



Biotic Inventory and Analysis of the Kettle Moraine State Forest

A Baseline Inventory and Analysis of Natural Communities, Rare Plants, and Animals

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Natural Heritage Inventory Program
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Executive Summary

Project Purpose and Objectives

The report is the result of a multi-year project to inventory and analyze selected biotic resources of the Kettle Moraine State Forest (KMSF) and the surrounding landscape. This project was undertaken by the Natural Heritage Inventory (NHI) section of the Wisconsin Department of Natural Resources' (WDNR) Bureau of Endangered Resources in cooperation with the Division of Forestry and Bureau of Parks and Recreation. Project goals were to provide baseline information on the rare species, high-quality natural communities, significant aquatic features, and ecology of the study area for use in developing new property Master Plans for six units of the Kettle Moraine State Forest and conserving biological diversity. The study area (Figure 1) for this project included the following units of the KMSF:

- Lapham Peak
- Loew Lake
- Mukwonago River
- Northern
- Paradise Valley
- Southern

Description of the Study Area

Located in southeastern Wisconsin, the KMSF occurs in Walworth, Jefferson, Waukesha, Washington, Fond du Lac, and Sheboygan counties and comprises about 59,000 acres (land under DNR management). The KMSF is located within the Southeast Glacial Plains Ecological Landscape (Figure 2), an area characterized by glacial till plains and outwash landforms, as well as rolling, ground, and interlobate moraines. Although they are all located within the same Ecological Landscape, the units vary greatly in terms of their ecology, original vegetation, resource use, and the management opportunities and challenges they present.

Northern and Loew Lake Units

The Northern Unit of the KMSF and part of the Loew Lake Unit are located along the tension zone (Figure 4), a zone that separates two floristic provinces, the prairie-forest and the northern hardwoods (Curtis 1959). Historic forest vegetation (Finley 1976) for this area was primarily upland hardwood forests. The most common type consisted of sugar maple, basswood, northern red oak, white oak, and black oak (Figure 4). The second most common type was an oak-dominated forest with white, black, and bur oak.

Current vegetation for this area is dominated by upland forests consisting of northern red oak and sugar maple, with Ephemeral Ponds as ecologically important inclusions. Forested, shrub-dominated, and open wetlands, Spring Ponds, Spring Runs, headwater streams, and rivers provide important habitat diversity. Pine, not present during the original land surveys, is now common, almost exclusively in plantations.

Southern, Mukwonago River, Lapham Peak, and Paradise Valley Units

Historic vegetation (Finley 1976) for the Southern, Mukwonago River, Lapham Peak, and Paradise Valley units of the KMSF was primarily oak-dominated forest with white, black, northern red, and bur oaks (Figure 4). The second most common type was more open and dominated by bur, white, and black oaks.

Much of the historic Oak Opening and Oak Woodland in this area have succeeded to dense hardwood forests due to fire suppression. Oaks continue to be an important tree species in this area and are found in closed-canopy Southern Dry-mesic Forests and restored Oak Openings and Oak Woodlands. Pine, not noted at all during the original land surveys, is common and almost exclusively in plantations. This area has some of the largest and highest quality Wet-mesic Prairies and Calcareous Fens in the state. Spring Ponds, Spring Runs, and headwater streams provide important habitat diversity.

Exceptional Characteristics of the Study Area

The following are ecologically important characteristics and management opportunities for the KMSF units that contribute to the area's biodiversity. These results from the biotic inventory and other surveys are not listed in order of importance or priority. The units listed below have the greatest opportunity to support high-quality habitat for a large number of rare and declining species and due to their large size, can reduce impacts from habitat fragmentation and ecological simplification. The units not mentioned are also biologically important because of their habitat for some rare and declining species and the opportunities for restoration of small natural communities and migration corridors.

Northern Unit

Landscape-scale Management Opportunities. The Northern Unit, along with the Southern Unit, is the largest area of public land in southeastern Wisconsin and offers a regionally rare opportunity to manage ecosystems at a landscape (rather than a stand) scale. The forests and wetlands of the Northern Unit provide habitat to many species that travel between these habitats and benefit from management that maintains habitat connections. Other opportunities for landscape-scale management on the Northern Unit include large blocks of older forests with inclusions of Ephemeral Ponds.

Old-growth Management Opportunities. The Northern Unit offers exceptional opportunities to manage for older forests and old-growth forests in a landscape dominated by agriculture. WDNR Forest Reconnaissance data for the Northern Unit indicate that 50% of the oak forests, the dominant forest cover type, are over 100 years old. This results in significant opportunities to promote forest stands that are at least 200 years old and develop structural characteristics required for species that use old-growth forests.

East Branch Milwaukee River. The East Branch Milwaukee River, with over 90% of its length contained within the Northern Unit, is a unique opportunity for long-term protection of a forested watershed within a largely agricultural landscape. It is an important tributary to the Milwaukee River and provides habitat for diverse fish, mussel, and beetle communities.

High-quality Forest Interior Bird Habitat. An impressive assemblage of rare forest interior breeding birds is present in the Northern Unit. These area-sensitive species are utilizing the minimally fragmented, contiguous, and older forests present. Many of these species have had significant population declines in Wisconsin and throughout their range, making the Northern Unit forests critical habitat for birds.

Migratory Bird Stopover Habitat. Portions of the Northern Unit support habitat for greater than 10,000 individual migrating landbirds (Grveles and Matteson 2008). Large blocks of forest with good structural complexity that are near water in a landscape dominated by agriculture and urban development are important resting and refueling sites for exhausted birds traversing across mainly in-hospitable terrain.

Ephemeral Ponds. The geological history of the Northern Unit has resulted in many Ephemeral Ponds. These areas are critical breeding habitat for certain invertebrates, as well as many amphibians such as wood frogs and salamanders. They also provide feeding, resting, and breeding habitat for birds, other listed species, and a source of food for many mammals.

Southern Unit

Landscape-scale Management Opportunities of fire-dependent natural communities. The Southern Unit is one of only a few locations in the state where it is possible to protect, manage, and restore the full

continuum of fire dependent natural communities at a large scale. This large area of state ownership in a region dominated by private land is important for the management necessary to maintain critical habitat connections between fire-dependent communities and the species that depend on them.

Globally Rare Natural Communities. The Southern Unit has a high-concentration of globally rare natural communities. Oak Openings, Mesic and Wet-mesic Prairies, and Calcareous Fens are all represented by high-quality examples and this unit offers some of the best opportunities in the Midwest to preserve and restore them at a large scale.

Significant Populations of Rare Species. The Southern Unit offers exceptional opportunities to protect habitat for numerous rare species. Many rare species are found in the high-quality oak savannas, Dry Prairies, Wet-mesic Prairies, Calcareous Fens, and shallow lakes.

Large Wetlands. The Southern Unit of the KMSF provides landscape-scale opportunities to manage Southern Sedge Meadows, Calcareous Fens, and Wet Prairies in a mosaic of open grasslands, shrublands, and Southern Tamarack Swamps. These open wetlands provide, or have the potential to provide, habitat for numerous rare species including grassland birds, small mammals, invertebrates, and a diverse mix of plant species. These open wetland complexes are largely associated with surrounding oak savanna allowing for similar management regimes.

Grassland Bird Habitat. Grassland bird populations have declined more dramatically than any other group of birds in North America and the Midwest (Askins et al. 2007; Sample and Mossman 1997). The Southern Unit supports critical habitat for grassland birds, with well over 4,000 acres of open habitat. This grassland acreage is made up of a highly diverse mix of remnant Dry-mesic and Wet-mesic Prairie, Surrogate Grassland, Southern Sedge Meadow, upland shrub, and Oak Opening.

Old-growth Management Opportunities. The Southern Unit offers opportunities to manage for older forests at a landscape-scale, in combination with management for oak savannas, Oak Woodland, and grasslands. WDNR Forest Reconnaissance data for the Southern Unit indicate that 77% of the oak forests, the dominant forest cover type, are over 100 years old. This results in significant opportunities to promote forest stands that are at least 200 years old and develop structural characteristics required for species that use old-growth forests.

Summary of Biotic Inventory Results

Rare Vascular Plants

Forty-five rare plant species have been documented on the KMSF, including four State Endangered species, thirteen State Threatened species, and 28 state Special Concern species. Although many rare plants are present on the KMSF certain habitats and species are significant.

The **Northern Unit**, supports high-quality Southern Tamarack Swamp and the matrix of wetland communities that occur with it that provide significant habitat for bog bluegrass (*Poa paludigena*), cuckooflower (*Cardamine pratensis*), and northern yellow lady's-slipper (*Cypripedium parviflorum* var. *masakin*). Other significant plant populations include yellow gentian (*Gentiana alba*; also known as cream gentian) and American gromwell (*Lithospermum latifolium*).

The **Southern Unit** supports oak savannas and Dry Prairies that have known populations of kitten tails (*Besseyia bullii*), forked aster (*Aster furcatus*), roundfruit St. John's-wort (*Hypericum sphaerocarpon*), autumn coral-root (*Corallorhiza odontorhiza*), white camas (*Zigadenus elegans* var. *glaucus*), and yellow gentian (*Gentiana alba*). Wet-mesic Prairies and Calcareous Fens support important populations of earleaf foxglove (*Tomanthera auriculata*), eastern prairie fringed orchid (*Platanthera leucophaea*), and over a dozen additional rare plant species, many of which likely reach their highest abundance on the KMSF.

Rare Animals

Seventy-four rare animal species have been documented on the KMSF, including 12 State Endangered and 15 State Threatened species (Table 2). Forty-seven state Special Concern animals are also known from the KMSF. This large number of rare animals from numerous taxonomic groups reflects the overall diversity of good-quality habitats that are present throughout the five units of the KMSF. Over 40% of the animals on the State Threatened and Endangered Species lists are found on the KMSF, including globally rare species.

Numerous Species of Greatest Conservation Concern (SGCN) from the Wisconsin Wildlife Action Plan (WDNR 2006b) are known or predicted from the Southeast Glacial Plains, including 7 mammal, 57 bird, 9 herptile, and 14 fish species (Appendix E). Many of these species have already been recorded on the KMSF; others have the potential to occur there and are known to use natural communities representing *Ecological Priorities* in the landscape (WDNR 2006b).

Natural Communities

Thirty-one high-quality natural community types have been documented on the KMSF, some of which are critically imperiled or globally rare.

- The **Northern Unit** has high-quality examples of Southern Mesic Forest, Southern Dry-mesic Forest, and Southern Tamarack Swamp.
- The **Southern Unit** has high-quality examples of Oak Openings, Mesic and Wet-mesic Prairies, and Calcareous Fens.

Threats to Natural Communities, Aquatic Systems, and Rare Species

Threats to the biodiversity of the KMSF include ecological simplification, forest fragmentation, altered ecological processes, invasive species, and high white-tailed deer densities. Some of these threats are currently more important to one unit rather than another. All of these threats, though, should be considered for each unit and limiting, avoiding, or reversing these threats will play a key role in conserving and enhancing biological diversity.

Primary Sites: Significance and Summaries

Primary Sites on the KMSF were identified because they contain relatively undisturbed and high-quality natural communities, provide important habitat for rare species, offer the property's best opportunities for restoration, could provide important ecological connections, or some combination of these factors.

Thirty-three Primary Sites were identified on the KMSF. The location of each site is illustrated on Figures 11 – 13.

Priority Opportunities for Biodiversity Conservation and Protection, Restoration, and Management Opportunities and Needs

Northern Unit

- Protect and manage **migratory bird stopover habitat**, which on the Northern Unit includes large blocks of forests that have good structural complexity and are near water where aquatic insects are emerging.

- Important primary sites for migratory bird stopover habitat includes: Crooked, Little Mud, and Kellings Lakes, Kewaskum Maple-Oak Woods, and Milwaukee River Floodplain Forest and Upland Forest.
- Maintain and develop **older forests and old-growth forests** that provide habitat for many rare and declining species in the state.
 - Primary sites with opportunities to manage for older forests and old-growth include Kettle Moraine Red Oaks and Haskell Noyes Woods SNA.
- Delineate **High Conservation Values Forests (HCVF)** (Forest Stewardship Council 2009).
 - The best opportunities for HCVF are the Primary Sites and high quality natural communities and rare species habitat outside of the Primary Sites.
- Promote landscape level management of, and reduce impacts, to **Ephemeral Ponds**.
 - Opportunities to protect forested Ephemeral Ponds and the species that depend on them are present at the following primary sites: Johnson Hill Kame, Wetlands, and Woods; Butler Lake, Flynn’s Spring, and Parnell Esker; Crooked, Little Mud, and Kellings Lakes; and Kettle Hole Woods.
- Manage and protect **wetlands** within a mosaic of older forests and good-quality aquatic communities.
 - Primary sites that offer opportunities to protect and manage wetlands with important landscape context include the Red Oak Habitat Preservation Area primary site and Crooked, Little Mud, and Kellings Lakes primary site.
- Maintain the quality and enhance the protection level of the **East Branch Milwaukee River**, a unique opportunity for long-term protection of a forested watershed that supports rare aquatic species.
 - Promote habitat for **rare plants**, especially the State Threatened **bog bluegrass** and **woodland bluegrass**, a state Special Concern species.
- Maintain and enhance habitat for **forest interior birds**, including several State Threatened and Endangered species.
 - Primary sites that provide excellent habitat for, and likely support source populations of forest interior birds are Kettle Moraine Red Oaks; Red Oak Habitat Preservation Area; and Johnson Hill Kame, Wetlands, and Woods.

Southern Unit

- The Southern Unit is one of only a few locations in the state where it is possible to protect, manage, and restore the full continuum of **fire dependent natural communities** at a large scale.
 - Important primary sites for the protection and management of ecological connections include the Palmyra Oak Woodland primary site, that, along with the adjacent Eagle Oak Openings and Prairie primary site offers an opportunity for landscape-level planning and ecological restoration to fit the needs of species using both closed-canopy forests and more open savanna types.
- Maintain **older forests** that provide habitat for many rare and declining species in the state, including birds, bats, & herptiles.
 - The Whitewater Moraine Woods primary site offers opportunities to manage for older forests and old-growth in a way that is compatible with savanna restoration elsewhere on the unit.

- Delineate **High Conservation Values Forests (HCVF)** (Forest Stewardship Council 2009).
 - The best opportunities for HCVF are the Primary Sites and high quality natural communities and rare species habitat outside of the Primary Sites.
- Manage and protect **wetlands and shallow lakes** within a mosaic of native grasslands and good-quality aquatic communities.
 - Primary sites within the Scuppernong Habitat Preservation Area, including Scuppernong Springs and Fens, Kettle Moraine Low Prairie SNA, and Scuppernong Prairie and Wetlands offer an exceptional opportunity to restore rare wetland natural communities with important landscape context.
- Manage and protect **prairies, Oak Openings, and Oak Woodlands**, increase connectivity between remnant sites, and improve habitat for many grassland, savanna, and woodland plant and animal specialists.
 - Primary sites that provide opportunities include Eagle Oak Openings and Prairie, that, along with the adjacent Palmyra Oak Woodland primary site, offers an opportunity for landscape-level planning of natural community complexes of prairies, Oak Openings, and Oak Woodland; the Kettle Moraine Oak Opening primary site, likely containing one of the best Oak Openings in the Kettle Moraine region; and the Young Prairie SNA primary site and sites within the Scuppernong Habitat Preservation Area that offer exceptional opportunities to protect and manage globally rare Wet-mesic Prairies.
- Promote habitat for **rare plants**, especially earleaf foxglove, forked aster, kitten tails, prairie straw sedge, eastern prairie fringed orchid, roundfruit St.-John's wort, and species of Calcareous Fens and Wet-mesic Prairies.
- Maintain **grassland bird habitat** as large landscapes of continuous grassland, maintain the cover of woody plants to less than 5%, eliminate hedgerows, and promote structural diversity within the grassland.
 - Primary sites that provide the best opportunities to maintain grassland bird habitat include the sites within the Scuppernong Habitat Preservation Area, including Scuppernong Springs and Fens, Kettle Moraine Low Prairie SNA, and Scuppernong Prairie and Wetlands and Young Prairie SNA.
- Maintain and enhance habitat for forest interior birds, including several threatened and endangered species.
 - Primary sites that provide excellent habitat for and likely support source populations of forest interior birds are Ottawa Oaks Woods and Prairies North, Palmyra Oak Woodland, and Whitewater Moraine.

Future Inventory, Monitoring, and Research Needs

Future inventory and monitoring of the biotic resources of the KMSF should be ongoing and periodic, based on needs identified in the master plan and elsewhere, with adjustments made to accommodate new information using the principles of adaptive management. Major needs for future research and monitoring efforts are related to monitoring the effects of prescribed fire on fire-dependant and fire-sensitive species, monitoring and control of invasive plants, research on the effects of savanna restoration and timber harvesting on forest interior birds, classifying and developing management guidance for Ephemeral Ponds, and conducting targeted surveys for select species not included in this effort.

Introduction

Project Purpose and Objectives

This report is the result of a multi-year project to inventory and analyze selected biotic resources of the Kettle Moraine State Forest (KMSF), State Natural Areas (SNA) within the KMSF, and the surrounding landscape. This project was undertaken by the Natural Heritage Inventory (NHI) section of the Wisconsin Department of Natural Resources' (WDNR) Bureau of Endangered Resources, in cooperation with the Division of Forestry and Bureau of Parks and Recreation. Project goals were to provide baseline information on the rare species, high-quality natural communities, significant aquatic features, and ecology of the study area relevant to the development of new master plans for the six units of the Kettle Moraine State Forest and the conservation of biological diversity. The study area (Figure 1) for this project included the following units of the KMSF*:

- Northern
- Southern
- Loew Lake
- Lapham Peak
- Paradise Valley
- Mukwonago River

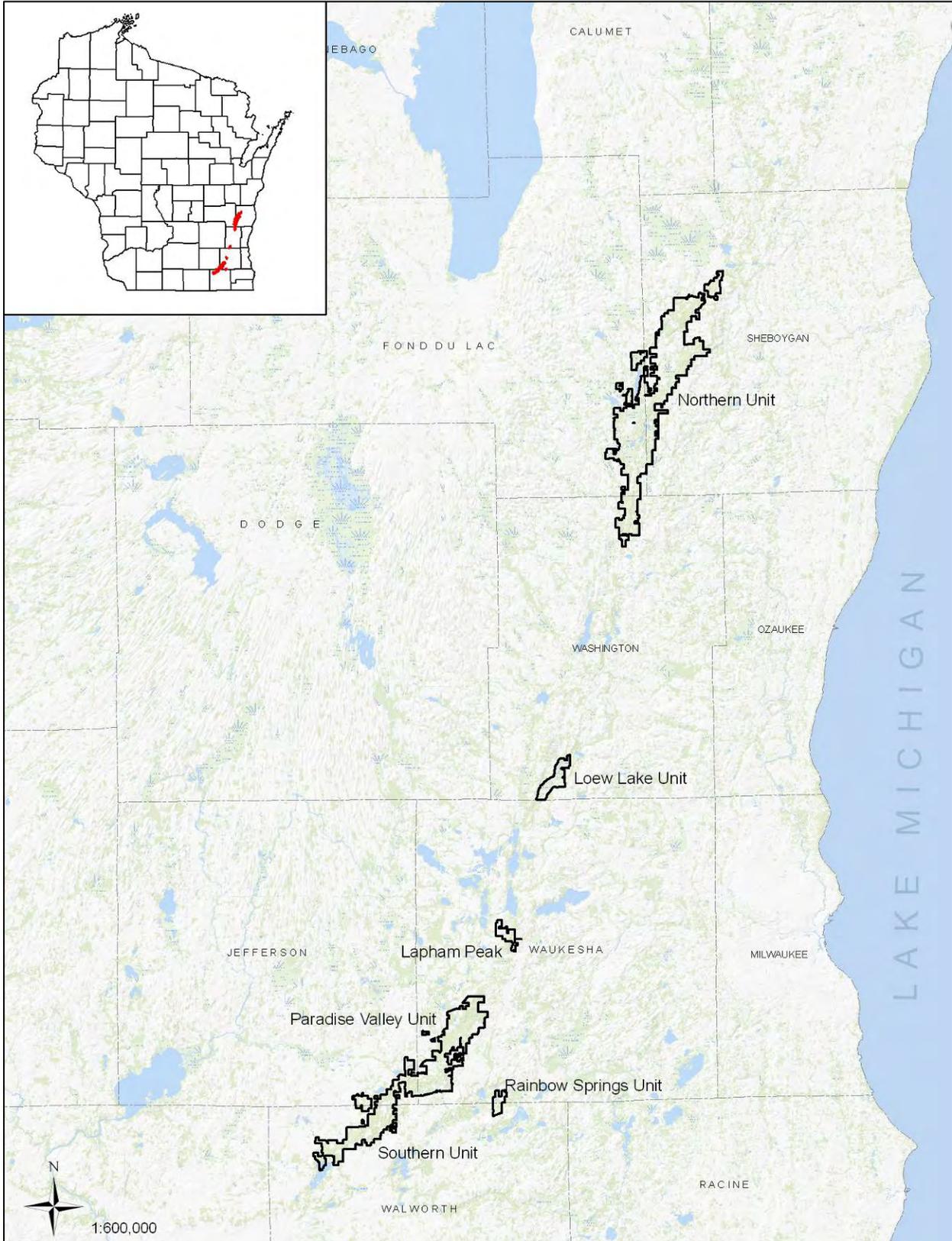
A biotic inventory and analysis is one of a number of assessments identified as critical for developing a new state forest master plan. The information provided in this report consolidates background information useful for the property master planning team and is intended to be used in conjunction with other sources of information, including the "Regional and Property Assessment," to develop overall recommendations for the forest. It is our hope that this information will also be useful to a wider audience that includes managers, administrators, conservation groups, private landowners, and others who have an interest in conserving the biological diversity of this landscape.

The primary objectives of this project were:

- identification and evaluation of natural communities,
- identification and evaluation of rare or otherwise significant plant and animal populations,
- identification and evaluation of selected aquatic features and their associated biota,
- identification of sites appropriate for the restoration of lost or declining communities or important habitats,
- identification of especially important protection, management, and restoration opportunities, focusing on both unique and representative natural features of the KMSF, as well as the surrounding landscape,
- The interpretation and synthesis of the information gathered for use by the property master planning team, as well as managers, administrators, and others involved in the implementation of land use decisions on the KMSF, as well as the surrounding landscape.

*The Pike Lake Unit of the Kettle Moraine State Forest was not included in this Biotic Inventory because the Master Plan for that unit is being written separately.

Figure 1. Location of the study area.



Overview of Methods

The Wisconsin Natural Heritage Inventory (NHI) program is part of the Wisconsin DNR's Bureau of Endangered Resources and a member of an international network of natural heritage programs representing all 50 states, as well as portions of Canada, Latin America, and the Caribbean. These programs share certain standardized methods for collecting, processing, and managing data for rare species and natural communities. NatureServe, an international non-profit organization, coordinates the network (see www.NatureServe.org for more information).

Natural heritage programs track certain elements of biological diversity: rare plants, rare animals, high-quality examples of natural communities, and other selected natural features. The NHI Working List lists plants and animals, as well as the natural community types recognized by NHI. The NHI Working List is periodically updated to reflect new information about the rarity and distribution of the state's plants, animals, and natural communities. The most recent Working List is available from the Wisconsin DNR Web site ("Wisconsin Natural Heritage Working List").

The Wisconsin NHI program uses standard methods for biotic inventory to support master planning (Appendix A). Our general approach involves collecting relevant background information, planning and conducting surveys, compiling and analyzing data, mapping rare species and high quality natural community locations into the NHI database, identifying ecologically important areas, and providing interpretation of the findings through reports and other means.

Field surveys for the KMSF biotic inventory were conducted primarily during 2009 with a limited number of surveys conducted during 2005 and 2007. Many sources were consulted to aid in the identification and prioritization of survey sites within the KMSF. Existing NHI data and discussions with KMSF staff, and the expertise of several biologists familiar with the properties or with similar habitats in the region are often the starting point for conducting a biotic inventory to support master planning. Additional references included interpretations of local and regional land cover from recent aerial photographs and topographical maps, information from the original land surveys for the area, and Southeast Wisconsin Regional Planning Commission (SEWRPC) natural area delineations and associated data. The collective results from these surveys and subsequent analyses were used to identify ecologically important areas on the KMSF.

Based on the location and ecological context, key inventory considerations for the KMSF included the identification of large blocks of contiguous forest, patches of less fragmented older forest with diverse structure (or the potential for developing structural attributes associated with older forests), oak forests with rich and diverse understory composition, intact wetland and aquatic communities, and microsites such as Calcareous Fens, Ephemeral Ponds, and remnant prairies. These areas have been found to harbor rare or otherwise sensitive habitat specialists. Private lands surrounding the KMSF were not surveyed.

Standard methods were used for surveying each taxa group. Table 1 summarizes the surveys conducted during the project along with the principal investigator(s) and the scope of each survey.

Table 1. Field surveys conducted during 2005-2009

Survey	Biologist(s)	Scope of Taxa Surveyed
Aquatic Insects	Kurt Schmude	All species sampled were documented
Bats	Andria Blattner, Jill Roberts, Mike Sobish	Data were collected for all species encountered.
Birds	Jeff Baughman, John Bielefeldt, Andrea Szymchak, Richard Staffen	Bird counts documenting all species encountered and targeted surveys for select species on the Working List
Fishes	Tom G. Anton, Chris Jones, Thomas Slawski, Francis M. Veraldi, Phillip W Willink	Fish surveys to determine presence and distribution of fishes within the KMSF. All species encountered were documented.
Herptiles	Patty Best, Jamie Beuapre, Gary S. Casper, Jason Dare, GERAL DeBoer, Ron Gritt, Randy Hetzel, Carl Koch, Beth Mittermaier, Stefanie Nadeau, Nathaniel Reinartz, Richard Staffen	Targeted surveys for Working List species. All species encountered during these surveys were documented
Mammals	Richard Bautz	All species sampled were documented
Mussels	Matthew Berg	Targeted surveys for Working List species. All species encountered during these surveys were documented
Natural Communities	Craig Anderson, Andy Clark, Eric Epstein, Christina Isenring, Ryan O'Connor	All plant species encountered during these surveys were documented as part of the natural community description
Rare Forest Raptors	Richard Staffen, Gene Jacobs, Dale Katsma	Targeted surveys for Working List species
Rare Plants	Craig Anderson, Andy Clark, Eric Epstein, Christina Isenring, Ryan O'Connor	Targeted surveys for Working List species. All species encountered during these surveys were documented
Terrestrial Invertebrates	Susan Borkin	Targeted surveys for Working List species. All species encountered during these surveys were documented

Background on Previous Efforts

Various large-scale research and planning efforts have identified a number of locations within the KMSF as being ecologically significant. The following are examples of such effort and the sites that were identified and described by those efforts.

Land Legacy Report

The Land Legacy Report (WDNR 2006a) was designed to identify Wisconsin's most important conservation and recreation needs for the next 50 years. The report assigned a score of five points on their five-point scale of conservation significance to the KMSF, meaning it possesses "outstanding ecological qualities, is of adequate size to meet the needs of the critical components, and/or harbors natural communities or species of global or continental significance." The report also identifies the middle kettle moraine, including Lapham Peak, Loew Lake, and Pike Lake units, as a legacy place providing an important link for a variety of upland, lowland, and aquatic species and communities throughout the kettle moraine region.

Wisconsin Wildlife Action Plan: Conservation Opportunity Areas

The area encompassing the KMSF was recognized in the Wisconsin Wildlife Action Plan (WWAP; WDNR 2006b) as having three Conservation Opportunity Areas (COA) (Appendix B). Conservation Opportunity Areas are places in Wisconsin containing ecological features, natural communities, or Species of Greatest Conservation Need habitat for which Wisconsin has a unique responsibility for protecting when viewed from the global, continental, upper Midwest, or state perspective (WDNR 2006b).

The South Kettle Moraine COA was determined to be of global significance in the WWAP because it includes the globally rare bur oak opening, representing the best opportunity for large scale restoration of this type.

The Mid to North Kettle Moraine COA was determined to be of continental significance in the WWAP because of the important combination of rugged topography, glacial features, a complex mosaic of vegetation types, and the presence of a large forested block in the midst of agricultural lands.

The Milwaukee River main branches COA was determined to be of upper Midwest significance in the WWAP because of aquatic resources associated with these large warmwater river systems and the opportunities for conserving Floodplain Forest, Northern Sedge Meadow, and Emergent Marsh communities and their representative SGCN.

A Regional Natural Areas and Critical Species Habitat Protection and Management Plan for Southeastern Wisconsin

The Southeastern Wisconsin Regional Planning Commission (SEWRPC) report on Natural Areas and Critical Species Habitat Protection and Management Plan (SEWRPC 1997) mapped the location and extent of natural areas and critical species habitat within southeast Wisconsin. In addition, SEWRPC classified sites as natural areas of statewide, regional, or local importance (NA-1, NA-2, NA-3). The plan developed and presented recommendations for the preservation and management of those natural areas and critical species habitats. The assessment identified numerous sites within the seven county regional planning district (counties include Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha) varying from statewide or greater significance to sites of local significance. Reed et al (2007) performed an Update to the Regional Natural Area and Critical Species Habitat Plan including areas within the KMSF.

Kettle Moraine Forest Legacy Area

The private forestlands within the landscape surrounding the KMSF were identified as the Kettle Moraine Forest Legacy by the national Forest Legacy Program (“Forest Legacy Program”). The Forest Legacy Program identifies and protects environmentally important private forestlands threatened with conversion to non-forest uses such as subdivision for residential or commercial development. To help maintain the integrity and traditional uses of private forest-lands the use of conservation easements is promoted.

The Nature Conservancy’s Prairie Forest Border Ecoregion: A Conservation Plan

The Nature Conservancy’s (TNC) Prairie-Forest Border Ecoregion Conservation Plan (TNC 2001) recognized the KMSF as a “Functional Landscape”. A functional landscape is a portfolio site selected for both coarse-scale aquatic and terrestrial targets and is intended to represent many other ecological systems, communities, and species (i.e., “all” biodiversity). The **Northern Unit** was noted for the mesic and dry-mesic forests providing suitable habitat for a nearly intact biota absent elsewhere in the ecoregion. The **Southern Unit** has a regionally high concentration of Calcareous Fens, remnant prairies, oak openings, and forest. In addition, the Southern Unit is noted as a priority landscape for grassland birds and prairie remnants.

Natural Heritage Inventory Peatlands Project

The Peatlands Project (Anderson et al. 2008) was a four field season statewide study conducted by the Bureau of Endangered Resources. The primary goals of the project were 1) to obtain baseline data on the presence/absence, abundance, and distribution of species in multiple taxon groups associated with peatland communities in Wisconsin, and 2) to document selected biotic and abiotic variables that could potentially influence the organisms being studied. Taxonomic groups were breeding passerine birds, amphibians, small mammals, selected groups of terrestrial and aquatic invertebrates, selected secretive marsh birds, and rare plants. Bryophyte surveys were also done at selected sites. The surveys were designed to be replicated in 5-10 years and used to detect changes in biota related to climate change. The project included five sites within the northern and southern units of the KMSF.

