Conservation Assessment for The Swamp Metalmark (Calephelis mutica McAlpine)

USDA Forest Service, Eastern Region

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This document is undergoing peer review, comments welcome

This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service - Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.

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EXECUTIVE SUMMARY

The swamp metalmark (*Calephelis mutica* McAlpine) is a small, reddish brown butterfly associated with graminoid/cyperoid wetlands in the Upper Midwest, Ohio Valley and Ozark Mountain regions. It is considered rare and local throughout its range; always found in close association with its primary larval food plants, native thistles (primarily *Cirsium muticum*; but also *C. altissimum* and *C. carolinianum*). This butterfly produces one to two broods per year, with the adults appearing in late spring (south) and again in late summer (north and south). Despite the production of multiple broods, the swamp metalmark is almost never common and most records consist of only one or a few individuals. The destruction of the nation's mesic grasslands and graminoid wetlands over the past 200 years has greatly reduced suitable habitat for this and many other species. The few high quality fragments that remain are often small and highly isolated from one another. Therefore, a concentrated, region-wide effort to protect and restore habitat for this species will be needed to ensure its long-term survival. It is recommended that restoration projects (particularly those involving hydric grasslands and graminoid/cyperoid wetlands) track the effects of restoration techniques on globally imperiled species such as the swamp metalmark, when present. Much is still unknown about this butterfly, particularly regarding its range of habitat requirements. Grassland and wetland restoration projects would be a rich source of pertinent information to address these fundamental questions. Once available, this information would also allow land managers to measure the effectiveness of a variety of restoration techniques, ultimately leading to more effective restoration of these ecosystems.

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NOMENCLATURE AND TAXONOMY

The genus *Calephelis* was first designated by Augustus Grote and Coleman Robinson and based on the type species "*Erycina*" *virginiensis* Guerin-Meneville (Grote and Robinson, 1869). *Calephelis* is Greek for "the beautiful deceiver", referring to the difficulty in discerning differences between many of the beautiful species. The swamp metalmark (*Calephelis mutica*) was first described by Wilbur McAlpine in 1937 as *Calephelis "muticum"* from specimens collected in a "tamarack swamp" near the town of Willis in Washtenaw County, Michigan (McAlpine, 1937). He also described the immature stages and life history from the same site (McAlpine, 1938). This population is now likely extinct, given the conversion of much of the region to agricultural production and residential development.

Initially, the swamp metalmark was thought by some to be a form of the closely related northern metalmark (*Calephelis borealis*), another Midwestern species (see McAlpine, 1937; 1971; Opler, 2004). The swamp metalmark is also very similar to the little metalmark (*Calephelis virginiensis*) and the three species are thought to have only recently differentiated from a common ancestor (Hall and Harvey, 2002). McAlpine described many new species and revised the genus *Calephelis* in 1971 and this revision stands as the most accurate assessment of the group to date. Hall and Harvey (2002) undertook a phylogenetic analysis of the closely related metalmark genera *Calephelis* and *Charis*.

DESCRIPTION OF SPECIES

DESCRIPTION OF ADULT STAGE

The metalmark butterflies of the genus *Calephelis* are all very similar in appearance; small, dark brown or reddish brown, with a checkerboard or lacework pattern of darker markings. All are characterized by two narrow rows of small, silvery white spots, passing vertically across the fore and hind wings (see Figure 1). The swamp metalmark typically measures 22-28 mm (0.8-1.25 inches) in wingspan. The wings (especially in the males) are angular, with hind wing more rounded. The color of the dorsal wing surface is a uniform deep mahogany red, with fine black, interconnected lines forming concentric circles outward from the body, giving the wings a "scalloped" or "checkerboard" appearance (see Figure 1). There is also a series of small, circular black spots just inside the outer edge of each wing. This row of spots is bounded on each side by a narrow line of silvery, greenish-white spots. Below, the pattern is repeated, but the ground color is reddish-golden to orange-brown with black or lead-gray flecks. These ventral dark markings often have metallic reflectance, hence the common name.

This species is very similar to *Calephelis borealis* and *C. virginiensis,* both of which fly with *C. mutica* in the southern parts of its range. Differentiation between these butterflies can be difficult, although location and habitat association can be used to identify the species, in most

cases. Typically, *Calephelis virginiensis* is smaller and more reddish than *C. mutica*. These two butterflies rarely occur near one another, except in extreme northeastern Oklahoma. *Calephelis virginiensis* is associated with wet-mesic, longleaf pine-wiregrass savanna and coastal, graminoid wetlands along the southern Atlantic Coastal Plain. Inland populations occur in similar wetlands along large tributaries near the Coastal Plain, such as the Arkansas River. *Calephelis mutica* populations in the region are associated with wetlands or hydric grasslands in the Ozark Mountains.

Calephelis borealis does occur in the central part of the range of *C. mutica* and the two can exist in close proximity to one another (e.g. Wabash County, Indiana and southern Missouri). Despite this, the northern metalmark is always associated with dry open, oak-dominated woodlands with an abundance of the larval food plant, ragwort (*Senecio obovatus*). Conversely, the northern populations of the swamp metalmark are associated with alkaline wetlands or fens. In southern Indiana, Kentucky and the Ozarks, *Calephelis mutica* populations occur in open grasslands or small fens adjacent to open oak woods. The two species could hypothetically occur near one another in these situations. However, the northern metalmark is always darker ventrally and the wings are usually more angular than in the swamp metalmark. This allows for fairly effective discrimination between the two, based purely on color, location and habitat. Adults of all three species are figured in Howe (1975), Opler (2004), Opler and Krizek, (1984), Opler and Malikul (1992) and Scott (1986).

DESCRIPTION OF IMMATURE STAGES

Eggs of *Calephelis mutica* are pinkish white, spherical and dorsally flattened, the classic "turban-shaped" of early Lepidopterists. The surface is covered with an intricate latticework of ridges and valleys, giving it a sculpted appearance. The young larvae are greenish white with a coat of long white hairs. The body is also covered with fine white hairs, giving the caterpillars a "ghostly" fuzzy appearance. As they reach the final instar, the hairs become longer, giving the coat a denser look. They are very well camouflaged upon their food plants, all of which have a wooly, white tomentum.

LIFE HISTORY

REPRODUCTION

Like all other Lepidoptera, the swamp metalmark goes through four distinct developmental stages: egg, larva, pupa and adult. In the Upper Midwest, a single brood is produced in a typical year. The first brood of adults appears in spring (May-July, depending on latitude), arising from partially grown larvae that overwinter hidden under thistle leaves (see McAlpine, 1938). The adults appear in late June and July, mate, lay eggs and the larvae feed, develop partially by fall and then overwinter in detritus at the base of a first year thistle rosette. In the Ohio Valley and Ozark regions, the spring brood appears in May and the larvae that arise from this develop rapidly, producing another adult brood by late August. Females from this brood also lay eggs on first-year *Cirsium* rosettes, which hatch into larvae that feed until partially grown and overwinter, to finish feeding and produce adults the following spring.

ECOLOGY

The larval food plant of *Calephelis mutica* throughout much of its range is swamp thistle (*Cirsium muticum*), a species of northern alkaline wetlands, fens, marshes and seeps (Britton and Brown, 1913; Deam, 1940; Gleason and Cronquist, 1991; Swink and Wilhelm, 1995; Voss, 1972-1997). The swamp thistle also occurs in similar habitats in the higher elevations of the Appalachians and in protected mountain valleys in the Ozarks (USDA-NRCS, 2004). The swamp metalmark is also associated with other native thistles in parts of its range, primarily *Cirsium altissimum* and *C. carolinianum* in southern Indiana (Bess, 2004). Figure 2 shows the current distribution of this butterfly and three species of native thistle in the eastern U. S. The swamp metalmark is not known to occur on the Atlantic Coastal Plain, where it is replaced (in somewhat similar habitats) by the little metalmark (*Calephelis virginiensis*).

The swamp metalmark is always associated with large populations of native thistles, particularly those with fairly thin, relatively unarmed leaves having a whitish tomentum on their ventral surface. Within the known geographic range and habitats reported for the swamp metalmark, this includes *C. muticum, C. carolinianum* and *Cirsium altissimum*. Vegetation in these habitats is typically tall (1-3 meters: 3-10 feet) and consists largely of grasses, sedges and rushes. The adults are slow fliers, remaining within the tops of the vegetation at all times. They usually fly only short distances, often stopping to rest or bask on vegetation. Adults feed on nectar from a variety of flowers, including wingstem (*Actinomeric alternifolia*), mountain mint (*Pycnanthemum virginianum*), black-eyed susan (*Rudbeckia hirta*) and sunflowers (*Helianthus* spp.). They also drink from wet mud and puddles.

In the southern parts of its range, there are two adult broods per season; one in spring (May-June), the second in late summer (August-September). In the Great Lakes populations, a single brood is produced in late June and July. However, fresh adults are occasionally observed in late summer (Bess, pers. obs.), suggesting a partial second brood in the north. Each adult brood period lasts approximately two weeks, during which they mate and females lay eggs on the larval food plant. The eggs hatch in a week and the young larvae feed on the undersurface of the basal thistle leaves. They typically hide under the lower leaves during the daytime, coming out to feed at night and on overcast days. They feed by scraping the lower leaf surface with their mandibles, removing all tissue except the dorsal cuticle. This feeding activity produces characteristic clear patches or "windows" in the leaves.

The larvae are always found on *Cirsium*, although overwintering individuals may occur a short distance away from the host plant in detritus from the previous year's growth. They are fairly sedentary during the daytime, curling into a ball if disturbed or exposed to light. This behavior exposes all of the hairs, which are possibly irritating. *Calephelis mutica* overwinters as a partly grown (3th instar) larva in the silk-lined nest under thistle leaves or in detritus nearby. Overwintering larvae emerge in early spring to feed briefly on new foliage prior to pupating. Pupation occurs within a silken nest that may or may not be attached to the foodplant. The pupa is tan and attached to a flat surface with a silken harness around its middle and a silk patch at its distal end, to which the pupa is attached. The pupa stage lasts from 4-10 days.

DISPERSAL/MIGRATION

Given its weak flight and specific foodplant requirements, the swamp metalmark rarely (if ever) leaves the streamside wetlands and grasslands where it occurs. Maximum individual dispersal distances are probably on the order of a few hundred yards, with the species generally regarded as rare and highly local in occurrence. However, populations are likely capable of dispersing over large areas of contiguous suitable habitat, particularly along stream corridors. This method of dispersal would be greatly facilitated by the production of two broods of adults per year, as is the case with the swamp metalmark. This species is not known to migrate.

OBLIGATE ASSOCIATIONS

The obligate habitat for the swamp metalmark is high quality, stream-side, graminoid wetlands and hydric grasslands containing an abundance of native thistles, particularly *Cirsium muticum* and *C. carolinianum*. In the Ohio Valley and Ozark regions, *Cirsium altissimum* occurs with C. carolinianum on seepy slopes and adjacent floodplain grasslands, where it is fed on by larvae of the swamp metalmark (Bess, 1997, 2004; Heitzman and Heitzman, 1987; Koenig, 2005). This butterfly rarely (if ever) occurs far from stands of these thistles, although adults may venture into adjacent habitats to feed on nectar from flowers. The swamp metalmark butterfly shares its habitat with a number of regionally and globally imperiled insect, plant and vertebrate species discussed under a later section ("**RESEARCH PRIORITIES**").

