemula

Species Common Name: Small-handed Leafcutter bee
NatureServe Global and State Ranks: G5- Secure, S2- Imperiled
Last Observed in Michigan: 2019
Estimated Spatial Increase/Decline (Historic – Current): -54%
Conservation Information: A stem nesting species that has experience declines compared to historic occurrence numbers.
Associated Plant Species in Michigan: *Campanula* sp., *Centaurea* sp., *Lotus* sp.



Megachile inermis

Species Common Name: Unarmed Leafcutter bee

NatureServe Global and State

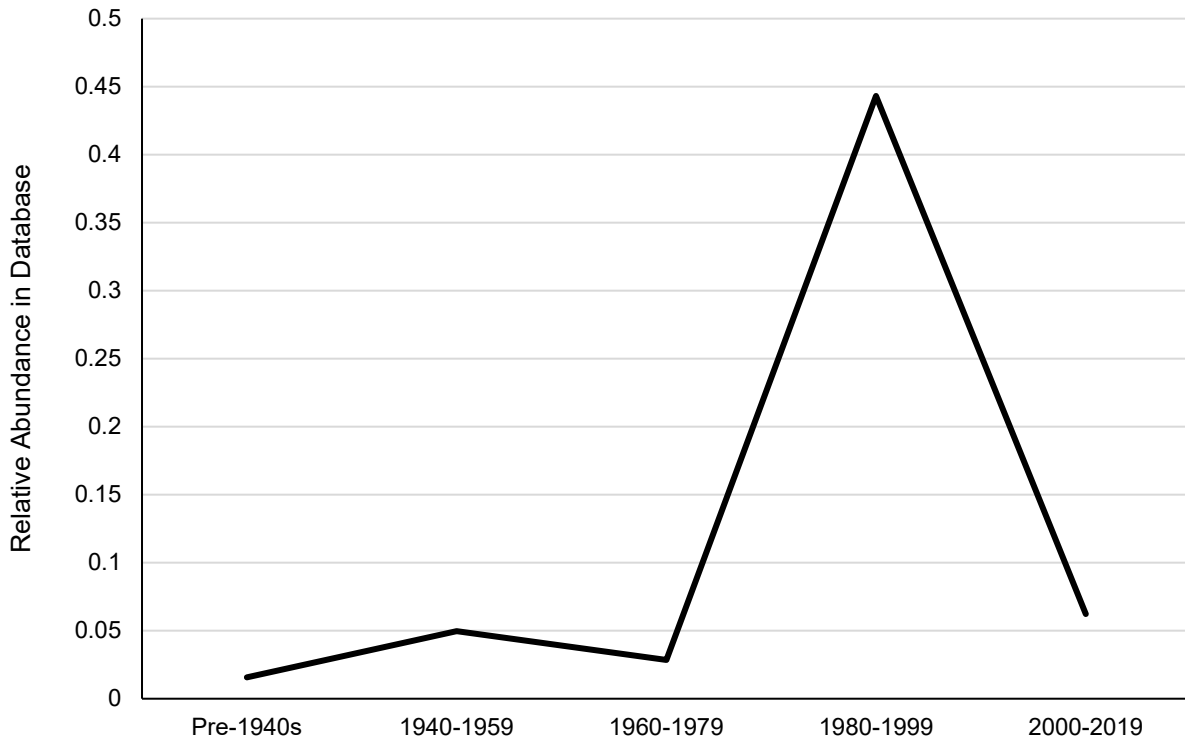
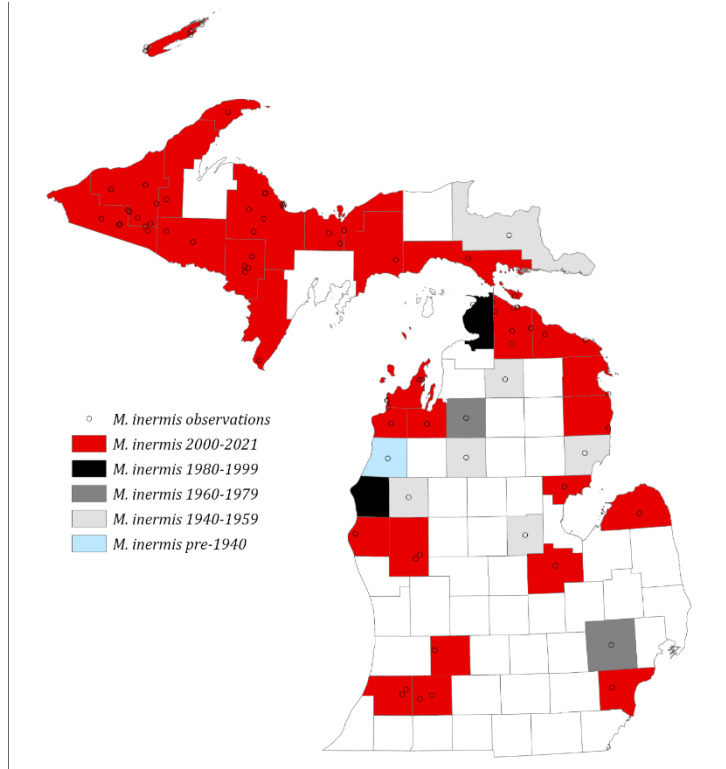
Ranks: G5- Secure, S3S4- Vulnerable to Apparently Secure

Last Observed in Michigan: 2020

Estimated Spatial Increase/Decline: +23%

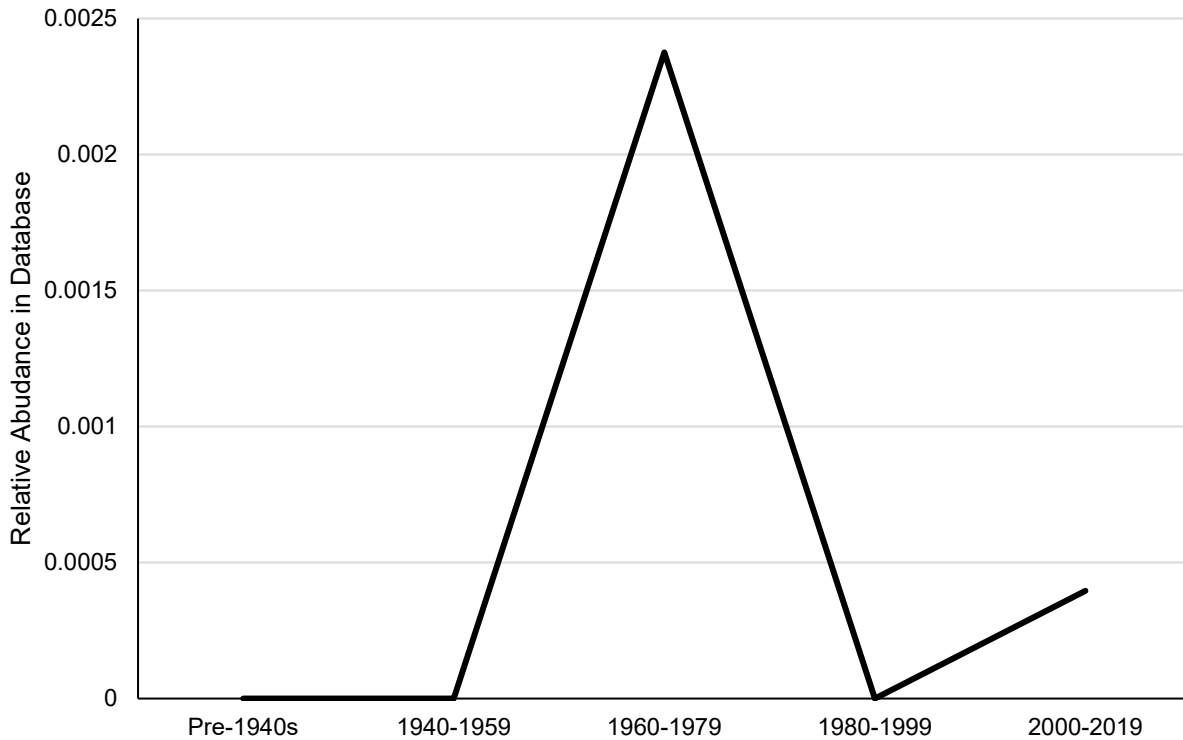
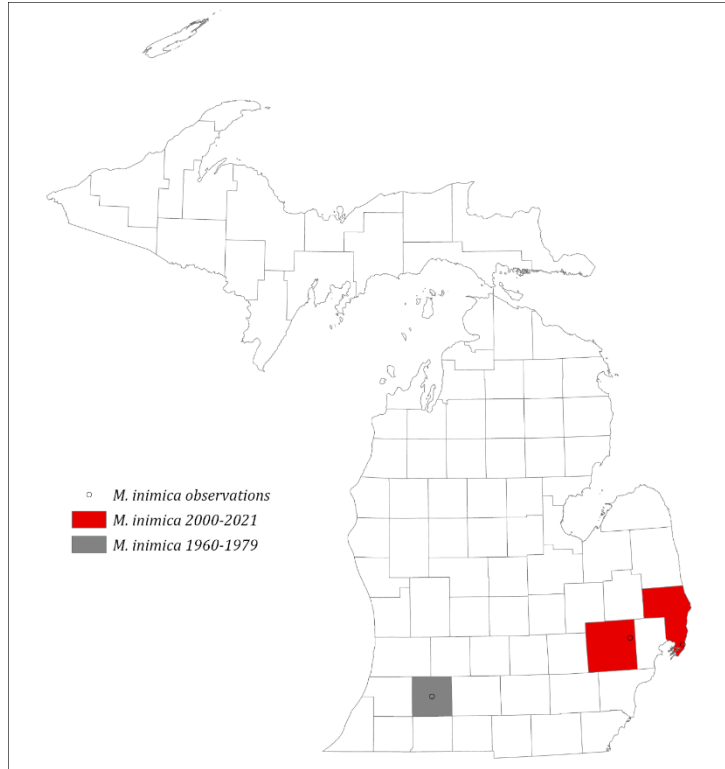
Conservation Information: Majority of occurrences in the Upper Peninsula with scattered occurrences in Southern Peninsula. Species will readily nest in stems and cavities and has a widespread distribution across the United States.