Breeding Bird Populations in the Southern Unit of the Kettle Moraine State Forest in Southeastern Wisconsin

Bielefeldt and Rosenfield (2005) estimated populations of all breeding bird species throughout the **Southern Unit** of KMSF from point counts, transect counts and other inventories conducted in 1981-2005. They detected a cumulative total of 137 species known or presumed to nest in the Southern Unit in one or more of the 1981-2005 years.

Inventory of the Kettle Moraine Red Oak State Natural Area / Red Oak Habitat Preservation Area

The inventory project (Beyer and Hoffman 2005) established a baseline breeding bird and vegetation layer dataset for this hardwood forest State Natural Area and Habitat Preservation Area in the **Northern Unit**. The goals of the project are to protect the integrity and function of the forest itself and the perpetuation of forest interior birds. The two datasets can be tracked over time to show how different levels of landscape management would affect populations of Species of Greatest Conservation Need.

Important Bird Area

Important Bird Areas (IBA; WDNR 2007) are critical sites for the conservation and management of Wisconsin’s birds. The **Northern Unit** of the Kettle Moraine State was recognized as an IBA because it supports significant breeding populations of priority forest species and is an exceptional spring and fall concentration area for migratory landbirds. The **Southern Unit** of the Kettle Moraine State Forest was recognized for its importance to priority grassland and savanna birds, very high numbers of fall migratory birds, and providing core habitat for two species of threatened birds.

Wisconsin Wetland Association Wetland Gems

The KMSF was recognized by the Wisconsin Wetland Association (WWA) as having several “wetland gems”. These habitats are critically important to Wisconsin’s biodiversity, provide nearby communities with valuable functions and services, and serve as recreational and educational opportunities (WWA 2009).

- Scuppernong River Area Wetland Gem, within the **Southern Unit**, is a more than 2000 acre fen, low prairie, marsh, and sedge meadow complex within the Southern Unit.
- Milwaukee River Floodplain Forest Wetland Gem, within the **Northern Unit**, is nearly 600 acres of diverse wetlands within the Northern Unit and includes the highest quality example of Floodplain Forest in the region.
- Spruce Lake Bog Wetland Gem, within the **Northern Unit**, features a diverse mix of wetland community types including an undisturbed bog lake and many plant and animal species typically found much further north in Wisconsin.

Grassland Bird Habitat Management

The grasslands and savannas of the **Southern Unit** were recognized by the WDNR as a Priority Landscape for Grassland Bird Management because of the highly diverse landscape present. The report noted that coordination of planning and management for habitats including prairies, sedge meadows, surrogate grasslands, upland shrub, savannas, and closed forests should be explored (Sample and Mossman 1997).

Forest Certification

All DNR-managed lands, including state parks, wildlife areas, and natural areas, are recognized by the Forest Stewardship Council and the Sustainable Forestry Initiative as being responsibly managed (WDNR 2009). This certification emphasizes the state’s commitment to responsibly managing and conserving forestlands, supporting economic activities, protecting wildlife habitat, and providing recreational opportunities.

Wisconsin Invertebrate Atlas

Occurrence data for primarily aquatic invertebrates of the KMSF have been compiled in the Wisconsin Invertebrate Atlas.

Special Management Designations

State Natural Areas are places on the landscape that protect high quality examples of natural communities, rare species populations, significant geological formations, and archeological sites.

Twenty State Natural Areas occur on the KMSF:

- Bluff Creek SNA
- Butler Lake and Flynn's Spring SNA
- Clifford F. Messinger Dry Prairie and Savanna Preserve SNA
- Clover Valley Fen SNA
- Crooked, Little Mud, and Kellings Lakes
- Eagle Oak Opening SNA
- Haskell Noyes Woods SNA
- Johnson Hill Kame SNA
- Kettle Hole Woods SNA

- Kettle Moraine Low Prairie SNA
- Kettle Moraine Oak Opening SNA
- Kettle Moraine Red Oak SNA
- Kewaskum Maple-Oak Woods SNA
- Milwaukee River and Swamp SNA
- Milwaukee River Floodplain Forest SNA
- Milwaukee River Tamarack Lowlands & Dundee Kame SNA
- Ottawa Lake Fen SNA
- Spring Lake SNA
- Spruce Lake Bog SNA
- Young Prairie SNA

Dedicated State Natural Areas are permanently protected through an Article of Dedication on the property. Within the KMSF, portions of Haskell Noyes Woods SNA, Spruce Lake Bog SNA, Kettle Moraine Low Prairie SNA, Young Prairie SNA, and Clover Valley Fen SNA are dedicated. Dedicated SNAs differ from designated SNAs because the Article of Dedication can be removed from the property only with the approval of the governor and the legislature. SNAs designated through a designation agreement can be cancelled after a short notice period.

Habitat Preservation Areas are defined as lands and waters containing excellent natural habitat and characteristics that are conducive to perpetuation and production of fish and wildlife. The 1991 master plans for the **Northern and Southern Units** of the Kettle Moraine State Forest established three Habitat Preservation Areas. Within the **Northern Unit**, the Kettle Moraine Red Oak Habitat Preservation Area (2,742 acres) was established to preserve habitat for forest interior bird species. The Little Mud Lake Habitat Preservation Area (126 acres), also within the **Northern Unit**, was established to protect the variety of salamanders, including red-spotted, blue-spotted, spotted, and tiger, that are found here. Within the **Southern Unit**, the Scuppernong River Habitat Preservation Area (3,500 acres) consists of wetlands, Wet prairie, Mesic Prairie, and hardwood forest that protect a number of rare species. The 1996 master plan for the **Loew Lake Unit** establishes a Habitat Preservation Area along the Oconowoc River and associated wetlands to preserve the riverine habitat.

Outstanding Resource Waters are officially designated (NR 102.11) waters that provide outstanding recreational opportunities, support valuable fisheries and wildlife habitat, have good water quality, and are not significantly impacted by human activities. The East Branch Milwaukee River is a designated Outstanding Resource Water. Outstanding Resource Waters typically do not have any point sources discharging pollutants directly to the water (for instance, no industrial sources or municipal sewage treatment plants) and no increases of pollutant levels are allowed. Less than 8% of the rivers and streams in Wisconsin have been designated Outstanding Resource Waters.

Regional Ecological Context

Southeast Glacial Plains Ecological Landscape

This section is largely reproduced from the Ecological Landscapes of Wisconsin Handbook (WDNR In Prep.). This Handbook was developed by the WDNR Ecosystem Management Planning Team (EMPT) and identifies the best areas of the state to manage for natural communities, key habitats, aquatic features, native plants, and native animals from an ecological perspective.

The WDNR has mapped the state into areas of similar ecological potential and geography called Ecological Landscapes. The Ecological Landscapes are based on aggregations of smaller ecoregional units (Subsections) from a national system of delineated ecoregions known as the National Hierarchical Framework of Ecological Units (NHFEU) (Cleland et al. 1997). These ecoregional classification systems delineate landscapes of similar ecological pattern and potential for use by resource administrators, planners, and managers. The KMSF is located within the Southern Green Bay Lobe Subsection of the NHFEU.

The KMSF study area is located in the Southeast Glacial Plains Ecological Landscape (WDNR In prep.) (Figure 2). The Southeast Glacial Plains Ecological Landscape borders the Illinois border and covers a large area of southeastern Wisconsin. This ecological landscape is home to some of the world's best examples of continental glacial activity. Drumlins, eskers, kettle lakes, kames, ground and end moraines, and other glacial features are evident throughout the entire area (WDNR 2006a). Most of this Ecological Landscape is composed of glacial materials deposited during the Wisconsin Ice Age (WDNR In Prep.). One area of interest is the interlobate moraine, a long "ridge" that formed between the Green Bay and Lake Michigan lobes during the Wisconsin Glaciation (WDNR 2006a). Other portions of this region offer very moderate relief, with glacial deposits forming the greatest irregularities (Martin 1965). Soils in this landscape vary from poorly drained clayey to well drained loamy soils with a silt loam surface over calcareous loam till.

The Southeast Glacial Plains Ecological Landscape has undergone dramatic changes in land use and land cover (WDNR In Prep.a), including settlers that plowed the prairies, drained the wetlands, and cut the forests for lumber and to make way for farmland. The landscape went from a primarily open structure of prairies, wetlands, and oak savanna in the western and southern part at the time of Euro-American settlement to primarily agricultural fields with some second growth woodlots and wetlands that were too difficult to drain. Over half of the wetlands in this Landscape were drained for farming purposes. In the northeastern part of the Landscape, land was cleared of forests for farming; however, the more rugged Northern Unit of the KMSF remained forested because it was too difficult to plow, although much of it was used for grazing.

Current land use in the Landscape, including agriculture, residential, timber management, and recreation, have contributed to ecological disturbances. These



Figure 2. Ecological Landscapes of Wisconsin and the study area.

disturbances include water level manipulation, fire suppression, residential development, the spread of invasive species, road and utility corridor creation, and agriculture.

Historically, vegetation in the Southeast Glacial Plains Ecological Landscape consisted of a mix of prairie, oak forests and savanna, and maple-basswood forests. Wet-mesic Prairies, Southern Sedge Meadows, Emergent Marshes, Calcareous Fens, and tamarack swamps were found in poorly drained, wetter portions of the Landscape. End moraines and drumlins supported savannas and forests. Agricultural and urban land use practices have drastically changed the land cover of the Landscape since Euro-American settlement. The current vegetation is primarily agricultural cropland. Remaining forests occupy only about 10% of the land area and important covertypes include oak, maple-basswood, and lowland hardwoods. No large areas of contiguous forest exist today except on the Kettle Interlobate Moraine, which has relatively rugged topography that is often ill-suited for agricultural uses.

Regional Biodiversity Needs and Opportunities

Opportunities for sustaining natural communities in the Southeast Glacial Plains Ecological Landscape were developed by the Ecosystem Management Planning Team (EMPT 2007) and later presented in the Wisconsin Wildlife Action Plan (WDNR 2006b). The goal of sustaining natural communities is to manage for natural community types that historically occurred in a given landscape and have a high potential to maintain its characteristic composition, structure, and ecological function over a long period of time (e.g., 100 years). This list can help guide land and water management activities so that they are compatible with the local ecology of the Ecological Landscape while maintaining important components of ecological diversity and function. These are the most appropriate community types that could be considered for management activities within the Southeast Glacial Plains Ecological Landscape.

There are management opportunities for 38 natural communities in the Southeast Glacial Plains Ecological Landscape. Of these, 21 are considered “major” opportunities (Table 2). A “major” opportunity indicates that the natural communities can be sustained in the Ecological Landscape, either because many significant occurrences of the natural community have been recorded in the landscape or major restoration activities are likely to be successful in maintaining the community’s composition, structure, and ecological function over a longer period of time. An additional 13 natural communities are considered “important” in this landscape. An “important” opportunity indicates that although the natural community does not occur extensively or commonly in the Ecological Landscape, one to several occurrences do occur and are important in sustaining the community in the state. In some cases, important opportunities may exist because the natural community may be restricted to just one or a few Ecological Landscapes within the state and there may be a lack of opportunities elsewhere.

Table 2. Major Natural Community Management Opportunities in the Southeast Glacial Plains Ecological Landscape (EMPT 2007 and WDNR 2006b)

Bog Relict	Emergent Marsh	Oak Opening	Southern Sedge Meadow
Calcareous Fen	Floodplain Forest	Oak Woodland	Southern Tamarack Swamp (rich)
Dry Cliff	Impoundments/Reservoirs*	Shrub Carr	Surrogate Grasslands
Dry Prairie	Inland lakes*	Southern Dry Forest	Warmwater rivers*
Dry-mesic Prairie	Mesic Prairie	Southern Dry-mesic Forest	Warmwater streams*
			Wet-mesic Prairie

*Natural Communities that were listed in the Wisconsin Wildlife Action Plan only.

Rare Species of the Southeast Glacial Plains Ecological Landscape

Numerous rare species are known from the Southeast Glacial Plains Ecological Landscape. “Rare” species include all of those species that appear on the WDNR’s NHI Working List (*Wisconsin Natural Heritage Working List*) classified as “Endangered,” “Threatened,” or “Special Concern.” Table 3 lists species known to occur in the Southeast Glacial Plains Ecological Landscape based on information stored in the NHI database as of November 2009 (WDNR In Prep).

Table 3. Listing Status for rare species in the Southeast Glacial Plains Ecological Landscape as of November 2009 (WDNR In Prep.)

Listing Status	Birds	Fishes	Herptiles	Invertebrates	Mammals	Plants	Total Fauna	Total Flora	Total Listed
WI Endangered	8	4	7	11		10	30	10	40
WI Special Concern	19	10	6	61	5	71	101	71	172
WI Threatened	10	6	3	5		28	24	28	52
U.S. Candidate			1				1	0	1
U.S. Endangered				2			2	0	2
U.S. Threatened						2	0	2	2

The Wisconsin Wildlife Action Plan denoted Species of Greatest Conservation Need (SGCN). Species of Greatest Conservation Need are animals that have low and/or declining populations that are in need of conservation action. They include various birds, fish, mammals, reptiles, amphibians, and invertebrates (e.g. dragonflies, butterflies, and freshwater mussels) that are:

- Already listed as threatened or endangered;
- At risk because of threats to their life history needs or their habitats;
- Stable in number in Wisconsin, but declining in adjacent states or nationally.
- Of unknown status in Wisconsin and suspected to be vulnerable.

There are 62 vertebrate SGCN significantly associated with the Southeast Glacial Plains Ecological Landscape (See Appendix E). This means that the species is (and/or historically was) significantly associated with the Ecological Landscape and restoration of natural communities this species is associated with in the Ecological Landscape would significantly improve conditions for the species.

Description of the Study Area

Location and Size

The study area is located in Walworth, Jefferson, Waukesha, Washington, Fond du Lac, and Sheboygan counties and comprises approximately 59,000 acres.

Ecoregion

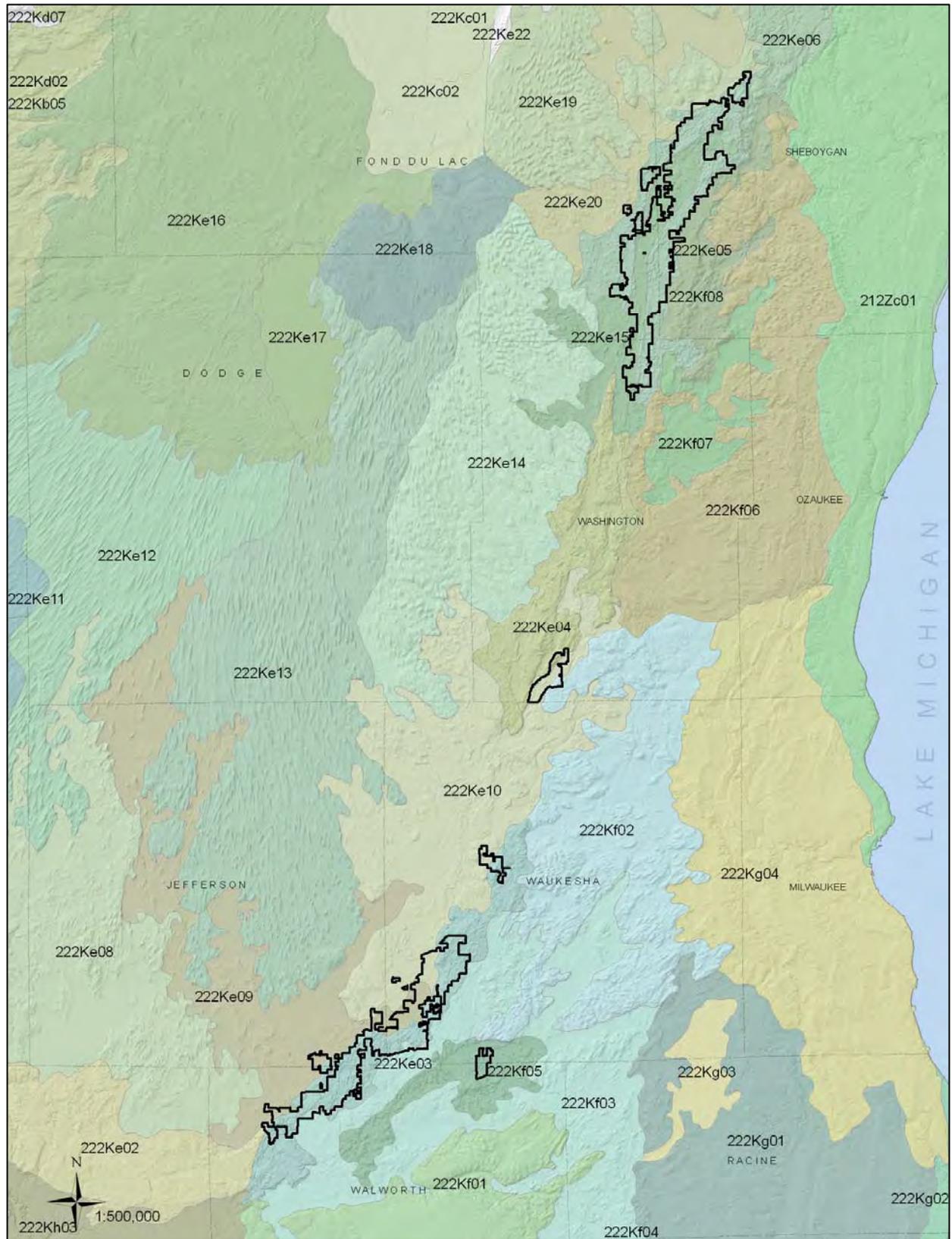
Landtype Associations

From the NHFEU, the units most relevant to this study are Landtype Associations (LTAs), the finer scaled polygons that make up each subsection based on repeating patterns of characteristic landforms. Landtype Associations represent an area of 10,000 – 300,000 acres and contain similarities of landform, soil, and vegetation. Figure 3 shows the distribution of the following LTAs on the KMSF:

- **222Ke05 (North Kettle Moraines).** The characteristic landform pattern is hilly kame moraine with eskers. Soils are predominantly well-drained loam and sand over calcareous gravelly sandy drift or outwash. This LTA comprises 33% of the KMSF.
- **222Ke03 (South Kettle Moraines).** The characteristic landform pattern is hilly kame moraine. Soils are predominantly well-drained loam and sand over calcareous gravelly sandy drift or outwash. This LTA comprises 27% of the KMSF.
- **222Ke15 (Kewaskum Plains).** Undulating kame terrace with scattered kames, kettles, and lake plains. Soils are predominantly well-drained silt and loam over calcareous sandy loam till or drift, gravelly sandy drift or outwash, or silty sandy or clayey lacustrine. This LTA comprises 20% of the KMSF.
- **222Ke09 (Jefferson Lake Plains).** The characteristic landform pattern is nearly level lake plain with broad areas of many widely scattered drumlins. Soils are predominantly poorly drained silt over calcareous silty, sandy, or clayey lacustrine or sandy outwash. This LTA comprises 7% of the KMSF.
- **222Ke10 (Oconomowoc Lakes).** The characteristic landform pattern is undulating outwash plain with many lakes and scattered morainal knolls. Soils are predominantly well-drained silt and loam over calcareous gravelly sandy outwash. This LTA comprises 7% of the KMSF.
- **222Kf05 (East Troy Lakes).** The characteristic landform pattern is rolling pitted outwash plain with many lakes. Soils are predominantly well-drained loam over calcareous gravelly sandy outwash. This LTA comprises 2% of the KMSF.
- **222Ke04 (Central Kettle Moraines).** The characteristic landform pattern is hilly kame moraine. Soils are predominantly well-drained loam over calcareous sandy loam till or drift or gravelly sandy drift or outwash. This LTA comprises 1% of the KMSF.
- **222Kf03 (Heart Prairie-Burlington Plains).** The characteristic landform pattern is undulating outwash plain with kames, lake plains, remnant moraines, and swamps common. Soils are predominantly well-drained loam over calcareous gravelly sandy outwash. This LTA comprises 1% of the KMSF.

- **222Kf08 (Beechwood Plains).** The characteristic landform pattern is undulating outwash plain with remnant moraines, scattered lake plains, and swamps. Soils are predominantly well-drained loam over calcareous gravelly sandy outwash and sandy loam till. This LTA comprises 1% of the KMSF.
- **222Ke19 (Mt. Calvary Moraine).** The characteristic landform pattern is rolling till plain with drumlins. Soils are predominantly well-drained silt and loam over calcareous loam till. This LTA comprises 1% of the KMSF.
- **222Kf02 (Waukesha Drumlins).** The characteristic landform pattern is rolling till plain with drumlins, swamps, and kame terraces common. Soils are predominantly well-drained loam and silt over calcareous loam till. This LTA comprises less than 1% of the KMSF.
- **222Ke20 (Armstrong Plains).** The characteristic landform pattern is nearly level outwash plain and marsh complex. Soils are predominantly well-drained silt and loam over calcareous gravelly sandy outwash and muck. This LTA comprises less than 1% of the KMSF.
- **222Ke02 (East Johnstown-Milton Moraines).** The characteristic landform pattern is undulating hummocky moraine and outwash plain complex with scattered lake plains. Soils are predominantly well-drained silt over calcareous sandy loam till or gravelly sandy outwash. This LTA comprises less than 1% of the KMSF.
- **222Ke06 (Millhome Moraines).** The characteristic landform pattern is rolling, hummocky moraine. Soils are predominantly well-drained loam over calcareous sandy loam till, gravelly sandy outwash, or loamy lacustrine. This LTA comprises less than 1% of the KMSF.

Figure 3. Landtype Associations for the study area.



Physical Environment

Geology and Geography

The KMSF lies within the interlobate region of the Green Bay and Lake Michigan lobes of the Laurentide ice sheet of the Wisconsin glaciation. It is within this region where, around 15,000 years ago, the collision and subsequent melting of the lobes created many of the geologic features the area is known for today.

The **Northern Unit** is characterized by collapsed outwash and till that resulted from the melting of the two lobes and left the hummocky topography of a moraine. Conical shaped hills, called kames, formed where holes in the glacier filled with till and debris. When the surrounding ice melted, the hills of debris were left. Kames within the **Northern Unit** include Dundee Kame and Johnson Hill. The **Southern Unit** is characterized by moraines and outwash plains that also formed with the melting of the Green Bay and Lake Michigan lobes of the glacier. Within the outwash plains are kettles that formed when buried ice blocks melted, leaving a round depression in the ground.

Soils

(From the Ecological Landscapes of Wisconsin Handbook [WDNR In Prep. a]) The Southern Green Bay Lobe (Subsection 222Ke) was formed by the Green Bay Lobe of the Wisconsin glacier. The dominant soils are calcareous loamy tills; there are also areas of outwash sands and gravel, and silty lacustrine materials. Soils on the moraine uplands and drumlins are formed in brown calcareous sandy loam to loam till. They range from well-drained to somewhat poorly drained and generally have silt loam surface textures, moderate to very slow permeability, and moderate to high available water capacity.

The outwash plains have upland soils with loamy alluvium or loess surfaces over calcareous outwash sands and gravel. They range from well-drained to somewhat poorly drained and generally have silt loam to loam surface textures, moderately rapid to moderate permeability, and moderate available water capacity.

Most lowland soils are very poorly drained non-acid muck, but may also be silty and clayey lacustrine, or loamy till. The major river valleys have soils formed in loamy to silty alluvium or non-acid muck; they range from moderately well-drained to very poorly drained, and have areas subject to periodic flooding.

Hydrology

The East Branch Milwaukee River is an important tributary to the Milwaukee River and over 17 miles (>90%), of its length is contained within the KMSF. The headwaters of the East Branch Milwaukee River, Watercress Creek and Long Lake, are also within the KMSF. Other important surface waters include the headwaters of the Oconomowoc and Scuppernong rivers, Loew Lake, and numerous small spring ponds and spring runs.

Large lakes are uncommon within the study area, although numerous small lakes are located in the southern half of the **Northern Unit**.

Wetlands are common in the study area and vary from open herbaceous dominated sedge meadows and Calcareous Fens, to shrub-dominated Shrub-carrs, to forested wetlands including Southern Hardwood Swamp, Southern Tamarack Swamp, and Bog Relict.

Ephemeral Ponds, isolated wetlands containing water for part of the growing season, are common on the **Northern Unit**.

Vegetation

Historic Vegetation

The **Northern Unit** of the KMSF and part of the **Loew Lake Unit** are located along the tension zone (Figure 4), a zone that separates two floristic provinces, the prairie-forest province and the northern hardwoods province (Curtis 1959). Many species are found at their range limits within the tension zone, i.e., the southern limits of many northern species and the northern limits of many southern species. The **Southern, Lapham Peak, Paradise Valley, and Mukwonago River Units** occur south of the tension zone. This distinction between the northern and southern groups of units is important in understanding the historic, current, and potential vegetation as well as the species that depend on the habitat of those areas.

Data from the original Public Land Surveys are often used to infer forest composition and tree species dominance for large areas in Wisconsin prior to widespread Euro-American settlement. The purpose of examining historical conditions is to identify ecosystem factors that formerly sustained species and communities that are now altered in number, size, or extent, or which have been changed functionally (for example, by constructing dams, or suppressing fires). Although data are limited to a specific snapshot in time, they provide valuable insights into Wisconsin's ecological capabilities. Maintaining or restoring some lands to more closely resemble historic systems and including some structural or compositional components of the historic landscape within actively managed lands can help conserve important elements of biological diversity (WDNR In Prep. a). Public Land Surveys for the area comprising the KMSF were conducted between 1832 and 1840.

Historic vegetation (Finley 1976) for the **Northern and Loew Lake Units** was hardwood forest. The most common type consisted of sugar maple (*Acer saccharum*), basswood (*Tilia americana*), northern red oak (*Quercus rubra*), white oak (*Q. alba*), and black oak (*Q. velutina*) (Figure 4). This type could possibly be classified as the NHI natural community type Southern Mesic or Southern Dry-mesic Forest. The second most common type was an oak-dominated forest with white, black, and bur oaks (*Q. macrocarpa*). This type could be classified as Oak Woodland or Southern Dry Forest. Other types present include swamp conifers (classified as Southern Tamarack Swamp, Northern Wet-mesic Forest, or Bog Relict), Oak Openings, and Southern Mesic Forest dominated by American beech (*Fagus grandifolia*), sugar maple, basswood, and northern red, white and black oaks. Historic grassland habitat (including the Mollisol soils they developed) was likely found in Oak Openings and Oak Woodland, with no mention of prairies in Finley (1976) or the original Public Land Survey notes.

Tree species documented during the Public Land Surveys can be used to understand the dominant tree species within the types Finley (1976) described and how that has changed over time. The tree species of the **Northern Unit** (Figure 5) were diverse. Sugar maple is the most dominant, with white oak the second most dominant. Of importance are the small amount of northern red oak and aspen (*Populus* spp.) trees mentioned and the lack of pines and white spruce (*Picea glauca*). This area was part of a large band of mesic forest species that extended from the Door Peninsula to the Rock River in Jefferson County. This was one of only two large areas of mesic forest species in southern Wisconsin, the other occurred in an area east of the Kickapoo River.

Figure 4. Pre-widespread Euro-American Settlement Vegetation for the study area. Data are from Finley (1976).

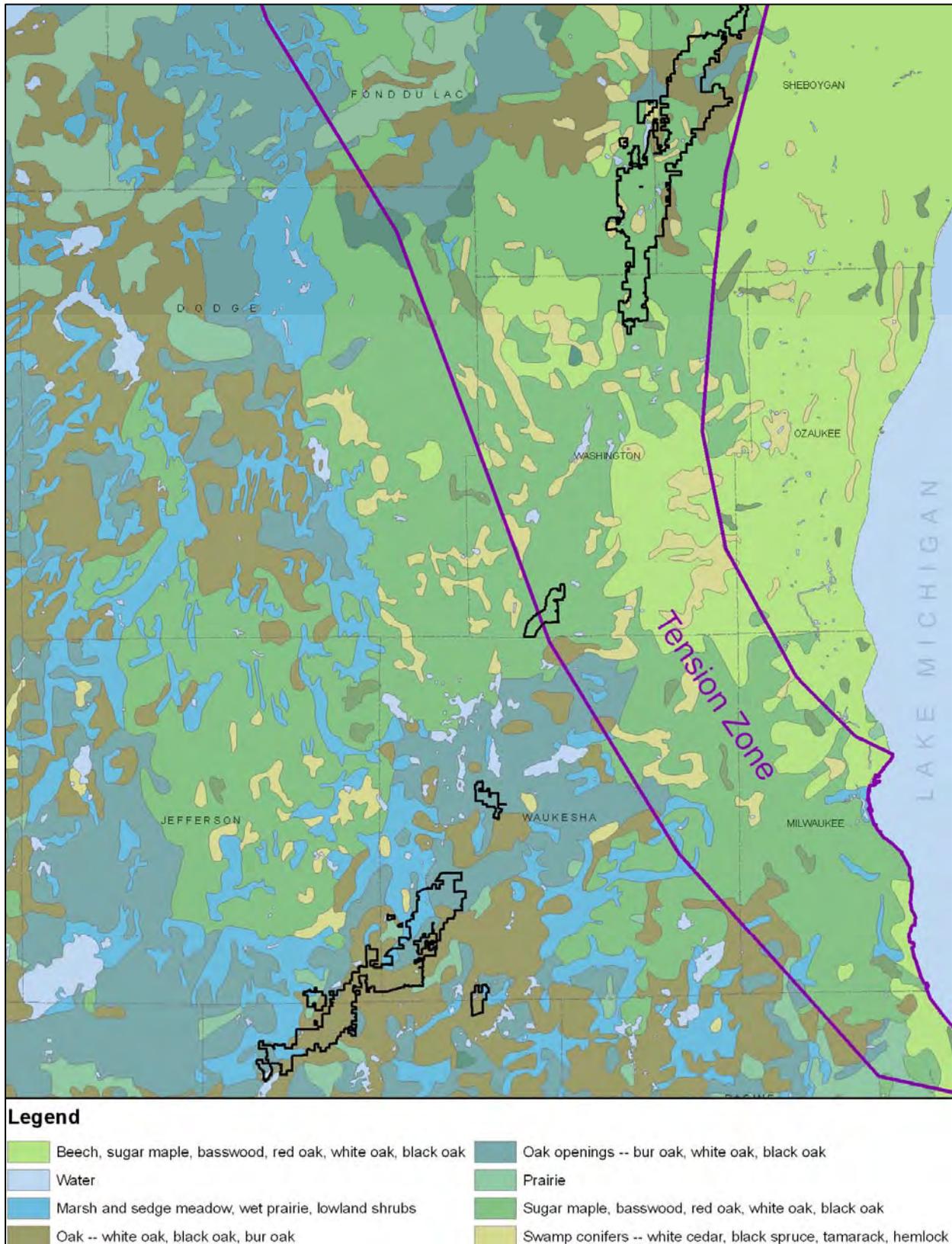
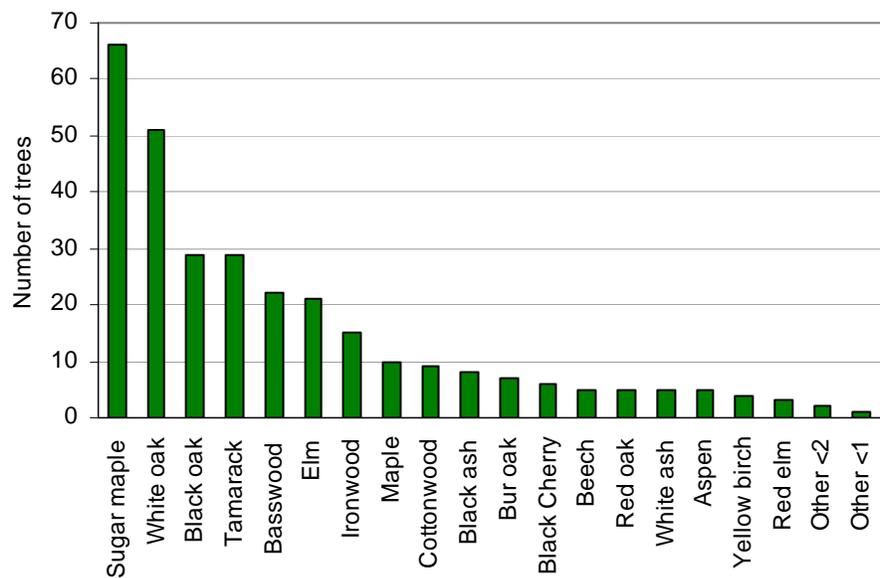
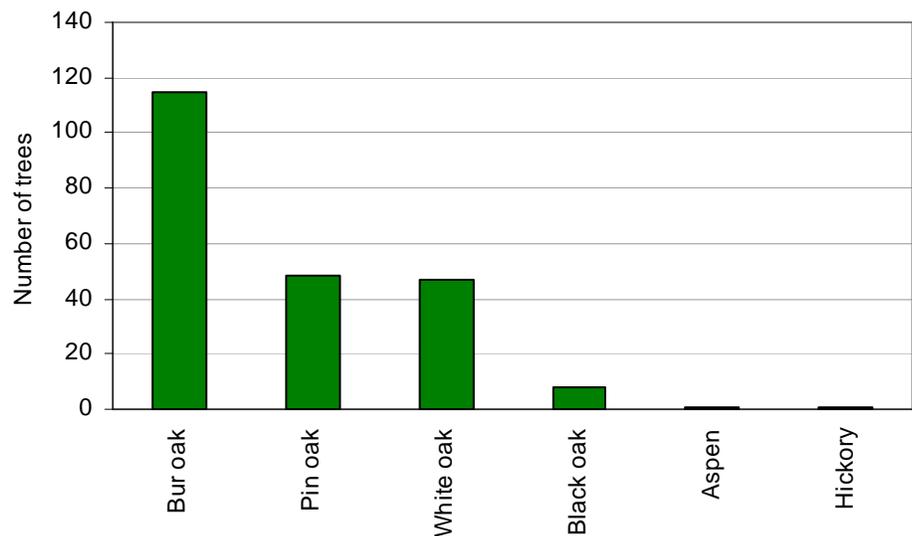


Figure 5. Pre-widespread Euro-American settlement tree species for the Northern Unit of the KMSF based on the original General Land Office Survey (from the WDNR GIS coverage Pre-European Settlement Vegetation Database of Wisconsin: Differentiated Section and Quarter Section Corners prepared by the University of Wisconsin-Madison Forest Landscape Ecology Lab.)