HABITAT

RANGE-WIDE

Across its range, *Calephelis mutica* occurs in three somewhat geographically isolated regions. In each region it is found in distinct clusters of structurally similar, grassland and/or wetland habitat types. These vary by region and include;

Upper Midwest

- Glaciated prairie fens, rich fens, sedge meadows (or southern wet meadow), shrub swamps and related plant communities where the larval food plant (*Cirsium muticum*) is common. For additional habitat descriptions and references, see: Albert, 1995, 2004a-b; Chapman, et al., 1989; MNNHP, 1993; NatureServe, 2004.

Midwestern fen habitat for the swamp metalmark is characterized by a relatively open canopy (<50 percent tree cover), with a rich herbaceous layer dominated by sedges, rushes and grasses. Typical sedges include *Carex aquatilis, C, lasiocarpa, C. lacustris, C. pellita, C. squarrosa, C. sterilis* and *C. stricta*. Rushes such as *Cladium mariscoides, Eleocharis elliptica, E. rostellata, E. erythropoda, Eriophorum angustifolium, Juncus brachycephalus, J. canadensis, J. effusus, Rhynchospora capillacea* and *Triglochin maritimum*, can be locally dominant, as can *Scirpus acutus, S. validus, S. americanus* and *S. atrovirens*. Common grasses include big bluestem (*Andropogon gerardii*), Kalm's brome (*Bromus kalmii*), Canada bluejoint (*Calamagrostis canadensis*), turtlehead (*Chelone glabra*), (*Glyceria striata*), marsh timothy (*Muhlenbergia glomerata*), little bluestem (*Schizachyrium scoparium*) and prairie cordgrass (*Spartina*

pectinata). Ferns are also common and include marsh fern (*Thelypteris palustris*), sensitive fern (*Onoclea sensibilis*) and royal fern (*Osmunda regalis*).

Characteristic forbs include hog peanut (*Amphicarpa bracteata*), angelica (*Angelica atropurpurea*), New England Aster (*Aster nova angliae*), swamp aster (*Aster puniceus*), swamp thistle (*Cirsium muticum*), spotted joe-pye-weed (*Eupatorium maculatum*), boneset (*E. perfoliatum*), round-leaved sundew (*Drosera rotundifolia*), fringed gentian (*Gentiana crinita*), marsh blazingstar (*Liatris spicata*), Michigan lily (*Lilium michiganense*), great blue lobelia (*Lobelia syphilitica*), fringed loosetrife (*Lysimachia quadriflora*), winged loostrife (*Lythrum alatum*), grass-of-Parnassus (*Parnassia glauca*), marsh betony (*Pedicularis lanceolata*), mountainmint (*Pycnanthemum virginianum*), black-eyed Susan (*Rudbeckia hirta*), purple pitcher plant (*Sarracenia purpurea*), prairie dock (*S. terebinthenaceum*, Ohio goldenrod (*Solidago ohioensis*), Riddell's goldenrod (*S. riddellii*), false asphodel (*Tofieldia glutinosa*), marsh violet (*Viola cucullata*), narrow-leaved violet (*V. lanceolata*), northern white violet (*V. pallens*) and numerous orchids.

Trees are typically sparse, although open fen habitats often abut forested wetlands. Tree species in these fens can include red maple (*Acer rubrum*), ash (*Fraxinus pennsylvanica*), butternut (*Juglans cinerea*), red cedar (*Juniperus virginianus*), tamarack (*Larix laricina*), tuliptree (*Liriodendron tulipifera*), sycamore (*Platanus occidentalis*), aspens (*Populus grandidentata* and *P. tremuloides*), pin oak (*Quercus palustris*), white cedar (*Thuja occidentalis*) and/or American elm (*Ulmus americana*). Shrubs can be numerous and often consist of near monocultures of dogwoods (*Cornus* spp.) and/or willows (*Salix* spp.). Other characteristic shrubs include bog birch (*Betula pumila*), spicebush (*Lindera benzoin*), ninebark (*Physocarpus americanus*), shrubby cinquefoil (*Potentilla fruticosa*), alder-leaved buckthorn (*Rhamnus alnifolia*), poison sumac (*Toxicodendron vernix*) and arrowwood (*Viburnum lentago*). *Calephelis mutica* avoids heavily forested or shrub-covered habitats, unless swamp thistle is locally abundant. Midwestern prairie fens are not considered globally imperiled at this time and are currently ranked G3G4 (see NatureServe).

Ohio Valley

- Wet-mesic tallgrass prairie and barrens, usually occurring in very open grassland along stream corridors. Associated with *Cirsium altissimum* and *C. carolinianum*. For additional descriptions and references on similar habitats, see: Anderson, et al., 1999; NatureServe, 2004.

The Ohio Valley habitats for the swamp metalmark differ from those to the north in that they are associated with rocky habitats known as barrens. However, seeps, springs and streams are plentiful, providing abundant water in localized areas. In some valleys and along old alluvial plains, fairly deep soils have been deposited and a plant community closely resembling wet-mesic tallgrass prairie has developed (as described in Weaver, 1954 and Weaver and Fitzpatrick, 1934). These grasslands are very similar to the "Kentucky Mesic Tallgrass Prairie" and the "Unglaciated Mesic Tallgrass Prairie" Ecological Associations described on the NatureServe Website. The Kentucky tallgrass habitat type is considered a G1G2 (Globally Imperiled) plant community or ecological association.

In high quality remnants, trees are sparse, except along streams and protected rock outcrops. The surrounding plant community is oak barrens, dominated by post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), white oak (*Q. alba* and black oak (*Q. velutina*). Tuliptree (*Liriodendron tulipifera*), black gum (*Nyssa sylvatica*), sycamore (*Platanus occidentalis*) and red elm (*Ulmus rubra*) are also common. Shrubs are diverse and can quickly dominate sites that are frequently burned. Common shrubs include paw paw (*Asimina triloba*), redbud (*Cercis canadensis*), flowering dogwood (*Cornus florida*), hazelnut (*Corylus americana*), huckleberry (*Gaylussacia baccata*), witch hazel (*Hamamelis virginiana*), Carolina buckthorn (*Rhamnus caroliniana*), raspberries (*Rubus alleghaniensis, R. occidentalis*), coralberry (*Symphoricarpos*), sassafras (*Sassafras albidum*), blueberries (*Vaccinium* spp.) and possum haw (*Viburnum rufidulum*).

The herbaceous vegetation is dominated by warm season grasses like big bluestem, bushy bluestem (*Andropogon glomerata*), broomsedge (*A. virginica*), silver plumegrass (*Erianthus*), little bluestem and Indian grass. Additional common grasses include wood oats (*Chasmanthium latifolium*), rye grasses (*Elymus hystrix, E. virginicus*) and panic grasses (particularly *Panicum anceps* and species of *Dichanthemium*). Sedges are also common and often locally dominant, including *Carex albicans, C. cephalophora, C. complanata, C. glaucodea* and *C. rosea*. The nodding bulrush (*Scirpus pendulus*) and nutsedge (*Scleria oligantha*) are also common.

Characteristic forbs include; wild onion (*Allium canadense*), wingstem (*Actinomeris alternifolia*), hog peanut, smooth blue aster (*Aster laevis*), swamp aster (*Aster puniceus*), white wild indigo (*Baptisia leucantha*), indian plantain (*Cacalia atriplicifolia*), poison hemlock (*Cicuta maculata*), tall thistle (*Cirsium altissimum*), Carolina thistle (*C. carolinianum*), tall tickseed (*Coreopsis tripteris*), fuzzy sticktight (*Desmodium canescens*), shootingstar (*Dodecatheon media*), rattlesnake master (*Eryngium yuccifolium*), mistflower (*Eupatorium coelestinum*), flowering spurge (*Euphorbia corollata*), downy sunflower (*Helianthus mollis*), marsh blazingstar, Michigan lily, bergamot, marsh phlox (*Phlox glaberrima*), obedient plant (*Physostegia virginiana*), scurfy pea (*Psoralidium tenuiflorum*), mountainmint (*Pycnanthemum pycnanthemoides, P. virginianum*), black-eyed Susan, wild petunia (*Ruellia humilis*), rose gentian (*Sabatia angularis*), rosinweed (*Silphium integrifolium*), prairie dock, stiff goldenrod (*Solidago rigida*), meadowsweet (*Thalictrum* sp.), spiderwort (*Tradescantia virginiana*) and early wingstem (*Verbesina helianthoides*).

Ozark Mountains

- Unglaciated, mountain valley seeps, spring runs, fens and wet-mesic prairies/barrens. The food plant in these habitats is primarily *Cirsium muticum*, although *C. altissimum* and *C. carolinianum* are also used. Additional plant community descriptions and references include Anderson et al., 1999; Koenig, 2005; MODNR, 2004; NatureServe, 2004; Nelson, 1985; Orzell and Kurz, 1984.

The Ozark Mountain fen habitats for *Calephelis mutica* are unique in that they represent the largest complex of unglaciated fens in North America (NatureServe, 2004). They are also globally imperiled and ranked as G1G2 plant communities (NatureServe, 2004). Many of the plant species present in the Upper Midwest fens also occur in Missouri fens. These include

grasses and sedges like big bluestem, *Carex interior*, *Carex leptalea*, *Carex lurida*, umbrella-sedge (*Fuirena* spp.), switchgrass (*Panicum virgatum*), little bluestem, bulrushes (*Scirpus* spp.), Indian grass and cordgrass (*Spartina pectinata*).

Forbs such as bushy aster (*Aster dumosus*), swamp aster, Indian paintbrush (*Castilleja coccinea*), turtlehead, spotted touch-me-not (*Impatiens capensis*), blueflag (*Iris virginica*), winged loosetrife, fringed loosetrife, sawtooth sunflower (*Helianthus grosseserratus*), downy sunflower (*Helianthus mollis*), cowbane (*Oxypolis rigidior*), grass-of-Parnassus, mountainmints (*Pycnanthemum* spp.), marsh coneflower (*Rudbeckia fulgida* var. *umbrosa*), prairie dock, rosinweed, Riddell's goldenrod, Culver's root (*Veronicastrum virginicum*), western ironweed (*Vernonia baldwini*) and marsh blue violet. Occasionally, the federally endangered prairie white fringed orchid (*Platanthera leucophaea*) may be present. Marsh fern, sensitive fern and royal fern are also common. Shrubs include alder (*Alnus rugosus*), willows, dogwood, spicebush and poison sumac. Trees in the surrounding forest include red maple, green ash, hop hornbeam, chestnut oak and red elm.

The swamp metalmark also occurs in Missouri counties not known to have *Cirsium muticum* (see Figure 2). Although most of these populations are in the Ozarks, at least two occur in the north-central part of the state, the tallgrass prairie region, in fens and seeps along the Missouri River. The non fen-associated Ozark populations occur in barrens habitats similar to those in the Ohio Valley (Heitzman and Heitzman, 1987; Koenig, 2005).

