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HABITAT CHARACTERIZATION OF FIVE RARE INSECTS IN MICHIGAN (LEPIDOPTERA: HESPERIIDAE, RIODINIDAE, SATYRIDAE; HOMOPTERA: CERCOPIDAE)

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ABSTRACT

Over 80 species of insects are listed as endangered, threatened, or special concern under Michigan's endangered species act. For the majority of these species, detailed habitat information is scant or difficult to interpret. We describe the habitat of five insect species that are considered rare in Michigan: *Lepyronia angulifera* (Cercopidae), *Prosapia ignipectus* (Cercopidae), *Oarisma poweshiek* (Hesperiidae), *Calephelis mutica* (Riodinidae), and *Neonympha mitchellii mitchellii* (Satyridae). Populations of each species were only found within a fraction of the plant communities deemed suitable based upon previous literature. Furthermore, individuals of each species were observed to be closely affiliated with just a few vegetation associations within larger plant communities. Restriction of these species to particular microhabitats was determined to be, in part, due to ecological or behavioral specialization of each insect species. We believe that the most holistic management and conservation practices for these rare insects in Michigan should focus on protecting the integrity of both the plant community and the microhabitat upon which these species depend.

Insects are one of the most species-rich groups of organisms on Earth (Samways 1995). This species diversity translates to a high degree of functional diversity, and forms the basis for complex linkages among populations and communities (Price 1997). Recognition of the importance of conserving insect species has developed rapidly in recent years, with considerable emphasis being placed on metapopulation stability, minimum viable population estimation, and extinction thresholds (e.g., Samways 1995, Hanski et al. 1995, Britten et al. 1994.

Despite such recent theoretical improvements, insect conservation biology suffers from a lack of empirical information concerning the precise habitat requirements of many rare or declining species (Price 1997). In Michigan, eight insect species are listed as endangered, 11 as threatened, and 66 are of special concern (Michigan Department of Natural Resources 1994). Detailed habitat data should be collected for these species in order to better understand their ecological requirements, and to assist land managers concerned with insect conservation (Noss and Cooperrider 1994). We focused our attention on a small sub-set of these insects, specifically five species known to

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occur in Michigan's imperiled wetland communities: *Lepyronia angulifera* Uhler (angular spittlebug); *Prosapia ignipectus* Fitch (red-legged spittlebug); *Oarisma poweskiek* Parker (poweskiek skipper); *Calephelis mutica* McAlpine (swamp metalmark); and *Neonympha mitchellii mitchellii* French (Mitchell's satyr). All of these species are listed as special concern in Michigan except for *N. m. mitchellii,* which is considered endangered under both state and federal law.

Lepyronia angulifera is a small, hump-backed spittlebug characterized by chocolate brown wings and a weakly inflated cibarium (Hamilton 1982). This spittlebug is considered common in the Caribbean Islands, and populations of *L. angulifera* are known from many states in the eastern United States. The food plants for this species are varied and include: *Sporobolus indicus* (L.) R. Br. (smut-grass), *Cyperus swartzii* Diet., and various other sedges for nymphs; and for adults, *Gossypium hirsutum* L. (cotton) in addition to a variety of monocots (Doering 1930, 1942; Metcalf and Bruner 1943, Hamilton 1982).

Prosapia ignipectus is a black spittlebug characterized by unmarked wings and scarlet infusions on the ventral surface, which are especially apparent near the leg bases and abdominal joints (Hamilton 1977, 1982). Nymphs have been reported to feed on the underground parts of *Andropogon scoparius* Michaux (little bluestem), with adults feeding aboveground on *A. scoparius* and other grasses (Hamilton 1982). Sandy prairies and barren communities stretching from the New England states through southern Pennsylvania appear to be the most frequently occupied habitats (Morse 1921).

Oarisma poweshiek is a medium-size, dark skipper with a conspicuous orange patch on the leading edge of the dorsal forewing and silvery-white veins on the ventral side of the wings (Scott 1986). It is found in grassy lake margins, moist meadows, and tallgrass prairie. Its natural host plant(s) are poorly known, but it has been reported to feed on *Eleocharis elliptica* Kunth (golden-seeded spikerush), other sedges, and ("reluctantly" in the lab) *Poa pratensis* L. (Kentucky bluegrass) (Scott 1986). Although limited by a small sample size, Borkin (1994) noted that *Sporobolis heterolepis* Gray and *Andropogon scoparius* (potentially) serve as oviposition sites.