Associated Plant Species in Michigan: *Centaurea maculosa*, *Centaurea stoebe*, *Cirsium vulgare*, *Epilobium angustifolium*, *Rudbeckia hirta*



Megachile inimica

Species Common Names: Hostile Leafcutter bee
NatureServe Global and State Ranks: G5- Secure, S2S3 Imperiled to Vulnerable
Last Observed in MI: 2020
Estimated Spatial Increase/Decline (Historic – Current): +100%
Conservation Information: A very rare species in Michigan. Only known from 1 historic and 2 contemporary records.
Associated Plant Species in Michigan: *Helianthus spp.*



Megachile lapponica

Species Common Name: Lapland Leafcutter Bee

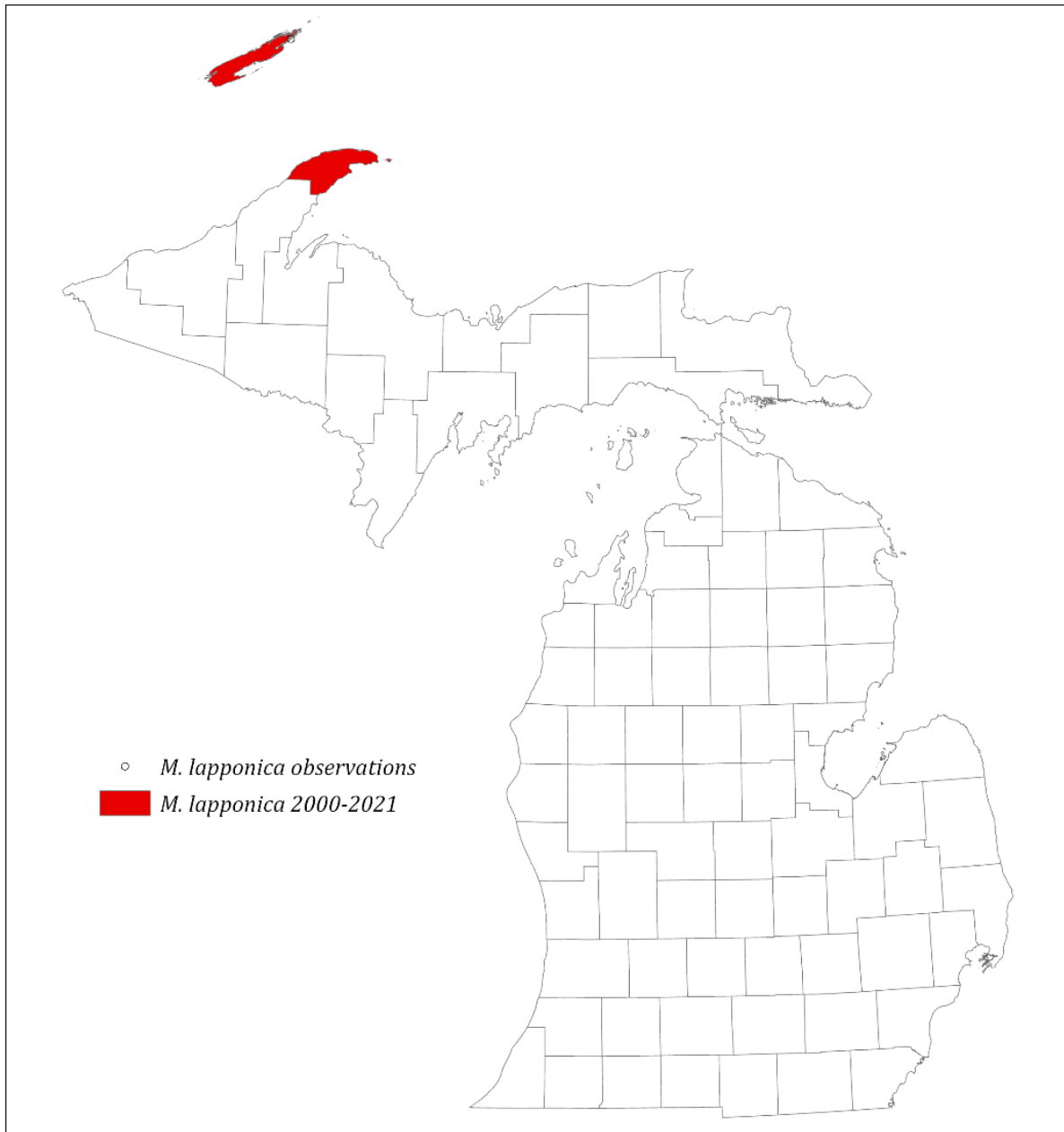
NatureServe Global and State Ranks: G5- Secure, SU- Species Status Unknown

Last Observed in Michigan: 2013

Estimated Spatial Increase/Decline (Historic – Current): +100% (first documented in 2013)

Conservation Information: Species associated with Boreal forests. Known from a single record in Isle Royale National Park. Considered a dietary specialist on the genus *Epilobium*.