NATIONAL FORESTS: HOOSIER NF (PERRY CO., IN)

In the Hoosier National Forest (HNF) of Indiana, the habitat for *Calephelis mutica* is considered typical of high quality remnants in the Ohio River Valley and is as described previously. However, the two known sites for *Calephelis mutica* within the Hoosier National Forest differ significantly from one another with respect to canopy closure and plant species composition.

The Hoosier National Forest populations of the swamp metalmark are associated with two (maybe three) species of native thistle: the tall (*Cirsium altissimum*), soft-stemmed (*C. carolinianum*) and possibly field (*C. discolor*). *Cirsium carolinianum* (*C. virginianum* of Deam, 1940) is very local in the Hoosier National Forest, occurring in isolated colonies near the Ohio River. In Indiana, this plant typically occurs on dry (but often seepy) slopes, usually near streams. It is an unusual thistle in that it blooms in early summer (late May-June in southern Indiana). *Cirsium altissimum* often occurs with this species and can be very common in southern Indiana, especially in open, fire-maintained barrens. It also occurs along poorly maintained roadsides and even in open, mesic natural communities, especially those that have received past disturbance of the vegetation. John Shuey (2005) states that the Boone Creek swamp metalmark population is associated with *Cirsium discolor*. Although this thistle has expanded its range in southern Indiana (compared to that reported by Deam, 1940), *Cirsium altissimum* is by far the most abundant native thistle at the Boone Creek site. However, the butterfly is not common at Boone Creek SA and a definite association has not been made (Bess, 2004).

SITE SPECIFIC

Hoosier NF: Boone Creek Special Area

Boone Creek Special Area (Boone Creek) is a relatively large (ca. 800 acres) remnant of dry and mesic habitats, set in a matrix of thousands of acres of fire-suppressed oak-pine barrens. Despite its size, Boone Creek contains comparatively little habitat for the swamp metalmark. Here, the metalmark is restricted to an area of roughly 60 acres along Boone Creek, where tall thistles (primarily *Cirsium altissimum*) grow in scattered colonies along the road and hillsides. Carolina thistle may also grow on the seepy hillsides adjacent to Boone Creek. The field thistle, *Cirsium discolor*, also grows here, although it is much less common than *C. altissimum*. John Shuey (pers. comm. and 2005) believes the swamp metalmark is using this thistle at Boone Creek, although *C. altissimum* is much more common and widely distributed. The field thistle appears to have only recently moved into southern Indiana, as Deam (1940) reported it as being rare in the southern part of the state. It is typically a species of moist, mucky soils, being especially common on recently drained wetlands. It can also be common in disturbed, sandy soils in the dune region.

The canopy at Boone Creek is completely closed (except directly over the road/Boone Creek) and dominated by oaks and maples. Ash, tuliptree and sycamore are also locally important. The herbaceous layer is fairly sparse and composed primarily of plants adapted to low light conditions (as listed above), with few species more typical of open grasslands or wetlands. A large amount of potential habitat for this species occurred until recently on private lands along Boone Creek barrens, immediately south of the Special Area. However, much of this potential habitat (formerly with abundant *Cirsium altissimum*) has recently been converted to non-native fescue (*Festuca arundinacea*) pasture, home sites and row crops. There is another nearby record for the swamp metalmark, known simply as "Oil Creek", of which Boone Creek is a tributary. Oil Creek traverse much of southeastern Perry County and there is potential for additional populations along similar streamside habitats across southern Indiana.

Hoosier NF: Clover Lick Special Area

The other known occurrence for *Calephelis mutica* within the HNF is the Clover Lick Special Area, a ca. 1,300 acre complex of open and closed canopy oak and oak-pine barrens. This site contains several hundred acres of habitat for the butterfly, with a diverse flora as listed above. Much of the occupied swamp metalmark habitat at Clover Lick barrens was formerly open oak barrens and prairie, with old, widely-spaced blackjack and post oaks occupying the canopy layer. *Cirsium altissimum* grows in profusion in open, seepy areas and along the floodplain of Clover Lick Creek. *Cirsium carolinianum* also occurs on these seepy slopes, usually with minimal canopy or shrub cover.

In areas that have been managed with manual cutting of brush and prescribed fire, a high quality wet-mesic grassland occurs, dominated by big bluestem and Indian grass. Other bluestems and sedges are also important. Characteristic forbs include wild onion, wingstem, hog peanut, smooth blue aster, poison hemlock, tall thistle, Carolina thistle, tall tickseed, rattlesnake master, fuzzy sticktight, shootingstar, mistflower, flowering spurge, marsh blazingstar, Michigan lily, bergamot, marsh phlox, obedient plant, mountainmint, black-eyed Susan, wild petunia, rose gentian, rosinweed, prairie dock, stiff goldenrod and meadowsweet. Approximately 400 acres of suitable habitat for this species occurs at the Clover Lick Special Area.

DISTRIBUTION AND ABUNDANCE

RANGE-WIDE DISTRIBUTION

The swamp metalmark has a patchy and discontinuous range in central North America (see Figure 2). Most known records are from Michigan (see Nielsen, 1999) and Missouri (Koenig, 2005). Several additional historic and/or recent occurrences in Wisconsin (WIDNR, 2005) and Indiana (INDNR, 2004; Masters and Masters, 1969; Shull, 1987), four to six in Arkansas (Bess, 2000; Koenig, 2005) and single records from Iowa and Minnesota (Opler, 1981). Kentucky is known to have four recorded populations (Covell, 1999), while Illinois and Ohio have two each (Opler, 2004). There is also an old historic record from "near Pittsburgh" Pennsylvania (see McAlpine, 1971). Throughout its range, this butterfly is considered uncommon to rare and always local in occurrence. Many records for this species consist of a single individual or specimen and few observations note more than 10 individuals on a given survey. Several historic occurrences are no longer extant, having been destroyed or altered significantly through fire suppression, hydrologic disturbance for agricultural or game production and other human uses.

STATE AND NATIONAL FOREST DISTRIBUTION

The following state-level distribution information for the swamp metalmark is gathered from Bess (2004), Covell (2001), Dole et al. (2004), McAlpine (1972), Norman (2004), Opler (1981 and 2004) and Shuey (2005) (see Figure 1). National Forest Information is provided for the Hoosier National Forest in Indiana. County-level comparisons with National Forest boundaries were also made for each additional state occupied by the butterfly. Known or potential occurrences for military installations and other federal landholdings have been included when relevant.

Arkansas

No known National Forest occurrences. However, populations occur near the Ozark National Forest and the Buffalo National River and these properties may contain habitat suitable for the species. The swamp metalmark is known to occur only in the Ozark Mountains of Arkansas, so it is quite possible that additional, undiscovered populations occur in the Ozark NF.

Illinois

There are no known National Forest occurrences. There is potential habitat in the Shawnee National Forest, but no surveys have been conducted. There is also an anecdotal record of a population being discovered by a butterfly collector at a Nature Preserve in Vermillion County. Additional surveys have not been undertaken to verify this occurrence (R. Panzer, 2005 pers. comm.), although it is included on Figure 2 based on the presence of suitable habitat in the county.

Indiana

The three known Ohio River Valley populations are contained within the boundaries of the Hoosier National Forest. However, the Boone Creek barrens and Oil Creek populations have substantial amounts of habitat on adjacent, unprotected private lands. The Harrison-Crawford

State Forest is immediately adjacent to the Hoosier NF and contains superficially suitable habitat for this species.

Iowa
The single historic Iowa population occurred in the east-central part of the state but has apparently been extirpated. No additional populations have been found to date, despite the continued presence of suitable habitat.

Kentucky
None of the known populations occur on Federal Forest lands, however two of the three occur on state owned land. The third occurs on a park owned by the City of Louisville. In 1990, Dr. Charles V. Covell, Jr. (Professor Emeritus, University of Louisville, Louisville, KY) indicated a location in the Red River Gorge (Daniel Boone NF) where a swamp metalmark was supposedly observed some years ago. An attempt should be made to verify this record, given the presence of suitable habitat for this species in the Daniel Boone NF.

Michigan
None of the Michigan populations occur on Federal Forest lands, although several do occur on state-owned lands and properties owned and managed by The Nature Conservancy. The northern-most populations in the state approach the boundaries of the Huron-Manistee National Forest and superficially suitable habitat for the butterfly occurs there. Given the recent observation of this species in a wetland in northern Wisconsin, attempts should be made to also check suitable habitat in the Hiawatha and Ottawa National Forests in Michigan's Upper Peninsula.

Minnesota
The single historic population appears to have been extirpated. It occurred on private land in the southeast part of the state. No other populations have been identified although suitable habitat occurs elsewhere in the state.

Missouri
A few populations occur near the Mark Twain NF. Others occur on lands owned by the state and city parks. The swamp metalmark is known from more than 30 historic occurrences in 20 counties across the central and southern parts of the state.

Ohio
No known National Forest occurrences, although suitable habitat may occur within the Wayne National Forest. The swamp metalmark is currently known only from fens in the northwestern portion of the state.

Oklahoma
Oklahoma contains only a single population of *Calephelis mutica*, in the extreme northeast corner of the state (Ottawa County). This is the only state where the swamp metalmark and little metalmark co-occur and they are both found in the same county.

Pennsylvania
I am including the McAlpine record from "near Pittsburgh" as valid, given his knowledge of the species and apparent satisfaction with the record, indicating he probably viewed the specimen himself (see McAlpine, 1971). It has been referenced frequently in the literature, with the swamp metalmark often described as "occurring from Pennsylvania, west to Wisconsin." No National Forest land occurs in the nearby region, however *Cirsium muticum* occurs throughout the state of Pennsylvania, including the Allegheny National Forest.

Wisconsin
No recorded National Forest occurrences, although the recent record from Marquette County, WI is near the Chequamegon-Nicolet National Forest and there could be suitable habitat within these landholdings.

RANGE WIDE STATUS

Calephelis mutica is considered imperiled in most or all parts of its range (D. F. Schweitzer for NatureServe, 2004). Without a concerted effort to protect and restore habitat for this species, it is in immediate danger of extirpation throughout much of its range. However, even in its supposed stronghold (the Ozarks of Missouri) there seems to be insufficient information to conclude that it is demonstrably secure (NatureServe, 2004). This is especially true with regards to its preferred habitats, unglaciated wet-mesic tallgrass prairie and prairie fen, both of which are globally imperiled plant communities. The following information was gathered (in part) from the NatureServe.org Website in 2005.

Global Status: G3
Global Status Last Reviewed: 07Jul2004
Global Status Last Changed: 07Jul2004
Rounded Global Status: G3
Status and Ranking By: D. F. Schweitzer

State-level Status (S-Ranks)
Arkansas (**S1**), Illinois (**S1**), Indiana (**S2**), Iowa (**SH**), Kentucky (**S2**), Michigan (**S1S2**), Minnesota (**SNR**), Missouri (**S3**), Ohio (**S1**), Oklahoma (**SNR**), Pennsylvania (**SNR**), Wisconsin (**S1**).