Calephelis mutica is a small butterfly with a reddish-brown upper wing surface highlighted by two rows of silver median dots (Scott 1986). It is distinguished from congeners by its habitat (wetlands), and its preference for thistles, primarily *Cirsium muticum* Michaux (swamp thistle) and *Cirsium altissimum* L. (tall thistle; Iftner et al. 1992). Records for *Calephelis mutica* within the United States are scattered, but include many mid-central states such as Indiana, Ohio, Kentucky, Pennsylvania, and New York (Opler and Krizek 1984).

Neonympha mitchellii mitchellii is a chocolate brown satyrid with submarginal rows of closely spaced, yellow rimmed "eyespots" (Scott 1986). While larval *N. m. mitchellii* have been reared on several species of *Carex* (sedge) and *Scirpus* (bulrush), it has been hypothesized that *Carex stricta* Lam. (tussock sedge) is the natural host (Shuey 1997, McAlpine et al. 1960). Extant populations of *N. m. mitchellii* are geographically restricted to two states: Michigan and Indiana. Ohio and New Jersey supported historical populations of the butterfly; however, adults have not been recorded in either state for some time.

The purpose of this paper is to present habitat and behavioral data for these five insect species using a combination of field work and literature synthesis. General habitat features are interpreted in terms of management and conservation biology. It is hoped that by clearly defining species' habitats, en-

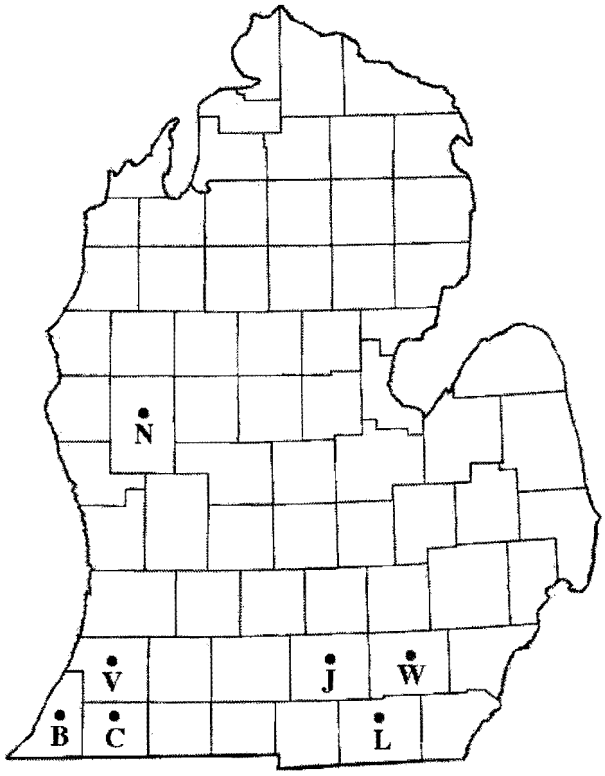

FIGURE 1: The Lower Peninsula of Michigan. We studied the habitat requirements of five rare insects in six counties: Newaygo (N), Van Buren (V), Berrien (B), Cass (C), Jackson (J), Washtenaw (W), and Lenawee (L).

tomologists will gain crucial information required to discover new populations, and natural area managers will be better equipped to manage these populations and the habitats that support them.

MATERIALS AND METHODS

Field surveys for each rare species were conducted on six sites managed by The Nature Conservancy in the lower peninsula of Michigan (Figure 1). Privately owned land falling adjacent to managed preserves was included in our sampling design with landowner consent. All of our study sites occurred in the following Michigan counties: Newaygo, Van Buren, Berrien, Cass, Jackson, Washtenaw, and Lenawee. Each study site was visited early in the field season and divided into community types based upon vegetation. Community types included in this study are listed in Table 1 according to county.

Table 1. Community types included in our surveys. Community type names follow Faber-Langendoen et al. (1996). For each community type, the dominant plant species are listed, followed by a general description of the principal structure layers found in each community.