Historic vegetation (Finley 1976) for the **Southern, Mukwonago River, Lapham Peak, and Paradise Valley Units** was mostly oak forest with white, black (this may have also included northern red oak), and bur oaks (Figure 4). This type could be classified as the NHI natural communities Oak Woodland or Southern Dry Forest. The second most common type was dominated by bur, white, and black oaks and could possibly be classified as Oak Opening. Other types present include marsh and sedge meadow, wet prairie, lowland shrubs, and prairie. The most common tree species mentioned in the **Southern Unit** during the Public Land Survey is overwhelmingly bur oak (Figure 6). The tree species data reinforce the historical importance of oak types on the **Southern Unit**.

Figure 6. Pre-widespread Euro-American settlement tree species for the Southern Unit of the KMSF based on the original General Land Office Survey (from the WDNR GIS coverage Pre-European Settlement Vegetation Database of Wisconsin: Differentiated Section and Quarter Section Corners prepared by the University of Wisconsin-Madison Forest Landscape Ecology Lab.)



Current Vegetation

Current vegetation of the KMSF has been influenced by many historical factors including grazing, homesteads, unregulated logging during the “cutover” period, and wildfires; as well as current factors including fire suppression, invasive species, forest management, ecological restoration, and recreation; and environmental factors including geology, soils, hydrology, and climate. The landscape surrounding the KMSF is largely agriculture, large metropolitan areas, and scattered small woodlots (Figure 7).

The steep, morainal topography of the **Northern and Loew Lake Units** is currently forested with Southern Dry-mesic Forests that have a similar tree species composition to historical forests. Southern Dry-mesic Forests in the northern part of the KMSF typically have a moderately dense canopy of 10-20 inch dbh trees; dominated by northern red oak and sugar maple with canopy associates of white oak, basswood, red maple (*Acer rubrum*), and white ash (*Fraxinus americana*). The subcanopy/sapling layer is generally dominated by sugar maple, ironwood (*Ostrya virginiana*), shagbark hickory (*Carya ovata*), big-tooth aspen (*Populus grandidentata*), and other canopy associates. The shrub layer can be sparse to dense and most often includes prickly ash (*Zanthoxylum americanum*), dogwoods (*Cornus* spp.), American hazelnut (*Corylus americana*), and viburnums (*Viburnum* spp). The ground layer can also be variable in cover and species composition. Typical ground layer species may include Pennsylvania sedge (*Carex pennsylvanica*), wild geranium (*Geranium maculatum*), large-flowered bellwort (*Uvularia grandiflora*), large-leaved aster (*Aster macrophyllum*), and early meadow-rue (*Thalictrum dioicum*). Ephemeral Ponds are a common inclusion within these forests. Dry-prairies may be located on the steep west and south sides of moraines within Southern Dry-mesic Forests and are generally less than one-half acre in size (Volkert 1984).

Southern Mesic Forests, characterized by a rich groundflora (including many spring ephemerals) and a sugar maple, northern red and white oak, and white ash dominated canopy, were historically and currently are, an uncommon type in the Northern and Loew Lake units. Many of these forests were cleared for farming because of their rich soils. Current older sites are dominated by 20-30 inch dbh canopy trees, while younger stands are dominated by 12-20 inch dbh canopy trees. Canopy associates may include basswood, black cherry (*Prunus serotina*), shagbark hickory, and American beech, which increase in abundance with proximity to Lake Michigan. The subcanopy is generally composed of eastern hornbeam (*Carpinus caroliniana*), ironwood, American elm (*Ulmus americana*), and canopy saplings. The groundcover can be sparse in some areas, but is typically rich with diverse spring ephemerals. Groundcover species commonly include large-flowered trillium (*Trillium grandiflorum*), large-flowered bellwort, and blue cohosh.

Outwash areas of the northern part of the KMSF have many wetlands, pine plantations, lakes, old fields, planted prairies, and clearings. Wetlands are diverse and vary from open (Northern and Southern Sedge Meadows and Emergent Marsh), to shrub dominated (Shrub-carr), to forested (Bog Relict, Northern Wet-mesic Forest, Hardwood Swamp, Southern Hardwood Swamp, and Southern Tamarack Swamp). Pine plantations are common, where they often occupy lands that were cleared, farmed, and then abandoned. The understory of plantations is often composed of a dense stand of common buckthorn (*Rhamnus cathartica*) and non-native honeysuckles (*Lonicera* spp). Old fields and planted prairies are generally grass and shrub dominated.

Forest Reconnaissance data for the **Northern Unit** of the KMSF (Figure 8) show the diversity of forest cover types, including many wetland types. The most common cover type on the **Northern Unit** is oak. Within this type, over 70% of the acreage has either central hardwoods or northern hardwoods as a secondary type. The second most common type is red (*Pinus resinosa*) and white pine (*Pinus strobus*). All but 29 acres of the 3,610 acres of red and white pine, white spruce, and miscellaneous coniferous type in the **Northern Unit**, are in plantations averaging 50 years of age, based on forest reconnaissance data. This is a significant change from historic vegetation since no pine and spruce were recorded during the Public Land Surveys.

Figure 7. Landcover for the study area from the Wisconsin DNR WISCLAND GIS coverage (WDNR 1993).

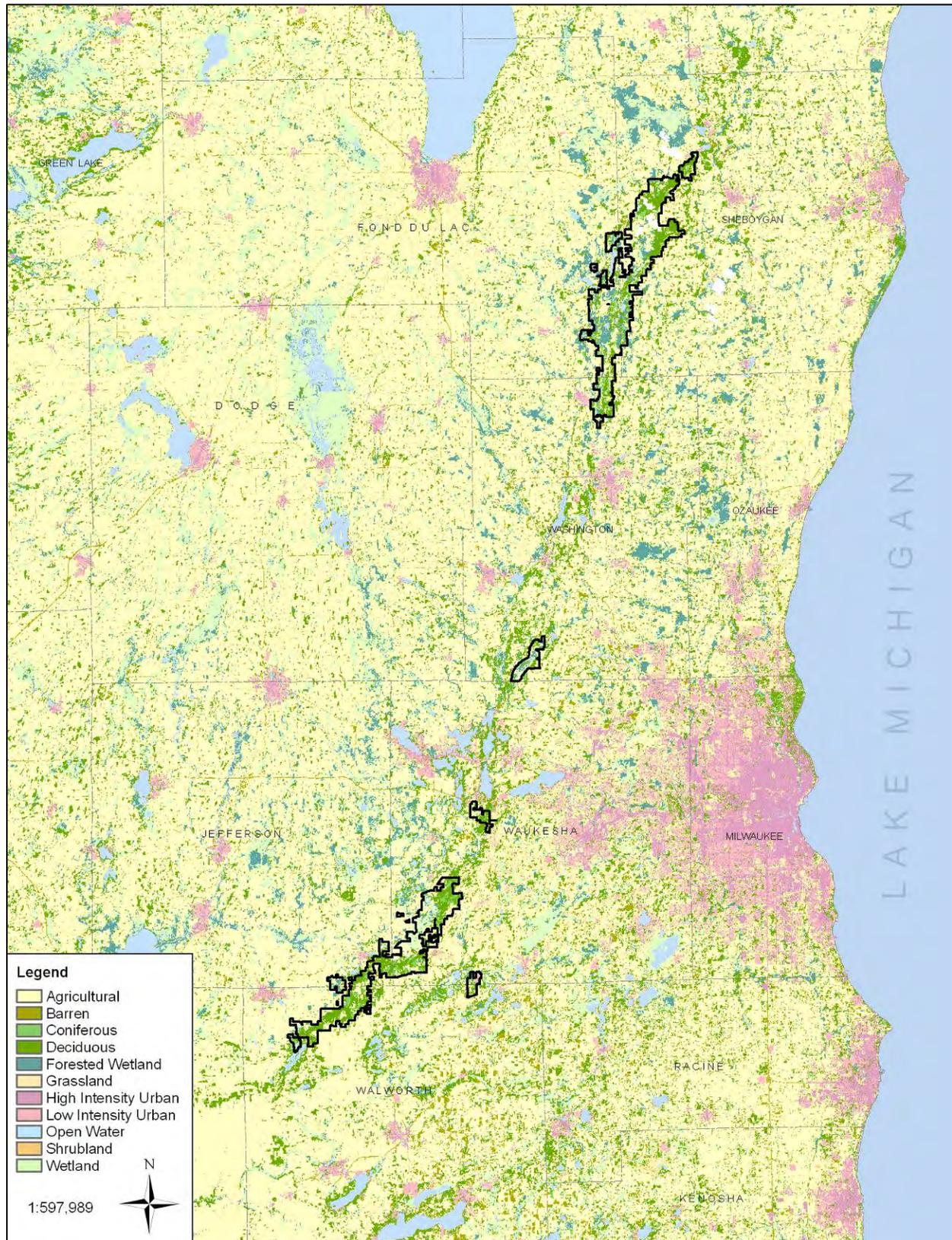
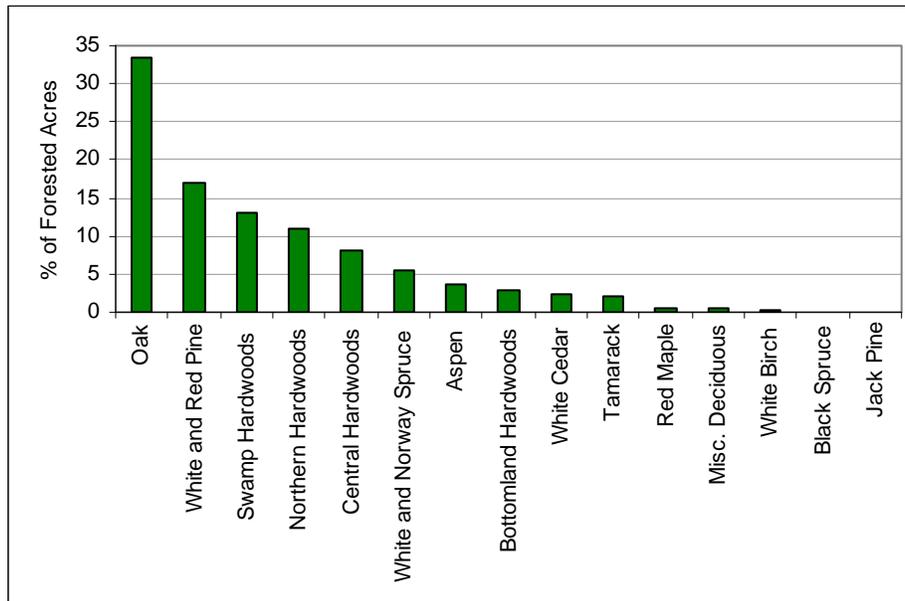


Figure 8. Forested cover types for the Northern Unit of the KMSF. Data are from the Division of Forestry WISFIRS (accessed June 15, 2010).



The southern group of KMSF properties, including the **Southern, Mukwonago River, Lapham Peak, and Paradise Valley Units**, has changed more drastically than the northern group since widespread Euro-American settlement. Much of the historic Oak Opening and Oak Woodland have succeeded to dense hardwood forests due to fire suppression. The moraines and outwash plains are currently dominated by forests, including closed-canopy Southern Dry-mesic Forests, Southern Dry Forests, and pine plantations.

The Southern Dry-mesic Forest community is commonly dominated by 12-24 inch dbh white, northern red, and bur oaks with various canopy associates including shagbark hickory, American elm, and black cherry. The shrub layer may be sparse to abundant depending on overstory canopy cover and more recently includes such non-native invasive species as common buckthorn and non-native honeysuckles, as well as the native, although often invasive, prickly ash. Typical ground cover species include arrow-leaved aster (*Aster sagittifolius*), common yarrow (*Achillea millefolium*), Pennsylvania sedge, and tall anemone (*Anemone virginiana*). Garlic mustard (*Alliaria petiolata*) is becoming more prevalent throughout these community types.

The Southern Dry Forests and Oak Woodlands vary in quality based on the current level of ecological restoration that has occurred. Currently, these types have a moderately dense canopy dominated by 12-24 inch dbh white, northern red, bur, and black oaks, often with such canopy associates as shagbark hickory and black cherry. The shrub layer can be quite dense and may include gray dogwood (*Cornus racemosa*) and American hazelnut but is often dominated by the invasives common buckthorn, non-native honeysuckles, and prickly ash. Where brushing or burning activities have occurred, the shrub layer is sparse, allowing a rich groundcover layer to develop, including such species as wild geranium, pointed tick-trefoil (*Desmodium glutinosum*), American lop-seed (*Phryma leptostachya*), tall anemone, and eastern shooting-star (*Dodecatheon meadia*). Unfortunately, the invasive garlic mustard is becoming more common as a dominant groundcover species.

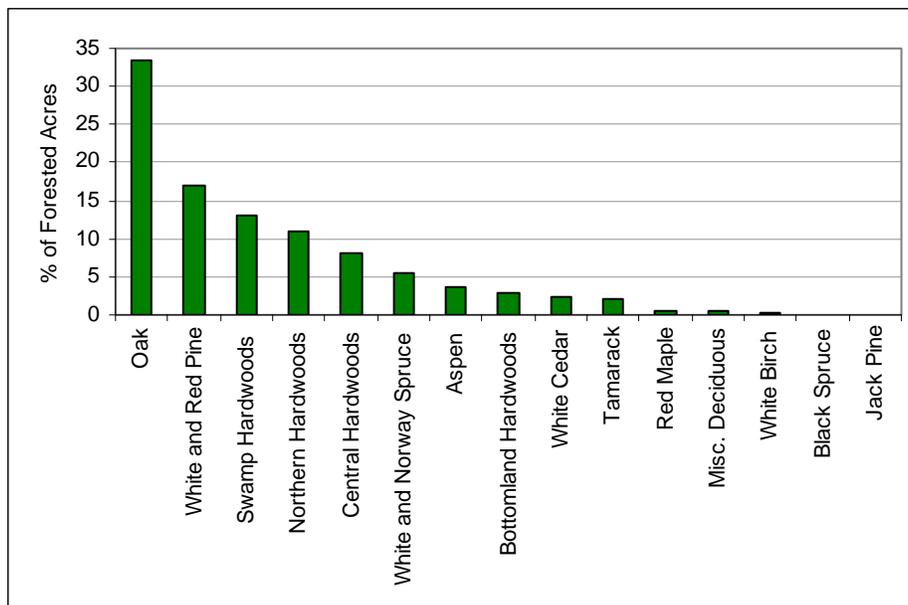
Although Oak Openings are currently uncommon in the southern KMSF, this area offers some of the best restoration and management opportunities anywhere in the state for this globally rare natural community type. Oak Openings are often located on southern to western facing slopes with 30-50% canopy cover of open-grown bur and white oaks, often with northern red and black oaks as canopy associates. Additionally, subdominant species such as shagbark hickory may be present. The understory is typically dominated by herbaceous savanna and prairie species including lead-plant (*Amorpha canescens*), Illinois

tick-trefoil (*Desmodium illinoense*), big blue-stem (*Andropogon gerardii*), and prairie drop-seed (*Sporobolus heterolepis*). In some instances, shrubby species such as prickly ash and sumac (*Rhus* spp.), have been or are becoming more established.

A matrix of wetlands and prairies is found on the outwash plains in the southern area of the KMSF. Calcareous Fens, Southern Sedge Meadows, Wet-mesic Prairies, and Mesic Prairies, often intergrade, making the types difficult to distinguish. These wetland areas are generally diverse, often large, and characterized by herbaceous and shrub vegetation. Many calciphile plants are present including fen star sedge (*Carex sterilis*), shrubby cinquefoil (*Pentaphylloides floribunda*), beaked spikerush (*Eleocharis rostellata*), and the state special concern Ohio goldenrod (*Solidago ohioensis*) and lesser fringed gentian (*Gentianopsis procera*). Some of the wetlands have Springs and Spring Runs, peat domes, and raised marl flats. Invasive species cover is generally low, although numerous species threaten these types including common reed grass (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*), and common and glossy (*Rhamnus frangula*) buckthorns.

Forest Reconnaissance data for the southern area of the KMSF (Figure 9) show a prevalence of the oak cover type. The second most common type is red and white pine. All but 105 acres of the 3,358 acres of red and white pine, white spruce, and miscellaneous coniferous type in the **Southern Unit**, are in plantations averaging 43 years of age, based on forest reconnaissance data. This is a significant change from historic vegetation since no pine and spruce were recorded during the Public Land Surveys. In southern Wisconsin, red pine is outside of its native range and often begins to decline at a young age (WDNR In prep. c). Central hardwoods, aspen, and forested wetland types are the remaining cover types in the area.

Figure 9. Forested cover types for the Northern Unit of the KMSF. Data are from the Division of Forestry WISFIRS (accessed April 7, 2010).



Natural Communities of the Study Area

High quality natural communities that have been documented in the Kettle Moraine State Forest and are mapped in the NHI database are listed in Table 4. Descriptions of natural community types are provided in Appendix C. Other community types are present, but these were represented by stands that were too small, too highly disturbed, or too altered to warrant inclusion in the NHI database.

The KMSF supports numerous high-quality, critically imperiled, and globally rare natural communities. Oak Openings, commonly referred to as oak savannas, are a globally critically imperiled natural community. This very rare natural community type was once found on 5.5 million acres in Wisconsin (Curtis 1959). The majority of these areas have been converted to residential or agricultural uses or succeeded to closed-canopy forests due to fire suppression. The **Southern Unit** of the KMSF offers some of the best management and restoration opportunities in the upper Midwest for Oak Openings. Mesic and Wet-mesic Prairies are globally rare natural communities that were once very common across southern Wisconsin and, along with other tallgrass prairies, their acreage has decreased by 99% (Leach and Givnish 1999, WDNR 1995). Like Oak Openings, Mesic and Wet-mesic Prairies have largely been converted to agricultural or residential uses or have succeeded to forest due to fire suppression. Calcareous Fens, present on the **Southern Unit**, are the rarest wetland plant community in Wisconsin and Minnesota and possibly one of the rarest in North America (Eggers and Reed 1997).

Table 4. NHI natural community types, with last observed dates, documented within the study area. For an explanation of state and global ranks, as well as state status, see Appendix D.

Common Name	Unit						State Rank	Global Rank
	Lapham Peak	Loew Lake	Northern	Paradise Valley	Mukwonago River	Southern		
Bog Relict			2009		2009*		S3	G3
Calcareous Fen						2009	S3	G3
Cedar Glade						1993	S4	GNR
Dry Prairie						2009	S3	G3
Emergent Marsh		2009	2009	1992		2009	S4	G4
Floodplain Forest			2009				S3	G3?
Hardwood Swamp			2009				S3	G4
Lake--Deep, Hard, Drainage		1995				1975	S3	GNR
Lake--Shallow, Hard, Drainage			2009				SU	GNR
Lake--Shallow, Hard, Seepage			2009				SU	GNR
Lake--Shallow, Soft, Drainage			1978				S3	GNR
Lake--Shallow, Soft, Seepage			2005				S4	GNR
Mesic Prairie						2009	S1	G2
Northern Sedge Meadow			2009				S3	G4
Northern Wet-mesic Forest			2009				S3S4	G3?
Oak Opening						2009	S1	G1
Oak Woodland						2009	S1?	GNR
Sand Prairie						2009	S2	GNR
Shrub-carr		2009	2009		1976	2009	S4	G5
Southern Dry Forest	2009					2009	S3	G4
Southern Dry-mesic Forest			2009			2009	S3	G4
Southern Hardwood Swamp		2009					S2	G4?

*This record is not yet mapped in the NHI database.

Common Name	Unit						State Rank	Global Rank
	Lapham Peak	Loew Lake	Northern	Paradise Valley	Mukwonago River	Southern		
Southern Mesic Forest			2009				S3	G3?
Southern Sedge Meadow		2009	2009			2009	S3	G4?
Southern Tamarack Swamp (Rich)		2009	2009				S3	G3
Spring Pond			1971				S3	GNR
Springs and Spring Runs, Hard			2009			2009	S4	GNR
Stream--Fast, Hard, Cold			2004				S4	GNR
Stream--Fast, Soft, Cold			1978				SU	GNR
Stream--Slow, Hard, Warm						1985	SU	GNR
Wet-mesic Prairie						2009	S2	G2

Rare Vascular Plants of the Study Area

The Kettle Moraine State Forest supports 151 known occurrences of 45 rare plant species (including 4 State Endangered species, 13 State Threatened species, and 28 state Special Concern species) (Table 5). Particularly significant are rare species associated with three groups of natural communities: 1) oak savanna and Dry Prairie, 2) Wet-mesic Prairie and Calcareous Fen, and 3) Southern Tamarack Swamp and associated wetland complexes. All of these community types have severely declined throughout Wisconsin but are well-represented by extensive, high-quality remnants in the KMSF.

Oak savannas and Dry Prairies support significant populations of kitten tails (*Besseyia bullii*), a globally vulnerable species endemic to the upper Midwest. The Southern Unit contains the largest number of occurrences and the largest population of kitten tails of any state-owned property in Wisconsin. Another Midwest endemic is forked aster (*Aster furcatus*), which is found at the interface of oak savannas/dry to mesic woodland forests and springs or groundwater seepage areas. High-quality examples of Oak Woodland support roundfruit St. John's-wort (*Hypericum sphaerocarpon*) and autumn coral-root (*Corallorhiza odontorhiza*). Open Dry Prairies in the KMSF support a large portion of the state's population of white camas (*Zigadenus elegans* var. *glaucus*; also found in Wet-mesic Prairies), as well as significant populations of yellow gentian (*Gentiana alba*; also found in Mesic and Dry-mesic Prairies).

Areas of Wet-mesic Prairie are extremely significant, especially in the Southern Unit and include pristine areas as well as large restoration areas such as the Scuppernong River Habitat Preservation Area. Wet-mesic Prairie supports the only two extant populations of earleaf foxglove (*Tomanthera auriculata*), as well as two populations of eastern prairie fringed orchid (*Platanthera leucophaea*), the only federally threatened plant on the KMSF. Wet-mesic Prairie and Calcareous Fen also support significant populations of over a dozen additional rare plant species, many of which likely reach their highest abundance on the KMSF. These include prairie milkweed (*Asclepias sullivantii*), prairie Indian plantain (*Cacalia tuberosa*), prairie straw sedge (*Carex suberecta*), small white lady's-slipper (*Cypripedium candidum*), flat-stemmed spike-rush (*Eleocharis compressa*), beaked spike-rush, lesser fringed gentian, tufted bulrush (*Scirpus cespitosus*), low nutrush (*Scleria verticillata*), Ohio goldenrod, sticky false asphodel (*Tofieldia glutinosa*), common bog arrow-grass (*Triglochin maritima*), slender bog arrow-grass (*Triglochin palustris*), and white camas (also found in dry, calcareous bluff prairies).

High-quality Southern Tamarack Swamp and the matrix of wetland communities that occur with it (Hardwood Swamp, Northern Wet-mesic Forest, and Shrub-carr) provide significant habitat for several

rare plants in the Northern Unit. In particular, these calcareous, groundwater-fed wetland complexes provide ideal habitat for bog bluegrass (*Poa paludigena*), a globally vulnerable species that likely reaches its greatest abundance in Wisconsin. Also found in these habitats are cuckooflower (*Cardamine pratensis*), northern yellow lady's-slipper (*Cypripedium parviflorum* var. *masakin*; also found in Wet Prairies in the Southern Unit), and showy lady's-slipper (*C. reginae*).

Table 5. NHI Working List plants documented within the study area. For an explanation of state and global ranks, as well as state status, see Appendix D. List of rare species, state rank, and state status based on 2009 Working List. [Editors note: Working List was substantially revised in June 2011; see NHI webpage for current Working List.]

Common Name	Scientific Name	Last Reported Documentation	State Rank	Global Rank	State Status	Federal Status
American Gromwell	<i>Lithospermum latifolium</i>	2009	S3	G4	SC	
Autumn Coral-root	<i>Corallorhiza odontorhiza</i>	1993	S3	G5	SC	
Beaked Spikerush	<i>Eleocharis rostellata</i>	2009	S2	G5	THR	
Bog Bluegrass	<i>Poa paludigena</i>	2009	S3	G3	THR	
Christmas Fern	<i>Polystichum acrostichoides</i>	1995	S2	G5	SC	
Common Bog Arrow-grass	<i>Triglochin maritima</i>	2009	S3	G5	SC	
Crawe Sedge	<i>Carex crawei</i>	2009	S3	G5	SC	
Cuckooflower	<i>Cardamine pratensis</i>	2009	S3	G5	SC	
Earleaf Foxglove	<i>Tomanthera auriculata</i>	2009	S1	G3	SC	
Eastern prairie fringed orchid	<i>Platanthera leucophaea</i>	2009	S2	G2G3	END	LT
Few-flower Spikerush	<i>Eleocharis quinqueflora</i>	1976	S2	G5	SC	
Flat-stemmed Spike-rush	<i>Eleocharis compressa</i>		S2	G4	SC	
Forked Aster	<i>Aster furcatus</i>	2004	S3	G3	THR	
Grassleaf Rush	<i>Juncus marginatus</i>	2005	S2	G5	SC	
Kitten Tails	<i>Besseyia bullii</i>	2009	S3	G3	THR	
Lesser Fringed Gentian	<i>Gentianopsis procera</i>	2009	S3	G5	SC	
Low Nutrush	<i>Scleria verticillata</i>	2009	S2	G5	SC	
Many-headed Sedge	<i>Carex sychnocephala</i>	1995	S2	G4	SC	
Marsh Blazing Star	<i>Liatris spicata</i>	1971	S3	G5	SC	
Narrow-leaved Vervain	<i>Verbena simplex</i>	1964	S1	G5	SC	
Northern Yellow Lady's-slipper	<i>Cypripedium parviflorum</i> var. <i>makasin</i>	2009	S3	G5T4Q	SC	
Ohio Goldenrod	<i>Solidago ohioensis</i>	2000	S3	G4	SC	
Prairie Indian Plantain	<i>Cacalia tuberosa</i>	2009	S3	G4G5	THR	
Prairie Milkweed	<i>Asclepias sullivantii</i>	2009	S2S3	G5	THR	
Prairie Parsley	<i>Polytaenia nuttallii</i>	1947	S3	G5	THR	
Prairie Straw Sedge	<i>Carex suberecta</i>	2009	S1	G4	SC	
Purple Milkweed	<i>Asclepias purpurascens</i>	2000	S3	G5?	END	
Richardson Sedge	<i>Carex richardsonii</i>	2001	S2	G4	SC	
Rough Rattlesnake-root	<i>Prenanthes aspera</i>	1947	S2	G4?	END	
Roundfruit St. John's-wort	<i>Hypericum sphaerocarpum</i>	2009	S1S2	G5	THR	
Showy Lady's-slipper	<i>Cypripedium reginae</i>	2009	S3	G4	SC	
Slender Bog Arrow-grass	<i>Triglochin palustris</i>	2009	S3	G5	SC	
Slim-stem Small-reedgrass	<i>Calamagrostis stricta</i>	1995	S3	G5	SC	
Small Skullcap	<i>Scutellaria parvula</i> var. <i>parvula</i>	1991	S1	G4T4	END	
Small White Lady's-slipper	<i>Cypripedium candidum</i>	2009	S3	G4	THR	
Sticky False-asphodel	<i>Tofieldia glutinosa</i>	2009	S2S3	G4G5	THR	
Swamp Agrimony	<i>Agrimonia parviflora</i>	2009	S1S2	G5	SC	
Torrey Sedge	<i>Carex torreyi</i>	2009	S1	G4	SC	
Tufted Bulrush	<i>Scirpus cespitosus</i>		S2	G5	THR	
Whip Nutrush	<i>Scleria triglomerata</i>	2000	S2S3	G5	SC	
White Camas	<i>Zigadenus elegans</i> var. <i>glaucus</i>	2009	S2S3	G5T4T5	SC	
Woodland Bluegrass	<i>Poa sylvestris</i>	1975	S1	G5	SC	
Woolly Milkweed	<i>Asclepias lanuginosa</i>	1965	S1	G4?	THR	
Yellow Evening Primrose	<i>Calylophus serrulatus</i>	1942	S2	G5	SC	
Yellow Gentian	<i>Gentiana alba</i>	2009	S3	G4	THR	
Yellow Water Lily	<i>Nuphar advena</i>	1943	S1	G5T5	SC	

Rare Animals of the Study Area

Seventy-four NHI Working List animal species have been documented in the study area, including 12 State Endangered and 15 State Threatened species (Table 6). Forty-seven state special concern animals are also known from the KMSF. This large number of rare animals from numerous taxonomic groups reflects the overall diversity of good-quality habitats that are present throughout the five units of the KMSF. Over 40% of the animals on the State Threatened and Endangered Species lists are found on the KMSF, including globally rare species.