Note that NatureServe does not recognize the swamp metalmark as occurring in Minnesota, Oklahoma or Pennsylvania. The Missouri S-rank seems inflated and would be more appropriate as an S2, given the number of known occurrences. Schweitzer states that "a recent reassessment of its status in Missouri concludes S3 is still an appropriate rank there with scattered localized populations in up to 20 counties (Debby Fantz email to Nicole Capuano of NatureServe July 7, 2004)". This data set (30-35 historic populations in 20 counties) was also reviewed for the present report and, as Schweitzer suggests, "there may be some question as to how many of these Missouri occurrences have been recently verified extant." However, his statement that "there is no known evidence of a serious decline there", meaning Missouri, cannot be justified from the data. The Missouri specimen data managed and provided by Phillip Koenig, suggests that the

swamp metalmark populations in Missouri are mostly small and highly isolated, with many not having been seen in 20-40 years, minimum. Several former sites are now residential or urban areas. Two of the largest, "protected" populations in the state (one a State Park and the other a City Park) were severely collected by amateur butterfly enthusiasts in the 1980's and may no longer be viable.

Schweitzer further states that "outside of the Ozarks, the swamp metalmark has a limited and highly fragmented range with very low habitat occupancy." The Arkansas populations have not been observed in over 30 years. This species may be extirpated or critically imperiled (S1 or S2) in Illinois, Iowa and Ohio. The Indiana and Kentucky populations are also imperiled (S2) through continued habitat loss and the threat from butterfly collectors. However, additional potential habitat remains to be surveyed in each of these states and the discovery of a few additional populations is possible. In Oklahoma, the swamp metalmark was recently recorded (Dole et al., 2004; Nelson, 2004) and is probably an S1S2, given the amount of potential habitat.

Conversely, the current Michigan S-rank seems overstated, based on the number of known occurrences and the extent of known and potential habitat. Several of the Michigan populations occur in fens complexes greater than 100 acres and others are protected as Nature Preserves. There are 85 known prairie fens in Michigan, totaling over 5,000 acres. The recent discovery of *Calephelis mutica* in northern Wisconsin suggests that the extensive peatlands of northern Michigan could also contain this species. Few (if any) of these have been surveyed for the swamp metalmark (Bess, 1988; Nielsen, 1999). Therefore, a rank of S2S3 seems much more appropriate. In Minnesota and Pennsylvania, the swamp metalmark is probably an S1S3 species, as potential habitat also exists that has not been adequately surveyed. However, it could conceivably be SH or SX.

Schweitzer states that there are "possibly around 100 occurrences for this species" in the U. S. Despite this, only 80 or so "populations" have been documented to date and many of these are no longer viable. Nearly all occurrences are isolated colonies, typically scattered along streamside wetlands that are being rapidly invaded by shrubs and young trees. The isolated nature of these populations on the landscape allows little chance for re-colonization should a localized extirpation occur. Brock and Kaufman (2003) indicate the species is disappearing and consider it a threatened species. Schweitzer concludes by stating that "aside from Missouri, the species would probably be ranked G2, but since Missouri is the core of the range, the global rank should be essentially the same as their state rank."

However, given the recent discovery of the swamp metalmark in northern Wisconsin, it may also occur in other northern wetlands that were previously thought unsuitable. Northern Michigan, Wisconsin and Minnesota have extensive areas of sedge meadow, rich to poor fen and related plant communities in which *Cirsium muticum* thrives. The New England States also have potential habitat for this species.

POPULATION BIOLOGY AND VIABILITY

The swamp metalmark occurs in a series of plant communities (or "ecological associations") that were once widespread across the Upper Midwest. It is a species of springy, streamside peatlands and hydric grasslands characterized by an open or absent canopy and a diverse, grass and sedge dominated herbaceous layer. The larval foodplants, *Cirsium* species, are fairly widespread across eastern North America (see Figure 2) and, prior to the westward expansion of Europeans in the 1800's, this butterfly was probably locally common wherever *Cirsium altissimum, C. carolinianum* or *C. muticum* occurred in central North American wetlands and hydric grasslands.

Most, if not all, of these habitats were historically fire-maintained (Auclair et al., 1973; Britton et al., 1980; Brown et al., 2000; Heinselmann, 1981; Garren, 1943; Kelsall, 1977; Lotspeich and Mueller, 1971; Rowe and Scotter, 1973; Slaughter et al., 1971; Thompson, 1959 TNC, 2000). In the southern and western parts of its range, the swamp metalmark's habitat often adjoined extensive prairies or barrens which were a continual source of fire (Anderson et al., 1999; Delcourt and Delcourt, 1997; Dorney and Dorney, 1984; Grimm, 1984; Henderson and Long, 1984; Higgins, 1986; Komarek, 1971, 1985; Lynch, 1941; Nuzzo, 1986; Tester, 1989, White, 1983). However, beaver activity and annual hydrologic cycles also play significant roles in creating and maintaining streamside fens and sedge meadows (Amon et al., 2002; Cahill, 1991; Little, 2004; NatureServe, 2004; TNC, 2002a-b; USDA Forest Service, 2004c).

In the past, as one area of streamside *Calephelis mutica* habitat was burned or flooded, or succeeded to shrubs and trees, additional habitat along the watercourse was made available for the butterfly. The thistle species on which the metalmark feeds tend to have broad tolerances with regards to light and moisture availability (Bess, pers. obs.). The swamp thistle, for example, will grow in open sedge meadows and fens, as well as along wooded seeps, the edges of bogs and in swamp forests or shrub swamps. This provides a variety of potential oviposition sites for female metalmarks and a diverse series of wetland plant communities would theoretically provide the greatest amount of metalmark habitat. Overwintering first-year *Cirsium* rosettes are succulent and well insulated against fire, possibly providing protection for any *Calephelis* larvae hiding under their leaves. Fire removes overlying duff and shrubs, reducing competition for light and, coupled with the increase in available nutrients from dissolved ash, stimulates the germination of *Cirsium* seeds and the growth of young plants (Bancroft, 1977; Bayley and Odum, 1976; Faulkner and de la Cruz, 1982; Knapp and Seastedt, 1986; Lotan et al., 1981; Peet et al., 1975; Smith and Kaedlec, 1985; Thor and Nichols, 1973; Tilman, 1987). Flooding (either from beaver or runoff) and subsequent draw down also exposes much new habitat for colonization by air-borne seeds such as those of *Cirsium muticum*.

The production of multiple adult broods in the southern parts of its range would likely facilitate colonization of new habitats. The swamp metalmark could disperse over a greater area (theoretically) than a similar species producing only a single brood of winged adults. Historically, these characteristics allowed the butterfly to expand its range over a fairly large region, especially given its size and weak flight.

POTENTIAL THREATS

PRESENT OR THREATENED RISKS TO HABITAT

Currently however, the amount of available swamp metalmark habitat has been greatly reduced through fire suppression, the draining and conversion of habitat to row crop agriculture, road construction and other human activities. Those fragments that do remain are highly isolated from one another on the landscape and the environmental forces that once created and regulated them are no longer functioning. This is leading to a precipitous loss of habitat in the very near future, unless action is taken to restore these natural systems.

In the northern parts of its range, vast areas of swamp metalmark habitat were ditched, drained and tilled for agricultural production. Many large peatlands were drained and then mined for their valuable peatmoss. Disturbed or degraded sites were often subsequently invaded by non-native plant species, which quickly excluded many native ones. Even early in the 20th century, researchers understood the dangers associated with destroying the nation's wetlands. Hanson (1939) warned that peatlands and other wetlands "should not be burned, drained, or altered in any way that hinders their ability to store water, mitigate floods, and maintain the water level in surrounding lands."

However, these warnings went largely unheeded, even after the passing of the Rivers and Harbors Acts of 1890 (superseded) and 1899 (33 U.S.C. 401, et seq.). Section 10 of the Act (33 U.S.C. 403) covered construction, excavation, or deposition of materials in, over, or under such waters, or any work which would affect the course, location, condition, or capacity of those waters. In 1972, amendments to the Federal Water Pollution Control Act added what is now commonly called "Section 404 Authority" (33 U.S.C. 1344) to the program. The act authorizes the Secretary of the Army, acting through the Chief of Engineers, to issue permits (after notice and opportunity for public hearings) for the discharge of dredged or fill material into waters of the United States. The Federal Water Pollution Control Act was further amended in 1977 and given the common name of "Clean Water Act" and was again amended in 1987 to modify criminal and civil penalty provisions and to add an administrative penalty provision.

Despite these protections for the Nation's wetlands, habitat suitable for *Calephelis mutica* has become fragmented as a result of past (and ongoing) degradation. Today, many populations of the butterfly are highly isolated from one another, separated by large expanses of degraded wetlands, plowed fields, roads, cities and other barriers to dispersal (see Hutchinson, 1996). These barriers to dispersal make swamp metalmark populations highly susceptible to extinction from localized catastrophic events. Additional potential threats to this species and its habitat are outlined below.

Fire Suppression

The suppression of wildfires has probably been among the more profound changes to the North American environment in the past 1,000 years (see Heinselman, 1981; Nuzzo, 1996). Fire is known to regulate vegetation structure, which has a reciprocal influence on fire frequency (Anderson and Owensby, 1920; Anderson and Brown, 1986; Anderson et al., 1999; Auclair, et al., 1973; Bancroft, 1977; Cohen et al., 1984; Daubenmire, 1968; Duever, et al., 1986; Forman, 1979; Glasser, 1985; Henderson and Long, 1984; Kozlowski and Ahlgrens, 1974; Schwaegman

and Anderson, 1984; Tester, 1989; Wade, et al., 1980; Weaver, 1954; Weaver and Fitzpatrick, 1934; Wells and Boyce, 1953; Wright and Bailey, 1982). Many formerly open, grass-dominated plant communities have quickly succeeded to shrublands and closed canopy forests in the absence of fire.

It has been well documented that many North American grass and sedge dominated plant communities burned with relative frequency in the past (Bayley and Odum, 1976; Bancroft, 1977; Cohen, 1974; Cohen, et al. 1984; Cypert, 1961; Duever, et al. 1986; Forman, 1979; Foster and Glaser, 1986; Garren, 1943; Glasser, 1985; Henderson and Long, 1984; Higgins, 1986; Komarek, 1971: Lotan, 1981; Loveless, 1959; Penfound, 1952; Schwegman and Anderson, 1984; Thompson, 1959; Wells, 1931, 1942). Many of the plants occurring in these communities are also “fire-dependent”, meaning they require periodic fire for their long-term survival (Anderson et al., 1970; Arend and Scholtz, 1969; Bayley and Odum 1976; Brown, et al., 2000; Daubenmire, 1968; Hulbert, 1969, 1981; Knapp and Seastadt, 1986; Peet et al., 1975; Thor and Nichols, 1973; Tilman, 1987; Wade, et al. 1980; Weaver, 1954; Weaver and Fitzpatrick, 1934; Whitford and Whitford, 1978; Wright and Bailey, 1982).

Like the grasslands with which they are often associated, North American peatlands were also fire-regulated in the past (Cohen, 1974; Heinselman, 1981; Kelsall, et al. 1977; Komarek, 1971; Rowe and Scotter, 1973; Slaughter, et al.1971; Vierick, 1973; Vierick and Schandelmeier, 1980; Wein, 1983; Wells and Boyce, 1953). The large peatlands, smaller bogs and swamps of the northern Lake States, Canada and Maine also support boreal vegetation but their fire regimes are different from areas with mineral soils (Anderson, 1982; Heinselman, 1981; Vierick and Schandelmeier, 1980). Acidic forested peatlands typically lack highly flammable grasses and sedges, instead having a wet, moss-dominated ground layer that will not readily carry spring ground fires (Foster, 1984; Heinselman, 1981).

