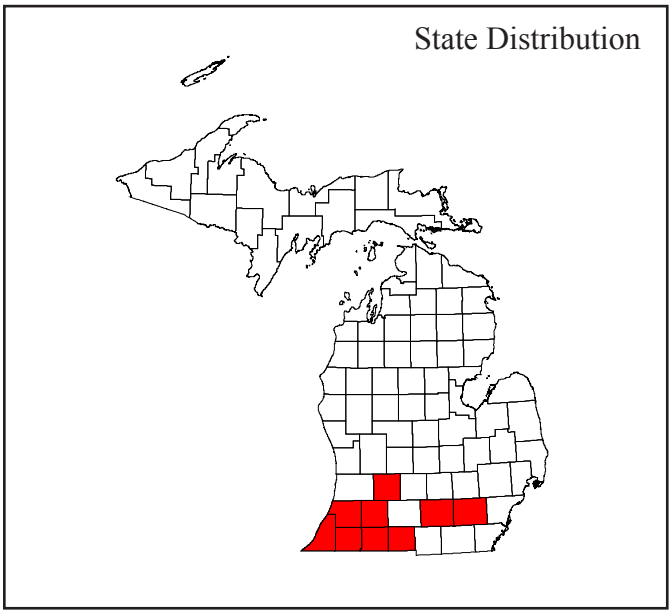
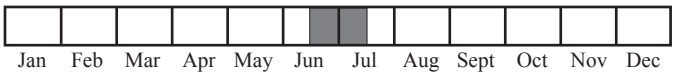
Neonympha mitchellii mitchellii French — Mitchell's satyr

Photo of female Mitchell's satyr by Jim McCormick



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. An additional historical population has been reported from central Maryland, but this record has never been verified and remains questionable (U.S. Fish and Wildlife Service [USFWS] 1998). 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 one site in northern Indiana. The species is considered extirpated in Ohio and New Jersey due to habitat loss and overcollecting (Evers 1994, USFWS 1998).

A closely related subspecies, the Saint Francis satyr (*Neonympha m. francisci*) currently occurs as a single metapopulation in the sandhills of North Carolina (Parshall and Krall 1989). It was listed as endangered in 1994. Recently, new populations of *Neonympha mitchellii* were discovered in Virginia in 1998 (Roble et al. 2001), in Alabama in 2000 (Glassberg 2001) and in Mississippi in 2003 (Hart 2004). Preliminary genetic analysis suggests that these populations are not *Neonympha mitchellii mitchellii*, but their biogeographic history and the taxonomic relationships between these populations and those occurring in Indiana, Michigan, and North Carolina have not yet been established (Hamm pers. comm. 2012).

State distribution: Mitchell's satyr has been recorded from at least 22 sites in 11 counties, extending as far north as Kent County (Wilsmann and Schweitzer 1991, USFWS 1998). Mitchell's satyr has not been documented at six of these sites in over a decade, and these sites are believed to be extirpated. Two counties (Kent and Lenawee) are no longer thought to support extant satyr populations (USFWS 1998). Comprehensive surveys of potential fen habitat resulted in the discovery of three additional occupied sites in 1999, 2002 and 2005 (Hyde et al. 2009). Surveys from 2007 to 2011 of known sites and potential habitat have confirmed extant populations at only 16 sites in 9 counties, primarily in southwest Michigan. Of the 16 extant populations, only 6 sites are considered likely viable. These are sites which consistently support higher densities of adults, contain adequate habitat to maintain healthy populations of the butterfly, and where conservation threats are being addressed (Michigan Natural Features Inventory [MNFI] 2012).

Michigan Natural Features Inventory
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Photo of male Mitchell's satyr by Doug Landis