Associated Plant Species in Michigan: NA



Megachile latimanus

Species Common Name: Broad-handed Leafcutter bee

NatureServe Global and State

Ranks: G5- Secure, S4- Apparently Secure

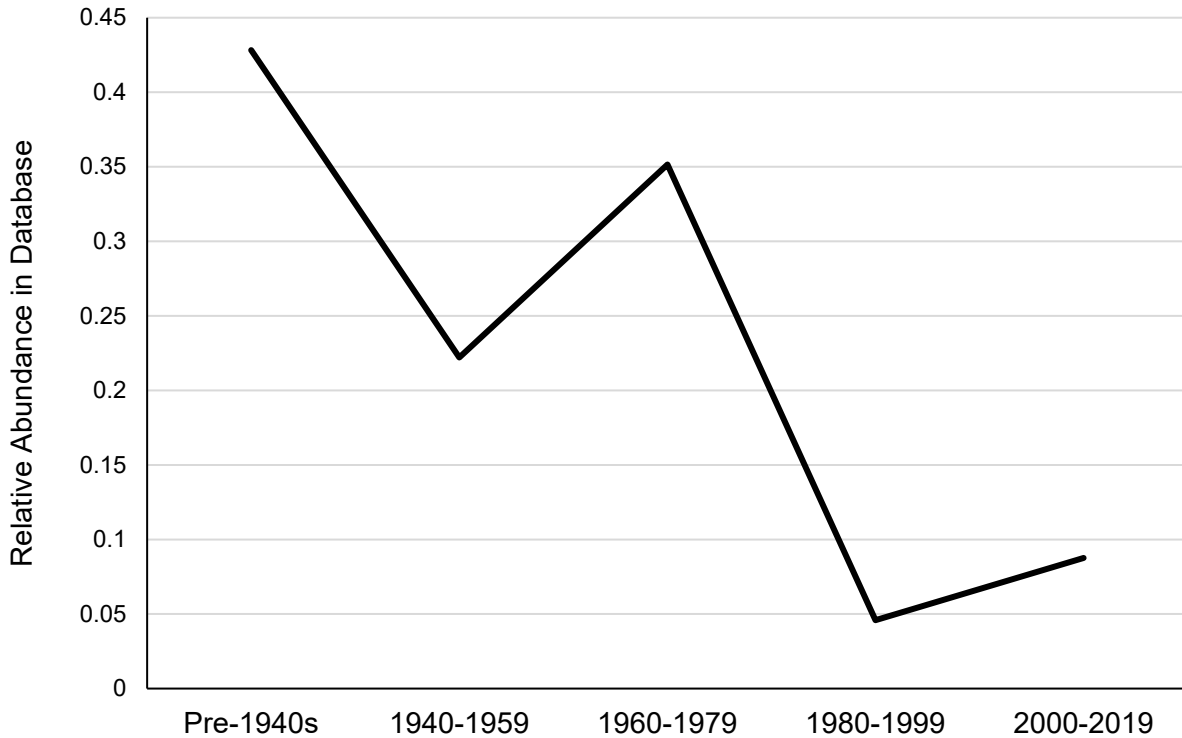
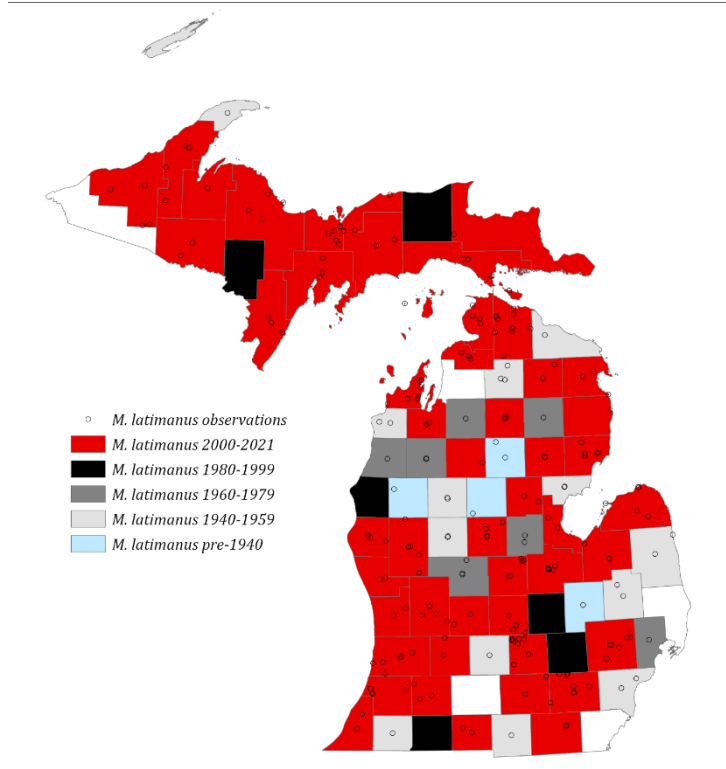
Last Observed in Michigan: 2020

Estimated Spatial Increase/Decline (Historic – Current): -29%

Conservation Information:

Geographically widespread species experiencing recent declines. Still abundant throughout Michigan.

Associated Plant Species in Michigan: Broadly generalist.



Megachile lippiae

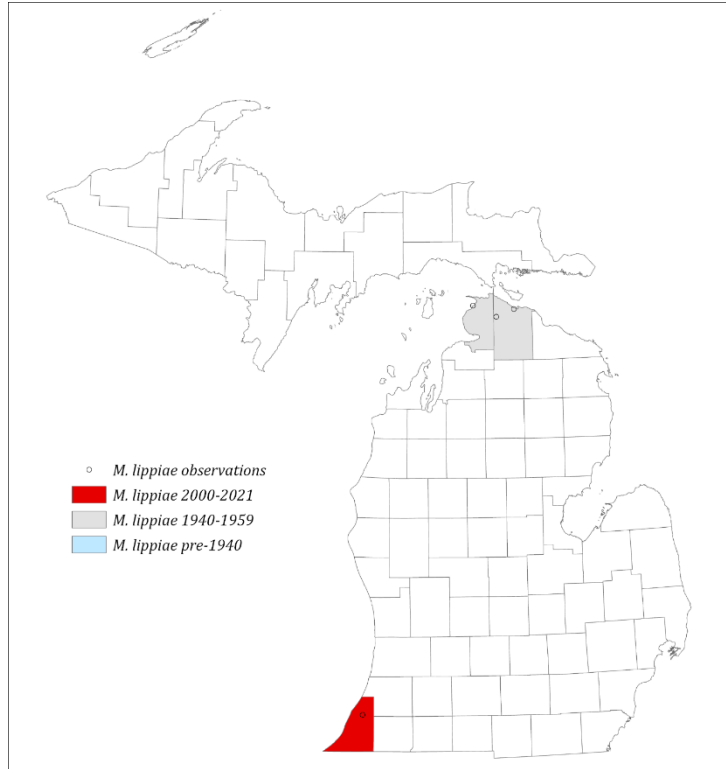
Species Common Name: Lippia
Leafcutter bee

NatureServe Global and State Ranks: G5- Secure, S1S2- Critically Imperiled to Imperiled

Last Observed in Michigan: 2015
Estimated Spatial Increase/Decline (Historic – Current): -50%

Conservation Information: Likely a ground nesting species. Thought to be extirpated until new documentation in 2015. Primarily a southern United States species.

Associated Plant Species in Michigan: *Verbena* sp.



Megachile melanophaea

Species Common Name: Black-and-gray Leafcutter bee

NatureServe Global and State

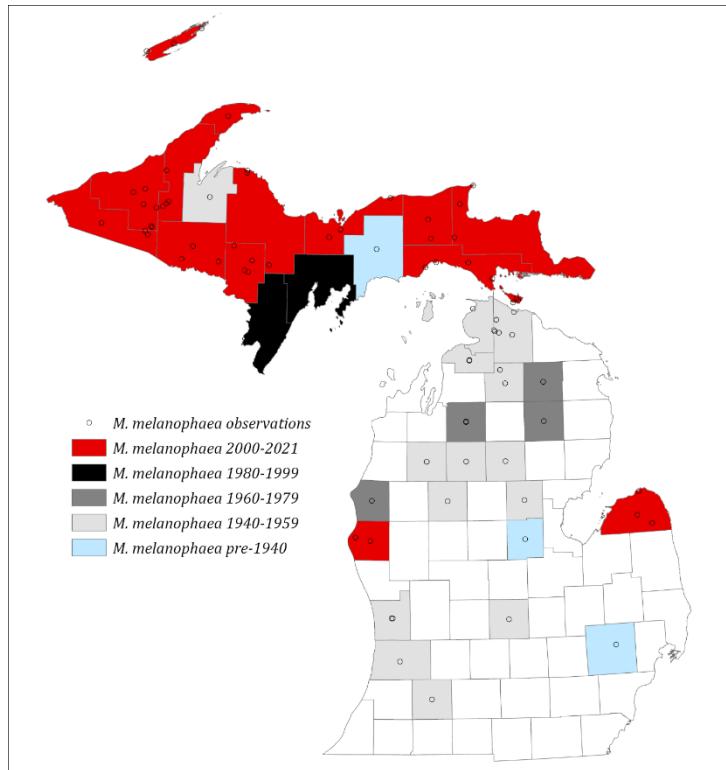
Ranks: G5- Secure, S3- Vulnerable

Last Observed in Michigan: 2020

Estimated Spatial Increase/Decline (Historic – Current): -63%

Conservation Information: Likely a ground nesting species. Currently found predominately in the Upper Peninsula. Historic populations across Southern Peninsula. Species seems to be in decline but stable in the Upper Peninsula. A northern species.

Associated Plant Species in Michigan: *Apocynum* sp., *Campanula* sp., *Epilobium* sp., *Lonicera* sp., *Vicia* sp.