In contrast, sedge and grass fens on mineral soils, even those with partial tree cover, burn best in spring before succulent vegetation develops (Heinselman, 1981). Thus, most fires in forested peatlands occur in July, August, or September of severe drought years, and most fires in sedge-grass fens occur in April, May, or early June. Heinselman (1981) also found evidence that the presettlement fire regime for large, spruce {*Picea* spp.) and sphagnum moss bogs in Minnesota was a cycle of cataclysmic crown fires roughly every 100-150 years. In contrast, his data suggested that the once vast grass-sedge fens of north-central and northwestern Minnesota burned at more frequent intervals, with periodic surface fires every 5-30 years. Heinselman further went on to state that the removal of fire from these ecosystems would be "among the greatest upsets in the environment that man could impose."

In degraded remnants of these habitat-types, prescribed burning relaxes competition from invading, non-fire adapted plants, allowing fire-adapted species to proliferate and expand into newly opened areas (Allan and Anderson, 1955; Anderson and Brown, 1986; Britton, et al., 1980; Daubenmire, 1968; Dorney and Dorney, 1989; Grimm, 1984; Henderson, 1982; Henderson and Long, 1984; Kozlowski and Ahlgren, 1974; Kline, 1984; Lotan, 1981; Miller, 1963; Schwartz and Heim, 1996; Schwegman and Anderson, 1984; Tester, 1989; Uhler, 1944; White, 1983; Wright and Bailey, 1982). Fire also reduces canopy cover of woody species and removes accumulated detritus (Gresham, C. A. 1985; Linde, 1969; Linduska, 1960; Miller, 1963;

Van Lear and Johnson, 1983; Witford and Whitford, 1978). This allows more sunlight to reach the soil surface, resulting in increased photosynthetic productivity in the herbaceous flora (Allan and Anderson, 1955; Auclair, et al. 1973; Cohen, 1974; Dorney and Dorney, 1981; Lorimer, 1985; Smith and Kadlec, 1985; Thor and Nichols, 1973; U.S. Fish and Wildlife Service, 1964). Burning also releases nutrients, although their availability is often limited temporally (Bancroft, 1977; Bayley and Odum, 1976; Faulkner and de la Cruz, 1982)

Severe fires during drought periods can also alter the physical characteristics of wetlands by burning deep into peat deposits and creating depressions, exposed mineral soil or areas of open water (Allan and Anderson. 1955; Bancroft, 1977; Cohen, 1974; Lynch, J. J. 1941; Miller, 1963; Wein and Maclean, 1983). Changes to the vegetative structure of wetlands can have profound effects on the local fauna. Frequent fires typically favor species that require grass, sedge and herb dominated vegetation as habitat for feeding, resting, mating, breeding or other activities. The reduction in woody cover and detritus accumulation further improves habitat for some species, while removing habitat for others. In the case of the swamp metalmark butterfly, fire can cause direct mortality of overwintering larvae, given their location in the detritus layer. However, on shaded sites and those with reduced sedge and grass cover, mortality is probably negligible. *Cirsium mutica* responds favorably to burn management and typically increases on sites following fire (Albert, 2004a). Therefore fire has been (and must continue to be) an essential part of habitat creation and maintenance for the swamp metalmark butterfly.

Grazing

Domesticated cattle and horses avoid thistles as forage and would not pose an immediate threat to the butterfly by consuming larval food sources, eggs, larvae and/or pupae. Often, thistles (particularly non-native species) are among the only vegetation left standing on heavily grazed pastures. However, trampling of eggs, larvae and pupae would be a real and potential threat from livestock. Sheep, swine and goats are often let loose into wetland "pastures" and will eat nearly all vegetable matter. In addition to removal of larval food sources, extensive livestock grazing reduces the cover of native grasses and forbs on which the adult swamp metalmark depends for resting places and nectar sources. Repeated heavy grazing degrades native plant communities, disturbs soil and can kill the original flora, providing germination sites for invasive weeds, shrubs and young trees (Tester and Marshall, 1962).

Well-managed, rotational, grazing would probably have only limited negative effects on this species. However, excessive stocking rates (which is often the norm) leads to the compaction and erosion of soils, destruction of foodplants and altering of plant community structure. Particularly in the Ohio Valley grasslands inhabited by the metalmark, the thin underlying soils are easily disturbed and overgrazing often leads to destruction of the vegetation and widespread erosion of topsoil. Swine, goats and sheep eat nearly all green matter. For example, in Perry County, Indiana, it is reported that all upland soils have been stripped of their original A and B soil horizons through severe erosion (Perry County Soil Survey). These factors have combined to make many sites formerly suitable for this species currently unfit as habitat.

Pasture Development

Intimately associated with grazing is the development and maintenance of sustainable pastures. In prehistoric times (and locally in our recent history) pastures have been developed, maintained and enhanced through the use of fire (Allan and Anderson, 1955; Anderson, 1996; Britton, et al., 1980; Anderson et al., 1979; Cohen, 1974; Heinselman, 1981; Henderson and Long, 1984; Komareck, 1971; Lynch, 1941; Miller, 1963; Nuzzo, 1986; Uhler, 1944; Sipple, 1978, 1979; USFWS, 1964; Wells, 1931, 1942). Fire removes the accumulated duff, kills seedlings and saplings of woody species and provides germination sites for the seeds of fire adapted grassland plants (see Anderson et al., 1970, 1984; Daubenmire, 1968; Dorney and Dorney, 1989; Glasser, 1985; Grimm, 1984; Henderson and Long, 1984; Knapp and Seastedt, 1986; Packard, 1988; Peet et al., 1975; Schwaegman and Anderson, 1984; Tester, 1989; Thor and Nichols, 1973; Tilman, 1987; White, 1983; Whitford and Whitford, 1978; Wright and Bailey, 1982). Prehistoric Native Americans were typically concerned with providing feeding grounds for game animals and the production of native plant crops (Anderson et al., 1999; Delcourt and Delcourt, 1997). European immigrants initially used fire to clear brush and enhance the growth of grasses and other plants that provided forage for their domesticated livestock. Unfortunately, excessive numbers of animals were often placed on grasslands with marginal amounts of available forage, leading to the destruction of the native vegetation and erosion of topsoil.

In the early 1800's, when America experienced its first great wave of westward expansion by Europeans, most formal training on the subject of pasturage was based in Europe. Therefore, nearly all American pasture development, enhancement or maintenance projects involved the seeding of cool-season, Eurasian grasses. Many overgrazed pastures were subsequently replanted with these grasses, further limiting and fragmenting the amount of available habitat for insects dependent on native wetlands and grasslands. This isolation of often small populations can lead to inbreeding and extinction (see Wilson and MacArthur, 1967). Species typically used in wet (or seasonally wet) pastures include smooth brome (*Bromus inermis*), fescue (*Festuca arundinacea* and *F. elatior*), orchardgrass (*Dactylis glomerata*), reed canary grass (*Phalaris arundinacea*) and/or bluegrasses (*Poa compressa* and *P. pratensis*). Clovers (*Medicago, Melilotus* and *Trifolium* spp.) are often placed in the grass mix to provide nitrogen fixation in the soil and fodder for livestock. These methods became indoctrinated into our system of land reclamation and persist to this day.

By producing large amounts of seed that germinate under cool temperatures, these grasses and clovers can quickly dominate areas of exposed soil and move into adjacent native habitats. They compete with native species for resources and can exclude many of them from sites where they were formerly common, especially following disturbance of the original vegetation. Farmers and ranchers typically spray herbicides to remove broadleaf species (such as thistles) from grass pastures. In addition, several introduced thistle species (none of which are fed upon by the swamp metalmark) are considered agricultural pests and their eradication is encouraged by government agencies. This leads to the indiscriminate spraying of all thistles. These factors eliminate potential habitat for the butterfly, particularly along fencerows, ditches and roadsides. Only in recent times (past 20 years) have native species been marketed as alternatives for use in erosion control, bank stabilization and pasture/range enhancement.

In addition, burning is also used to control annual weeds and insect pests in fencerows, ditches and pastures. On small, isolated sites, the use of fire can also be a factor in exterminating small populations of the swamp metalmark. Overwintering larvae are exposed in the surface litter and subject to mortality from immolation.

Competition from Introduced Species

In addition to the pasture species mentioned above, a number of other introduced plants threaten the quality and survival of swamp metalmark habitat (see McKnight, 1993; Miller, 2003; Swearingen, 2004). These include garlic mustard (*Alliaria petiolata*), Japanese honeysuckle (*Lonicera japonica*), bush honeysuckle (*Lonicera mackii* and *L. tartarica*), Japanese stilt grass (*Microstegium vimineum*), giant reed (*Phragmites australis*) and glossy buckthorn (*Rhamnus cathartica*). Native raspberries (particularly *Rubus alleghaniensis, R. occidentalis* and *R. pennsylvanicus*) can also be highly competitive, especially on fire-suppressed and previously grazed sites. Each of these will be dealt with separately in the following sections.

Garlic Mustard

Non-native garlic mustard is a severe threat to the long-term survival of many plant communities. This plant is highly adaptable and survives under a broad range of moisture, light and soil conditions (Anderson and Kelley, 1995; Anderson et al., 1996; Brunelle, 1996; Byers and Quinn, 1998; Cruden et al., 1996; Dhillion and Anderson, 1999; Nuzzo, 1993; Roberts and Bodrell, 1983). Garlic mustard overgrows native herbaceous plants, often excluding them from the flora (see Brothers and Springarn, 1992; Luken and Shea, 2000; Luken et al., 1997; McCarthy, 1997; Nuzzo, 1999). Although it is fond of disturbed situations, garlic mustard can invade relatively pristine plant communities, especially along paths, roadsides and utility rights-of-way (Brothers and Springarn, 1992; Brunell, 1996; Luken et al., 1997; Luken and Shea, 2000; Nuzzo, 1999). Typically referred to as an upland species, this plant can readily invade fens from adjacent uplands and spread rapidly across the top of *Carex stricta* tussocks (Bess, pers. obs.).

Japanese and Bush Honeysuckles

These non-native honeysuckles have long been used for landscape and wildlife plantings. Both produce large numbers of berries, which are readily eaten by birds and redistributed across our the countryside. They are now a common (often dominant) component of the understory in our woodlands and forests. Both *Lonicera japonica* and *L. mackii* can become so abundant as to exclude nearly all other flora from the ground and shrub layers. They are especially abundant in woodlands and barrens that have experienced a history of grazing that reduced the native vegetative cover. In particular, *L. japonica* has taken over much potential habitat for the swamp metalmark throughout the Ohio Valley and Ozark regions. All *Lonicera* species can be controlled with fire or manual cutting and herbicide application, although re-infestations are often inevitable (Luken et al., 1997; Luken and Shea, 2000).