There is a large representation of area-sensitive forest interior bird species present with six state listed species noted as breeding in the KMSF. This includes nineteen known breeding territories for Red-shouldered Hawks. This species requires large tracts of older growth, closed canopy forest in close proximity to wetlands, primarily the Ephemeral Ponds occurring in high numbers in the **Northern Unit**. Good populations of Cerulean Warblers were found at the in the larger blocks of older dry-mesic and mesic forests with a diverse structural complexity. Hooded Warblers are found in high numbers in the **Southern Unit** with population estimates for the property possibly being over 220 pairs, likely representing the best population in the entire state (Bielefeldt and Rosenfield 2005).

Three rare snakes are found in the state forest including a new record for the KMSF for the eastern ribbonsnake (*Thamnophis sauritus*), a State Endangered species with only four non-historical (post-1979) records known in the entire state. This species appears to be restricted to sphagnum bogs in south-central and eastern Wisconsin. Two juvenile individuals were observed during cover board surveys. One-half of the known current records for the State Endangered queensnake (*Regina septemvittata*) occur in the KMSF. This rare aquatic snake is restricted to southeast Wisconsin and requires clear, fast-flowing, warm-water streams and small rivers with populations of aquatic crayfish, the preferred prey of queensnakes. An outlier population of the State Threatened Butler's gartersnake (*Thamnophis butleri*) occurs in the **Northern Unit** of the KMSF.

New locations were documented in the KMSF for three state listed mussels: the rainbow shell (*Villosa iris*; END), ellipse (*Venustaconcha ellipsiformis*; THR), and slippershell mussel (*Alasmidonta viridis*; THR). The ellipse was relatively common and widespread throughout both the Milwaukee River and the Rock River drainages. The rainbow shell was found in low numbers with dead shells found at two reaches outside of the KMSF and the only live collection coming from one site. The slippershell mussel was formerly common and widespread throughout both drainages. Current mussel surveys found only two slippershell locations, both of which had old, live individuals present, leaving the long-term viability of these local populations in question (Berg 2009).

Two globally rare butterflies occur within the KMSF, the Powesheik skipperling (*Oarisma powesheik*) and the swamp metalmark (*Calephelis muticum*), both State Endangered species. The Powesheik skipperling utilizes Wet-mesic to Mesic Prairie habitats in Wisconsin. Native grasses and sometimes sedges are used as larval food plants and black-eyed Susan (*Rudbeckia hirta*), shrubby cinquefoil, and swamp milkweed (*Asclepias incarnata*) are the most commonly used nectar plants. One population of this skipper, currently composed of 2 subpopulations, is known to occur in the **Southern Unit**. The swamp metalmark is strongly associated with open fen-like or wet meadow habitats with low or sparse vegetation that include an abundance of swamp thistle (*Cirsium muticum*), their larval food plant. No new populations of either species were found during surveys, although potential sites for habitat expansion or future introductions are present.

A significant range extension for the spatterdock darner, a State Threatened species, was documented in two shallow lakes in the **Southern Unit**. This species was only previously known in Wisconsin from a few shallow lakes in Marquette County.

Table 6. Rare animals documented within the study area. For an explanation of state and global ranks, state status, and NHI tracking, see Appendix D. An explanation of Species of Greatest Conservation Need is on page 26. Species with a “W” in the “Tracked by NHI” column are on the Watch List (see Appendix D) and are not mapped in the NHI database. Various sources were used to determine the Watch List species and SGCN present and this may not be a complete list. List of rare species, state rank, status, and tracked status based on 2009 Working List. [Editors note: Working List was substantially revised in June 2011; see NHI webpage for current Working List.]

Common Name	Scientific Name	Last Reported Documentation	State Rank	Global Rank	State Status	SGCN	Tracked by NHI
Beetle							
A Crawling Water Beetle*	<i>Haliplus pantherinus</i>	2009	S2S3	GNR	SC/N	Y	Y
A Dubiraphian Riffle Beetle	<i>Dubiraphia bivittata</i>	2009	S3S4	GNR	SC/N	Y	W
A Predaceous Diving Beetle*	<i>Celina hubbelli</i>	2009	S2S3	GNR	SC/N	Y	Y
A Predaceous Diving Beetle	<i>Copelatus chevrolati</i>	2009	--	GNR	SC/N	Y	W
A Predaceous Diving Beetle	<i>Graphoderus Manitobensis</i>	2009	--	GNR	SC/N	Y	W
A Predaceous Diving Beetle	<i>Hydroporus badiellus</i>	2009	S3?	GNR	SC/N		Y
A Predaceous Diving Beetle*	<i>Hydroporus pseudovilis</i>	2009	S1S2	GNR	SC/N	Y	Y
A Predaceous Diving Beetle	<i>Ilybius ignarus</i>	2009	S3	GNR	SC/N	Y	W
A Predaceous Diving Beetle	<i>Neoscutopterus hornii</i>	2009	S3S4	GNR	--	Y	
A Predaceous Diving Beetle	<i>Rhantus sinuatus</i>	2009	S3S4	GNR	SC/N	Y	
A Riffle Beetle*	<i>Stenelmis sandersoni</i>	2002	SNR	GNR	--	Y	
A Water-penny Beetle*	<i>Ectopria spp. 2</i>	1985	SNR	GNR	--	Y	
A Water Scavenger Beetle*	<i>Laccobius agilis</i>	2009	S2S3	GNR	SC/N		Y
An Elmid Beetle	<i>Microcylloepus pusillus</i>	1985	S3S4	GNR	--	Y	
Cantrall's Bog Beetle*	<i>Liodessus cantralli</i>	2009	S1S2	GNR	SC/N	Y	Y
Enochrus hamiltoni	<i>Enochrus hamiltoni</i>	2009	SNR	GNR	--	Y	
Laccornis latens	<i>Laccornis latens</i>	2009	--	GNR	SNR	Y	
Suphisellus puncticollis	<i>Suphisellus puncticollis</i>	2009	--	GNR	SNR	Y	
Bird							
Acadian Flycatcher	<i>Empidonax vireescens</i>	2010	S3B	G5	THR	Y	Y
American Woodcock	<i>Scolopax minor</i>	1998	S4B	G5	SC/M	Y	W
Barn Owl	<i>Tyto alba</i>	1981	S1B,S1N	G5	END	Y	Y
Bell's Vireo	<i>Vireo bellii</i>	2009	S2B	G5	THR	Y	Y
Black Tern	<i>Chlidonias niger</i>	2009	S2B	G4	SC/M	Y	Y
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	2010	S4B	G5	SC/M	Y	W
Black-crowned Night-heron	<i>Nycticorax nycticorax</i>	1974	S2B	G5	SC/M		Y
Blue-winged Warbler	<i>Vermivora pinus</i>	2010	S4B	G5	SC/M	Y	W
Bobolink	<i>Dolichonyx oryzivorus</i>	2010	S4B	G5	SC/M	Y	W
Brown Thrasher	<i>Toxostoma rufum</i>	1996	S4B	G5	SC/M	Y	W
Canada Warbler*	<i>Wilsonia canadensis</i>	1991	S3B	G5	SC/M	Y	Y
Cerulean Warbler	<i>Dendroica cerulea</i>	2010	S2S3B	G4	THR	Y	Y
Dickcissel	<i>Spiza americana</i>	2009	S3B	G5	SC/M	Y	Y
Eastern Meadowlark	<i>Sturnella magna</i>	2010	S4B	G4	SC/M	Y	W

Field Sparrow	<i>Spizella pusilla</i>	2010	S4B	G5	SC/M	Y	W
Golden-winged Warbler	<i>Vermivora chrysoptera</i>	1993	S4B	G4	SC/M	Y	W
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	2010	S4B	G4	SC/M	Y	W
Henslow's Sparrow	<i>Ammodramus henslowii</i>	2010	S3B	G4	THR	Y	Y
Hooded Warbler	<i>Wilsonia citrina</i>	2009	S2S3B	G5	THR	Y	Y
Kentucky Warbler	<i>Oporornis formosus</i>	2007	S1S2B	G5	THR	Y	Y
King Rail	<i>Rallus elegans</i>	2010	S1B	G4	SC/M	Y	Y
Least Flycatcher	<i>Empidonax minimus</i>	2007	S4B	G5	SC/M	Y	W
Northern Harrier	<i>Circus cyaneus</i>	2007	S3B/S2N	G5	SC/M	Y	W
Osprey	<i>Pandion haliaetus</i>	2009	S4B	G5	SC/M	Y	Y
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	2010	S3B	G5	SC/M	Y	W
Red-necked Grebe	<i>Podiceps grisegena</i>	2009	S1B	G5	END	Y	Y
Red-shouldered Hawk	<i>Buteo lineatus</i>	2009	S2B	G5	THR	Y	Y
Upland Sandpiper	<i>Bartramia longicauda</i>	2004	S4B	G5	SC/M	Y	Y
Veery	<i>Catharus fuscescens</i>	2010	S4B	G5	SC/M	Y	W
Vesper Sparrow	<i>Poocetes gramineus</i>	2000	S3B	G4	SC/M	Y	W
Whip-poor-will	<i>Caprimulgus vociferus</i>	2010	S4B	G5	SC/M	Y	W
Willow Flycatcher	<i>Empidonax traillii</i>	2010	S4B	G5	SC/M	Y	W
Wood Thrush	<i>Hylocichla mustelina</i>	2010	S1B	G5	SC/M	Y	W
Worm-eating Warbler	<i>Helmitheros vermivorus</i>	1999	S3B	G5	END	Y	Y
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	2009	S2B	G5	SC/M	Y	Y
Yellow-breasted Chat	<i>Icteria virens</i>	2009	S2B	G5	SC/M		Y
Butterfly							
Azure Bluet	<i>Enallagma aspersum</i>	1989	S2S3	G5	SC/N		Y
Broad-winged Skipper	<i>Poanes viator</i>	1992	S3	G5	SC/N		Y
Columbine Dusky Wing	<i>Erynnis lucilius</i>	1962	S2	G4	SC/N	Y	Y
Hickory Hairstreak	<i>Satyrium caryaevorum</i>	1993	S2	G4	SC/N	Y	Y
Little Glassy Wing	<i>Pompeius verna</i>	1993	S1?	G5	SC/N	Y	Y
Mulberry Wing	<i>Poanes massasoit</i>	2009	S3	G4	SC/N		Y
Powesheik Skipperling	<i>Oarisma powesheik</i>	2009	S1	G2G3	END	Y	Y
Swamp Metalmark	<i>Calephelis muticum</i>	1978	S1	G3	END	Y	Y
Two-spotted Skipper	<i>Euphyes bimacula</i>	1989	S3	G4	SC/N		Y
Caddisfly							
A Caddisfly	<i>Limnephilus sericeus</i>	2009	SNR	G5	--	Y	
A Lepidostomatid Caddisfly	<i>Lepidostoma libum</i>	2009	S1?	G3G4	SC/N	Y	Y
A Long-horned Casemaker Caddisfly	<i>Triaenodes nox</i>	2009	S1S3	G5	SC/N	Y	Y
Crustacean							
A Side-swimmer	<i>Crangonyx richmondensis</i>	2009	S3	G5	SC/N	Y	W
Northern Clearwater Crayfish	<i>Orconectes propinquus</i>	2009	--	G5	SC/N		W
Dragonfly and Damselfly							
Azure Bluet	<i>Enallagma aspersum</i>	1989	S2S3	G5	SC/N		Y
Double-striped Bluet	<i>Enallagma basidens</i>	2009	S2	G5	SC/N		Y
Eastern Red Damselfly*	<i>Amphiagrion saucium</i>	1988	S3	G5	SC/N	Y	Y

Elfin Skimmer	<i>Nannothemis bella</i>	1992	S2S3	G4	SC/N	Y	Y
Fragile Forktail	<i>Ischnura posita</i>	1990	S2S3	G5	SC/N	Y	Y
Highland Dancer	<i>Argia plana</i>	1989	S2	G5	SC/N	Y	Y
Lancet Clubtail	<i>Gomphus exilis</i>	2009	S3S4	G5			Y
Pronghorned Clubtail*	<i>Gomphus graslinellus</i>	2009	S2	G5	SC/N		Y
River Bluet	<i>Enallagma anna</i>	1990	S2	G5	SC/N	Y	Y
Slender Bluet	<i>Enallagma traviatum</i>	1990	S1S2	G5	SC/N	Y	Y
Spatterdock Darner*	<i>Rhionaeschna mutata</i>	2009	S1	G4	THR	Y	Y
Swamp Darner*	<i>Epiaeschna heros</i>	2009	S1?	G5	SC/N	Y	Y
Unicorn Clubtail	<i>Arigomphus villosipes</i>	1989	S1S2	G5	SC/N	Y	Y
Fish							
Banded Killifish	<i>Fundulus diaphanus</i>	1979	S3	G5	SC/N	Y	Y
Greater Redhorse	<i>Moxostoma valenciennesi</i>	2007	S3	G4	THR	Y	Y
Lake Chubsucker	<i>Erimyzon sucetta</i>	2008	S3	G5	SC/N	Y	Y
Least Darter	<i>Etheostoma microperca</i>	2009	S3	G5	SC/N	Y	Y
Longear Sunfish	<i>Lepomis megalotis</i>	2003	S2	G5	THR	Y	Y
Pugnose Shiner	<i>Notropis anogenus</i>	1979	S2	G3	THR	Y	Y
Slender Madtom	<i>Noturus exilis</i>	2009	S1	G5	END	Y	Y
Weed Shiner	<i>Notropis texanus</i>	1902	S3	G5	SC/N		Y
Frog							
American Bullfrog	<i>Lithobates catesbeianus</i>	2009	S3	G5	SC/H		Y
Northern Cricket Frog	<i>Acris crepitans</i>	1985	S1	G5	END	Y	Y
Pickerel Frog	<i>Lithobates palustris</i>	2009	S3S4	G5	SC/H	Y	Y
Grasshopper							
Striped Sedge Grasshopper	<i>Stethophyma lineatum</i>	2005	S3	G5	SC/N	Y	W
Leafhopper							
A Leafhopper	<i>Flexamia prairiana</i>	1996	S1	GNR	SC/N	Y	Y
A Leafhopper	<i>Memnonia panzeri</i>	2009	S2?	GNR	SC/N	Y	Y
Red-tailed Prairie Leafhopper	<i>Aflexia rubranura</i>	2003	S2	G2	END	Y	Y
Mammal							
Arctic Shrew	<i>Sorex arcticus</i>	2010	S3S4	G5	SC/N		Y
Eastern Red Bat	<i>Lasiurus borealis</i>	2009	S3	G5	SC	Y	W
Franklin's Ground Squirrel	<i>Spermophilus franklinii</i>	2005	S2	G5	SC/N	Y	Y
Hoary Bat	<i>Lasiurus cinereus</i>	2009	S3	G5	SC	Y	W
Northern Long-eared Bat	<i>Myotis septentrionalis</i>	2010	S3	G4	SC/N	Y	Y
Pygmy Shrew	<i>Sorex hoyi</i>	2009	S3S4	G5	SC/N		Y
Silver-haired Bat	<i>Lasionycteris noctivagans</i>	2010	S3	G4	SC/N	Y	W
Mayfly							
A Mayfly	<i>Caenis diminuta</i>	2009	SNR	G5		Y	
Moth							
An Owlet Moth	<i>Macrochilo bivittata</i>	1993	S3	G3G4	SC/N	Y	Y
Liatrix Borer Moth	<i>Papaipema beeriana</i>	2002	S2	G2G3	SC/N	Y	Y

Midwestern Fen Buckmoth	<i>Hemileuca sp. 3</i>	1993	S3	G5T3T4	SC/N	Y	Y
Silphium Borer Moth	<i>Papaipema silphii</i>	2010	S2	G3G4	END	Y	Y
Mussel							
Creek Heelsplitter	<i>Lasmigona compressa</i>	2009	S3S4	G5	SC/P		W
Ellipse	<i>Venustaconcha ellipsiformis</i>	2009	S2	G4	THR	Y	Y
Rainbow Shell	<i>Villosa iris</i>	2009	S1	G5Q	END	Y	Y
Slippershell Mussel*	<i>Alasmidonta viridis</i>	2009	S2	G4G5	THR	Y	Y
Other							
Bird Rookery	Bird Rookery	2010	SU	G5	SC		Y
Herp Hibernaculum	Herp Hibernaculum	2009	SU	GNR	SC		Y
Migratory Bird Concentration Site	Migratory Bird Concentration Site	2006	SU	G3	SC		Y
Salamander							
Four-toed Salamander	<i>Hemidactylum scutatum</i>	2009	S3	G5	SC/H	Y	Y
Mudpuppy*	<i>Necturus maculosus</i>	1990	S3S4	G5	SC/H	Y	Y
Snake							
Butler's Gartersnake	<i>Thamnophis butleri</i>	2009	S3	G4	THR	Y	Y
Eastern Hog-nosed Snake	<i>Heterodon platirhinos</i>	2009	S3?	G5	SC/H		Y
Eastern Ribbonsnake	<i>Thamnophis sauritus</i>	2009	S1	G5	END	Y	Y
North American Racer	<i>Coluber constrictor</i>	1972	S2	G5	SC/P	Y	Y
Northern Ring-necked Snake	<i>Diadophis punctatus edwardsii</i>	1993	S3?	G5T5	SC/H		Y
Queensnake	<i>Regina septemvittata</i>	2009	S1	G5	END	Y	Y
Western Ribbonsnake	<i>Thamnophis proximus</i>	1973	S1	G5	END	Y	Y
True Bug							
A Broad-shouldered Water Strider	<i>Microvelia fontinalis</i>	2009	--	GNR	SC/N	Y	W
A Velvet Water Bug*	<i>Hebrus burmeisteri</i>	2009	S2S3	GNR	SC/N	Y	Y
A Water Scorpion	<i>Nepa apiculata</i>	2009	S3	GNR	SC/N	Y	W
Turtle							
Blanding's Turtle	<i>Emydoidea blandingii</i>	2010	S3	G4	THR	Y	Y

Threats to the Biodiversity of the KMSF

Threats to the biodiversity of the KMSF are all interrelated and include ecological simplification, forest fragmentation, hydrological manipulation, invasive species, deer overabundance, and altered ecological processes.

Ecological Simplification

A major conclusion of Wisconsin's Statewide Forest Assessment 2010 was that Wisconsin forest composition and structure is changing and becoming more simplified (WDNR 2010a). Ecological simplification can be seen in the change in herbaceous species composition, the decline of native herbaceous species diversity and the increase in non-native plants, as well as simplification of forested overstory composition (Rooney et al. 2004). Factors contributing to ecological simplification include invasive species, altered ecological processes, and, for forests, the amount of non-forested habitat surrounding a forest patch and deer herbivory (Rogers et al. 2009; Rooney et al. 2004; WDNR 2010a).

The size, structure, and composition of the forests of the KMSF are important for biodiversity. Structural characteristics such as large trees, cavity trees, snags, and coarse woody debris provide habitat for rare and declining species. Trends in Wisconsin's forests show a lack of old forests, old-growth forests, and a continued decline of the oldest age classes of trees (WDNR 2010a). Rogers et al. (2009) showed that rates of ecological simplification and loss of native plant species were slower in large forest patches within a less fragmented landscape than smaller and more isolated patches.

Wisconsin's wetlands, including those in the KMSF, have also suffered from ecological simplification. Factors contributing to ecological simplification that impact wetlands include invasive species, altered hydrology, conversion to agriculture, and sediment/nutrient-laden runoff from croplands.

Forest Fragmentation

The KMSF contains the largest block of forest in southeastern Wisconsin (Figure 10) and is the only major opportunity within this area to enhance habitat for area-sensitive forest species and to reduce the impact of forest fragmentation. Within the large area, though, much of the forest is fragmented by roads, camping facilities, and adjoining land uses, including residential and agricultural uses. Although little can be done to remove existing infrastructure, minimizing the impacts of forest fragmentation is important.

Forest fragmentation results in an increase in forest edge and an increase in nest failure in ground and shrub-nesting forest birds, including neotropical migrants (Donovan et al. 1995; Knutson et al. 2004). The forest edge can be an "ecological trap" for ground and shrub-nesting forest bird species. Flaspohler et al. (1999) showed that the zone around a cleared area in a forest can extend up to 300 meters into the intact forest. Within this zone, ground-nesting bird nest density increases, but the nest success decreases. The decrease in nest success could be due to the increase in edge-adapted predators such as raccoons, skunks, and crows; nest-parasitizing cowbirds; and competition from edge-adapted species. New research has also shown the impacts of fragmentation to native forest floral species diversity. Rogers et al. (2009) found that large forest patches in mostly minimally fragmented landscapes lost few native species, were more likely to recruit new species, and experienced slower rates of ecological simplification over the past 55 years than did smaller and more isolated patches.

Altered Ecological Processes

The vegetation that historically occurred within the KMSF developed within a complex environment comprised of both elements that are static over ecological time (e.g., soils, underlying landforms) and dynamic ecological processes (e.g., hydrological cycles, nutrient cycles, wildfires). Many of the dynamic ecological processes that shaped the landscape of the KMSF have been altered by humans.

Hydrological manipulation and degradation occurs through many means, including damming, ditching, draining, sedimentation, and erosion. Dams affect aquatic species and habitats by fragmenting them into disjunct segments, preventing the movements of some species between different stretches of streams. Increased water-levels associated with dams can displace small mammals due to prolonged flooding and restrict dispersal corridors and foraging areas of upland small mammals (Bautz 2010). In addition, natural hydrological fluctuations associated with free-flowing rivers and streams are integral to wetlands formed under fluctuating water levels and the many species that depend upon them, including amphibians that rely on a specific hydrological regime to complete certain life-stages (PARC 2002).

Maintaining sufficient surface and groundwater levels is a major concern for the lotic communities in this region that are dependent on them (Schmude 2009).

Sedimentation, erosion, and nutrient-laden runoff into waterways are the biggest threat facing mussel survivability in the KMSF (Berg 2009). Land use changes, poorly managed agricultural practices, and mineral or timber extraction can result in an increase in suspended solids and sedimentation in rivers and streams (Wood & Armitage 1997). Comparisons of current relative frequencies and distribution of unionid mussels for the two drainages in the **Northern and Southern Units** of the KMSF found significant mussel population losses in number of sites and consistent mussel population losses in numbers of rivers, when compared to historic records. Soil erosion associated with horse trails crossing through or running alongside rivers throughout the KMSF threaten mussel populations.

Fire is an essential ecological process to many natural communities and rare species within the KMSF, especially in the **Southern Unit**. Without regular fire, native woody species can invade and dominate these communities. By volatilizing elevated soil nitrogen, fire also indirectly influences nutrient cycling, shifting conditions to favor native plants and to disfavor non-natives. In woodlands, fire facilitates seedling establishment, controls tree species that are not adapted to fire, and prevents smothering of short-statured plants through the removal of leaf litter. In grasslands, fire promotes growth, flowering and overall diversity of native plants by removing excess thatch among other things.

Invasive Species

Invasive species are present on the KMSF and surrounding landscape and in many areas, especially the Lapham Peak, Mukwonago River, and **Southern Units**, are numerous and widespread. Non-native invasive species thrive in newly disturbed areas because they establish quickly, tolerate a wide range of

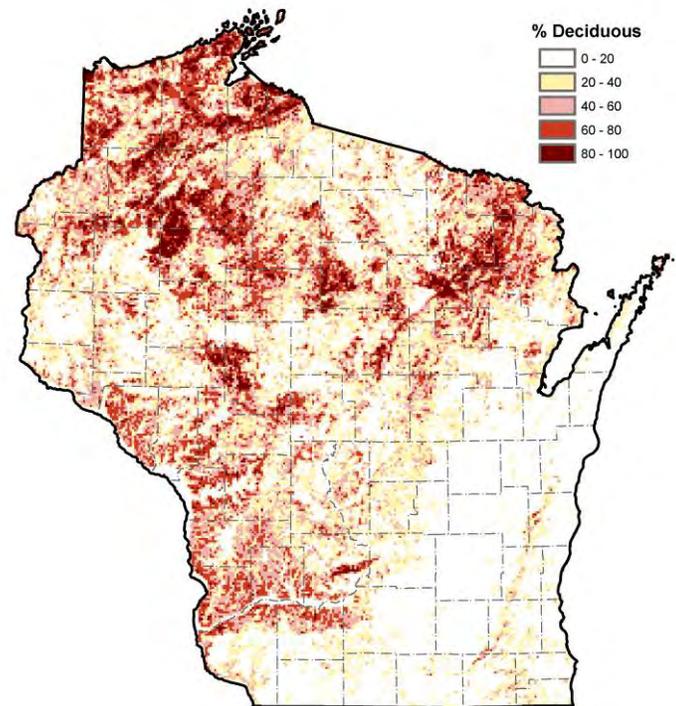


Figure 10. Continuous deciduous forested blocks in Wisconsin. Map derived from the USGS 2001 National Land Cover Database using the Deciduous Forest category and calculating percent deciduous forest in 640-acre block (mean block statistics).

conditions, are easily dispersed, and are no longer limited by the diseases, predators, and competitors that kept their populations in check in their native range. As a result, invasive plants can kill and out-compete native plants by monopolizing light, water, and nutrients and altering soil chemistry and mychorrizal relationships. In situations where invasive plants become dominant, they may even alter ecological processes by limiting the ability to use of prescribed fire and modifying hydrology. In addition to the threats on native communities and native species diversity, invasive species negatively impact forestry (by reducing tree regeneration, growth and longevity), recreation (by degrading fish and wildlife habitat and limiting access), agriculture, and human health (noxious weeds and non-native pathogens). Species that are widespread on the KMSF and have the greatest impact to native species diversity, rare species habitats, or high-quality natural communities are listed in Table 7. These species are all present in the **Southern Unit** and many exist and pose a future threat to the **Northern Unit**.

Table 7. Known widespread invasive species on the KMSF.

Common Name	Latin Name	Upland Habitats		Wetland Habitats		Aquatic
		Open	Wooded	Open	Wooded	
Animal						
common carp	<i>Cyprinus carpio</i>					X
gypsy moth	<i>Lymantria dispar</i>		X			
rusty crayfish	<i>Orconectes rusticus</i>					X
zebra mussels	<i>Dreissena polymorpha</i>					X
earthworms	<i>Acanthodrilidae,</i> <i>Lumbricidae,</i> <i>Megascloedidae</i> spp.		X			
Plant						
Canada thistle	<i>Cirsium arvense</i>	X		X		
Common buckthorn	<i>Rhamnus cathartica</i>	X	X	X	X	
Common reed	<i>Phragmites australis</i>			X	X	
Curly-leaf pondweed	<i>Potamogeton crispus</i>					X
Dame's rocket	<i>Hesperis matronalis</i>		X		X	
Eurasian bush honeysuckles	<i>Lonicera</i> spp.	X	X			
Eurasian water milfoil	<i>Myriophyllum spicatum</i>					X
Garlic mustard	<i>Alliaria petiolata</i>	X	X		X	
Glossy buckthorn	<i>Rhamnus frangula</i>	X	X	X	X	
Multiflora rose	<i>Rosa multiflora</i>	X	X			
Narrow-leaved cat-tail	<i>Typha angustifolia</i>			X		
Purple loosestrife	<i>Lythrum salicaria</i>			X		
Reed canary grass	<i>Phalaris arundinacea</i>			X	X	
Spotted knapweed	<i>Centaurea biebersteinii</i>	X				
Watercress	<i>Nasturtium officinale</i>					X
Wild parsnip	<i>Pastinaca sativa</i>	X		X		
Yellow and white sweet clover	<i>Melilotus officinalis</i> and <i>M. alba</i>	X				
Fungus						
Oak wilt	<i>Ceratocystis fagacearum</i>		X		X	

The high recreational use of the KMSF has contributed to the introduction and spread of invasive species throughout the property. Campgrounds, common use areas, and trails are typical areas where invasive species are introduced by visitors' footwear, clothing, vehicle tires, and recreational equipment. Once established, these invasives not only continue to spread along recreational corridors but also invade remote high-quality areas via other vectors such as wind, water, and wildlife. Invasive species can also be

spread through management activities such as timber operations and roadside mowing if these activities are not followed with adequate invasives control measures.

A number of invasive species are new or not widespread invaders on the KMSF (Table 8). These species present an opportunity for early detection and rapid response. In addition to the most serious invasive species threats listed above, species with small population sizes could be considered management priorities (Boos et al. 2010). In addition, species that are within the area of the KMSF, but have not yet been located (Table 9), are important to consider for early detection and rapid response.

Table 8. New or not-widespread invasive species on the KMSF.

Common Name	Latin Name	Upland Habitats		Wetland Habitats		Aquatic
		Open	Wooded	Open	Wooded	
Animal						
Red swamp crayfish	<i>Procambarus clarkii</i>					X
Plant						
Asian bittersweet	<i>Celastrus orbiculatus</i>	X	X			
Black swallow-wort	<i>Vincetoxicum nigrum</i>	X	X			
Common teasel	<i>Dipsacus fullonum</i> subsp. <i>sylvestris</i>	X				
Cut-leaved teasel	<i>Dipsacus laciniatus</i>	X				
Edible pokeweed	<i>Phytolacca acinosa</i>	X	X			
Japanese knotweed	<i>Polygonum cuspidatum</i>	X	X	X	X	
Japanese hedge parsley	<i>Torilis japonica</i>		X			
Fungus						
Annosum root rot*	<i>Heterobasidion annosum</i>		X			

*Pine plantations only. Currently only known from the Southern Unit.

Table 9. Invasive species that are within the area, but not currently known from the KMSF.

Common Name	Latin Name	Upland Habitats		Wetland Habitats		Aquatic
		Open	Wooded	Open	Wooded	
Animal						
beech scale	<i>Cryptococcus fagisuga</i>		X			
emerald ash borer	<i>Agrilus planipennis</i>		X		X	
Sirex woodwasp	<i>Sirex noctillio</i>		X			
Plant						
flowering rush	<i>Butomus umbellatus</i>			X		
tall manna grass	<i>Glyceria maxima</i>			X		
Fungus						
Nectria	<i>Nectria coccinea</i> var. <i>faginata</i> .		X			

For recommendations on controlling specific invasive species consult with DNR staff; refer to websites on invasive species, such as the DNR invasive species website (“Invasive Species”) and the website of the Invasive Plants Association of Wisconsin (“Invasive Plants Association of Wisconsin”); and seek assistance from the local invasive species group: the Southeastern Wisconsin Invasive Species Consortium (“SEWISC”). Invasive species best management practices for forestry, recreation, urban forestry, and rights-of-way were developed by the Wisconsin Council on Forestry (“Invasive Species Best Management Practices”).

Beech Bark Disease

Beech bark disease, discovered in Door County in late 2009, is a major threat to American beech trees and the wildlife that depend on them. American beech is present in small numbers in the **Northern Unit** and is an important wildlife tree. Beech bark disease is the result of an interaction between the beech scale insect native to Europe and *Nectria* fungi (Houston and Obrien 1998). The disease results in a high mortality rate for American beech trees and can change the forest structure and negatively impact species that depend on the nut crop for food or trees for habitat (WDNR 2008).