Recognition: Mitchell's satyr is a medium-sized butterfly with a wingspan that ranges from 3.4 – 4.4 cm (1.3 to 1.8 in). **The color of its wings can range from a warm tan to a dark chocolate brown**. **A key feature is the the distinctive row of closely spaced, yellow-ringed black eyespots that are dotted with silver or yellow scales, located near the margin of the ventral surface, or underside of the wings. Two orange bands encircle the eyespots** (Opler and Krizek 1984, Nielsen 1999). The **dorsal, or upper wing surface is unmarked** but thinly scaled so that the ventral pattern often shows through (USFWS 1998). Males are slightly smaller than females (Opler and Krizek 1984), and are darker both above and below (French 1889). Mature larvae are lime green with pale, longitidunal stripes and a bifurcate or forked 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 on average 50% larger and are lighter brown in color than Mitchell's satyr. Their flight is moderately rapid and very erratic. The wood nymph is much larger in size with two big eyespots on the outer portion of each forewing. The little wood satyr is similar in size to the Mitchell's satyr, but has only two prominent eyespots on both the dorsal and ventral surfaces of each wing. This species exhibits a bouncy, energetic flight and is frequently seen patroling the crowns of trees (Opler and Krizek 1984). The Mitchell's satyr can be easily identified in the field and distinguished from these other species by its slow bobbing flight pattern as it flies through, or just over, the tops of the sedges and shrubs. It covers ground very slowly and generally does not fly far before settling (Opler and Krizek 1984, Shuey 1997).

Best survey time: The best time to survey for this species is during the peak flight period which can occur as early as the last week of June at some sites during some years, (Hyde pers. comm. 2012) to the first two weeks in July (Opler and Krizek 1984, USFWS 1998). 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 tamarack trees and shrubs. 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^{o}F), overcast days, and their activity is significantly reduced during hot (>90^{o}F), sunny days (Shuey 1997). Mitchell's satyr 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). Mating usually occurs in the morning or late afternoon, and oviposition often takes place in the afternoon (Opler and Krizek 1984, Szymanski 1999, Darlow 2000, Hyde et al. 2000).

Habitat: In Michigan and Indiana, the Mitchell's satyr is found in prairie fen complexes. Sites that continue to support Mitchell's satyr contain peat soil with carbonate-rich groundwater seeps. These sites are usually dominated by narrow leaved sedges (which always include *Carex stricta*) and contain scattered tamarack (*Larix laricina*) and poison sumac (*Toxicodendron vernix*) (Kost and Hyde 2009). Prairie fens are rarely homogeneous systems but rather consist of a mosaic of open, shrubby and forested communities and associated ecotones. 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).

Adult Mitchell's satyrs have most often been observed at the interface between open fen or sedge meadow and bordering stands of shrubs and trees (McAlpine et al.1960, Rogers et al. 1992, Szymanski 1999). Barton and Bach (2005) report that most Mitchell's satyrs were

captured within 3 meters of woody vegetation during a mark-release-recapture (MRR) study conducted at the largest occupied site in Michigan. Szymanski (1999) and Darlow (2000) reported observations of ovipositing by Mitchell's satyr within 1 meter of a tree or shrub. These results suggest that Mitchell's satyrs prefer edge habitat and avoid expansive open areas. 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.

Biology: Although more remains to be learned about the ecology of this species, recent investigations have provided useful information. Mitchell's satyr is single-brooded throughout its range (McAlpine 1960). Adults fly from late June through late July and are active at a given site for two to three weeks (USFWS 1998, Barton and Bach 2005). Males generally emerge a few days before the females. During the flight period, the butterflies mate, lay eggs, and die. Under caged conditions, the eggs hatch within 7 to 11 days, and the larvae feed through the summer until the fourth instar. The larvae then diapause and overwinter on the leaves of tussock sedge (McAlpine 1960, Tolson and Ellsworth 2008). Captive rearing efforts by the Toledo Zoo have shown that Mitchell's satyr is quite susceptible to desiccation during its overwintering period, suggesting that groundwater is not only important in supporting habitat structure, but in maintaining critical humidity levels (Tolson and Ellsworth 2008). The larvae resume feeding the following spring and complete the fifth instar. In late May to late June, the larvae form a chrysalis about 40 cm (15 in) from the base of a tussock sedge plant (Tolson and Ellsworth 2008). The chrysalis persists for 10 to 15 days (McAlpine 1960). However, this species' larval phenology has not yet been confirmed under natural field conditions.

