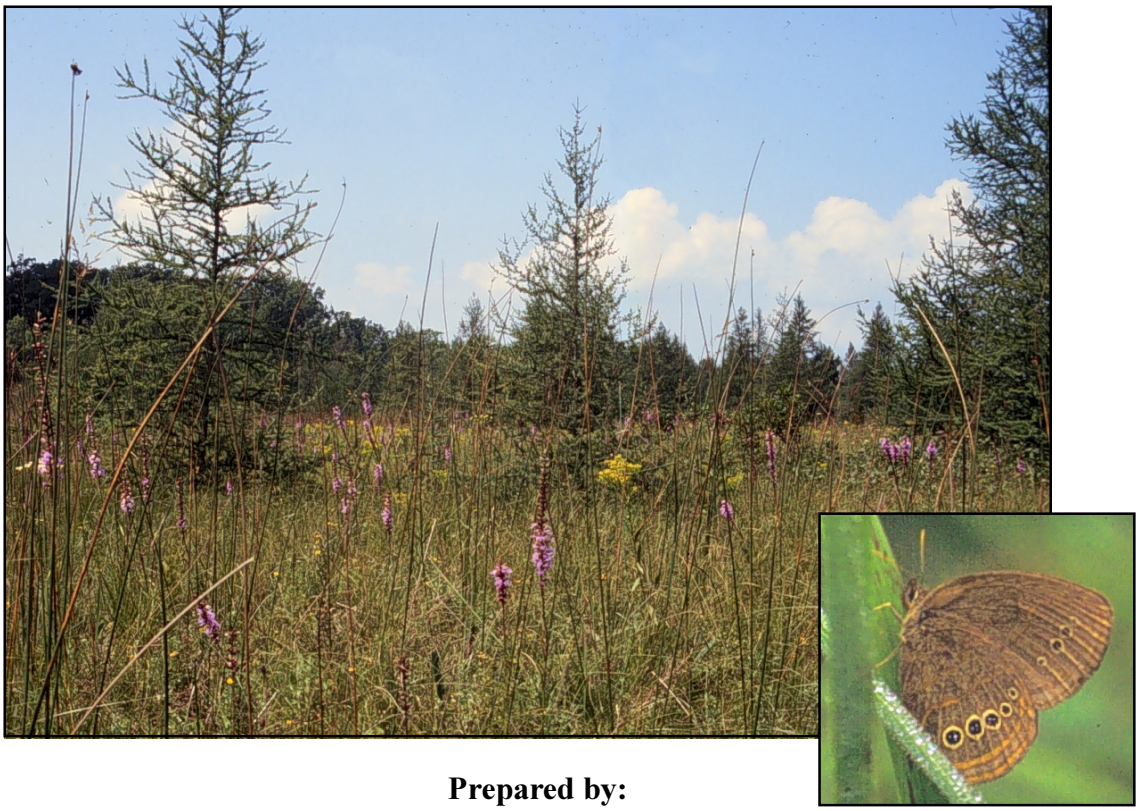
Surveys for the Recovery of Mitchell's Satyr Butterfly (*Neonympha m. mitchellii*) in Michigan: Final Report - 2000



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Federal Building, Fort Snelling
Twin Cities, MN 55111

Report Number 2001-05
Submitted March 31, 2001

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan Natural Features Inventory

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Introduction

Mitchell's satyr, *Neonympha mitchellii mitchellii* French, is a federally-listed endangered species now known from only 17 sites in southern lower Michigan and two sites in northern Indiana. The satyr was listed by the USFWS in 1992. To reclassify to federal threatened status, 16 geographically distinct populations or metapopulations must be established rangewide, including 12 in Michigan; to de-list, nine more populations must be established (U. S. Fish and Wildlife Service 1997). These populations must remain viable for five consecutive years following reclassification, which will require a valid, repeatable monitoring protocol. At least 15 of the 25 recovered populations also must be protected and managed for the benefit of this species. Currently, only nine occupied sites in Michigan are considered to have any potential to contain viable populations. Satyrs at the remaining sites typically occur in much lower numbers or the amount of suitable habitat is limited in size or by threats to the site, making their long-term viability uncertain.

Various factors have contributed to the decline of Mitchell's satyr; the most important may be the loss and disruption of suitable habitat. The known historical range for the species in Michigan, Ohio and Indiana coincides with prime agricultural area, and farming and other development activities have heavily impacted much of it. Wetland alteration or complete draining has resulted in the loss of the single known Ohio population of the butterfly, and several sites in Michigan (U.S. Fish and Wildlife Service 1997). Other alterations to hydrology include the removal of forest cover from adjacent uplands, drain tiling of adjacent fields, and ditch or drain maintenance. Road development has, in several cases, divided fens and changed water flow to the extent that former fen habitat has been converted to plant communities not suitable for the satyr.

Much of the species biology is largely unknown, although general accounts of closely related species (e.g. *N. m. francisi*, *Satyrodes eurydice*, *S. appalachia*, *Megisto cymela*) may be applicable. Observations of captive larvae by McAlpine et al. (1960), caged larvae by Legge and Rabe (1996), and larvae and pupae *in situ* by Szymanski (1999b) provide some insight into the species' basic biology and can be used to clarify protection and management goals. Several biologists, most recently Iftner et al. (1992), Legge and Rabe (1996), Rogers et al. (1992), Sferra and Darnell (1993), Szymanski (1999b), Hyde et. al. (1999 and 2000) and Clampitt (2000) have reported observations of adults. A recent summary of much of this information has been provided by Szymanski (1999a). Darlow (2000) contributes a detailed understanding of the behavior, habitat usage and oviposition of this butterfly in his work at two of the occupied satyr sites. Further studies of the butterfly's biology, behavior, and habitat use are essential to direct effective protection, management and recovery efforts.

Field studies will continue to be extremely difficult for this species because of its ephemeral nature and the fragility of its habitat. Survey work is limited to a single, short (two to three weeks) flight period each year. The species is difficult to observe even when it is known to occur at a site and, at low numbers, may be found only on an irregular basis. Consequently, our understanding of its biological and ecological requirements, habitat affinities, as well as subsequent development of recovery and management plans, will be slow to evolve.

Michigan Natural Features Inventory (MNFI) has been working to determine the status and distribution of the satyr in Michigan since the 1980s. Wilsmann and Schweitzer (1991) have summarized much of the early work. With support from the U.S. Fish and Wildlife Service surveys continued into the 1990s in attempts to locate new extant sites, reconfirm historical occurrences, and monitor the butterfly's presence at known locations (Federal Aid in Endangered Species, Michigan Projects E-1-24, E-1-25, E-1-26, E-1-28, E-1-29 and E-1-30).

In 1995 and 1996 MNFI ecologists conducted an analysis of historical habitat at Mitchell's satyr sites with financial support from the Frey Foundation. This project was an attempt to more clearly identify the critical habitat components of Mitchell satyr habitat, to improve the likelihood of locating additional extant populations and to better understand the present status and distribution of the species. Infra-red aerial photos from 1978, black and white aerial photos from 1938-40, and presettlement vegetation maps from 1816-1826 prepared by Comer et al. (1995), were examined for each of sixteen extant and extirpated satyr populations (MacKinnon and Albert 1996). Community types with potential for satyr habitat were mapped including wet prairie, emergent marsh, and tamarack swamp. Known sites and those sites where previous surveys were unsuccessful were mapped. Drainage systems that contained both satyr populations and probable satyr

habitat were examined and sites were prioritized for future surveys. This analysis resulted in the identification of nearly 100 sites with potential satyr habitat. Beginning in 1996, MNFI ecologists surveyed 30 sites within the larger watersheds containing known Mitchell's satyr populations. Their goal was to identify high quality prairie fens and other fen-associated elements. Ten of these sites had suitable Mitchell's satyr habitat and were revisited during the satyr summer flight period by both ecology and zoology staff. These surveys resulted in the discovery of two new Mitchell's satyr populations at Jackson County East and St. Joseph County East. Five others among the 10 suitable sites were recommended for additional surveys in 1997. In addition, zoology staff conducted Mitchell's satyr larval studies at Jackson County Central, an occupied fen complex (Legge and Rabe 1996). Also in 1996, the first meeting of the Mitchell's Satyr Working Group was held. The Group has provided a forum for a regular exchange of information between parties actively working on satyr recovery in Indiana and Michigan. This facilitates the coordination and cooperation of partners in the Midwest. The Group also has provided regular input to the Fish and Wildlife Service.

Continuing in 1997, MNFI staff surveyed a total of 39 sites in eight southern Michigan counties for Mitchell's satyr; no new occupied sites were found. Five of the sites visited were identified as having quality prairie fen communities present with potential satyr habitat, and were targeted for future surveys.

In 1998, MNFI began a three-year study with funding from the U.S. Fish and Wildlife Service. This report summarizes the work completed and highlights relevant findings. This project has allowed us to identify the most significant populations of *Neonympha m. mitchellii* in Michigan and assess their current condition including threats to existing populations and their habitat. We have identified potential sites that may be suitable for reintroduction or translocation efforts in order to meet recovery goals in Michigan. We have begun to collect information on associated rare species and now are in a better position to direct habitat management and restoration efforts for the satyr. We also have begun monitoring known populations, and accumulated 2-3 years of data on key sites.

During the 1990's, a consensus emerged within the international conservation community about the importance of planning and working at larger geographic scales to conserve biodiversity. In response, The Nature Conservancy (TNC) adopted the ecoregional approach and goal outlined in Conservation by Design: A Framework for Mission Success (The Nature Conservancy 1996). The Conservancy's conservation goal is the long-term survival of all viable native species and community types through the design and conservation of portfolio sites within ecoregions. "Portfolio" refers to the suite of sites within an ecoregion that would collectively conserve the native species and community types, called targets, found in that ecoregion. "Sites" are selected and defined on the basis of the targets' ecological requirements and threats. They can vary in size and may include different ownerships and land uses. Each portfolio is expected to include the number and distribution of sites needed to protect multiple, viable or recoverable occurrences that collectively maintain the genetic and ecological variation necessary for the long-term survival of the portfolio targets. Each site in the portfolio represents an area within which TNC or its partners can work at sustainable levels to conserve, or where necessary restore, the ecosystem patterns and processes that sustain the targets for which that site was selected.

The commitment of TNC to ecoregion-based conservation had several ramifications for the recovery of Mitchell's satyr. Most importantly, the Michigan and Indiana field offices of TNC have included all of the known, currently extant, Mitchell's satyr sites as portfolio targets in their ecoregional priorities. By developing partnerships and directing critical resources toward these sites, long-term conservation strategies will be developed and implemented. Over the long-term, by incorporating a plan for the Mitchell's satyr recovery into an ecosystem framework, larger scale processes such as hydrology and biotic community integrity will be restored and stresses to the wetlands essential for the satyr's survival will be reduced.

In an effort to reduce some of the immediate threats to satyr populations it is prudent to continue to focus conservation efforts on influencing local land use and land management decisions. Unfortunately, the 17 known Mitchell's satyr populations are located in small, isolated sites, spread across southern Michigan. This scattered distribution makes it challenging to develop long-term contacts with landowners, build strong relationships, and provide the necessary information and stewardship resources to protect the species. To accomplish this goal it may be most effective to work cooperatively with local land conservancies who can promote stewardship in areas with satyr populations. MNFI currently is working with the Southwest Michigan Land Conservancy (SWMLC) to develop and implement a comprehensive long-term

landowner contact and education program targeted towards the conservation of remaining Mitchell's satyr populations in southwest Michigan. Over the next three years we will provide them with information and expertise on the Mitchell's satyr as well as associated rare species such as the eastern massasauga rattlesnake (*Sistrurus c. catenatus*). This project is supported by the U.S. Fish and Wildlife Service (Federal Aid in Endangered Species, Michigan Project E-1-31).

A summary of work completed in 1998 and 1999, the first two years of the project, can be found in Hyde et al. 1999, Hyde et. al. 2000 and Kost 2000. Objectives for 2000, the final year of this project, are listed below. Activities related to Jobs 1.1, 1.2, 1.5, 2.1, 2.2, 3.1, 3.2, and 3.3 (in part) have been summarized in this report. Activities related to Job 1.3, 1.4 and 3.3 (in part) are reported in a MNFI report (number 2001-04) "Use of a GIS-based habitat model to identify reintroduction sites for Mitchell's satyr (*Neonympha m.mitchellii*) in Michigan."

Objectives of 2000, Year Three

Job 1.1. Conduct field surveys to identify *N. m. mitchellii* occurrences within the species known historical range in Michigan and in new habitat with potential to support the species.

Job 1.2. Conduct surveys for eggs, larvae and pupae to improve our understanding of satyr life history.

Job 1.3. Characterize habitat at occupied sites to use in identifying potential reintroduction or translocation sites.

Job 1.4. Identify potential reintroduction or translocation sites to meet recovery goals in Michigan.

Job 1.5. Survey for rare species associated with satyr habitat as time permits.

Job 2.1. Assess threats to *N. m. mitchellii* at all occupied sites, including habitat destruction, the presence of invasive exotic species, altered hydrology, and lack of landowner interest in managing for the species.

Job 2.2. Work with Michigan Satyr Working Group to develop and initiate a monitoring protocol for *N. m. mitchellii* occurrences and associated relevant species and habitat characteristics.

Job 3.1. Provide updated occurrence information to regulatory agencies, Natural Heritage BCD, ecoregional planning teams, landowner contact and private lands management programs, and other appropriate management, protection, and conservation projects.

Job 3.2. Identify ecosystems as conservation units around viable sites, incorporating objectives for other state and federally listed species and species of concern, and provide to relevant conservation and protection efforts.

Job 3.3. Consult with researchers, other experts, and the Michigan Mitchell's Satyr Working Group to discuss results and to determine the next steps for inventory, site assessment, and reintroduction or translocation efforts.

Methods

Landowner Contact

In the year 2000 a total of 118 individual landowners were contacted to request permission to survey their property for Mitchell's satyr and other fen associated species. This was a continuation of an intensive landowner contact effort initiated in 1996 as part of fen-related surveys funded by the Frey Foundation. Landowners were contacted by letter, telephone or in some cases by knocking on their door. Discussions with each landowner emphasized the importance of wetland communities, fens in particular, and the status of the Mitchell's satyr and other associated rare species. Photographs of the Mitchell's satyr butterfly, other butterflies which are often confused with the satyr, and prairie fen habitat were copied and laminated and used when talking with landowners and describing the butterfly and its habitat. Landowners were asked to sign an authorization form, indicating their permission for us to conduct surveys on their property and stating our intent to hold the landowner harmless from liability for personal injury or property damage claims in connection with our activities. Copies of landowner authorization forms were carried by scientists when conducting satyr surveys and then later kept on file for future reference. Follow-up letters were sent to all landowners that granted us permission to conduct surveys, thanking them for their cooperation and informing them of the results of the surveys. Landowners that had a prairie fen on their property were provided with information emphasizing the value of this natural community and outlining activities that

threaten fens and fen-associated plants and animals. Those individuals that had Mitchell's satyr on their land were informed of the status of the species and the significance of finding the satyr on their property. They were provided with information on how to manage their land in a way that will preserve or enhance the satyr's habitat and informed about activities that pose a threat to the satyr. Finally they were encouraged to contact us if they had any questions or concerns.

Mitchell's Satyr Surveys and Threat Assessment

Teams of two scientists conducted walk-through surveys of potential habitat during the satyr flight period. Surveys were conducted during optimal weather conditions, avoiding days that had significant wind or rain. Surveys were generally conducted in the late morning, late afternoon and early evening, avoiding the midday period. During the mid-day period satyrs tend to be more sedentary. Satyrs typically fly during a two to three-week period ranging from late June through mid-July. In 2000 the flight occurred from June 23 through July 20 (Clampitt pers. comm and Darlow pers. comm). Observers walked in a meandering pattern looking forward, to the sides, and behind to increase the likelihood that all butterflies were seen. Particular attention was paid to areas containing fine-leaved sedges growing in association with low growing shrubs and tamarack (*Larix laricina*), seeps and springs, and small openings along streams and between the shrubs. Adult Mitchell's satyr butterflies are most easily confused with the eyed-brown (*Satyrodes eurydice*), the Appalachian eyed-brown (*S. appalachia*), and the little wood satyr (*Megisto cymela*). The Mitchell's satyr was distinguished from these similar species by its characteristic slow, erratic and low flight pattern, its smaller size and darker coloration, and the number and arrangement of eye spots on the wings. Individuals were identified as they flew or rested and it was not necessary to capture butterflies with a net. Close-focusing binoculars were often used to aid in this identification and it was not necessary to capture butterflies with a net or handle them in any way. If a Mitchell's satyr was found, extreme care was taken to avoid trampling the vegetation in the event that eggs were present. Surveyors used existing game trails whenever possible to minimize impacts to the habitat.

Photographs of sites and the habitat occupied by the satyr were taken and when possible, photographs of adult satyrs were taken as well. A video camera was also used on one occasion to document an adult satyr nectaring on a flower.

A threat assessment was conducted at all occupied sites visited in 2000. by documenting current disturbances and noting potential threats. Threats may include: altered hydrology; off road vehicle (ORV) use; livestock grazing; shrub encroachment; development and land use changes; lack of landowner interest in managing for the satyr; point and non-point sources of pollution; or the presence of invasive species such as purple loosestrife (*Lythrum salicaria*), reed canary-grass (*Phalaris arundinacea*), glossy buckthorn (*Rhamnus frangula*), and cattails (*Typha* spp.). Management needs also were identified at this time.

An MNFI Mitchell's Satyr Survey Form was completed at each site where surveys were conducted for the butterfly. Recorded data included site information, land ownership, animal species observed, current disturbances, potential threats and detailed habitat descriptions (Appendix 1). In addition an MNFI Special Animal Form was completed for any listed animals that were observed. Similarly an MNFI Special Plant Form or MNFI Natural Community Form was completed when a listed plant or high quality natural community was documented. An MNFI Site Summary Form was completed for any newly discovered location occupied by a listed animal, listed plant or by a high quality natural community. Data were then entered into the MNFI Biological Conservation Database.

Surveys for Associated Rare Species

Observers were vigilant in searching for other rare plant and animal species while conducting Mitchell's satyr surveys at known or potential sites in 2000. Some rare animals and plants were found incidental to satyr behavioral observation work or vegetation sampling. Other listed species were targeted by conducting surveys at the most optimal time for their occurrence.

The state threatened poweshiek skipper (*Oarisma poweshiek*) occurs in prairie fen communities and its flight period overlaps (at least in part) with that of the satyr. Because of its affinity for nectaring on yellow flowers, surveyors carefully looked for this skipper on shrubs and plants, such as shrubby cinquefoil

(*Potentilla fruticosa*) and black-eyed-susan (*Rudbeckia hirta*), while conducting satyr surveys.

The state special concern swamp metalmark (*Calephelis mutica*, SC) is another fen inhabiting lepidopteran species. Its adult flight period also overlaps that of the satyr, however, it flies for an additional one to two weeks after the satyr flight ends. This species also shows an affinity for nectaring on yellow flowers so surveyors carefully looked for this butterfly on species such as black-eyed susan and shrubby cinquefoil. In addition, this butterfly exhibits moth-like flight behavior (flying and alighting under the surface of leaves) so surveyors walked through the fen looking for any lepidopteran which exhibited this behavior and occasionally tapped the stem of certain plants to potentially knock roosting butterflies from their perches. These surveys focused on areas with concentrations of the larval hostplant swamp thistle (Cirsium muticum). In addition a limited amount of time was spent looking for larval feeding damage on the thistles.

Targeted surveys were conducted for another insect associated with satyr habitat, the state special concern tamarack tree cricket (*Oecanthus laricis*, SC). Ten known satyr sites were surveyed including: Barry County South, Barry County Southwest, Branch County Site, Berrien County North, Berrien County South, Cass County Northwest, Cass County Southwest, Kalamazoo County North, St. Joseph County East and Van Buren County Northeast. In addition surveys for this species were conducted at several potential satyr sites in Allegan, Barry and Hillsdale counties. This species of tree cricket spends nearly its entire life in the branches of tamarack trees. During August we surveyed using a typical insect sweep net extended 10 feet in length by fastening a piece of 3/4-inch conduit onto the handle. This allowed surveyors to sample from the tops of small trees and from the upper branches of larger tamaracks. All tree cricket specimens were collected and returned to the laboratory where they were identified to the species level.

During September, black-light surveys were conducted for *Papaipema* moth species at three known satyr sites: Barry County South, Cass County Southwest (two different locations), and St. Joseph County East, as well as at another prairie fen site in Barry County. All black-light surveys began at sunset and continued until midnight. A tubular 15-watt DC black-light and 250-watt mercury vapor lamp were suspended from a rectangular aluminum frame 4.5 feet above the ground. A portable gas-powered generator powered the bulbs. A six foot by six foot white bed sheet was suspended on the aluminum frame that supported the black-light. The ultraviolet light illuminated the white bed sheet and insects attracted to the black-light frequently landed on the sheet. Individual insects were then collected in a killing jar saturated with ethyl acetate. Moths were later pinned, spread, and identified in the laboratory. The purpose of black-light surveys was to document suites of rare species of *Papaipema* that occur at known Mitchell's satyr sites. These data can then be compared to *Papaipema* species assemblages at potential satyr reintroduction sites.

Surveys for the Blanchard's cricket frog (*Acris crepitans blanchardii*, SC) were conducted in early July at five known satyr sites including: Barry County South, Barry County Southwest, Cass County Northwest, Kalamazoo County West and Van Buren County Northeast. In Michigan, cricket frogs usually emerge from hibernation in late March or early April, and breed from late May through mid-July. During the breeding season, the males give a distinctive call which consists of a series of metallic clicks, similar to the sound made when two pebbles are tapped together. Sites were surveyed by listening for calling males in the evening during the breeding season. At each site, surveyors recorded all frog and toad species that were heard, and provided an estimate of the number of calling males and a call index for each species (1- indicating separate, distinct calls; 2 - indicating overlapping calls, and 3 - indicating a full chorus). Surveyors also recorded the general habitat type and condition (e.g., area developed, little habitat available) of each site, weather conditions, and time of survey.

Surveys for the eastern massasauga rattlesnake (*Sistrurus c. catenatus*, SC), were conducted at all occupied satyr sites while doing surveys for the satyr and other associated species in June, July, August and September. Massasaugas are usually active between April and late October. Although daily activity cycles appear to vary widely, they tend to be the most active during the warmest parts of the day in spring and fall. In the summer months they typically shift their activity periods to the cooler parts of the day and may even become nocturnal (Seigel 1986). Surveys for this species are difficult. When they are threatened, eastern massasaugas will typically remain motionless, relying on their cryptic coloration to blend into their surroundings. They are often difficult to see in the vegetation that occurs in their preferred wetland habitats. Thus, surveys are usually conducted by simply walking through suitable habitat during the time of the

year and time of the day when they are likely to be most active. During the numerous visits to occupied, and potential satyr habitat that occurred between June and September, surveyors were always looking for massasaugas.

Mitchell's Satyr Monitoring

As a result of the 1996 Mitchell's Satyr Working Group meeting (see Acknowledgements) individuals from this group met on May 24, 1997 to discuss monitoring needs for the Mitchell's satyr. At that time it was agreed that Pollard transects conducted during the Mitchell's satyr flight period were the preferred method for monitoring this species (Pollard and Yates, 1993). The group also discussed a variety of factors that likely affect the number of adults seen during a Pollard walk and recognized the need to evaluate these factors. The group also identified priority sites where monitoring activities would be initiated. Monitoring was conducted at these sites in 1997, and 1998. In a working group meeting on February 24,1999, members agreed to re-evaluate the effectiveness of Pollard counts and to think about using a different technique, potentially a timed area search (meander survey). Members agree to do both a Pollard count and timed area search at several sites in 1999 to evaluate the effectiveness of the Pollards and develop an index relating satyr numbers to the Pollard counts. On January 19, 2000, the Working Group determined that it was important to conduct meander surveys at occupied sites on more than one occasion during the field season to more effectively monitor these populations. It was decided that visiting sites three times during the flight period and conducting timed meander surveys would provide valuable data on the distribution and number of butterflies and would help determine long-term site viability as well as reflect the impacts of various management activities.

Nine known occupied sites were monitored by MNFI staff in 2000 to assess the distribution and population status of the satyr using timed meander surveys. These sites include: Barry County South, Barry County Southwest, Branch County Site, Cass County Southwest, Kalamazoo County North, Kalamazoo County West, St. Joseph County East, Van Buren County Northeast, and the newly rediscovered Washtenaw County West. Staff at the Michigan Field Office of The Nature Conservancy conducted timed meander surveys at five occupied satyr sites including: Cass County East, Jackson County Central, Jackson County East, Jackson County West and St. Joseph County West. In addition, Pollard transect surveys were continued at Cass County East and Jackson County Central. An MNFI Satyr Survey Field Form (Appendix 1) was completed for each site visit. Assessments were conducted at these sites to document current and potential threats and to identify management needs. The results of these assessments are addressed in the site summary section of this report. In addition, Neil Darlow, a graduate student working with the USFWS, conducted behavioral observations, Pollard transects and meander surveys at Berrien County North and Berrien County South during the 2000 field season.

Michell's Satyr Oviposition Observations and Larval Searches

One of the goals of our 1999 and 2000 work was to better document female satyr concentration areas and to test the methodology of observing satyr oviposition under field conditions. These tasks will become increasingly important as we move toward actively managing satyr occupied fens. Females were distinguished from males based on their larger average size, lighter coloration, and characteristic flight (males tend to be much more active, with females rarely seen in undisturbed flight) (Shuey pers. comm).

Four sites (Cass County Southwest A, Cass County Southwest B, Barry County South, and Branch County) which had an especially high number of females were re-visited during the second full week of the satyr flight. Over a four-day period a total of 26 person hours was spent observing several different female satyrs in hopes of observing oviposition. When oviposition was observed, these locations were marked with wire flags and photos were taken of the eggs on the oviposition host. Representative plants that looked identical to the oviposition host were vouchered for identification purposes.

A limited amount of time (8-10 person hours) was spent in September 1999 searching the sedges and grasses that were in close proximity to known oviposition sites. Two techniques were used to look for

larvae including searching sedges for feeding damage and actually looking for early instar larvae on individual sedges. All oviposition sites and female concentration areas documented in 1999 were visited to search for satyr larvae during a one-week period in May of 2000. A total of 48 person hours were spent in the field actively searching for larvae.

Results and Discussion

Landowner Contact

Of the 118 landowners contacted in 2000, 99 granted us permission to survey their property. In 1999, 80 landowners were contacted and 62 granted us permission to survey their property. In 1998, 100 landowners were contacted and 79 of these granted us permission to conduct surveys. We were very pleased that over the three-year period, 80% of landowners that were contacted provided us access to their land. This suggests that many people in southern Michigan are interested in learning more about the plants and animals that occur on their property and are willing to cooperate, at least to some degree, with organizations whose mission is to conserve biodiversity. The majority of the 23 landowners who were told that they have the Mitchell's satyr on their property responded either positively or had a neutral response. This is contrary to the notion that most people will have an adverse reaction if they learn they have an endangered species on their property. Many individuals were pleased to learn that they have the satyr and were genuinely supportive of efforts to preserve the species and its habitat. Nurturing positive relationships with private landowners and promoting their stewardship of the butterfly will continue to be very important for the recovery of this species.

Mitchell's Satyr Surveys and Threat Assessment

In 2000 MNFI zoology and ecology staff surveyed a total of 28 sites, involving 77 different landowners in 11 southern Michigan counties, for the Mitchell's satyr and associated species. Sites ranged in size from less than one acre to greater than 100 acres. Twenty-three landowners had satyrs on their property, 21 landowners had prairie fen but no satyrs were found, and 33 landowners did not have prairie fen habitat on their land. We were unable to visit 22 properties in 2000 due to time constraints.

The Mitchell's satyr was reconfirmed at one historical satyr site, Washtenaw County West in 2000, despite unsuccessful surveys in previous years. Satyrs were last documented at this site in 1958. Surveyors documented the satyr at the historical site, although most of the butterflies were found on adjacent land located to the west. This site consists of very small prairie fen openings located along a stream on private land owned by three different individuals. All of these landowners are supportive of our efforts to conserve this butterfly and its habitat. More information about this site is included in the site summaries section of this report. We did not reconfirm the satyr at two other historical sites, Kalamazoo County East and the Lenawee County Site. Surveys at the Branch County Site resulted in the identification of additional areas of occupied habitat within the same drainage.

Personnel from the Michigan Field Office of The Nature Conservancy reconfirmed the satyr at Jackson County West. Satyrs were last seen at this site in 1994, while conducting a roadside survey. This year is the first time that landowner permission has been secured so that appropriate habitat could be thoroughly surveyed. The site contains over a hundred acres of herbaceous wetland, most of it sedge meadow. Satyrs were observed in a small fen consisting of less than 10 acres. No satyrs were seen in the sedge meadow. TNC staff also reconfirmed the satyr at Jackson County East. Satyrs were observed here for the first time in 1996 and permission for surveys had not been granted again until this year. Satyrs were observed in scattered fen openings at this site, which unfortunately is heavily overgrown with invasive species. Information about these two sites can be found in the site summaries section of this report.

In 1999 MNFI staff surveyed a total of 30 sites involving 55 landowners in 12 southern Michigan counties. In 1998 a total of 32 sites on 54 different properties were surveyed in eight counties. Over the past three years, as a result of our efforts, a total of 75 sites involving 151 landowners have been surveyed for the Mitchell's satyr. Some of these sites, particularly those occupied by the satyr, were visited during more than one year of the study. Of the sites surveyed, 15 (35 landowners) were visited multiple years.

In 1996 MNFI ecologists identified 97 sites that had some potential for prairie fen. Survey sites were ranked initially based on their probability of containing a high quality fen complex. As the project evolved and botanists, ecologists and zoologists continued to conduct field surveys, 45 additional sites with potential for prairie fen and Mitchell's satyr were identified. Many of these sites were considered to be of higher priority than some of the sites originally identified. As a result, 97 out of the 142 sites identified by MNFI ecologists as having potential for prairie fen were surveyed. The majority of high priority sites have been surveyed completely. The remaining sites were not surveyed for a number of reasons. Twenty eight of the remaining 45 sites were ranked as a low priority for surveys as the result of further aerial photo interpretation. Landowner permission was denied at most of the remaining fen complexes. In addition, our strategy shifted in the latter years of this project to spend more time monitoring populations at known sites and expanding our knowledge of these sites and the surrounding areas. As a result additional occupied habitat was found at six of the occupied sites. A summary of sites surveyed during the last three years is provided in Table 1.

Table 1. Summary of sites surveyed for the Mitchell's satyr: 1998-2000.

County	# Sites visited in 1998	# Landowner properties visited in 1998	# Sites visited in 1999	# Landowner properties visited in 1999	# Sites visited in 2000	# Landowner properties visited in 2000
Allegan	0	0	1	1	0	0
Barry	4	2	2	1	3	1
Berrien	0	0	0	0	2	2
Branch	7	11	2	2	1	5
Calhoun	0	0	1	2	0	0
Cass	4	5	7	16	7	24
Hilldale	5	10	2	4	1	1
Jackson	4	9	1	1	3	7
Kalamazoo	5	12	4	11	2	8
Kent	0	0	1	1	0	0
Lenawee	2	2	1	5	1	2
Oakland	1	1	0	0	0	0
Ottawa	0	0	1	1	0	0
St. Joseph	0	0	0	0	3	14
Van Buren	0	0	7	10	2	4
Washtenaw	0	0	0	0	3	8
Total	**32**	**52**	**30**	**55**	**28**	**77**

* Some sites received multiple visits.

In Michigan, the Mitchell's satyr is found within prairie fen and along the margins of associated, adjacent communities such as sedge meadow, shrub-carr, and tamarack swamp. Considered rare (G3,S3) both globally and locally, prairie fens in Michigan are restricted to the interlobate region of the southern Lower Peninsula where massive, glacial ice sheets deposited large moraines of sand and gravel (Albert 1995). The lower slopes of these porous moraines leak calcium and magnesium rich groundwater, which creates a unique environment suitable to only a select group of species. The Mitchell's satyr appears to be restricted to this specialized ecosystem. However, its range in Michigan occupies only a portion of the area in which prairie fens occur (Kost 2000). Figure 1 depicts the areas where we have conducted surveys for the Mitchell's satyr over the past three years. Areas surveyed that contained prairie fen communities are distinguished from areas that did not contain fens. The map shows the counties where the 17 known satyr sites occur along with the three extirpated sites. In each county there is a number, which depicts the total number of occupied satyr sites that occur in that county.

Future survey work should focus on expanding searches in potential habitat near occupied sites and historical sites. This is especially important in the vicinity of newly discovered or rediscovered sites. Although the probability of finding new sites is small, the surveys could be useful in identifying complexes that have high potential as satyr reintroduction sites.

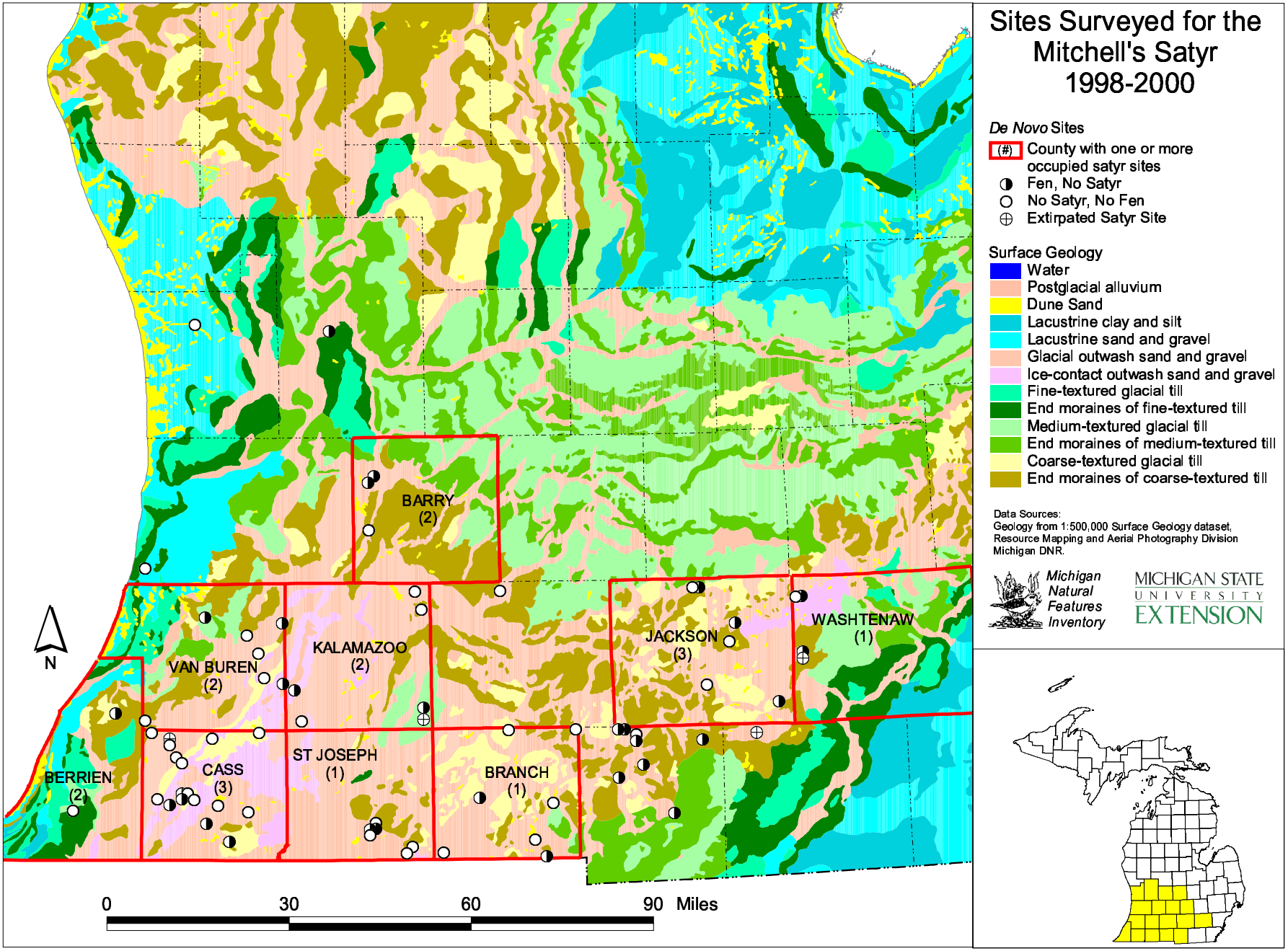

Figure 1. Sites surveyed for the Mitchell's satyr 1998-2000.