Emerald Ash Borer

The emerald ash borer (*Agrilus planipennis*), an invasive, wood-boring beetle that attacks ash trees, was positively identified for the first time in Wisconsin in 2008 and is now found in 6 counties. The beetle attacks all species of ash (*Fraxinus* spp.) in Wisconsin and the risk to forests is high with models predicting that a healthy forest will lose 98% of its ash trees in 6 years (<http://www.emeraldashborer.wi.gov>). Four of the six counties in which the KMSF occurs are under quarantine to prevent the spread of emerald ash borer from an infected county. Given the large numbers of visitors to the KMSF and their potential to transport the beetle on firewood the potential for emerald ash borer introduction on the KMSF is high.

Exotic Earthworms

The invasion of forests by European earthworms of the families Acanthodrilidae, Lumbricidae, and Megascolecidae is a concern throughout Wisconsin. While native earthworms were absent from this Landscape after the last glaciation, exotic earthworms have been introduced since Euro-American settlement, primarily as discarded fishing bait (Hendrix and Bohlen 2002, Hale et al. 2005). Exotic earthworms can have dramatic impacts on forest floor properties by greatly reducing organic matter (Hale et al. 2005), microbial biomass (Groffman et al. 2004), nutrient availability (Bohlen et al. 2004, Suarez et al. 2004), and fine-root biomass (Fisk et al. 2004). These physical changes in the forest floor reduce densities of tree seedlings and rare herbs (Gundale 2002) and can favor invasive plants (Kourtev et al. 1999). In a study of 51 Northern Wisconsin forest stands, Wiegmann (2006) found that shifts in understory plant community composition due to exotic earthworms were more severe in stands with high white-tailed deer densities.

Deer Abundance

The current level of the white-tailed deer herd in Wisconsin has become a significant barrier to the conservation of biodiversity and sustainable forest management (WDNR 2010a). Herbivory by white-tailed deer has been identified as a major disturbance contributing to ecological simplification of Wisconsin's forests (Rooney et al 2004; Kovach et al 2006; Wisconsin Council on Forestry 2007; WDNR 2010a). Deer herbivory in the KMSF impacts songbirds and rare plant abundance and frequency by altering natural community composition and structure. Deer herbivory causes a decreased cover in the shrub and sapling layer which negatively impacts species richness and abundance of songbirds that nest in that layer (deCalesta 1994, McShea and Rappole 2000).

Management Considerations and Opportunities for Biodiversity Conservation for the Kettle Moraine State Forest

The Primary Site(s) listed for each opportunity for biodiversity conservation mentioned below represents the best known site(s) to protect, manage, and/or restore that feature.

Landscape Level Priorities

Ecological Connections

The KMSF offers a significant opportunity to manage a landscape mosaic of diverse habitats. The **Southern Unit** is one of only a few locations in the state where it is possible to protect, manage, and restore the full continuum of fire-dependent natural communities at a large scale. The **Northern Unit** offers a regionally rare opportunity to manage uplands with wetlands at a large scale.

This mosaic of diverse habitats with rivers and streams that course through uplands and wetlands, punctuated by lakes and ponds, meets the needs of many animal species that require a variety of habitat types for shelter, foraging, rearing their young, and hibernating. By providing this waterbody-to-wetland-to-upland continuum, the habitat needs for wildlife are maximized, and their safe movement from one habitat type to the next is ensured. Managing this habitat mosaic at a landscape scale, in particular the fire-dependent natural communities of the **Southern Unit**, can benefit plants and animals by creating large blocks of high-quality complementary habitats.

Some examples of multiple-habitat usage include:

- Turtles such as the Blanding's use a wide variety of habitat types. In addition to a variety of aquatic habitats, this species may move between a variety of wetland types, and even spend a good deal of time on land. They prefer to nest in sandy soils, and are most vulnerable while traveling up to a mile to find a suitable site.
- Many salamander species spend most of the year in the forest under woody debris and leaf litter, but need fishless wetlands or ephemeral ponds for breeding. Similarly, some frogs and toads breed in wetlands, but may forage far from water in upland areas.
- The habitat for many dragonfly species nymphs is shallow, slow-moving waters or spring-fed wetlands, while upland meadows and fields near breeding habitat are typically used by foraging adults.
- Several rare bat species use snags for roosting but open areas and water sources are important areas for foraging.
- The southern red-backed vole (*Clethrionomys gapperi*) inhabits only sites that fulfill its highly habitat requirements; a mosaic of low forested or shrub wetlands with adjacent older closed canopy uplands, coarse woody debris and adequate leaf litter. It has a short life span and dispersal corridors are essential.
- Important primary sites for the protection and management of ecological connections include the Palmyra Oak Woodland primary site in the **Southern Unit**, that, along with the adjacent Eagle Oak Openings and Prairie primary site, offers an opportunity for landscape-level planning and

ecological restoration to fit the needs of species using both closed-canopy forests and more open savanna types.

Migratory Bird Stopover Site

Portions of the **Northern Unit** were identified as a migratory bird concentration area for spring and fall landbirds (>10,000 migrants) through modeling efforts and workshops (Grveles and Matteson 2008). Important components of the KMSF concentration area include large blocks of forests that have good structural complexity and proximity to water where aquatic insects are emerging. Because agriculture and urban development dominate the surrounding landscape, these forest patches offer respite to exhausted birds traversing across mainly inhospitable terrain. For these reasons, it is likely that the entire KMSF provides an important corridor for migratory birds. In particular, Crooked, Little Mud, and Kellings Lakes Primary Site in the **Northern Unit** has been recognized as an important place for migrating waterfowl due to its diversity of wetlands. Also in the **Northern Unit**, the Kewaskum Maple-Oak Woods and Milwaukee River Floodplain Forest and Upland Woods Primary Sites are important migratory bird stopover sites.

Threats to Migratory Bird Stopover Sites and migratory birds include habitat destruction and alteration (Duncan 2002). Habitat alteration includes the simplification of forest structure or the alteration of forest composition, including invasive species that may change the kinds, quantity, and quality of food resources (Duncan 2002). Streams are susceptible to pollutants from nutrient runoff and road salts which could harm prey species if water quality diminishes. The KMSF has the opportunity to support up to 10,000 migrating landbirds in the spring and fall (Grveles and Matteson 2008) by maintaining large blocks of forests and preventing habitat alterations such as simplification of forest structure or the alteration of forest composition.

Older Forests / Old-Growth

Older forests (greater than 100-120 years old) in Wisconsin are rare and declining, largely due to timber harvesting and conversion to other land uses (WDNR 2010a). The WDNR has identified a need to conserve, protect, and manage old-growth forests (WDNR 2004, WDNR 1995) and old-growth management is a component of Forest Certification. The age and structure of an old-growth natural community varies with species and site, but in general old-growth characteristics do not significantly develop until 200 years. Old-growth stands are sometimes characterized by a multi-layered, uneven age and size class structure; a high degree of compositional and structural patchiness and heterogeneity; and significant amounts of coarse woody debris and tip-up mounds (WDNR In Prep. a). Old-growth and older forests provide structural diversity that can support unique assemblages of plants, birds, and other animals. Old-growth forest management is one important facet of providing the diverse range of habitats needed for sustainable forest management (WDNR 2010a).

The KMSF offers exceptional opportunities to manage for older forests and old-growth forests on a landscape level. This opportunity is unique in a landscape dominated by agriculture and a current forest cover of only about 10% (WDNR In Prep. a). Although only 4% of Wisconsin's forests are over 100 years old and most are between 60 and 80 years old (WDNR 2010a), WDNR Forest Reconnaissance data for the KMSF indicate that 50% of the oak forests in the **Northern Unit** and 77% of the oak forests in the **Southern Unit**, the dominant forest cover type in both units, are over 100 years old. Another 20% of the forests in both units are between 96 and 100 years old. Many of the oak species of the KMSF, including northern red, white, and bur, are all exceptionally long-lived trees with maximum lifespans of 300 to 600 years (Burns and Honkala 1990). This results in significant opportunities to promote forest stands that are at least 200 years old and develop structural characteristics required for species that use old-growth forests.

Older forests of the KMSF provide habitat for many rare and declining species in the state, especially birds and bats. Primary sites with opportunities to manage for older forests and old-growth include Kettle Moraine Red Oak and Haskell Noyes Woods SNA in the **Northern Unit** and Whitewater Moraine Woods in the **Southern Unit**.

High Conservation Value Forests

The Wisconsin DNR manages 1.5 million acres that is certified by the Forest Stewardship Council (FSC) and the Sustainable Forest Initiative (SFI). Forest certification requires forests to be managed using specified criteria for ecological, social, and economic sustainability. Principle 9 of the *Draft 7 FSC-US Forest Management Standard* concerns the maintenance of High Conservation Value Forests (HCVF). High Conservation Value Forests are defined as possessing one or more of the following High Conservation Values:

- Contain globally, regionally, or nationally significant concentrations of biodiversity values, including rare, threatened, or endangered species and their habitats
- Globally, regionally, or nationally significant large landscape level forests, contained within, or containing the management unit, where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance
- Are in or contain rare, threatened, or endangered ecosystems
- Provide basic services of nature in critical situations (e.g., watershed protection, erosion control)
- Are fundamental to meeting basic needs of local communities (e.g., subsistence, health)
- Are critical to local communities' traditional cultural identity (areas of cultural, ecological, economic, or religious significance identified in cooperation with such local communities)

Based on the current draft criteria for defining HCVFs (Forest Stewardship Council 2009) the best opportunities for HCVF on the KMSF are the Primary Sites and high quality natural communities and rare species habitat that are outside of the Primary Sites.

Community Level Priorities and Restoration Opportunities

Ephemeral Ponds

Ephemeral Ponds, also referred to as vernal pools, are isolated wetlands that contain water for part of the growing season and, most importantly for amphibian and invertebrate populations, are fishless. The KMSF has an abundance of Ephemeral Ponds that developed about 8-10,000 years ago during the Wisconsin Glaciation. The receding margin of the Green Bay and Lake Michigan lobes contained buried ice that upon melting left collapsed areas of round-bottomed pits known as kettles. Kettles often support Ephemeral Ponds which play a distinctly different role in the landscape than wetlands with standing water throughout the season and wetlands with saturated soil. These areas are critical breeding habitat for certain invertebrates, as well as for many amphibians such as wood frogs and salamanders. They also provide feeding, resting, and breeding habitat for birds and a source of food for many mammals.

The Wisconsin Ephemeral Ponds Project (WEPP; Bernthal et al. 2009) developed methods to map Ephemeral Ponds in southeastern Wisconsin. This project completed mapping of all Ephemeral Ponds within the Milwaukee River basin, including areas of the **Northern Unit**, and on the **Southern Unit** within Eagle Township of Waukesha County. The value of knowing the locations of Ephemeral Ponds is strong since Ephemeral Ponds can be difficult to identify in winter when tree marking and timber harvesting often occurs and because areas with known concentrations of Ephemeral Ponds may warrant special consideration during the master planning process.

Threats to Ephemeral Ponds include reed canary grass infestations that may lower water levels leading to a premature drying of these wetlands and forest management practices in the ponds and surrounding uplands that result in soil compaction, erosion, and loss of forest canopy or coarse woody debris.

Recommendations for management of Ephemeral Ponds include minimizing soil compression (through winter harvest and/or low pressure tires) within 300 m of Ephemeral Ponds (Casper 2010) and maximizing the abundance of decomposing downed woody debris in order to maintain the core terrestrial habitat for pond breeding amphibians. In the **Northern Unit**, downed woody debris should include larger logs (>8 inch diameter) which are critical habitat for eastern red-backed salamanders (Casper 2010).

The KMSF represents a unique opportunity to provide landscape-level protection to Ephemeral Ponds, an important habitat feature to many rare animal species within a large forested context. Opportunities to protect forested Ephemeral Ponds and the species that depend on them are present at the following primary sites, all within the **Northern Unit**, Johnson Hill Kame, Wetlands, and Woods; Butler Lake, Flynn's Spring, and Parnell Esker; Crooked, Little Mud, and Kellings Lakes; and Kettle Hole Woods.

Wetlands and Aquatic Features

Wetlands are abundant throughout the KMSF and include forested and non-forested types. The open wetland types, including Calcareous Fens, Southern Sedge Meadows, and Wet Prairies, are most common in the **Southern Unit**. Forested wetland types, including Southern Tamarack Swamps, Bog Relicts, Floodplain Forest, and Hardwood Swamp are better represented in the Northern and Loew Lake units.

Southern Sedge Meadows at one time covered nearly one million acres in the state (Hoffman 2002), but wetland losses increased with technological advancements in converting wetlands to agriculture in the mid 1900's. Now only about 200,000 acres remain and many of these acres are now dominated by the invasive reed canary grass (Hoffman 2002). Calcareous Fens have always been rare in Wisconsin due to their unique requirements but likely only cover less than 1,000 acres currently in the state (Hoffman 2002) and are considered the rarest wetland plant community in Wisconsin and Minnesota and possibly one of the rarest in North America (Eggers and Reed 1997). Many are small in size and are threatened by the encroachment of trees, shrubs, and invasive herbaceous plants; altered hydrology; and sedimentation. Protecting, managing, and restoring the remaining fens, sedge meadows, and low prairies within a matrix of open wetlands types would benefit the many plant and animal species requiring these habitats.

Unique aquatic resources present in the KMSF include Spring Ponds, Spring Runs, and headwater streams. All add significantly to the overall diversity of the properties and more research is needed to better understand the representative plants and animals of these aquatic types. Springs typically have high water clarity, low sedimentation, and are a stable system with very little change in water temperature, water flow, or chemical composition. They also contribute to high water quality of the streams they feed. These features are highly susceptible to damage, and land use practices that lead to soil or hydrological disturbance should be avoided. Recharge areas need to be identified and managed carefully if the springs and seeps are to remain functional.

Threats to open wetland communities include disruption of hydrology, runoff from roads and adjacent agricultural areas, and invasive species. Especially problematic are non-native shrubs such as glossy buckthorn which convert diverse, open, graminoid-dominated wetlands to shrub thickets. Reed canary grass and non-native cat-tail (*Typha angustifolia* and *T. X glauca*) pose a particular threat to sedge meadows. In addition, new infestations of cat-tail have invaded Calcareous Fens in the KMSF and may be contributing to the local extirpation of rare plants, including orchids (Smith 2010). Management to reduce invasive species in these areas is critical. Anecdotal evidence suggests that prescribed fire may increase the abundance of non-native cat-tail, and alternative management strategies to combat these species may need to be investigated. Monitoring of invasive species before and after management would be beneficial to ensure activities are helping to meet overall restoration objectives.

The KMSF offers several opportunities to manage and protect wetlands within a mosaic of native grasslands, older forests, and good-quality aquatic communities. Some of the best wetlands could be considered for special management and protection designation, particularly where rare and declining species have been documented. The Red Oak Habitat Preservation Area primary site, in the **Northern Unit**, offers an exceptional opportunity to protect and manage a large forest with important hydrological connections, including the Bear Lake Marsh, Crooked, Little Mud, and Kellings Lakes primary site, also in the **Northern Unit**, includes a diversity of habitats providing opportunities to manage for numerous animal species of conservation concern utilizing shrub and forested wetlands to older tracts of upland forests. In the **Southern Unit**, sites within the Scuppernong Habitat Preservation Area, including Scuppernong Springs and Fens, Kettle Moraine Low Prairie SNA, and Scuppernong Prairie and Wetlands, offer an exceptional opportunity to restore globally rare natural communities that provide habitat for many rare species.

Prairies and Savannas

Prairies, Oak Openings, and Oak Woodlands were historically common in Wisconsin but are now rare throughout the state. Restoration of these globally rare natural communities is critical to the survival of many rare plants and animals that depend on them. The KMSF offers opportunities to restore prairies, Oak Openings, and Oak Woodlands on a landscape scale and within a matrix of other habitats.

One of the best large-scale opportunities to preserve/restore the Oak Opening community in Wisconsin is in the **Southern Unit** of the KMSF (WDNR 2006b; WDNR In prep.a). Complexes of Oak Openings, prairies, and Oak Woodlands were present in the **Northern Unit** within the much larger forested landscape. Historically, Oak Openings were abundant in Wisconsin, covering approximately 5.5 million acres (Curtis 1959) south of the Tension Zone. Review of historic literature indicates that Oak Openings once supported an exceptionally diverse flora, about 25% of the entire native flora of Wisconsin (Leach and Givnish 1999). Of the about 75,000 acres (Hoffman 2009) of Oak Opening remaining in Wisconsin, many of these are highly degraded or have succeeded to closed-canopy oak forests. The few extant remnants are mostly on drier sites, with the mesic and wet-mesic Oak Openings almost totally destroyed by conversion to agricultural or residential uses and by the encroachment of other woody plants due to fire suppression.

Oak woodland once occupied approximately 1.4 million acres (Curtis 1959) in Pre-European settlement Wisconsin; today, it is extraordinarily rare – only about 140,000 acres remain in the state (Hoffman 2009). Most of these remnants are highly degraded and have converted to closed-canopy oak forest.

Prairie once occupied approximately 2.1 million acres in Wisconsin. Now, approximately 2,000 acres remain – less than 0.1% (Leach and Givnish 1999). Of these, only those prairies that occurred at the wet and dry ends of the soil spectrum survived. Virtually all deep-soil Mesic Prairies were converted to agricultural or residential uses. The surviving remnants are highly degraded due to fire suppression, overgrazing, invasion of woody species, invasive species and, in the case of Wet Prairies, ditching, and tiling.

Major opportunities exist in the KMSF to restore prairies, Oak Openings, and Oak Woodlands, increase connectivity between remnant sites, and improve habitat for many grassland, savanna, and woodland plants and animal specialists. Ecological restoration that would restore closed-canopy forests to Oak Openings and Oak Woodland may limit habitat for certain species. As with all ecological restoration opportunities, sufficient resources must be available to ensure success of the project before the difficult decision of limiting habitat for some species in favor of other species is made.

Primary sites that provide opportunities include Eagle Oak Openings and Prairie, in the **Southern Unit**, that, along with the adjacent Palmyra Oak Woodland primary site, offers an opportunity for landscape-level planning of prairies, Oak Openings, and Oak Woodland. The Kettle Moraine Oak Opening primary site, in the **Southern Unit**, is a large site that likely has one of the best Oak Openings in the Kettle

Moraine region. The Young Prairie SNA primary site and the sites within the Scuppernong Habitat Preservation Area offer exceptional opportunities to protect and manage globally rare Wet-mesic Prairies.

East Branch Milwaukee River

The East Branch Milwaukee River is a unique opportunity for long-term protection of a forested watershed within a largely agricultural landscape. It was recognized as a Conservation Opportunity Area in Wisconsin's Wildlife Action Plan, because of its aquatic significance and the opportunities for conserving Floodplain Forest, Northern Sedge Meadow, and Emergent Marsh communities and their representative Species of Greatest Conservation Need (WDNR 2006b).

Over 90% of the East Branch's length is contained within the **Northern Unit**. Also partially contained are the headwaters for the East Branch that begins with Watercress Creek, a trout stream in Sheboygan County. The river then flows south through Long Lake, and Mauthe Lake until it reaches the Milwaukee River mainstem in Washington County. Unlike the Milwaukee River mainstem, most of the East Branch remains in a relatively natural, unchannelized condition.

The East Branch is a warmwater river with a muck, sand, and gravel bottom and is an important tributary to the Milwaukee River that provides important habitat for rare aquatic species. It hosts a diverse fish, mussel, dragonfly, and beetle community. Bordering the river are large wetland complexes of Southern Hardwood Swamp, Northern Wet-mesic Forest, Northern Wet Forest, Southern Sedge Meadow, and Shrub-carr. Several aquatic beetle species thought to be rare have been found at Watercress Creek, the headwaters of the East Branch.

Within the Milwaukee River Basin, the surface drainage networks are generally well-connected, sloping downward from the north and west to the south and east, leaving relatively few areas that are internally drained (WDNR 2001). Agriculture is dominant in the Milwaukee River East-West Watershed, covering about 47% of the land area, followed by wetlands (19%), grasslands (16%), and forests (12%). Hence, the main threats to the rare aquatic species include agricultural runoff contributing to altered sediment loads and nutrients, non-native species, streambank erosion, impoundments, and other hydrological impacts to surface and groundwater.

Ecological Priorities for SGCN

The Wisconsin Wildlife Action Plan identifies ecological priorities in each Ecological Landscape. Ecological priorities are the natural communities in each Ecological Landscape that are most important to the Species of Greatest Conservation Need. Appendix E highlights the Ecological Priorities for the vertebrate SGCN on the KMSF. Note that these Ecological Priorities include all of the natural communities that we have determined to provide the best opportunities for management on the KMSF from an ecological/biodiversity perspective.

Natural Community Management Opportunities

The Wisconsin Wildlife Action Plan (WAP) (WDNR 2006b) identifies 34 natural communities for which there are "Major" or "Important" opportunities for protection, or restoration, or management in the Southeast Glacial Plains Ecological Landscape. Twenty four of these natural communities are present on the KMSF:

- Bog Relict
- Calcareous Fen
- Cedar Glade
- Dry Prairie
- Emergent Marsh
- Floodplain Forest
- Inland Lakes
- Mesic Prairie
- Northern Hardwood Swamp
- Northern Sedge Meadow
- Northern Wet Forest
- Northern Wet-mesic Forest
- Oak Opening
- Oak Woodland
- Shrub Carr
- Southern Dry Forest
- Southern Dry-mesic Forest
- Southern Hardwood Swamp
- Southern Mesic Forest
- Southern Sedge Meadow
- Southern Tamarack Swamp (rich)
- Surrogate Grasslands
- Warmwater Streams
- Wet-mesic Prairie

Wisconsin's Statewide Forest Strategy

Wisconsin's Statewide Forest Assessment (WDNR 2010a) was based on Wisconsin's Forest Sustainability Framework ("Wisconsin Forest Sustainability Framework") and was designed to assess the current state of Wisconsin's public and private forests and analyze the sustainability of our forested ecosystems. Wisconsin's Statewide Forest Strategy (WDNR 2010b) contains a collection of strategies and actions designed to address the management and landscape priorities identified in the Statewide Forest Assessment. The strategies are broad guides intended to focus the actions of the forestry community.

All three of these documents include topics related to biological diversity in Wisconsin's forests, and provide information useful for department master planning and management activities. The following strategies, organized using their number in the Statewide Forest Strategy document, are particularly pertinent to the KMSF planning efforts in regard to opportunities to maintain or enhance biological diversity (WDNR 2010b). These strategies may not be applicable to all units of the KMSF.

Strategy Number	Strategy
1	Encourage planting to enhance, protect, and connect larger tracts of forested land in appropriate locations consistent with ecological landscapes.
5	Pursue the conservation and protection of large, unfragmented blocks of forest lands
6	Strengthen collaborative and large scale planning at the town, county, state and federal levels
7	Increase the functional size of forest blocks by encouraging coordination of management of clusters of forest ownerships
11	Encourage the management of under-represented forest communities
12	Improve all forested communities with a landscape management approach that considers the representation of all successional stages
13	Increase forest structure and diversity
14	Encourage the use of disturbance mechanisms to maintain diverse forest communities
15	Maintain the appropriate forest types for the ecological landscape while protecting forest health and function
22	Strive to prevent infestations of invasive species before they arrive
23	Work to detect new (invasive species) infestations early and respond rapidly to minimize impacts to forests
24	Control and management of existing (invasive species) infestations.
25	Rehabilitate, restore, or adapt native forest habitats and ecosystems
29	Attempt to improve the defenses of the forest and increase the resilience of natural systems to future climate change impacts

Management Opportunities for Rare Species

Significant Populations of Plants

The Kettle Moraine State Forest supports 151 known occurrences of 45 rare plant species (including 4 State Endangered species, 13 State Threatened species, and 28 state Special Concern species). The KMSF plays a critical role in conserving several species in particular.

Earleaf foxglove (*Tomanthera auriculata*, G3, S1, state special concern)

The earleaf foxglove was considered extirpated from Wisconsin until it was rediscovered in 1999 at two sites in the **Southern Unit**. This globally vulnerable species has a wide distribution across the eastern U.S., but is considered rare in every state in which it occurs. A hemiparasite, it is dependent on a healthy forb community rich in composites (Asteraceae) and is found in Wet-mesic to Dry Prairies (NatureServe 2010). Threats to the species include mowing while the species is flowering (mid to late August), fire suppression and succession of prairies to shrublands. The **Southern Unit** contains the entire population of the species known in Wisconsin. Both sites are under management to conserve the eared false foxglove and a host of other Wet-mesic Prairie species.

Eastern prairie fringed orchid (*Platanthera leucophaea*, G2G3, S2, State Endangered, federal threatened)

The eastern prairie fringed orchid is the only federally threatened plant species occurring on the KMSF. This species is endemic to the upper Midwest and has experienced severe population declines due to development, habitat alteration, and fire suppression. Two occurrences of the orchid have been documented on the KMSF, only one of which has been recently observed. Population numbers are very low and the species is in critical need of prescribed fire management because of its dependence on periodic moderate disturbance.

Forked aster (*Aster furcatus*/*Eurybia furcata*, G3, S3, State Threatened)

Endemic to the Midwest, **forked aster** is a globally vulnerable species and is considered rare throughout its range. Wisconsin is thought to be the stronghold for the species, where it is largely restricted to the southeast part of the state. **Forked aster** occurs in two areas in the **Southern Unit**, where it is found near the interface of oak savanna and seepage wetlands. Management to maintain a partial canopy and prescribed fire are thought to be neutral to beneficial for this species (NatureServe 2010).

Kitten tails (*Besseya bullii*, G3, S3, State Threatened)

The KMSF likely supports over 25% of the statewide population of kitten tails in Wisconsin. This globally vulnerable species is found only in the upper Midwest, where it is considered rare in every state in which it is found (NatureServe 2010). Wisconsin likely contains the most occurrences of any state, and the KMSF contains the greatest number of occurrences of any property in the state, making it a critical area for the conservation of the species worldwide. Eighteen occurrences are known from the KMSF. The species thrives in oak savannas on dry to dry-mesic, gravelly, calcareous soil, often on or at the crest of steep slopes with a south or west aspect. Due to a lack of fire to maintain open savanna canopies, the species has greatly declined in abundance and vigor, and is now often found along trails and other artificial openings. Threats to the species include fire suppression, canopy closure, invasive shrubs, and gravel mining. Prescribed fire and control of invasive shrubs is critical for this species.

Prairie straw sedge (*Carex suberecta*, G4, S1, State Special Concern)

Prairie straw sedge is found primarily in the Midwest, where it has been documented from only three sites in the state, including the **Southern Unit** of the KMSF. Threats to the species include hydrologic alteration, conversion of open to shrub-dominated wetlands, and invasive species.

Roundfruit St. John’s-Wort (*Hypericum sphaerocarpon*, G5, S1S2, State Threatened)

Roundfruit St. John’s-wort occurs in 16 locations in the state, but the KMSF holds the only occurrence found within the past 25 years. Although this population is very small, it may represent the best known opportunity to conserve the species in the state. Specific habitat needs for the species are unclear, but it likely requires open Oak Woodlands and high-quality Shrub-carr. Prescribed fire management of these areas is likely to benefit this species.

Woodland bluegrass (*Poa sylvestris*, G5, S1, State Special Concern)

Woodland bluegrass inhabits high-quality Southern Mesic Forest and is known from only four sites in Wisconsin since the 1950s, including the **Northern Unit** of the KMSF. The greatest threats to this species are garlic mustard (found in several small patches) and potential habitat alterations in and adjacent to the site..

Species of Calcareous Fens and Wet-mesic Prairies

With its calcareous soils and abundant springs and associated wetlands, the KMSF contains many rare plants associated with Calcareous Fens and Wet-mesic Prairies (Table 10). Management to restore fens and prairies such as periodic prescribed burning and control of invasive species is beneficial to these species. While most occur across a wider area of the Southeast Glacial Plains Ecological Landscape and some occupy habitat with similar moist, calcareous characteristics (such as in Door County) many of these species reach their highest abundance in the KMSF.

Table 10. Rare plant species associated with Calcareous Fens and Wet-mesic Prairies

Common Name	Scientific Name	State Status
Beaked spike-rush	<i>Eleocharis rostellata</i>	THR
Common bog arrow-grass	<i>Triglochin maritima</i>	SC
Flat-stemmed spike-rush	<i>Eleocharis compressa</i>	SC
Lesser fringed gentian	<i>Gentianopsis procera</i>	SC
Low nutrush	<i>Scleria verticillata</i>	SC
Ohio goldenrod	<i>Solidago ohioensis</i>	SC
Prairie Indian plantain	<i>Cacalia tuberosa</i>	THR
Prairie milkweed	<i>Asclepias sullivantii</i>	END
Slender bog arrow-grass	<i>Triglochin palustris</i>	SC
Small white lady’s-slipper	<i>Cypripedium candidum</i>	THR
Sticky false asphodel	<i>Tofieldia glutinosa</i>	THR
Tufted bulrush	<i>Scirpus cespitosus</i>	THR
White camas	<i>Zigadenus elegans</i> var. <i>glaucus</i>	SC

Grassland Birds

Biologists and birders are concerned about population declines of many grassland bird species. Since the Federal Breeding Bird Survey began in 1966, grassland birds have declined more steeply than any other group of birds in North America and the Midwest (Askins et al. 2007; Sample and Mossman 1997). The **Southern Unit** of the KMSF is noted as a priority landscape for grassland birds with current grassland acreage totaling well over 3,000 acres (Sample and Mossman 1997; WDNR 2006b; WDNR in prep. a). This grassland acreage supports numerous uncommon bird species (Table 11) and is made up of a highly diverse mix of remnant Dry-mesic and Wet-mesic Prairie, Surrogate Grassland, Southern Sedge Meadow, upland shrub, and Oak Opening. Much of this grassland habitat is contained in the Scuppernong valley and Young Prairie areas (Sample and Mossman 1997). With continuing grassland and Oak Opening restoration work in the Scuppernong River Habitat Area and the potential for additional expansion of these open habitats, the **Southern Unit** could provide the region's largest remaining reservoir of contiguous native prairie and associated grassland/meadowland habitats (Bielefeldt and Rosenfield 2005).

The **Northern Unit** contains many planted prairies and old fields that provide habitat for grassland birds such as Eastern Meadowlark, Bobolink, Dickcissel, Henslow's, Field, Grasshopper and Vesper Sparrows (Baughman 2010; Volkert 1992). The **Northern Unit** was not identified as a priority landscape for grassland birds (Sample and Mossman 1997; WDNR 2006b), primarily because better opportunities for large-scale grassland management exist further south and west (WDNR in prep. a). Large areas of grassland habitat that have well-established prairie plantings (e.g. Jersey Flats) could continue to be maintained for grassland birds, although smaller grassland habitats within larger blocks of forest should be re-forested to reduce fragmentation and edge effects.

Grassland bird habitat is most effectively maintained as large landscapes of continuous grassland, uninterrupted by hedgerows, with the cover of woody plants less than 5% (Sample and Mossman 1997). Hedgerows fragment grasslands and provide habitat for predators of grassland birds. Structural diversity within the grassland, including short and tall grass, a mix of grasses and forbs, and a management rotation of type, intensity, and frequency, is also important for grassland bird habitat. Many grassland bird species, however, require the structure present in other habitats within a grassland complex, including upland shrubs (Bielefeldt 2010) and Oak Opening, and therefore it is important to consider these and other variables from a landscape perspective.