Photo of Mitchell's satyr eggs and 1st instar larvae by Mitch Magditch

Photo of Mitchell's satyr instar larvae by Mitch Magditch

Mitchell's satyr caterpillars are thought to eat various species of sedge (*Carex* spp.) in their natural habitat (McAlpine 1960). Shuey (1997) hypothesized that the primary hostplant for this species is *Carex stricta* (tussock sedge) due to the close association between adult Mitchell's satyr and dense stands of this plant in the field; previous rearing experiments in which larvae completed development with potted *C. stricta*; and the fact that butterflies in the family Satyridae often utilize host plants that are ecological dominants. Recent larval feeding experiments conducted by Tolson and Ellsworth (2008) at the Toledo Zoo documented that first instar larvae will select and feed on several different species of sedges and grasses, although not all will support successful development. Six species of *Carex* (*C. buxbaumii, C. lasiocarpa, C. leptalea, C. prairea, C. sterilis and C. stricta*) and two grasses, *Dichanthelium implicatum* (*Panicum i.*) and *Poa palustris* were found to support normal development until the third instar in late August. Futhermore, most larvae migrated to the potted *Carex stricta* by mid-August to begin diapause. Legge and Rabe (1996) documented oviposition on the undersurface of leaves of five different herbaceous plant species during caged experiments at an occupied site. Other researchers have observed females ovipositing *in situ* on the underside of tiny forbs (<5 cm) located below the sedge and grass canopy (Legge and Rabe 1996, Szymanski 1999, Darlow 2000, Hyde et al. 2000) as well as on the undersurface of *Carex stricta* leaves (Szymanski 1999).

Mitchell's satyr 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 in their lifetime (Szymanski 1999). Barton (2007) summarized results from several MRR studies conducted at five Michigan sites between 1998 and 2007. The median values for distances traveled per day by each individual were 22 m/day for males and 13 m/day for females. The median home range sizes for both sexes were small; 0.06 ha (0.15 acres) for males and 0.03 ha (0.07 acres) for females. The data support the hypothesis that the Mitchell's satyr adults stay close to their natal areas. Interestingly, Barton (2008) reports that at the largest occupied site, the maximum distance traveled between consecutive captures was 710 m for males and 478 m for females. Barton and Bach (2005) propose that given appropropriate space (i.e. corridors), the species could disperse and colonize new suitable areas.

Conservation/Management: Mitchell's satyr is one of the most endangered butterflies in North America and was listed as federally endangered by the United States Fish and Wildlife Service in 1992 (USFWS 1998). The primary threat to the continued survival of this species is habitat loss and modification (Shuey 1997, Szymanski 1999). Prairie fens have been greatly affected by human-induced perturbations, including altered hydrology, nutrient loading, sedimentation, invasive species, excessive grazing and fire suppression (Kost and Hyde 2009, Hoving 2010). Many of the wetland complexes currently occupied by Mitchell's satyr have been fragmented, 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 1998). It is suspected that habitat degradation of the fens resulting from changes in hydrology and degradation of water quality is a contributing factor to the decline of Mitchell's satyr. Recent research conducted in southeast Michigan demonstrates the importance of both local and regional processes to the groundwater regime of fens. Changes in the quantity, seasonality, or chemistry of water entering and flowing through fens likely threaten prairie fen ecosystems (Li pers. comm. 2012).

The introduction of increased sediments and nutrients into fens is especially problematic. Sedimentation, the deposition of mineral sediment onto the surface of organic soils, facilitates invasion by exotic plant species such as glossy buckthorn (*Frangula alnus* [*Rhamnus frangula*]), purple loosestrife (*Lythrum salicaria*), common buckthorn (*Rhamnus cathartica*), and the common reed (*Phragmites australis*) (USFWS 1998, Kost and Hyde 2009, Hoving 2010). In addition, added nutrients from leaking septic tanks, drainfields, agricultural runoff, lawn fertilizer and salt spray provide a competitive advantage to aggressive invasive plants and threaten the plants and animals that have evolved to thrive in a highly alkaline, low nutrient environment (Kost and Hyde 2009, Hoving 2010).

Photo of glossy buckthorn invading a fen in Jackson County by Daria Hyde

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 1998, Hoving 2010). Many fen habitats have become unsuitable for Mitchell's satyr's and extant populations have become fairly isolated. Dispersal among populations, colonization of new sites and recolonization of extirpated sites have become increasingly unlikely (USFWS 1998). Finally, this species is vulnerable to collection for commercial exploitation, although the impact on a population varies with the timing, frequency, and number of individuals collected (Evers 1994, USFWS 1998).

Successful conservation and recovery of this species will require 1) protection of existing populations and their habitat through property acquisition or conservation easements; 2) implementation of appropriate habitat management activities at occupied sites to maintain or restore critical fen processes and connectivity; 3) restoration of fens and associated

landscape context to a condition and configuration necessary to allow future introductions of Mitchell's satyr into currently unoccupied fens; 4) introduction of Mitchell's satyr into suitable unoccupied sites within their historical range that are protected and managed by federal or state agencies or by private conservation organizations; and 5) committment to an active research program (USFWS 1998, Hoving 2010).