County	Approx. acres	Community types present
Berrien	75	Central Mesic Tallgrass Prairie (*Andropogon gerardii—Sorghastrum nutans—(Sporobolus heterolepis)—Liatris* spp. *—Ratibida pinnata* Herbaceous Vegetation)
		Cinquefoil—Sedge Prairie Fen (*Pentaphylloides floribunda /Carex sterilis—Andropogon gerardii -Cacalia plantaginea* Shrub Herbaceous Vegetation)
		Dogwood—Willow—Poison Sumac Shrub Fen (*Cornus amomum—Salix* spp.*—Rhus vernix –Rhamnus lanceolata* Fen Shrubland)
		Tussock Sedge Wet Meadow (*Carex stricta—Carex* spp. Herbaceous Vegetation)
Cass	300	Central Tamarack—Red Maple Rich Swamp (*Larix laricina—Acer rubrum / Rhamnus alnifolia, Vaccinium corymbosum* Forest)
		Dogwood—Willow—Poison Sumac Shrub Fen (*Cornus amomum—Salix* spp.*—Rhus vernix—Rhamnus lanceolata* Fen Shrubland)
		Tussock Sedge Wet Meadow (*Carex stricta—Carex* spp. Herbaceous Vegetation)
Jackson	500	Central Tamarack—Red Maple Rich Swamp (*Larix laricina—Acer rubrum / Rhamnus alnifolia, Vaccinium corymbosum* Forest)
		Cinquefoil—Sedge Prairie Fen (*Pentaphylloides floribunda /Carex sterilis—Andropogon gerardii, Cacalia plantaginea* Shrub Herbaceous Vegetation)
		Dogwood—Willow—Poison Sumac Shrub Fen (*Cornus amomum—Salix* spp.*—Rhus vernix—Rhamnus lanceolata* Fen Shrubland)
		Midwest Calcareous Seep (*Carex* spp.*—Cladium mariscoides —Rhynchospora capillacea -Tofieldia glutinosa* Herbaceous Vegetation)
		Tussock Sedge Wet Meadow (*Carex stricta—Carex* spp. Herbaceous Vegetation)
Lenawee	700	Cinquefoil—Sedge Prairie Fen (*Pentaphylloides floribunda / Carex sterilis—Andropogon gerardii -Cacalia plantaginea* Shrub Herbaceous Vegetation)
		Dogwood—Willow—Poison Sumac Shrub Fen (*Cornus amomum—Salix* spp.*—Rhus vernix—Rhamnus lanceolata* Fen Shrubland)
		Midwest Calcareous Seep (*Carex* spp.*—Cladium mariscoides—Rhyncospora capillacea—Tofieldia glutinosa* Herbaceous Vegetation)
		Tussock Sedge Wet Meadow (*Carex stricta—Carex* spp. Herbaceous Vegetation)

Table 1. Continued.

County	Approx. acres	Community types present
Newaygo	80	Midwest Dry-mesic Sand Prairie (*Schizarchyrium scoparium—Sorghastrum nutans—Bouteloua curtipendula* Dry-mesic Herbaceous Vegetation)
Van Buren	100	Inland Coastal Plain Marsh (*Rhyncospora capitellata—Rhexia virginica—Rhyncospora scirpoides -Scirpus hallii* Herbaceous Vegetation)
Washtenaw	10	Cinquefoil—Sedge Prairie Fen (*Pentaphylloides floribunda /Carex sterilis—Andropogon gerardii -Cacalia plantaginea* Shrub Herbaceous Vegetation)
		Midwest Calcareous Seep (*Carex* spp.—*Cladium mariscoides—Rhyncospora capillacea—Tofieldia glutinosa* Herbaceous Vegetation)

Plant nomenclature follows Voss (1972, 1985, 1996) for Michigan species. Insect nomenclature follows Hamilton (1982) and Scott (1986).

Potential habitat for both cercopid species (*L. angulifera* and *P. ignipectus*) was assessed with sweep transects through preserves with previously documented populations of each species. For *L. angulifera*, surveys included fen and sedge meadow habitats in Berrien, Lenawee, and Jackson Counties. *Prosapia ignipectus* was sought on preserves with: fen and sedge meadow communities in Jackson, Berrien, and Lenawee Counties and prairie communities in Van Burren and Newaygo Counties. The number of transects in each preserve was based on preserve area and the observed heterogeneity of preserve vegetation. Transects were roughly 50 m in length, with approximately 75 net sweeps per transect. Sweep effort was coordinated with adult phenology as reported in Hanna (1970) and Hamilton (1982). Independent sweep samples were taken while walking at a constant pace, swinging a net through the vegetation. Hamilton (1982) was used for specimen identification. The dominant plant species were recorded for each transect. We qualitatively compared habitat attributes between transects in which one (or both) spittlebugs species was found and transects which did not produce species' occurrences. Collection of individuals within a transect was assumed to indicate utilization of the resources within that transect.