The best opportunities for maintaining viable source populations of area-sensitive grassland bird species are at primary sites within the Scuppernong Habitat Preservation Area, including Scuppernong Springs and Fens, Kettle Moraine Low Prairie SNA, and Scuppernong Prairie and Wetlands and Young Prairie SNA.

Table 11. Bird Species of Conservation Concern found in grassland habitats in the Southern Unit

Common Name	Scientific Name	State Status
Bell's Vireo	<i>Vireo bellii</i>	THR
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	SGCN
Blue-winged Warbler	<i>Vermivora pinus</i>	SGCN
Bobolink	<i>Dolichonyx oryzivorus</i>	SGCN
Brown Thrasher	<i>Toxostoma rufum</i>	SGCN
Dickcissel	<i>Spiza americana</i>	SC/M
Eastern Meadowlark	<i>Sturnella magna</i>	SGCN
Field Sparrow	<i>Spizella pusilla</i>	SGCN
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	SGCN

Common Name	Scientific Name	State Status
Henslow's Sparrow	<i>Ammodramus henslowii</i>	THR
Northern Harrier	<i>Circus cyaneus</i>	SGCN
Upland Sandpiper	<i>Bartramia longicauda</i>	SC/M
Short-eared Owl	<i>Asio flammeus</i>	SC/M
Vesper Sparrow	<i>Pooecetes gramineus</i>	SGCN
Western Meadowlark	<i>Sturnella neglecta</i>	SC/M
Willow Flycatcher	<i>Empidonax traillii</i>	SGCN
Yellow-breasted Chat	<i>Icteria virens</i>	SC/M

*This is not currently a breeding population, but a wintering population.

Forest Interior Birds

An impressive assemblage of rare forest interior breeding birds (Table 12) is present throughout the KMSF. These area-sensitive species are utilizing the minimally fragmented, contiguous, and older forests present on the KMSF. Large blocks of forest interior habitat are rare in southeastern and southcentral Wisconsin, where total forest cover of the Southeast Glacial Plains Ecological Landscape is only 10% (WDNR In Prep. a), much of it in fragmented and isolated parcels. The Kettle Interlobate Moraine's rugged topography is often ill-suited for row crop uses and provides the only large areas of contiguous forest in the entire Ecological Landscape (WDNR In Prep. a). For many species, the KMSF likely provides the most viable habitat in the southeast portion of the state. As with many other characteristics, the **Northern and Southern Units** of the KMSF differ in regard to amount and quality of forest interior bird habitat, as well as other ecological opportunities that could affect use by forest interior birds.

Many of the rare forest interior birds found on the KMSF have had significant population declines in Wisconsin and throughout their range, further reinforcing the importance of the KMSF for providing habitat. Breeding Bird Survey data show an annual significant decline of 4.4% for Cerulean Warblers in Wisconsin (Mossman 2006). Other forest interior birds that may be declining include Acadian and Least Flycatchers and Veery. Species that have had population increases continue to be threatened by the edge effects of forest fragmentation.

Primary determinants of interior forest habitat quality include stand composition, age, size, structure, canopy closure, proximity to water or roads, slope and aspect, stand size and shape, and proximity to other stands on the landscape (Wilson 2008). Limiting fragmentation associated with, but not limited to, clear-cutting, road building, or utility and pipeline development is important to the continued viability of these large blocks of forest and their associated bird species (WDNR 2006b).

Maintaining the vertical structural diversity currently found within less fragmented forest stands is also important for some forest interior species. Cerulean, Kentucky, and Hooded Warblers, as well as Veery and Wood Thrush all require a complexity of forest layers for nesting. These species use both native and non-native shrub and tree species. Some forest interior birds also rely on limb structure that promotes horizontal canopy nesting areas.

Within the **Southern Unit** there are now extensive forests consisting of overgrown Oak Openings and Oak Woodland, some oak forest, and plantations of white and red pine. Older-aged pine plantations adjacent to deciduous forests in the **Southern Unit** likely play a role in reducing fragmentation and even providing nesting habitat for uncommon species (Bielefeldt & Rosenfield 2005) which otherwise would likely not be present (WDNR In Prep. a). Consideration could be given, however, to slowly converting these areas back to the native hardwood forest types over a period of time. In southern Wisconsin, red pine is outside of its native range and often begins to decline at a young age (WDNR In prep. c).

Forest-associated species, especially birds, are known to expand into previously unavailable habitat, i.e., degraded oak savanna where the canopy became closed following fire cessation. This is especially important in the **Southern Unit**. It is important to acknowledge, therefore, that savanna enhancement activities (accelerated understory restoration and frequent prescribed fire) may result in reduced numbers of some forest species of conservation concern, including birds. Robinson (1994) found that the reintroduction of fire to overgrown Oak Woodlands substantially altered the bird communities. Species that appeared to be adversely impacted by burning included several species characteristic of dense understory and lower canopy layers (e.g., Acadian Flycatcher, Wood Thrush, Red-eyed Vireo, Worm-eating Warbler, and Hooded Warbler) or open ground layers (Ovenbird and Whip-poor-will). These species were found, however, to at least occasionally occupy burned areas. These results suggest that the abundance of birds of the forest shrub/sapling and ground layers will be strongly affected by the timing of burns, severity of the burns, openness of the canopy, the duration of the inter-burn interval, level of cowbird parasitism, and the size of the burn unit. Ecological restoration that restore closed-canopy forests to Oak Opening or Oak Woodland may limit habitat for certain species. As with all ecological restoration opportunities, sufficient resources must be available to ensure success of the project before the difficult decision of limiting habitat for some species in favor of other species is made.

Oak Woodlands, in the context of large contiguous forest patches, can provide a 'soft edge' between other habitat types and a closed-canopy forest. Oak Woodland restoration, within a large forested area, could promote understory growth and development of full-canopied oaks that produce horizontal limb structure for nesting that is favorable for many state threatened Cerulean Warblers, and other area-sensitive species such as Kentucky Warbler, Hooded Warbler, Veery, and Wood Thrush.

Small patches of forest habitat (less than 250 acres) in the Midwest often function as population sinks for forest interior songbirds (Donovan et al. 1995), and may better serve avian conservation if they are restored to oak savanna/Oak Woodland habitat (Brawn 2006). This stems from the fact that bird species that use oak savanna/Oak Woodland habitat are generally not as sensitive to habitat patch size as their closed canopy forest bird counterparts (Brawn et al. 2002). Some areas of the **Southern Unit** may not presently be of sufficient size or ecological context to adequately provide for forest interior birds.

Maintaining and expanding large blocks of contiguous, older forests in southern Wisconsin is critical for the future of many forest interior birds. The KMSF offers opportunities, within a landscape dominated by agricultural and urban uses, to provide habitat for these species. Primary sites that provide excellent habitat and likely support source populations of forest interior birds in the **Northern Unit** are Kettle Moraine Red Oak; Red Oak Habitat Preservation Area; and Johnson Hill Kame, Wetlands, and Woods. Primary sites in the **Southern Unit** that provide habitat for and likely support source populations of forest interior birds are Ottawa Oaks Woods and Prairies North, Palmyra Oak Woodland, and Whitewater Moraine. These areas should be maintained for forest interior birds and management that opens up the canopy for oak savanna restoration or timber harvesting should be carefully evaluated for its impacts to these species.

Table 12. Forest Interior Breeding Birds of the KMSF

Common Name	Scientific Name	State Status
Acadian Flycatcher	<i>Empidonax virescens</i>	THR
Cerulean Warbler	<i>Dendroica cerulea</i>	THR
Hooded Warbler	<i>Wilsonia citrina</i>	THR
Kentucky Warbler	<i>Oporornis formosus</i>	THR
Least Flycatcher	<i>Empidonax minimus</i>	SC/M
Ovenbird	<i>Seiurus aurocapilla</i>	none
Red-shouldered Hawk	<i>Buteo lineatus</i>	THR
Scarlet Tanager	<i>Piranga olivacea</i>	none
Veery	<i>Catharus fuscescens</i>	SC/M
Wood Thrush	<i>Hylocichla mustelina</i>	SC/M
Worm-eating Warbler	<i>Helmitheros vermivorus</i>	END
Yellow-throated Vireo	<i>Vireo flavifrons</i>	none

Bat Conservation

The KMSF provides critical migrating and breeding habitat for bats. The older forests provide characteristics which are favorable bat habitat by offering roosting, foraging, and commuting habitat. Very limited mobile land-based acoustic bat surveys were conducted in the KMSF (**Northern and Southern Units**) during the spring movement and summer residency periods. The surveys indicated the presence of six of the possible eight bat species known to occur in Wisconsin, the only species not detected were Indiana bat (*Myotis sodalis*) and Eastern pipistrelle (*Perimyotis subflavus*). Detectability of a given species with this survey method is affected by orientation of the microphone, weather elements (e.g., relative humidity, wind), habitat, flight speed, and flight altitude.

By feeding on destructive insects, bats are an important component of a healthy forest. Opportunities to promote bat habitat includes providing resources for roosting, foraging, and drinking. Bats of the KMSF roost under loose, peeling bark and in crevices and cavities. Often these attributes are found in older forests with snags of varying decay level, size, and height. Foraging is done in and along small to medium forest openings or gaps, such as ponds, natural and artificial openings, roads, or water courses (Taylor 2006). Maintaining a diverse forest flora and reducing non-native plant abundance is important for foraging by promoting invertebrate prey diversity (WDNR 2006b). Water resources are used for drinking, travel, and foraging. Maintaining high-water quality and access to water is important for protecting bat populations. Wide buffers (generally wider than those recommended in Best Management Practices for water quality) around water, including Ephemeral Ponds, wet meadows, and streams, are important for bats and other wildlife species using these areas (Taylor 2006).

Hibernaculum disturbance, habitat degradation, and wind-turbine mortality are threats that affect all bat species found in Wisconsin. An emerging threat to Wisconsin's bats, White-Nose Syndrome, has been called the "most precipitous wildlife decline in the past century in North America" by Bat Conservation International ("White-Nose Syndrome") and has devastated bat populations in the eastern United States in the last four years. It is currently unknown how the fungus (*Geomyces destructans*) causing White-Nose Syndrome kills the bats. Due to the emerging threats that face the bat population in Wisconsin and with limited availability of data from this region, more information in the form of surveys (acoustic and roost) are needed to more accurately describe the bats that use the KMSF.

Primary Sites: Significance and Summaries

Thirty-three ecologically important sites were identified on the KMSF. These “Primary Sites” were identified because they contain relatively undisturbed, high-quality, natural communities, provide important habitat for rare species, offer opportunities for restoration, could provide important ecological connections, or some combination of the above factors. Figures 11-13 illustrates the locations of the Primary Sites.

Kettle Moraine State Forest Primary Sites

KMSF01.	Glenbeulah Forest
KMSF02.	Kettle Moraine Red Oaks
KMSF03.	Red Oak Habitat Preservation Area
KMSF04.	Watercress Creek
KMSF05.	Johnson Hill Kame, Wetlands, and Woods
KMSF06.	Spruce Lake Bog
KMSF07.	Butler Lake, Flynn's Spring, and Parnell Esker
KMSF08.	Crooked, Little Mud, and Kellings Lakes
KMSF09.	Milwaukee River Tamarack Lowlands and Dundee Kame SNA
KMSF10.	East Branch Milwaukee River
KMSF11.	Haskell Noyes Woods SNA
KMSF12.	Milwaukee River and Swamp SNA
KMSF13.	Spring Lake SNA
KMSF14.	Kettle Hole Woods SNA
KMSF15.	Kewaskum Maple-Oak Woods SNA
KMSF16.	Milwaukee River Floodplain Forest and Upland Woods
KMSF17.	Loew Lake Wetland Complex
KMSF18.	Ottawa Oaks Woods and Prairies North
KMSF19.	Ottawa Lake Fen SNA
KMSF20.	Ottawa Oaks Woods and Prairies South
KMSF21.	Scuppernong Springs and Fens
KMSF22.	Kettle Moraine Low Prairie SNA
KMSF23.	Scuppernong Prairie and Wetlands
KMSF24.	Highway 59 Railroad Prairie
KMSF25.	Palmyra Oak Woodland
KMSF26.	Eagle Oak Openings and Prairie
KMSF27.	Kettle Moraine Oak Opening
KMSF28.	Young Prairie SNA
KMSF29.	La Grange Savanna
KMSF30.	Whitewater Moraine Woods
KMSF31.	Bluff Creek SNA
KMSF32.	Clover Valley Fen SNA
KMSF33.	Messinger Dry Prairie and Savanna Preserve

Figure 11. Location of Primary Sites on the Northern Unit of the Kettle Moraine State Forest.

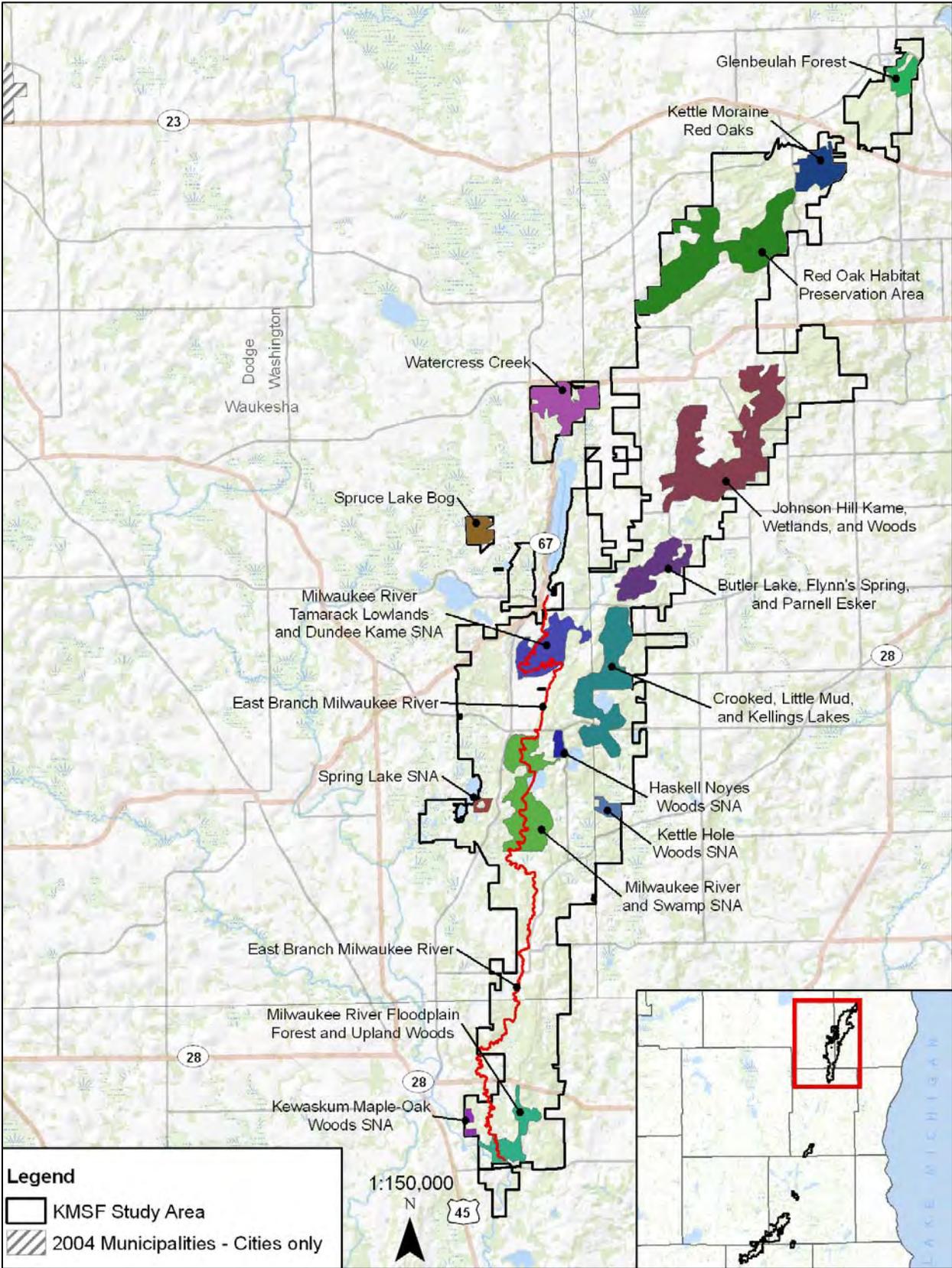


Figure 12. Location of Primary Sites on the Loew Lake Unit of the Kettle Moraine State Forest.

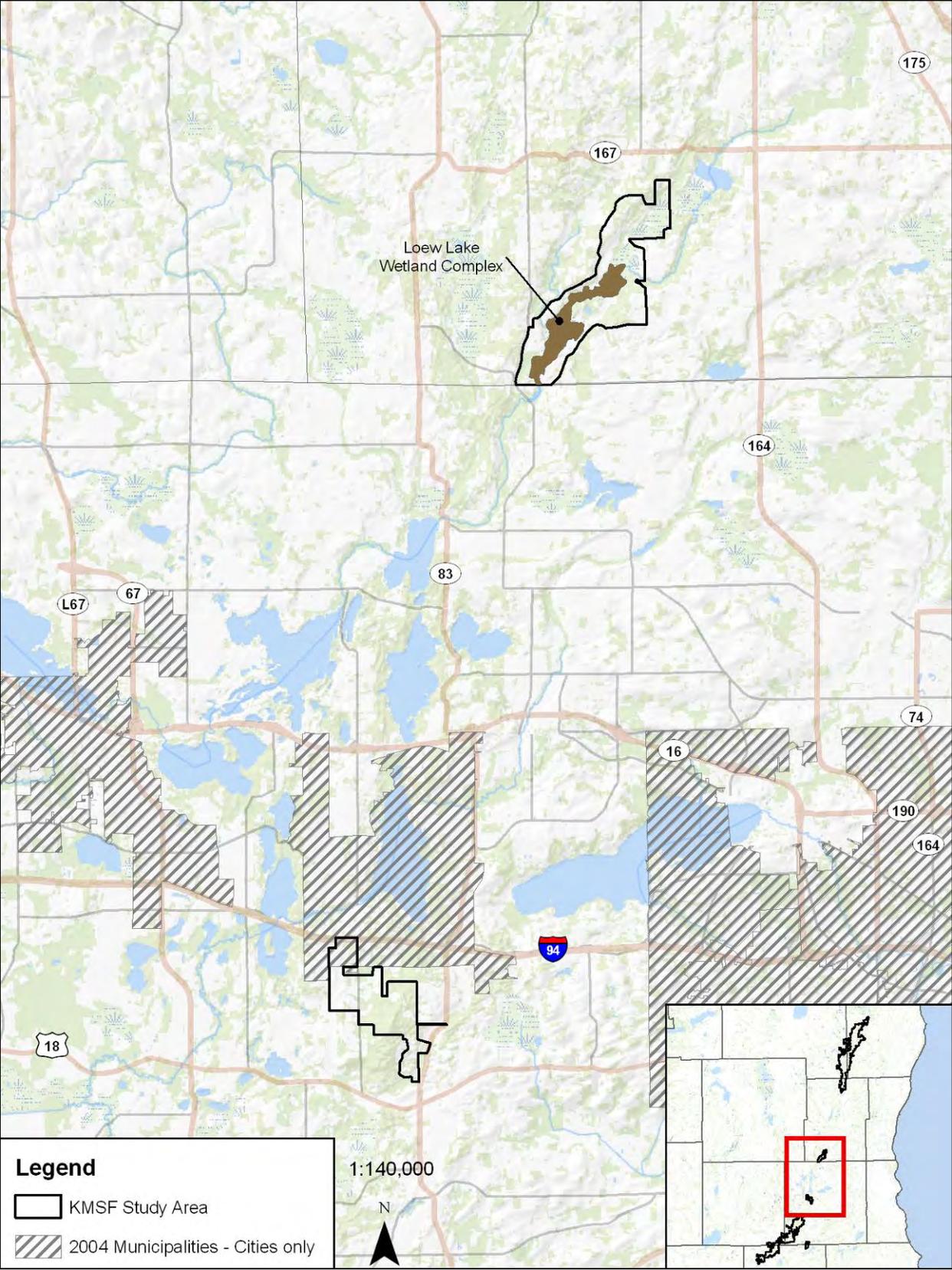
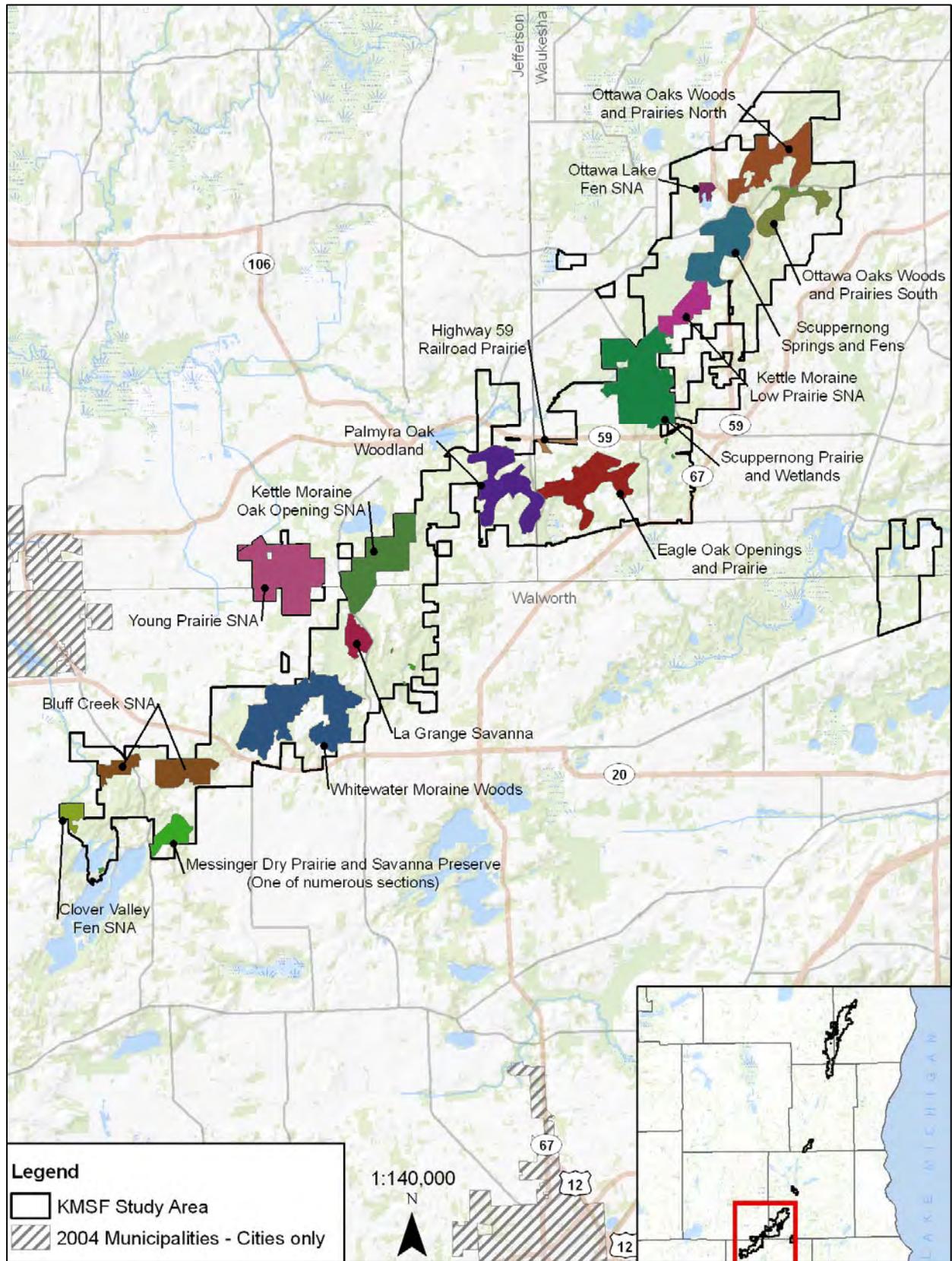


Figure 13. Location of Primary Sites on the Southern Unit of the Kettle Moraine State Forest.



Future Inventory, Monitoring and Research Needs

Ephemeral Ponds – More comprehensive information on Ephemeral Ponds, including inventory, mapping, and monitoring are needed. Vascular plants, invertebrates, herptiles, and abiotic attributes should all be targets of survey efforts. In particular, a salamander monitoring program for the **Northern Unit** of the KMSF, focusing in and around good-quality forested Ephemeral Ponds and forested wetlands, utilizing aquatic funnel trapping, visual encounter surveys, and visual egg searches, could contribute to the knowledge of the biodiversity of these areas.

Road Mortality – Identify places where herptile mortality on roadways is a problem and consider use of road signs or ecopassages in these areas.

Forest Interior Bird Research – More research is needed on the effects of forest management, including timing and intensity of thinnings and regeneration harvests, and savanna restoration on forest interior birds in southern Wisconsin.

Small Mammals – A more complete small mammal inventory combined with a monitoring program designed specifically to study small mammal population changes associated with landscape restoration efforts, corridor ecology, and to better define the threshold levels of environmental conditions to species persistence on the landscape.

Swamp Metalmark – Additional survey and monitoring efforts could occur in areas where potential habitat and larval host plants were located during 2008 and 2009 inventory.

Mukwonago River Unit – Further breeding bird surveys in off-trail, wetland, and riparian habitats along the Mukwonago River in the recently acquired Mukwonago River Unit.

Invasive Plants – Continued monitoring and control of invasive species will be critical on the KMSF.

Bat Surveys and Monitoring – Due to the emerging threats that face the bat population in Wisconsin and with limited availability of data from this region, more data in the form of surveys (acoustic and roost) are needed to more accurately describe the bats that use the KMSF. It would be beneficial to establish volunteer-based acoustical bat monitoring routes on lakes, streams, and rivers in the KMSF to identify areas of high bat concentrations. In addition, surveys to locate bat roosting areas are warranted..

Water Quality of Streams and Rivers – Identify critical habitat sites for stream bank protection and implement habitat restoration projects to further protect shore lands.

Fire-sensitive Species – Research and monitoring is needed to determine effects of prescribed burning on fire-sensitive species.

Fish – A number of rare fish species previously known from the KMSF were not detected in targeted surveys in 2009. This could have resulted from inadequate survey efforts or actual declining fish populations. An analysis of fish survey efforts, focusing on trends in presence/absence of target species, is needed to help interpret the paucity of rare species documented during surveys efforts in 2009.

Sensitive pollinators – Survey efforts are needed to determine the health of sensitive pollinators, including bees, on the KMSF.

Hine's Emerald Dragonfly – The Federally Endangered Hine's emerald dragonfly is dependant on burrowing crayfish for its survival. Burrowing crayfish are present on the KMSF and, these areas should be surveyed for this species.

Glossary

adaptive management - a formal, structured approach to dealing with uncertainty in natural resource management, using the experience of management as an ongoing and continually improving process.

Ecological Landscape - landscape units developed by the WDNR to provide an ecological framework to support natural resource management decisions. The boundaries of Wisconsin's sixteen Ecological Landscapes correspond to ecoregional boundaries from the National Hierarchical Framework of Ecological Units, but sometimes combine subsections to produce a more manageable number of units.

ecopassage – a series of guidewalls and/or under-highway tunnels that allow wildlife to safely cross roadways.

element occurrence - an Element Occurrence (EO) is an area of land and/or water in which a rare species or natural community is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential continued (or historic) presence and/or regular recurrence at a given location. For species, the EO often corresponds with the local population, but when appropriate may be a portion of a population (e.g., a single nest territory or long distance dispersers) or a group of nearby populations (e.g., metapopulation). For communities, the EO may represent a stand or patch of a natural community or a cluster of stands or patches of a natural community. Because they are defined on the basis of biological information, EOs may cross jurisdictional boundaries.

esker - a ridge, commonly sinuous in pattern, composed of sand and gravel that was deposited by a stream that flowed in an ice-walled channel beneath a glacier.

Forest Certification – a market-based, non-regulatory forest conservation tool designed to recognize and promote environmentally-responsible forestry and sustainability of forest resources. The certification process involves an evaluation of management planning and forestry practices by a third-party according to an agreed-upon set of standards (from <http://www.pinchot.org/project/59>). See <http://dnr.wi.gov/forestry/certification/> regarding certification of WDNR managed lands.

hemiparasite – A plant, such as mistletoe, that obtains some nourishment from its host but also photosynthesizes.

kame – conical hills formed where holes in a glacier filled with a variety of sediment including outwash, lake sediment, and till.

kettle lake - lakes formed from a depression caused by a block of buried glacier ice that gradually melted, causing the overlying land surface to collapse downward.

Landtype Association (LTA) - a level in the National Hierarchical Framework of Ecological Units (see next entry) representing an area of 10,000 – 300,000 acres. Similarities of landform, soil, and vegetation are the key factors in delineating LTAs.

Last Observed Date (LastObs) - The last confirmed observation date of the element occurrence extant at this site (not necessarily the date the site was last visited).

lotic - pertaining to flowing waters, rivers.

moraine - landforms composed of unsorted materials deposited by glaciers. They can cover broad geographic areas of millions of acres. Topography can vary from nearly level "till" plains to rough end moraine landscapes composed of steep dry ridges interspersed with deep kettle holes. These glacial "kettles" are frequent locations for lakes and wetlands.

mapping precision – the locational accuracy to which an element occurrence is known.

natural community – an assemblage of plants and animals, in a particular place at a particular time, interacting with one another, the abiotic environment around them, and subject to primarily natural disturbance regimes. Those assemblages that are repeated across a landscape in an observable pattern constitute a community type. No two assemblages, however, are exactly alike.

nymph - the immature form of some invertebrates, particularly insects, which undergoes in gradual metamorphosis before reaching its adult stage.

representative - native plant species that would be expected to occur in native plant communities influenced primarily by natural disturbance regimes in a given landscape - e.g., see Curtis (1959).

SGCN (or “Species of Greatest Conservation Need”) – native wildlife species with low or declining populations that are most at risk of no longer being a viable part of Wisconsin’s fauna (from the “Wisconsin Wildlife Action Plan,” WDNR 2006b).

unionid – refers to freshwater mussels in the order Unionoida.

Species List

Common Name	Scientific Name
Animals	
Acadian Flycatcher	<i>Empidonax vireescens</i>
Butler's gartersnake	<i>Thamnophis butleri</i>
Cerulean Warbler	<i>Dendroica cerulea</i>
eastern ribbonsnake	<i>Thamnophis sauritus</i>
ellipse mussel	<i>Venustaconcha ellipsiformis</i>
emerald ash borer	<i>Agrilus planipennis</i>
four-toed salamander	<i>Hemidactylium scutatum</i>
Hooded Warbler	<i>Wilsonia citrina</i>
Hooded Warbler	<i>Wilsonia citrina</i>
northern long-eared bat	<i>Myotis septentrionalis</i>
Ovenbird	<i>Seiurus aurocapillus</i>
pickerel frog	<i>Rana palustris</i>
powesheik skipperling	<i>Oarisma powesheik</i>
queensnake	<i>Regina septemvittata</i>
rainbow shell mussel	<i>Villosa iris</i>
Red-eyed Vireo	<i>Vireo olivaceus</i>
Red-shouldered Hawk	<i>Buteo lineatus</i>
slippershell mussel	<i>Alasmidonta viridis</i>
southern red-backed vole	<i>Microtus ochrogaster</i>
swamp metalmark	<i>Calephelis muticum</i>
white-tailed deer	<i>Odocoileus virginianus</i>
Wood Thrush	<i>Hylocichla mustelina</i>
Worm-eating Warbler	<i>Helmitheros vermivorus</i>
Plants	
American beech	<i>Fagus grandifolia</i>
American elm	<i>Ulmus americana</i>
American hazelnut	<i>Corylus americana</i>
American lop-seed	<i>Phryma leptostachya</i>
arrow-leaved aster	<i>Aster sagittifolius</i>
ash	<i>Fraxinus</i> sp.