Surveys for Associated Rare Species

During Mitchell's satyr surveys in 2000, other rare species were confirmed at eight of the occupied satyr sites. The eastern box turtle (*Terrapene c. carolina*, SC), was newly documented at Barry County South, Barry County Southwest, Cass County Southwest, Kalamazoo County West, St. Joseph County East and Van Buren County Northeast. The eastern box turtle was reconfirmed again in a location at the Cass County Southwest Site where it was seen in previous years. The tamarack tree cricket was recorded for the first time at four sites: Branch County Site, Cass County Northwest, Cass County Southwest and St. Joseph County East. The blazing star borer moth (*Papaipema beeriana*, SC) was newly documented at Cass County Southwest. The golden borer moth (*Papaipema cerina*, SC) was recorded for the first time at St. Joseph County East. The marsh wren (*Cistothorus palustris*, SC) was documented at St. Joseph County East and the cut-leaved water parsnip (*Berula erecta*, T) was recorded at Kalamazoo County West.

In 2000, rare species also were documented while conducting Mitchell's satyr surveys in areas adjacent to known sites and in new areas with potential for satyr habitat. One federal candidate species, the eastern massasauga rattlesnake was found at a location in Barry County. In addition, the regal fern borer moth (*Papaipema speciosissima*, SC) was also documented from this same site. The prairie Indian plantain (*Cacalia plantaginea*, SC) was found during surveys at another location in Barry County. A pair of ospreys (*Pandion halieatus*, T) was observed on an artificial nesting platform at a site in Berrien County.

The results of this project are significant not only for documenting the distribution of the Mitchell's satyr but also for the discovery of rare plants, animals and exemplary natural communities. Between 1998 and 2000 a total of 44 new plant, animal and community records were documented as a result of this project (See Table 2.). Most of the newly documented plants and animals are associated with prairie fens. Ten new prairie fen records were added to the database. Five of these sites are prairie fens that were newly discovered during this project. The other five sites are prairie fens associated with known satyr sites. These fens were evaluated by an ecologist and were determined to be of high enough quality to be included in the database. The co-occurrence of associated rare species is often thought to be an indication of more intact landscapes and natural processes. Sites with more species, therefore, may have greater potential for long-term viability. This information should be useful in future evaluations of site potential for the introduction and establishment of new Mitchell's satyr populations to meet recovery goals.

Abstracts for many of these species can be found in Appendix 2 including: prairie Indian plantain, small white lady's-slipper (*Cypripedium candidum*, T), Blanding's turtle (*Emydoidea blandingii*, SC), blazing star borer moth, eastern box turtle, eastern massasauga rattlesnake, Mitchell's satyr, spotted turtle (*Clemmys gutatta*, T) and prairie fen. Additional species associated with prairie fens and included as abstracts in Appendix 2 are: mat muhly grass (*Muhlenbergia richardsonis* T), prairie dropseed (*Sporobolus heterolepis*, SC), Blanchard's cricket frog, culver's root borer moth (*Papaipema sciata*, SC), red-legged spittlebug (*Prosapia ignipectus*, SC), and Silphium borer moth (*Papaipema silphii*, T). These abstracts, many of which were produced as part of this project, are a helpful educational tool and were provided to managers and landowners who had these species on their property or who expressed and interest in learning more about them. They are available on our website at: http://www.dnr.state.mi.us/wildlife/Heritage/Mnfi/default.htm.

New abstracts for other rare plants, animals and high quality natural communities are continually added to our website as they become available. All educational resources, including abstracts and photographs, will be made available to future partners working to conserve the Mitchell's satyr and prairie fen habitat in Michigan.

Despite the number of new plant, animal and community records that were documented, it is important to note that surveys for associated rare species were not the prime objective of this project, which focused mainly on surveys for Mitchell's satyr. At this time, we do not consider these surveys to be completed. More work is needed at occupied satyr sites to identify the distribution and status of many other fen-associated species, especially the eastern massasauga, Kirtland's snake, spotted turtle, Poweshiek skipper, spittlebugs and *Papapeima* moths.

Table 2. Newly documented occurrences of animals, plants and high quality natural communities identified as part of the Mitchell's satyr project, 1998-2000.

Species	Scientific Name	Survey Site	Status-State (Federal)
Plants			
Cut-leaved water parsnip	*Berula erecta*	Kalamazoo County North	SC
Cut-leaved water parsnip	*Berula erecta*	Kalamazoo County West	SC
Prairie Indian plantain	*Cacalia plantaginea*	Horseshoe Lake - Barry Co.	SC
Prairie Indian plantain	*Cacalia plantaginea*	Cass County Northwest	SC
Prairie Indian-plantain	*Cacalia plantaginea*	Van Buren County Northeast	SC
White lady's-slipper	*Cypripedium candidum*	Waldron Fen - Hillsdale Co.	T
Insects			
Angular spittlebug	*Lepyronia angulifera*	Barry County South	SC
Blazing star borer moth	*Papaipema beeriana*	Cass County Southwest	SC
Golden borer moth	*Papaipema cerina*	St. Joseph County East	SC
Mitchell's satyr	*Neonympha m. mitchellii*	Van Buren County Northeast	E (E)
Regal fern borer moth	*Papaipema speciosissima*	Hall Lake - Barry Co.	SC
Regal fern borer moth	*Papaipema speciosissima*	Hall Lake - Barry Co.	SC
Tamarack tree cricket	*Oecanthus laricis*	Barry County South	SC
Tamarack tree cricket	*Oecanthus laricis*	Barry County Southwest	SC
Tamarack tree cricket	*Oecanthus laricis*	Branch County Site	SC
Tamarack tree cricket	*Oecanthus laricis*	Cass County Northwest	SC
Tamarack tree cricket	*Oecanthus laricis*	Cass County Southwest	SC
Tamarack tree cricket	*Oecanthus laricis*	St. Joseph County East	SC
Reptiles			
Blanding's turtle	*Emydoidea blandingii*	Kalamazoo County West	SC
Eastern box turtle	*Terrapene c. carolina*	Barry County South	SC
Eastern box turtle	*Terrapene c. carolina*	Barry County Southwest	SC
Eastern box turtle	*Terrapene c. carolina*	Cass County Southwest (3 sites)	SC
Eastern box turtle	*Terrapene c. carolina*	Kalamazoo County West	SC
Eastern box turtle	*Terrapene c. carolina*	St. Joseph County East	SC
Eastern box turtle	*Terrapene c. carolina*	Van Buren County Northeast	SC
Eastern massasauga	*Sistrurus c. catenatus*	Van Buren County Northeast	SC (C)
Eastern massasauga	*Sistrurus c. catenatus*	Hall Lake- Barry Co.	SC (C)
Spotted turtle	*Clemmys guttata*	Jeptha Lake Fen -Van Buren Co.	T
Spotted turtle	*Clemmys guttata*	Palmer Preserve - Kalamazoo Co.	T
Birds			
Marsh wren	*Cistothorus palustrus*	St. Joseph County East	SC
Osprey	*Pandion halieatus*	Mills Lake-Berrien Co.	T
Natural Communities			
Prairie Fen		Campbell Creek -Van Buren Co.	
Prairie Fen		Horseshoe Lake Fen - Barry Co.	
Prairie Fen		Kalamazoo County West	
Prairie Fen		Lost Nation SGA - Hillsdale Co.	
Prairie Fen		N. Br. Pokagon Cr.- Cass Co.	
Prairie Fen		67th Ave. Fen - Van Buren Co.	
Prairie Fen		St. Joseph County West	
Prairie Fen		St. Joseph County East	
Prairie Fen		Van Buren County Northeast	
Prairie Fen		Washtenaw County West	
Relict Conifer Swamp		Spruce Lake- Washtenaw Co.	

Monitoring Mitchell's satyr populations is important for a number of reasons. It is a useful tool that allows for the comparison of the numbers of butterflies recorded at different sites under different conditions. Monitoring also may help in determining how the abundance of this butterfly changes over time at a single location. It should help in assessing management needs as well as the impacts of management activities at satyr sites. It may over time provide a reasonable estimate or baseline of the population, useful when developing "safe harbor" agreements with landowners. Finally, it will assist in determining the long-term viability of satyr populations at each occupied site. It is difficult to determine when a population is no longer extant at a site. Are five or ten years of negative survey information enough to determine that a population has become extirpated? One particular study (Shuey, pers. com.) relocated satyrs at a small site after an 8-year absence even though it had been surveyed every year between the sightings. Thus regular, effective monitoring is critical in helping to assess population status and to guide conservation activities for this species.

There can be considerable variation in flight times between years and between sites. During 1997 the flight occurred between July 7 and July 30. In 1998, 1999, and 2000 the flight occurred earlier, beginning June 23- 24 and ending July 15-20. It is critical to find one or more reference populations and to have someone monitor the site (or sites) closely so we can determine the beginning of the adult flight period each year.

Over the past five years we have attempted to devise the best methodology for monitoring adult satyr populations at occupied sites and have learned much in the process. It is clear that different monitoring techniques yield different numbers of butterflies and that there are pros and cons for each method. It is still unclear which method is the best technique for monitoring this elusive species. There are multiple variables that can impact a surveyor's ability to detect satyrs including temperature, humidity, wind, vegetation structure, sex of the butterfly, time of day, time of the flight period and especially pre-conceived ideas of what is considered potential habitat. These variables must be taken into account and factored into our analysis. It is important to clearly define the goal of monitoring at the onset of implementing a monitoring program to assess the best method for achieving this goal. The Mitchell's Satyr Working Group will continue to discuss this issue and refine the various methodologies as appropriate.

Beginning in 1997, Pollard transects were established and walked at a number of occupied sites in an effort to develop a monitoring protocol for this species and to learn more about the life history and habitat requirements of the Mitchell's satyr. The Michigan Chapter of The Nature Conservancy established Pollard transects through portions of occupied habitat at Cass County East, Cass County Southwest, Jackson County Central, St. Joseph County East, and St. Joseph County West. This effort continued in 1998, 1999, and 2000 and is summarized in the final reports submitted to the USFWS for these years. (Summerville 1997, Clampitt and Summerville 1998, Clampitt and Krueger 1999, Clampitt, 2000). In addition Pollard transects were established at Berrien County North and Berrien County South and walked in 1997, 1998, 1999, and 2000. These results are summarized in Szymanski (1998, 1999b and 2000).

The benefits of Pollard transects are that they are repeatable, the method can be learned readily, they are not time intensive and the data can be compared easily between years with little subjectivity. Pollard transects may be valuable over time but may have lower sensitivity to changes in the short term. For now, they are probably not as useful in obtaining estimates of population size or in monitoring trends when compared with other methods for this species given the small numbers of satyrs observed on transects and the variation in patch occupancy by the satyr between years at a given site. The maintenance required to set up the transects each year is time intensive and it could be argued that this time might be better spent conducting searches for the satyr (Clampitt pers comm.).

Szymanski (1999a) examined the population structure and habitat use of the Mitchell's satyr at Berrien County North and Berrien County South using mark-release-recapture (MRR) methods in 1997 and 1998. Szymanski (2000) reported the MRR study to be useful in determining how butterflies disperse between and within habitat patches at the two occupied sites where she conducted her research. This method also helped in determining the boundary of suitable satyr habitat. It was helpful in providing a population estimate of the satyr at the sites where it was used. Szymanski (2000) reports that population estimates from Pollard transects do not correlate well with MRR estimates and that she does not believe Pollard transects are useful in

obtaining estimates of population size. The potential disadvantages associated with MRR are the degree of trampling and potential habitat destruction that can result from using this method and the fact that the method is extremely time intensive.

In 2000, the Mitchell's Satyr Working Group determined that it was important to conduct timed meander surveys at occupied sites on more than one occasion during the field season to more effectively monitor satyr populations. It was decided that visiting occupied sites at least three times during the flight period and conducting timed meander surveys would provide valuable data on the distribution and number of butterflies at each site. These meander surveys were devised to cover all suitable habitat types as well as to monitor butterflies in known Mitchell's satyr concentration areas.

Timed meander surveys were conducted in 2000 at 16 of the known and two of the historical satyr sites. Dates that surveys were conducted, the amount of time spent conducting the survey, the number of satyrs observed, and the number of satyr seen per hour for each survey date are summarized in Table 3. This table may be helpful in trying to determine the peak of the flight at each site, but comparison of numbers of satyrs at each site may not be as helpful as there are so many factors which influence the number of satyrs detected during counts. Most of these sites were visited at least three times, some more frequently. We found that meander surveys can result in higher numbers of butterflies detected than on Pollard transects, although this depends upon the site and the amount of time spent. The time spent by MNFI staff in 2000 ranged between 0.5 and 3 hours, depending on the amount and distribution of suitable habitat at each site. Szymanski (2000) detected similar numbers of satyrs during Pollard transects and meander surveys at Berrien County South and Berrien County North although the time spent conducting meander surveys was equal to the time spend walking Pollard transects (approximately 6 minutes). Meander surveys conducted at other sites were generally much longer than 6 minutes. TNC staff observed similar numbers of satyrs per unit effort during transects and meander surveys, although satyrs were found in different patches as a result of the meander surveys (Clampitt 2001).

Meander surveys provide more opportunities to discover butterflies in habitat patches previously thought to be unoccupied and over time may provide a better picture of overall distribution, patch occupancy rates and habitat use by the butterfly. Although meander surveys require no set up time, as with Pollard transects, they are usually more time intensive to conduct. Care should be taken to use existing deer trails when possible to minimize the risk of trampling. Meander surveys are more subjective than Pollard transects or MRR methods, although this is not necessarily a bad thing. Surveyors are more likely to go to where they are seeing the satyr, even if the habitat does not appear ideal, rather than in a predetermined place where satyrs were seen in previous years. It will be important to refine this methodology so that data can be compared between years and between sites. Recording start and stop times for each patch of habitat surveyed, rather than just at the beginning and end of the meander survey will aid in defining the numbers of satyrs recorded per unit effort. Delineating areas where satyrs are seen each year on a base map of the site will help to gauge habitat use over the years.

During the past two years we have been making every attempt to determine the sex of the satyrs as we observe them in the field. We have found that this additional information is very useful. It helps to determine the mid-point of the flight season, as this is when the sex ratio nears 50/50. Because we know that males fly earlier in the year than females, if the majority of observations are of female satyrs, then it is likely that the survey was conducted during the latter part of the flight. In addition, there may be different activity times for males and females, and knowing which sex is likely to be flying will help to maximize the effectiveness of surveys. Knowing the sex of satyrs observed during surveys in specific habitats will be very useful in guiding management activities. Although this species is a very sedentary butterfly, female movement is significantly less than male movement (Szymanski 1999a). Thus, if males are seen, it may be possible that they are only passing through the area patrolling for females. If females are seen, it may be an indication of habitat that is important for oviposition and larval development. Management in these areas should be undertaken cautiously.

A subcommittee of the Mitchell's Satyr Working Group will be working to define standardized survey methodology to be used by surveyors, including agencies, conservation groups and consultants, when conducting *de novo* surveys. In addition, they will outline protocol to be used for monitoring known populations as well as for evaluating the best management tools to be used at occupied sites, both before and after management is initiated. At this time we recommend that monitoring be continued on a regular basis at all occupied sites.

Table 3. Search effort and number of Mitchell's satyrs observed at sites during timed-meander surveys in 2000.

Site (Tract)	Date/Time Visit #1.	Date/Time Visit # 2.	Date/Time Visit # 3 & # 4.	No. of Satyrs	No. of Satyrs/hr
Barry Co. South	6-29/3.0hr	6-30/0.5hr	7-12/2.0hr	15 6 5	5 12 2.5
Barry Co. Southwest (Tract A)	6-30/2.0hr	7-10/0.75	7-12/2.0hr	0 8 4	0 10.6 2
Barry Co. Southwest (Tract B)	7-10/0.5hr			2	4
Branch Co. Site (Tract A)	6-29/3.0hr	7-7/2.0hr	7-12/1.0hr	87 22 1	29 11 1
Branch Co. Site (Tract B)	6-29/1.75hr	7-7/1.0hr	7-12/2.0hr	60 8 10	34.3 8 5
Berrien Co. North *	6-30/0.10 hr	7-6/0.10hr	7-12/0.10hr	3 3 2	30 30 20
Berrien Co. South *	6-30/0.10hr	7-6/0.10hr	7-12/0.10hr	0 5 2	0 50 20
Cass Co. East (Tract A) **	6-26/2hrs	6-29/2hrs	7-7/1.5hrs	0 0 0	0 0 0
Cass Co. East (Tract B) **	6-30/1.5hrs	7-6/3hrs	7-10/0.5hrs	20 7 2	13.3 2.3 4
Cass Co. East (Tract C) **	6-28/4hrs			0	0
Cass Co. East (Tract D) **	7-5/2hrs			0	0
Cass Co. East (Tract E) **	6-28/1.5hrs	6-29/1.0hrs		4 1	2.6 1
Cass Co. Southwest (Tract A)	6-27/1.0hr	7-3/0.25hr		10 4	10 16
Cass Co. Southwest (Tract B)	6-27/0.5hr			2	4
Cass Co. Southwest (Tract C)	6-29/0.25	6-30/0.75hr	7-6/1.0hr	0 0 2	0 0 2
Cass Co. Southwest (Tract D)	6-27/0.5hr	6-28/0.25hr	6-30-/0.5hr 7-3/0.5hr	7 5 10 21	14 20 20 42
Cass Co. Southwest (Tract F)	6-27/1.5hr	7-3/0.75hr		21 29	14 38.6
Cass Co. Southwest (Tract G)	6-28/0.25hr	7-3/0.25hr		4 6	16 24
Jackson Co. Central (Tract A)	6-23/3hrs	6-26/2hrs	7-11/1.5 hrs	1 7 3	0.3 3.5 2
Jackson Co. Central (Tract B)	7-11/1.5 hrs			8	5.3
Jackson Co. East (Tract A) **	7-2/2.5 hrs			25	10
Jackson Co. East (Tract B) **	7-7/4.5 hrs			1	0.2
Jackson Co. West **	6-29/2.75 hrs			14	5.1
Kalamazoo Co. East (Extirpated)	7-4/1.0hr			0	0

Table continues

Table 3. continued

Site (Tract)	Date/Time Visit #1.	Date/Time Visit # 2.	Date/Time Visit # 3 & # 4.	No. of Satyrs	No. of Satyrs/hr
Kalamazoo Co. North	6-29/0.5hr	7-5/2.0hr		5 8	10 4
Kalamazoo Co. West	7-4/2.0hr	7-12/3.05hr		17 6	8.5 1.7
Lenawee Co. Site (Extirpated)	7-13/4.0hr			0	0
St. Joseph Co. East	6-28/2.5hr	7-6/2.5hr	7-12/2.0hr	3 6 1	1.2 .4 .5
St. Joseph Co. West **	6-29/2hrs	7-6/0.75 hr		6 15	3 20
Van Buren Co. Northeast	6-29/1.25hr	7-6/1.0hr	7-10/0.5hr	0 7 10	0 7 20
Washtenaw Co. West (Tract A)	7-6/1.25hr	7-10/0.75hr	7-11/3.0hr	16 3 7	12.8 4 2.3

* Sites surveyed by USFWS, ** Sites surveyed by TNC

Mitchell's Satyr Oviposition Observations and Larval Searches

Four sites (Cass County Southwest A, Cass County Southwest B, Barry County South, and Branch County) which had an especially high number of females were re-visited during the second full week of the satyr flight. Over a four-day period a total of 26 person hours were spent observing several different female satyrs in hopes of observing oviposition. Five oviposition events, resulting in a total of 17 eggs laid, were observed in the field. All females flew below the sedge and grass canopy just prior to ovipositing. Other researchers have reported this pre-oviposition behavior, including Szymanski (1999b) and Darlow (2000). All egg laying events occurred very near the ground surface (2-4") and on the underside of small forb leaves. Our results compare favorably with other researchers (Darlow 2000, Szymanski 1999b; Legge and Rabe 1996). Szymanski (1999b) also reported observing satyrs ovipositing on the undersurface of *Carex stricta* leaves. One interesting similarity between all studies is the fact that oviposition was observed only during the afternoon hours (between 1346 and 1745 with the majority occurring between 1517 and 1627) (Hyde et. al 2000, Darlow 2000, Szymanski 1999b, 2000). If this pattern remains the rule, then researchers trying to document oviposition may only have to follow female satyrs during the afternoon. These oviposition observations also provided additional insights into the microhabitat variables that may be important for oviposition sites.

Oviposition sites and female concentration areas documented in 1999 were visited to search for satyr larvae during a one week period in May of 2000. No larvae were located although some of the sedges within close proximity to the oviposition site exhibited lepidopteran feeding damage. Our results and others (Darlow, Szymanski pers. comm.) suggest that searching for larvae in the field is both time consuming and for the most part fruitless. The best bet for determining larval concentration areas within fens is by observing females. These areas can be further delimited by observing and recording females which are exhibiting pre-oviposition behavior ("fluttering") (Darlow 2000). A less desirable method may include recording locations of all females observed during the optimal oviposition time period.

During the time that behavioral observations were being conducted, observers noted both male and female satyrs nectaring on water hemlock (*Cicuta maculata*), Indian hemp (*Apocynum cannabinum*) and Indian plantain (*Cacalia plantaginea*) on three occasions at the Branch County Site and at Cass County Southwest. This is only the second time that nectaring behavior has been documented during observations of satyrs in the field. Darlow (2000) also made nectaring observations at Berrien County North and Berrien County South. Nectar plants included mountain mint (*Pycanthemum virginianum*), black-eyed Susan (*Rudbeckia hirta*) and

swamp milkweed (*Asclepias incarnata*). These observations are intriguing and may suggest that during some years nectaring may play a role that could impact satyr distribution and population dynamics.

Although these behavioral observations are time consuming to conduct, their value is becoming increasingly important. As we begin work to improve habitat conditions at satyr sites, information about the location of female concentration areas and oviposition sites will be critical in determining the most appropriate management strategy for each site. Identifying these critical areas prior to implementing management will provide a more complete understanding of how the butterflies are using the habitat and will minimize unnecessary threats to Mitchell's satyr.

Conservation Planning

Threats Identified at Mitchell's Satyr Sites

A threat assessment was conducted at occupied and previously occupied Mitchell's satyr sites during the 3-year project. Some of the primary threats to prairie fens and the butterfly are identified in Table 4. Additional threats not noted here may include the presence of giant reed grass (*Phragmites arundinacea*) an invasive species, the destruction of habitat by ORV's, the creation of horse trails and hiking trails through fen habitat, the use of chemicals to control gypsy moths and other forest and agricultural pests and the collection of satyrs by butterfly collectors. These threats are discussed in more detail, as appropriate, in the site summaries section of this report. An overview and discussion of invasive species management follows.

Glossy buckthorn (*Rhamnus frangula*) is a non-native, invasive species, which rapidly forms dense, even-aged thickets. The large leaves and continuous canopy create dense shade. *R. frangula* often invades wetlands that are comparable to its European wetland habitats including wet prairies, marshes, calcareous fens, sedge meadows, S*phagnum* bogs and tamarack swamps. *R. frangula* is most successful under drier conditions in wetlands that are often created by water manipulation including drainage (ditches, roads, sluices), agricultural and water table reduction (agricultural irrigation, residential wells). Research conducted in England found that a mixed sedge area colonized by *R. frangula* seedlings became continuous shrub-carr in about 20 years. Cultural controls include cutting, girdling, mowing, excavation, and burning and are especially effective when used in conjunction with herbicide. In Michigan, land stewards working with The Nature Conservancy strongly recommend the use of spot burning to eliminate the flush of seedlings that emerge following cutting and herbicide treatment of dense stands (Jack McGowan-Stinski and Sherri Laier pers. comm.). Chemical controls include the use of glyphosate, fosamine (ammonium salt), Picloram, and 2, 4-D and may be applied during the dormant season (Converse 1994, Reinartz 1997).

Cattails (genus *Typha*) can behave like aggressive introduced weeds in a variety of natural communities throughout North America. Cattails usually occur as scattered sterile plants in high quality natural communities, but when a community is disrupted, cattail populations may respond by spreading vegetatively at a rapid rate. The effect of the growth spurt is closing open water, eliminating habitat and species diversity, and reducing the opportunity for other plants to become established and survive. Cattails are successful because they form extensive monocultures very rapidly through vegetative reproduction and maintain their dominance with the formation of dense rhizomes mats and litter. Cattails are tolerant to habitat changes, pollutants in the water system, and saline or basic substrates. Modification of surface hydrology, wildfire suppression and wetland enrichment usually precedes the growth of cattail monocultures. Management of cattails to control their spread in natural communities should be site specific and could include such active measures as hand cutting root stalks, burning and flooding, shading and use of herbicides (Motivans and Apfelbaum 1997).

Purple loosestrife (*Lythrum salicaria*) is native to Eurasia and is a highly invasive species in North America. Like other invasive species, purple loosestrife crowds or shades out native species and eventually forms a virtually monotypic stand. It is found in wetlands such as cattail marshes, sedge meadows, and open bogs and also occurs along streambanks, riverbanks and lakeshores. In addition, the plant is found in ditches and other disturbed wet soil areas. *L. salicaria* flourishes in wetland habitats that have been disturbed or degraded from draining, dredging, natural drawdown in dry years, bulldozing, siltation, shore

manipulation, or trampling by cattle. Expansion in a wetland can be extensive and sudden due to the abundance of seeds produced and the rapid growth of seedlings. Purple loosestrife seeds germinate in such high densities that it out-competes native seedlings. Management of *L. salicaria* involves the use of hand pulling, herbicides and biological controls (Bender and Rendall 1987).

Reed canary grass (*Phalaris arundinacea*) is a cool-season perennial grass that invades wetlands, moist meadows and riparian areas by forming dense, persistent, monotypic stands. These stands exclude and displace desirable native plants and animals. Since *P. arundinacea* is tolerant of freezing temperatures and begins to grow very early in the spring, it can outcompete many other species. Reed canary grass spreads within sites by creeping rhizomes and forms dense and impenetrable mats of vegetation. New sites are colonized by seeds. Reed canary grass invasion is promoted by disturbances such as ditching of wetlands, stream channelization, deforestation of swamp forests, sedimentation, overgrazing and intentional planting. There are a variety of methods which have proven successful in the management of reed canary grass, many used in combination with each other. These include: disking, mowing, use of herbicides, prescribed burning, alteration of water levels and planting a competitive crop of native grasses and forbs (Lyons 1998).

Glossy buckthorn, cattails, purple loosestrife and reed canary grass all pose a serious threat to Mitchell's satyr. Since these invasive species form monocultures, they reduce species diversity at satyr sites. The fine-leaved sedges, which are the foodplant for satyr larvae, are light demanding and are quickly out-competed by these invasives. We do not know which microhabitat variables are most critical to the satyr at various stages of its life cycle, but it is clear that these invasive species drastically alter the community structure and microhabitat in the wetlands where they occur.

It is prudent to begin controlling invasive species before they reach the explosive stage so that our efforts are most effective in the long run. Challenges associated with managing these sites will only increase in scope and complexity, as invasive species become established and as vegetative succession progresses. Management techniques appropriate for addressing these threats must be weighed carefully to assess and address any potential risks to the Mitchell's satyr and other associated plant and animal species. Monitoring both before and after management is implemented is critical to insure that any negative impacts to the satyr are minimal.

Table 4. Threats identified at Mitchell's satyr sites

Survey Site	First Obs.	Last Obs.	Glossy Buckthorn	Cattails	Purple Loosestrife	Reed Canary Grass	Shrub Invasion	Altered Hydrology
Barry Co. South	1974	2000					X	
Barry Co. Southwest	1965	2000	X	X		X	X	
Berrien Co. North	1986	2000					X	
Berrien Co. South	1987	2000		X			X	
Branch Co. Site	1965	2000		X	X	X	X	
Cass Co. East	1889	2000			X	X	X	X
Cass Co. Northwest (extirpated?)	1979	1993		X	X		X	X
Cass Co. Southwest	1987	2000		X			X	X
Jackson Co. Central	1974	2000	X		X	X		X
Jackson Co. East	1996	2000	X	X	X		X	X
Jackson Co. West	1980	2000			X			

Table Continues

Table 4. Continued

Survey Site	First Obs.	Last Obs.	Glossy Buckthorn	Cattails	Purple Loosestrife	Reed Canary Grass	Shrub Invasion	Altered Hydrology
Kalamazoo Co. East (extirpated)	1978	1978						X
Kalamazoo Co. North	1973	2000	X	X			X	X
Kalamazoo Co. West	1974	2000	X				X	X
Lenawee Co. Site (extirpated)	1965	1980			X		X	
St. Joseph Co. East	1996	2000		X		X	X	X
St. Joseph Co. West	1952	2000		X	X	X	X	
Van Buren Co. Northeast	1999	2000	X	X			X	
Van Buren Co. Site	1974	1993						
Washtenaw Co. West	1958	2000		X	X	X	X	X

Historical Changes at Mitchell's Satyr Sites

An analysis of the historical condition of Mitchell's satyr habitat along with comparisons to present day condition can provide some guidance to managers trying to restore and expand habitat complexes. Photo interpretation of known and historical Mitchell's satyr sites has revealed that between 1938 and 1978 theses sites have experienced a reduction in open wet meadow acreage accompanied by increases in shrub and tree dominated areas (MacKinnon and Albert 1996).

Comparisons of present and presettlement vegetation cover at several known Mitchell's satyr sites shows a drastic reduction in open, sedge-dominated wetland acreage. Figures 2 and 3 illustrate these changes at one of the occupied sites. The first map depicts the presettlement vegetation, circa 1800, interpreted from the General Land Office surveys, for this site (Comer et. al. 1995). The second map illustrates the current vegetation at the site as interpreted from 1999 aerial photographs. While 106 acres of wet prairie was thought to occur in presettlement times, only 9 acres (8%) remain in an open condition today at this site. The remainder of the wetland has converted to shrubby meadow (e.g., 20% - 80% shrub cover), shrub-carr (e.g., > 80% shrub cover), conifer swamp and hardwood swamp. When shrubby meadow (15 acres) and shrub-carr (4 acres) are included along with wet meadow as suitable habitat, it appears that a 73% reduction in available habitat has occurred at this site.

The boundary that is indicated on the map of the photo-interpreted vegetation (Figure 3) represents the area within the site that is currently occupied by the satyr including a buffer of potential suitable habitat. The area within the boundary has undergone a 66% reduction in available habitat. We have generated these maps for most of the occupied and previously occupied satyr sites in Michigan and have conducted a similar analysis. These maps can be used as tools to help gauge changes in land cover types and land use patterns and may help guide future surveys, management and restoration efforts at these sites. They will be provided to the Southwest Michigan Land Conservancy and other land managers to assist in the next phase of satyr recovery in Michigan (Federal Aid in Endangered Species, Michigan Project E-1-31).

It should be noted that a typical large fen complex is rarely a homogeneous system. The Berrien County South site, for example, supports seven identifiable wetland communities (Rogers et al. 1992). These different communities represent the interplay of dynamic processes such as disturbance, groundwater discharge, and plant succession, which act to produce a mosaic of habitat types within each wetland complex. We do not yet clearly understand how the satyr moves around and uses the complex. The specific habitat requirements for Mitchell's satyr seem to include structural components as well as the presence of suitable host plants. Much of the species' known

behavior, especially female concentration areas and oviposition sites, tends to suggest that it can tolerate some degree of shrubbiness, and may in fact not prefer large open expanses of sedges. Several authors have reported that the satyr is typically found in only small portions of what otherwise appear to be large expanses of suitable habitat (Bess 1988, Martin 1987, McAlpine et al. 1960, Rutkowski 1966). Several lepidopterists have noted that the species seems to occur in association at the interface between open sedge meadow and the shrubby edges of later successional habitats (Badger 1958, McAlpine et al. 1960, Rogers et al. 1992, U.S. Fish and Wildlife Service 1997, Shuey pers. comm.). In New Jersey, D. Schweitzer reports that the related Georgia satyr (*Mitchellii areolata*) seldom occurs more than a few dozen meters from trees or tall shrubs, even in extensive, very open sedge meadows (U.S. Fish and Wildlife Service 1997). So the effects of presettlement vegetation succession on satyr populations are not straightforward. The reduced size of large sedge-dominated acreage may in itself not be as important as the overall loss of edge habitat associated with that reduction. It is likely that a more open mosaic with loose connections between patches of suitable habitat would have been prevalent in the presettlement landscape. It is important, therefore, that future management seek not only to restore the open habitat, but to do so in a way that provides maximum amounts of sedge to shrub interface and loosely connected pockets of sedge in tamarack savanna and shrub-carr.

The transition of open graminoid-dominated communities to shrub-carr and swamp forest is well documented (Curtis 1959, White 1965). Because food plants of the Mitchell's satyr larvae, particularly the thin-leaved sedges *C. diandra*, C. *lasiocarpa*, *C. prairea*, *C. sartwellii*, *C. sterilis*, and *C. stricta,* are all light-demanding species and rarely occur in closed canopy environments, the conversion of open fen to shrub-carr and swamp forest results in a critical loss of larval habitat. As trees and shrubs begin to dominate once open wetlands, light demanding sedges are gradually out-competed by species more tolerant of shade. In the absence of active management aimed at creating and maintaining thin-leaved, sedge-dominated openings, this process of canopy closure results in a direct decline in available habitat for Mitchell's satyr larvae.

Evidence from wetland peat cores and General Land Office surveyor notes indicates that in the past, graminoid dominated wetlands such as prairie fen, sedge meadow and wet prairie were maintained in an open condition by frequent wildfires (Curtis 1959, Davis 1979, Comer et. al. 1995). Because shrub-carr and swamp forest are not easily burned, this conversion may be considered permanent without manual manipulation (e.g., cutting and herbicide) or long term flooding (e.g., beaver dams or impoundments). In the past, beaver likely played a key role in maintaining a network of open, graminoid-dominated communities. In the absence of wildfire and beaver-induced flooding, land mangers will need to take an active role in maintaining networks of open, sedge-dominated communities if we are to be successful in expanding habitat for the Mitchell's satyr.