Adult *Oarisma poweshiek* were intensively sought with meander surveys that extended throughout the herbaceous wetlands at the Jackson County site. Less intensive searches were conducted in fen and sedge meadow habitats at the Lenawee and Washtenaw County sites. We attempted to quantify the number of adults seen at the Jackson County site by noting the number of adults seen along each meander survey. Care was taken to note behaviors, with particular attention to nectaring, mating, and interspecific interactions. Differences between habitat patches occupied by adults of *O. poweshiek* and those lacking individuals were assessed.

Surveys for *C. mutica* were conducted on wetlands with historically documented populations in Lenawee, Jackson, Cass, and Washtenaw Counties. *Calephelis mutica* was sought by walking through a preserve, searching for adults. Since adults of *C. mutica* are cryptic and reclusive, butterflies were intentionally flushed by gently brushing a net over the top of the herb layer. Particular attention was given to patches of vegetation with high densities of

the larval host plant, *Cirsium muticum* or the butterfly's favorite nectar sources, yellow composites (Opler and Krizek 1984). Habitat characteristics that appeared favorable to the growth and health of these plant resources were also noted.

The habitat needs *of N. m. mitchellii* received our most intense scrutiny (Clampitt and Summerville 1998). Prior to the flight period of *N. m. mitchellii*, we established a monitoring transect through wetlands in Cass and Jackson Counties using a modification of the method described by Pollard and Yates (1993). Each transect was divided into seven segments, representing as many potential habitat types (e.g., sedge meadow, prairie fen, open carr, black ash-tamarack swamp) as were found within each wetland community.

During the flight season of *N. m. mitchellii*, the transects were walked a total of nine days, with separate walks at 1030, 1400, and 1730 EDT for a total of 27 surveys per site. Surveys were conducted by walking each transect at a deliberate pace looking ahead, to the sides, and behind to ensure that all butterflies were seen. In an effort to standardize our analyses, only *N. m. mitchellii* seen within one meter of the observer were tallied for density estimation (Pollard and Yates 1993). The time that the observer entered and left each segment was recorded, and individuals of *N. m. mitchellii* that were observed were tallied based upon the segment in which they occurred. An analysis of habitat utilization was made by comparing the distribution *of N. m. mitchellii* among transect segments.

Plant species lists for each segment and site were analyzed using the Michigan Floristic Quality Assessment package (Herman et al. 1996). This package uses the habitat fidelity of wild plants to assess both habitat quality and wetland character of a site. For this, a coefficient of conservativeness (**C**) and a coefficient of wetness (**W**) were assigned to each plant species in Michigan. Coefficients of conservatism were assigned on an 11-point scale, from 0 to 10. A species with a C of 0 grows in weedy or disturbed habitats, while a species with a C of 10 grows only in very specific and natural habitats. Because an intact community is composed of plants with C ranging from 0 to 10, the mean C will typically be near 5.0. A degraded community will have lost the most conservative species, and the mean C will be lower. Similarly, the values of W range from –5 to +5. A species with a W of –5 (obligate wetland species) can only be found in wetlands while a species with a W of +5 (upland species) grows only in uplands. A species with a W of 0 is just as likely to be found in an upland site as in a wetland site. Given a reasonably complete species list for a site, the mean values of C and W provide a good indication of the quality and character of the habitat or transect segment.

RESULTS

Despite our intense field surveys in 1997 (approximately 500 person-hours), large populations of target species were seldom observed. Thus, the following results have been compiled based on relatively small sample sizes. The problems of biological rarity will be discussed briefly in the next section.

Lepyronia angulifera. Three individuals were collected from the Lenawee County fen. All (two females and one male) were found within one of six sweep transects. This transect ran through a marly fen dominated by *Eleocharis elliptica*, *Scirpus validus* Vahl (softstem bulrush), and *Scirpus americanus* Person (three-square). *Carex stricta* was also present in low densities. Other sweep transects passing through areas of fen or sedge meadow dominated by *C. stricta* or other sedges did not produce this species. Further, transects passing through more mesic areas of fen containing a high cover of

grasses or a high density of shrubs (especially *Rhamnus frangula* L. (glossy buckthorn) did not yield *L. angulifera*. This species was not found in areas of the fen subjected to a prescribed burn within the past year although many burned sites contained vegetation similar to the patch occupied by *L. angulifera*.