Japanese Stilt Grass

Like garlic mustard, Japanese stilt grass poses a serious threat to habitat for *Calephelis mutica* throughout much of the southern portion of its range (Barden, 1987, 1991; Fairbrothers and Gray, 1972; Hunt and Zaremba, 1992; LaFleur, 1996). This fairly recent introduction moves into natural areas quickly along roadsides, paths and waterways. In the south, where many small streamlets dry up or cease flowing during the summer months, this grass can establish itself

quickly on newly exposed soil in the streambed. The species forms numerous clones over the growing season, each of which flowers in late summer. Once established, this grass typically forms a solid monoculture along roadsides and pathways. Rain events wash plants and seed down roadways and paths into drains and streams, quickly distributing fresh propagules over a large area. Japanese stilt grass is best controlled with a combination of mowing prior to seed set, with follow up mowing and herbicide application as needed (Barden, 1987, 1991).

Non-Native Buckthorns (*Rhamnus* species)
The threat, mode of dispersal and methods of control for this species are the same as the honeysuckles mentioned previously. However, *Rhamnus* species sprout vigorously from the root crown following removal of above ground parts. Manual cutting and application of herbicide to the cut stumps is the only reliable control method. Non-native buckthorn's are a particular threat to prairie fen communities and have completely taken over some sites.

Native Raspberries (*Rubus* species)
The threat, mode of dispersal and methods of control for this species are the same as the honeysuckles mentioned previously. Large clones and colonies of raspberry species often carpet fire-suppressed fens and sedge meadows. They typically shade out all herbaceous growth and facilitate the growth of shade tolerant shrubs and trees. Native raspberries can be removed fairly readily through repeated use of prescribed fire. However, on many fire-suppressed sites, a lack of sedges and grasses to act as fuel often limits the ability of fire to remove large raspberry colonies. A combination of cutting, herbicide application, seeding and prescribed fire may be needed to restore heavily infested sites.

Over utilization

The swamp metalmark's small size and secretive habits make it relatively difficult to collect on a large scale. However, metalmarks are colorful butterflies and the specie's rarity has made it a prize among collectors since its original description. In certain areas, i.e. the Ozarks of Missouri, this species can be locally common in high quality fen-barrens complexes. A review of the specimen data for the state (compiled by R. Heitzman and P. Koenig) shows that amateur butterfly collectors removed 284 specimens of the swamp metalmark from a single site between 1979 and 1994, and 65 of these were killed by a single collector in one day! The same collector removed another 48 specimens two months later and was responsible for a total of 191 specimens. This exceeds the number of known specimens from all other states combined, 1937 to present. All specimens appear to have been taken illegally on a State-Owned Nature Preserve, where butterfly collecting is expressly forbidden without a Scientific Collecting Permit (Timothy Vogt, 2005 MO State Parks, pers. comm.). The impact of this type of irresponsible collecting on the species' long-term survival is unknown, but cannot be considered beneficial. The pressure from collectors on this and other rare species will only increase as habitat losses continue and their rarity increases.

Disease or Predation

The use of *Bacillus thuringiensis kurstaki* (Btk) for control of the introduced gypsy moth (*Lymantria dispar*) has potential for negatively affecting populations of the swamp metalmark. Swamp metalmark larvae are present throughout much of the growing season. This makes them susceptible to drift of Btk onto *Cirsium* growing in areas adjacent to where gypsy moths are

present. Potential effects from the gypsy moth and its control efforts are dealt with in the following section.

Gypsy Moth Outbreaks and Control Efforts

Since its introduction into New England in the early 1800's, the Eurasian gypsy moth (*Lymantria dispar*) has posed a direct and indirect threat to native Lepidoptera, including the swamp metalmark. For many years, the gypsy moth had few predators or parasites in North America, and its populations soared to outbreak proportions throughout the Northeast. It then rapidly spread west and now inhabits much of the Upper Midwest (see Schweitzer 2004b for a review). The larvae feed primarily on oaks (*Quercus* spp.) and defoliated countless acres of oak and mixed hardwood forest, woodland and barrens. This includes sites that contain or are adjacent to swamp metalmark habitat.

Attempts to eradicate the gypsy moth in the mid 20th century involved the use of broad scale organophosphate insecticides such as DDT and Carbaryl. These spraying campaigns covered over 12 million acres in the northern and central Appalachians and affected a wide array of organisms, insects and non-insects alike (Schweitzer, 2004b). Chemicals such as DDT also accumulate in successive trophic levels as they pass through an ecosystem. Organisms at the top of food chains (such as insectivores) develop ever-increasing levels of toxins, causing death and/or reduced fecundity. Given the widespread, catastrophic effects of DDT and Carbaryl spraying, these pesticides have been banned in the United States.

In 1976, the growth inhibitor Diflurobenzuron (trade name Dimilin or Vigilante) was registered to control pest insects, while eliminating the indiscriminate poisoning of other organisms (see Schweitzer, 2004). Diflurobenzuron inhibits the formation of chitin, a protein that is the principal component of most arthropod exoskeletons. It only affects young insects, killing them when they go through their next moult ("skin shedding event"). Many fungi also contain chitin in their cell walls, and may also be affected (Dubey, 1995). Like the earlier pesticides, Dimilin kills insects (and most other Arthropods) indiscriminately across all orders (see Uniroyal, 1983).

The chemical also has a long-lasting residual effect by becoming bound to leaves (particularly conifers) and remaining active even after leaf fall (Martinat et al., 1987; Mutanen et al., 1988; Whimmer et al., 1993). Both aquatic leaf shredders and terrestrial detritivores that feed on these fallen leaves are highly susceptible to this chemical (Bradt and Williams, 1998). Widespread mortality has been documented in the field and laboratory, in both aquatic and terrestrial ecosystems (Bradt and Williams, 1990; Butler et al., 1997; Dubey, 1995; Hansen and Garten, 1982; Lih et al., 1995; Martinat et al., 1987, 1988a-b; 1993; McCasland et al., 1998; Mutanen, et al., 1988; Reardon, 1995; Swift et al., 1988).

Bacillus thuringiensis kurstaki (*Btk*) is a relatively new threat to the swamp metalmark, introduced in the fight to control Gypsy moth outbreaks in the early 1970's. *Btk* is a naturally occurring soil pathogen that is stated to affect only Lepidoptera larvae, causing high rates of mortality in exposed individuals across many families (Peacock et al., 1998). The bacterium attacks the lining of the gut wall, interrupting the uptake of nutrients by the affected caterpillar, causing starvation and death. *Btk* spraying for both gypsy moth and spruce budworm control is known to have long-lasting, deleterious effects on resident populations of non-target Lepidoptera

(Boettner et al., 2000; Butler et al., 1995, 1997; Cooper et al., 1990; Hall et al., 1990; Herms et al., 1997; Johnson, et al., 1995; Krieg and Langenbruch, 1981; Miller, 1990; Morris, 1969; Schweitzer, 2000, 2004b; Severns, 2002; Wagner, 1995; Wagner et al., 1996; Whaley, 1998).

Gypsy moth outbreaks tend to occur in oak-dominated forests, woodlands and barrens. The larvae of this moth also feed readily on a number of other species occurring in forests of which oaks are a component. Unfortunately for the metalmark, the gypsy moth currently occurs throughout the northern portion of its known range. Oak barrens, woodlands and forests also typically adjoin sedge meadows, fens and related plant communities. Therefore, the potential for co-occurrence is high. Should the gypsy moth begin moving south, there is also potential for coincidental occurrence of it and the swamp metalmark. Therefore, large scale spraying efforts within the range of the swamp metalmark will have deleterious effects on its long-term survival. Btk is currently the preferred control agent for outbreaks of the gypsy moth and in Wisconsin alone, more than 250,000 acres were sprayed in 2004 (see USDA, 2004a).

These control efforts not only indiscriminately kill countless insects, but also have long-lasting effects on the habitats that are sprayed. The loss of caterpillars from spraying is known to negatively affect fecundity and body weight in nesting birds, bats and small mammals (Bellocq et al., 1992; Cooper et al., 1990; Holmes, 1998; Sample, 1991; Sample et al., 1993a-b, 1996; Seidel and Whitmore, 1995; Whitmore et al., 1993a-b; Williams, 2000). This effect is typically carried over through at least a second year, mimicking the reduction in observed Lepidoptera larvae during the season of application. Given that gypsy moth larvae develop at the same time of year as the swamp metalmark, spraying of *Btk* or other pesticides in occupied habitat could certainly have a negative effect on the resident butterfly population.

Currently, a fungus (*Entomophaga maimaiga*) has been introduced in the war on gypsy moths (see Hajek, 1998; McManus et al., 1989; Reardon and Hajek, 1998). The fungus appears to be specific to butterfly and moth larvae, particularly the family Lymantriidae, which contains the gypsy moth (see Wallner, 1989). However, in laboratory bioassays of non-target insects, other larvae were found to be susceptible (Hajek et al., 1995, 1996, 2000). This is particularly true for those with a granular skin surface or coating of short, dense hairs, e.g. all Lymantriidae; the Noctuidae genus *Catocala*. The larvae of the swamp metalmark also fit this description and, although not tested for susceptibility, should be considered potentially sensitive to infections by the fungus. Another fairly specific control agent is the gypsy moth nuclear polyhedrosis virus (trade name Gypchek). This virus is also supposedly specific to Lymantriidae and particularly the gypsy moth (Reardon et al., 1995). A recent, non-lethal, control method is the use of pheromones (trade name Disparlure) to disrupt mating in the gypsy moth. This chemical is specific to the Lymantriidae and is not known to affect other Lepidoptera.

Peat Mining

Although this practice has diminished within the range of the swamp metalmark over the past 30 years, peat mining was among the chief forces in the destruction of the butterfly's habitat in the 19th and early 20th centuries (see Blatchley, 1907). Peat was mined for fuel and (later) for use in the nursery and gardening supply industry. Currently, most commerical grade peat comes from Canada. Peat mining destroyed the vegetation not only in the mined area, but in adjacent habitats as well. Typically a site was ditched and drained prior to mining, altering the regional

hydrology, further disturbing potential habitat for the butterfly and other species requiring sedge and forb dominated fen. As areas dried, shrubs and young trees took root, quickly shading out the herbaceous vegetation. Other areas downslope from these ditches often ponded with water, further destroying fen and sedge meadow vegetation. Ponded areas quickly converted to shrub swamp or emergent/submergent vegetation.

Residential Development

Residential Development can negatively affect habitat for *Calephelis mutica* in a variety of ways. The clearing of sites for houses and associated roadways eliminates habitat and divides what remains into highly isolated islands, separated by paved streets, parking lots, lawns and other habitats inhospitable to the butterfly. Lawn development and maintenance eliminates the native flora, and drift of herbicides and insecticides has a cumulative effect in deteriorating what remains in adjacent natural areas. Fertilizer and pesticide runoff can also contaminate adjacent natural areas, enter streams and rivers and can degrade local and regional water quality (Medina, 1990). In the Northeast and Upper Midwest, high-end and exclusive residential developments are often located in remnants of mature forests overlooking wetland areas. Ironically, wildlife viewing is one of the main selling points for these developments.

Inadequacy of Existing Regulatory Mechanisms

Recent political maneuvering in the Nation's Capitol has served to weaken the U. S. Army Corp. of Engineer's ability to enforce the Clean Water Act and left many "isolated" wetlands to certain doom. Now many states are left to decide their own wetland protection levels, with little continuity across state lines. Our wetland protection laws have stemmed the wanton destruction of wetlands, but much filling, ditching and draining continues today. The recent weakening of the regulatory capabilities of the U. S. Army Corp. will only serve to hasten the rate of attrition.