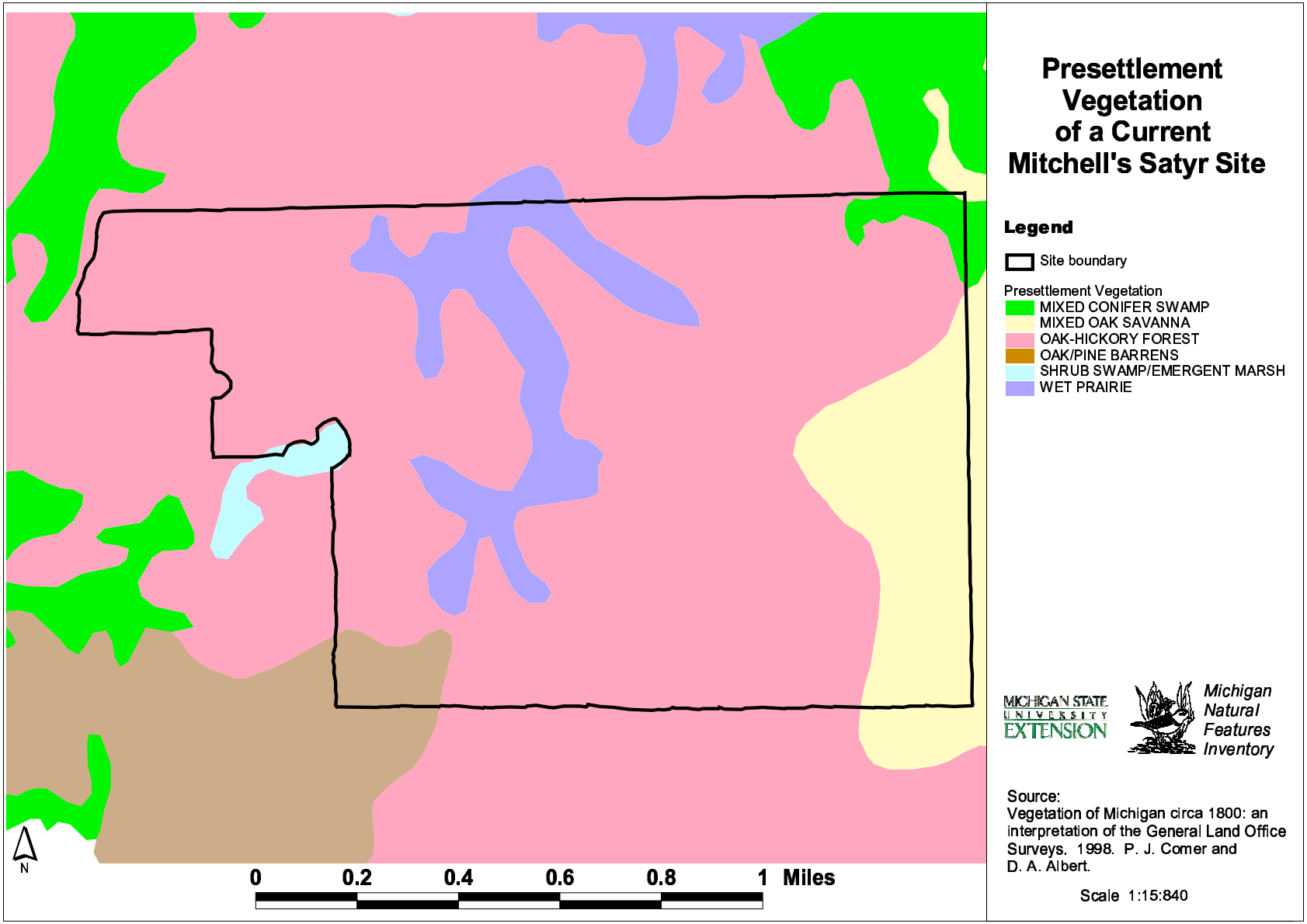

Figure 2. Presettlement vegetation of a current Mitchell's satyr site.

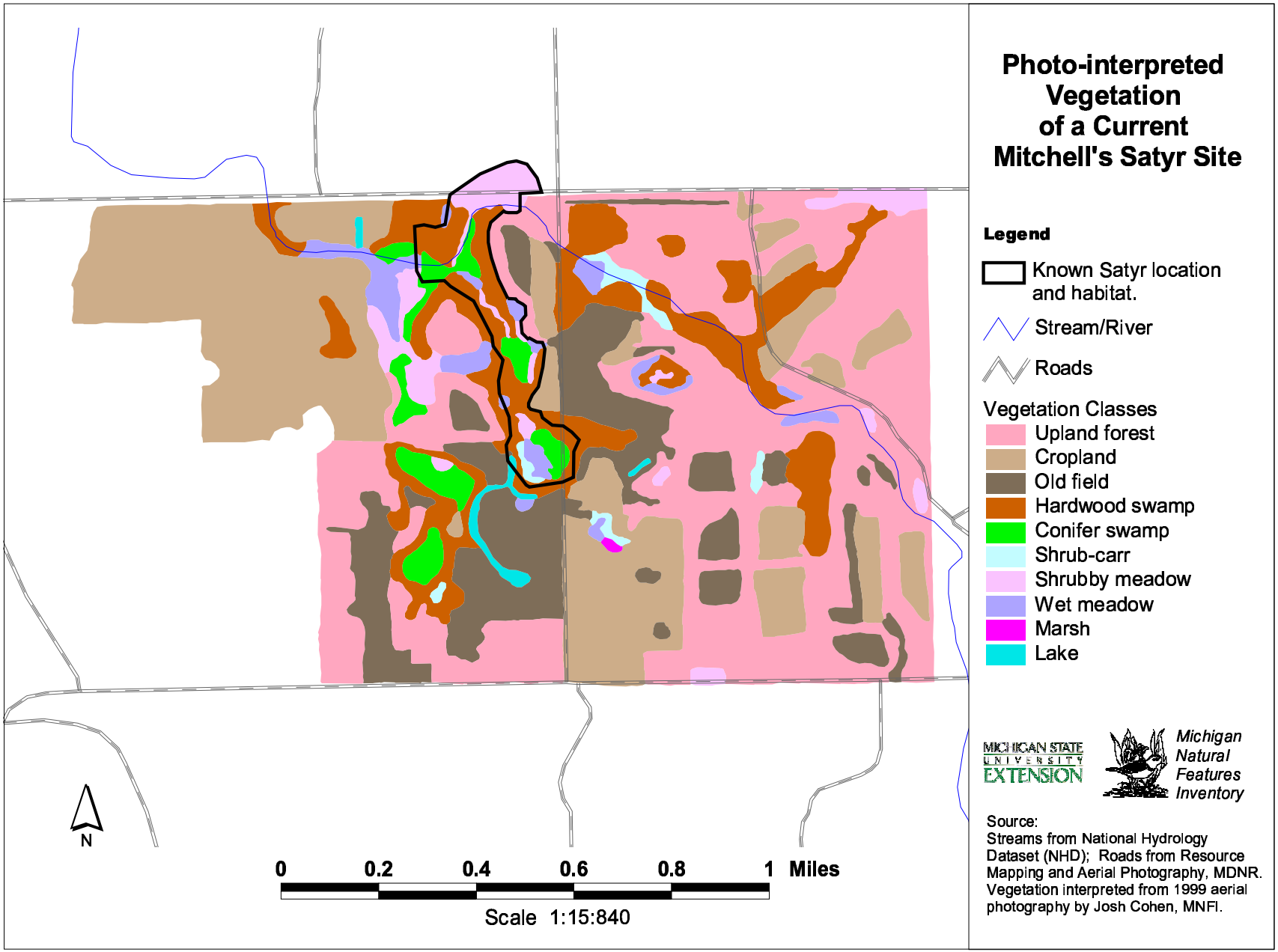

Figure 3. Photo-interpreted vegetation of a current Mitchell's satyr site

Vegetative Characteristics and Succession at Mitchell's Satyr Sites

In 1999 we analyzed the vegetation characteristics of Mitchell's satyr habitat at seven of the occupied Mitchell's satyr sites (Kost 2000). As a result we have a better understanding of the vegetative components and vegetative structure that is thought to be critical for this species. Our research supports the findings of others which describe the habitat of Mitchell's satyr as a mosaic of open prairie fen and sedge meadow mixed with tamarack savanna and shrub-carr (McAlpine et al. 1960, Shuey et. al 1994, Szymanski 1999a). Thin-leaved sedges, especially *Carex stricta,* C. *sterilis*, and *C. lasiocarpa*, dominated the ground layer of each of the habitats we sampled. Other ground layer species found at all of the sites included smooth swamp aster (*Aster firmus*), marsh bellflower (*Campanula aparinoides*), swamp thistle (*Cirsium muticum*), common boneset (*Eupatorium perfoliatum*), fowl manna grass (*Glyceria striata*), marsh wild-timothy (*Muhlenbergia glomerata*), cowbane (*Oxypolis rigidior*), swamp goldenrod (*Solidago patula*), marsh fern (*Thelypteris palustris*), and violet (*Viola* spp.). Shrubby cinquefoil, a small, compact shrub which also occurred as part of the ground layer, was a significant component of cover at more than half of the sites we sampled. Lastly, tamarack and poison sumac (*Toxicodendron vernix*) formed the upper stratum at most sites, creating a community structure often referred to as tamarack savanna.

We suspect that the heterogeneous structure and patterns of community juxtaposition occurring at these Mitchell's satyr sites may be critical to the species' survival. Research focused on habitat utilization has confirmed that Mitchell's satyr butterflies use several different vegetation zones (Szymanski 1999a, Darlow 2000), suggesting an adaptation of behavioral thermoregulation (McAlpine et al. 1960, Shuey et. al 1994, Szymanski 1999a). A variety of microhabitats may be necessary to ensure survival during other life stages as well. Darlow (2000) conducted research at Berrien County North and Berrien County South on the behavior, habitat use and oviposition of the satyr and presents some interesting findings. Although this data was only collected during one field season, it represents the largest data-set so far collected for both behavioral observations and oviposition events for *N. m. mitchellii*. All oviposition events observed (n=15) occurred at the interface of habitat types within one meter of shrubs. Oviposition occurred on a variety of forbs, both small and intermediate. He reports that *N. m. mitchellii* appears to select the general oviposition locale during the inspection flight, suggesting that at least a component of site choice is structural. He concludes that habitat management should focus on creating a mosaic of patches, each including a diversity of microhabitats.

Management Considerations for Prairie Fens and Mitchell's Satyr Sites

It is clear that management must be implemented at occupied sites in order to maintain the mosaic of habitats required by the satyr. Management for maintaining openings, increasing the size of openings and restoring a more natural mosaic of vegetation types will require tree and shrub removal and control of invasive plants. The fens supporting Mitchell's satyr in Michigan and Indiana may have been subjected to occasional wildfires in the past. Nearly all of the historical sites in these two states occur in association with glacial outwash and moraine deposits, and sandy soils on adjacent uplands (MacKinnon and Albert 1996). Prior to European settlement, these glacial deposits supported upland communities such as oak barrens and oak woodlands, and remnants of these communities can still be found today. Oak barrens and oak woodlands are fire maintained communities, and in the absence of wildfire generally convert through natural successionary processes into more mesic oak forest (Curtis 1959). This evidence suggests that wildfires are required to maintain these upland habitats and likely swept through the adjacent wetland complexes. The severity and frequency of wildfire in these systems is mostly unknown, but would have depended on time of year and weather conditions like temperature, humidity and wind speed. Site conditions like landscape position, fuel load and seasonal rainfall amounts also would play a role. It is less likely that the habitats supporting this butterfly in Ohio and New Jersey were subjected to wildfires. The surrounding uplands in these states are more mesic, and wildfire events were not a regular occurrence in these regions.

The reintroduction of fire into these systems is likely to benefit the graminoid-dominated wetland plant communities (e.g., prairie fen, sedge meadow and wet prairie) in several ways. Prescribed burns have been shown to successfully reduce leaf litter in these community types, allowing sunlight to reach the soil surface and stimulate seed germination (Kost and De Steven 2000, Warners 1997). Because many wetland sedges including *Carex stricta*, overwinter as young

shoots (Bernard and Gorham 1978), they are poised for early spring growth and able to out-compete newly emerging seedlings for space and light. Prescribed burns conducted during the dormant season have the effect of setting back the early spring growth of sedges (Warners 1997). Although *Carex stricta* abundance has been found to increase as a result of burning, the temporary setback of early spring growth reduces its ability to compete with newly germinated seedlings. By allowing for seed bank expression and seedling establishment, prescribed burns facilitate seed bank replenishment, and thus help ensure future plant diversity. This may be especially important for several types of plants including annual species whose presence is almost entirely dependent on the seed bank and species with small statures that might otherwise be out-competed by taller vegetation (Kost and DeSteven 2000, Leech and Givnish 1996). Both types of species have been found to be especially abundant following prescribed burning (Kost and DeSteven 2000). Prescribed fire also has been shown to temporarily increase the availability of important plant nutrients and increase flowering and seed production (Daubenmire 1968, Vogl 1974, Collins and Gibson 1990, Laubhan 1995). The increased flowering and seed production following burning further contributes to maintaining the seed bank. Plants growing in recently burned areas also have been shown to be nutritionally superior to plants from adjacent unburned areas. The higher nutrient levels are thought to contribute to the preferential grazing of burned areas over unburned areas by some animal species (Smith and Kadlec 1985, Reed 1997).

Fire is thought to cause direct mortality of Mitchell's satyr in its egg, pupae and larval forms. Its use as a management tool requires extreme caution and careful planning to avoid complete elimination of the butterfly from an occupied site. This is especially true at the onset of management since so many of the known sites have a small population of satyrs, and their habitat is small and isolated from other occupied patches. Initial restoration of occupied areas may need to rely on more labor-intensive techniques like hand-cutting and spot herbiciding. At some point, when habitat for the satyr has expanded and population levels increased to more robust levels, prescribed fire may become the appropriate tool for maintaining the restored and expanded habitat at a site.

If fire is used to help restore or maintain open fen patches, only a small portion of a site's total occupied habitat should be burned in any one year. Where feasible, it may be advisable to conduct burns in adjacent unoccupied habitat prior to burning occupied portions of habitat. This will allow the plant community to benefit from the burn without impacting the Mitchell's satyr population and it is possible that the satyr may be drawn to the burned site. It will be important to allow several years between burns to help ensure recolonization of burned areas by other fire-sensitive species. Conducting burns in late fall or early spring will also help reduce the potential of negatively impacting amphibian and reptile populations at the site.

As restoration progresses and habitat expands, it may be appropriate to evaluate the response of Mitchell's satyr to fire. This would need to be done cautiously, but we might be greatly limiting our habitat restoration and maintenance efforts if we summarily rule out the use of prescribed fire. We suggest that such an effort receive rigorous experimental design considerations with appropriate controls to evaluate both the short and long-term response of satyr larvae and adults to prescribed burns. It also might be prudent to have a contingency plan in place for implementing this type of study should an occupied site be burned accidentally.

Controlling woody plant invasion may be accomplished through manual cutting accompanied by herbicide application of cut stumps. Shrub removal may be most effective when followed within the next year by a prescribed burn to control resprouting and new woody seedlings. Where a prescribed burn is not practical, spot burning the woody seedlings may be a prudent alternative. Land stewards from The Nature Conservancy in Michigan report that spot burning is a critical step in their efforts to control invasive glossy buckthorn seedlings (J. McGowan-Stinski and S. Laeir per comm.). Spot burning is typically done during the growing season to control the dense flush of glossy buckthorn seedlings that occur under an adult plant that has been cut and stump treated during the previous dormant season. This process involves using a propane torch to apply heat directly to the woody seedlings. Hand-pulling the glossy buckthorn seedlings may also be used but because of the large amount of time and effort required for hand-pulling, its practicality as a control method may be limited to sites where the infestation is minimal.

Hydrological processes are critical for the maintenance of prairie fen vegetative structure. Agricultural and residential drains and wells alter groundwater flow into the prairie fen. The resulting lowered groundwater table cannot supply the calcareous seepage, which underlies prairie fen communities. As these fens become drier they are more vulnerable to invasive

species and conversion to shrub-carr and swamp forest communities. Land use planning designed to protect the aquifer recharge area of the prairie fen is needed to retain this unique hydrology (Michigan Natural Features Inventory 1997).

Working With Partner's

Over the three years of this project, we have provided updated occurrence information to a variety of partners and have worked with them to share pertinent information about the satyr, associated rare species and their habitat. The Natural Heritage BCD has been updated each year with current information on Mitchell's satyr and associated rare plants, animals and high quality natural communities. We have consulted with regulatory agencies such as the USFWS, Department of Environmental Quality and the Michigan Department of Transportation to identify potential threats and insure that proposed projects do not negatively impact the satyr and its habitat. We have worked closely with The Nature Conservancy in their ecoregional planning process to help identify portfolio targets and sites within the ecoregion. MNFI data were used in this process to identify viable sites and associated conservation units. We have informed local land conservancies and private lands management programs about the status, distribution and management needs of the Mitchell's satyr. We have collaborated with public land managers such as the MDNR Parks Division and Wildlife Division regarding monitoring and management needs of the satyr and associated rare species when appropriate. During the past year we provided information to scientists in the private sector who are researching the potential impacts of Bt agricultural crops on rare lepidoptera.

It is prudent that managing and monitoring of the satyr be maintained at the local level by TNC, other local land conservancies, watershed councils and State park and game area biologists working at occupied sites. These partners are in the best position to establish a long-term presence and to direct needed resources towards landowner contact and education, continued surveys in areas with potential satyr habitat, and stewardship of the satyr and its habitat. The Mitchell's Satyr Working Group should continue to provide training, input and expertise to our partner's as the overall effort moves to a more local level.

Site Summaries

The following section contains summaries for all of the 16 known Mitchell's satyr sites, the one site, which is thought to still be occupied by the satyr and the three sites where the satyr is thought to be extirpated. Included are descriptions of the sites, survey results, and identification of potential threats and monitoring and management needs at these locations.

Barry County South (EO .007)

Satyrs were first documented at this location in 1974. The site was visited on three occasions in 2000. Fifteen satyrs were observed on June 29, with fewer satyrs seen on the two subsequent visits. This small wetland complex (approximately five acres) consists of sedge and grass fens, wet and wet-mesic prairie and tamarack forest, bisected by a creek. Most of the fen habitat occurs in a narrow strip along the creek although several fen pockets occur away from the stream. Most satyrs observed at this site over the past three years were seen at the north end of the fen at the junction of the two creeks. On two occasions satyrs have been seen in the small fen openings located away from the stream. The four distinct fen communities which occur at this site are characterized by tamarack (*Larix laricina*) and small sedge openings dominated by *Carex stricta, C. aquatilis,* bulrush (*Scirpus* spp.), shrubby cinquefoil (*Potentilla fruticosa*), goldenrod (*Solidago* spp.), Joe-pye weed, (*Eupatorium maculatum*), boneset (*E. perfoliatum*), tall tickseed (*Coreopsis tripteris*) and swamp thistle (*Cirsium muticum*). Big bluestem (*Andropogon gerardii*) and little bluestem (*Andropogon scoparius*) are fairly abundant in two of the fen communities. This fen complex is becoming overgrown with gray dogwood (*Cornus racemosa*), red-osier dogwood (*Cornus stolonifera*), alder-leaved buckthorn (*Rhamnus alnifolia*) and tamarack. Invasive species that occur here include occasional patches of reed canary grass (*Phalaris arundinacea*), and cattail (*Typha* spp.). Without active management it is likely that this fen complex will succeed to shrub-carr and swamp forest, effectively eliminating suitable habitat for the satyr. The tamarack tree cricket (*Oecanthus laricis* SC) was

recorded here during 1999 surveys and during 2000 the angular spittlebug (*Lepyronia angulifera* SC) and the eastern box turtle (*Terrapene c. carolina*, SC) were documented. In addition, the prairie Indian plantain (*Cacalia plantanginea* SC) also occurs at this site. Most of the satyr habitat occurs on publicly owned land although some potential for the satyr exists on adjacent private parcels. We have not been able to secure permission to survey adjacent private parcels to assess whether potential satyr habitat is present. No satyrs have been seen in the area north of the road where they historically occurred since 1974. Coordination with the State agency managing this site is critical to develop appropriate and timely management and restoration strategies. Creating additional openings adjacent to occupied patches to expand the amount of suitable habitat and encourage future colonization of these openings by satyrs is recommended.

Barry County Southwest (EO .005)
Satyrs have been documented at this site since 1965. Although it was considered by many to be extirpated (last observed in 1986), surveys conducted in 1998 confirmed 6 adults in approximately 1 acre of habitat just south of the historical site along the same creek. During surveys in 1999 and 2000, adults were seen in the same small pockets of open habitat that were identified during the 1998 survey. These satyrs were found in shrub-carr with sedge openings. Surveys conducted in 2000 resulted in the discovery of satyrs in a fen opening southwest of the known occupied patch. No satyrs have been seen since 1986 in the area north of the road where they historically occurred. The occupied area is characterized by small areas of seeps along the drainage and contains various sedge species including *Carex stricta, C. aquatilis,* and *C. lacustris.* Other fen indicators present include boneset (*Eupatorium perfoliatum*), Joe-pye weed (*E. maculatum*), shrubby cinquefoil (*Potentilla fruticosa*), goldenrod (*Solidago* spp.), Indian grass (*Sorghastrum nutan*), dogwood (*Cornus* spp.), and poison sumac (*Toxicodendron vernix*). The wooded fen zone includes tamarack (*Larix laricina*), willow (*Salix* spp.), red maple (*Acer rubrum*), black cherry (*Prunus serotina*) and yellow birch (*Betula alleghaniensis*). State-listed plant and animals from the site include the eastern box turtle (*Terrapene c. carolina* SC), tamarack tree cricket (*Oecanthus laricis*, SC) and prairie Indian plantain (*Cacalia plantaginea* SC). Shrub encroachment is a significant problem and will need to be managed in order for the satyr population to persist here. The road that bisects historical habitat from the newly discovered occupied areas has likely impacted the hydrology of the fen and may be contributing to succession of the site to shrub-carr and swamp forest. Further analysis and surveys are needed to more fully delineate the portion of the fen complex occupied by satyr, and to help better characterize the quality of the habitat and guide management. Creating additional openings adjacent to satyr occupied patches to expand the amount of suitable habitat and encourage future colonization of these openings is warranted. Glossy buckthorn (*Rhamnus frangula*) also will need to be controlled. Coordination with the State agency managing this site is critical for its restoration and management.

Berrien County North (EO .009)
Satyrs have been documented at this site since 1986. The satyrs occur in two distinct habitat patches located within an 800 acre nature preserve that is owned by a private non-profit organization. This nature preserve occurs on peat, clay and sandy soils in an oak-forested river valley. A variety of natural communities are represented including marsh, swamp forest, dry forest, upland meadow, a remnant bog, a rich sedge meadow and prairie fen. One occupied patch is open fen grading into thick shrub-carr and is approximately 3.5 acres. The second patch is a small (0.5 acre) sedge opening in an otherwise closed canopy forested wetland and is dominated by shrubs. This smaller patch is bisected by a nature trail. The two patches are separated by a distance of 317 yards and function as independent demographic units. Dominant vegetation in the larger patch includes *Carex stricta*, *C. prairea*, many small cedars (*Thuja occidentalis*), poison sumac (*Toxicodendron vernix*) bog birch (*Betula pumila*), ninebark (*Physocarpus opulifolius*), pitcher plant (*Sarracenia purpurea),* buckbean (*Menyanthes* spp.), fringed brome (*Bromus cilatus*), black-eyed Susan (*Rudbeckia hirta*), whorled loosestrife (*Lysimachia quadriflora*), and grass-of-parnassus (*Parnassia glauca*). Dominant vegetation in the smaller patch includes *Carex stricta, C. prairea, C. lasiocarpa,* northern swamp dogwood (*Cornus racemosa),* red-osier dogwood (*C. stolonifera*), tamarack (*Larix laricina*) and willow (*Salix* spp.). Mark-release-recapture studies were conducted at this site in 1997 and 1998. The total brood population estimate ranged from 174 to 372 in 1997 and from 164 to 276 in 1998. State-listed plant and animals from the site include the eastern box turtle (*Terrapene c. carolina* SC), the eastern massasauga rattlesnake (*Sistrurus c. catenatus* SC) and the state endangered Kirtland's snake (*Clonophis kirtlandii* E). The primary management challenge at this site is shrub invasion. Shrub removal has been conducted during the winter months with some success. It will be important to expand existing

patches and work to connect the habitat patches as much as possible if the satyr population at this site is to remain viable. Monitoring and management of this site will be coordinated through the local nature center.

Berrien County South (EO .022)
Satyrs were first documented in this area in 1987. The site is part of a linear wetland complex that spans approximately 25 acres. It features two areas of good quality prairie fen set in a mosaic of swamp forest, shrub swamp, wet meadow and marsh. Upland hardwood forest dominated by oak cover the steep slopes along the river corridor. The Mitchell's satyr has been documented in eight patches, although recently only three of them have been occupied, and access is not readily available for one of the three patches. One of the occupied patches (3.5 acres) is a mosaic of sedge meadow and scattered shrubs. The second patch (2.3 acres) is separated from the first by approximately 250 yards of thick shrub swamp. Dominant vegetation in these patches includes *Carex stricta*, *C. lasiocarpa*, *C. sterilis*, *C. leptalia*, *C. lacustris*, cattail (*Typha* spp.), Joe-pye weed (*Eupatorium maculatum*), swamp goldenrod (*Solidago uliginosa*), rough-leaved goldenrod (*Solidago patula*), (*Rudbeckia hirta*), marsh fern (*Thelpteris palustris*), pussy willow (*Salix discolor*), red-osier dogwood (*Cornus stolonifera*) alder buckthorn (*Rhamnus alnifolia*), and nannyberry (*Viburnum lentago*). Mark-release-recapture studies were conducted at this site in 1997 and 1998. The total brood population estimate ranged from 166 to 271 in 1997 and from 164 to 362 in 1998. State listed plants and animals documented from this site include prairie trillium (*Trillium recurvatum* T), white lady-slipper (*Cypripedum candidum* T), Blanding's turtle (*Emydoidea blandingii*), eastern box turtle (*Terrapene c. carolina* SC) and spotted turtle (*Clemmys guttata* T). This site is considered to be one of the most productive in the state for the eastern box turtle (Rogers et. al 1992). Management challenges at this site includes the invasion of cattails, shrub encroachment and the development of roads and bridges. The ownership at this site is a combination of private landowners and the State of Michigan. It is unclear which organization will conduct future monitoring and management.

Branch County Site (EO .016)
Satyrs have been known from this site since 1965. Surveys conducted in 1985, 1987 and 1993 were unable to reconfirm the 1965 record. It was believed that no suitable habitat for the satyr remained here due to the apparent succession of the fen to shrub swamp. However, in 1998 MNFI staff observed satyrs in both the area thought to be the historical location as well as in an area located to the east, which had not been previously surveyed. In 1999 MNFI staff observed 14 satyrs in the area east of the historical location. In addition, oviposition was also documented at this site in 1999. During a survey visit in 2000 an unprecedented number of satyrs (147) were recorded. Oviposition was again documented at this site in 2000. Suitable habitat is estimated to range between 20-25 acres. A mosaic of open prairie fen, tamarack savanna and swamp hardwood forest characterizes the complex, which is surrounded by pasture, hay fields, upland hardwoods and residential property. Habitat occupied by the satyr has numerous dogwood (*Cornus* spp.) clumps interspersed with sedges (including *Carex stricta*) and some open areas of sedge meadow. Numerous fen indicator species are evident such as tamarack (*Larix laricina*), shrubby cinquefoil (*Potentilla fruticosa*), poison sumac (*Toxicodendron vernix*), Joe-pye weed (*Eupatorium maculatum*) and boneset (*E. perfoliatum*). Shrub encroachment is a significant problem and must be addressed if habitat for the satyr is to be maintained at this site. In addition, purple loosestrife (*Lythrum salicaria*) is abundant in some areas and has the potential to dramatically change the structure and composition of the fen if not addressed. Three private landowners currently own portions of the habitat occupied by the satyr. The owner of the eastern portion of the habitat runs a beef cattle operation and is supportive of our efforts to learn more about the satyr on her property. She does allow her cattle access to the occupied site as she rotates the cattle between pastures. Although they generally remain in the upland areas, some grazing of the occupied area does occur especially during dry years. During a spring larval survey conducted in May of 2000 it was discovered that the cattle had grazed part of the fen heavily. During surveys for adults in late June of 2000, 87 individuals were recorded from this recently grazed portion of the site. It is unclear whether greater numbers of satyr were observed since the shorter sedge made it easier to see the butterflies, whether butterflies moved from the ungrazed areas or whether the grazing stimulated the growth of more nutritious sedge positively impacting larval growth and survival. It is possible that runoff from cattle manure could lead to nutrification of the fen complex and trampling by cattle could provide new areas for invasive species, like purple loosestrife to spread. In fact, purple loosestrife is already very abundant in the grazed portion of the fen and threatens to diminish plant species diversity. The impact of grazing on the site should be addressed carefully with future research and monitoring as it could have important management implications. The new owners of the historical habitat

to the west may build a private home on the upland edge of this property. They attempted to create horse trails through portions of the fen but stopped this activity once they became aware of the presence of the satyr. They accompanied us while conducting satyr surveys on their land and were shown the satyrs and their habitat. The other landowner expressed a desire to dig a pond on his property but agreed to consult with the proper authorities before commencing this activity. Continued monitoring of the satyr population at this complex and identification of key female activity areas is critical so that appropriate management can be coordinated with the permission and cooperation of the private landowners. Southwest Michigan Land Conservancy has targeted this site for monitoring and future management.

Cass County East (EO .001)

This site has been known to support Mitchell's satyrs since 1889 and is located in a wetland complex of approximately 300 acres. The area is a complex of shrub-carr, sedge meadow, hardwood swamp and tamarack swamp. The Nature Conservancy (TNC) currently owns approximately 150 acres of the wetland and is managing this area for the satyr and other rare species. The satyr occurs primarily in several small pockets totaling perhaps 15 acres at the west end of the wetlands owned by TNC. Small numbers of satyrs also have been observed in recent years in pastured wetlands, tamarack savanna and tamarack/black ash swamp on private farms to the east. Suitable habitat is estimated to range between 20 and 30 acres. A mix of cultivated land and secondary forest surrounds the entire wetland complex. Hog farming is the predominant type of agriculture in the area. Although the site is calcareous, most of the usual prairie fen species are absent, perhaps as a result of water level alterations or lack of fire. *Carex strica* and purple stemmed aster (*Aster puniceus*) dominate the sedge meadow where the satyrs are found. Subdominants include *Carex lacustris,* swamp goldenrod (*Solidago uliginosa*), Joe-pye weed (*Eupatorium maculatum*), and boneset (*E. perfoliatum*). In some areas along the creek, reed canary grass (*Phalaris arundinacea*) forms dense patches. Shrub invasion into the meadow, particularly by red osier dogwood (*Cornus stolonifera*), silky dogwood (*C. amomum*), gray dogwood (*C. foemina*), and poison sumac (*Toxicodendron vernix*) is also a problem. Purple loosestrife (*Lythrum salicaria*) has taken hold in the wetlands located on private property and is extremely abundant along some portions of the creek outside of occupied habitat. Management activities have been initiated by TNC to create new openings within 10 m of occupied openings in order to provide additional satyr habitat. Other rare plants and animals known from this site include cut-leaved water parsnip (*Berula erecta* T), eastern few-fruited sedge (*Carex oligocarpa* T), Jacob's ladder (*Polemonium reptans* T), bog bluegrass (*Poa paludigena* T), Blanding's turtle (*Emydoidea blandingii* SC) and eastern box turtle (*Terrapene c. carolina* SC). Management at this site has been limited to the creation of two small openings in dense shrub thickets close to occupied areas in 2000. Narrow-leaved sedges were rare in these areas before the shrubs were removed and they did not expand substantially during the summer of 2000. Future management on TNC's land will focus on ensuring that sedges do expand within these openings and controlling reed canary grass. TNC staff also hopes to work with neighboring landowners to improve their land management practices, including the control of purple loosetrife on their lands.

Cass County Northwest (EO .008)

The Mitchell's satyr was first discovered at this site in 1979 when an MNFI biologist was exploring the area for plants. The butterfly was last confirmed at this location in 1993 despite recent surveys in 1996, 1998, 1999 and 2000. It is believed that the Mitchell's satyr butterfly has been extirpated at this site. This fen (approximately 8-10 acres) is rich in species and contains five State listed plants. It merges into a calcareous tamarack swamp which grades into a sedge mat at the lake edge. The area is characterized by many fen indicator species including *Carex stricta*, shrubby cinquefoil (*Potentilla fruticosa*), Joe-pye weed (*Eupatorium maculatum*), boneset (*E. perfoliatum*), Virginia mountain mint (*Pycnanthemum virginianum*), hardstem bulrush (*Scirpus acutus*), spike-rush (*Eleocharis* spp.), brome grass (*Bromus* spp.), swamp thistle (*Cirsium muticum*), pitcher plant (*Sarracenia purpurea*), poison sumac (*Toxicodendron vernix*), tamarack (*Larix laricina*), dogwood (*Cornus* spp.) and willow (*Salix* spp.). Other rare plants and animals that occur at this site include: prairie Indian plantain (*Cacalia plantaginea* SC), white lady's slipper (*Cypripedium candidum* T), Leiberg's panic-grass (*Panicum leibergii* T), Jacob's ladder (*Polemonium reptans* T), rosinweed (*Silphium integrifolium* T), tamarack tree cricket (Oecanthus laricis SC), and the eastern box turtle (*Terrapene c. carolina* SC). Threats at this site include altered hydrology from the road and ditch that bisect the northern portion of the fen, invasion by cattail (*Typha* spp.) and purple loosestrife (*Lythrum salicaria*) and potential development of the fen by present landowners. We were not able to obtain access to the southern portion of the fen complex in

1999. This land was sold to a development company and our request to conduct surveys for the satyr was denied. Although satyrs were never recorded from this portion of the complex, aerial photography indicates that suitable habitat may occur here. Periodic monitoring of this site will be conducted by the Southwest Michigan Land Conservancy.

Cass County Southwest (EO .021)
The Mitchell's satyr was first recorded at this fen complex in a fringe of fen surrounding a lake in 1987. Since then, each year that intensive surveys have been conducted satyrs have been found in new pockets of fen habitat. In 1998, two new areas of fen occupied by the satyr were discovered along a stream to the east. During 1999 satyrs were found in one new fen pocket to the northeast and reconfirmed at five other fen patches. In 2000 one additional area of occupied habitat was discovered on the opposite side of the lake where the historical population was originally documented. This site is composed of six distinct occupied patches of fen habitat owned by eight different private landowners. Although difficult to estimate, the total amount of occupied habitat presently ranges between 20 and 25 acres. These patches are separated by barriers of unsuitable habitat that make it highly unlikely for genetic exchange to occur between these isolated satyr populations. Unsuitable habitat includes agricultural fields, thick shrub-carr, a highway right-of-way, and a railroad right-of-way. Potential threats to this complex include altered hydrology from the digging and/or peat mining of adjacent ponds, and the placement of roads and the railroad; shrub encroachment; development of private lands; maintenance of the highway and railroad ROWs; and the spread of cattails (*Typha* spp.). Characteristic plants at this complex include: tamarack (*Larix laricina*), dogwood (*Cornus* spp.), poison sumac (*Toxicodendron vernix*), shrubby cinquefoil (*Potentilla fruticosa*), narrow-leaved sedges (*Carex stricta* and *Carex sterilis*), boneset (*E. perfoliatum*), Joe-pye weed (*Eupatorium maculatum*), marsh fern (*Thelypteris palustris*), Ohio goldenrod (*Solidago ohioensis*), swamp thistle (*Cirsium muticum*) and Virginia mountain mint (*Pycnanthemum virginianum*). Additional state-listed plants and animals recorded to date from this fen complex include prairie Indian plantain (*Cacalia plantaginea*, SC), rosinweed (*Silphium integrifolium*, T), white ladyslipper (*Cypripedium candidum*, T), eastern box turtle (*Terrapene c. carolina*, SC), spotted turtle (*Clemmys guttata*, T), tamarack tree cricket *(Oecanthus laricis* SC), and the blazing star borer moth (*Papaipema beeriana* SC). Management of this site is challenging due to multiple ownership and increasing human development. Communication with the company that maintains the railroad corridor, which is very near occupied satyr habitat, is critical to insure that activities detrimental to the satyr are avoided. Landowner education is very important in order to restore and maintain habitat for Mitchell's satyr at this large fen complex. Involvement by the Southwest Michigan Land Conservancy at this site should prove beneficial as they can provide a local presence for coordinating monitoring and management of the satyr in this complex.

Jackson County Central (EO .003)
Satyrs were first documented at this site in 1974 and have been consistently observed in good numbers since 1986. This site is a large wetland complex that stretches 3 miles along a creek. The Nature Conservancy (TNC) owns about 80 acres of the wetland, the County owns one tract, and the remaining wetlands are in private ownership. This wetland complex grades from a pond and shrub swamp in the south through a moderately diverse sedge meadow and then into a mosaic of prairie fen, shrub-carr and tamarack savanna and tamarack forest. Most of the tamarack (*Larix laricina*) is found in the central and northern portions of the wetland where it grows in a gradient from dense thickets to tamarack savanna within a sedge meadow. The sedge meadow is dominated by *Carex stricta, C. lacustris*, cattail (*Typha glauca*) and Joe-pye weed (*Eupatorium maculatum*). The fen is characterized by shrubby cinquefoil (*Potentilla fruticosa*), bog birch (*Betula pumila*), *C. stricta*, and poison sumac (*Toxicodendron vernix)*. Fen patches dominated by *C. stricta,* spike-rush (*Eleocharis* spp.)*,* softstem bulrush (*Scirpus validus*)*,* twig-rush (*Cladium mariscoides*)*,* and alder buckthorn (*Rhamnus alnifolia*) mingle with shrub-carr dominated by dogwoods (*Cornus* spp.), ninebark (*Physocarpus opulifolius*), and glossy buckthorn (*Rhamnus frangula*)*,* with open or closed stands of tamarack. Much of the surrounding land is agricultural or low density housing. Rare plants and animals known from this site include bog bluegrass (*Poa paludigena* T), mat muhly (*Muhlenbergia richardsonis* T), white lady-slipper (*Cypripedium candidum* T), Blanding's turtle (*Emydoidea blandingii* SC), eastern box turtle (*Terrapene c. carolina* SC), eastern massasauga rattlesnake (*Sistrurus c. catenatus* SC), angular spittlebug (*Lepyronia angulifera* SC), red-legged spittlebug (*Prosapia ignipectus* SC), Poweshiek skipper (*Oarisma poweshiek* T), regal fern borer (*Papaipema speciosissima* SC), Silphium borer moth (*Papaipema silphii* T), swamp metalmark (*Calephis*

mutica SC) and tamarack tree cricket (*Oecanthus laricis* SC). Management at this site has included removing adult glossy buckthorn and purple loosestrife from both occupied areas and nearby unoccupied areas.