Megachile mendica

Species Common Name: Black-and-gray Leafcutter bee

NatureServe Global and State

Ranks: G5- Secure, S4- Apparently Secure

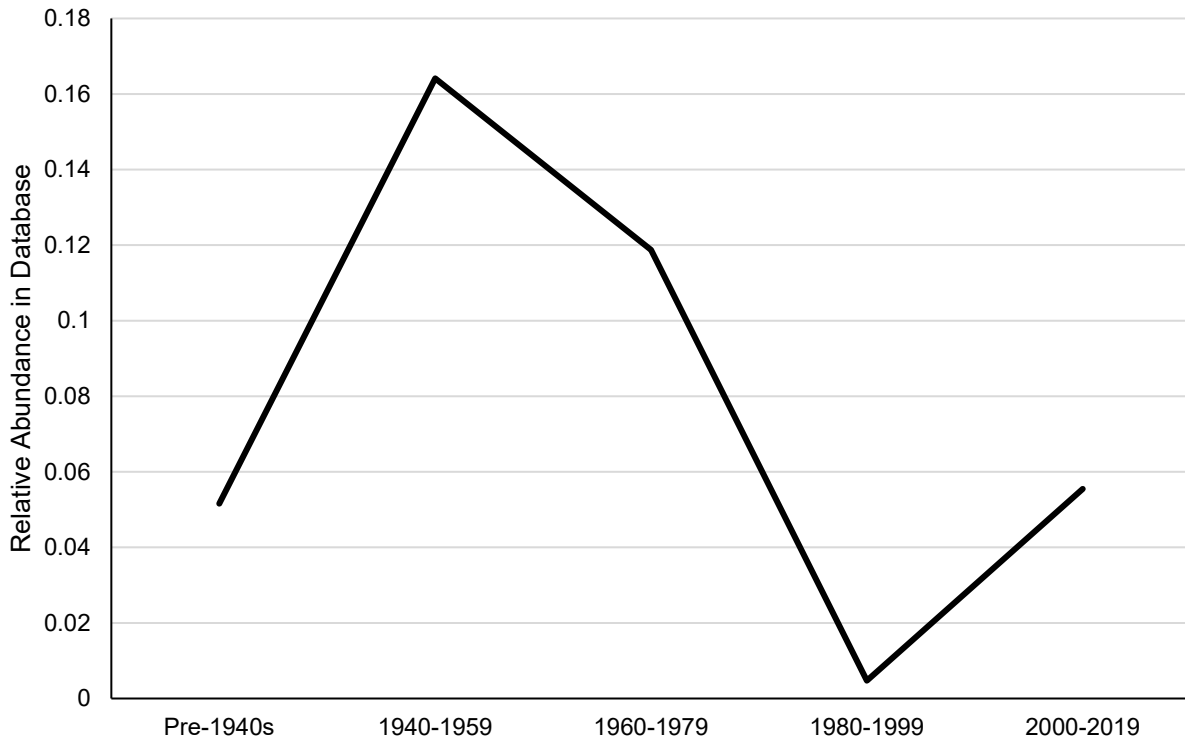
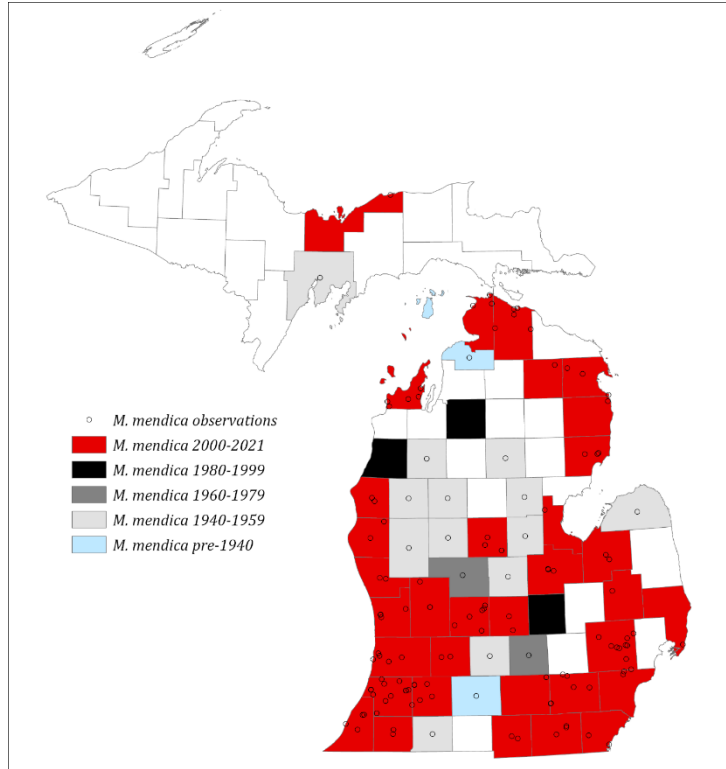
Last Observed in Michigan: 2021

Estimated Spatial Increase/Decline (Historic – Current): -19%

Conservation Information: Readily nests in stems, cavities, and soil.

Widely distributed across the United States. Broadly a generalist forager.

Associated Plant Species in Michigan: Generalist forager in Michigan.



Megachile montivaga

Species Common Name: Black-and-gray Leafcutter bee

NatureServe Global and State

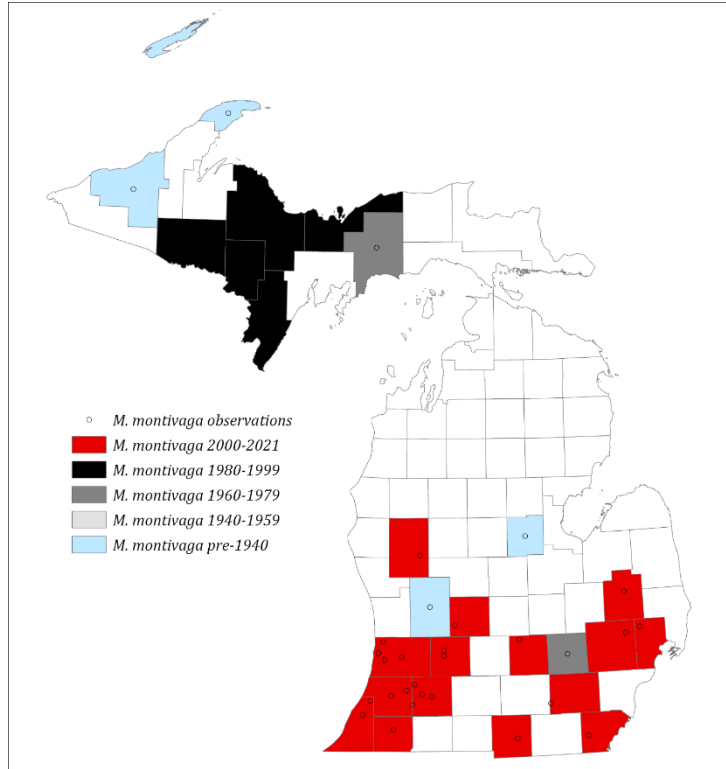
Ranks: G5- Secure, S3- Vulnerable

Last Observed in Michigan: 2020

Estimated Spatial Increase/Decline (Historic – Current): +15%

Conservation Information: Nests in plant stems and uses floral petals to construct nests. Linked to environment.

Associated Plant Species in Michigan: *Asclepias* sp., *Cirsium* sp., *Coreopsis* sp., *Epilobium* sp., *Silphium* sp.