Common Name	Scientific Name
Plants continued	
aspen	<i>Populus</i> sp.
autumn coral-root	<i>Corallorhiza odontorhiza</i>
basswood	<i>Tilia americana</i>
beaked spikerush	<i>Eleocharis rostellata</i>
big blue-stem	<i>Andropogon gerardii</i>
big-tooth aspen	<i>Populus grandidentata</i>
black cherry	<i>Prunus serotina</i>
black oak	<i>Quercus velutina</i>
black-eyed Susan	<i>Rudbeckia hirta</i>
blue cohosh	<i>Caulophyllum thalictroides</i>
buckthorn	<i>Rhamnus</i> sp.
bur oak	<i>Quercus macrocarpa</i>
common bog arrow-grass	<i>Triglochin maritima</i>
common buckthorn	<i>Rhamnus cathartica</i>
common reed grass	<i>Phragmites australis</i>
common yarrow	<i>Achillea millefolium</i>
cuckooflower	<i>Cardamine pratensis</i>
dogwood	<i>Cornus</i> sp.
earleaf foxglove	<i>Tomanthera auriculata</i>
early meadow-rue	<i>Thalictrum dioicum</i>
eastern hornbeam	<i>Carpinus caroliniana</i>
eastern prairie fringed orchid	<i>Platanthera leucophaea</i>
eastern shooting-star	<i>Dodecatheon meadia</i>
fen star sedge	<i>Carex sterilis</i>
flat-stemmed spike-rush	<i>Eleocharis compressa</i>
forked aster	<i>Aster furcatus</i>
garlic mustard	<i>Alliaria petiolata</i>
glossy buckthorn	<i>Rhamnus frangula</i>
gray dogwood	<i>Cornus racemosa</i>
honeysuckle	<i>Lonicera</i> sp.
hybrid cat-tail	<i>Typha X glauca</i>

Common Name	Scientific Name
Plants continued	
Illinois tick-trefoil	<i>Desmodium illinoense</i>
ironwood	<i>Ostrya virginiana</i>
kitten tails	<i>Besseyia bullii</i>
large-flowered bellwort	<i>Uvularia grandiflora</i>
large-flowered trillium	<i>Trillium grandiflorum</i>
large-leaved aster	<i>Aster macrophyllus</i>
lead-plant	<i>Amorpha canescens</i>
lesser fringed gentian	<i>Gentianopsis procera</i>
low nutrush	<i>Scleria verticillata</i>
narrow-leaved cat-tail	<i>Typha angustifolia</i>
northern red oak	<i>Quercus rubra</i>
Ohio goldenrod	<i>Solidago ohioensis</i>
Pennsylvania sedge	<i>Carex pennsylvanica</i>
pointed tick-trefoil	<i>Desmodium glutinosum</i>
prairie drop-seed	<i>Sporobolus heterolepis</i>
prairie Indian plantain	<i>Cacalia tuberosa</i>
prairie milkweed	<i>Asclepias sullivantii</i>
prairie straw sedge	<i>Carex suberecta</i>
prickly ash	<i>Zanthoxylum americanum</i>
red maple	<i>Acer rubrum</i>
red pine	<i>Pinus resinosa</i>
reed canary grass	<i>Phalaris arundinacea</i>
roundfruit St. John's-wort	<i>Hypericum sphaerocarpon</i>
shagbark hickory	<i>Carya ovata</i>
showy lady's-slipper	<i>Cypripedium reginae</i>
shrubby cinquefoil	<i>Pentaphylloides floribunda</i>
slender bog arrow-grass	<i>Triglochin palustris</i>
small white lady's-slipper	<i>Cypripedium candidum</i>
sticky false asphodel	<i>Tofieldia glutinosa</i>
sugar maple	<i>Acer saccharum</i>
sumac	<i>Rhus</i> sp.

Common Name	Scientific Name
Plants continued	
swamp milkweed	<i>Asclepias incarnata</i>
swamp thistle	<i>Cirsium muticum</i>
tall anemone	<i>Anemone virginiana</i>
tufted bulrush	<i>Scirpus cespitosus</i>
white ash	<i>Fraxinus americana</i>
white camas	<i>Zigadenus elegans</i> var. <i>glaucus</i>
white oak	<i>Quercus alba</i>
white pine	<i>Pinus strobus</i>
white spruce	<i>Picea glauca</i>
wild geranium	<i>Geranium maculatum</i>
woodland bluegrass	<i>Poa sylvestris</i>
yellow gentian	<i>Gentiana alba</i>

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Additional Resources

Numerous online resources are available for learning more about the rare species, natural communities, and ecological concepts contained within this report. These are just a few of the resources that we recommend.

1. Bureau of Endangered Resources' Animals, Plants, and Communities Web Pages

Information for plants, animals, and natural communities on the Wisconsin Working List, as well as Species of Greatest Conservation Need from the Wisconsin Wildlife Action Plan. For reptiles and amphibians, information for more common species is also provided here. At this time, the level of detail available varies among species; some have detailed factsheets while others have only a short paragraph or a map. These pages will continue to evolve as more information becomes available and are the Bureau of Endangered Resources' main source of information for species and communities. <http://dnr.wi.gov/topic/EndangeredResources/Biodiversity.html>

2. Wisconsin Natural Heritage Inventory Working List

The Wisconsin Natural Heritage Working List contains species known or suspected to be rare in the state and natural communities native to Wisconsin. It includes species legally designated as "Endangered" or "Threatened" as well as species in the advisory "Special Concern" category. This Web page offers a printable pdf file and a key to the Working List for use in conjunction with the information provided in #1 above. <http://dnr.wi.gov/topic/NHI/WList.html>

3. Ecological Landscapes of Wisconsin Handbook

Wisconsin's 16 Ecological Landscapes have unique combinations of physical and biological characteristics such as climate, geology, soils, water, or vegetation. This handbook will contain a chapter for each of these landscapes with detailed information about their ecology, socioeconomics, and ecological management opportunities. An additional introductory chapter will compare the 16 landscapes in numerous ways, discuss Wisconsin's ecology on the statewide scale, and introduce important concepts related to ecosystem management in the state. The full handbook is in development as of this writing, and chapters will be made available online as they are published. Currently, a set of Web pages provide brief Ecological Landscape descriptions, numerous maps, and other useful information, including management opportunities for natural communities and Species of Greatest Conservation Need. <http://dnr.wi.gov/topic/landscapes/>

4. The Wisconsin Wildlife Action Plan

This plan is the result of a statewide effort to identify native Wisconsin animal species of greatest conservation need. The plan also presents priority conservation actions to protect the species and their habitats. The plan itself is available online, and there are several online tools to explore the data within the plan. The Web pages are closely integrated with the pages provided in items #1 and #3 above. The Wildlife Action Plan Web pages are quite numerous, so we recommend the following links as good starting points for accessing the information.

<http://dnr.wi.gov/topic/wildlifehabitat/actionplan.html>

5. Wisconsin's Biodiversity as a Management Issue - A Report to Department of Natural Resources Managers

This now out-of-print report presents a department strategy for conserving biological diversity. It provides department employees with an overview of the issues associated with biodiversity and

provides a common point of reference for incorporating the conservation of biodiversity into our management framework. The concepts presented in the report are closely related to the material provided in this report, as well as the other resources listed in this section.

<http://dnr.wi.gov/files/PDF/pubs/rs/rs0915.pdf>

6. Wisconsin's Statewide Forest Strategy

Wisconsin's Statewide Forest Strategy is a collection of many strategies and actions designed to address major issues and priority topics over the next five to ten years. It provides a long-term, comprehensive, coordinated approach for investing resources to address the management and landscape priorities identified in the Statewide Forest Assessment. Several of the strategies contain issues related to biodiversity and ecosystem management.

<http://dnr.wi.gov/topic/ForestPlanning/strategy2010.asp>

7. 2010 Wisconsin's Statewide Forest Assessment

The goal of this project was to assess the "state of affairs" of Wisconsin's public and private forests and analyze the sustainability of our forested ecosystems. The Statewide Forest Assessment helps to explain trends, identify issues, and present an updated view of the status of forests in Wisconsin. The first chapter deals with biological diversity in Wisconsin's forests, and the major conclusions from this assessment were used to develop the strategies in # 6 above.

<http://dnr.wi.gov/topic/ForestPlanning/assessment2010.html>

Appendix A

Natural Heritage Inventory Overview and General Methodology

This biotic inventory and analysis was conducted by the Wisconsin Natural Heritage Inventory (NHI) program. The Wisconsin NHI program is part of the Wisconsin DNR's Bureau of Endangered Resources and a member of an international network of Natural Heritage programs representing all 50 states, as well as portions of Canada, Latin America, and the Caribbean. These programs share standardized methods for collecting, processing, and managing data for rare species, natural communities, and certain other natural features (e.g., bird rookeries). NatureServe, an international non-profit organization, coordinates the network. This appendix provides a general overview of the methodology we use for these projects. Please see the NatureServe Web site for more detailed information about standard methods used by the Heritage Network (www.NatureServe.org) for locating, documenting, and ranking rare species and natural community occurrences.

General Process Used when Conducting Biotic Inventories for Master Planning

The Wisconsin NHI Program typically uses a “coarse filter-fine filter” approach to conducting biotic inventory projects for master planning. This approach begins with a broad assessment of the natural communities and aquatic features present, along with their relative quality and condition. The area's landforms, soils, topography, hydrology, current land uses, and the surrounding matrix are also evaluated using Geographic Information Systems (GIS) and other electronic and hardcopy data sources. Data that describe conditions for the area prior to Euro-American settlement are often used during this step and at other times to further understand the ecological capabilities of the area. Often, we consult with local managers, biologists, or others familiar with the ecology of the area when preparing for an inventory project. The goals for this step are to identify the important ecological attributes and biological processes present, as well as to focus our inventory efforts.

The level of survey intensity varies based on the size and ecological complexity of the property or group of properties, as well as the resources available. For larger properties such as state forests, biotic inventory efforts typically take more than one year. Ideally, taxa surveys are conducted following a coarse-filter analysis that sometimes include extensive natural community surveys. There is often time for “mop-up work” during the year following the completion of the main survey effort, whereby additional surveys are conducted for areas that could not be reached the first year or for which new information has become available. For smaller properties, a “Rapid Ecological Assessment” often takes the place of a full-scale biotic inventory. The level of effort for these projects varies based on the needs of the study area, although surveys are almost always completed during one field season. Coarse filter work for rapid assessments is often done based on GIS data, aerial photos, data acquired from previous efforts, and information from property managers and others knowledgeable about the area.

Taxa-specific surveys can be costly and intensive and sometimes must be completed during a very narrow period of time. For example, bird surveys must be completed within an approximately one-month time window. For this and several other reasons, ***our surveys cannot locate every rare species occurrence within a given area.*** Therefore, it is important to use resources as efficiently as possible, making every effort to identify the major habitats present in the study area from the start. This approach concentrates inventory efforts on those sites most likely to contain target species to maximize efficient use of resources. Communication among biologists during the field season can help identify new areas of

interest or additional priorities for surveys. The goal is to locate species populations with the highest conservation value whenever possible.

After all of the data are collected, occurrences of rare species, high-quality natural communities, and certain other features are documented, synthesized, and incorporated into the NHI Database. The NHI program refers to this process as “mapping” the data and uses a tabular and spatial database application designed specifically for the Heritage Network. Other secondary databases are also used by the Wisconsin NHI Program for storing additional species and community information such as species lists, GPS waypoints, photos, and other site documentation.

Once the data mapping and syntheses are completed, the NHI Program evaluates data from the various department biologists, contractors, and other surveyors. This information is examined along with many other sources of spatial and tabular information including topographic maps, various types of aerial photography, digital soil and wetland maps, hydrological data, forest reconnaissance data, and land cover data. Typically, GPS waypoints and other spatial information from the various surveys are superimposed onto these maps for evaluation by NHI biologists.

In addition to locating important rare species populations and high-quality natural community occurrences, the major products culminating from all of this work are the “Primary Sites.” These areas contain relatively undisturbed, high-quality, natural communities; provide important habitat for rare species; offer opportunities for restoration; could provide important ecological connections; or some combination of the above factors. The sites are meant to highlight, based on our evaluation, the best areas for conserving biological diversity for the study area. They often include important rare species populations, High Conservation Value Forests, or other ecologically important areas.

The final report describes the Primary Sites, as well as rare or otherwise notable species, and other ecological opportunities for conserving or enhancing the biological diversity of the study area. The report is intended for use by department master planning teams and others and strives to describe these opportunities at different scales, including a broad, landscape context that can be used to facilitate ecosystem management.

Select Tools Used for Conducting Inventory

The following are descriptions of standard tools used by the NHI Program for conducting biotic inventories. Some of these may be modified, dropped, or repeated as appropriate to the project.

File Compilation: Involves obtaining existing records of natural communities, rare plants and animals, and aquatic features for the study area and surrounding lands and waters from the NHI Database. Other databases with potentially useful information may also be queried, such as: forest reconnaissance data; the DNR Surface Water Resources series for summaries of the physical, chemical, and biological characteristics of lakes and streams (statewide, by county); the Milwaukee Public Museum's statewide Herp Atlas; the Wisconsin Breeding Bird Atlas; other NHI “atlas” and site databases; museum/herbarium collections for various target taxa; soil surveys; geological surveys; and the department’s fish distribution database.

Additional data sources are sought out as warranted by the location and character of the site, and the purpose of the project. Manual files maintained within the Bureau of Endangered Resources, including the State Natural Area files, often contain information on a variety of subjects relevant to the inventory of natural features for an area.

Literature Review: Field biologists involved with a given project consult basic references on the natural history and ecology of the area, as well as any documented rare species. This sometimes broadens and/or sharpens the focus of the inventory efforts.

Target Elements: Lists of target elements including natural communities, rare plants and animals, and aquatic features are developed for the study area. Field inventory is then scheduled for the times when these elements are most identifiable or active. Inventory methods follow accepted scientific standards for each taxon.

Compilation of Maps and Other Spatial Data: USGS 7.5 minute topographic quadrangles, most often in digital form, serve along with aerial photos as the base maps for field survey and often yield useful clues regarding access, extent of area to be surveyed, developments, and the presence and location of special features. These are used in conjunction with numerous GIS layers, which are now a basic resource tool for the efficient and comprehensive planning of surveys and the analysis of their results.

WDNR wetland maps consist of aerial photographs upon which all wetlands down to a scale of 2 or 5 acres have been delineated. Each wetland polygon is classified based on characteristics of vegetation, soils, and water depth. These polygons have been digitized for most counties, and the resulting GIS layers can be superimposed onto other maps.

Ecoregion GIS layers are useful for comprehensive projects covering large geographic areas such as counties, national and state forests, and major watersheds. These maps integrate basic ecological information on climate, landforms, geology, soils, and vegetation. Ecological Landscapes provide the broad framework most often used in Wisconsin; however smaller units, including Landtype Associations, can be very helpful for evaluating ecoregions at finer scales.

Aerial photographs: These provide information on a study area not available from maps, paper files, or computer printouts. Examination of both current and historical photos, taken over a period of decades, can be especially useful in revealing changes in the environment over time. The Wisconsin NHI Program uses several different types of both color and black and white air photos. Typically, these are in digital format, although paired photos in print format can be valuable for stereoscopic viewing. High-resolution satellite imagery is often cost-prohibitive but is available for some portions of the state and is desirable for certain applications.

Original Land Survey Records: The surveyors who laid out the rectilinear Town-Range-Section grid across the state in the mid-nineteenth century recorded trees by species and size at all section corners and along section lines. Their notes also included general impressions of vegetation, soil fertility, and topography, and note aquatic features, wetlands, and recent disturbances such as windthrow and fire. As these surveys typically occurred prior to extensive settlement of the state by Europeans, they constitute a valuable record of

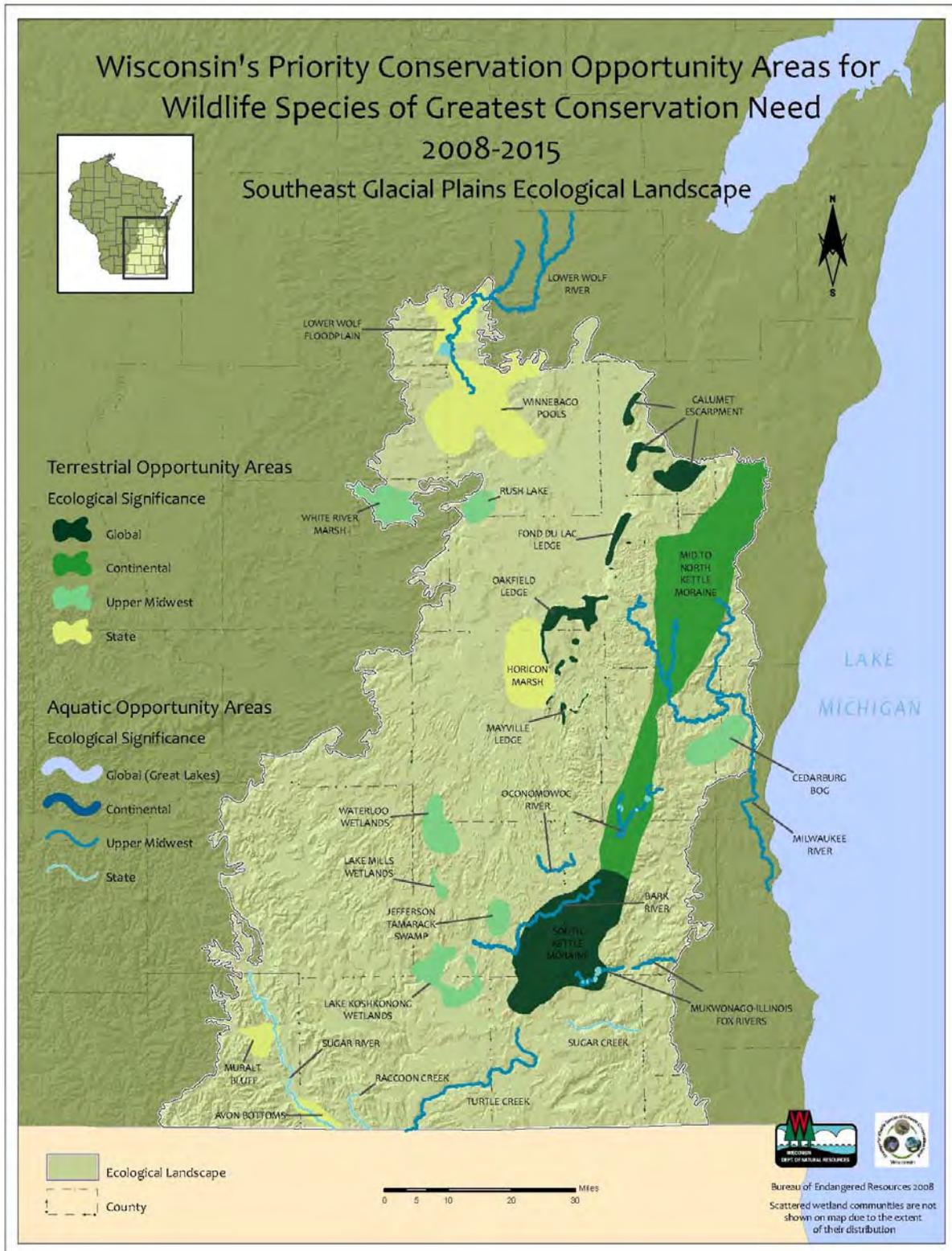
conditions prior to extensive modification of the landscape by European technologies and settlement patterns. The tree data are available in GIS format as raw points or interpreted polygons, and the notes themselves can provide helpful clues regarding the study area's potential ecological capabilities.

Interviews: Interviews with scientists, naturalists, land managers or others knowledgeable about the area to be surveyed often yield invaluable information.

Global Positioning Systems (GPS): Small, portable GPS units are now a routine piece of field equipment used for virtually all NHI survey work. Collecting coordinates (waypoints) facilitates mapping and makes it easy to quickly communicate specific locations among biologists. Often waypoints are paired with photos and/or other information and stored in a waypoint tracking database.

Aerial Reconnaissance: Fly-overs are desirable for large sites, and for small sites where contextual issues are especially important. When possible, this should be done both before and after ground level work. Flights are scheduled for those times when significant features of the study area are most easily identified and differentiated. They are also useful for observing the general lay of the land, vegetation patterns and patch sizes, aquatic features, infrastructure, and disturbances within and around the site.

Appendix B



Appendix C

Summary Descriptions for Rare Species and High-quality Natural Communities Documented on the Kettle Moraine State Forest

The following paragraphs give brief summary descriptions for each of the rare species and high-quality natural communities documented on the KMSF and mapped within the NHI Database. More information can be found on the Endangered Resources Web site (www.dnr.wi.gov/org/land/er/) for several of these species and natural communities.

Rare Animals

A Broad-shouldered Water Strider

A broad-shouldered water strider, *Microvelia fontinalis*, is listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. Species of the *Microvelia* genus find habitat on the surface of water among vegetation in temporary or permanent ponds, lakes, or calm areas of streams where they prey upon other water surface arthropods.

A Crawling Water Beetle

A crawling water beetle, *Halipus pantherinus*, is listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. As a member of the genus *Halipus*, this beetle lives among algae and aquatic vegetation as the edges of lakes, ponds, and backwater areas. Adults may occur year-round and will overwinter in permanent standing water, with larvae occurring in the spring.

A Dubiraphian Riffle Beetle

A dubiraphian riffle beetle, *Dubiraphia bivittata*, is listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. This is the largest species in the genus *Dubiraphia* and it occurs uncommonly in medium to large rivers throughout the State (Hilsenhoff and Schmude 1992). As a member of the Riffle Beetle family (*Elmidae*), these beetles can likely be found crawling on stones and woody debris in riffle zones of freshwater streams. The adults mate in water where the female will lay single eggs or groups of eggs on the stream bottom. These species when found can be useful indicators of the environmental quality of a stream.

A Leafhopper

A leafhopper, *Flexamia prairiana*, a State Special Concern leafhopper and a Species of Greatest Conservation Need, has been noted in prairie or grassland habitats. *Bothriochloa* spp., *Andropogon gerardii*, and *Schizachyrium scoparium* have been reported as being host plants for the species.

A Leafhopper

A leafhopper, *Memnonia panzeri*, a State Special Concern leafhopper and a Species of Greatest Conservation Need, can be found in prairie habitats. Prairie Dropseed (*Sporobolus heterolepis*) is the obligate host plant for this species.

A Lepidostomatid Caddisfly

A Leptidostomatid caddisfly, *Lepidostoma libum*, a State Special Concern caddisfly and a Species of Greatest Conservation Need, can be found in streams and rivers. This very rare species often has cases made of small sand grains or bits of plant material.

A Long-horned Casemaker Caddisfly

A long-horned casemaker caddisfly (*Triaenodes nox*), a State Special Concern caddisfly and a Species of Greatest Conservation Need, has been found in ponds, lake shores, and generally slow-flowing areas of streams and rivers.

A Predaceous Diving Beetle

A predaceous diving beetle, *Celina hubbelli*, a State Special Concern beetle and a Species of Greatest Conservation Need, has been found in shallow cattail habitats where they pierce cattails to obtain oxygen.

A Predaceous Diving Beetle

A predaceous diving beetle, *Copelatus chevrolati*, is listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. As a member of the genus *Copelatus*, it is likely that this species can be found in standing water of ponds, pools, and temporary pools in leaf litter and is most active from March to August.

A Predaceous Diving Beetle

A predaceous diving beetle, *Hydroporus pseudovilis*, is listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. As a member of the genus *Hydroporus*, this species is most likely found at the margins of shallow ponds, lakes, or other bodies of standing water among emergent vegetation.

A Predaceous Diving Beetle

A predaceous diving beetle (*Ilybius ignarus*), a State Special Concern beetle and a Species of Greatest Conservation Need, has been found in marshes, ponds, and swamps.

A Side-swimmer

A side-swimmer, *Crangonyx richmondensis*, is a crustacean that has been listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. This species is found in freshwater habitats from creeks, springs, ditches, and drains, to shallow water lake and pond habitats, as well wetland habitats including swamps and bogs.

A Velvet Water Bug

A velvet water bug, *Hebrus burmeisteri*, is listed as Special Concern in Wisconsin as well as a Species of Greatest Conservation Need by the Wisconsin. This species can likely be found near the shoreline of shallow ponds or near stagnant pools where vegetation is dense.

A Water Scavenger Beetle

A water scavenger beetle, *Enochrus sayi*, is listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. This species is likely to be found in ponds or along stream where it feeds on dead plant or animal material.

A Water Scavenger Beetle

A water scavenging beetle (*Laccobius agilis*), a State Special Concern beetle and a Species of Greatest Conservation Need, has been found in ponds, spring ponds and seeps, and margins of streams.

A Water Scorpion

A water scorpion, *Nepa apiculata*, is listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. This species can be found in ponds, slow streams, in mud, or dense vegetation where it preys on other aquatic invertebrates.

Acadian Flycatcher

Acadian Flycatcher (*Empidonax virescens*), a bird listed as Threatened and a Species of Greatest Conservation Need in Wisconsin, prefers lowland deciduous forests and heavily wooded hillsides in large blocks of southern forests. The breeding season extends from mid-May through late July.

American Bullfrog

American Bullfrog (*Rana catesbeiana*), a State Special Concern species, may be found throughout Wisconsin in any permanent body of water - lakes, ponds, rivers, and creeks, although they have a very patchy distribution. In Wisconsin, bullfrogs appear to favor oligotrophic to mesotrophic waters, often breeding where dense submergent vegetation filters out the majority of the suspended solids. Adult bullfrogs overwinter in water to avoid freezing. Bullfrogs are active from April through mid-October. They breed from mid-May through late July or later. Larvae overwinter before transforming the following year or, in rare situations, in their second full year.

An Owlet Moth

An Owlet Moth (*Macrchilo bivittata*), is listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. This species can be found in wetlands, especially calcareous areas of sedge meadows, fens, wet prairie, and occasionally boggy areas.

Arctic Shrew

Arctic Shrew (*Sorex arcticus*), a state Special Concern mammal. This species is found in tamarack and spruce swamps. Sometimes in alder or willow marshes, rarely in leatherleaf-sphagnum bogs.

Azure Bluet

Azure Bluets (*Enallagma aspersum*), a State Special Concern species, are members of the Pond Damsel Family (Coenagrionidae) and are in a group of about 17 similar bluet species in Wisconsin.

Ranging throughout eastern United States and extreme southeastern Canada, this species prefers vegetated and bog-bordered ponds or occasionally boggy swamps with no fish. It is known in Wisconsin from just a few widely scattered sites. In Wisconsin, adults have been documented from early July to late August.

Banded Killifish

Banded killifish (*Fundulus diaphanus*), a State Special Concern fish and a Species of Greatest Conservation Need, prefers clear water of the bays and quiet backwaters of large lakes and medium to large streams with and sparse to no vegetation over gravel, sand, silt, marl, clay detritus or cobble. Spawning occurs from June through mid-August.

Barn Owl

Barn Owl (*Tyto alba*), a bird listed as Endangered in Wisconsin and a Species of Greatest Conservation Need, inhabits open to partly open country, and prefers uncultivated field and wetland edges. It nests in buildings, caves and hollow trees. The breeding season extends from late March through late September.

Bell's Vireo

Bell's Vireo (*Vireo bellii*), a bird listed as Threatened and a Species of Greatest Conservation Need in Wisconsin, prefers dense shrubby areas within an open prairie landscape. The breeding season extends from late May to mid-July.

Black Tern

Black Tern (*Chlidonias niger*), a bird listed as Special Concern and a Species of Greatest Conservation Need, prefers large shallow marshes with abundant vegetation adjacent to open water. Nesting occurs from May through the end of July.

Black-crowned Night-heron

Black-crowned Night-heron (*Nycticorax nycticorax*), a bird listed as Special Concern, prefers freshwater wetlands dominated by bulrush and cattail with small groves of alder, willow, or other brush. Their breeding season occurs from mid-April through mid-September.

Blanding's Turtle

Blanding's turtles (*Emydoidea blandingii*) are listed as a Threatened species and a Species of Greatest Conservation Need in Wisconsin. They utilize a wide variety of aquatic habitats including deep and shallow marshes, shallow bays of lakes and impoundments where areas of dense emergent and submergent vegetation exists, sluggish streams, oxbows and other backwaters of rivers, drainage ditches (usually where wetlands have been drained), and sedge meadows and wet meadows adjacent to these habitats. This species is semi-terrestrial and individuals may spend a good deal of time on land. They often move between a variety of wetland types during the active season, which can extend from early March to mid-October. They overwinter in standing water that is typically more than 3 feet in deep and with a deep organic substrate but will also use both warm and cold-water streams and rivers where they can avoid freezing. Blanding's generally breed in spring, late summer or fall. Nesting occurs from about mid-May through June depending on spring temperatures. They strongly prefer to nest in sandy soils and may travel well over a mile to find suitable soils. This species appear to display nest site fidelity, returning to its natal site and then nesting in a similar location annually. Hatching occurs from early August through early September but hatchlings can successfully overwinter in the nest, emerging the following late April or May. This species takes 17 to 20 years or more to reach maturity.

Broad-winged Skipper

Broad-winged skipper (*Poanes viator*), a State Special Concern butterfly, is a wetland obligate. It is found in small localized colonies in sedge marsh/swamp with *Carex lacustris*, *aquatilis*, *lasiocarpa*. Perhaps needs a relatively high water table where it is found with cattails and sedges. This is a univoltine species with adults present in July or into early August. The hibernation site is unknown but broadwinged skippers overwinter as partially grown larvae.

Butler's Gartersnake

Butler's gartersnakes (*Thamnophis butleri*), a Threatened Species and a Species of Greatest Conservation Need in Wisconsin, prefer almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation such as reed canary grass. Butler's gartersnakes can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until daytime temperatures fall consistently below 50 deg. F. Breeding usually occurs in April and early May but can occur in fall and live young are born between mid-July and mid-August.

Canada Warbler

Canada Warbler (*Wilsonia canadensis*), a State Special Concern bird and a Species of Greatest Conservation Need, is typically most abundant in moist, mixed coniferous-deciduous forests with a well-developed understory. They nest in dense vegetation, often in areas with mosses, ferns, and decaying stumps or logs.

Cantrall's Bog Beetle

Cantrall's bog beetle (*Liodessus cantralli*), a State Special Concern beetle and a Species of Greatest Conservation Need, has been found in small ponds to large marshes, and within Sphagnum mats of fens.