Jackson County East (EO .012)
This is a small fen complex of approximately 40 acres owned by 5 different private landowners. This fen is located on a drainage basin with coarse textured end moraine. The lowland rises steeply on all sides to the moraine hills that have been converted to agriculture except for one area in the southwest that has remained forested. Prior to disturbance the fen area drained immediately into a lake. MNFI staff first explored this area in 1996 during satyr surveys. In 1996 thirty or more adult satyrs were observed in the southwest portion of the complex which contains approximately 30 acres. In 2000 TNC staff recorded 25 satyrs in this same portion of the complex as well as several satyrs on an adjacent landowner's property to the south. Most satyrs were observed in prairie fen openings that were surrounded by clumped shrubs and/or tamarack. These openings are fairly shrubby in comparison to some of the other sites where the satyr has been found. Several small creeks run though the complex draining into a nearby lake. Shrubs become tall and dominant along the creek. The area is quite shrubby with many thick clumps of glossy buckthorn (*Rhamnus frangula*), dogwood (*Cornus* spp.), scattered tamarack (*Larix laricina*) and poison sumac (*Toxicodendron vernix*). Prairie fen openings are small and highly divided by tall shrubs. Dominant vegetation in these opening include *Carex stricta*, Joe-pye weed (*Eupatorium maculatum*), and shrubby cinquefoil (*Potentilla fruticosa*). The lowland rises steeply on all sides to the moraine hills. A buffer of forest occurs in one area but remaining uplands consist mostly of agriculture. Threats include the presence of exotic species (glossy buckthorn, *Rhamnus frangula* and purple loosestrife, *Lythrum salicaria*), shrub invasion and dredging disturbance. It will require extensive resources to eradicate the glossy buckthorn from this site and remove the shrubs that are closing in the occupied patches of habitat. Although adjacent landowners are interested in protecting their wetlands for the satyr it is unclear whether the primary landowner is interested in cooperating with this type of management. For these reasons the future viability of this site remains unclear. The Michigan Office of The Nature Conservancy will maintain communication with this landowner so that this population can be monitored.

Jackson County West (EO .002)
The Mitchell's satyr was first documented at this site in 1980 and small numbers of satyrs were seen from the road near this site in 1986 and 1994. Landowner permission was finally secured in 2000 and appropriate habitat was thoroughly surveyed for the first time. The site contains over a hundred acres of herbaceous wetland, most of it sedge meadow. In 2000, 14 satyrs were observed in a small fen covering less than 10 acres. No satyrs were seen in the sedge meadow. The fen is bordered by a dirt road on the east and a stream to the north. The stream drains out of a large lake located to the east. Surrounding communities include an extensive sedge meadow, maple woods, oak-hickory woods, hardwood swamp, marsh, old field and some stands of tamarack. Shrubs are scattered throughout the prairie fen but are denser near the stream. Dominant vegetation includes *Carex stricta*, shrubby cinquefoil (*Potentilla fruticosa*), dogwood (*Cornus* spp.) and occasional Joe-pye weed (*Eupatorium maculatum*), willow (*Salix* spp.), poison sumac (*Toxicodendron vernix*), and tamarack (*Larix laricina*). White lady-slipper (*Cypripedium candidum* T) also is known to occur at this site. There is some purple loosestrife (*Lythrum salicaria*) near the road, along an impoundment on the stream and in the sedge meadow located to the west of the fen. The small amount of suitable habitat makes the satyr at this site vulnerable to demographic and ecological forces that could lead to its extirpation. The future of this site is unclear and will depend on the willingness of the landowner and available resources to expand areas of suitable habitat. The Michigan Office of The Nature Conservancy will maintain communication with this landowner so that the population can be monitored and that needed management (removal of purple loosestrife) can be implemented at this site.

Kalamazoo County East (EO .019)
It is believed that the Mitchell's satyr is extirpated from this site. One Mitchell's satyr was reported from this area in 1978 and none have been observed since, despite surveys in 1987,1989, 1993, 1998, and most recently in 2000. The public land where the satyr was originally reported consists of bottomland swamp forest, shrub-carr and areas of sedge meadow dominated by *Carex lacustris*. It has always been considered unlikely habitat for the satyr, even by the original surveyor. The area appears to have been flooded, perhaps for an impoundment. Surveys in 1998 and 2000 focused on potential fen habitat within the same drainage to the north and south of this site. No suitable habitat was identified in the area.

Kalamazoo County North (EO .020)
Satyrs were first discovered at this fen complex in 1973 and were most recently seen here in 2000. Potential and occupied satyr habitat occurs on private land that spans nearly 2 miles along a high-quality cold water stream (known for trout fishing), owned by 12 different property owners. Habitat along this drainage ranges from high quality prairie fen with many seeps and springs to dense shrub-carr. Surveyors have been unsuccessful in finding the satyr at the historical site where they were first seen in 1973. It is unclear whether the dredging of a pond which occurred at the historical site in the early 1990's, impacted the hydrology in such a way that the habitat became unsuitable for the satyr. Extensive surveys in 1998 documented only 12 satyrs in one small area (<1 acre) under a powerline, despite searches of several other areas where they had been seen in previous years. Five satyrs were again found in this one small portion of the fen in 1999, although the area was only checked briefly to avoid trampling the vegetation. As in 1998, satyrs were not found in other parts of this complex in 1999. In 2000, satyrs were seen around a pond directly south of the presently occupied site, although potential habitat here is quite limited. A high-quality prairie fen occurs just south of the occupied patches but the landowners who are building a private home have been unwilling to allow recent surveys. Both landowners that have the satyr on their property are supportive of our efforts to conserve the satyr and its habitat although the amount of occupied habitat is no larger than one acre in size. Characteristic plants at this site include tamarack (*Larix laricina*), shrubby cinquefoil (*Potentilla fruticosa*), dogwood (*Cornus* spp.), poison sumac (*Toxicodendron vernix*), narrow-leaved sedges (*Carex stricta, C. sterilis, C. flava*), Virginia mountain mint (*Pycnanthemum virginianum*), Ohio goldenrod (*Solidago ohioensis*), and marsh fern (*Thelypteris palustris*). Other rare plants and animals that have been documented in this wetland complex include: cut-leaved water parsnip (*Berula erecta* T), eastern box turtle (*Terrapene c. carolina* SC) and swamp metalmark (*Calephelis mutica* SC). Potential threats to this complex include altered hydrology from the digging of ponds, shrub encroachment, development of private lands, maintenance of the powerline, and the spread of cattails (*Typha* spp.). Management of this complex is challenging due to multiple ownership and increasing human development. Communication with the utility company that maintains the powerline corridor, occupied by the satyr, is critical to insure that activities detrimental to the satyr are avoided. Landowner education is very important in order to restore and maintain habitat for Mitchell's satyr at this site. Involvement by the Southwest Michigan Land Conservancy should prove beneficial to the satyr as they can provide a local presence for coordinating monitoring and management of the satyr in this complex.

Kalamazoo County West (EO .018)
The Mitchell's satyr was first documented at this site in 1974 and last observed in here in 2000. The wetland complex consists of an alkaline lake surrounded by shoreline wetlands. The uplands surrounding the lake rise steeply resulting in numerous springs and seeps at their bases. Fen and associated sedge meadow, marsh, shrub-carr and swamp forest occur at various locations in the area. In addition, open marl flats with strings or islands of stunted tamarack and moss occur in the fen complex. Satyrs have been documented on six different landowner's properties and most seem supportive of efforts to identify occupied habitat for this species. It is estimated that occupied habitat is approximately 5 to 6 acres. Characteristic plants at this site include tamarack (*Larix laricina*), shrubby cinquefoil (*Potentilla fruticosa*), poison sumac (*Toxicodendron vernix),* dogwood (*Cornus* spp.), willow (*Salix* spp.), bog birch (*Betula pumila*), alder-leaved buckthorn (*Rhamnus alnifolia*), sedges (*Carex stricta*, *C. sterilis, C. flava*) marsh fern (*Thelypteris palustris*) and spike rush (*Eleocharis* spp.). Other listed plants and animals that occur in this complex include prairie Indian plantain (*Cacalia plantaginea* SC), narrow-leaved reedgrass (*Calamagrostis stricta* T), white lady's slipper (*Cypripedium candidum* T), fleshy stickwort (*Stellaria crassifolia* T), Blanding's turtle (*Emydoidea blandingii* SC), and spotted turtle (*Clemmys guttata* T). Glossy buckthorn (*Rhamnus frangula*) is present in some areas of fen habitat especially along the drainage ditch and shrub encroachment is a problem. Past disturbances to the historical site have resulted in altered hydrology including: the digging of a channel from the springs to the lake to lower water levels, the construction of a road leading to the lake, and the filling of the wetlands around the lake for residential development. Current threats include altered hydrology from the drainage ditch, road and home building, and shrub encroachment and glossy buckthorn invasion. Involvement by the Southwest Michigan Land Conservancy should prove beneficial to the satyr as they can provide a local presence for coordinating monitoring and management of the satyr in this complex.

Lenawee County Site (EO .004)
Even though suitable habitat still occurs within this large wetland complex, it is believed that Mitchell's satyr has been extirpated. However, this is not known conclusively due to the vagueness of the original sighting record. Surveys conducted in 1987, 1989, 1993, and 1998-2000 on private and public lands in the area were unsuccessful in finding the satyr. Tamarack (*Larix laricina*) and poison sumac (*Toxicodendron vernix*) dominate the wetland area with small pockets of sedge (*Carex spp.*) throughout. The tamarack tree cricket (*Oecanthus laricis* SC) was documented from this wetland complex in 1999. There are several lakes in the area and a small creek bisects the fen complex. The site has become overgrown with gray dogwood (*Cornus racemosa*), red-osier dogwood (*Cornus stolonifera*), and alder-leaved buckthorn (*Rhamnus alnifolia*), and purple loosestrife (*Lythrum salicaria*) is dense in some portions of the fen. Without active management it is likely that this fen complex will succeed to shrub-carr and eliminate any remaining suitable habitat for the satyr. Past surveys have identified some areas of private land adjacent to the site that may contain suitable satyr habitat. Because the majority of the potential habitat is in state ownership, this should be considered as a possible reintroduction site, if proper management is coordinated and implemented to address the shrub encroachment and invasive species problems.

St. Joseph County East (EO .010)
This site is part of a large contiguous wetland that includes extensive areas of high quality prairie fen and tamarack swamp. The fen is located northeast and southwest of a large lake along a creek that feeds and drains the lake. Surrounding landuse includes agriculture and private homes. Satyrs were first discovered at this site in 1996 on three different private parcels and have been confirmed in 1997, 1999 and 2000. Most of the satyrs have been seen in a prairie fen that has been degraded due to the digging of a channel and a pond. This area is a mosaic of tamarack savanna, open shrub carr and sedge meadow. The size of occupied habitat is estimated to range between 20-25 acres. Characteristic vegetation includes *Carex stricta*, *Carex sterilis*, *Carex hystericina*, *Carex leptalea*, spike-rush (*Eleocharis* spp.), boneset (*Eupatorium perfoliatum*), swamp goldenrod (*Solidago patula*), shrubby cinquefoil (*Potentilla fruticosa*), dogwood (*Cornus* spp.), poison sumac (*Toxicodendron vernix*), bog birch (*Betula pumila*), tamarack (*Larix laricina*) and alder leafed buckthorn (*Rhamnus alnifolia*). Other rare plants and animals documented from this site include cut-leaved water parsnip (*Berula erecta*), the eastern box turtle (*Terrapene c. carolina* SC), the tamarack tree cricket (*Oecanthus laricis* SC), golden borer moth (*Papaipema cerina* SC), and the marsh wren (*Cistothorus palustris* SC). Threats at this site include the presence of cattail (*Typha* spp.), reed canary grass (*Phalaris arundinacea*) and shrub invasion, although these threats are manageable if they are addressed in the near future. Landowners are very cooperative and with appropriate resources and coordination this could remain a viable site for the satyr. The Southwest Michigan Land Conservancy will be monitoring the satyr at this site and working with landowners to implement management in the future.

St. Joseph County West (EO .006)
Satyrs were first documented at this site in 1952. Recent survey efforts have documented their presence in 1986, 1988, 1989, 1993, 1994, and 1997-2000. The site includes three separate areas, which are a mosaic of tamarack savanna, open fen and shrub-carr, which border a creek on both public and private land. Surrounding land use is agricultural, residential and recreational with large areas of upland forest. Most recently satyrs have only been seen in the western portion of this site on private land. Occupied habitat in this area is estimated to range between 10-15 acres. The two landowners have been cooperative and have allowed access to the occupied site. Nearly all of this property adjacent to the creek has favorable satyr habitat and contains a rich diversity of fen species. Dominant vegetation in the fen includes *Carex strica*, *Carex lasiocarpa*, *Carex prairea*, *Carex* sterilis, Carex *lacustris*, poison sumac (*Toxicodendron vernix*), tamarack (*Larix laricina*), shrubby cinquefoil (*Potentilla fruticosa*), dogwood (*Cornus* spp.), bog birch (*Betula pumila*), boneset (*Eupatorium perfoliatum*), Joe-pye weed (*E. maculatum*) marsh fern (*Thelypteris palustris*), and spike-rush (*Eleocharis* spp.). Cattail (*Typha* spp.) is common and there are some areas of reed canary grass (*Phalaris arundinacea*) and purple loosestrife (*Lythrum salicaria*). Management of these exotics as well as shrub control is needed to maintain suitable habitat for the satyr over time. Areas to the east where satyrs were documented in the past are less diverse with only small pockets of fen and are overall much wetter sites. Rare plants recorded from this area include cut-leaved water parsnip (*Berula erecta* T), wild rice (*Zizania aquatica* var. *aquatica* T) and narrow-leaved reedgrass (*Calamagrostis stricta* T). Many rare animals have been documented at this site including Indiana bat (*Myotis sodalis* E), eastern massasauga (*Sistrurus c. catenatus* SC), copperbelly watersnake (*Nerodia erythrogaster neglecta* E), black rat snake (*Elaphe o.*

obsoleta SC), spotted turtle (*Clemmys guttata* T), Blanding's turtle (*Emydoidea blandingii* SC), eastern box turtle (*Terrapene c. carolina* SC), quiet underwing (*Catacola dulciola* SC), and grey petaltail (*Tachopteryx thoreyi* SC). Southwest Michigan Land Conservancy will continue to monitor this site and work with local landowners on implementing appropriate management at this site in the future.

Van Buren County Northeast (E0 .013)
The Mitchell's satyr was first discovered at this site in 1999 during *de novo* surveys of potential fen habitat. Five adults were seen in a fen that occurs as a narrow band along a creek connecting two lakes in the area. Satyrs were again documented here in 2000 as well as on the other side of the creek on an adjacent landowner's property. The site is characterized by a forested outer strip, adjacent to an area of dense, glossy buckthorn-dominated shrub-carr, which grades into prairie fen. The soil is saturated, dark and mucky with marl and seeps present. Size of occupied habitat is estimated at less than 5 acres. Abundant or common species include shrubby cinquefoil (*Potentilla fruticosa*), dogwood (*Cornus* spp.), tamarack (*Larix laricina*), alder-leaved buckthorn (*Rhamnus alnifolia*), poison sumac (*Toxicodendron vernix*), spike rush (*Eleocharis* spp.), willow (*Salix* spp.), big bluestem (*Andropogon gerardii*), bluejoint grass (*Calamagrostis canadensis*), Ohio goldenrod (*Solidago ohioensis*) and asters (*Aster* spp.). Other rare plants and animals that occur at this site include leadplant (*Amorpha canescens* SC), prairie Indian plantain (*Cacalia plantaginea* SC), white lady's slipper (*Cypripedium candidum* T), eastern box turtle *(Terrapene c. carolina* SC) and Eastern massasauga rattlesnake (*Sistrurus c. catenatus* SC). Threats to this site include shrub encroachment and the presence of exotic or invasive species including glossy buckthorn (*Rhamnus frangula*) and cattails (*Typha* spp.). In addition, there is potential for the runoff of fertilizer and chemicals from a golf course and residential lawns to impact the fen complex. The current landowner of the site where most of the satyrs have been documented is very cooperative. The adjacent landowner did not provide permission to access his property but was informed that we did observe satyrs on his land from the opposite side of the creek. Southwest Michigan Land Conservancy will continue to monitor satyrs at this site.

Van Buren County Site (EO .015)
It is not known whether the satyr still occurs at this site, since permission to survey the core area of habitat has not been secured. Satyrs were first documented here in 1986 and later reconfirmed in this area in 1994. The site is a large wetland complex with areas of tamarack savanna and fen heavily invaded by shrubs in some areas. Northern openings appear to have been grazed in the past. Surrounding land use is primarily agricultural, low density residential and recreational. The area of suitable habitat for the satyr is estimated to range between 5 and 20 acres. Characteristic vegetation at this site includes *Carex stricta*, *Carex lacustris*, shrubby cinquefoil (*Potentilla fruticosa*), poison sumac (*Toxicodendron vernix*), bog birch (*Betula pumila*), big bluestem (*Andropogon gerardii*), and scattered tamarack (*Larix laricina*). The eastern box turtle (*Terrapene c. carolina* SC) has also been recorded from this area. Until permission can be obtained to thoroughly survey this site, its viability remains unknown. Staff at the Southwest Michigan Land Conservancy will pursue communication with key landowners at this site so that a survey can be conducted.

Washtenaw County West (EO. .011)
Scientists first documented satyrs at this location in 1958 when 500 individuals were observed. In 1965 one individual was seen along the road. Despite searches in 1987 and 1992, satyrs were not seen again at this site until 2000 when one satyr was seen in a tamarack swamp at the historical site and 16 individuals were seen in prairie fen just west of the historical location. The fen occurs in a narrow band along both sides of a stream that flows into a pond. The area of occupied habitat is currently estimated to be 1-2 acres in size. To the south the fen grades into a patch of reeds (*Phragmites* spp.) and then into tamarack swamp with a *Sphagnum*-dominated ground layer. On the northeast side the fen grades into dense reed canary grass (*Phalaris arundinacea*). The surrounding uplands are forested with areas of agricultural land and residential homes. The fen contains several seeps with grass of parnassus (*Parnassia glauca*) and rush (*Juncus brachycephalus*). The ground layer is dominated by *Carex stricta*, shrubby cinquefoil (*Potentilla fruticosa*), and swamp goldenrod (*Solidago patula*). Poison sumac (*Toxicodendron vernix*), spicebush (*Lindera benzoin*), tamarack (*Larix laricina*), and gray dogwood (*Cornus racemosa*) characterizes the shrub layer. Trees in the subcanopy and canopy include tamarack, American elm (*Ulmus americana*), basswood (*Tilia americana*) and red maple (*Acer rubrum*). Although habitat along the stream flowing out of the pond appears suitable, no satyrs were seen in this area. The eastern box turtle (*Terrapene c. carolina* SC) also has been recorded from this site. Purple loosestrife (*Lythrum salicaria*) is common at the occupied site and will likely increase in abundance over time. Shrub and tree encroachment is

severe and will likely form a closed canopy within 25 years or less. Management needs are high at this site and management activities should be implemented soon before the challenges become too great in scope. All three landowners that have satyrs on their property are very supportive and would likely cooperate with needed management in the future. Currently there is no group that is dedicated to monitoring and managing this site. It is possible that a local watershed organization, willing to provide some stewardship could be identified. This possibility should be explored further so that appropriate efforts are directed towards conserving this satyr population.

Acknowledgements

As with any large, complex, multi-year project, this one involved a variety of Michigan Natural Features Inventory (MNFI) staff and other partners who collectively made the impossible, possible. Their efforts have contributed greatly to our understanding of the distribution and status of the Mitchell's satyr (*Neonympha mitchellii mitchellii*) in Michigan.

First, our original project proposal was greatly strengthened by the able assistance of Lucinda Corcoran, U.S. Fish and Wildlife Service Wildlife Biologist; Eric Sink, Michigan Department of Natural Resources Federal Aid Coordinator; Robert Humphries, Wildlife Division Federal Aid Coordinator; and Ray Rustem, Wildlife Division Natural Heritage Supervisor.

The Mitchell's Satyr Working Group provided stimulating discussion and suggestions for specific project activities, as well as shared results from their own projects. We thank all members of the group who have worked so patiently with us: Mark Hodgkins and Jennifer Szymanski, U.S. Fish and Wildlife Service; John Shuey, Indiana Field Office of The Nature Conservancy; Chris Clampitt, Doug Pearsall, John Legge, Sherri Laier, Jack McGowan-Stinski, and Dave Ewert, Michigan Field Office of The Nature Conservancy; Ray Rustem, Wildlife Division, Michigan Department of Natural Resources; and Helen Enander, Yu Man Lee, Jeff Cooper, John Paskus and Ed Schools, MNFI.

The comprehensive and intensive nature of the field surveys conducted over the past three years for this species would not have been possible without the skill and dedication of many individuals. We would like to acknowledge the following MNFI staff: Jeff Cooper, Zoologist; Yu Man Lee, Zoologist; Matt Smar, former Zoology Assistant; Erica Choberka, Botanist; Phyllis Higman, Botanist; Michael Penskar, Program Botanist; Bethany Soule, former intern; Dennis Albert, Program Ecologist; Josh Cohen, Ecologist; Rich Corner, former Ecologist; Glenn Palmgren, Stewardship Ecologist; Pete Badra, Aquatic Zoologist; Stephanie Carman, Aquatic Zoologist; David Stagliano, Aquatic Zoologist; Jennifer Olson, Environmental Review Specialist; John Paskus, Conservation Planning Specialist; Janet Hayward former Assistant Information Manager; and Judy Soule, Director. We also appreciate the assistance provided by Pat Lederle, Endangered Species Coordinator; Kim Herman, Heritage Stewardship Coordinator; and Lori Sargent, Endangered Species Specialist, Wildlife Division, Michigan Department of Natural Resources. Lastly, we would like to thank the staff and volunteers from the Southwest Michigan Land Conservancy, Nicole Hill, Land Protection Specialist; Renee Kivikko, former director; and Russ Schipper, Frank Ballo and Lynne Steil, Board of Directors.

Since the majority of our survey work takes us to private lands, we deeply appreciate the diligence of Stephanie Carman, Jeff Cooper, Yu Man Lee, John Paskus and Matt Smar in obtaining landowner permission for access over the past three years. Without willing and interested landowners, this study would not be possible.

Helen Enander, Information Technology Professional, produced the maps for this report. Her GIS skills are a valuable resource that have contributed greatly to the project. We also would like to acknowledge Becca Boehm and Michael Fahsoway, Information Technology Professionals, for providing quality control of the Mitchell's satyr data, entering and digitizing these records into the database and for their assistance in formatting this report. Finally we thank Sue Ridge, Director of Administration and Laraine Reynolds, Administrative Assistant, who provided help in the countless ways that aid in conducting and completing our work.

Funding for this project is a contribution of Federal Aid in Endangered Species, Michigan Project E-1-30.

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APPENDIX 1

MNFI Mitchell's Satyr Survey Form

MICHIGAN NATURAL FEATURES INVENTORY
Mitchell's Satyr Survey Form

SITE INFORMATION

Surveyor(s): _____ **Date**: _____
County: _____ **Quad name/code**: _____
TRS: _____ **Air Photo #**: _____
Survey Site Name:_____
Directions to site: _____
_____
_____

Approximate acreage of potential habitat: _____
Percent of suitable habitat surveyed: _____
Natural and/or artificial disturbance: _____
_____
_____
Landowner's name, address /phone number_____

SURVEY/BIOLOGICAL DATA

Weather:_____
Mitchell's satyr observed: yes__ no__
Circumstances of observation (deliberate, accidental observation, etc.): _____
_____
Describe individuals observed— sex, number, behavior, location, etc.:_____
_____
_____
_____
Estimated number of individuals in the local population and the basis of this estimate: _____
_____
History of site – yrs. of confirmed vs. suspected breeding, population trends, etc.: _____
_____

List other animal species observed at this site. Note especially listed species and potential predators, competitors, and prey.

Species	ID (+ or ?)	Number obs.	Notes, observations, etc.

RETURN TO: Michigan Natural Features Inventory, P.O. Box 30444, Lansing, MI, 48909-7944

HABITAT DATA

Presence of seeps: yes___ no___
Soil is saturated, dark, and mucky: yes____ no____
Marl present: yes___ no___

Habitat Structural Categories (assess the pertinent wetlands at the scale of at least 5 acres):

a) Forest (canopy cover of trees > 60%)
b) Savanna (scattered trees with 25 to 60% cover)
c) Dense carr (shrubs > 1m tall cover > 60% of the ground)
d) Open carr (shrubs > 1m tall cover 25 to 60% of the ground)
e) Meadow (woody species > 1m tall cover < 25% of the ground)
f) Mosaic of (circle main components): a b c d e

Threats (circle one):

a) Altered hydrology (indicate type of alteration):_____
b) ORV use
c) Grazing
d) Shrub encroachment
e) Development/land use change (indicate type of change):
_____
_____
_____
_____
f) Other: _____
_____
_____
_____

Invasive Plants (note abundance):

(A = abundant, C = common, O = occasional, R = Rare):
a) Purple loosestrife ___ d) Glossy buckthorn ___
b) Reed canary grass ___ e) Typha ___
c) Giant Reed Grass ___ f) Other _____

VEGETATION COVER:

FEN INDICATOR PLANT SPECIES

Please note the following species observed. Note abundance of each species using the following scale:
A = Abundant, C= Common, O = Occasional, R = Rare, NO = Not Observed

Species	Abundance	Species	Abundance
Shrubby cinquefoil		Fringed brome	
Dogwood		Blue-joint grass	
Quaking aspen		Pitcher plant	
Willow		Boneset	
Bog birch		Joe-pye weed	
Tamarack		Riddlles goldenrod	
Alder-leafed buckthorn		Bog valerian	
Poisin sumac		Whorled loosestrife	
Carex sterilis		Round-leafed sundew	
Carex flava		Bog lobelia	
Spike rush		Virginia mountain mint	
Indian grass		Aster spp.	
Little bluestem		Ohio goldenrod	
Big bluestem		Marsh fern	
Marsh wild-timothy			

Overall height of ground cover (circle one):

a) 0 – 0.5
b) > 0.5 – 1m
c) > 1m

Overall height of shrub layer (circle one):

a) 1 –2m
b) > 2m

Overall height of tree layer (circle one):

a) 2 – 5m
b) 5m – 10m
c) 10m – 20m
d) > 20m

APPENDIX 2

Species Abstracts

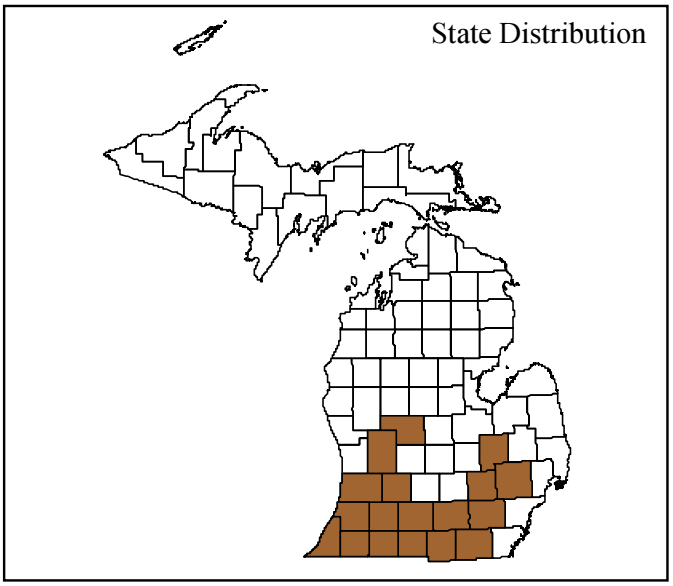
Communities
Prairie Fen

Plants
Mat muhly grass (*Muhlenbergia richardsonis*)
Prairie dropseed (*Sporobolus heterolepis*)
Prairie Indian plantain (*Cacalia plantaginea*)
Small white lady's-slipper (*Cypripedium candidum*)

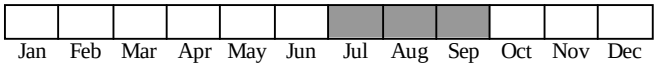
Animals
Blanchard's cricket frog (*Acris crepitans blanchardi*)
Blanding's turtle (*Emydoidea blandingii*)
Blazing star borer moth (*Papaipema beeriana*)
Culver's root borer moth (*Papaipema sciata*)
Eastern box turtle (*Terrapene c. carolina*)
Eastern massasauga rattlesnake (*Sistrurus c. catenatus)*
Mitchell's satyr (*Neonympha mitchelli mitchellii*)
Red-legged spittlebug (*Prosapia ignipectus*)
Silphium borer moth (*Papaipema silphii*)
Spotted turtle (*Clemmys guttata*)

Prairie fen — Community Abstract


Photo by Dennis A. Albert.



Best Survey Period



Global and state rank: G4/S4

Total range: Prairie fens are geologically and biologically unique wetlands found only in the glaciated Midwest. They are distinguished from other calcareous fens by a tallgrass prairie flora and fauna component. They currently are known in Illinois, Indiana, Iowa, Ohio, Michigan, Minnesota, North Dakota, Wisconsin and southern Ontario. Similar communities are also known in unglaciated Missouri (Orzell & Kurz 1984). In Michigan, prairie fens occur in the southern three to four tiers of counties, primarily in the glacial interlobate region.

Rank justification: With the exception of Missouri, prairie fens are restricted to glaciated portions of the Midwest with specific geologic features, and are a regionally common natural community. Prior to European settlement, prairie fens were undoubtedly more numerous than they are today. Agriculture and urban development in Michigan have disrupted groundwater flow and destroyed wetlands, including prairie fens. In addition, lack of fire has likely caused prairie fens to succeed into shrub carr communities (Moran 1981). Currently, about 85 prairie fens are identified in Michigan totalling about 2,000 acres (810 hectares).

Landscape context: Prairie fens occur in the glacial interlobate region of Michigan's southern Lower Peninsula. This region contains a broad outwash plain scattered with "islands" of coarse-textured end and ground moraine, and ice contact ridges (Albert 1995). Prairie fens are typically located along the junction of outwash plain and moraine or ice contact ridge. They occur on lower slopes of the moraine or ridge, where coarse-textured glacial deposits provide high hydraulic conductivity, forcing groundwater to the surface (Moran 1981). Prairie fens are often associated with and drain into a small lake or pond, or, less often, a river or stream. Sapric peat, one foot to greater than 36 feet (.5 to >12 meters) deep (Moore et al. 1993), is typical prairie fen substrate, which is saturated with a constant supply of groundwater. Groundwater is calcareous, or rich in both calcium and magnesium bicarbonates; resulting from flow through limestone bedrock and/or coarse textured calcareous glacial deposits (Curtis 1959, Moran 1981, White & Chapman 1988). The high concentrations of bicarbonates often precipitate as marl at the soil surface. Soils are circumneutral with a typical pH range from 6.8 to 8.2. (White & Chapman 1988, Aaseng et al. 1993).

Natural processes: Hydrological processes are very important in prairie fen vegetative structure.

Saturated peat is maintained by a constant inflow of groundwater rich in calcium and magnesium from surrounding glacial deposits. Calcium and magnesium-rich groundwater often upwells through the peat and forms broad seeps or local springs. Once groundwater enters the prairie fen, drainage continues through the peat either in diffuse surface flow or in stream flow (Almendinger et al. 1994).

In the early 1800s, prairie fens were part of an ecosystem complex maintained by fire (Chapman 1988).

Prior to European settlement, dry, open upland communities such as mixed oak barrens or white oak

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savannas were often adjacent to prairie fens (Comer et al. 1995). Native American or lightning strike fires burned uplands and likely spread into adjacent prairie fens (Vogl 1969). These fires burned surface vegetation, inhibited shrub invasion, and maintained the open prairie fen community structure (Curtis 1959).

Vegetation description: Historically, prairie fen vegetation was adapted to the natural processes described above. Fire is supressed in most landscapes today, and therefore the vegetative structure in existing prairie fens is largely a result of the unique hydrology. Vegetation of this community consists of obligate wetland and calcicolous species mixed with tallgrass prairie and sedge meadow species.

Three (or four) vegetation zones are often present in prairie fens (Chapman 1988). Inundated flats or depressions are located around lake or stream margins. This zone can be expansive around lakes, or localized along small ponds, streams, or springs. It is the wettest portion of the prairie fen, with up to a foot (.3 meter) of standing water in the spring and early summer. Dominant species include *Scirpus acutus* (hardstem bulrush), *Scirpus americanus* (three-square), *Cladium mariscoides* (twig-rush), *Juncus brachycephalus* (rush), *Eleocharis elliptica* (golden-seeded spike-rush), and *E. rostellata* (spike-rush).

Sedge meadow is the largest and most characteristic vegetative zone of a prairie fen. This zone is saturated but not inundated and slightly sloping with stable peat. Any number or combination of three general associations of dominance can be found in the sedge meadow zone. The sedge-shrub association is a combination of sedges and low growing shrubs, often dominated by *Potentilla fruiticosa* (shrubby cinquefoil), *Carex stricta* (meadow sedge), and *C. aquatilis* (sedge). The sedge-composite association is often dominated by *C. stricta* (meadow sedge), *Eupatorium maculatum* (joe-pye weed), *E. perfoliatum* (common boneset), and *Aster* spp. (asters). The grass-sedge association is often dominated by *C. stricta*, *C. sterilis*, *C. aquatilis* (sedges), *Andropogon scoparius* (little bluestem), *A. gerardii* (big bluestem), and *Sorghastrum nutans* (Indian grass). Other species common in all associations of the sedge meadow zone include *Bromus ciliatus* (fringed brome), *Calamagrostis canadensis* (blue-joint grass), *Lysimachia qaudriflora* (whorled loosestrife), *Muhlenbergia glomerata* (marsh wild-timothy), *Pycnanthemum virginianum* (Virginia mountain mint), *Rudbeckia hirta* (black-eyed Susan), *Solidago ohioensis* (Ohio goldenrod), and *Thelypteris palustris* (marsh fern). Other shrubs in this zone include *Betula pumila* (bog birch), and *Cornus spp*. (dogwoods). Lack of fire and disruptions in groundwater flow often result in the colonization of these and other shrub and tree species including *Salix spp*. (willows), *Populus tremuloides* (quaking aspen), *Rhamnus alnifolia* (alder-leaved buckthorn), and *Ulmus americana* (American elm). Diversity and herbaceous cover are greatest in the sedge meadow zone, which distinguishes prairie fen from other calcareous fen communities in Michigan.

A wooded fen zone dominated by shrubs and trees is often located around upland edges of prairie fen.

The zone usually occurs on higher and slightly sloping surfaces where upland grades to wetland.

However, lower and wetter wooded fen zones also occur. *Larix laricina* (tamarack) is often a major component and sometimes dominant in the wooded fen zone. Occasionally, these zones resemble deciduous swamp dominated by *Acer rubrum* (red maple) and *Ulmus americana* (American elm). Shrub species, such as *Cornus stolonifera* (red-osier dogwood), *C. foemina* (gray dogwood), *Physocarpus opulifolius* (ninebark), *Salix candida* (sage willow), *Spiraea alba* (meadowsweet), and *Toxicodendron vernix* (poison sumac) are common in both types of wooded fen.