Megachile mucida

Species Common Name: A Leafcutter bee

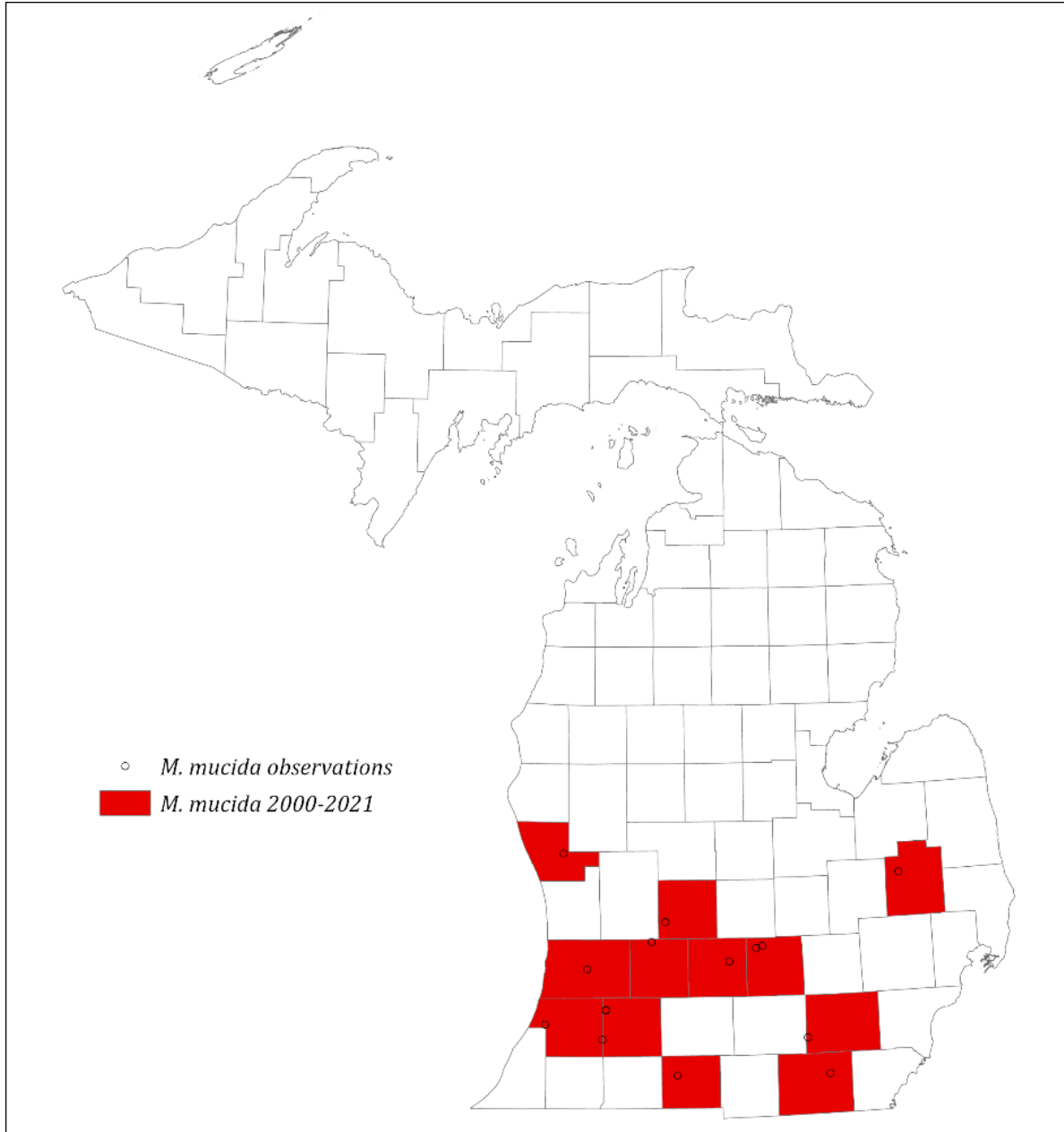
NatureServe Global and State Ranks: G4- Apparently Secure, S4- Apparently Secure

Last Observed in Michigan: 2018

Estimated Spatial Increase/Decline (Historic – Current): +100% (No historic records)

Conservation Information: Ground nesting species. Recent collections suggest this species is expanding in distribution and occupancy in Michigan.

Associated Plant Species in Michigan: *Baptisia* sp., *Lotus* sp., *Penstemon* sp.



Megachile perihirta

Species Common Name: Furry Leafcutter bee

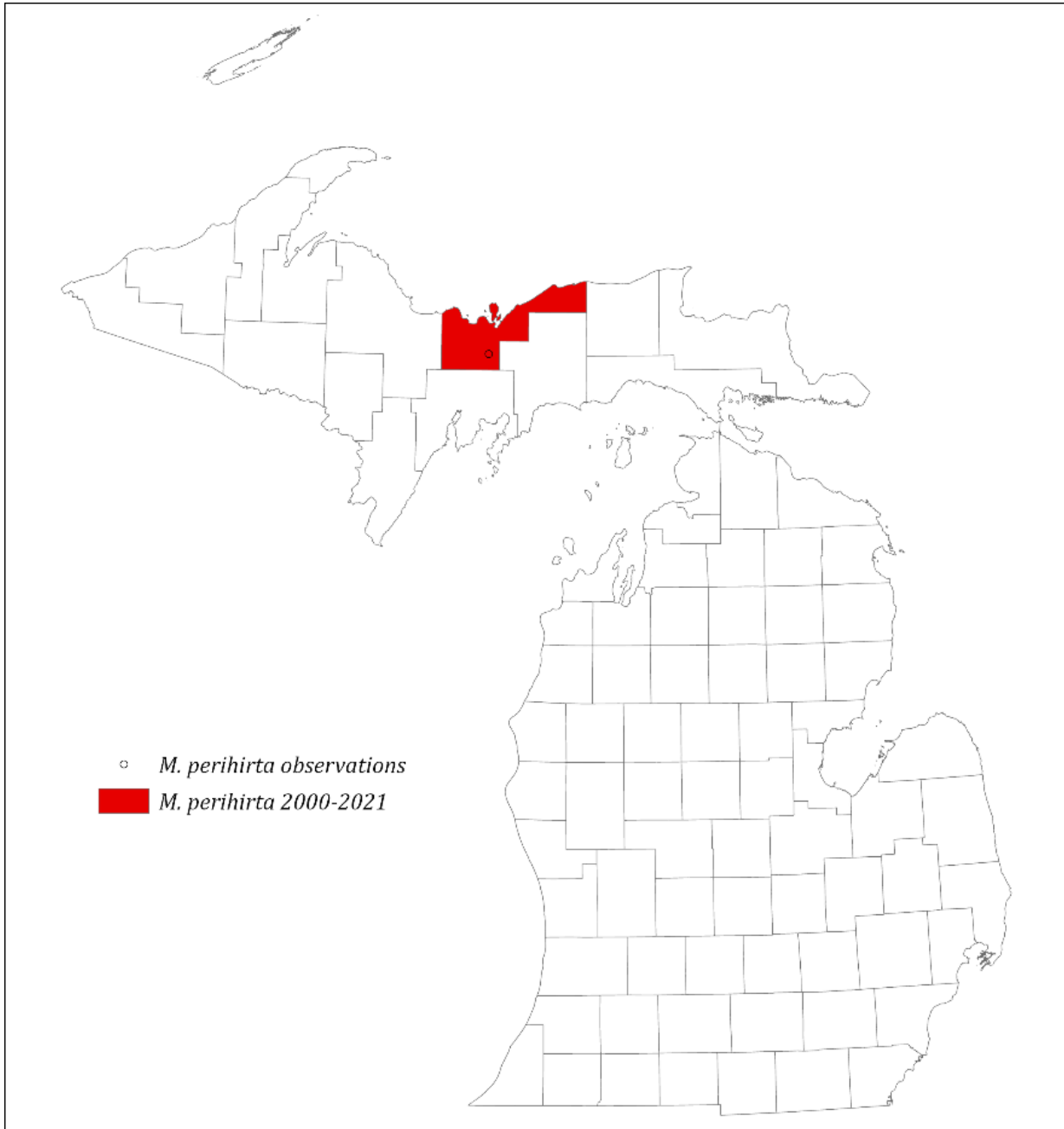
NatureServe Global and State Ranks: G5- Secure, SU- Species Status Unknown

Last Observed in Michigan: 2017

Estimated Spatial Increase/Decline (Historic – Current): +100% (No historic records)

Conservation Information: Ground nesting species. Very little information on this species in Michigan.

Associated Plant Species in Michigan: NA



Megachile petulans

Species Common Name: Petulant Leafcutter bee

NatureServe Global and State

Ranks: G5- Secure, S2- Imperiled

Last Observed in Michigan: 2017

Estimated Spatial Increase/Decline (Historic – Current): -33%

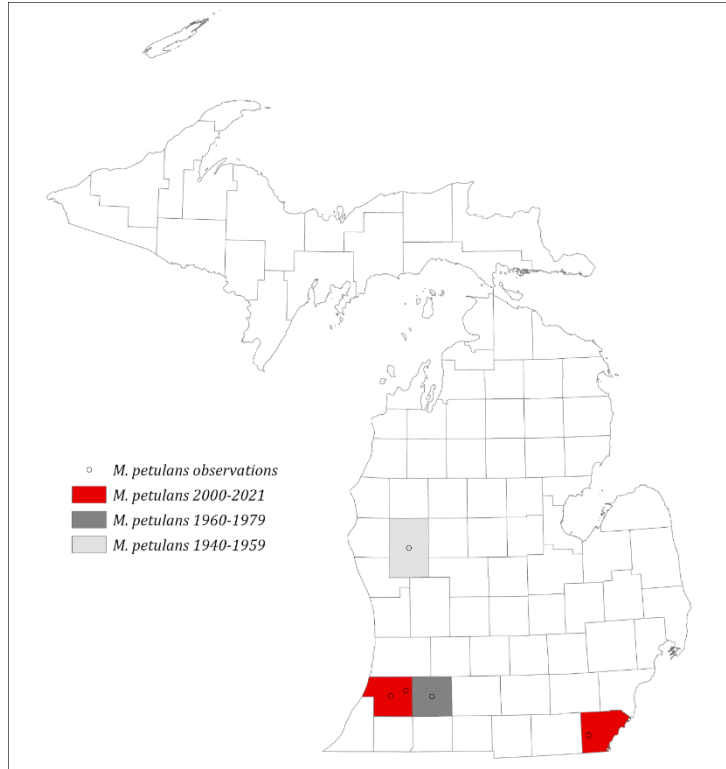
Conservation Information: Known from a few locations in southern Michigan. Species experiencing decline in Michigan.