Results of surveys at the Jackson County fen were similar. At this site, however, three of seven transects produced *L. angulifera*. Nine *L. angulifera* (seven females and two males) were collected in a marly patch of fen dominated by *Eleocharis elliptica*, *Scirpus validus*, and *Cladium mariscoides* (Muhl)Torrey (twigrush). *Gentianopsis procera* Holm (small fringed gentian) was the dominant forb in this marly patch. Two transects running through patches of fen dominated by *Carex stricta, Potentilla fruticosa*, and *Eupatorium maculatum* L. (joe-pye weed) each produced one male. An unidentified *Eleocharis* (spikerush) was also present in these areas at low densities. Three sweep transects in patches of vegetation with varying cover of shrubs (*Cornus* spp., *Salix* spp., and *Toxicodendron vernix* (L.) Kuntze) did not yield any *L. angulifera*. Sweeping in a patch of fen dominated by *Carex lacustris* Willd. (lake sedge) also failed to produce any individuals of this species.

Thus, on our sites, *Lepyronia angulifera* appears to be restricted to patches of vegetation containing *Eleocharis* (and perhaps also *Scirpus*). The most productive transects at both sites ran through marl flats, which tended to lack a shrub component and did not have a very high density of *Carex* spp. Forb density was uniformly low in these marl flats although *Gentianopsis procera* and, to a lesser extent, *Potentilla fruticosa* were present.

Prosapia ignipectus. This species was found in very low densities at both the Lenawee and Jackson County fens, but it was not collected in prairie communities. The only transects to produce *P. ignipectus* were those that passed through mesic prairie fen patches characterized by *Andropogon scoparius, Andropogon gerardii* Vitman (big bluestem), *Potentilla fruticosa, Eupatorium maculatum*, and *Carex stricta*. In these transects, grasses and forbs occurred at low to moderate densities, and most of the plant density was provided by *C. stricta*. At the Lenawee County fen, these conditions were found in one transect (with only one individual collected). At the Jackson County fen, two individuals were collected. Transects which included shrub species with moderate to high cover, transects with *Carex lacustris* dominant, or transects falling in recently-burned patches of vegetation did not produce *P. ignipectus*. This species was also collected by one of us (Summerville) in association with *Lepyronia gibbosa* Ball (prairie spittlebug) and *Neophilaenus lineatus* L. (lined spittlebug) in sandy prairies along power line rights-of-way in Newaygo County. These prairie remnants support reasonably dense growth of *Andropogon* sp., and are likely to harbor dense populations of rare spittlebugs (Summerville 1998).

Oarisma poweshiek. This species was only found to occur at the Jackson County fen site. This skipper was only found in marly areas dominated by *Eleocharis* spp., although its favorite nectar resources, *Rudbeckia hirta* and *Potentilla fruticosa*, appeared to be abundant throughout the site. One exception was a single individual noted nectaring on a *P. fruticosa* in an open fen dominated by *Carex stricta*. This area was separated from a marly *Eleocharis* patch by several hundred meters of open fen and a narrow band of *Larix laricina* (DuRoi) Koch (tamarack). The population of this rare skipper was estimated to be greater than 100 individuals, however, occupied habitat represented roughly 10–15% of the total fen area.

Calephelis mutica. This species was found in two of the four potential sites. At the Jackson County fen, nine adults were observed, and at the Lenawee County fen, two adults were noted. All were observed in areas of

low monocot growth with scattered *Rudbeckia hirta*, *R. fulgida* Aiton, *Potentilla fruticosa*, *Solidago* spp. (goldenrod), and *Cirsium muticum*. In general, the monocot cover was provided by *Carex stricta*. This butterfly was frequently observed nectaring on *R. hirta* and, occasionally, *P. fruticosa*. There was no woody vegetation in these patches.

This butterfly was not collected at either the Cass or Washtenaw County sites where it had been reported in the past. At these two sites, shrub cover had become considerable. Although this butterfly's host plant was found in low densities at both sites, *R. hirta* was conspicuously absent from both sites in 1997. Some *P. fruticosa* occurs at the Washtenaw County site, but it is separated from host plant resources by a dense barrier of shrubs. The *Cirsium muticum* growing in these sites appeared short and stunted, perhaps due to shading.

Neonympha mitchellii mitchellii. The transect for monitoring this butterfly at both the Cass and Jackson County sites started under a swamp forest canopy, crossed areas with an open canopy dominated by a variety of native trees or shrubs as well as open areas dominated by native sedges and grasses, and returned to the starting point. Although a complete botanical inventory was beyond the scope of this study, we identified more than 70 native plant species along each transect. With the exception of two transect segments at the Jackson County site, the mean W was less than –1 (Table 2) and the transects were clearly dominated by wetland plant species. The mean C for the transect segments ranged from 3.64 to 4.48 (except 7a and 7b at the Jackson County site), indicating that they crossed reasonably high-quality wetlands (Table 2).