Another vegetative zone is sometimes distinct in areas of calcareous groundwater seepage. These areas are either broad and flat or small and broken and sparsely vegetated with marl precipitate at the surface.

The high concentration of calcium and magnesium in these areas results in vegetation dominated by calcicolous species including *Carex flava* (sedge), *Lobelia kalmii* (bog lobelia), *Parnassia glauca* (grass-of-parnassus), *Rhynchospora alba* (beak-rush), and *Triglochin maritimum* (bog arrow-grass). Carnivorous *Drosera rotundifolia* (round-leaved sundew), *Sarracenia purpurea* (pitcher plant), and *Utricularia intermedia* (flat-leaved bladderwort) are also found in this zone.

Strata	Most abundant
Tree canopy	*Larix laricina* (tamarack)
Short shrub	*Potentilla fruiticosa* (shrubby cinquefoil), *Betula pumila* (bog birch)
Herbaceous	*Carex stricta*, *C. aquatilis* (sedges), *Eleocharis rostellata* (spike-rush), *Cladium mariscoides* (twig rush), *Scirpus acutus* (bulrush)


Photo by William W. Brodowicz.

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Michigan indicator species: *Larix laricina* (tamarack), *Parnassia glauca* (grass-of-parnassus), *Potentilla fruiticosa* (shrubby cinquefoil), *Pycnanthemum virginianum* (Virginia mountain mint), *Solidago ohioensis* (Ohio goldenrod), *S. riddellii* (Riddell's goldenrod), and *Sorghastrum nutans* (Indian grass).

Other noteworthy species: Several rare animals are associated with prairie fen. *Oecanthus laricis* (tamarack tree cricket) is associated with the wooded fen zone often fringing a prairie fen. *Neonympha mitchellii mitchellii* (Mitchell's satyr) is also associated with more open edges of wooded fen zone where tamarack trees and poison sumac are scattered within a meadow of tall sedges. *Oarisma poweshiek* (poweshiek skipper) is found associated with spike and bulrushes in the inundated flat/ depression zone.

Celephelis muticum (swamp metalmark) is found associated with its host plants *Circium muticum* (swamp thistle) primarily and *C. altissimum* (tall thistle). *Lepyronia angulifera* (angualr spittlebug) has been collected from marly flats. Food plants for the adults include *Sporobolus indicus* (smut-grass), *Cyperus sweinitzii* (umbrella sedge), and other sedges. Adults of this species feed on *Gossypium hirsutum* (cotton) as well as a variety of monocots. Although not restricted to fens, *Sistrurus catenatus catenatus* (massasauga) is often found in the sedge meadow zone.

Rare plants associated with prairie fen include *Cacalia plantaginea* (tuberous Indian plantain), *Carex richardsonii* (Richardson's sedge), *Cypripedium candidum* (white ladies-slipper), *Muhlenbergia richardsonis* (mat muhly), *Rudbeckia sullivantii* (black-eyed Susan), *Sporobolus heterolepis* (prairie dropseed), and *Valeriana ciliata* (common valerian).

Invasive, non-native species such as *Rhamnus frangula* (glossy buckthorn) establish monocultures along wooded fen edges and often extend into the sedge meadow zone. *Lythrum salicaria* (purple loosestrife) can also invade the inundated flat/depression zone.

Conservation/management: Protecting hydrology is most important in the maintenance of vegetative structure in prairie fens. Groundwater flow into the prairie fen is altered by agricultural and residential drains and wells. The underlying groundwater table is lowered because of groundwater extraction and lack of recharge due to drained surface water. A lower groundwater table cannot supply the calcareous seepage which underlies prairie fen communities. Land use planning to protect the aquifer recharge area to the prairie fen is necessary to retain the unique hydrology. Many of the existing prairie fens already have disrupted aquifer recharge areas and portions of these communities are slowly changing to shrub-carr.

Healthy woodlands, savanna, and prairies in uplands adjacent to fens allow infiltration of precipitation into the groundwater. Whereas lawns, agricultural fields, and impervious surfaces contribute warm, nutrient & sediment-laden surface water runoff into fens.

Nutrient addition from leaking septic tanks and drain fields is suspected of contributing to the dominance of invasives such as *Typha angustifolia* (narrow-leaved cat-tail), and *Phragmites australis* (reed) and purple loosestrife in portions of several prairie fens (Panno, S.V et al. 1999).

Control of invasive and woody species invasion is necessary in these prairie fens to restore natural vegetative patterns of diversity. Fire and manual removal have proven effective in controlling exotics and native woody invasives (Kohring 1982, Zimmeran 1983). Bowles et al. (1996) determined that although fire did not significantly decrease woody species frequency it increased graminoid dominance.

Research needs: Quantify vegetational differences of structure and species diversity in prairie fens across the regional distribution. Investigate historical fire frequency within prairie fens. Determine how varying degrees of hydrological disruption effect patterns of praire fen vegetative structure. Investigate the association of rare species with prairie fens (i.e. Mitchell's satyr). Further identify the most effective management techniques in restoring native prairie fen flora and fauna.

Similar communities: wet prairie, wet-mesic prairie, southern wet meadow, shrub carr, lakeplain prairie, northern fen, poor fen, interdunal wetland, bog

Other classifications

Michigan Natural Features Inventory (MNFI) Presettlement Vegetation: not specifically noted, likely associated with 6227-wet prairie, 6122-marsh.

Michigan Department of Natural Resources (MDNR): L-lowland brush, N-marsh, T-tamarack.

Michigan Resource Information Systems (MIRIS): 612-shrub/scrub, 623-non-forested flats.

National Wetland Inventory (NWI): not specifically mentioned.

The Nature Conservancy National Classification: CODE: (V.A.7.N.p).

Alliance: *Potentilla fruiticosa*/*Carex* (*flava*, *interior*, *sterilis*, *lasiocarpa*) (saturated shrub herbaceous).

Association: *Potentilla fruiticosa*/*Carex sterilis-Carex flava-Eleocharis rostellata-Cacalia plantaginea* (shrub herbaceous vegetation).

Related abstracts: Mitchell's satyr, poweshiek skipper, white lady's-slipper, prairie dropseed

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Funding for abstract provided by Michigan Department of Natural Resources - Wildlife Division.

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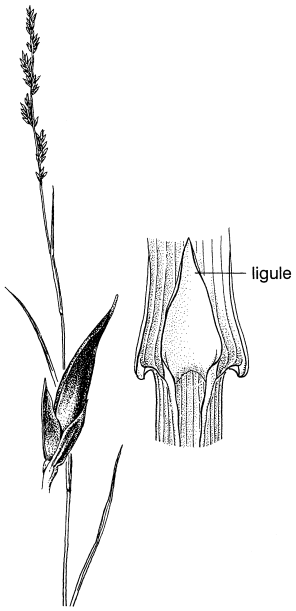
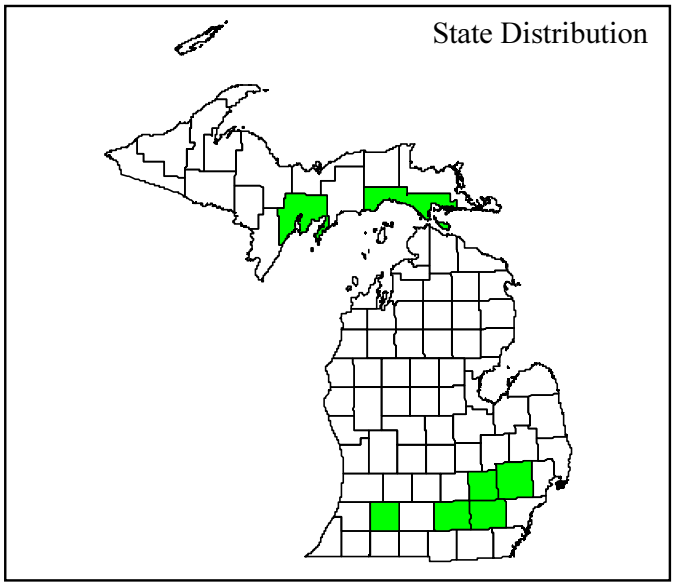
Muhlenbergia richardsonis (Trin.) Rydb. mat muhly





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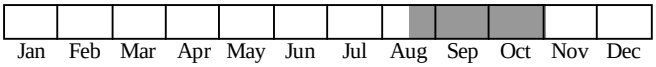

Status: State threatened

Global and state rank: G5/S2

Other common names: muhly grass

Family: Poaceae (grass)

Synonyms: *Muhlenbergia brevifolia* (Nutt.) Nash.

Total range: *Muhlenbergia richardsonis* is abundant in the western prairies, and extends from the Yukon south to California and New Mexico, ranging eastward to Nebraska, Minnesota, Wisconsin, and Michigan. It also occurs through southern Canada to Anticosti Island in the Gulf of St. Lawrence, and south to Maine.

State distribution: Approximately a dozen records for mat muhly are scattered across southern Lower Michigan, the majority of these identified within the last two decades. In the Lower Peninsula this species is found primarily within the glacial interlobate region, where it forms a local groundcover in high quality prairie fens. One Washtenaw County site, a small local fen, has been badly degraded and is probably not viable. In the Upper Peninsula, this species is also found in localized abundance along portions of the Escanaba River in Delta County, where it occurs on alvar, and from a single site in Mackinac County, where it is found in a marl fen. An 1895 Farwell collection from Keweenaw County is considered by Voss (1972) to be suspicious, possibly representing an introduction from the West.

Recognition: *Muhlenbergia richardsonis* is a very slender, wiry grass that grows in loose to dense tufts or mats, sometimes forming a sod. The stems, which may reach 2-6 dm in height, arise from the prostrate bases of old stems or occasionally from stolons (horizontal above-ground stems), but not from rhizomes (underground stems), which are lacking in this species. The wiry, narrow, 1-2 m wide stem leaves are erect to ascending and infolded, with ligules (at the innter juncture of leaf sheath and blade) 1.5-3 mm long. Inflorescences, which are produced terminally, consist of several short, narrow, ascending, panicles. Tiny one-flowered spikelets (2.4-3.5 mm long), are borne on stalks less than twice their length. The glabrous and long tapering lemmas (tiny bracts at the base of on individual floret) lack hairs at their base.

M. cuspidata (plains muhly), a similar species known only from a 19th century collection in Keweenaw County (from rocky bluffs) has lemmas with minute hairs and ligules shorter than 0.5 mm. *M. uniflora*, a species that might occur with *M. richardsonis* in Upper Michigan, is a considerably smaller plant easily distinguished by its broad open panicle. All of our other species of *Muhlenbergia* can be distinguished by the presence of relatively long hairs at the base of the lemma.

Best survey time: This slender grass develops flowering stalks in the late summer, which may be visible by early August. However, this species is best sought from about mid-August through October.

Habitat: In southern Michigan, this species typically occurs in prairie fens (alkaline peatlands), often forming a dense turf with other prairie grasses such as *Andropogon gerardii* (big bluestem), *A. scoparius* (little bluestem), *Sorghastrum nutans* (Indian grass), and *Sporobolus*

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heterolepis (prairie dropseed). Other frequent and characteristic associates include *Potentilla fruticosa* (shrubby cinquefoil), *Larix laricina* (larch), *Salix candida* (hoary willow), *Carex buxbaumii* (Buxbaum's sedge), *C. stricta*, (strict sedge), *C. sterilis* (sedge), *C. sartwellii* (sedge), *C. prairea* (sedge), *Solidago ohioensis* (Ohio goldenrod), *Hierochloe odorata* (sweet grass), *S. riddellii* (Riddell's goldenrod), *Muhlenbergia glomerata* (muhly grass), *Eupatorium perfoliatum* (boneset), *E. maculatum* (joe-pye-weed), and *Thelypteris palustris* (marsh fern), among numerous other forbs and woody plants. In Upper Michigan, *M. richardsonis* forms a dense turf with prairie dropseed on portions of the Escanaba River alvar, a globally rare, prairie-like grassland community that forms a thin turf of vegetation over limestone and dolomite bedrock. In other portions of its range, mat muhly occurs in a variety of wet to dry, usually alkaline habitats and also in sandy prairies (Hitchcock 1951).

Biology: Mat muhly is a warm-season perennial, commencing growth relatively late in the spring and flowering from about mid-July through September. Fire is an important component of this species' ecology. Anderson and Bailey (1980) found that after annual spring burns on grassland in Alberta, *M. richardsonis* responded with increased seed head production.

Conservation/management: The Mackinac County locality lies in a proposed Research Natural Area within Hiawatha National Forest, and a Washtenaw County population is in a county nature park. Other colonies are partly or wholly on private land, several being maintained under informal protection agreement, and some populations are protected within preserves of The Nature Conservancy and other private organizations.

This species benefits from fire, as described above. Prescribed burning is also frequently important in southern Michigan fen habitats to control shrubs, which without management may encroach vigorously to the detriment of several plant and animal species.

Research needs: Monitoring to determine the response to prescribed fire and other management regimes is a principal research need at present. *Muhlenbergia richardsonis* is known in one southern Michigan State Game Area to support a newly described leafhopper (*Flexamia huroni* Hamilton & Bess); further inventories are thus necessary to determine the range and status of the leafhopper and its relationship and natural history with regard to *Muhlenbergia*.

Related abstracts: prairie fen, edible valerian, English sundew, prairie dropseed, prairie Indian plantain, small white lady's-slipper, Mitchell's saytr

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Abstract citation

Penskar, M.R. and P.J. Higman. 1999. Special plant abstract for *Muhlenbergia richardsonis* (mat muhly). Michigan Natural Features Inventory, Lansing, MI. 2 pp.

Funding for abstract provided by Michigan Department of Natural Resources - Wildlife Division.

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Sporobolus heterolepis (Gray) Gray — prairie dropseed

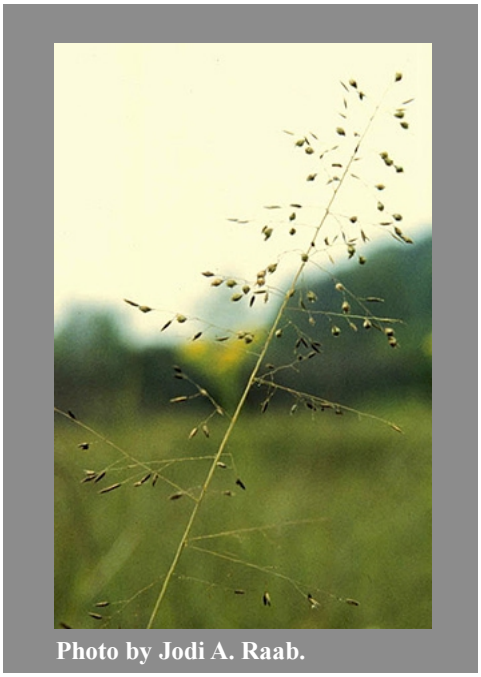
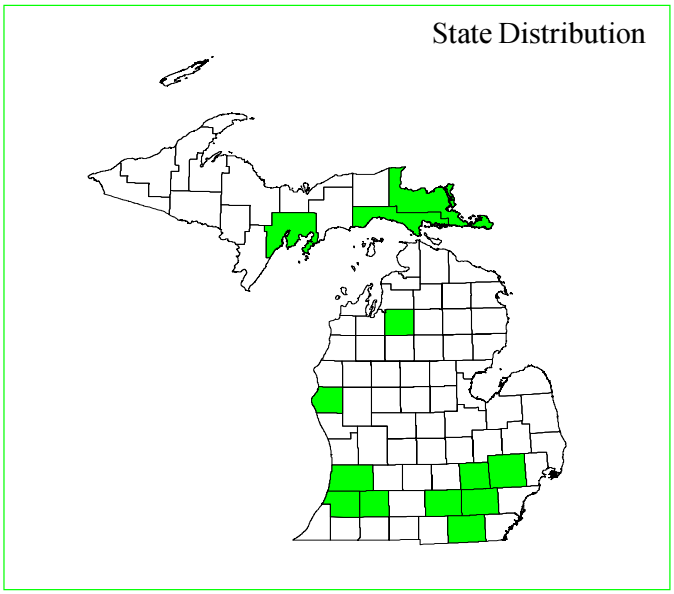


Photo by Jodi A. Raab.



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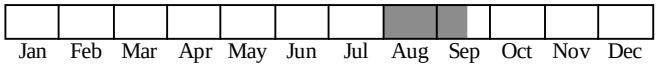

Status: State special concern

Global and state rank: G5/S3

Other common names: Northern dropseed

Family: Poaceae (also known as Graminae; grass family)

Total range: A prairie species at the heart of its range in central United States, prairie dropseed ranges north into Saskatchewan and Manitoba, south to Texas and Arkansas, and west to Colorado and Wyoming. Widely scattered, localized populations occur eastward from Ontario, Quebec, and New York to Michigan, Ohio, Kentucky, North Carolina, and Louisiana.

State distribution: Prior to 1994 in the Lower Peninsula, this grass was known only from a dozen or so sites in the southern three tiers of counties where it is frequent to locally common. In 1994, a large population was discovered in Crawford County, in northern Lower Michigan, during an intensive floristic inventory of Camp Grayling Military Reservation (Higman et al. 1994). Upper Peninsula occurrences of prairie dropseed are restricted to highly localized areas where it is a dominant component of the bedrock grassland (alvar) communities along the Escanaba River and on the expansive exposed bedrock on Drummond Island.

Recognition: *Sporobolus heterolepis* **grows in dense, roundish clumps** or tufts, forming a turf when abundant. The tall, waist-high stems, reaching 4-10 dm in height, bear **elongate, usually narrow and somewhat inrolled leaves**, the basal ones up to one-half as long as the stems. The **ligule** (at the inner juncture of leaf sheath and blade) consists of **a fringe of short hairs**. Fertile stems are terminated by an open to ovoid inflorescence with spreading to ascending branches. Each one-flowered spikelet is about 3.5-6.5 mm in length, and the glumes (tiny, leaf-like scales at the base of the spikelet) are distinctly unequal, the first about one-half as long as the second. The lemma and palea (tiny bracts at the base of an individual floret) are glabrous and lack lateral nerves. Perhaps most distinctive of this species is the **characteristic fruit, a somewhat shiny, yellowish, spherical grain** (2 mm in diameter) that when mature splits the palea and spreads open the parts of the spikelet. *Panicum virgatum* (switchgrass) superficially resembles prairie dropseen in general aspect, but the glumes are conspicuously nerved and it lacks spherical fruits.

Best survey time/phenology: The characteristic spherical fruits are unmistakable in this species, thus the optimal survey time is when the species is fruiting, typically during August and into early September. With experience, one can learn to distinguish the dense basal tufts of narrow, inrolled leaves characterized by a short fringe of hair at the ligule. For the very experienced, the rather delicate inflorescence, prior to fruiting, can also be keyed in on, noting characteristics of the glumes, lemma, and palea, within the context of appropriate habitat.

Habitat: In the Upper Peninsula, prairie dropseed is characteristic of alvar, becoming a dominant, turf-forming plant of that thin-soil, limestone and dolomite bedrock community. On Drummond Island, prairie dropseed was found to be the most abundant species of the Maxton Plains

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alvar, dominating in pavement and other grassland sites (Stephenson and Herendeen, 1986). Its common associates include *Carex scirpoidea* (bulrush sedge), *Eleocharis compressa* (flattened spike-rush), *Senecio pauperculus* (ragwort), and *Andropogon scoparius* (little bluestem). The northern Lower Michigan population consists of hundreds of plants that occur in pockets along a linear, mesic sand prairie-like wetland. It appears to follow a pro-glacial lakeplain resulting from the receding Wisconsin glaciation. This rather unique site includes other rarities such as *Solidago houghtonii* (Houghton's goldenrod), *Scirpus clintonii* (Clinton's bulrush), and *Juncus vaseyi* (Vasey's rush), New England violet (*Viola novae-angliae*) as well as additional species characteristic of the Great Lakes shore such as *Deschampsia cespitosa* (hair grass) and *Castelleja coccniea* (Indian paintbrush). In southern Michigan, *S. heterolepis* occurs primarily in calcareous wetlands (prairie fens), where it may be a frequent to dominant plant with *Andropogon gerardii* (big bluestem), *Andropopgon scoparius*, *Sorghastrum nutans* (Indian grass), *Muhlenbergia richardsonis* (mat muhly), *Carex stricta*, and a number of other prairie fen associates. Within the main body of its range, prairie dropseed occurs in upland and lowland mesic prairies, dry open ground, and in open woods.

Biology: Prairie dropseed is a perennial, fruiting primarily during August, though fruiting specimens have been collected from early July through September. As with many other prairie plants, fire is an important component of this species' biology and ecology. Research conducted on burned and unburned prairies sites, where *S. heterolepis* was a dominant component, has demonstrated that fire greatly enhances productivity, both in biomass and flowering (Ehrenreich and Aikman, 1957; Dix and Butler, 1954). The beneficial effects of fire largely result from the removal of deep litter layers, improving nutrient cycling, raising soil temperatures (which stimulates nitrifying bacteria), and eliminating competing vegetation (Wright, 1980). In the alvar communities of Upper Michigan, however, fire may not be a critical environmental factor. Stephenson (1983) suggests that drought rather than fire has prevented the succession of invading vegetation, particularly competing woody plant species. Stephenson and Herendeen (1986) found drought to have profound effects on the alvar species of the Maxton Plains, where following a significant decrease in rainfall, prairie dropseed failed to grow and successfully flower over large portions of the communities it dominated.

Conservation/management: Much of the Maxton Plains alvar is under protection of The Nature Conservancy and the DNR with a portion of the state land proposed for Natural Area dedication. One southern Michigan population also lies within a Nature Conservancy preserve (Ives Road Fen), and at least portions of two other localities are in Michigan Nature Association sanctuaries (Harvey's Rocks and Little Goose Lake Fen). A fifth locality is within a Washtenaw County park. Hydrologic alterations can degrade or destroy prairie dropseed's habitat, as can woody encroachment due to fire supression in southern Michigan fens.

Research needs: Attempts to locate additional inland locations in northern Lower Michigan, similar to the Camp Grayling site, may provide insight into the ecological requirements of this species and could possibly lead to the discovery of additional rarities.

Related abstracts: Alvar, prairie fen, English sundew, mat muhly, prairie Indian plantain, small white lady's-slipper, Eastern massasauga, Mitchell's satyr.

Selected references:

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Higman, P.J. and M.R. Penskar. 1999. Special plant abstract for *Sporobolus heterolepis* (prairie dropseed). Michigan Natural Features Inventory, Lansing, MI. 2 pp.

Updated September 2000.

Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division.

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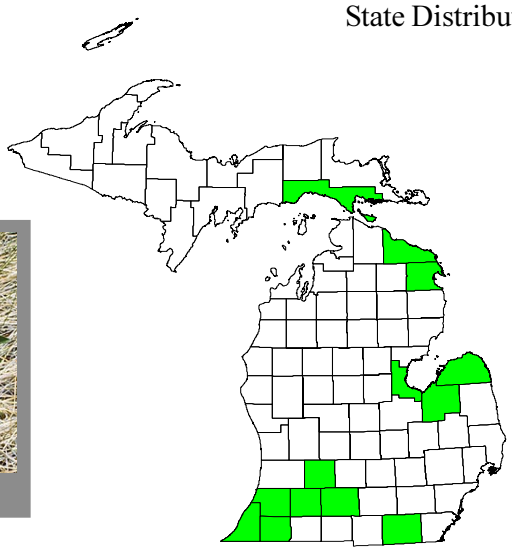
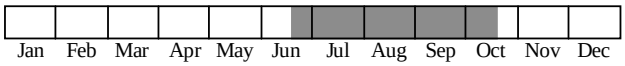
Cacalia plantaginea (Raf.) Shinners — prairie Indian-plantain

Photo by Susan R. Crispin

Photo by William Brodovich





Legal status: State threatened

Global and state rank: G4G5/S2

Family: Asteraceae (aster family)

Other common names: tuberous Indian plantain

Synonyms: *Cacalia tuberosa* Nutt.

Total range: The prairie Indian plantain ranges from Alabama and eastern Texas north to Nebraska, Minnesota, and southern Ontario. It is considered rare in Wisconsin, Minnesota, South Dakota, and Ontario.

State distribution: This species is confined primarily to a few counties of southwestern Michigan, where it has been found at more than 30 localities of the nearly 50 sites known for the state, most still extant. Several populations are known in Lenawee County as well. In the remnant lakeplain prairies of Saginaw Bay, it has been reduced to just two known populations, both comprised of rather small and localized colonies. Vigorous local populations are disjunct on the shores of Lake Huron in Presque Isle County and Alpena County as well as on Bois Blanc Island (Mackinac County). A Macomb County records dates from 1843, the vicinity of its collection having been long since converted to agriculture.

Recognition: Stems of *Cacalia plantaginea*, which may range from 6-18 dm in height, are stout, smooth, and finely but **distinctly grooved**, arising from **short, tuberous-like, fleshy roots**. The thick, elliptical, **alternate leaves are smooth-margined** and **long-stalked** toward the stem base, with **conspicuous longitudinal nerves that converge at the leaf tip**. (The common name of this genus derives its name, in part, from the similarity to leaves of the true plantain family.) Upward the leaves become much reduced and stalkless. **Whitish flowers** are borne terminally in relatively **flat-topped, branched clusters of** perhaps 20 or more narrowly cylindric heads, each with five tubular disk flowers and no ray flowers, the flower heads subtended by **strongly keeled phyllaries (bracts).**

Cacalia plantaginea is superficially similar to the related *C. atriplicifolia* (pale Indian-plantain), a somewhat uncommon and localized species associated with oak woodlands, old dunes, prairie communities, creek banks, and floodplain forests (Voss 1996). It bears a very similar inflorescence but is easily distinguished by its **broadly ovate, coarsely toothed leaves with pale undersurfaces and palmate venation, stems that lack grooves, and phyllaries that are not prominently keeled**. Leaves of tuberous Indian-plantain are somewhat like those of the common weedy plantains, *Plantago rugelii* and *P. major*; however, these taxa, which are members of the plantain family (Plantaginaceae), are much smaller plants that occur throughout the state in many disturbed habitats and thus are very unlikely to be confused with *Cacalia*.

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Best survey time/phenology: Owing to the distinctive habitats of this species in Michigan, tuberous Indian-plantain can be reliably sought during much of the growing season, as its leaves are distinctive and it is unlikely to be confused with any other species. Experienced botanists and other surveyors may even seek this plant at other times of the year, owing to the rather distinctive curled appearance of the withered, spent leaves.

Habitat: This plant occurs in three similar types of habitats in the state. Southern Michigan populations inhabit high quality prairie fens on the margins of major morainal areas with rich organic soils saturated by seepage of calcareous groundwater. Predominant and common species in these fens include such typical plants as *Carex stricta* (strict sedge), *Carex lasiocarpa* (sedge), *Andropogon gerardii* (big bluestem), *Sorghastrum nutans* (Indian grass), *Potentilla fruticosa* (shrubby cinquefoil), tamarack (*Larix laricina*), *Toxicodendron vernix* (poison sumac), *Eleocharis rostellata* (beaked spike-rush), *Parnassia glauca* (grass-of-Parnassus), *Liatris spicata* (blazing star), *Sarracenia purpurpea* (pitcher-plant), *Calamagrostis canadensis* (bluejoint), *Solidago ohioensis* (Ohio goldenrod), *Solidago riddellii* (Riddell's goldenrod), *Lobelia kalmii* (Kalm's lobelia), *Hierchloe odorata*, (sweet grass), and numerous other fen species. The wet and wet-mesic prairies of the Saginaw Bay lakeplain provided significant habitat for this species prior to European settlement; however, now only two small populations are now known to remain. At these localities, moist, calcareous loamy sands support diverse communities dominated by *Spartina pectinata* (prairie cordgrass), *Carex stricta* (strict sedge), *C. lasiocarpa* (sedge), *Scirpus acutus* (bulrush), *Eupatorium maculatum* (Joe-pye-weed), and *Calamagrostis canadensis* (bluejoint) in wetter areas, and such species as *Sorghastrum nutans* (Indian grass), big bluestem, blazing star, *Silphium terebinthinaceum* (prairie dock), *Asclepias hirtella* (tall green milkweed), *Platanthera leucophaea* (Eastern prairie fringed orchid), *Veronicastrum virginicum* (Culver's root), shrubby cinquefoil, *Linum medium* (flax), *Pycnanthemum virginianum* (mountain-mint), *Tofieldia glutinosa* (false asphodel), and several other fen and prairie species in mesic portions of this lakeplain tallgrass prairie landscape.

Prairie Indian-plantain also grows in marly swales along the shores of Lake Huron, where it occurs in a natural community type known as northern fen. In addition to many of the aforementioned fen species, the associates include several typical northern and boreal species such as *Carex buxbaumii* (Buxbaum's sedge), *C. castanea* (sedge), *Thuja occidentalis* (Northern white cedar), and *Vaccinium oxycoccos* (cranberry), in addition to a number of rare plant associates that may be present, including *Solidago houghtonii* (Hougton's goldenrod), *Iris lacustris* (dwarf lake iris), *Carex concinna* (beauty sedge), and *Pinguicula vulgaris* (butterwort). This species exists in similar habitats on the Bruce Peninsula of Ontario (Stebbins, 1935). Throughout its range, prairie Indian-plantain primarily inhabits wet prairies, preferring fens only toward the northern and eastern portions of its distribution.

Biology: This perennial has fleshy roots that are technically not, contrary to one of its names, tuberous (Shinners 1950). This species flowers in early to mid-July and fruits mature during August.

Conservation/management: Two southwestern Michigan populations of prairie Indian plantain—one large and one very small—lie in specially designated tracts within State Game Areas, and another is within a State Recreation Area. Both northern disjunct localities are also on state land, one occurring within a state dedicated natural area on Bois Blanc Island known as Snake Island. At least three large southern populations are in fens owned and managed by The Nature Conservancy (TNC), and one is partly owned by the Michigan Nature Association (MNA). Several large populations lie on private lands. The fen habitat of this plant is highly vulnerable to hydrologic disturbances, and requires fire to prevent encroachment of shrubs, which shade out this and other herbaceous species. Maintenance of the hydrological regime as well as carefully employed prescribed burns are perhaps the two most critical factors in perpetuating viable populations.

Research needs: Life history studies, including investigations of population dynamics, demography, reproduction, and related research would assist in the management of the unique communities that contain this and many other rare plants and animals, several of which are globally rare.

Related Abstracts: Prairie fen, mat muhly, pitcher plant, prairie dropseed, small white lady's-slipper, Blanchard's cricket frog, blazing star borer moth, Culver's root borer, eastern massasagua, Mitchell's satyr, red legged spittlebug.

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Abstract citation:

M.R. Penskar and P.J. Higman 2000. Special Plant Abstract for *Cacalia plantaginea* (prairie Indian plantain). Michigan Natural Features Inventory. Lansing, MI. 3 pp.

Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division.

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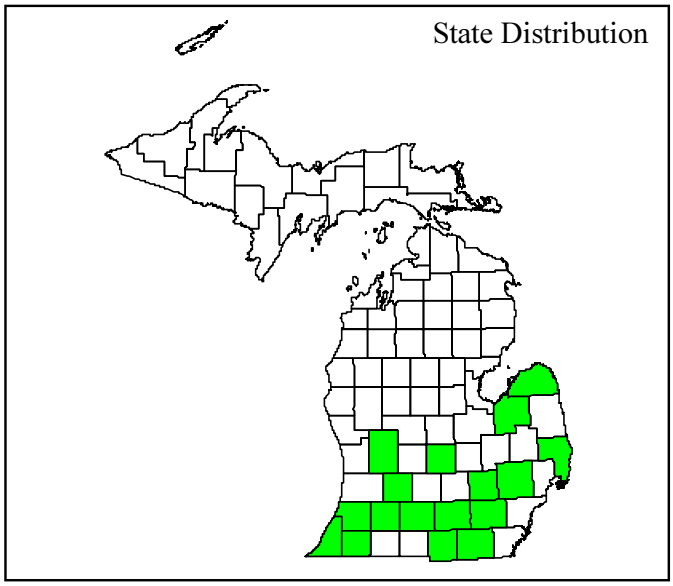
Cypripedium candidum Muhl. ex Willd. — small white lady's-slipper



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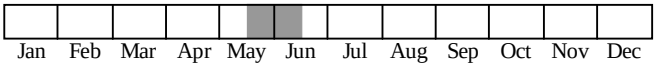

Status: state threatened

Global and state rank: G4/S2

Other common names: white lady-slipper

Family: Orchidaceae

Total range: This principally upper Midwestern species ranges eastward to New Jersey and New York, extending west through southern Michigan to Minnesota, the eastern Dakotas, and southern Manitoba and Saskatchewan. To the south it ranges to Nebraska, Missouri, and Kentucky. It is considered rare in Iowa (S1), Illinois (S3), Indiana (S2), Kentucky (S1), Michigan (S2), Minnesota (S3), North Dakota (S2S3), New York (S1), Ohio (S1), South Dakota (S1), Wisconsin, and Manitoba. In Pennsylvania and Saskatchewan, it is considered extirpated and is known only from historical records in Missouri and New Jersey.

State distribution: Small white lady's-slipper is restricted to southern Michigan, occurring primarily within a narrow band from Berrien and Kalamazoo counties in the southwest to southeastern Michigan, were it is concentrated in Livingston, Oakland, Washtenaw, and Jackson counties. Two localities in the thumb region constitute the northernmost occurrences in the state. About one-third of approx. 81 recorded occurrences have succumbed to ecological succession or loss of habitat due to development pressures. Of the remaining extant populations, several are quite large, consisting of over 100-200 individuals.

Recognition: Although *Cypripedium candidum* produces solitary stems, mature plants commonly form small, dense, clonal clumps. This relatively small lady's-slipper averages about 20 cm in height, each stem producing **several strongly-ribbed, sheathing leaves that are densely short-hairy**. Stems are usually terminated by **a single flower (occasionally there may be two) characterized by its ivory-white pouch** (the lip or lower petal) which may be **faintly streaked with purple veins** toward the bottom and slightly purple-spotted around the pouch opening. The **lateral petals**, which are similar to the sepals, are **pale yellow-green and spirally twisted**. *Cypripedium candidum* is known to hybridize with two well-known varieties of yellow lady's-slipper, *C. calceolus* var. *pubescens* and *C. calceolus* var. *parviflora*, producing *C.* X*favillianum* and *C.* X*andrewsii*, respectively. These hybrids are the only taxa that small white lady-slipper is likely to be confused with. However, *Cypripedium* X*favillianum* can be distinguished by its larger size and very pale yellow pouch, and *C.* X*andrewsii*, which produces a white pouch like *C. candidum* can be distinguished by the dark, strongly spiralling petals and sepals more characteristic of var. *parviflorum*.

Best survey time/phenology: Surveys for this species should be conducted from late May to early June, when it typically flowers. It is fairly difficult to confirm the identity of non-flowering specimens.

Habitat: In Michigan, small white lady's-slipper occurs primarily in prairie fens and other marly, alkaline sites with groundwater seepage. These graminoid-dominated peatlands are commonly found adjacent to lake and stream systems. It also occurs in wet prairie communities of the

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clay lakeplain regions of southwestern Michigan and the thumb. These wet prairies are similar to tallgrass prairies, the typical habitat of this species outside of Michigan. Case (1987) also reports that it has been found in damp depressions in limestone barrens in Kentucky. Typical prairie fen soils in Michigan are Houghton mucks, often forming deep organic deposits. Common associates of white lady's-slipper include *Andropogon gerardii* (big bluestem), *Sorghastrum nutans* (Indian grass), *Potentilla fruticosa* (shrubby cinquefoil), *Carex stricta* (sedge), *Betula pumila* (bog birch), *Thelypteris palustris* (marsh fern), *Valeriana uliginosa* (valerian) and *V. edulis* var. *ciliata* (edible valerian, state threatened), *Sporobolus heterolepis* (prairie dropseed, state special concern), *Muhlenbergia richardsonis* (mat muhly, state threatened), *Solidago ohioensis* (Ohio goldenrod), *S. riddellii* (Riddell's goldenrod), *Pycnanthemum virginianum* (mountain mint), *Rhamnus alnifolia* (alder-leaved buckthorn), *Hierochloe odorata* (sweet grass), and numerous other species typical of southern Michigan fens, including several additional listed taxa.