In addition, the current, species-based approach to federal laws regarding the protection of imperiled organisms does not currently afford legal protection to the swamp metalmark. This is despite the fact that its global rarity would make it a candidate for listing as a federally threatened species. A system for environmental protection and restoration based on the conservation of ecological associations or plant communities would be more appropriate for protecting many of the Nation's natural resources. Many organisms are endangered simply because their habitats are becoming increasingly fragmented and degraded by human activity. This is especially true for those requiring fens, wet-mesic prairie or southern barrens. Federally mandated efforts to restore our Nation's wetlands (some of which are underway), savannas and barrens would not only protect hundreds of species from impending peril, but also provide our human population with expanded opportunities for jobs, hunting, fishing, gathering of forest products, education, research, observation and enlightenment.

SUMMARY OF LAND OWNERSHIP & EXISTING HABITAT PROTECTION

The U. S. Forest Service owns occupied swamp metalmark habitat in Indiana, only. Additional U. S. landholdings with potential for suitable habitat occur in Arkansas, Illinois, Kentucky, Ohio, Oklahoma and Wisconsin. Additional state and privately managed lands (Wildlife Refuges, Nature Preserves, Conservation Areas, etc.) may also contain populations of this species. Overviews of known state-level protection for this species are given below.

Arkansas
Known populations are near the Ozark NF and the Buffalo National River and these properties may contain suitable habitat for the butterfly. Several State Parks, State Forests and other public landholdings occur within the range occupied by this butterfly and may also contain suitable habitat. At least one State Park contained a population of this specie sin the 1960's. However, this population was frequently visited by butterfly collectors, who removed an unknown number of specimens.

Illinois
Two historic populations are known from Illinois. The first known occurrence in the state was at the Bluff Springs Fen Nature Preserve in Cook County. This population was active until 1939 and then presumably went extinct. A re-introduction program (using females collected in Wisconsin) was undertaken in 2002 and appears to have been successful. A second population was supposedly discovered by a butterfly collector (in Vermillion County) within the past 20 years (R. Panzer, 2005 pers. comm.).

Indiana
The swamp metalmark is known in the state from two widely separated areas: Glaciated fens in the northeast corner, and unglaciated tallgrass prairie along the Ohio River. The northeastern populations are known primarily from Nature Preserves in a large fen complex in LaGrange and Steuben Counties. These populations are well known and (at least in the past) visited by butterfly collectors. Another population occurs on adjacent private lands. An odd, outlying population was known historically from Wabash County but has probably been extirpated. The southern populations occur in mesic barrens and tallgrass prairie along streams in the Hoosier National Forest. Both of the National Forest populations are protected but known to butterfly collectors.

Kentucky
Populations that are protected to some degree occur at Otter Creek Park in Meade County and Pennyrile Forest State Resort Park in Caldwell and Christian Counties. However, both are known to butterfly collectors. The Daniel Boone National Forest in east central Kentucky contains superficially suitable habitat for this species. Several Nature Preserves operated by the State and The Nature Conservancy contain potential habitat for this species, as do the Ft. Knox Military Reservation and Land between the Lakes National Recreation Area. Additional State Parks, State Forests and other public landholdings occur within the range of this skipper and may contain suitable habitat.

Michigan
Several populations occur on State-owned lands or Nature Preserves, however, all are known to butterfly collectors. The northern populations are near the Huron-Manistee National Forest and suitable habitat in these forests should be surveyed for this species. With the recent discovery of *Calephelis mutica* in a wetland in northern Wisconsin, there is also potential for this species to occur in the extensive peatlands of the Hiawatha and Ottawa National forests in Michigan's Upper Peninsula.

Minnesota
The single population was recorded from the extreme southeast corner of the state, either in or near the Beaver Creek Valley State Park.

Missouri
Several populations in the southern part of the state are within the boundary of the Mark Twain National Forest. Others occur on State-owned and protected Nature Preserves. However, all of these are known to butterfly collectors and several have experienced heavy collecting pressure in the past. Some may no longer be viable. Additional public landholdings (e.g. Ozark National Scenic Waterways and State/private Parks and Nature Preserves) may also contain potential habitat for this species.

Ohio
The only known populations occur in fens in the northwest corner of the state. Additional potential habitat may occur in the Wayne National Forest, East Fork State Park and other State and TNC land holdings.

Oklahoma
A single population is reported from the northeast corner of the state, however ownership is unknown.

Pennsylvania
The only known record is a vague "near Pittsburgh", which places it near the Allegheny National Forest. Potential habitat should be checked for the metalmark during both larval and adult broods.

Wisconsin
The swamp metalmark was recently found to occur in Marquette Co., which places it near the Chequamegon-Nicolet National Forest. Suitable habitat in the National Forest should be surveyed for this species. Additional suitable habitat occurs on State and privately owned Nature Preserves, Conservation Areas and other protected lands.

SUMMARY OF EXISTING MANAGEMENT ACTIVITIES

Little or no management is currently being directed at the swamp metalmark's habitat based solely on the species' presence or absence. However, the butterfly's preferred habitats happen to be globally imperiled plant communities; southern tallgrass prairie/barrens and prairie fen. Therefore, *Calephelis mutica* habitat has received some management, given ongoing efforts to protect and restore the Nation's remaining prairies and oak barrens.

In most areas management has taken the form of prescribed fire. Both the Boone Creek and Clover Lick barrens sites in Indiana have undergone prescribed fire management. The efforts at Clover Lick appear to have created a substantial amount of habitat for this species and it was found scattered throughout roughly 100 acres of the 1,300 acre site. Given that *Cirsium* remains at least partially green throughout the dormant season, it is probably not completely consumed by the average fire. Larvae hibernating in the basal rosette of leaves might be protected from fire

in some cases, allowing for rapid colonization of recently restored habitat. However, this species should be considered fire-sensitive, although it is likely that at least some *Cirsium* and hibernating larvae escape fire in a given burn. Efforts to manually remove exotic invasive plants (as mentioned in previous sections) have also benefited this species, by reducing competition with its larval food plant and adult nectar sources.

PAST AND CURRENT CONSERVATION ACTIVITIES

The swamp metalmark has always been reported as rare and local, though not usually from a conservation standpoint. Only recently have researchers begun to suggest that the species is indeed imperiled and that efforts should be undertaken to identify known and active populations, and begin to assess their health and needs for continued survival. Currently, the swamp metalmark is considered critically imperiled (S1) in several states. It is considered imperiled (S2) in Arkansas, Kentucky and South Carolina and vulnerable (S3) in Georgia and Mississippi. All other states have it listed as secure or unranked.

Midwest Prairie Fens or Rich Fens

Prairie fens are found across the upper Midwestern United States and adjacent Canada. Over 200 occurrences totaling over 5, 000 acres have been documented, 85 in Michigan alone (Albert, 2004; Albert and Penskar, pers. comm.; NatureServe, 2004). At least 100 National occurrences are know to be of A or B rank, and many of these have protected status focused on their maintenance. However, many of these fens are small and have been negatively affected by hydrological alterations, fire suppression, nutrient inputs from adjacent agricultural land use and/or have been invaded by exotic plants. The state of Wisconsin is also blessed with numerous fens and has developed a "Protocol for Incidental Take Authorization" for the swamp metalmark butterfly. This is a procedural guidance document for state and industry representatives to use in determining whether activities under their supervision have potential to impact this endangered species.

In 2004, the Toledo Zoo (Toledo, Ohio) received grant monies from the "National Institute of Museum and Library Services" to initiate programs to protect and enhance populations of three endangered butterfly species, including the swamp metalmark. The Zoo received $55,759.00 in Conservation Project Support to undertake "Research in Conservation" (IMLS, 2004). This grant included $46,152.00 to study the "Development of Conservation Husbandry and Breeding Strategies" for three endangered, fen-obligate butterfly species, including the Mitchell's satyr (*Neonympha mitchelli*), purplish copper (*Lycaena helloides*), and swamp metalmark, (*Calephelis muticum*). An additional $9,607.00 were allocated to create a curriculum on the conservation of these species and work with state organizations to create a DVD for the public. The Zoo provided an Applicant Match of $98,754.00, providing a total grant of $154,513.00.

Ohio Valley Prairies

This vegetation type has been vastly reduced in extent, and today may only consist of roadside remnants. This would make the southern Indiana and northern Kentucky examples of global significance. In Kentucky, The Nature Conservancy, Kentucky Department of Fish and Wildlife Resources and the Kentucky Natural Heritage Commission are currently protecting and managing several remnants of these community types. However, insect surveys have not been

conducted on several of these and those that have been surveyed have not been revisited in nearly 10 years.

RESEARCH AND MONITORING

Currently, little research is being conducted regarding the swamp metalmark (see IMLS, 2004). The larval food plants are attractive species and highly valuable for butterfly and hummingbird gardens. They also produce seeds that are food for a variety of songbirds, particularly goldfinches. The swamp metalmark and its preferred habitats are also visually attractive, features which would make them excellent candidates for raising public awareness of (and funding for) fen and wet-mesic prairie restoration. The City of Chicago has attempted a re-introduction of this species at one of their prairie fen Nature Preserves that was formerly occupied by the butterfly. This project involved collecting females in Wisconsin, having them lay eggs in captivity, and then raising the larvae to a stage where they could be released in the wild. Initial evidence suggests that this re-introduction worked and might prove itself as a means of restoring populations of the swamp metalmark.

EXISTING SURVEYS, MONITORING, AND RESEARCH

Many of the historic records for this species have not been visited in over 20 years, some in nearly 100. Verification of all historic occurrences, either extant or extirpated, and an accompanying population estimate should be an early priority for research on this species. At the present time, little to no monitoring or survey work is being focused on this species, despite its relative rarity. However, recent surveys for rare insects on the Hoosier National Forest uncovered one of the two known Indiana populations of *Calephelis mutica* (Bess, 2004). The Nature Conservancy may be also be surveying for and/or monitoring this species in some states where it occurs (e.g. Michigan and Oklahoma).

SURVEY PROTOCOL

Surveys for the swamp metalmark should initially be focused on known populations of the native thistles on which it feeds. As a rule of thumb, northern surveys should focus on wetlands with large populations of *Cirsium muticum*, while southern surveys (southern IN, MO and south) should target high quality fen, wet-mesic prairie and barrens with either of the three known food plants. Timing of surveys should occur when the adults are present, as these are the easiest to capture and have identified. Larvae may also be searched for on the *Cirsium* plants and are fairly distinctive. Photographs of suspected adults and larvae should be taken and kept with precise information regarding location, date and time. Given the extreme difficulty in identifying this species, a specimen from any new locality should be collected as a voucher. In an emergency situation, collected adults can be pinched firmly on the thorax and placed in a glassine envelope or similar protective sleeve. If a killing jar is at your disposal, this may be used instead. Adults can also be placed live into glassine envelopes and frozen, but this is best left to professionals. Collected adults should be either kept in a glassine envelope or pinned and affixed with a label bearing the following information:

1. State, County or Parish, Town, Range, Section and quarter section (or nearest reference point) of origin;
2. Date of Collection
3. Name of Collector
4. Type of habitat and any associated plants

MONITORING PROTOCOL

To conduct long-term monitoring programs, a permanent monitoring transect will need to be developed (see Pollard, 1977). Monitoring programs will naturally vary from site to site and depend greatly on the amount of resources available to conduct such programs. At a minimum, a long-term monitoring program for *Calephelis mutica* should involve the designation of at least one permanent, butterfly monitoring transect per occupied site. Monitoring transects should pass through all representative habitats at a site, with emphasis placed on areas with *Cirsium altissimum, C. caorlinianum* or *C. muticum*. Canopy closure should vary along the transect as much as is representative of the site being surveyed, from open to closed.