Neonympha mitchellii mitchellii was not uniformly or randomly dispersed along the transects. Rather, individuals were highly clumped in specific segments (Table 2). Of the 49 observations of individuals at the Cass County site, 35 (72%) of them occurred within transect segment 5 (moderately open shrub carr). Nearly all other observations occurred within the relatively small segment 2 (open shrub carr). Combining the *N. m. mitchellii* observations from the physiognomically similar transect segments 2 and 5 accounts for roughly 92% of all the individuals observed at the Cass County fen. Similarly, at the Jackson County site, 25 of the 40 (63%) individuals were seen in the two segments that crossed open tamarack savanna. Most of the remaining individuals were seen in an open fen or moderately open savanna. This butterfly was not seen in areas of extremely dense shrub carr or in deciduous forests proximal to *Carex stricta* patches. However, it was observed twice in an open sedge meadow and once in a dense tamarack stand. All of these observations were within 10 meters of more densely populated habitat. Since *Carex stricta* was abundant throughout both wetlands, other factors (e.g. shade provided by woody species) were postulated as contributing factors to the observed distribution of *N. m. mitchellii*. It should also be noted that *N. m. mitchellii* was not seen during 22% (Cass County) to 34% (Jackson County) of the surveys, all of which were conducted during the 1997 flight period. Weather has been postulated as a major determinant of *N. m. mitchellii* flight behavior, and the conditions under which this species can most reliably be found are the subject of a continuing study (Clampitt and Summerville 1998).

DISCUSSION

The five insects considered in this study were restricted to specific vegetation assemblages within larger wetland communities. Since their distribu-

Table 2. Habitat characteristics of transect segments included in this study and their use by *N. m. mitchellii*. Values for "Mean C" and "Mean W" calculated using the Floristic Quality Index of Herman et al. (1996). Dominant plant species are listed in order of decreasing estimated relative cover. Vegetation structure was determined by the relative abundance and relative covers of the dominant plant species recorded in each transect segment. "Satyr frequency" refers to the percentage of the surveys in which at least one by *N. m. mitchellii* was seen.

Site and Transect Segment Cass County	Vegetation Structure[1,2]	Dominant Plant Species	Mean C 4.05	Mean W −2.06	Total satyrs seen 49	Satyr frequency 78
1	Closed swamp forest	*Fraxinus nigra, Larix laricina, Cornus foemina*	4.17	−1.35	0	0
2	Open carr	*Carex lacustris, Carex stricta, Eupatorium maculata*	4.48	−3.74	10	33
3	Dense carr	*Cornus foemina, Salix sp.*	4.07	−2.23	0	0
4	Sedge meadow	*Carex lacustris, Carex stricta, Eupatorium maculatum*	3.73	−3.73	2	7
5	Mod. open carr	*Carex lacustris, Carex stricta, Phalaris arundinacea*	4.09	−3.03	35	59
6	Mod. dense carr	*Cornus foemina, Carex lacustris*	3.64	−3.18	2	3
7	Dense carr	*Cornus foemina, Salix sp., Onoclea sensiblis, Carex lacustris*	4.00	−2.20	0	0
Jackson County			3.89	−0.32	40	66
1	Mesic forest	*Quercus velutina, Carex pensylvanica*	3.86	0.45	0	0
2	Mod. open savanna	*Eupatorium maculata, Carex stricta*	3.89	−3.00	7	17
3	Open savanna	*Carex stricta, Larix laricina*	4.30	−2.87	15	46
4	Closed savanna	*Carex stricta, Larix laricina*	4.11	−3.26	1	4
5	Open savanna	*Carex stricta, Larix laricina*	4.46	−2.36	10	29
6	Open fen	*Carex stricta, Potentilla fruticosa*	4.42	−2.06	7	29
7a	Mesic forest	*Populus deltoides, Quescus alba*	3.25	2.00	0	0
7b	Old field	*Solidago canadensis, Rubus flagellaris*	2.70	2.37	0	0
TOTAL (for both sites)					89	

[1]Cover was estimated as follows: (open = 0–10% woody growth; moderate-open = 10–40% woody growth; moderate-dense = 40–70% woody growth; dense = 70–100% woody growth.