Biology: Flowering occurs in late May to early June. Case (1987) and Luer (1975) both report that this perennial species develops rapidly, often blooming before the leaves have fully flushed and unwrapped the stems. Curtis (1943) estimated that at least 12 years or more are necessary for maturation following germination, and observed that clones are formed through the production of small plants from adventitious buds on 2 to 3-year-old roots. Curtis (1954) also documented the marked variation in flower and fruit production from year to year, and found no correlation between avg. flower and fruit production and the relative abundance of this species in the vegetation in comparison to other lady-slipper species. In a pollination study in southern Ontario, Catling and Knerer (1980) found small halictine and andrenid bees to be the principal pollinators. These bees were dependent on the availability of nectar from a variety of other flowering species whose blooming period coincided with *C. candidum.*

Conservation/management: Exemplary occurrences are protected and managed by several conservation organizations, including The Nature Conservancy and the Michigan Nature Association. However, many sites have been severely disturbed or destroyed through agricultural activities, peat or marl mining, land drainage, and other human activities. Others have succumbed to the invasion of woody shrubs due to ecological succession, while still others are threatened by the invasion of exotic species, the most notable pests being *Rhamnus frangula* (glossy-leaved buckthorn) and *Lythrum salicaria* (purple loosestrife). Prevention of hydrological changes and maintenance of a farily open condition are necessary for maintaining viable fen habitat. Careful fire management has been recommended for both shrub control and the healthy maintenance of populations (Bowles 1983). Kohring (1981) observed the favorable response of a population following a planned burn in a railroad right-of-way, noting that the number of blooming plants tripled and plant vigor increased. The use of prescribed burns should be carefully studied before, during and after their use in order to determine if and how burning can best be employed to maintain and/or enhance small white lady's-slipper populations. Since at least one Federal and State threatened insect species, (Mitchell's satyr), is known to inhabit prairie fens in southwest Michigan, any burn strategy employed should consider the presence of rare insects, mollusks, and herptiles.

Research needs: Due to the significant development pressure in southern Michigan where this species is most common, research regarding compatible development activities is of highest priority. Specific precautions that must be taken in order to maintain fen hydrology should be determined and proposed as policy. The role of fire as a management tool to minimize succession or the invasion of exotic species should also be investigated. Research on the breeding biology and genetic diversity of this species will provide a sounder basis for making management decisions.

Related abstracts: wet prairie, wet-mesic prairie, edible valerian, English sundew, mat muhly, prairie dropseed, prairie Indian-plantain, Mitchell's satyr

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Abstract citation

Michigan Natural Features Inventory. 1998. Special plant absract for *Cypripedium candidum* (small white lady's-slipper). Lansing, MI. 3 pp.

Funding for abstract provided by Michigan Department of Natural Resources - Wildlife Division.

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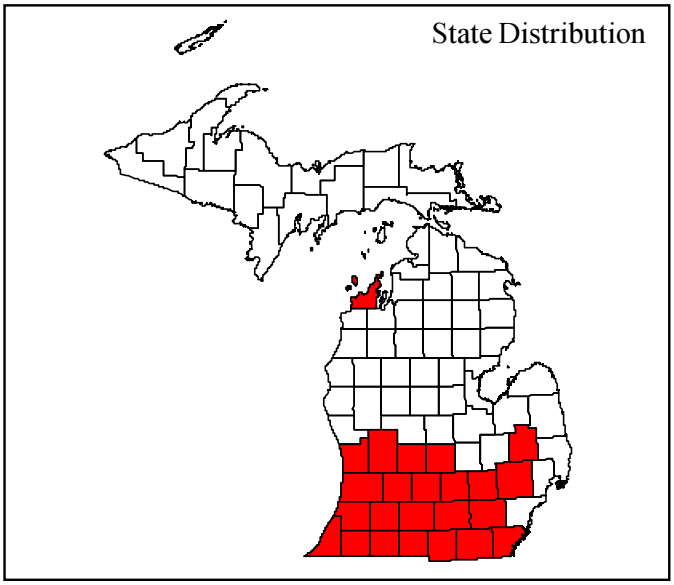
Acris crepitans blanchardi (Harper) — Blanchard's cricket frog

Photo by Thomas R. Johnson



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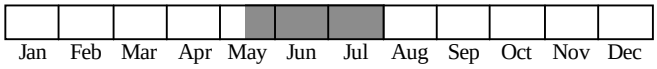

Status: State special concern

Global and state rank: G5T5/S2S3

Family: Hylidae (treefrog family)

Range: The Blanchard's cricket frog is found from southern Michigan and western Ohio west to southeastern South Dakota and eastern Nebraska, and south to northern Tennessee in the east and northern Mexico in the west (Conant and Collins 1998). An isolated colony has been documented in northeastern Colorado. Several populations also have been reported from Point Pelee and Pelee Island in Ontario, Canada, although these are believed to be extirpated. Blanchard's cricket frogs also are believed to be extiripated from Minnesota. The northern cricket frog (*Acris crepitans crepitans*) occurs to the east and south of this subspecies, and the coastal cricket frog (*A. crepitans paludicola*) occurs along the Louisiana coast.

State distribution: Historically, Blanchard's cricket frogs were distributed over much of the southern half of the Lower Peninsula of Michigan. Museum records from 1900 to 1950 documented cricket frogs from 19 counties in southern Michigan. Field surveys and museum specimens after 1950 recorded cricket frogs from five more counties including Leelanau County, which is highly unusual since this is so far north of its typical range. It is unknown whether this is a relict population from a warmer postglacial period or a recent introduction. However, since the early to mid-1980's, this species has declined dramatically in Michigan, particularly in southeast Michigan. Since 1985, cricket frog populations have been reported from less than 10 sites in four counties in southeast Michigan (Lenawee, Washtenaw, Oakland and Lapeer) and about 40 sites in seven counties in southwest Michigan (Allegan, Barry, Berrien, Calhoun, Kalamazoo, Kent and Van Buren).

Recognition: The Blanchard's cricket frog is a tiny, non-climbing member of the treefrog family. Adults range in length from **0.6 to 1.5 inches** (Harding 1997). Cricket frogs have moist, **warty skin** and an acutely rounded snout. They are usually **tan, brown, gray, or olive green** in color, sometimes with bright green, tan, black or reddish blotches or stripe down the back. Most individuals have a **dark, triangular mark on the back of the head between the eyes**, a light line from each eye to the shoulder, and numerous vertical light bars on the snout. Other markings include a dark stripe from the shoulder to the groin, a dark stripe on the inner side of each thigh and dark stripes on the upper surface of the hind legs. Tadpoles are olive or brown mottled with black on their upper surface, and have an iridescent pale yellow to white belly. Their tail is very long with a black tip and a narrow dark line along the upper margin of the tail. During the breeding season, males are distinguished from females by their darker throat and yellow vocal pouch. The males also have a distinctive **breeding call which consists of a rapid series of metallic clicks**, similar to the sound made when two pebbles or marbles are tapped together.

Michigan frogs similar in appearance to the Blanchard's cricket frog include the western chorus frog (*Pseudacris triseriata triseriata*) and the northern spring peeper

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(*Pseudacris crucifer crucifer*). The western chorus frog can be distinguished by the whitish stripe along its upper lip and brownish stripes through the eyes from the nostril to the groin and down the middle and sides of its back. The western chorus frog does have a dark triangular shaped mark or stripe on the top of its head. The spring peeper has an imperfect X-shaped mark on its back, and lacks the warty appearance of the Blanchard's cricket frog. The calls of these species also differ from that of the Blanchard's cricket frog.

Best survey time: The best time to survey for this species is during the breeding season which typically is from mid- to late May to mid-July. The best way to survey for this species is to listen in the evening (after sunset) for the distinctive clicking calls of the males during the breeding season. Optimal weather conditions for frog call surveys include air temperatures above 60°F and high humidity or light rain; calling activity, in general, decreases on cold or windy nights (Karns 1986).

Habitat: Blanchard's cricket frogs inhabit the open edges of permanent ponds, lakes, floodings, bogs, seeps and slow-moving streams and rivers (Harding 1997). They prefer open or partially vegetated mud flats, muddy or sandy shorelines, and mats of emergent aquatic vegetation in shallow water. Quiet, reasonably permanent water is essential for this species, with transient shallow pools occupied only if near a larger body of water. Cricket frogs also can be found in farm ponds, drainage ditches, gravel ponds and strip mine ponds, although polluted water is poorly tolerated (Minton 1972). In Michigan, many known cricket frog sites are located along ponds and lakes that are alkaline in nature often with fen habitat along the shoreline. This frog is thought to be the most aquatic of North American treefrogs, and usually does not leave the vicinity of water after the breeding season, except during rainy weather (Oldham & Campbell 1986).

Biology: Cricket frogs usually emerge from hibernation in late March to early April and breed from mid-to late May through mid-July. Frogs begin calling each year in the daytime, but as the temperature increases, they also call at night (Blair 1961, Burkett 1984). Males call from mats of vegetation in the water and along the mud banks of ponds and lakes. Amplexus (i.e., mating) and egg-laying occur in warm, shallow water near the calling sites (Harding 1997). Between 200 and 400 eggs are laid and attached either singly or in clusters to submerged vegetation (Harding 1997). The eggs hatch within a few days, and metamorphosis occurs in five to ten weeks after hatching. The newly transformed froglets are tiny, from 0.4 to 0.6 inches long, but they grow rapidly and some reach breeding size by the following spring (Harding 1997). Blanchard's cricket frogs are reluctant to hibernate and have been found active in Illinois as late as December and as early as February (Smith 1961). Individuals overwinter in cracks, depressions or vegetation along the shoreline.

Blanchard's cricket frogs are opportunistic feeders and eat throughout the day and night. Their diet consists of terrestrial and aquatic insects and other small invertebrates. Causes of mortality include desiccation, predation, parasitism, winter kill, and natural death. Predators include dragonfly larvae, leeches, aquatic spiders, turtles, fish, other frogs, snakes, birds, raccoons, and opossums.

During the latter part of the breeding season, the population shifts in less than a month from a mostly adult population to one consisting almost entirely of juveniles. This is due to rapid mortality of adults and rapid recruitment of young (Burkett 1984). Individuals are very short-lived, generally surviving only one, or in some cases, two breeding seasons (Burkett 1984, Harding 1997). Burkett (1984) found the average life expectancy of cricket frogs in Kansas to be about four months, with about 5% of the population surviving the winter and less than 0.1% living into the following fall. He suggests that complete population turnover occurs in about sixteen months, with only one age class represented in a breeding population. This life history differs from that of most anurans which typically live through more than one breeding season, and the breeding population usually consists of several age classes.

Cricket frogs tend to remain in fairly small areas; nearly 50% of the recaptures in a study in Kansas were within 25 feet of the previous place of capture (Burkett 1984). Dispersal requires moist habitat conditions and generally occurs during and following rains (Burkett 1984). A study in Texas documented average dispersal distances for different age classes ranging from 74 to 160 feet (Pyburn 1958), while a study in Kansas reported average movements of 64 to 82 feet (Burkett 1984). If cricket frog populations function as metapopulations requiring dispersal and intermixing among sub-populations, then their limited ability to disperse and short generation times suggest that populations need to be connected by suitable habitat and/or distances.

Conservation/management: Although the reasons for the decline of Blanchard's cricket frogs are not entirely clear, it is likely that habitat loss and degradation are the most significant problems for this species. Vast amounts of Michigan's original wetlands have been destroyed, and many of the remaining areas are affected by pollution. Much of the lakefront property in southern Michigan has been developed for homes and flood protection, eliminating many of the mud flats and vegetated shallow water areas required by this frog. It is critical that some portion of these habitats be protected from development and human-induced disruption, particularly at sites where cricket frogs still occur. Vegetation succession also has likely contributed to habitat loss. Hay (1998) contends that a reduction in cattle grazing in Wisconsin has reduced suitable habitat for cricket frogs at some known sites and has increased habitat for species such as green frogs. Maintaining open or sparsely vegetated areas along the shorelines of suitable waterbodies would provide potential habitat for this species.

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Given their highly permeable skin, amphibians, in general, tend to be very susceptible to pesticides and other chemical pollutants. Since cricket frogs are highly restricted to aquatic habitats, they may be especially susceptible to aquatic pollutants (Oldham & Campbell 1986, Minton 1972). High levels of DDE and PCB have been reported in Blanchard's cricket frogs from Pelee Island, Ontario, a predominantly agricultural area (Campbell 1978). Paralyzed cricket frogs have been found in rice fields in Texas immediately following treatment with the pesticide carbofuran (Flickinger et al. 1980). The use of agricultural or residential chemicals in areas with cricket frog populations may pose a threat to this species. Avoiding or limiting the use of these chemicals in areas where runoff would impact cricket frog sites would likely benefit the species. Maintaining buffers of natural vegetation or shoreline habitat between water bodies and agricultural fields or developed areas also would help reduce the input of chemical runoff into cricket frog habitat.

Another threat may be the stocking of lakes and ponds with non-native game fish, many of which consume both tadpoles and adult frogs (Harding & Holman 1992). Even native species such as bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) can impact amphibian populations when they are stocked in upland ponds where they were previously not resident (Thurow 1994). Bronmark and Edenhamn (1994) report that several breeding populations of European cricket frogs disappeared as soon as fish were introduced but returned when the fish were removed. Fish introductions into extant cricket frog sites should be re-examined, and avoided or discontinued when possible.

Despite being a native species, the bullfrog (*Rana catesbeiana*) may pose an additional threat to the Blanchard's cricket frog. This species tends to tolerate habitat disturbances, and in altered environments, may increase in numbers to the detriment of other species (Thurow 1994). Adult bullfrogs consume other frog species, including Blanchard's cricket frogs, and their tadpoles will eat frog eggs (Oldham & Campbell 1986). However, it is questionable whether the bullfrog poses a problem in Michigan, where it has not notably increased and is less likely to occur in the same habitats as Blanchard's cricket frogs (Harding pers. comm.).

Although the species is listed only as special concern, the Blanchard's cricket frog is protected in Michigan under the Director's Order No. DFI-166.98, Regulations on the Take of Reptiles and Amphibians, which is administered by the Michigan Department of Natural Resources' Bureau of Fisheries. It is unlawful to take a cricket frog from the wild except as authorized under a permit from the Director (legislated by Act 165 of the Public Acts of 1929, as amended, Sec.302.1c (1) and 302.1c (2) of the Michigan Compiled Laws). Public land managers and the general public should be informed that this species is protected and should not be collected or harmed.

Research needs: An assessment of the current distribution and abundance as well as the long-term viability of Blanchard's cricket frogs in the state is needed. Additional surveys are needed to confirm and monitor populations, and to continue to document new populations. More research on this species' life history, particularly its habitat requirements at local and landscape scales and dispersal capability, is warranted. More information on the species' population structure and dynamics should be obtained to develop appropriate and effective management and conservation strategies. The specific factors contributing to the species' decline in Michigan (and regionally) need further elucidation. Also, potential impacts of various management and land use practices such as prescribed burning and the use of herbicides should be investigated. Finally, the need for and likelihood and implications of successfully relocating or reintroducing cricket frogs to sites with suitable habitat should be examined.

Related Abstracts: Prairie fen, mat muhly, prairie dropseed, prairie Indian-plantain, small white lady's-slipper, Blanchard's cricket frog, Blanding's turtle, blazing star borer moth, Culver's root borer, eastern box turtle, eastern massasagua, Mitchell's satyr, red legged spittlebug, spotted turtle.

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Y. Lee, D.A. Hyde and J. Legge. 2000. Special animal abstract for *Acris crepitans blanchardi* (Blanchard's cricket frog). Michigan Natural Features Inventory. Lansing, MI. 4 pp.

Updated September 2000.

Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division.

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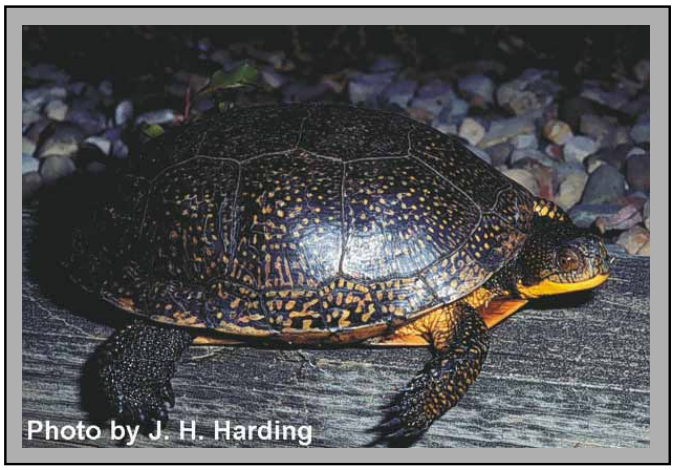
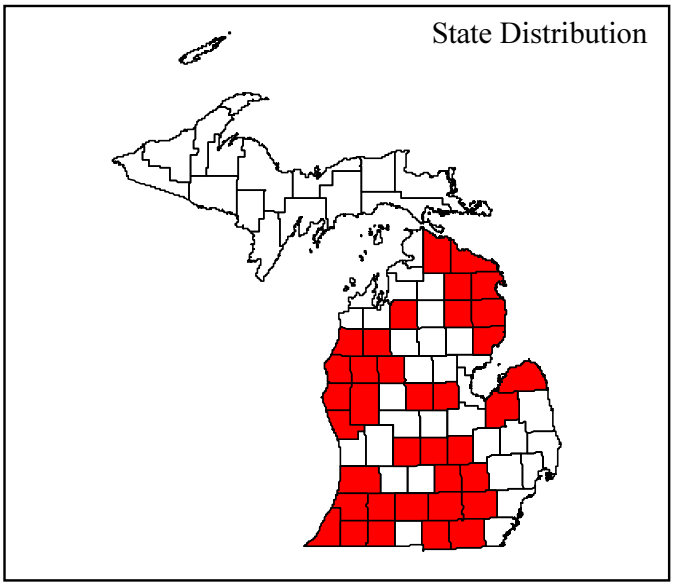
Emydoidea blandingii Holbrook — Blanding's turtle





Best Survey Period

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				■	■						

Status: State special concern

Global and state rank: G4/S3

Family: Emydidae (pond and box turtles)

Range: Blanding's turtles occur from southwestern Quebec and southern Ontario south through the Great Lakes region to central Illinois and west to central Nebraska, including parts of Missouri, Iowa, South Dakota, and Minnesota (Ernst et al. 1994). Disjunct populations occur in Maine, New Hampshire, Massachusetts, New York, and Nova Scotia. Within the Great Lakes region, Blanding's turtles are found throughout southern Ontario, Michigan and Wisconsin, and in northern Ohio, northern Indiana and northern Illinois (Harding 1997).

State distribution: Michigan Natural Features Inventory (1999) has compiled documentation of Blanding's turtles from 36 counties in Michigan's Lower Peninsula. However, a statewide systematic survey for this species has never been conducted, and this species has been reported, at least historically, from almost every county in the Lower Peninsula and four counties in the central Upper Peninsula (i.e., Marquette, Dickinson, Delta, and Schoolcraft) (Harding and Holman 1990, Harding pers. comm.). It also has been reported anecdotally from Alger and Menominee counties in the Upper Peninsula (Harding pers. comm). Blanding's turtles are fairly common in parts of the Lower Peninsula, but are generally rare and have a fairly localized distribution in the Upper Peninsula (Harding and Holman 1990).

Recognition: The Blanding's turtle is a medium to large turtle with adult carapace (upper part of shell) length ranging from 6 to 11 inches, a **bright yellow chin and throat**, and a **very long neck** (Harding 1997). The elongated, dome-like, and smooth carapace is neither keeled nor serrated (i.e., not having raised ridges or pointed projections). The **carapace** is usually **black with yellowish spots and streaks**. The head also is dark with brown or yellow spots, and is relatively flat with a short, rounded snout and a **notched upper jaw, giving the appearance of a permanent "smile,"** according to Harding (1997). The **plastron** (underside of shell) typically is **yellow with a dark blotch at the outer corner of each scute, or scale**. Most adults have a **flexible hinge in the plastron**. Males have a slightly concave plastron, and the vent or anal opening is located beyond the end of the carapace when the tail is fully extended. Females have a flat plastron, and the vent is located under the end of the carapace (Ernst et al. 1994, Harding 1997). Hatchlings have a gray, brown, or black carapace, 1.2 to 1.4 inches long, with a low keel, and a plastron with a large, black central blotch and yellow or cream color along the edge (Harding 1997).

Best survey time: Although Blanding's turtles are active and can be seen from early April to late October or early November, the best time to survey for this species is in May and June during the mating and nesting seasons when the turtles are most active (Harding 1997, Harding pers. comm.). During this time period, the easiest way to survey for this species is to conduct visual surveys for basking turtles, particularly on cool, sunny days. Also, this species is primarily diurnal and most active in the morning, although this may vary with temperature (Ernst et al.

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1994). In addition to visual surveys, Blanding's turtles can be trapped throughout the active season using baited aquatic traps (e.g., hoop and net traps) and terrestrial drift fences (Congdon et al. 1983, Kofron and Schreiber 1985, Congdon and van Loben Sels 1991).

Habitat: Blanding's turtles inhabit productive, clean, shallow waters with abundant aquatic vegetation and soft muddy bottoms over firm substrates (Ernst et al. 1994). This species is found in ponds, marshes, swamps, bogs, wet prairies, river backwaters, embayments, sloughs, slow-moving rivers, protected coves, and lake shallows and inlets (Harding and Holman 1990, Van Dam 1993, Harding 1997). Blanding's turtles also occupy terrestrial habitats in the spring and summer, during the mating and nesting seasons, and in the fall, to a lesser extent. They prefer to nest in open, sunny areas with moist but well-drained sandy or loamy soil. They also will use lawns, gardens, plowed fields or even gravel road edges if suitable natural nesting habitat is not available (Harding 1997).

Biology: Blanding's turtles are active as early as April in Michigan. During the active season, they are often seen basking on muskrat lodges, stumps, logs, sedge or cattail clumps, or steep banks of dikes and ditches (Ernst et al. 1994). Blanding's turtles also are often seen along roads. At night, these turtles are found in or under aquatic vegetation. During the summer and fall, when shallow water habitats start to dry, some Blanding's turtles migrate overland to new bodies of water, while others aestivate on land, burrowing under roots, mud, or plant debris (Van Dam 1993, Harding 1997). Blanding's turtles generally are active during the day, however, in the summer, they may limit their activities to early morning and evening, or even become nocturnal (Harding 1997). Blanding's turtles typically enter overwintering sites in late October to early November. They usually hibernate underwater in deeper waterbodies, often buried in organic substrate.

Mating can occur anytime during the active season but occurs most frequently in the spring (Harding 1997). Mating occurs in shallow to deep water in wetland habitats. Males may travel considerable distances overland during the mating season to locate females. Nesting occurs from late May to early or mid-June with most nesting occurring in June. On average, only about half of the sexually mature females in a population reproduce in a given year (Congdon et al. 1983). Females leave the wetlands to excavate nests in upland, open sandy areas adjacent to marshes. Females may travel up to 1,200 m to find suitable nesting sites, and typically exhibit nest site fidelity (Congdon et al. 1983). Nesting usually occurs at night. Clutch size ranges from 6 to 21 eggs (Harding 1997). Eggs hatch in 50 to 75 days, with most hatchlings emerging in August or early September (Harding 1997). Blanding's turtles in Michigan reach sexual maturity in 14 to 20 years (Congdon and van Loben Sels 1993).

Blanding's turtles are omnivorous. They feed predominantly on crayfish and aquatic insects, but also consume mollusks, small fish, earthworms, tadpoles, and aquatic plants (Kofron and Schreiber 1985, Harding 1997). They feed primarily under water, and generally forage along the substrate (Harding 1997).

Raccoons, foxes, and skunks are the primary predators of Blanding's turtle eggs, hatchlings and juveniles (Congdon et al. 1983, Harding 1997). Fish, frogs, snakes, wading birds, crows and other animals also will consume hatchling and juvenile Blanding's turtles. Nest predation rates can be high, ranging from 42 to 93 percent in Michigan (Congdon et al. 1983). However, adult turtles have few natural predators (Harding 1997). Annual survival rates of adult Blanding's turtles have exceeded 93% in the past, and are among the highest reported for freshwater turtles (Congdon et al. 1993).

Conservation/management: Blanding's turtles are characterized by delayed sexual maturity, small clutch size, low reproductive success, high adult survival rates, and long adult lives. Given these life history traits, this species requires high annual survivorship of adults and juveniles to maintain stable populations (Congdon et al. 1993). For example, Congdon et al. (1993) found that a Blanding's turtle population in southern Michigan had to have annual adult and juvenile survivorship of at least 93% and 72%, respectively, to maintain population stability.

The primary threat to Blanding's turtles is habitat loss and degradation (Van Dam 1993, Harding 1997). Blanding's turtles require clean, shallow water with abundant aquatic vegetation, and appear to be sensitive to habitat alteration (Kofron and Schreiber 1985). Sources of habitat loss and alteration include drainage or inundation of wetlands, river channelization, water impoundments, agricultural activities along edges of sloughs and ponds, herbicide and pesticide use, and development of upland nesting areas (Kofron and Schreiber 1985). Habitat fragmentation can pose a significant threat since nest predation, primarily by raccoons, skunks, and opossums, was found to increase near habitat edges (Temple 1987). Road mortality also is a substantial threat to Blanding's turtles because of their tendencies to migrate long distances over land (Harding pers. comm.). This species' docile nature makes it highly vulnerable to collection for the pet trade; however, this issue has not been a major concern because there currently is little demand for this species (Harding 1997).

The most critical conservation need for this species is protection and management of suitable wetland and nesting habitat. Maintaining large and small wetland systems connected to suitable upland habitat is crucial for this species (Harding 1997). In addition, maintaining good water quality, restricting herbicide and pesticide use in or near wetlands, implementing minimum development set-back distances, leaving buffer zones during timber harvest, grazing and agricultural operations, and minimizing the construction of roads in or near suitable wetlands would be beneficial to this species. Management of woody vegeta-

tion (e.g., through timber harvesting) may benefit this species by maintaining open nesting areas. Timber harvesting during the winter (i.e., late November through March) would minimize the potential for harming this species during logging operations. In some cases, active management in terms of on-site protection of nest sites and predator control may be necessary (Van Dam 1993). Stream channelization and water impoundments should be avoided in areas with suitable habitat.

The general public should be informed that this species is protected, and should not be collected or harmed. In Michigan, the Director's Order No. DFI-166.98, Regulations on the Take of Reptiles and Amphibians, states that it is unlawful to take a Blanding's turtle from the wild except as authorized under a permit from the Director (legislated by Act 165 of the Public Acts of 1929, as amended, Sec.302.1c (1) and 302.1c (2) of the Michigan Compiled Laws). This regulation is implemented by the Michigan Department of Natural Resources' Bureau of Fisheries. Any suspected illegal collection or trade of Blanding's turtles should be reported to local authorities, conservation officers or wildlife biologists.

Research needs: Nesting and wintering sites and healthy populations in the state need to be identified (Harding pers. comm.). Long-term studies are needed to monitor population sizes and trends in representative habitats throughout the species' range in Michigan. Information on the amount of habitat required to sustain a population needs to be obtained (Van Dam 1993). Terrestrial habitat use and daily and seasonal movements need to be better defined. Information on nest site fidelity, overland migrations, and population recruitment, especially of juvenile turtles, also needs to be gathered. Impacts of land uses and management practices, such as drawdowns, on Blanding's turtle populations and habitat should be further investigated. Effective methods to educate the public about the turtle's status and conservation also need to researched (Harding pers. comm.).

Related abstracts: Eastern box turtle, wood turtle, prairie fen, wooded dune and swale

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Abstract citation

Lee, Y. 1999. Special animal abstract for *Emydoidea blandingii* (Blanding's turtle). Michigan Natural Features Inventory, Lansing, MI. 3 pp.

Funding for abstract provided by Michigan Department of Natural Resources - Wildlife Division and Non-Game Program.

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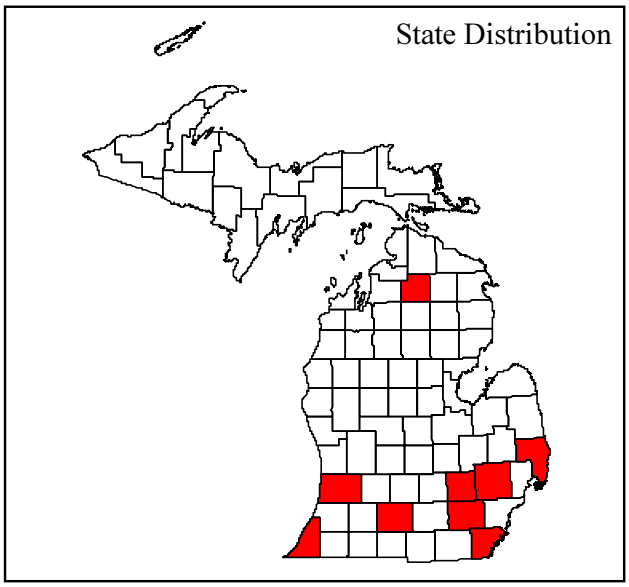
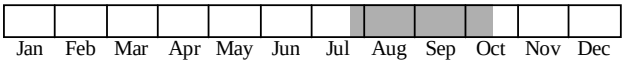
Papaipema beeriana Bird — blazing star borer


Photo by David L. Cuthrell.



Best Survey Period



Status: State special concern

Global and state rank: G3/S1S2

Family: Noctuidae (owlet moths)

Range: The blazing star borer occurs as a series of disjunct populations throughout the midwestern United States having been recorded from the following states: Iowa, Illinois, Indiana, Ohio, Wisconsin, and Michigan.

State distribution: The blazing star borer is known from less than 12 sites in Michigan and has been reported from ten counties. It has been collected from several southern counties (Allegan, Berrien, Calhoun, Washtenaw, Monroe, Livingston, Oakland, and St. Clair) and one county in the northern lower peninsula (Otsego).

Recognition: This moth, in the family Noctuidae, has a wing-span of 31-36 mm (1.2-1.5 in). It has two color forms, both spotted and unspotted. **The unspotted form has forewings which are dull brownish, frosted with whitish scale-bases, and with scattered white scales**; markings practically absent or very faint (Forbes 1954). The hing wings are a paler and more uniform gray. **The spotted form, *lacinariae* Bird, has forewings similar to the unspotted form with the exception of white spots** (Forbes 1954). Many species of *Papaipema* are difficult to identify but most can be sorted into species groups (Rings et al. 1992). These species groups can then be sent to experts for positive identification. Series (5 to 10 individuals from the same location) of specimens are easier to work with because of the large amount of individual variation. In addition, many field-collected specimens can be quite worn (many of the scales missing) giving the specimen a lighter appearance than normal, or eliminating many of the scale characteristics important for identification. To add to the confusion some species, like the blazing star borer, have spotted and unspotted forms, both of which are sympatric (occur at the same location at the same time).

Best survey time: The blazing star borer is a late-season flier with Michigan adult capture dates ranging from 13 September through 5 October. The best way to survey for this species is by blacklighting, a technique where a sheet is stretched across two trees or poles and an ultraviolet light is used to attract moths to the sheet. Moths can be collected directly from the sheet. You also can search for the larvae of many species of *Papaipema* by searching for signs of feeding activity in late July or early August. This includes inspecting blazing star (*Liatris* spp.) plants that are wilted or otherwise stunted, for a small hole near the base of the plant and a pile of frass (caterpillar feces) near this opening. Often times you can see the pile of frass at the base of the plant and then locate the hole in the stem.

Habitat: The blazing star borer occurs with its larval host plant, blazing star or snakeroot (*Liatris* spp.) In Michigan the species has been recorded from a variety of plant communities crossing gradients from wet to dry including lakeplain prairies, prairie fens, and sand

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prairie or barrens. Many Michigan sites represent only small parcels of what was once widespread habitat. At known sites associated prairie plants typically include big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), common mountain mint (*Pycanthemum virginianum*), tall coreopsis (*Coreopsis tripteris*), Ohio goldenrod (*Solidago ohioensis*), Culver's root (*Veronicastrum virginicum*), and switch grass (*Panicum virgatum*).

Biology: Eggs are laid on or near the food plant in the fall and hatch in the spring around mid-May (Bird 1923). Larvae can be found in the root and lower stem of the host plant in most years from 14 July-7 August. Feeding and tunneling in the root causes the plants to wilt and the leaves can turn brown at the tips. The final instar leaves the root and pupates in the soil near the plant. Pupae can be found from 10 August until the adult flight times of 13 September through 5 October. *Papaipema* moths as a whole fly late in the season, usually late August through October. There is also limited data that suggest prairie *Papaipema* moths are active late in the evening (actually early morning hours) (Schweitzer 1999). Based on our blacklighting observations in southern Michigan, *beeriana* is active for a short period of time beginning around 2300 and ending near 2400 hours EST. Several factors need to be considered including ambient temperatures, humidity levels, precipitation, wind, and moon phase; all of which affect moth behavior. Major natural enemies of *Papaipema* include mammals such as rodents and skunks (Hessel 1954, Decker 1931, Schweitzer 1999), woodpeckers (Decker 1930) as well as numerous parasitoids and predatory insects. Small mammals in some cases can completely eradicate small populations (Hessel 1954). A tachinid fly, *Masicera senilis*, and a braconid wasp, *Apanteles papaipemae*, are probably the most important parasitoids of *Papaipema* (Decker 1930).

Conservation/management: Protection of known populations is essential to protect this species in Michigan. Almost all major workers on the genus have commented on the fire sensitivity of *Papaipema* eggs, and Decker (1930) highly recommends use of fire to control the pest species *P. nebris*. Land managers should heed Dana's (1986) general advice and always assume high mortality of *Papaipema* eggs in fall, winter, or spring burn units. To protect *Papaipema* populations, Schweitzer (1999) recommends protecting an adequate amount of the foodplant and to divide habitat into smaller burn units. No *Papaipema* site should ever be entirely burned in a single year. Foodplants spread over a large area or in several discrete patches reduce the risk from predators and parasitoids as compared to a comparable number of plants in a single dense patch. Most, if not all, of these parasitoids are native species and in most cases they do not need to be controlled. All known sites of *beeriana* on managed lands should be monitored periodically. There is no information to suggest how often this should be done and likely these surveys will be at the level of presence/absence, either of larvae or adults. Schweitzer does believe one could quantitatively sample larvae (or at least larval burrows) to estimate the actual size of a population. Monitoring is especially critical when planning to implement prescribed burns. Keep in mind that distribution of the *Papaipema* population among the various burn units will probably vary from year to year, so current information is needed. Generally decisions will be made on information from the previous growing season, since this is the best information on the distribution of *P. beeriana* eggs within a site.

Research needs: Major research needs, as outlined by Schweitzer (1999), include information on habitat requirements other than foodplants, on conditions under which females disperse, and on presence or absence of *Papaipema* on prairie preserves and other fire managed habitats. The latter is needed before dormant season burn regimens are implemented. Any information on speed of recolonization after prescribed burns would be useful. It would be important to try and document how recovery occurred, i.e., from other burn units, from outside the managed area, from skips in the burn, or from very wet microhabitats. More actual information on survival of *Papaipema* in mid or late summer burns is needed. More precise information as to what date *Papaipema* larvae have moved below ground is needed. This information can be used to better time burns, conduct mowing, or schedule grazing rotations. Information is needed to determine whether adults can locate suitable places for oviposition in foodplant patches burned or grazed earlier in the same season. For example, can adults (which typically occur October 1) find places to lay eggs in habitats burned in July or August. Information on how high eggs are placed on the host plant is needed so that the potential suitability of mowing as a management option can be evaluated.

Related abstracts: lakeplain prairie, prairie fen, pine barrens, culver's root borer moth

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Schweitzer, D. 1999. Draft copy of Element stewardship abstract for *Papaipema* moths. The Nature Conservancy, Arlington, VA. 21 pp.

Abstract citation

Cuthrell, D.L. 1999. Special animal abstract for *Papaipema beeriana* (blazing star borer). Michigan Natural Features Inventory, Lansing, MI. 3 pp.