Associated Plant Species in

Michigan: *Centaurea stoebe*,

Desmodium paniculatum, *Melilotus alba*,

Monarda fistulosa



Megachile pugnata

Species Common Name: Pugnacious Leafcutter bee

NatureServe Global and State

Ranks: G5- Secure, S5- Secure

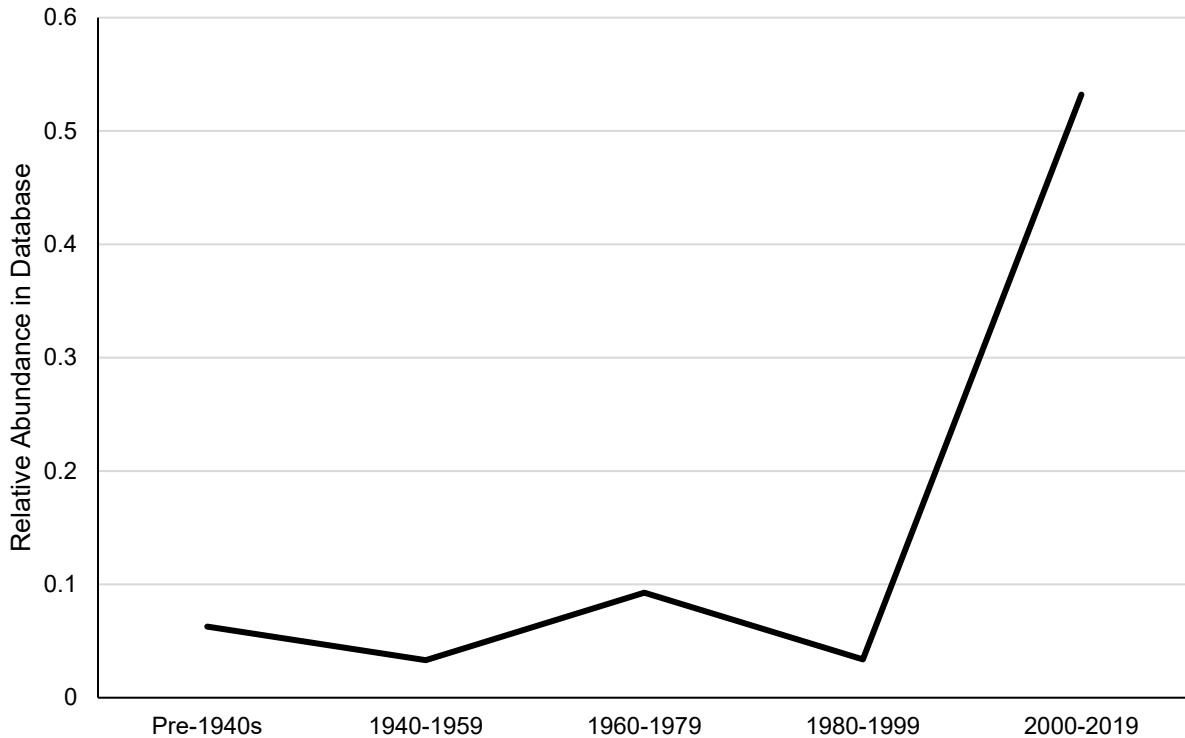
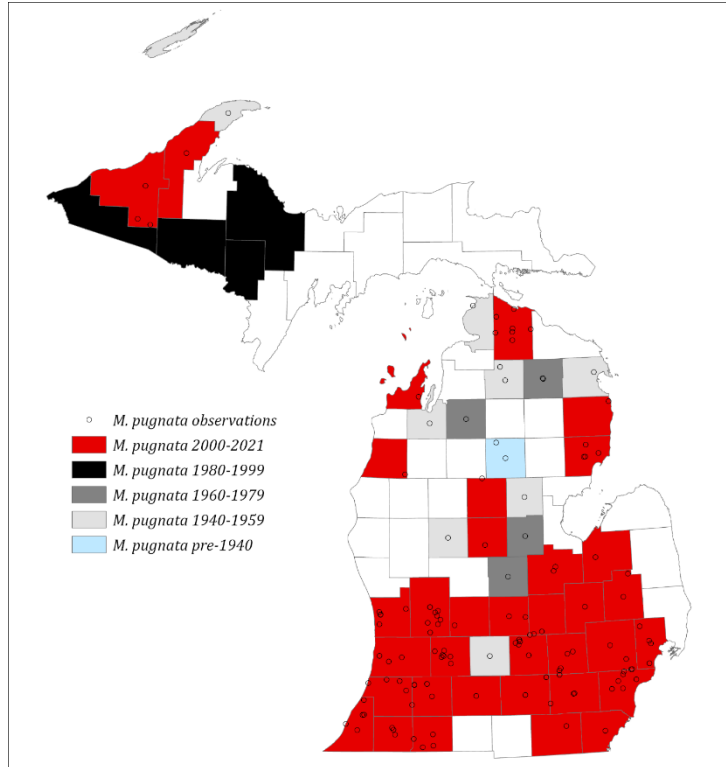
Last Observed in Michigan: 2021

Estimated Spatial Increase/Decline (Historic – Current): -3%

Conservation Information: Very common species in Michigan.

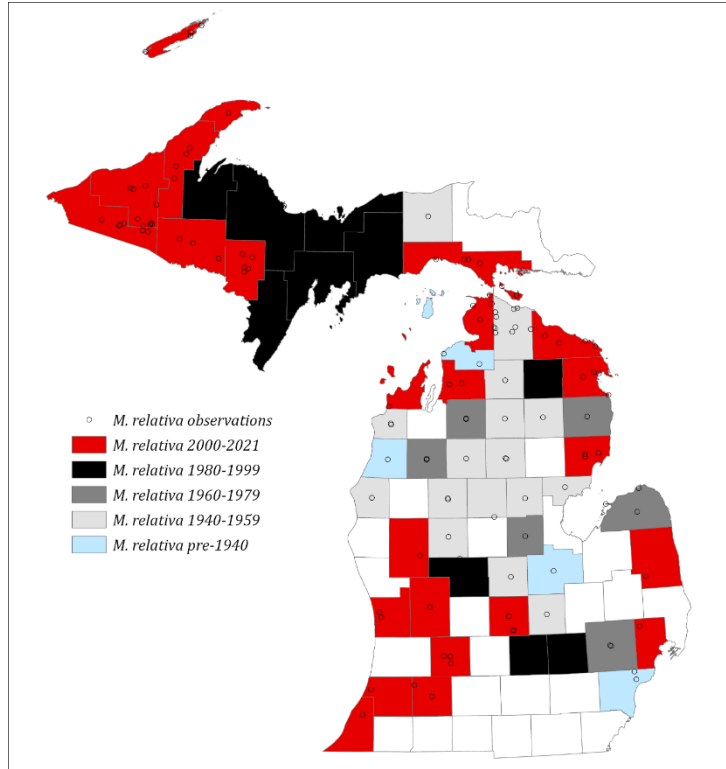
Populations widespread across the state. Populations seem to be increasing. Will readily nest in trap nests.

Associated Plant Species in Michigan: Specialist on Asteraceae.



Megachile relativa

Species Common Name: Relative Leafcutter bee
NatureServe Global and State Ranks: G5- Secure, S2S3- Imperiled to Vulnerable
Last Observed in Michigan: 2019
Estimated Spatial Increase/Decline (Historic – Current): -55%
Conservation Information: Historically very common, becoming increasingly rare in contemporary samples. Stem-nesting species.
Associated Plant Species in Michigan: Specialist on Asteraceae.