The monitoring transect should be of a length that can be covered by one or two observers in one to two hours, while walking at a moderate pace. All swamp metalmark butterflies observed within 30 feet of the transect line should be counted and their sex and flight condition (freshly emerged, slightly worn, badly worn) noted. Information on behavior should also be recorded, such as nectaring, ovipositing, mating, resting, etc. Standardized survey forms can easily be developed and a sample is attached as Figure 3. At a minimum; transect name, location, date, time, temperature and cloud cover should be noted on each survey form. Information on plant phenology, species in bloom, canopy cover, invasive species, predation, etc. is also useful. Surveys should be conducted every day with suitable weather conditions for the duration of the flight period. These surveys provide a wealth of data for use in tracking long-term trends in population size, phenology, distribution and resource utilization.

RESEARCH PRIORITIES

Further research is needed regarding the exact habitat requirements of the swamp metalmark, such as:

1. Optimal canopy cover,
2. Minimum patch size,
3. Percent cover and frequency of thistles necessary for long-term survival,
4. Optimal density of associated vegetation (especially adult nectar sources),
5. Fire effects and optimal fire regime,
6. Effects of invasive plants (and efforts to control them) on swamp thistle, nectar sources and the skipper, and
7. Effects of silvicultural activities such as pine plantations, pesticide application, harvesting, etc,

Additional Areas of Potential Swamp Metalmark Research

Additional areas of research center on developing optimal habitat restoration procedures for prairie fens and wet-mesic tallgrass prairies and re-introduction methodology for the butterfly. It

is also quite probable that there are undetected populations of this species in the central United States. Regional and state level efforts are needed to survey for this and many other rare insect species.

Other Rare Species Associated with the Swamp Metalmark

The swamp metalmark butterfly shares its habitat with a number of rare species, particularly insects (Bess, 1988, 1997, 2000). In its northern fen habitats, this species occurs with the federally endangered Mitchell's satyr butterfly (*Neonympha mitchellii*: G2). Other globally or regionally rare butterflies include the Powesheik skipper (*Oarisma powesheik*: G2), mustard white butterfly (*Pieris oleracea*: G4), mulberrywing skipper (*Poanes massasoit*: G4), regal fritillary (*Speyeria idalia*: G2G3), Dion skipper (*Euphyes dion*: G3G4), broadwing skipper (*Poanes viator*: G3G4), two spotted skipper (*Euphyes bimacula*: G3G4).

The moth family Noctuidae is the most highly derived of the order Lepidoptera and one of the largest and most diverse groups of organisms on earth, with well over 38, 000 species worldwide (Poole, 1988). These moths have expanded into every imaginable niche and many have developed highly elaborate behaviors and very specific microhabitat and food plant requirements. Therefore, it should come as no surprise that this group is especially important in fens. Numerous boreal species reach the southern limits of their distribution in the fens of the northern United States. These include *Amathes opacifrons, Anomogyna dilucida, A. youngii, Chortodes enervata, Chortodes inquinata, Chrysaspidea* (=*Plusia*) *venusta, Hemipachnobia monochromatea, L. multilinea, Metalepsis fishii, M. salicarum, Papaipema appassionata, Polia atlantica, Sideridis congermana, Spartiniphaga includens, S. panatela* and *Xylena nupera*.

More southern wetland and prairie associated species are also found in fens, including *Amolita roseola, Leucania linita, Luperina stipata, Machrochilo louisiana, Oligia obtusa, Papaipema beeriana, P. cerina, P. lysimachiae, P. sciata, P. silphii, P. speciosissima, Pyrausta laticlavia, P. tyralis,* and *Spartiniphaga inops*. Many of these species have not yet been assigned G-Ranks. Additional rare fen-associated insects include the tamarack locust (*Melanoplus punctulatus*: G3), tamarack tree cricket (*Oecanthus laricis*: G2G3), Huron leafhopper (*Flexamia huroni*: G1); toothpick grasshopper (*Pseudopomala brachyptera*: G5), striped sedge locust (*Stethophyma lineata*: G5) and the graceful sedge locust (*Stethophyma gracile*: G5). Despite often having high G-Ranks, many of these species are listed as S1 or S2 species in every state in which they occur (see NatureServe).

In the barrens of southern Indiana and central Kentucky, most of the insects associated with *Calephelis mutica* have only recently begun to receive attention (Bess, 2004). While Blatchley (1920) documented the grasshoppers in the early 1900's and a few people have gathered information on butterfly occurrences (e.g. Masters and Master, 1969), other insects have remained largely ignored. Recently, however, surveys on the barrens of southern Indiana and Kentucky have identified a very rich assortment of imperiled insect species, many of which are more typical of habitats in the Great Plains and southern prairies (Bess, 1990; 1996; 2000).

The rarer species include the globally imperiled Bell's roadside skipper (*Amblyscirtes belli*) and rattlesnake master borer moth (*Papaipema eryngii*), as well as the dusted skipper (*Atrytonopsis hianna*), golden banded skipper (*Autochton cellus*), arrowhead spiketail dragonfly

(*Cordulegaster obliquus*), unexpected milkweed moth (*Cycnia inopinatus*), Kansas flathead leafhopper (*Dorydiella kansana*), eastern rhinocerus beetle (*Dynastes tityus*), golden-winged damselfly (*Lestes eurinus*), extinct grass moth (*Leucania extincta*), calliope cicada (*Melampsalta calliope*), Nebraska conehead katydid (*Neoconocephalus nebrascensis*), the robust marsh conehead katydid *(N. robustus*), Kansas prairie leafhopper (*Prairiana kansana*), the scurfypea jaguar moth (*Schinia jaguarina*), the German cousin (*Sideridis congermana*) and the downy sunflower moth (*Tricholita notata*).

Little (if any) inventory or research work has been undertaken on any of the above-mentioned species, particularly with regards to their overall distribution, current viability and basic habitat requirements. Many face the same threats to their prolonged existence as the swamp metalmark, although each will have its own set of needs and responses to various environmental changes, including restoration activities.

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APPENDIX

LIST OF CONTACTS

INFORMATION REQUESTS

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REVIEW REQUESTS

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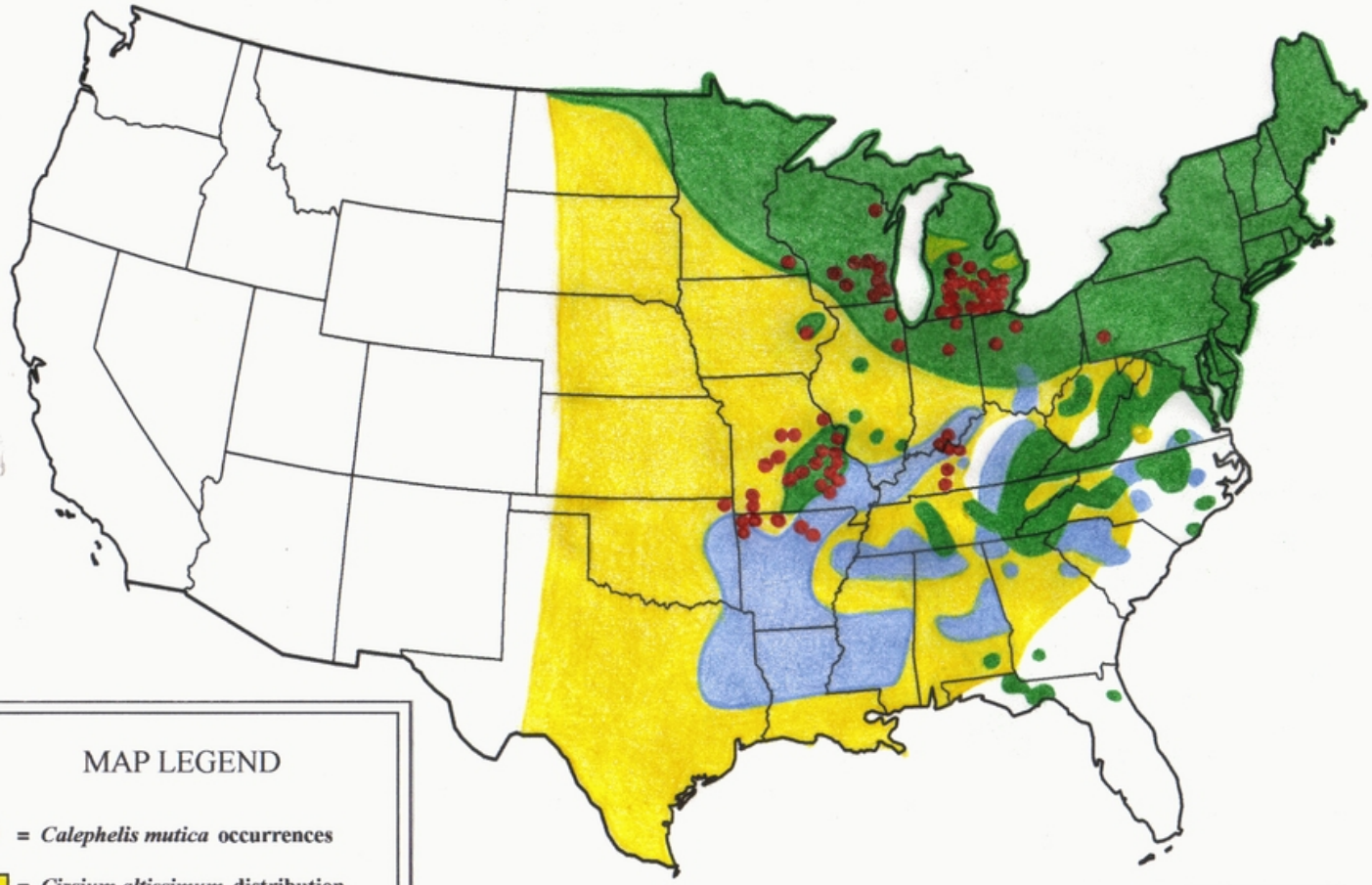
FIGURES

Figure 1. The Swamp Metalmark (*Calephelis mutica*), June 6, 2003: Cloverlick Barrens Special Area, Hoosier National Forest, Perry County, Indiana.



MAP LEGEND

= *Calephelis mutica* occurrences

= *Cirsium altissimum* distribution

= *Cirsium carolinianum* distribution

= *Cirsium muticum* distribution

Figure 2. Known Distribution of the Swamp Metalmark (*Calephelis mutica*) and its Foodplants in the Eastern United States.

Figure 3. Sample Field Form for Conducting *Calephelis mutica* Surveys.

Transect:
Date:
Observer(s):
Survey Number:
Page of

Begin Time:
End Time:
Temperature:
Wind:
Cloud Cover:

Species	Time	Number Observed	Sex	Condition	Behavior	Plant Associations