Funding for abstract provided by Michigan Department of Natural Resources - Wildlife Division and Non-Game Program.

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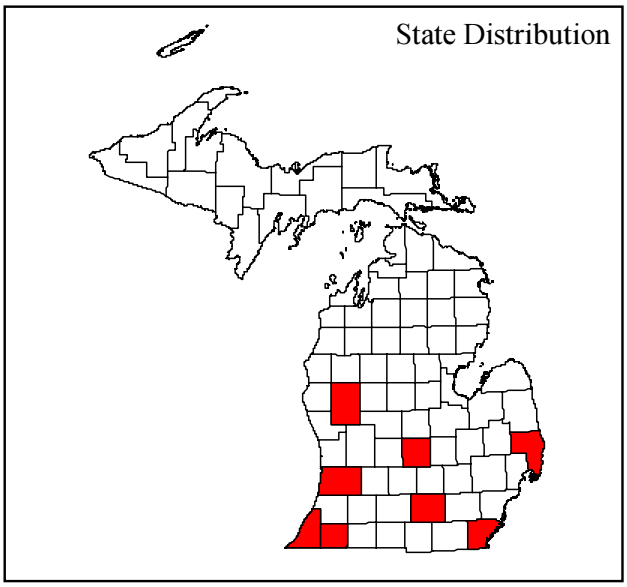
Papaipema sciata Bird — culver's root borer


Photo by David L. Cuthrell.



Best Survey Period

Status: State special concern

Global and state rank: G3G4/S2S3

Family: Noctuidae (owlet moths)

Range: The culver's root borer has been reported from several disjunct localities from the following states: historically Connecticut, Maine, New York, and New Jersey with current records from Iowa, Michigan, Missouri, Minnesota, Illinois, and Wisconsin (Forbes 1954; Peterson et al. 1990).

State distribution: Known from nine sites in eight counties in lower Michigan including Barry, Berrien, Cass, Clinton, Jackson, Monroe, Newaygo, and St. Clair. These moths are very local in occurrence and are rarely found a great distance from their larval food plants.

Recognition: The culver's root borer (Lepidoptera: Noctuidae) has a wingspan of near 40 mm (1.6 in.). Adult forewings with **basal (inner portion of wing nearest the body) two-thirds chocolate brown, marginal third bluish gray, typically with a series of yellowish lunules (crescent-shaped markings) surrounded with white; forewings also with a group of white spots** (Forbes 1954). Hind wings are a solid light chocolate brown. The more common ironweed borer, *Papaipema limpida*, is very similar in appearance but usually can be separated by the pattern of white spots on the forewings. Many species of *Papaipema* are difficult to identify but most can be sorted into species groups (Rings et al. 1992). These species groups can then be sent to experts for positive identification. Series of specimens, which are usually 5-10 individuals from the same location, are easier to work with because they capture the individual variation typical for each site. In addition, many field-collected specimens can be quite worn (many of the wing scales missing) which gives the specimen a lighter appearance than normal, and can eliminate many of the scale characteristics important for identification. To add to the confusion many similar *Papaipmea* species are sympatric (occur at the same location at the same time).

Best survey time: The culver's root borer is a late-season flier with Michigan capture dates ranging from mid-September to mid-October. The best way to survey for this species is by blacklighting, a technique where a sheet is stretched across two trees or poles and an ultraviolet light is used to attract moths to the sheet. Moths can be collected directly from the sheet. You also can search for the larvae of many species of *Papaipema* by searching for signs of feeding activity in late July or early August. This includes inspecting culver's-root (*Veronicastrum virginicum*) plants that are wilted or otherwise stunted, for a small hole near the base of the plant and a pile of frass (caterpillar feces) near this opening. Oftentimes you can see the pile of frass at the base of the plant and then locate the hole in the stem (see Nielsen 1995).

Habitat: The culver's root borer occurs with its larval host plant, culver's-root (*Veronicastrum virginicum*). In Michigan culver's-root has been recorded from a

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variety of plant communities crossing gradients from wet to dry including lakeplain prairies, prairie fens, and sand prairies. Many Michigan sites represent only small isolated parcels of what was once widespread habitat. At known sites, associated prairie plants typically include big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), common mountain mint (*Pycanthemum virginianum*), tall coreopsis (*Coreopsis tripteris*), Ohio goldenrod (*Solidago ohioensis*), marsh blazing star (*Liatris spicata*), and switch grass (*Panicum virgatum*).

Biology: Eggs are laid on or near the food plant in the fall and hatch in late spring or early summer. Larvae can be found in the root and lower stem of the host plant in most years from 21 July through 14 August. Feeding and tunneling in the root causes the plants to wilt, dry and become black. In extreme cases the stem becomes broken and dies. The final instar leaves the root and pupates in the soil near the plant. Pupae can be found from late August until adults fly, typically 28 September through 17 October. *Papaipema* moths as a whole fly late in the season, usually late August through October. *Papaipema sciata* adults have been recorded in Michigan from 19 September through 3 October. Limited data suggests that prairie *Papaipema* moths are active late in the evening (actually early morning hours) (Schweitzer 1999). Several factors seem to effect moth beahavior including ambient temperatures, humidity levels, precipitation, wind, and moon phase. Major natural enemies of *Papaipema* include mammals such as rodents and skunks (Hessel 1954, Decker 1931, Schweitzer 1999), woodpeckers (Decker 1930) as well as numerous parasitoids and predatory insects. Small mammals in some cases can completely eradicate small populations of *Papaipema* (Hessel 1954). A tachinid fly, *Masicera senilis*, and a braconid wasp, *Apanteles papaipemae*, are probably the most important parasitoids of *Papaipema* larvae (Decker 1930).

Conservation/management: Protection of known populations is essential to preserve this species in Michigan. Almost all major workers on the genus have commented on the fire sensitivity of *Papaipema* eggs, while Decker (1930) highly recommends use of fire to control the pest species *P. nebris*. Land managers should heed Dana's (1986) general advice and always assume high mortality of *Papaipema* eggs in fall, winter, or spring burn units. To preserve the rarer *Papaipema* populations, Schweitzer (1999) recommends protecting an adequate amount of the foodplant by dividing their habitat into smaller burn units. These smaller units can be burned in rotation with 3-5 years between burns of a single unit, and adjacent units should not be burned in consecutive years. **No *Papaipema* site should ever be entirely burned in a single year.** Foodplants spread over a large area or in several discrete patches reduce the risk from predators and parasitoids as compared to a comparable number of plants in a single dense patch. Most, if not all, of these parasitoids are native species and in most cases they do not need to be controlled. All known sites of *sciata* on managed lands should be monitored periodically. There is no information to suggest how often this should be done and likely these surveys will be at the level of presence/absence, either of larvae or adults. Researchers can quantitatively sample larvae (or at least larval burrows) to estimate the actual size of a population. Monitoring is especially critical when planning to implement prescribed dormant season burns. Keep in mind that distribution of the *Papaipema* population among the various burn units will probably vary from year to year, so current information is needed. Generally decisions will be made on information from the previous growing season, since this is the best information on the distribution of *P. sciata* eggs within a site.

Research needs: Major research needs, as outlined by Schweitzer (1999), include information on habitat requirements other than foodplants, on conditions under which females disperse, and on presence or absence of *Papaipema* on prairie preserves and other fire managed habitats. The latter is needed before any burn regimens are implemented. Any information on speed of recolonization after prescribed burns would be useful. It would be important to try and document how recovery occurred, i.e., from other burn units, from outside the managed area, from skips in the burn, or from very wet microhabitats. More actual information on survival of *Papaipema* in mid or late summer burns is needed. More precise information as to what date *Papaipema* larvae have moved below ground is needed. This information can be used to better time burns or schedule grazing/mowing rotations. Information is needed to determine whether adults can locate suitable places for oviposition in foodplant patches burned or grazed earlier in the same season. For example, can adults (which typically occur October 1) find places to lay eggs in habitats burned in July or August. Information on how high eggs are placed on the host plant is needed so that the potential suitability of mowing as a management option can be evaluated.

Related abstracts: lakeplain prairie, prairie fen, eastern prairie fringed orchid, blazing star borer, red-legged spittlebug

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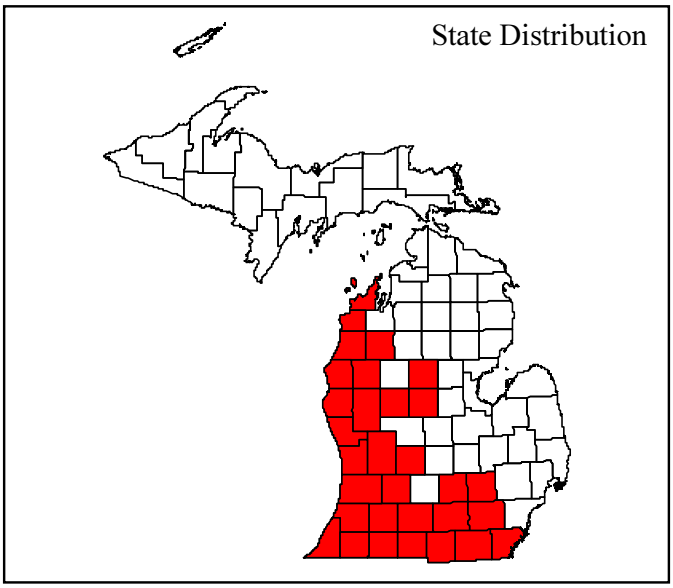
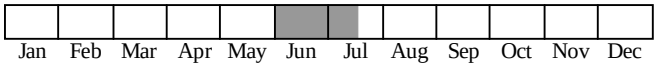
Terrapene carolina carolina (Linnaeus) eastern box turtle



Best Survey Period



Status: State special concern

Global and state rank: G5T5/S3

Family: Emydidae (pond and box turtle family)

Range: The eastern box turtle occurs from Ne. Massachusetts to Georgia, and west to Michigan, Illinois, and Tennessee. The subspecies *Terrapene c. triunguis* (three-toed box turtle) ranges from Missouri to Texas and south central Alabama. *Terrapene c. major* (Gulf Coast box turtle) occurs along the Gulf Coast region of Florida and southern Louisiana and *Terrapene c. bauri* (Florida box turtle) occurs in the Florida peninsula and in some of the Keys. The various races of *Terrapene carolina* intergrade with one another where their ranges come in contact (Conant and Collins 1998).

State distribution: Historically eastern box turtles have been found in the southern and western Lower Peninsula in 31 counties. They are locally common in the southwestern counties but are rare throughout the rest of their former Michigan range. In the past ten years the eastern box turtle has been reported in 20 counties including Allegan, Barry, Berrien, Calhoun, Cass, Clare, Jackson, Kalamazoo, Kent, Lake, Manistee, Mason, Muskegon, Newaygo, Oakland, Oceana, St. Clair, St. Joseph, VanBuren, and Washtenaw counties.

Recognition: The eastern box turtle is a small land turtle with a **high-domed carapace** (upper part of shell) and a **hinged plastron** (bottom part of shell) which allows it to close its shell tightly and hide its head, legs and tail. The carapace has **a slight keel** (raised ridge) along the midline and ranges from 4.6 to 7.8 inches (11.8 to 19.8 cm) in length. It is **brown or black with a highly variable pattern of yellow or orange markings within each scute** (a large scale or plate). The plastron can be yellowish, brown or black and is either plain or marked with blotches or lines. Males are usually larger and more brightly colored than females, often have reddish or pinkish eyes (brown in females) and have a concave plastron (flat or slightly convex in females). The skin of the head and legs is usually dark with yellow streaks and spots, although in some individuals (especially males) the yellow or orange can cover most of the head and forelimbs. There are four toes on each hind foot and the tail is quite short. Hatchling turtles have a much flatter shell than adults and are mostly grayish brown with a spot of yellow on each large scute (hatchling spotted turtles (*Clemmys guttata*) have a blacker shell). Other adult Michigan turtles of similar size or shape to the eastern box turtle are the wood (*Clemmys insculpta*) and Blanding's (*Emydoidea blandingii*). The wood turtle has a flatter carapace, usually with characteristic roughly grooved circular growth rings, and its plastron lacks a hinge. The larger Blanding's turtle has a domed carapace that is elongated, smooth and unkeeled, with a profusion of light dots. It also has a bright yellow chin that contrasts strongly with its dark head (Harding 1997).

Best survey time: Box turtles can be seen anytime between April and October, although most sightings coincide with egg laying, which occurs from early June through mid July. Weather is a more predictable factor than time of year in determining turtle activity as they are often found the morning after a rainstorm, otherwise spending much time buried under leaf litter, brush piles

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and rotting logs (Harding 1997).

Habitat: The eastern box turtle is Michigan's only truly terrestrial turtle. It typically occurs in forested habitats with sandy soils near a source of water such as a stream, pond, lake, marsh or swamp (Tinkle et al. 1979). They also may be found in adjacent thickets, old fields, pastures, vegetated dunes, marshes and at bog edges. Access to unshaded nesting sites in sandy, open areas, is critical for successful reproduction.

Biology: The box turtle's annual cycle begins in April and ends in October. Mating generally occurs soon after the turtles emerge from their hibernacula in April but may also occur in summer and fall. Egg laying usually takes place in the evening from early June until the middle of July, with 3 to 11 leathery shelled eggs being buried often in an open elevated location. Incubation requires 50 to 90 days with hatching typically occurring in September or October. Hatchlings are rarely seen as they spend most of their time hiding under forest debris.

Box turtles dig into the soil at the onset of cool weather, digging deeper as temperatures decline. The most common night and winter retreat is a cavity constructed by the turtle in leaves, debris or soil. Some individuals move about in the winter and may leave their hibernacula in the spring well before the last frost (Claussen et al. 1991), although some turtles die when early spring thaws are followed by a return to severe cold (Harding 1997). Box turtles exhibit a high degree of natural freeze tolerance and have been shown in laboratory studies to survive the freezing of 58% of their body water for up to 72 hours without injury (Costanzo and Claussen 1990).

Box turtles are diurnal and most active in the spring and fall. In the summer they may have a brief activity period in the morning, or following moderate to heavy rainshowers (Harding 1997). Stickel (1950) found that weather conditions most favorable to turtle activity are high humidity, warm sunny days, and frequent rains. In hot weather box turtles will soak at the edges of ponds and streams, yet avoid deep water since they are generally poor swimmers (Harding and Holman 1990). During the heat of midsummer they may congregate in mudholes, burrow in the mud in marshy areas (Smith 1961) or burrow beneath logs or rotting vegetation (Conant and Collins 1998). Sunning takes place in forest openings with protective cover nearby. Turtles not actively moving about are usually found using habitat cover of brush piles or tangles of vines and briars.

Typical home ranges are small, ranging from 3.7 to 40 acres, although males wander widely which may help to maintain genetic diversity within and between populations (Harding 1997).

It is estimated that nest mortality in Michigan box turtle populations ranges between 70% to 100% and juvenile mortality is thought to be nearly as high (Harding 1999). Skunks, raccoons and foxes prey on box turtle eggs; smaller juvenile turtles are vulnerable to these mammals as well as shrews, birds and snakes. The plastral hinge is not functional in very young turtles but they can give off a strong odor that may act to deter predators (Harding 1997). The young are largely carnivorous and eat mostly insects, earthworms and other invertebrates, yet take more plant foods as they grow. Adults are omnivorous eating a great variety of plants, insects, worms, slugs, snails, carrion, mushrooms, berries and fruit. Sexual maturity in females is usually not reached until they are 10 years old. Eastern box turtles are reported to have lived over a century although the average lifespan is thought to be 50 years with individuals rarely living past 80 years. It is possible to estimate a growing turtle's age by counting the growth rings on the scutes of the plastron. Estimates beyond the age of 20 are unreliable since most turtles have stopped growing by this age and the plastron is often worn smooth (Stickel 1978).

Conservation/management: Harding (1997) cites the rapid conversion of woodlands and wetlands into agricultural land over the past century as the primary cause for the elimination of the box turtle from much of its former range. The present spread of suburban development continues to fragment habitat and isolate the remaining populations, in addition to increasing their vulnerability to road mortality. Demand for box turtles in the domestic and international pet trade has encouraged poaching and has contributed to the depletion of their populations (Harding 1997). In 1994 the box turtle was added to Appendix II in CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora). This prevents unauthorized exports of box turtles and more closely regulates commercial trade to help prevent them from becoming threatened (Liebermann 1994). In Michigan, under the Director's Order No. DFI-166.98, Regulations on the Take of Reptiles and Amphibians, it is unlawful to take a box turtle from the wild except as authorized under a permit from the director (legislated by Act 165 of the Public Acts of 1929, as amended, Sec.302.1c (1) and 302.1c (2) of the Michigan Compiled Laws). Harding (1997) believes that these laws offer some important protection, but fail to protect box turtles from their worst enemies, bulldozers and automobiles. There is much concern that the high rates of nest predation and juvenile mortality in Michigan coupled with the number of adults killed on roads, and the time it takes for turtles to reach sexual maturity, dim the long term outlook for the box turtle (Harding 1999). Conservation efforts should concentrate on protecting large tracts of habitat on public land to provide the box turtle additional protection from the effects of development (Tinkle 1979). Wetland hydrology and quality should be maintained by preventing improper off road vehicle (ORV) use and controlling invasive weeds in these areas. Upland nesting areas should be identified, protected and in some cases created. New roads should be routed to avoid separating the turtle's habitat from nesting areas (Harding 1999). Finally, the

local public should be educated about the laws protecting reptiles and amphibians and encouraged to leave wild turtles in their natural habitats rather than collecting them for pets.

Research needs: Additional surveys are needed to locate box turtle populations and important nesting areas so they can be adequately protected. Studies should focus on understanding population structure and determining the factors that contribute to population viability (Harding 1999).

Related abstracts: Blanding's turtle, eastern massasauga

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Funding for abstract provided by U.S. Fish and Wildlife Service and Michigan Department of Natural Resouces - Wildlife Division, Non-Game Program.

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Sistrurus catenatus catenatus eastern massasauga

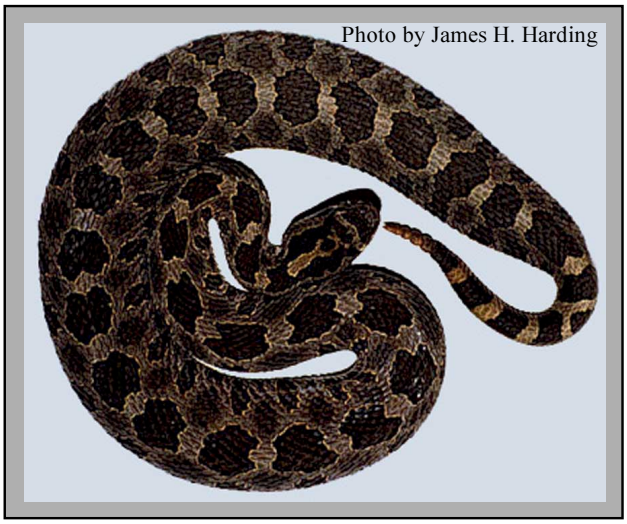
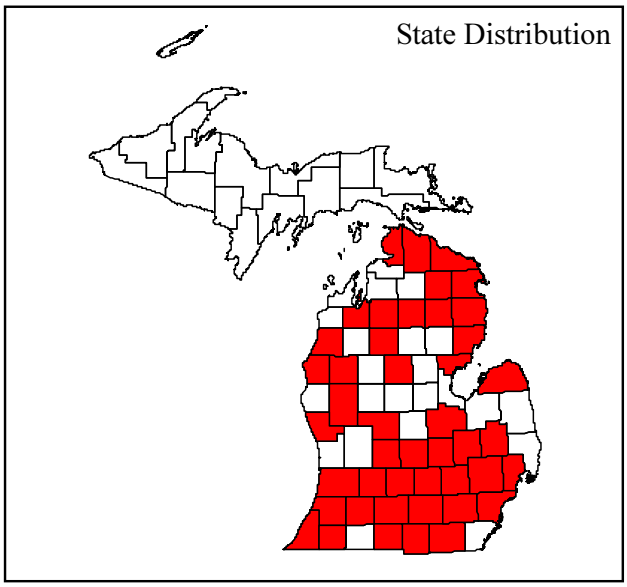


Photo by James H. Harding



Best Survey Period

Status: Federal candidate species, State special concern

Global and state rank: G3G4T3T4/S3S4

Family: Viperidae (pit vipers and vipers)

Range: The eastern massasauga occurs from southeastern Minnesota, eastern Iowa, and northeastern Missouri east to southern Ontario, western New York, and northwestern Pennsylvania (Harding 1997). This species was once common across its range, but has declined drastically since the mid-1970s (Szymanski 1998). Massasaugas now mainly occur in disjunct, isolated populations, and have been afforded some level of legal protection in every state or province in which this subspecies occurs (Szymanski 1998).

State distribution: Michigan appears to be the last U.S. stronghold for this species relative to other states within its range. Historically, eastern massasaugas were found throughout the Lower Peninsula and on Bois Blanc Island. Within the last decade, eastern massasaugas have been reported from about 150 sites in 50 counties. These sightings appear to cluster in several regions across the Lower Peninsula, indicating areas where massasaugas may be concentrated (Legge and Rabe 1994). These include Oakland, Livingston, Jackson and Washtenaw counties in southeast Michigan, Allegan, Barry and Kalamazoo counties in southwest Michigan, and Iosco, Crawford and Kalkaska counties in northern Michigan. Nearly one-third of the historical occurrences in the state has not been reconfirmed in the past ten years (Legge 1996). Massasaugas have not been reported from Branch, Ingham, Shiawassee, Macomb, Huron, Clare, Oscoda, Montmorency and Emmet counties since prior to 1980 (some since the early 1900's) (Legge and Rabe 1994, Legge 1996). It is important to note, however, that a statewide, systematic field survey for this species has not been conducted. Also, massasaugas are highly cryptic and difficult to observe in its natural habitat. Therefore, massasaugas may still be present in areas that lack recent, as well as historical, records.

Recognition: Several characteristics readily identify this species from all other snakes in Michigan. The massasauga is a medium-sized (18.5 to 39.5 inches in length), thick-bodied snake (Harding 1997). It has a distinctive color pattern of **dark brown rectangular blotches** down the back with two or three additional rows of **dark spots along the sides**, and **alternating dark and light bands along the tail**. The **background color is gray, gray-brown or brown**. The belly or underside of the snake is usually black with gray, white or yellowish mottling (Harding 1997). The massasauga is a rattlesnake, and therefore has a **segmented rattle** at the end of its tail. It also has a **triangular-shaped head** (i.e., widens at the back of the head and narrows at the neck), **vertical slit-shaped pupils**, and **large, heat-sensing pits or openings** between the nostrils and the eyes. The scales are keeled (i.e., have a raised ridge), and the anal plate (i.e., enlarged scale partly covering the anal opening) is divided into two parts. It is the only **venomous** snake found in the state. Newborn massasaugas range

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in length from 7 to 10 inches and look similar to adults except are lighter in color (Harding 1997). They have only a single button at the end of their tails, and are unable to produce the sound of a rattle.

Several snakes in Michigan are frequently mistaken for eastern massasaugas. These include the eastern fox snake (*Elaphe vulpina gloydi*, State threatened), northern water snake (*Nerodia sipedon*), eastern milk snake (*Lampropeltis triangulum triangulum*), and eastern hog-nosed snake (*Heterodon platirhinos*). Although these snakes have a similar pattern of dark blotches on the back, these snakes usually have a lighter background color. They also lack the rattle, head shape, and pupil shape of the massasauga. Eastern fox snakes generally have a more slender and longer body than the massasauga (total adult lengths of 35 – 67 inches) (Harding 1997). The eastern hog-nosed snake has an upturned snout and is able to flatten and spread its neck out when threatened. Also, several of these snakes often will mimic the eastern massasauga and vibrate their tails rhythmically when threatened. If the snake is located in dry leaf litter, it can produce a buzzing sound similar to the massasauga's rattle.

Best survey time: Massasaugas typically are active between April and late October (Seigel 1986), and can be seen anytime during the active period. However, the best times to survey for this species are during spring emergence (i.e., April and May) for all age classes and during the basking and birthing period in mid- to late summer (i.e., late July, August and early September) for gravid females (Szymanski 1998, Casper et al. *in prep.*). Massasaugas are presumed to be most active during these time periods. Another survey window for this species is during fall ingress (i.e., mid-September through October) when snakes are moving to hibernacula (Seigel 1986, Johnson 1995, Szymanski 1998).

The recommended survey method currently is visual searches (Casper et al**.** *in prep*.). Optimal weather conditions for visual surveys include greater than 50% cloud cover, less than 15 mph wind speed, and air temperatures between 50 and 80° F (Casper et al. *in prep.*). Casper et al. (*in prep*.) recommend morning and evening surveys. However, although daily activity cycles vary among populations, Seigel (1986) found that during the spring and fall, massasaugas tend to be most active during the warmest parts of the day (e.g., 1200 – 1600 h). During the summer, they tend to be more active in late afternoon during cooler temperatures and may even become nocturnal.

Habitat: Eastern massasaugas have been found in a variety of wetland habitats, including bogs, fens, shrub swamps, wet meadows, marshes, moist grasslands, wet prairies, and floodplain forests (Hallock 1990, Harding 1997). Populations in southern Michigan are typically associated with open wetlands, particularly prairie fens, while those in northern Michigan are better known from lowland coniferous forests, such as cedar swamps (Legge and Rabe 1996). Massasaugas also generally occupy wetland habitats in the spring, fall, and winter, but in the summer, snakes migrate to drier, upland sites, ranging from forest openings to old fields, agricultural lands and prairies. In general, structural characteristics of a site appear to be more important than vegetative characteristics for determining habitat suitability (Beltz 1992). Specifically, all known sites appear to be characterized by the following: (1) open, sunny areas intermixed with shaded areas, presumably for thermoregulation; (2) presence of the water table near the surface for hibernation; and (3) variable elevations between adjoining lowland and upland habitats (Beltz 1992).

Ecology: Massasaugas usually are active between April and late October. Spring emergence typically starts in late March and early April as groundwater levels rise and ground temperature approaches air temperature (Harding 1997, Szymanski 1998). Massasaugas spend most of the time in the spring basking on elevated sites such as sedge and grass hummocks, muskrat and beaver lodges, or dikes and other embankments. Individuals may spend up to several weeks in the wetlands near their hibernation sites before moving to their summer habitats (Johnson 1995). This seasonal shift in habitat use appears to vary regionally and among populations (Szymanski 1998). In Wisconsin, King (1997) documented only gravid females dispersing to the drier uplands to have their young, while the males and non-gravid females remained in the wetlands.

Mating occurs in the spring, summer and fall (Reinert 1981, Vogt 1981, Harding 1997). The females give birth to litters of 5 to 20 live young in August or early September in mammal burrows or fallen logs in the uplands (Vogt 1981, Harding 1997). Female massasaugas reach sexual maturity at three or four years of age, after which they have been reported to reproduce both annually and biennially in different parts of their range (Reinert 1981, Seigel 1986, Harding 1997).

Massasaugas usually hibernate in the wetlands in crayfish or small mammal burrows. They also have been known to hibernate in tree roots and rock crevices as well as submerged trash, barn floors, and basements (Johnson and Menzies 1993). Hibernation sites are located below the frost line, often close to groundwater level. The presence of water that does not freeze is critical to hibernaculum suitability (Johnson 1995). Individuals tend to return to the same hibernation site each year (Prior 1991) and tend to hibernate singly or in small groups of two or three (Johnson and Menzies 1993).

Massasauga home ranges and movement distances can be quite variable. King (1997) reported mean home ranges of approximately 5 to 7 acres for neonates and gravid females, 17 acres for non-gravid females and 398 acres for males. Other studies have reported mean home ranges of less than 2.5 acres (Reinert and Kodrich 1982) to 64 acres (Johnson 1995). Reported maximum movements range from 0.1 mile in Michigan (Hallock 1990) to 2 miles in Wisconsin (King 1997). King (1997) recorded average movement distances of 0.03 mile for neonates, 0.2 mile for non-gravid females, 0.4 mile for gravid females, and 0.8 mile for males.

Massasaugas feed primarily on small mammals such as voles, moles, jumping mice, and shrews. They also will consume other snake species and occasionally birds and frogs. Natural predators for the massasauga, particularly the eggs and young, include hawks, skunks, raccoons, and foxes (Vogt 1981).

When they are threatened, eastern massasaugas will typically remain motionless, relying on their cryptic coloration to blend into their surroundings. They sound their rattle when alarmed but will occasionally strike without rattling when surprised. This species is generally considered unaggressive; it is unusual for the species to strike unless it is directly disturbed (Johnson and Menzies 1993). Although the venom is highly toxic, fatalities are very uncommon because the species' short fangs can inject only a small volume (Klauber 1972). Small children and people in poor health are thought to be at greatest risk.

Conservation/management: The greatest threats to eastern massasauga populations are habitat loss and degradation due to human activities, including the draining of wetlands for agriculture, residential development, roads and pollution (Szymanski 1998). In addition to the loss of wetlands, essential upland habitat has been destroyed and fragmented. Vegetative succession also has reduced habitat availability (Beltz 1992, Johnson 1995). Current land use practices, hydrological changes and fire suppression have altered or eliminated the natural disturbance regimes necessary for maintaining the early successional structure with which massasaugas are associated (Szymanski 1998). Vehicle-caused mortality and injury also pose a significant threat to populations as suitable habitat becomes fragmented by roads (Szymanski 1998).

Overcollection for commercial, recreational, scientific, or educational purposes has greatly reduced massasauga numbers at many sites, particularly collection for the pet trade and bounty hunting in states other than Michigan (Szymanski 1998). The lack of uniform protection for the massasauga across its range can create loopholes for illegal take and trade (Szymanski 1998), and lead to increased collecting pressure in states where take is not prohibited. Indiscriminant persecution by humans also has contributed to this species' decline. In Michigan, the eastern massasauga is protected under the Director's Order No. DFI-166.98, Regulations on the Take of Reptiles and Amphibians, which is administered by the Michigan Department of Natural Resources' Fisheries Bureau. It is unlawful to take an eastern massasauga from the wild except as authorized under a permit from the Director (legislated by Act 165 of the Public Acts of 1929, as amended, Sec.302.1c (1) and 302.1c (2) of the Michigan Compiled Laws). Public land managers and the general public should be informed that this species is protected and should not be collected or harmed. Any suspected illegal collection of eastern massasaugas should be reported to local authorities, conservation officers or wildlife biologists. The eastern massasauga also was listed as a federal candidate species by the U.S. Fish and Wildlife Service in 1999, and may be proposed for listing as threatened or endangered under the Endangered Species Act in the future.

Habitat protection of suitable wetlands and associated uplands is crucial for successful conservation of the eastern massasauga. Where populations are concentrated on public lands, land management practices need to be sensitive to protecting massasauga habitat. For instance, potential adverse impacts of land management practices such as timber harvesting, mowing, or prescribed burning can be avoided or minimized if these activities are conducted in late fall, winter, or early spring (i.e., November through early March) when the snakes are hibernating. Hydrological alterations such as winter drawdowns should be conducted prior to the initiation of hibernation to reduce the potential for causing winter mortality due to desiccation or freezing (Szymanski 1998). Viable massasauga populations in the state should be identified and targeted for long-term conservation and management efforts. Finally, people need to be educated about the biology and ecology of the eastern massasauga in order to reduce direct harassment and harm to individual snakes. This is especially important in areas where human-massasauga interactions are frequent (e.g. state and local parks).

Research needs: Currently, the greatest obstacle to effective conservation and management of the eastern massasauga in Michigan is incomplete knowledge of the distribution and abundance of the species. While recent sightings have been summarized (Legge and Rabe 1994), additional and systematic field surveys are needed. Additional work is needed to obtain long-term data on selected populations to identify healthy or viable massasauga populations. A reliable and efficient protocol or methodology for surveying and monitoring this species and estimating population size needs to be developed. Continued research is needed to improve our understanding of the specific biology

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and ecology of Michigan massasaugas as well as potential impacts of various management practices. The genetic diversity of extant populations needs to be examined. Effective methods to educate the public about how to co-exist with massasaugas also need to be researched and implemented.

Related abstracts: Mitchell's satyr butterfly, prairie fen, spotted turtle, Blanchard's cricket frog, eastern fox snake, wood turtle, Blanding's turtle, small white lady's-slipper, mat muhly, red-legged spittlebug, swamp metalmark

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Funding for this abstract is a contribution of Federal Aid in Endangered Species, Michigan Project E-1-29.

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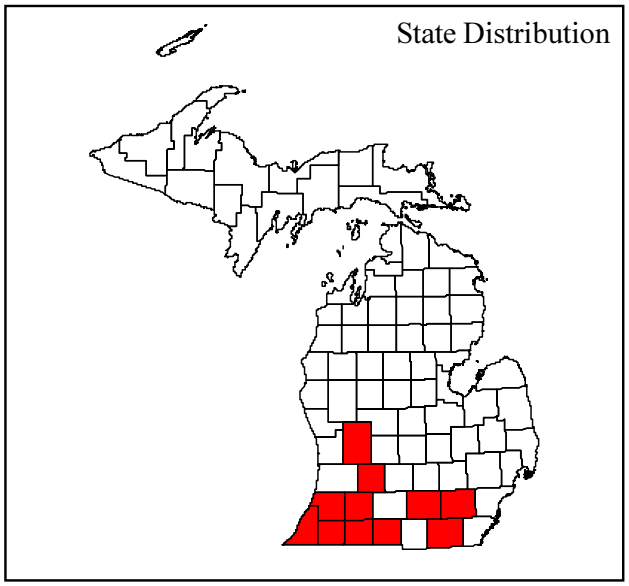
Neonympha mitchellii mitchellii French — Mitchell's satyr butterfly



Best Survey Period

Status: Federally endangered, State endangered

Global and state rank: G1G2T1T2/S1

Family: Nymphalidae

Range: Mitchell's satyr is known historically from approximately 30 sites in four states including southern Michigan, northern Indiana, northern Ohio, and northern New Jersey (U.S. Fish and Wildlife Service (USFWS) 1997). An additional historical population has been reported from central Maryland, but this record has never been verified and remains questionable (USFWS 1997). Most of the historical sites are known from Michigan, possibly indicating the former core of this species' range (Szymanski 1999). Today, Mitchell's satyr occurs primarily in southern Michigan and at only two sites in northern Indiana. The species is considered extirpated in Ohio and New Jersey due to habitat loss and overcollecting (Evers 1994, USFWS 1997).

State distribution: Mitchell's satyr has been documented from at least 22 sites in 11 counties, extending as far north as Kent County (Wilsmann and Schweitzer 1991, USFWS 1997). Surveys from 1995 to 2000 of known sites and potential habitat have confirmed extant populations at only 16 sites in 9 counties, primarily in southwest Michigan (Hyde et al. 2001). Of the 22 historical populations, five are believed to be extirpated (i.e., satyrs have not been seen at the site for over a decade) (USFWS 1997, Hyde et al. 2001). Two counties (Kent and Lenawee) are no longer thought to contain extant satyr populations. However, it is important to note that recent systematic surveys have reconfirmed satyr at several sites previously considered extirpated. Of the extant populations, only nine are considered high quality sites with potential for containing viable satyr populations (i.e., sites which consistently support higher densities of adults, and contain adequate habitat to maintain healthy populations of the butterfly) (USFWS 1997).

Recognition: Mitchell's satyr is a **dark, chocolate brown**, medium-sized butterfly with a wing span that ranges from 1.5 to 1.75 inches (Opler and Malikul 1992). **The ventral surface, or underside, of the forewing and hindwing contains a row of four to five black, yellow-ringed ocelli, or eyespots, with the central three eyespots on the hindwing being the largest. Two orange bands encircle the eyespots.** The **dorsal, or upper, wing surface is unmarked** but thinly scaled so that the ventral pattern often shows through (USFWS 1997). Males are darker and slightly smaller than females (Opler and Krizek 1984). Mature larvae are pale green with pale, longitidunal stripes and a bifurcate tail (McAlpine et al. 1960).