Megachile rotundata

Species Common Name: Alfalfa Leafcutter bee

NatureServe Global and State

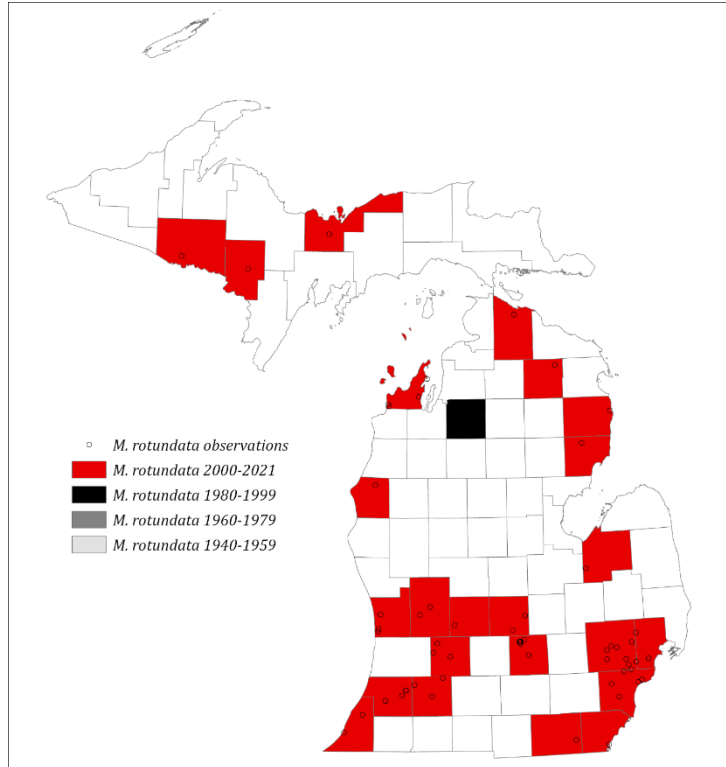
Ranks: G5- Secure, SNR- Exotic

Last Observed in Michigan: 2020

Estimated Spatial Increase/Decline (Historic – Current): +380%

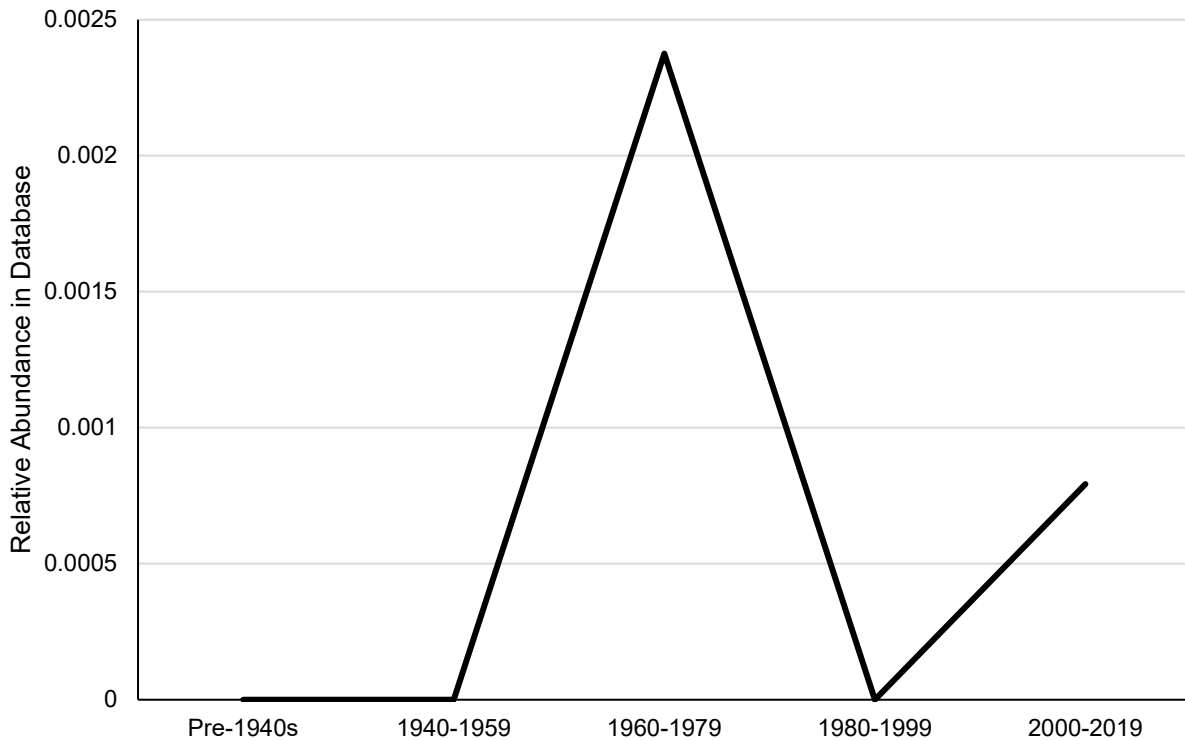
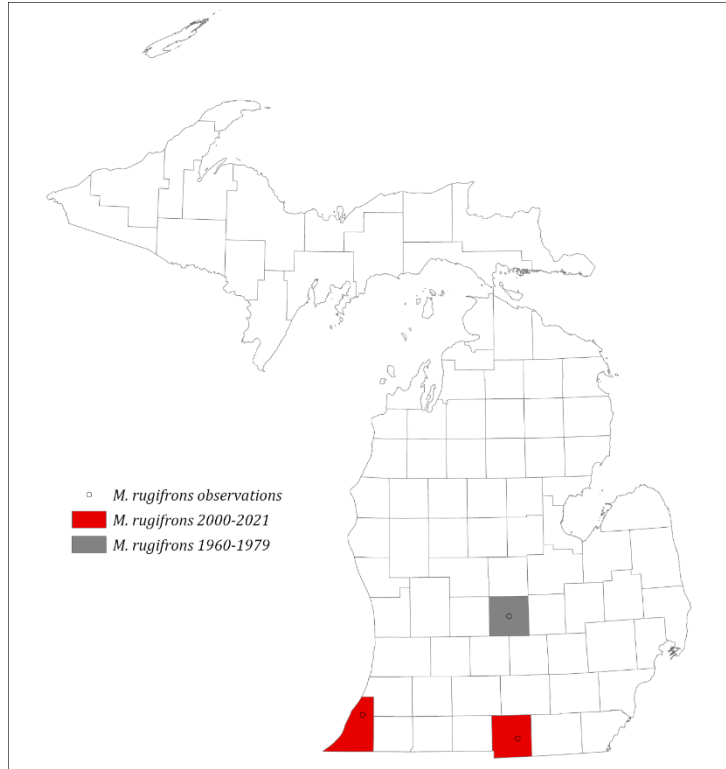
Conservation Information: Exotic species used for alfalfa production in the United States. Readily uses trap nests.

Associated Plant Species in Michigan: Generalist foraging.



Megachile rugifrons

Species Common Name: A
Leafcutter bee
NatureServe Global and State Ranks: G2- Imperiled, S2- Imperiled
Last Observed in Michigan: 2017
Estimated Spatial Increase/Decline (Historic – Current): +100%
Conservation Information: Species is represented by 3 occurrences. Michigan is on northern edge of species' range.
Associated Plant Species in Michigan: *Apocynum cannabinum*, *Lespedeza* sp.