[2]Carr refers to the growth of underbrush (i.e., shrub-fen community in Table 1). Segments containing savanna-like structure correspond to shrub and herbaceous fen communities described in Table 1.

tion appears to be restricted to relictual wetland communities described above, these species should be considered remnant-dependent in Michigan (*sensu* Panzer et al. 1997). The microhabitats of these remnant-dependent species appear to be particular seral stages of the plant communities in which they occur. Thus, *Calephelis mutica* occurs in wetland communities, but occupies only an early seral stage of vegetation within that community: low herb growth with no woody component. *Lepyronia angulifera* and *Calephelis mutica* share a similar, early successional wetlands habitat (e.g., neither is found in the presence of shrubby growth), but rely on a vastly different herbaceous microhabitat: *Eleocharis-Scirpus* patches compared with *Cirsium-Rudbeckia* patches. These patches were probably maintained in the past by a combination of factors (e.g., high water table, abundance of aqueous minerals, occasional wildfires, and herbivory from grazing mammals).

Various factors are known to affect the distribution of insect species (Price 1997), and we did not attempt to quantitatively elucidate reasons why the five insect species were restricted to one or two relictual plant communities. At the broadest scale, the distribution of these species is defined by food plant distribution. In the case of *Lepyronia angulifera*, however, Michigan food plants have yet to be precisely identified. Hanna (1970) describes the this specie's hosts as "sedges, in association with cinquefoil, gentian, and pitcher plants at the edges of small bog-like lakes." Marl flats within fens seem to match the character of this habitat description, but we did not observe feeding by adults of *L. angulifera* in the field.

The case of *P. ignipectus* is slightly different from the examples provided by the other four species. *Prosapia ignipectus* is more commonly found in sandy areas from Southern Ontario, throughout New England, to southern Pennsylvania (Hamilton 1982). We collected this species in sandy prairies of Newaygo County, and, in extremely low numbers, in fens. Since so few specimens were obtained in 1997, this observation is difficult to interpret. Perhaps fens with *Andropogon scoparius* serve as sink habitats (*sensu*; Pulliam 1988) for this species. Nymphs of *P. ignipectus* are known to be subterranean, and it is possible that areas of fen with saturated soil during most of the year foster high mortality rates due to asphyxiation, fungal infestation, or microbial infection. The individuals we observed may have dispersed from more upland communities, however, such communities are lacking in the matrices surrounding each wetland preserve. Historically, prairie fens are likely to have developed within a mosaic of upland dry prairie (on elevated plateaus) with lowland areas supporting wet meadows or fens. Thus, conversion of dry prairie for agriculture or development may have eliminated source populations for fen colonization. If this is the case, populations of *P. ignipectus* in wetlands may be dynamically unstable, and successful conservation of this species in Michigan may depend upon maintaining a linkage of dry prairie and wetland habitats. Further collecting is necessary to assess how *P. ignipectus* uses wetland habitats and whether it can attain large populations within those areas.

Oarisma poweshiek rarely strayed from patches of its hypothesized *Eleocharis* host plant, despite the high density of nectar sources occurring in *Carex* dominated fen patches. It should be noted that the *Eleocharis* marl flats occupied by *O. poweshiek* seldom attain the stem density that *Carex* patches attain, and *Eleocharis* marl flats lack the tall forb growth (e.g., *Eupatorium* sp.) commonly observed in sedge fens. Further, *O. powesheik* was never observed in shrubby patches of prairie fen, even when potential nectar sources were available. Thus, one potential hypothesis explaining *O. poweshiek's* avoidance of *Carex* patches containing *Rudbeckia* nectar sources is that *O. poweshiek* discriminates suitable habitat from unsuitable habitat

based on the architecture of the herbaceous layer. Other species of Lepidoptera have been shown to evaluate habitat suitability based upon variation in plant architecture (Rausher 1995).

Our description of the habitat of *O. poweshiek* confirms and extends other authorities' observations. Holzman (1972) asserted that the preferred nectar flower of this skipper was *Lobelia spicata* Lam. (pale-spiked lobelia), with few visits made to other forbs such as *Rudbekia hirta*. In contrast, we frequently observed individuals of the powesheik skipper nectaring on *Rudbekia hirta*. Visits at these flowers were prolonged nectaring bouts; flowers were rarely used for perching behavior. There are close similarities among our Michigan habitat observations and the habitat descriptions for *O. poweskiek* provided by Catling and Lafontaine (1986) for Canada and Borkin (1994) for Wisconsin. The preferred habitat appears to be open wetland dominated by a mixture of grasses, sedges, rushes, and low-growing forbs. Both the Manitoba sites explored by Catling and Lafontaine (1986) and the Michigan sites described here and by Holzman (1972) note the presence of *Eleocharis elliptica* in occupied habitats. Our observations suggest that *O. poweshiek* is reluctant to leave these patches and enter patches having significant woody cover, indicating that dispersal of this skipper may be limited within patchy landscapes. Although Borkin (1994) has demonstrated that *O. poweshiek* may oviposit on other monocot species, their status as suitable host plants remains in question. Further research is required to determine the range of hosts that will support populations of this skipper.