At occupied sites, it is necessary to maintain existing habitat and associated ecosystem processes and to restore additional habitat throughout the wetland. Natural hydrologic regimes should be maintained or restored, since altered hydrology can lead to rapid influx of cattail (*Typha* spp.) and other invasive species, increased invasion by woody plants, and a decreased diversity of native vegetation. When the restoration of hydrology is too costly or impractical, other ongoing management activities can be implemented to compensate for these alterations (Hoving 2010). Barton and Bach (2005) suggest that satyr sites should be managed to maintain a matrix of open fen, shrub-carr zones and sufficient transitional edge habitat rather than the creation of large open sedge meadow habitat. It also is important to minimize inter-patch distance and provide corridors of suitable habitat between patches for dispersal (Szymanski 1999). Haddad (1999) found that corridors had proportionally greater effects on butterfly movement rates as their widths increased. He also found that as the patch sizes increased, corridors became less effective. Since most Mitchell's satyr populations are small, the creation of corridors to connect medium to small sized patches of isolated habitat may be an effective way to increase these populations (Barton and Bach 2005). Swengel and Swengel (2007) recommend permanent non-fire refugia be established among burn units when managing occupied areas with prescribed fire. To avoid negative impacts to Mitchell's satyr, the manual removal of invasive vegetation in combination with the use of wetland approved herbicides is recommended during the dormant season. Extreme care should be taken to minimize damage to native fen vegetation when treating invasives with chemicals (Hoving 2010). Since so few viable populations of this species are known, introduction of Mitchell's satyr at historical sites that appear to still contain suitable habitat as well as at suitable unoccupied sites within its historical range should be implemented to help ensure long-term viability of this species (USFWS 1998).

Photo of fen habitat utilized by Mitchell's satyr by Chris Hoving

Research Needs: A better understanding of the biology and ecology of Mitchell's satyr is crucial for developing effective long-term protection strategies for this species. Further research is needed to understand the local and regional hydrology contributing to the groundwater regime of occupied fens and to determine whether altered hydrology or water chemistry is threatening the integrity of these wetlands. In addition, management strategies to restore fen hydrology should be evaluated (Li pers. comm. 2012). Continued genetic analysis is needed to understand the biogeographic history and taxonomic relationships between Mitchell's satyr populations in Michigan and Indiana as well as *Neonympha mitchellii* populations in Alabama and Mississsippi. This research will assist with future efforts for augmentation and translocation of butterflies. Further research is needed to understand the potential impacts of *Wolbachia* spp., an intracellular reproductive parasite, on Mitchell's satyr populations and any implications this may have on future captive rearing and reintroduction efforts (Hamm pers. comm. 2012). Captive rearing of Mitchell's satyrs and introduction of adults or larvae should be initiated at suitable sites. This effort should be carefully monitored and evaluated to inform future introduction efforts (Toslon pers. comm. 2012). Finally, surveys of known and suitable unoccupied sites should continue in order to monitor existing populations and habitat, and to identify new populations. It is also important to carefully monitor Mitchell's satyr populations both before and after habitat management activities are implemented at a site.

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

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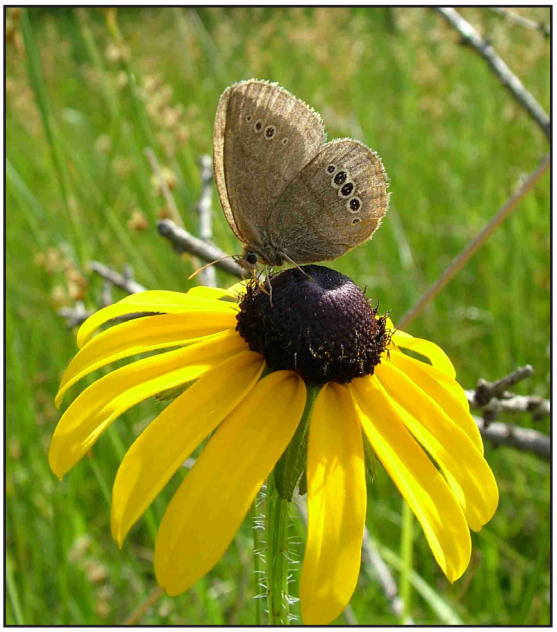

Mitchell's satyr occasionally nectar on flowers although it is rarely seen.
Photo by Barbara J. Barton

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