Megachile sculpturalis

Species Common Name: Giant Leafcutter bee

NatureServe Global and State

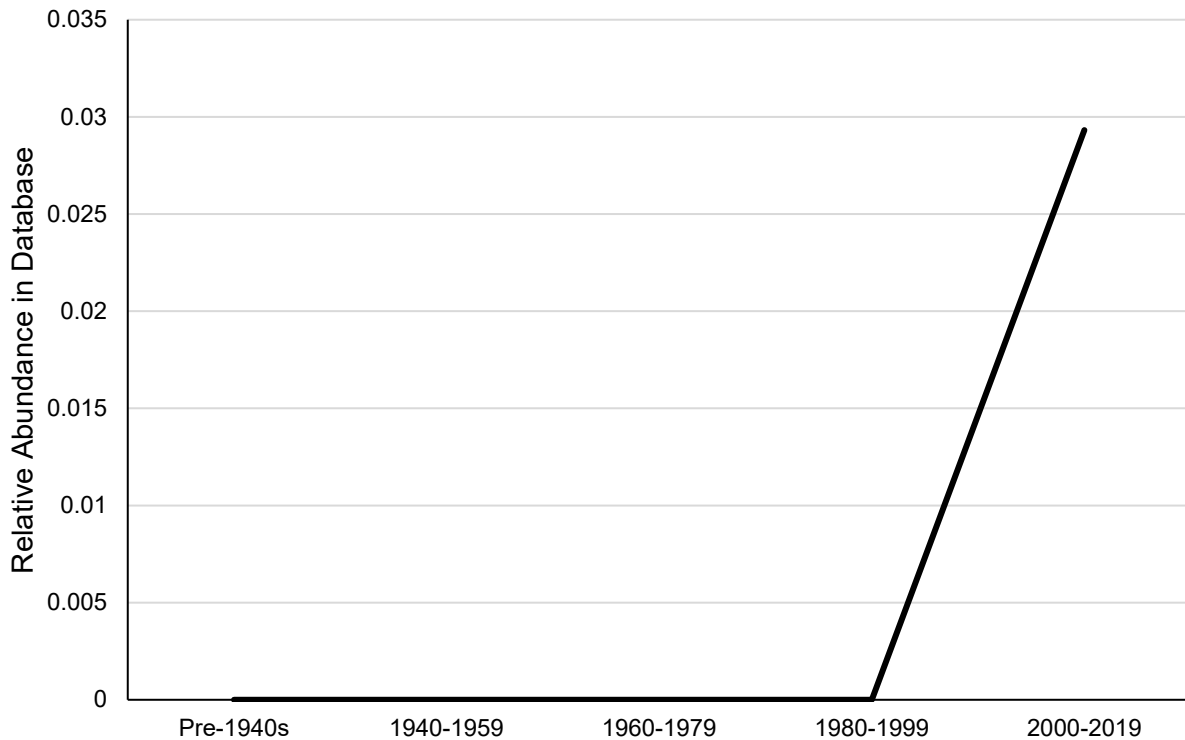
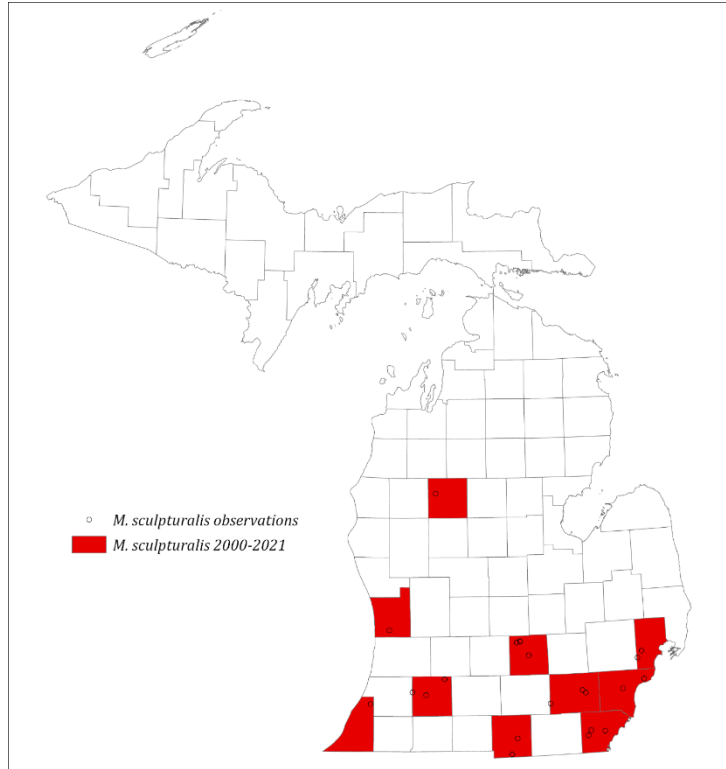
Ranks: G5- Secure, SNR- Exotic

Last Observed in Michigan: 2021

Estimated Spatial Increase/Decline (Historic – Current): +100% (No historic records)

Conservation Information: Species is exotic species from East Asia.

Associated Plant Species in Michigan: *Desmodium* sp., *Lythrum* sp., *Sophora* sp.



Megachile texana

Species Common Name: Texas Leafcutter bee

NatureServe Global and State

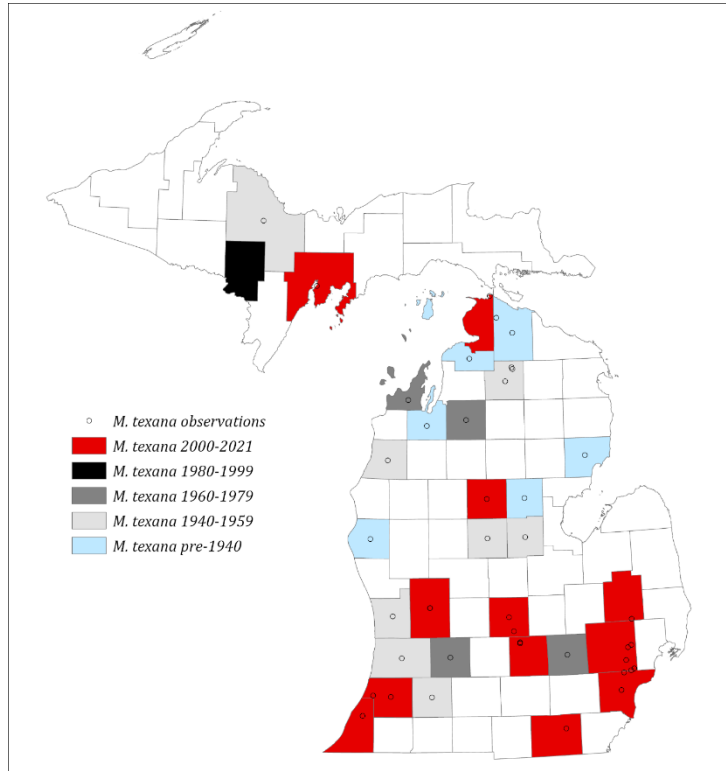
Ranks: G5- Secure, S3S4- Vulnerable to Apparently Secure

Last Observed in Michigan: 2021

Estimated Spatial Increase/Decline (Historic – Current): -48%

Conservation Information: A ground nesting species found throughout the United States. Michigan is in northern range for the species.

Associated Plant Species in Michigan: *Asclepias* sp., *Coreopsis* sp., *Lespedeza* sp., *Symphotrichum* sp.



Discussion

Documenting the spatial and temporal changes in a species' occupancy is a crucial step in determining a species' conservation status. In this report, we focused on the genus *Megachile*, and provided the first assessment of species diversity, distribution, and conservation status for species found in Michigan. The first major trend we found in this analysis is that the number of *Megachile* occurrences in the Michigan dataset has increased drastically over the last century, generally due to an increase in sampling effort. Sampling methodologies have also changed, with an increase in the use of bee bowls, blue vane traps, and stem nest boxes in contemporary study designs (Killewald et al. 2019, Graham et al. 2000, Tepedino & Portman 2021). It is difficult to parse out the effect of sampling methodology on species occurrence records in this study, but it is possible that the methodologies used during contemporary native bee collection bias the number of individuals collected of each species (Tepedino & Portman 2021). For example, in a study that used artificial stems to trap bees in bee boxes for data collection, one species of leafcutter bee (*M. pugnata*) dominated the community which utilized the available nesting resources (Graham et al. 2020). Interestingly, this species has experienced a drastic increase in database presence over the last few decades, possibly due to increased attraction to stem nesting boxes.

In this report, we provide evidence that species of leafcutter bees are experiencing variability in range changes in Michigan and identified a set of species likely experiencing range contractions. Most notably, *M. gemula*, *M. melanophaea*, *M. relativa*, and *M. lippiae* have each experienced at least a 50% reduction in their occupied range in Michigan when compared to historic distributions. Notably, multiple species have capture rates at concerning low frequencies throughout the last century of collections. These include *M. lapponica*, *M. lippiae*, *M. perihirta*, and *M. rugifrons*. The evidence suggests that these species have always occupied habitats in Michigan, albeit at low abundances. A single species, *M. dakotensis*, has not been discovered in the state since the 1960s and is likely extirpated from Michigan. The information presented here should be interpreted with caution, as species in this study do have diverse life-history stages which may influence capture rates and thus final estimates of occurrence and distributional changes. For example, species that are ground nesting are unlikely to be captured using trap nests. Therefore, for these species, our interpretation of population and spatial inference rely more heavily on standard aerial netting efforts. However, a set of these species could require conservation efforts to support their populations in Michigan.

Through our state conservation status rank assessments, we identified multiple species whose populations are 'Imperiled' in Michigan. These include *M. lippiae* (S1S2), *M. frugalis* (S2), *M. gemula* (S2), *M. petulans* (S2), and *M. rugifrons* (S2). These ranking decisions are attributed to concerning low occurrence numbers and/or evidence of ranged contractions compared to historic data. It's important to continue monitoring these species in the state to ensure that populations persist and do not become extirpated in the future. Directed conservation efforts may be needed to meet species population goals.

This project supports the Great Lakes Restoration Initiative Pollinator Task Force by assessing a new suite of native bee species in Michigan to prioritize conservation efforts. As the Task Force continues to prioritize the conservation of diverse wild bee community assemblages in the Great Lakes basin, it will become increasingly necessary to identify which species are in the greatest need of conservation through habitat restoration and/or targeted conservation programs. Building a broader dataset of species-specific statuses in the state will benefit the prioritization of limited resources and decrease the likelihood of extirpation of at-risk species.

Acknowledgements

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