For *Calephelis mutica*, shade provided by shrubs was hypothesized to affect the growth form and quality of *Cirsium muticum*, the butterfly's larval host plant. Further, within many fens, nectar sources (especially *Rudbeckia hirta*) were observed growing in numbers up to, but never within, a half-day shade zone cast by woody growth. Thus, the distribution of *Calephelis mutica* may be defined by resource patch dynamics mediated by the ability of the sun to reach the herb layer throughout the day. The aggressiveness of *Rhamnus frangula* represents a pervasive threat to *Calephelis mutica*, fragmenting and shrinking suitable habitat patches as the shrub spreads. At the Lenawee County site, however, the spread of this shrub is being controlled by cutting the shrubs, treating the stumps with an herbicide, and then burning the area to eliminate resprouts and seedlings. We observed a large number of *Cirsium muticum* and *Rudbeckia fulgida* in recently burned patches. Further research is necessary to assess this butterfly's response to fire and other management practices (e.g., haying or brush cutting).

Neonympha mitchellii mitchellii appears to be found in greatest numbers in a mid- seral stage of fen or sedge meadow succession, selecting habitat based upon the presence of its hypothesized host plant, *Carex stricta*, and some threshold amount of carr or tamarack savanna. At many sites, the influence of invasive species (especially *Rhamnus frangula*) and the disruption of key ecological processes such as groundwater quality and quantity and fire, has altered the natural successional pathways of plant communities (Shuey 1997). In the absence of management, the ultimate result from these disruptions will be the elimination of successional dynamics (including patch creation) and the extirpation of the insect species dependent upon shrinking resource bases (Samways 1995).

Our analysis of the habitat of *N. m. mitchellii* confirmed and quantified several decades of entomological observations. We observed this butterfly most often in areas of *Carex stricta* near stands of woody vegetation. As synthesized by Shuey (1997), the majority *of N. m. mitchellii* habitats are sedge-rich fens and sedge meadows with some shrub component. We noted that the species of woody growth varied considerably, ranging from *Larix laricina*, to

Toxicodendron vernix (poison sumac), to *Cornus amomum* Miller (pale dogwood). This strongly suggests that although woody species provide an important structural character to *N. m. mitchellii* habitat, the precise species involved are less important . Woody cover may provide shaded zones during the heat of the day, protection from predators, roosting sites during inactive periods, or sheltered oviposition sites. Further research is required to resolve questions of how much structural cover is "optimal" for the butterfly, and to answer questions concerning the role of plant architecture in the butterfly's ecology.

A confounding factor in generalizing about these species' habitats is their rarity, both within a site and within the region. In particular, rarity obscures the interpretation of negative results, making it difficult to determine whether failure to collect a species in a given patch is due to its absence, insufficient sampling, or random effects (Price 1997; Samways 1995). We acknowledge this inherent problem, and believe that continued sampling will fill questionable voids in our data set. Populations of each focal species are found in Michigan counties outside of the scope of research. Cross-referencing of our habitat data with additional habitat information for these species in the Heritage database for Michigan suggests that we have captured the essence of each species' habitat requirements in Michigan.

It is of primary importance to document the habitat requirements of rare species if the administrative mechanisms of biological conservation are to be successful. Furthermore, for current theories of conservation biology to be successfully applied to insects, natural history information must be used to assist with model parameterization, especially patch-occupancy models such as those used for modeling metapopulations, source-sink dynamics or percolation. A large body of theoretical ecology is firmly in place; responsibility now falls to field entomologists to collect vital micro-habitat data akin to the work of ornithologists for avian conservation in previous decades (Samways 1995).

Conservation plans are only as good as the data used to create them. Four of the five *species (P. ignipectus* is a special case) we considered in this research appear to be habitat specialists at two scales: the community and the microhabitat. Thus, these species may be properly considered wetland specialists; however, it is fundamentally important to recognize that each species also is restricted to a specific (or a few specific) microhabitats within wetland communities. For conservation and management to be successful, an understanding of species' requirements at both scales is important. Neglecting the details of microhabitat specialization may jeopardize efforts to preserve Michigan's insect biodiversity. It is our hope that the information presented in this paper expands our understanding of the insect species Michigan is struggling to protect.

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