Other Michigan species that may be confused with the Mitchell's satyr butterfly because they are similar in appearance and habitat use include the Appalachian brown *(Satyrodes appalachia*), eyed brown (*Satyrodes eurydice*), large wood nymph (*Cercyonis pegala)*, and little wood satyr (*Megisto cymela*) butterflies. The Appalachian brown and eyed brown butterflies are larger and lighter brown or more tan in color than Mitchell's satyr, and have very different eyespot

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patterns. The wood nymph is much larger with only one or two large eyespots on the forewing. The little wood satyr is similar in size, but has only two black eyespots on each wing. The Mitchell's satyr butterfly also can be distinguished from these species by its slow, bobbing flight pattern. It also typically flies closer to the tops of sedges and shrubs than do the other four species.

Best survey time: The best time to survey for this species is during the peak flight period which typically occurs during the first two weeks in July, but can occur as early as the last week in June (USFWS 1997). The best way to survey for this species is to conduct visual surveys while meandering through suitable habitat, particularly along the interface of open wetland habitat and shrubby/forested vegetation. This species' behavior and activity appear to be strongly influenced by ambient temperatures and solar radiation. Mitchell's satyr are most active and easiest to observe on warm (80-90°F), overcast days, and their activity is significantly reduced during hot (>90°F), sunny days (Shuey 1997). At some sites, Mitchell's satyrs also have exhibited a diurnal activity pattern in which individuals are active during the cooler parts of the day (i.e., early morning and late afternoon) and appear to rest during the warmest part of the day (i.e., midday) (Clampitt pers. comm.).

Habitat: Although this species' habitat requirements are not yet fully understood, this butterfly appears to be restricted to calcareous wetlands that range along a continuum from open fen, wet prairie, prairie fen, and sedge meadow to shrub-carr and tamarack savanna (Shuey 1997, Szymanski 1999). Despite the range of ecological communities occupied by Mitchell's satyr, several attributes appear constant among known satyr sites: (1) peat soil, (2) a herbaceous community dominated by sedges, which always include *Carex stricta*, (3) scattered deciduous shrubs or coniferous trees, most often poison sumac (*Toxicodendron vernix*), tamarack (*Larix laricina*) or red cedar (*Juniperus virginiana*), and (4) groundwater seeps (MacKinnon and Albert 1996, Shuey 1997, Szymanski 1999). Mitchell's satyr habitat also appears to exhibit large variability in vegetative structure and composition at the habitat patch scale, suggesting the importance of habitat heterogeneity (Szymanski 1999).

Biology: Little is known about the ecology of this species. Mitchell's satyr is single-brooded throughout its range (USFWS 1997). Adults fly in late June through mid-July. Adults usually are active at a given site for two to three weeks. Males generally emerge a few days before the females. During the flight period, the butterflies mate, lay eggs, and die. McAlpine et al. (1960) found, under caged conditions, that the eggs hatch within 7 to 11 days, and the larvae feed through the summer until the fourth instar. The larvae then diapause, resume feeding the following spring and complete the fifth instar. However, this species' larval phenology has not yet been confirmed under natural field conditions.

The primary hostplant for this species is believed to be *Carex stricta*, based on laboratory experiments (McAlpine et al. 1960) and the close association between adult Mitchell's satyr and dense stands of *C. stricta* in the field (Shuey 1997). The larvae feed on *C. stricta* and other fine-leaved sedges in the fens. However, Legge and Rabe (1996) documented oviposition on the undersurface of leaves of five different herbaceous plant species. Other researchers have observed females ovipositing *in situ* on the underside of tiny forbs (<5 cm) (Szymanski 1999, Hyde et al. 2001).

Mitchell's satyr also seems to be associated with woody vegetative structure as researchers have encountered adult satyrs most often at the interface between open fen or sedge meadow and woody vegetation (McAlpine et al. 1960, Rogers et al. 1992, Szymanski 1999). Shuey (1997) observed that during warm, sunny conditions, adults seek out shaded resting areas under shrubs or sedges, and fly only in response to disturbance. Szymanski (1999) found that Mitchell's satyrs tend to be very sedentary, and utilize only a small proportion of the available habitat at a site, generally moving a total distance of less than 50 meters.

Conservation/management: Mitchell's satyr is one of the most endangered butterflies in North America (USFWS 1997). The primary threat to the continued survival of this species is habitat loss and modification (Shuey 1997, Szymanski 1999). Many of the wetland complexes occupied currently have been altered or drained for agriculture or development. Wetland alteration is responsible for extirpating the single known satyr population in Ohio and several populations in Michigan (USFWS 1997). Wetland alteration also can lead to invasion by exotic plant species such as glossy buckthorn (*Rhamnus frangula*), purple loosestrife (*Lythrum salicaria*), common buckthorn (*Rhamnus cathartica*), and the common reed (*Phragmites australis)* (USFWS 1997). In addition, landscape-scale processes that may be important for maintaining suitable satyr habitat and/or creating new habitat, such as wildfires, fluctuations in hydrologic regimes, and flooding from beaver (*Castor canadensis*) activity, have been virtually eliminated or altered throughout the species' range (USFWS 1997). As a result, suitable satyr habitat and extant populations have become fairly isolated. Dispersal among populations, colonization of new sites and recolonization of extirpated sites have become increasingly unlikely (USFWS 1997). Finally, this species is vulnerable to collection for commercial exploitation, although the impact on a population varies with the timing, frequency, and number collected

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(Evers 1994, USFWS 1997). Currently, this does not appear to be a significant threat to satyr populations in Michigan (Shuey 1997).

Successful conservation and recovery of this species will require protection of existing populations and habitat, protection of suitable unoccupied habitat, development of appropriate habitat management techniques, possible reintroduction into historical and suitable unoccupied sites, protection from collection, and an active research program (Evers 1994, USFWS 1997). Many populations of this species occur on private land. These sites need to be acquired or protected through management agreements or conservation easements (Shuey 1997, USFWS 1997). At known sites, it is necessary to maintain existing habitat and restore additional habitat throughout the wetland. It also is important to minimize inter-patch distance and provide corridors of suitable habitat between patches for dispersal (Szymanski 1999). Satyr sites should be managed to maintain a mosaic of woody and sedge cover, and habitat heterogeneity in general. If fire is to be used as a management tool, it should be done so carefully and at a small scale initially. The Mitchell's satyr working group should be consulted before any burns are scheduled for occupied sites. Invasive species should be monitored and removed. Natural hydrologic regimes need to be maintained or restored. Since so few viable populations of this species are known, re-introduction of Mitchell's satyr into historical sites that appear to still contain suitable habitat and introduction of satyr into suitable unoccupied sites should be implemented to help ensure long-term viability of this species (USFWS 1997).

Research needs: Gaining a better understanding of the biology and ecology of Mitchell's satyr is crucial for developing effective long-term protection strategies for this species. Research is needed on this species' life history, especially larval ecology, habitat use and requirements, response to habitat disturbance, and population structure and dynamics. Aspects of larval ecology that need to be examined in the field include oviposition substrates, hostplant use, feeding patterns, larval resting and diapause locations, and rates of growth and development (USFWS 1997). This species' primary hostplant needs to be verified in the field. A detailed assessment of vegetation structure and composition at occupied and unoccupied sites needs to be conducted to document the range of habitats used by this species (USFWS 1997). Information on within-site dispersal, distribution and habitat use can help identify important areas within a site (e.g., areas for reproduction) and help guide protection and management of wetland complexes occupied by Mitchell's satyr (USFWS 1997). Natural processes and disturbances essential for maintaining satyr habitat and compatible with the Mitchell's satyr as well as associated species need to be identified (USFWS 1997). Studies are needed to to develop effective population monitoring techniques as well as appropriate methodology for selecting sites for reintroductions. Finally, surveys of known and suitable unoccupied sites should continue in order to monitor existing populations and habitat, and to identify new populations.

Related abstracts: prairie fen, eastern massasauga, spotted turtle, Blanchard's cricket frog, small white lady's-slipper, mat muhly, red-legged spittlebug, swamp metalmark

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Updated: March 2001

Funding for this abstract is a contribution of Federal Aid in Endangered Species, Michigan Project E-1-29.

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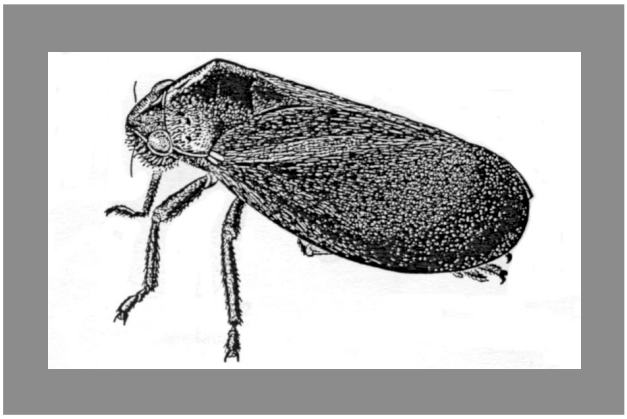
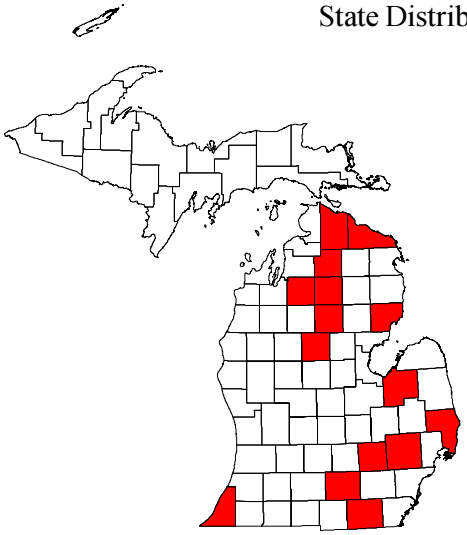
Prosapia ignipectus (Fitch) red-legged spittlebug

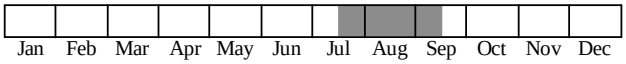


Drawing courtesy of:
Eastern Cereal and Oilseed Research Centre
For the Department of Agriculture and Agri-Food, Government of Canada

State Distribution



Best Survey Period



Status: State special concern

Global and state rank: G4/S2S3

Family: Cercopidae (spittlebug, froghopper)

Range: The spittlebug genus *Prosapia*, as defined by Fennah (1949, 1953) and later by Hamilton (1977), is restricted to North America with only two species (*bicincta*, *ignipectus*) occurring in the northern United States and Canada. These taxa were considered the same species (but separate subspecies) until futher work by Hamilton (1977) elevated each to full species status. The red-legged spittlebug in Canada is found locally in southernmost Ontario. In the United States it appears to occur commonly in sandy regions of the northeast, south to southern Pennsylvania (Hamilton 1982), and west through Wisconsin, Illinois, and into eastern Iowa.

State distribution: Only two verified collection localities (Presque Isle and Berrien counties) were known from the state prior to 1994. During inventories, by Michigan Natural Features Inventory (MNFI), for lakeplain prairies in southern Michigan the species was recorded from St. Clair and Tuscola counties (Comer et al. 1995). During 1995-1999 additional surveys by MNFI documented the red-legged spittlebug from Cheboygan, Clare, Crawford, Jackson, Kalkaska, Lenawee, and Livingston counties. The species is now known in Michigan from 20 locations in 15 counties.

Recognition: The red-legged spittlebug (Homoptera: Cercopidae) is a medium-sized spittlebug with adult males ranging from 6.8 to 8.3 mm (0.27 - 0.33 in.); females are slightly smaller on average ranging 7.5 to 7.9 mm (0.30 - 0.31 in.)(Hamilton 1982). **This is the only black spittlebug in Michigan that has an undersurface boldly marked with scarlet near the leg bases and leg joints, and on the abdomen.** A very similar species *Prosapia bicincta* is slightly wider in form and usually is marked with three fine crossbands of yellow, orange, or scarlet on the upper side (Hamilton 1982). Rarely an unmarked specimen of *bicincta* is reported, which requires comparison of genitalia to positively separate the two species (Hamilton 1977).

Best survey time: Adults of the red-legged spittlebug have been recorded in Michigan from July 17 through September 19. The best way to survey for this species is to use a standard insect sweep net in suitable habitat. Several sweep samples may be needed to detect adults of this species in an area because the red-legged spittlebug occurs in small colonies that occupy diminutive portions of available habitat (Hanna 1970). Nymphs (sub-adult life stages) are believed to feed on the subterranean parts of little bluestem, *Schizachyrium scoparium* (Hamilton 1982), and therefore sampling for this life stage could prove to be extremely time consuming and potentially destructive.

Habitat: The red-legged spittlebug has been recorded in associaton with alvar grassland in Presque Isle County, from prairie fens in Berrien and Jackson

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counties, from jack pine barrens in northern lower Michigan, and lakeplain prairie in southern Michigan. At the lakeplain prairie sites the spittlebug occurs in areas dominated by big (*Andropogon gerardii*) or little bluestem and other prairie species including: switch grass (*Panicum virgatum*), common mountain mint (*Pycnanthemum virginianum*), bush clover (*Lespedeza capitata*), common polygala (*Polygala sanguinia*), colic root (*Aletris farinosa*), heath aster (*Virgulus ericoides*), sedges (*Carex* spp.), tall coreopsis (*Coreopsis tripteris*), marsh blazing star (*Liatris spicata*), shrubby St. John's wort (*Hypericum kalmii*), fringed close gentian (*Gentiana andrewsii*), ironweed (*Veronia missurica*), tall sunflower (*Helianthus giganteus*), Ohio goldenrod (*Solidago ohioensis*), Riddell's goldenrod (*S. riddellii*), Culver's root (*Veronicastrum virginicum*), and the grass pink orchid (*Calopogon tuberosus*).

Biology: Little is known about the life history and ecology of most spittlebugs, except for a few species of economic importance. Recent studies by Peck indicate that a closely related *Prosapia* species undergoes five nymphal instars (Peck 1999). Cercopid nymphs, or spittlebugs, occur in the protection of masses of spittle which they produce to surround themselves at feeding sites on host plants (Peck 1999). Adults, commonly known as froghoppers, do not produce spittle but rely on their jumping ability and warning coloration for defense as they move about and feed on similar grass host plants (Peck 1996). Both life stages feed on xylem sap of their host plants which include little bluestem (Morse 1921) and other grasses (Hamilton 1982). Adult red-legged spittlebugs have been found from mid-July to mid-September in Michigan. Peck (1999) found in one *Prosapia* species that adult males peak in abundance 3-4 weeks in advance of the maturation of females. Female red-legged spittlebugs likely lay their eggs in the fall, with eggs being the overwintering life stage. In this group relatively few eggs are laid, usually not exceeding 35 (Hamilton 1982). The nymphs first appear in spring and establish spittle masses on the surface roots and fine stems of grasses. Later instars are still largely limited to the litter layer or soil surface. A wider variety of feeding sites become suitable to late instar nymphs including mature stems, sometimes several centimeters into the grass canopy (Peck 1998). While it is unlikely that the species is restricted to a single plant species, in Michigan adults have been found in association with either big or little bluestem grasses and one adult was collected from redbud. (Hanna and Moore 1966).

Conservation/management: The most significant threats to the existence of this species have been identified as habitat destruction or alteration. Types of direct habitat loss include commercial and residential development, constructing pipelines, and filling of wetlands. Alteration of habitats include changing the hydrology of sites, succession of habitat due to fire supression, and invasion of alien plant species such as purple loosestrife and glossy buckthorn in southern Michigan and leafy spurge in the northern barrens. Hydrology alterations may include building roads, railways, pipelines, and ditches. Wetland hydrology and quality should also be mantained by preventing improper off-road vehicle use and controlling invasive weeds in these areas. Protection of known populations (and associated habitats) is a priority for sustaining this species. Additional surveys should be conducted throughout the state in appropriate habitats including mesic lakeplain prairie, barrens, and alvar grassland communities. Until more is known about the life history of this insect, it should be considered sensitive to fire during all life stages. Management of the surrounding prairie fens, prairies, alvars, and barren communities with prescribed burns should take into account known population sites leaving some unburned areas of host plant essential for recolonization. Additional information on the ecology and life history of the red-legged spittlebug is also needed to provide a stronger basis for management planning efforts.

Research needs: Additional surveys are needed across the eastern United States to determine the present distribution of this spittlebug and to further evaluate habitat specificity. Research on this species' life history should also be a top priority.

Related abstracts: lakeplain prairie, prairie fen, pine barrens, eastern prairie fringed orchid, blazing star borer, culver's root borer

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Updated September 2000.

Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division.

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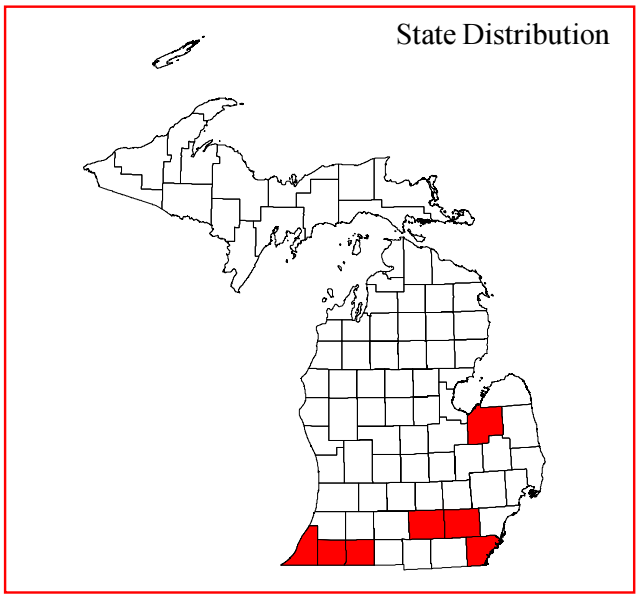
Papaipema silphii Bird — silphium borer

Photo by David L Cuthrell



Best Survey Period

Status: State threatened

Global and state rank: G5/S2S3

Family: Noctuidae (owlet moths)

Range: The silphium borer is restricted to the northeastern fringe of the tallgrass prairie region of North America. It has been reported from Michigan, Missouri, Ohio, Illinois, and Wisconsin.

State distribution: Known historically from nine sites in seven counties (Berrien, Cass, St. Joseph, Jackson, Washtenaw, Monroe, Tuscola) of southern Michigan, a recent survey (1989) for the moth found it to be extant at only seven locations in Michigan. The populations are very localized in distribution, though prior to European settlement and agricultural development, this species undoubtedly was more common than it is today. Most remaining populations are small, occur in habitat that requires management, and are threatened by fires, and roadside and railroad right-of-way maintenance activities. Many of the scattered occurrences of *Silphium* species in Michigan do not support the moth.

Recognition: The silphium borer (Lepidoptera: Noctuidae) is one of the largest *Papaipema* species in Michigan with a wingspan of 40-50 mm (1.6-2.0 in.) (Bird 1915). It can easily be confused with the two sunflower borers, *Papaipema necopina* and *P. maritima*, as well as the plain form of *P. beeriana*. The silphium borer moth is **brownish-black with a dusting of white scales on the dorsal forewings**. **When fresh, this species has a distinctive purplish cast and a large tuft of hair-like scales on the thorax**. Many species of *Papaipema* are difficult to identify but most can be sorted into species groups (Rings et al. 1992). These species groups can then be sent to experts for positive identification. Series (5 to 10 individuals from the same location) of specimens are easier to work with because of the large amount of individual variation. In addition, many field-collected specimens can be quite worn (many of the scales missing) giving the specimen a lighter appearance than normal, or eliminating many of the scale characteristics important for identification. **Larvae of *P. silphii* are pinkish in color with a large, brown head and may reach a length of 50 mm or more at maturity** (Bird 1915). They bore in the root of their food plant, prairie dock (*Silphium terebinthenaceum*) and perhaps other *Silphium* species. Signs of feeding are a few brown or yellow leaves, a wilted flower stalk, and large amounts of brown frass around the base of the plant (Hessel 1954).

Best survey time: Adult dates range from mid-September through the third week of October. The best way to survey for this species is by blacklighting, a technique where a sheet is stretched across two trees or poles and an ultraviolet light is used to attract moths to the sheet. Moths can be collected directly from the sheet. You also can search for the larvae of many species of *Papaipema* by searching for signs of feeding activity (Hessel 1954, Nielsen 1995). This includes inspecting *Silphium* plants that are wilted or otherwise

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stunted, for a small hole near the base of the plant and a pile of frass (caterpillar feces) near this opening. Often times you can see the pile of frass at the base of the plant and then locate the hole in the stem. Larvae are most easily located between mid-July and mid-August.

Habitat: In Michigan, the silphium borer occurs in a variety of prairie habitats including mesic prairie, prairie fen, and lakeplain mesic prairie. In many cases, only a remnant of the former habitat remains and frequently it is along a roadside or railroad where past maintenance activities have kept the habitat open. Formerly, controlled burns were frequently used to maintain railroad rights-of-way, thus enhancing the remnant prairies. However, the fire-sensitive borer moth would have survived these burns only if they were properly timed or if some individuals escaped the fires and later recolonized the area. Today, herbiciding, and in some places bulldozing, are the common maintenance practices, both of which can destroy host plant populations.

Biology: The silphium borer is restricted to large colonies of the larval food plant, prairie dock (*Silphium terebinthenaceum*) or possibly other *Silphium* species. The minimum plant population size necessary to sustain the moth is not known. Eggs are laid on or near the food plant in the fall and hatch in late spring. By early July, larvae have moved to their final feeding place by burrowing into the stem of the host plant and moving down into the rootstock. They create extensive tunnels while feeding, causing the plant to wilt slightly or to lose a few leaves. The final instar pupates in the soil under or near the root (Bird 1915). Adults are somewhat sedentary, though they will come to a blacklight.

Conservation/management: Protection of known populations is essential for the persistence of this species in Michigan. Only two populations occur in nature preserves and one of them is quite small due to the limited number and poor vigor of the food plant. Several populations are on roadsides or within railroad rights-of-way where intensive maintenance activities such as bulldozing and herbicides can eliminate a population. Landowners and managers should be contacted at all sites and advised of protection and management concerns. Habitat management for prairies typically includes brush removal and prescribed burns. The eggs and young larvae of this species and all other *Papaipema* are extremely sensitive to fires. The later instar larvae and pupae are protected from all but the hottest fires because they are underground. If prescribed burns are necessary, they should be conducted only in late summer, after the larvae are within a rootstock and before adults emerge in early fall. Prudent management requires dividing the site into subunits and burning only part of the site each year. Adults are quite sedentary and would not be expected to quickly recolonize an isolated site from which they had been extirpated (Hessel 1954), though they should move quickly between adjacent burn units (D. Schweitzer 1990, pers. comm.). Additional surveys and monitoring are needed. Of particular importance is information about the minimum size of a *Silphium* population necessary to support the moth indefinitely and the effects of management on both the moth and the host plant populations.

Research needs: Major research needs, as outlined by Schweitzer (1999), include information on habitat requirements other than foodplants, on conditions under which females disperse, and on presence or absence of *Papaipema* on prairie preserves and other fire managed habitats. The latter is needed before dormant season burn regimens are implemented. Any information on speed of recolonization after prescribed burns would be useful. It would be important to try and document how recovery occurred, i.e., from other burn units, from outside the managed area, from skips in the burn, or from very wet microhabitats. More actual information on survival of *Papaipema* in mid or late summer burns is needed. More precise information as to what date *Papaipema* larvae have moved below ground is needed. This information can be used to better time burns or schedule grazing rotations or mowing. Information is needed to determine whether adults can locate suitable places for oviposition in foodplant patches burned or grazed earlier in the same season. For example, can adults (which typically occur October 1) find places to lay eggs in habitats burned in July or August. Information on how high eggs are placed on the host plant is needed so that the potential suitability of mowing as a management option can be evaluated.

Related Abstracts: edible valerian, English sundew, mat muhly, prarie dropseed, culver's root borer moth, blazing star borer, Mitchell's satyr, red-legged spittlebug, lakeplain prairie, prairie fen

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Abstract citation:

Cuthrell, D.L. 2000. Special animal abstract for *Papaipema silphii* (silphium borer moth). Michigan Natural Features Inventory, Lansing, MI 3 pp.

Updated September 2000.

Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division.

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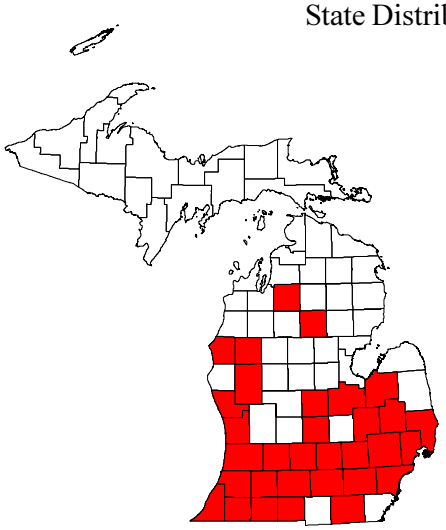
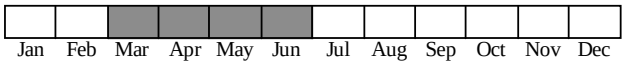
Clemmys guttata Schneider — Spotted turtle

Photo by James H. Harding

State Distribution



Best Survey Period



Status: State threatened

Global and state rank: G5/S2

Family: Emydidae (pond and box turtle family)

Range: Spotted turtles range from northeastern Illinois east through Michigan, northern Indiana, central Ohio, Pennsylvania and New York to southeastern Ontario and southern Maine, and south along the Atlantic coast to northern Florida (Ernst et al. 1994). Isolated populations occur in central Illinois, the western Carolinas, northern Vermont and southeastern Quebec (Harding 1997).

State distribution: Spotted turtles historically have been known from primarily the southern and western portions of Michigan's Lower Peninsula. Today, spotted turtles are uncommon to rare in Michigan, and tend to occur in isolated populations surrounded by unsuitable habitat (Harding 1997). Michigan Natural Features Inventory (2000) has compiled documentation of this species from 32 counties in the state, including isolated populations in north central Michigan in Roscommon County. This species has not been reconfirmed in Kalkaska, Lake, Clinton, Eaton, Ingham, Jackson and Branch counties within the last 20 years (Michigan Natural Features Inventory 2000). However, it is important to note that this species has not been systematically surveyed throughout the state, and may still occur in additional counties as well as those in which it has not been recently confirmed.

Recognition: The spotted turtle is a small turtle with adult carapace (i.e., top shell) lengths ranging from 3.5 to 5.4 inches. This turtle can be easily identified by the **round yellow spots** on its **broad, smooth, black or brownish black carapace.** Spots may fade in older individuals, and some individuals are spotless (Ernst et al. 1994). **The plastron (i.e., bottom shell) is hingeless,** and is usually **yellow or orange with a black blotch along the outer margin of each scute or scale;** in some males or older individuals, the black blotches cover the entire plastron. Their **heads are black** and typically have at least a few **spots on top and one or more irregular yellow or orange blotches on the sides near the eardrum.** Males have tan chins, brown eyes, and concave (i.e., curved inward) plastrons, with the vent or anal opening beyond the edge of the carapace when the tail is fully extended (Harding 1997). Females have yellow chins, orange eyes, broader, higher carapaces, and flat or convex (i.e., curved outward) plastrons, with the vent under the edge of the carapace when the tail is fully extended. Hatchlings average about 1.14 inches in carapace length, and usually have a single spot on each plate of their carapace. The plastron is yellowish orange with a central dark blotch.

Best survey time: The best time to survey for this species is early in the spring during the mating season, from March through May, before the vegetation gets too tall and dense (Conant 1951, Ernst 1976). In parts of its range, spotted turtles also are fairly visible in June during the nesting season when females will leave their drying pools to migrate to nest sites (Ernst 1976). The

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best way to survey for this species is to first search suitable habitat from a distance with binoculars or a spotting scope, scanning for individuals swimming in the water or basking in or along the river. This should be followed by slowly walking through the habitat, looking for turtles in the water or basking in the vegetation. Search efforts should concentrate on shallow pools of water or transitional areas from deeper water (Mauger pers. comm.). Optimal weather conditions for observing spotted turtles are sunny or partly sunny days above 60° F (Mauger pers. comm.). Spotted turtles are not very active on overcast or rainy days (Ernst 1976). Some studies have indicated a tendency for more observations during the morning hours from 7 am to 1 pm (Mauger pers. comm.), although this will vary with weather conditions.

Habitat: Spotted turtles require clean, shallow, slow-moving bodies of water with muddy or mucky bottoms and some aquatic and emergent vegetation (Ernst et al. 1994, Harding 1997). Spotted turtles utilize a variety of shallow wetlands including shallow ponds, wet meadows, tamarack swamps, bogs, fens, sedge meadows, wet prairies, shallow cattail marshes, sphagnum seepages, small woodland streams and roadside ditches (Ernst et al. 1994, Harding 1997, Mauger pers. comm.). Although spotted turtles are considered fairly aquatic, they are frequently found on land in parts of its range and during certain times of the year (i.e., during the mating and nesting seasons and during the summer) (Ward et al. 1976). Terrestrial habitats in which spotted turtles are found include open fields and woodlands and along roads.

Biology: Spotted turtles become active in early spring as soon as the ice and snow melt, usually in late March to mid-April. This species appears to tolerate and prefer cooler water and air temperatures than do other related turtles, initiating activity at water temperatures as low as 37°F (Ernst et al. 1994). In early spring, spotted turtles spend a great deal of time basking on logs, muskrat houses, and grass or sedge hummocks. Spotted turtles are generally difficult to find in the summer due to decreased activity levels and dense vegetation. Spotted turtle activity levels generally peak in May, or when mean monthly air temperatures are between 56 and 64°F, and start to decline in June, or when mean monthly air temperatures are between 64 and 72°F (Ernst et al. 1994). They become dormant or aestivate by late June or early July (Ernst 1982). In the spring, spotted turtles are active throughout the day, beginning at sunrise. At night, they burrow into the muddy bottoms of the wetland or crawl into mammal burrows or under vegetation (Ernst et al. 1994). In the summer, individuals are active primarily in the morning, and become dormant in the afternoon. Some individuals aestivate in muskrat burrows or lodges or dig into mud or submerged root systems, while others leave the water and burrow into soil or leaf litter (Harding 1997). Only nesting females are active in the evening.

Spotted turtles typically enter hibernation in mid-October (Harding 1997). They hibernate in shallow water in the mud or in muskrat burrows or lodges (Ernst et al. 1994). These sites are deep enough to not freeze completely, but are shallow enough to thaw quickly in the spring (Ernst 1982). Spotted turtles have been found to hibernate in congregations of up to 12 individuals (Bloomer 1978).

Spotted turtles reach sexual maturity at about 7 to 10 years of age (Ernst 1970). Mating occurs from March to May, and generally takes place in the water. Nesting usually occurs in the evening in early to mid-June in the Great Lakes region (Harding 1997). Nests are placed in well-drained areas with sandy or loamy soils exposed to full sunlight. Nest sites include grassy tussocks, hummocks of grass, sedge or sphagnum moss, marshy pastures and edges of roads (Hunter et al. 1992, Ernst et al. 1994). Females appear to nest near their core activity or foraging habitat (Mauger pers. comm.). The females dig a 2- to 2.5-inch deep flask-shaped cavity into which two to seven eggs are laid (Harding 1997). The hatchlings emerge in August or September, but may overwinter in the nest.

Spotted turtles have small home ranges of about 1.2 to 8.6 acres, although this may simply be an artifact of the amount of habitat available at many of the sites (Harding 1997). A study in Pennsylvania documented typical daily movements of less than 0.01 mile (65 feet); these mostly consisted of trips from evening retreats to daytime basking or foraging areas (Ernst 1976). Foraging turtles may move up to 0.03 mile. During the mating season, males in search of females may move up to 0.16 mile from water, while nesting females in search of a suitable nest site may travel up to 0.03 mile from water (Ernst 1976). In Maine, individuals readily travelled as much as 0.30 miles overland between wetlands to take advantage of available food sources (Hunter et al. 1992).

The spotted turtle is omnivorous, feeding primarily underwater. Their diet ranges from aquatic vegetation to larval amphibians, slugs, snails, crayfish, insects, worms and carrion (Harding 1997). Spotted turtles and their eggs are preyed upon by bald eagles, raccoons, skunks and muskrats (Ernst et al. 1994, Harding 1997). Wild spotted turtles have lived over 30 years, and can probably live up to 50 years (Hunter et al. 1992, Ernst et al. 1994).

Conservation/management: Similar to other turtle species, spotted turtles are characterized by relatively

late sexual maturity and low reproductive potential. These life history traits suggest that high annual survivorship of adults and juveniles is particularly crucial for maintaining a stable population. Mortality or removal of adults and juveniles at a rate faster than they can be replaced can lead to population declines and potential local extinctions over time. Small, fragmented populations also tend to be highly susceptible to extinction as a result of catastrophic or chance events.

The primary threats to this species are habitat destruction and degradation and illegal collection for the pet trade (Harding 1997). In the last few decades, much of the shallow wetlands preferred by the spotted turtle has been drained or filled and converted to agricultural, residential and commercial land uses (Harding 1997). Many of the remaining populations occupy small, isolated, remnant wetlands (i.e., <10 acres) that continue to be threatened by development and pollution. Spotted turtles are highly valued by reptile hobbyists because of their small size and bright coloration, and collectors have severely reduced or eliminated populations throughout the species' range (Harding 1997). Increased nest predation due to large small mammal predator populations, particularly raccoons, represents a substantial threat to spotted turtles and turtle populations in Michigan in general. Increased urbanization and associated increase in road density and traffic have resulted in higher road mortality of spotted turtles, and have further fragmented their habitat and isolated populations. Vandalistic shooting of spotted turtles also occurs (Harding 1997).

Protection of extant populations and suitable wetland and nesting habitats is crucial for conserving this species. Providing connectivity among populations to allow for genetic exchange also is vital for preserving the long-term viability of this species. Increased protection of small, wetland complexes is important for maintaining sufficient habitat. In general, implementing minimum development setback distances, leaving buffer zones during agricultural and land management operations, maintaining good water quality and hydrologic integrity, minimizing the delivery of pollutants into the wetlands, and minimizing the construction of roads in or near suitable wetlands would be beneficial to this species. Maintaining open upland nesting areas through woody vegetation management also would benefit this species. Altering the timing of land use activities (e.g., working in upland habitat during the winter from November through February when spotted turtles are hibernating in the water) could help minimize the potential for adversely impacting this species. Predator control and on-site protection of nest sites may be warranted in some instances. Stream channelization and water impoundments should be avoided in areas with suitable habitat.

This species has been given various levels of legal protection throughout its range, however, protection needs to be consistent across its range to completely eliminate commercial trade of this species (Harding 1997). In Michigan, the spotted turtle is listed as state threatened and is protected under the state's Endangered Species Act and the Director's Order No. DFI-166.98, Regulations on the Take of Reptiles and Amphibians. It is unlawful to take a spotted turtle from the wild except as authorized under an endangered species permit from the Michigan Department of Natural Resources. "Take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect or attempt to engage in any such conduct. Public land managers and the general public should be informed that this species is protected, and should not be collected or harmed. Any suspected illegal collection of spotted turtles should be reported to local authorities, conservation officers or wildlife biologists.

Research needs: An assessment of the species' current distribution and status throughout the state is needed. Spotted turtles have been documented from a fairly large number of sites in Michigan, but intensive surveys and monitoring are needed at these sites to determine whether they contain viable populations and to document population structure and trends. Nesting and wintering areas at these sites also need to be identified. Although the general life history and ecology of the spotted turtle are fairly well known, more information specific to spotted turtles in Michigan would be useful (e.g., movement and dispersal distances, home range, habitat use, reproductive success, long-term survivorship, potential carrying capacity). Impacts of various land uses and management activities on spotted turtle populations and habitat should be further investigated. The genetic diversity of extant populations needs to be examined. The impact of illegal collecting on spotted turtles in Michigan needs to documented and quanitified. Finally, effective strategies for ensuring the long-term viability of spotted turtles need to be investigated and developed.

Related abstracts: Prairie fen, mat muhly, prairie dropseed, prairie Indian plantain, small white lady's-slipper, Blanchard's cricket frog, Blanding's turtle, eastern box turtle, eastern massasauga, Kirtland's snakewood turtle, Mitchell's satyr butterfly.

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Abstract citation:

Lee, Y. 2000. Special animal abstract for *Clemmys guttata* (spotted turtle). Michigan Natural Features Inventory. Lansing, MI. 4 pp.

Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division.

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