Cerulean Warbler

Cerulean Warbler (*Dendroica cerulea*), a bird listed as Threatened and a Species of Greatest Conservation Need in Wisconsin, prefers lowland deciduous forests dominated by mature stands of American elm, cottonwood, and green ash and large upland blocks of mature dry-mesic to mesic forests. The breeding season extends from late April through mid-July.

Columbine Dusky Wing

Columbine dusky wing (*Erynnis lucilius*), a State Special Concern butterfly and a Species of Greatest Conservation Need, is found in woodland habitat with wild columbine (*Aquilegia canadensis*); most often in rocky ravines, gullies, or woodland edge. Also found in prairie habitat edged with oak woods. This species is bivoltine, their flight periods are the first three weeks of May and mid July through early August. Larvae live in leaf nests on the hostplant and mature larvae overwinter in the litter at the base of the plant.

Creek Heelsplitter

The creek heelsplitter (*Lasmigona compressa*), a State Special Concern mussel, occurs mainly in rivers and streams of various sizes, including very small creeks, but is rare in lake habitats. It is found on substrates of gravel, sand, or mud and has a wide variety of glochidial hosts, including black and yellow bullhead, brook stickleback, creek cub and black crappie to name a few.

Dickcissel

Dickcissel (*Spiza americana*), a bird of Special Concern and a Species of Greatest Conservation Need in Wisconsin, prefers open pasture and fields of clover and alfalfa. Grasslands, meadows, and savanna are also important nesting areas. This bird requires vegetation with medium to tall height-density and a significant component of forbs, some stiff-stemmed. Breeding occurs from late May to early August.

Double-striped Bluet

Double-striped bluet (*Enallagma basidens*), a State Special Concern damselfly occurs has been found in permanent or semi-permanent lakes, ponds, reservoirs, borrow pits, slow parts of streams or rivers, or spring fed streams. It rarely occurs in bog ponds.

Eastern Hog-nosed Snake

Eastern Hog-nosed snakes (*Heterodon platirhinos*), listed as Special Concern in Wisconsin, are harmless to humans despite their intimidating behavior of puffing up with air, flattening their necks like cobras, and hissing loudly when threatened, garnering the nickname “puff adder”. Hog-nosed snakes almost never bite, but rather will feign death if provoked enough. These snakes are often found in open, sandy woodlands and their upturned, hog-like snout is used to burrow after toads, a favorite food. Hog-nosed snakes mate in the Spring and females lay up to 60 eggs in June or July, usually in an underground burrow. The young snakes hatch out about 60 days later, and are usually grayish with black blotches. Adult coloration appears as they mature.

Eastern Red Damsel

The eastern red damsel (*Amphiagrion saucium*), is listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. The favored habitat of this species is around spring-fed bogs or pond margins, sometimes with a deep peat layer, at other times where seeps, with a scattering of *Sphagnum* and algae, run over sand. In general, shallow, freshwater habitats are preferred.

Eastern Ribbonsnake

Northern ribbonsnakes (*Thamnophis sauritus*), listed as Endangered and a Species of Greatest Conservation Need in Wisconsin, are semi-aquatic and primarily found in bog relics near or south of the Tension Zone. Records from Peninsula State Park in Door County are from atypical Wisconsin habitat, although they appear to be persisting in this location. Northern ribbonsnakes emerge in April and remain active into October. They breed in spring shortly after emerging and give live birth from mid July through August.

Elfin Skimmer

Elfin skimmer (*Nannothemis bella*), a State Special Concern dragonfly and a Species of Greatest Conservation Need, has been found in shallow water wetlands, usually with sphagnum or other underwater vegetation. The flight period is from mid June through early August.

Elktoe

Elktoe (*Alasmidonta marginata*), a State Special Concern mussel, is found in various-sized streams with flowing water, sand, gravel or rock substrates that are stable. The known host fishes include widespread species including redbhorse, sucker species, and rockbass.

Ellipse

Ellipse (*Venustaconcha ellipsiformis*), a mussel presently listed as Threatened and a Species of Greatest Conservation Need in Wisconsin. This species prefers shallow, flowing, clean small streams with stable substrate in the eastern and southern part of the state. It has also been recorded from localized populations in the western part of the state. The host fish are mostly small stream species including the rainbow darter, Johnny darter and mottled sculpin.

Four-toed Salamander

Four-toed salamanders (*Hemidactylium scutatum*), a State Special Concern species and a Species of Greatest Conservation Need, prefer northern and southern hardwood forests and to a lesser degree, conifer swamps. They overwinter from November through late March by burrowing underground to avoid freezing. Mating can occur in fall or spring at breeding ponds, seepage pools or springs. In April, females move to microhabitats of dense, usually sphagnum, mosses overhanging the water's edge or dense mosses on downed woody debris overlying the water. Four-toed salamanders will also nest in inundated sedge tussock wetlands when mosses are not present. This species' unique nesting microhabitats appear to limit their abundance. Females remain with their eggs until hatching. Eggs hatch in late May or June and larvae drop into the water where they live until transforming in about six weeks. Four-toed salamanders remain active through November.

Fragile Forktail

Fragile forktail (*Ischnura posita*), a State Special Concern damselfly and a Species of Greatest Conservation Need, has been found in marshy, still or slow moving waters, or partially shaded swamps or spring ponds. The flight period extends from late July to late August.

Franklin's Ground Squirrel

Franklin's Ground Squirrel (*Spermophilus franklinii*), a mammal listed as Special Concern and a Species of Greatest Conservation Need, this semi-colonial species prefers brushy and partly wooded areas, dense grassy, shrubby marshland, as well as, prairie edges, rather than open prairie. Mating occurs from the late April to mid-May and young are born between late May to mid-June.

Greater Redhorse

Greater Redhorse (*Moxostoma valenciennesi*), a fish listed as Threatened and a Species of Greatest Conservation Need in Wisconsin, This species prefers clear water of medium to large rivers, over bottoms of sand, gravel, or boulders. Spawning occurs in May or June.

Henslow's Sparrow

Henslow's Sparrow (*Ammodramus henslowii*) a bird listed as Threatened and a Species of Greatest Conservation Need in Wisconsin, prefers old fields, open grasslands, wet meadows, unmowed highway right-of-ways, undisturbed pastures, timothy hay fields, and fallow land grown up to tall weeds. The breeding season extends from mid-May through mid-July.

Hickory Hairstreak

Hickory hairstreak (*Satyrium caryaevorum*) is a butterfly listed as a Special Concern and a Species of Greatest Conservation Need in Wisconsin. The Hickory Hairstreak is not a common species in Wisconsin, but may be found throughout the state, typically in clearings and woodland edges especially where Hickory, its preferred host plant for young, grows. Caterpillars of this species have also been reported to feed on Walnut, Oak, and Ash. One brood is produced from late June through July. Adults

can be found to feed on nectar from flowers of common milkweed, dogbane, New Jersey tea, staghorn sumac, and white sweet clover.

Highland Dancer

Highland Dancer (*Argia plana*), a dragonfly listed as species of Special Concern and a Species of Greatest Conservation Need in Wisconsin, is often found near springs associated with streams, especially those near rocky riffles. The flight season extends from mid-June to late August.

Hooded Warbler

Hooded Warbler (*Wilsonia citrina*), a bird listed as Threatened and a Species of Greatest Conservation Need in Wisconsin. This species is found in large upland forest tracts in southern Wisconsin, where they occur in pockets of dense understory near small or partial canopy openings. Breeding occurs from late May through mid July.

Kentucky Warbler

Kentucky Warbler (*Oporornis formosus*), a bird listed as Threatened and a Species of Greatest Conservation Need in Wisconsin. This species is found in large tracts of hardwood forest in southern Wisconsin, especially along Mississippi and Wisconsin rivers and their bluffs, and the Baraboo Hills. They breed in sites that are moist, with heavy undergrowth, thickets and ground vegetation. The breeding season extends from mid-May through late June.

King Rail

King Rail (*Rallus elegans*), a bird listed as Special Concern and a Species of Greatest Conservation Need, prefers shallow marshes. The breeding season extends from mid-May to mid-July.

Lake Chubsucker

Lake Chubsucker (*Erimyzon sucetta*), a fish listed as Special Concern and a Species of Greatest Conservation Need, prefers moderately clear lakes, oxbow lakes, sloughs of weedy lakes and their associated marshy streams dense with organic debris over bottoms of cobble, sand, boulders, mud or silt. Spawning occurs from mid May through early July.

Least Darter

Least Darter (*Etheostoma microperca*), a fish listed as Special Concern and a Species of Greatest Conservation Need, prefers clear, warm, quiet waters of overflow ponds, pools, lakes and streams over substrates of gravel, silt, sand, boulders, mud or clay with dense vegetation or filamentous algal beds. Spawning occurs from late April into July.

Liatrix Borer Moth

Liatrix borer moth (*Papaipema beeriana*), a moth listed as Special Concern and a Species of Greatest Conservation Need, prefers mesic tall grass prairie or wetter situations with significant host plants, *Liatrix pycnostachya* and probably other blazing stars (*Liatrix* sp.).

Little Glassy Wing

Little glassy wing (*Pompeius verna*), a butterfly listed as Special Concern and a Species of Greatest Conservation Need, is found in grassy openings in wooded areas near swamps, streams, bogs. Host plants appear to include grasses, especially purple top grass (*Tridens flavus*). Flight period is from late June-July. Little glassywings overwinter as partially grown larvae.

Longear Sunfish

Longear Sunfish (*Lepomis megalotis*), a fish listed as Threatened and a Species of Greatest Conservation Need in Wisconsin, prefers clear, shallow, moderately warm, still waters of streams and occasionally in lakes. Found in or near vegetation. Spawning occurs from late May through mid-July, sporadic to August.

Midwestern Fen Buckmoth

The Midwestern fen buckmoth (*Hemileuca sp. 3*), is listed as a Special Concern and also a Species of Greatest Conservation Need in Wisconsin. Reported most often in Central to southeastern Wisconsin, this species is associated with calcareous shrub swamps, carrs, and fens. Eggs are commonly laid on small willows where they overwinter and typically hatch in May. Some populations may also use bog birch, purple loosestrife, and *Meyanthes*. The larval stage is less than two months and the larvae tend to feed on willow species, or other host plants where eggs may have been laid.

Mudpuppy

Mudpuppies (*Necturus maculosus*), a State Special Concern species and a Species of Greatest Conservation Need, prefer medium to large rivers and lakes. They have a preference for completely aquatic microhabitats such as riprap, talus, boulder/rock piles, beneath flat rocks, under large sunken woody debris, dense mats of submergents in the deep littoral zone, or eroded pockets of clay lenses in riverbanks. Mudpuppies are active year-round, breed in late fall and spawn in June. Eggs hatch in July or August. This amphibian species is the only host of the state-threatened salamander mussel.

Mulberry Wing

Mulberry wing (*Poanes massasoit*), a Special Concern butterfly, has been found in marshes and sedge meadows. Host plants appear to be arrow-leaved sedges including *Carex stricta*, and possibly *C. aquatilis*. This butterfly is univoltine with the flight period from mid to late June through July. Mulberry wings overwinter as partially grown larvae.

North American Racer

Yellow-bellied racers (*Coluber constrictor*) are a species of Special Concern, a Species of Greatest Conservation Need, and a Protected Wild Animal. Racers prefer moderate to dry sand prairies and bluff prairies. They are well adapted to open, sunny or savanna-like conditions. This species overwinters individually or communally with other snakes. Fractured limestone is often used to avoid freezing or desiccation during winter. The racer has declined in recent decades due to natural succession resulting from fire suppression and a lack of management to maintain open canopy conditions. Racers are active from April through early October. They breed in spring or fall and lay their eggs from mid-June to early July below the surface in sandy soils. Eggs hatch in 55-65 days, usually in August or early September.

Northern Clearwater Crayfish

The northern clearwater crayfish (*Orconectes propinquus*), a State Special Concern species, generally inhabits the rapid parts of streams with rock/gravel substrate where it may burrow into the substrate and prefers cool, unpolluted water. Mating for this crayfish tends to be in the fall, with brooding occurring in spring.

Northern Cricket Frog

Northern cricket frog (*Acris crepitans*), a State Endangered species and a Species of Greatest Conservation Need, prefer ponds, lakes, and a variety of habitats along and adjacent to streams and rivers including, marshes, fens, sedge meadows, low prairies, and exposed mud flats. The species tends to breed in quite water (no or low flow) and may also move from streams and rivers to adjacent wetlands and ponds. Cricket frogs cannot tolerate freezing or complete inundation for more than 24 hours during the

winter and seek a variety of microhabitats that provide suitable overwintering conditions, including crayfish burrows, small mammal burrows, rotted-out root channels, seepage areas where groundwater flow prevents freezing at the surface or spaces created by sloughing streambanks. Cricket frogs are active from late-March through November. Breeding occurs from mid-May through mid-August, with some larvae not transforming until late September.

Northern Long-eared Bat

Northern Long-eared Bat, (*Myotis septentrionalis*), a mammal listed as Special Concern and a Species of Greatest Conservation Need, is usually dull light brown, with a gray underbelly. Habitat for the summer may include day roosts in buildings, under tree bark or shutters, or caves during the night. Hibernation sites are often in mines or caves, and this species may co-hibernate with other species. Foraging habitat includes forested hillsides and ridges, and small ponds or streams. Mating occurs in the fall with delayed fertilization in the spring, and one young produced between May and July.

Northern Ring-necked Snake

Northern ringneck snakes (*Diadophis punctatus edwardsii*), a species of Special Concern, prefer moist to moderately dry deciduous forests. They also are found in openings within the woods or near woods edges, but almost always are under cover such as rocks, downed woody debris or artificial materials. Within the forest, this species may also be found between the bark and core wood of tree stumps or within rotting logs. No specific overwintering habitat has been described in Wisconsin, although they likely use rotted out root channels and other structures that offer a moist, no-freeze environment. They are active from mid-April through early October, breed late April through early June and lay their eggs between late-June and early July. Eggs may be laid communally by two or more females. Hatching occurs in August or early September.

Osprey

Osprey (*Pandion haliaetus*), a State Special Concern species and a Species of Greatest Conservation Need, prefer large trees in isolated areas in proximity to large areas of surface water, large complexes of deciduous forest, coniferous forest, wetland, and shrub communities. Large lakes and rivers with nearby tall pine trees are preferred for nesting. The breeding season extends from late April through August.

Pickerel Frog

Pickerel frogs (*Lithobates palustris*) are a Species of Special Concern and a Species of Greatest Conservation Need in Wisconsin. It has a rather complex habitat range as it prefers to overwinter in cold water streams, seepage pools or spring holes, often taking advantage of water cress for cover. It moves to warmer water ponds to breed and lay eggs from April through mid-June. Adults spend most of the active season foraging on land in riparian habitats along streams and rivers. This species is active from late March to early November but can remain semi-active in winter under water. Larvae metamorphose from mid-July to mid-August.

Powesheik Skipperling

Powesheik skipper (*Oarisma powesheik*), a butterfly listed as Endangered and a Species of Greatest Conservation Need in Wisconsin. Powesheiks require wet mesic prairie or southern fen habitat with native grasses, sedges, and a significant component of plants in the sunflower family. These wet communities often support JoePyeweed (*Eupatorium maculatum*), swamp milkweed (*Asclepias incarnata*), gayfeather (*Liatrix pycnostachya*), big bluestem (*Andropogon gerardii*), and possibly cordgrass (*Spartina pectinata*). This is a univoltine species, with adults present mid-June through July, peaking the first two weeks of July. Eggs are laid near the tips of leaf blades. Eggs and larvae are on the host plants from late June through the winter until pupation in late May.

Pronghorned Clubtail

Pronghorned clubtail (*Gomphus graslinellus*), a State Special Concern dragonfly has been found in slow moving streams, ponds or lakes. The flight period is early June through late July.

Pugnose Shiner

Pugnose Shiner (*Notropis anogenus*), a fish listed as Threatened and a Species of Greatest Conservation Need in Wisconsin, prefers weedy shoals of glacial lakes and low-gradient streams over bottoms of mud, sand, cobble, silt, and clay. Spawning occurs from mid-June through mid-July.

Queensnake

Queensnakes (*Regina septemvittata*), listed as Endangered and a Species of Greatest Conservation Need in Wisconsin, prefer clear warm-water streams and small rivers. They are strongly associated with aquatic crayfish, and require both moderate to fast flows and rocky substrates. They also prefer open-canopy habitats where they spend the majority of their time basking in grasses or in shoreline brush and foraging in water or along the shoreline. This species overwinters in crayfish burrows but also in artificial structures such as cracked bridge abutments, old dams and seawalls. Queensnakes are active from late April through early October and breed mid-May through mid-June. Live young are born in August or early September.

Rainbow Shell

Rainbow shell (*Villosa iris*), a mussel listed as Endangered and a Species of Greatest Conservation Need in Wisconsin, is found in shallow, flowing, clean small streams with stable gravel substrate in the eastern part of the state. It has a very restricted geographical range in Wisconsin. The known host fish include smallmouth and largemouth basses and rockbass.

Red-shouldered Hawk

Red-shouldered Hawk (*Buteo lineatus*), a bird listed as Threatened and a Species of Greatest Conservation Need in Wisconsin. This species prefers larger stands of medium-aged to mature lowland deciduous forests, dry-mesic and mesic forest with small wetland pockets. Breeding occurs from mid-March through early August.

Red-tailed Prairie Leafhopper

Red-Tailed Leafhopper (*Aflexia rubranura*), a leafhopper Endangered and a Species of Greatest Conservation Need in Wisconsin, inhabits dry to wet-mesic prairies with the host plant, prairie dropseed (*Sporobolus heterolepis*).

River Bluet

River bluet (*Enallagma anna*), a State Special Concern damselfly and a Species of Greatest Conservation Need, has been collected Larvae confined to slow streams and rivers and sometimes are associated with springs or spring fed streams in Wisconsin.

Round Pigtoe

Round pigtoe (*Pleurobema sintoxia*), a State Special Concern mussel. In Wisconsin, this species prefers various habitat types. It occurs only in clean water of small streams to large rivers on stable substrate. The known host fish include a number of cyprinid species.

Silphium Borer Moth

Silphium borer moth (*Papapaima silphii*), a moth listed as Endangered and a Species of Greatest Conservation Need, prefers sunny areas where host plants (Silphium species including prairie dock, cup-plant, rosinweed, and compass plant) exist in good numbers. Habitat is generally wet to dry-mesic prairie.

Slender Bluet

Slender bluet (*Enallagma traviatum*), a State Special Concern damselfly and a Species of Greatest Conservation Need, is usually found in permanent lakes and ponds with abundant emergent vegetation.

Slender Madtom

Slender Madtom (*Noturus exilis*), a fish listed as Endangered and a Species of Greatest Conservation Need in Wisconsin, prefers clear, moderate to swift currents of streams and wide rivers over bottoms of gravel and boulders interspersed with fine sand. Spawning occurs from late May through June.

Slippershell Mussel

Slipper shell (*Alasmidonta viridis*), a mussel listed as Threatened and a Species of Greatest Conservation Need in Wisconsin, is found in small to medium-sized streams with flowing hard water, sand or gravel bottoms. It is presently found only in the eastern and southern parts of Wisconsin. The known hosts are banded and mottled sculpins and johnny darter.

Spatterdock Darner

Spatterdock darner (*Aeshna mutata*) a State Special Concern dragonfly and a Species of Greatest Conservation Need, has been found in shallow peaty lakes with abundant floating vegetation in the Central sands region. The flight period extends from early June through late June.

Striped Sedge Grasshopper

The striped sedge grasshopper (*Stethophyma lineatum*) is listed as Special Concern and as a Species of Greatest Conservation Need in Wisconsin. This grasshopper has been known to occur in both grassland/herbaceous terrestrial habitats, as well as low boggy meadows, swamps, marshes, and at the edges of lakes and tamarack bogs.

Swamp Darner

Swamp darner (*Epiaschna heros*), a State Special Concern dragonfly and a Species of Greatest Conservation Need, has been found in shady ponds, ditches, or sloughs bordering woods. The flight period extends from early June to late July.

Swamp Metalmark

Swamp metalmark (*Calephelis mutica*), a butterfly listed as Endangered and a Species of Greatest Conservation Need in Wisconsin, has been found in alkaline wetlands (fens). Wet meadows, marshes or tamarack bogs may surround fen areas. Its host plant is swamp thistle, *Cirsium muticum*. The single two-week flight period occurs between mid-July and mid- August.

Two-spotted Skipper

Two-spotted skipper (*Euphyes bimacula*), a State Special Concern butterfly is found in sedge meadow, wet prairie, or marsh. Its host plants are grasses and sedges such as *Carex trichocarpa* and *C. stricta*. Adults fly in mid June through July, primarily early July in central Wisconsin. Overwinters as partially grown larvae.

Unicorn Clubtail

Unicorn clubtail (*Arigomphus villosipes*), a State Special Concern dragonfly and a Species of Greatest Conservation Need, has been found in ponds and sluggish streams with little vegetation. Their flight period is in late June.

Upland Sandpiper

Upland Sandpiper (*Bartramia longicauda*), a bird listed as Special Concern and a Species of Greatest Conservation Need, prefers tallgrass prairies, sedge meadows, unmowed alfalfa/timothy fields and scattered woodlands. The breeding season extends from early May through late September.

Weed Shiner

Weed Shiner (*Notropis texanus*), a fish listed as Special Concern, prefers sloughs, lakes, and still to sluggish sections of medium streams to large rivers, over substrates of sand, mud, clay, silt, detritus, gravel or boulders. Spawning occurs from late June through July at approximately 18 degrees Celsius.

Western Ribbonsnake

Western ribbonsnakes (*Thamnophis proximus*), a State Endangered Species and a Species of Greatest Conservation Need, are found along rivers and in and adjacent to marshes. Nothing has been reported regarding overwintering for this species in Wisconsin, but they are known to communally den with other snakes. They are active from late April through early October, breed primarily in May, and give birth to live young from late July through August.

Worm-eating Warbler

Worm-eating Warbler (*Helmitheros vermivorus*), a bird listed as Endangered in Wisconsin. This species is found in southern counties, often on steep west- or south-facing slopes dominated by mature oaks and a dense understory, in large forest tracts such as the Baraboo Hills and Wyalusing State Park. Breeding occurs from June to early July.

Yellow-billed Cuckoo

The yellow-billed cuckoo (*Coccyzus americanus*) is listed as a Special Concern and a Species of Greatest Conservation Need in Wisconsin. This neo-tropical migrant species is fairly common in southern Wisconsin in the summer, being less common in the central part of the state and rare to the north. An open deciduous wood with dense shrubby undergrowth, often near water is preferred habitat. Breeding typically occurs in June, frequently correlated with abundant sources of hairy caterpillars, such as tent caterpillars, and other large insects. Breeding is rapid with only 17 days between the time eggs are laid and fledging of chicks.

Yellow-breasted Chat

The yellow-breasted chat (*Icteria virens*), listed as a species of Special Concern in Wisconsin, is difficult to monitor and so Wisconsin distribution has been hard to determine. However, it has been noted that this species prefers dense brush and shrub areas often near the edge of deciduous woods. Breeding and nesting occur between June and July.

Rare Plants

American Gromwell

American Gromwell (*Lithospermum latifolium*), a State Special Concern plant, is found in upland hardwood forests, often with dolomite near the surface. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early June through late August.

Autumn Coral-root

Autumn Coral-root (*Corallorhiza odontorhiza*), a State Special Concern plant, is found in deciduous forests. Blooming occurs early August through early September; fruiting occurs throughout September. The optimal identification period for this species is early August through late September.

Beaked Spikerush

Beaked Spikerush (*Eleocharis rostellata*), a State Threatened plant, is found in calcareous fens, often on bare shoreline marl flats. Blooming occurs early June through early October; fruiting occurs late June through mid October. The optimal identification period for this species is early August through early October.

Bog Bluegrass

Bog Bluegrass (*Poa paludigena*), a State Threatened plant, is found in forested seeps and fens, mostly under hardwoods and alders. Blooming occurs throughout June; fruiting occurs late June through early July. The optimal identification period for this species is throughout June.

Christmas Fern

Christmas Fern (*Polystichum acrostichoides*), a State Special Concern plant, is found in rich mesic woods. This species can be identified yearround.

Common Bog Arrow-grass

Common Bog Arrow-grass (*Triglochin maritima*), a State Special Concern plant, is found on fen mats, open neutral to calcareous conifers swamps, and Great Lakes swales. Blooming occurs late June through early August; fruiting occurs late July through early September. The optimal identification period for this species is early July through late August.

Crawe Sedge

Crawe Sedge (*Carex crawei*), a State Special Concern plant, is found in calcareous wetlands and dolomitic pavement, often near Lake Michigan, as well as fens and moist calcareous prairies. Blooming occurs late April through late May; fruiting occurs late May through late June. The optimal identification period for this species is throughout May.

Cuckooflower

Cuckooflower (*Cardamine pratensis*), a State Special Concern plant, is found in cold, seeping calcareous swamps. Blooming occurs late May through late June; fruiting occurs throughout June. The optimal identification period for this species is late May through late June.

Downy Willow-herb

Downy Willow-herb (*Epilobium strictum*), a State Special Concern plant, is found in fens, marshes, and sedge meadows. Blooming occurs late July through early September; fruiting occurs late July through early October. The optimal identification period for this species is late July through late September.

Earleaf Foxglove

Earleaf Foxglove (*Tomanthera auriculata*), a State Special Concern plant, is found in prairies or open upland woods. Blooming occurs from late August through early September. The optimal identification period for this species is late August through early September.

Few-flower Spikerush

Few-flower Spikerush (*Eleocharis quinqueflora*), a State Special Concern plant, is found on cold coniferous poor fen mats but in a variety of moist meadows in calcareous areas. Blooming occurs late June through late July; fruiting occurs early July through late September. The optimal identification period for this species is early July through late September.

Flat-stemmed Spike-rush

Flat-stemmed Spike-rush (*Eleocharis compressa*), a State Special Concern plant, is found in moist to wet, often calcareous prairies and mud flats. Blooming occurs early May through early June; fruiting occurs late June through late July. The optimal identification period for this species is late June through late July.

Forked Aster

Forked Aster (*Aster furcatus*), a State Threatened plant, is found in dry to mesic hardwoods, often on streamsides or slopes with dolomite near the surface. Blooming occurs early August through early October; fruiting occurs late August through early October. The optimal identification period for this species is late August through late September.

Grassleaf Rush

Grassleaf Rush (*Juncus marginatus*), a State Special Concern plant, is found in acid peaty ditches and depressions in pine and oak barrens areas. Blooming occurs early July through early August; fruiting occurs throughout August. The optimal identification period for this species is early July through early August.

Hairy Beardtongue

Hairy Beardtongue (*Penstemon hirsutus*), a State Special Concern plant, is found on dry gravelly and sandy prairies, or in hillside oak woodlands. It is also naturalized on roadsides. Blooming occurs late May through late June; fruiting occurs late July through late August. The optimal identification period for this species is late May through late June.

Hooker Orchis

Hooker Orchis (*Platanthera hookeri*), a State Special Concern plant, is found in a variety of dry to moist, mostly mixed coniferous-hardwood forests. Blooming occurs late May through late July; fruiting occurs early July through late August. The optimal identification period for this species is early June through early September.

Innocence

Innocence (*Houstonia caerulea*), a State Special Concern plant, is found in dryish prairies and woodlands, as well as damp meadows. Blooming occurs late April through early July; fruiting occurs late May through early August. The optimal identification period for this species is late April through late June.

Kitten Tails

Kitten Tails (*Besseya bullii*), a State Threatened plant, is found commonly in small woodland openings, or near bluff edges. Blooming occurs late May through late June; fruiting occurs late June through late August. The optimal identification period for this species is late May through late August.

Lesser Fringed Gentian

Lesser Fringed Gentian (*Gentianopsis procera*), a State Special Concern plant, is found on wet dolomite pavement near Lake Michigan, as well as cold fens, seeps, and meadows in calcareous areas. Blooming occurs late August through early October; fruiting occurs early September through early October. The optimal identification period for this species is late August through early October.

Low Nutrush

Low Nutrush (*Scleria verticillata*), a State Special Concern plant, is found in calcareous fens. Blooming occurs late June through late July; fruiting occurs early July through early September. The optimal identification period for this species is early July through early September.

Many-headed Sedge

Many-headed Sedge (*Carex sychnocephala*), a State Special Concern plant, is found on muddy, sandy, marly, and peaty shorelines of lakes and ponds. Blooming occurs early July through early September; fruiting occurs late July through late October. The optimal identification period for this species is late July through late September.

Marsh Blazing Star

Marsh Blazing Star (*Liatrix spicata*), a State Special Concern plant, is found in moist, sandy calcareous prairies. Blooming occurs late July through early August; fruiting occurs throughout August. The optimal identification period for this species is early August through early September.

Narrow-leaved Vervain

Narrow-leaved Vervain (*Verbena simplex*), a State Special Concern plant, is found on dry soil of woods, fields, rocky places and roadsides. Blooming occurs from late May through early September. The optimal identification period for this species is late June through mid-August.

Northern Yellow Lady's-slipper

Northern Yellow Lady's-slipper (*Cypripedium parviflorum var. makasin*), a State Special Concern plant, is found in fens, calcareous swales, and rich springy forest edges. Blooming occurs late May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through early July.

Ohio Goldenrod

Ohio Goldenrod (*Solidago ohioensis*), a State Special Concern plant, is found most commonly on wet dolomite lake flats in Door County and in fens and moist calcareous prairies in the southeast portion of

the state. Blooming occurs early August through late September; fruiting occurs throughout September. The optimal identification period for this species is late August through early September.

Prairie Indian Plantain

Prairie Indian Plantain (*Cacalia tuberosa*), a State Threatened plant, is found in a variety of deep-soiled prairies. Blooming occurs early May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through late July.

Prairie Milkweed

Prairie Milkweed (*Asclepias sullivantii*), a State Threatened plant, is found in moist prairies. Blooming occurs early June through early July; fruiting occurs throughout July. The optimal identification period for this species is early June through early July.

Prairie Parsley

Prairie Parsley (*Polytaenia nuttallii*), a State Threatened plant, is found in prairies and persisting in open areas that were savannas. Blooming occurs early May through late June; fruiting occurs late June through late August. The optimal identification period for this species is early May through late August.

Prairie Straw Sedge

Prairie Straw Sedge (*Carex suberecta*), a State Special Concern plant, is found in fens and moist to wet calcareous meadows and prairies. Blooming occurs late May through early June; fruiting occurs throughout June. The optimal identification period for this species is throughout June.

Prairie White-fringed Orchid

Prairie White-fringed Orchid (*Platanthera leucophaea*), a State Endangered and Federally Threatened plant, is found in moist, undisturbed, deep-soiled and/or calcareous prairies and rarely in tamarack fens. Blooming occurs early June through early August; fruiting occurs throughout August. The optimal identification period for this species is late June through late July.

Purple Milkweed

Purple Milkweed (*Asclepias purpurascens*), a State Endangered plant, is found in open oak forest margins and roadsides; it has wide soil moisture tolerances. Blooming occurs early June through late July; fruiting occurs early July through late August. The optimal identification period for this species is late June through late July.

Reflexed Trillium

Reflexed Trillium (*Trillium recurvatum*), a State Special Concern plant, is found in rich hardwood forests. Blooming occurs late April through early May; fruiting occurs throughout June. The optimal identification period for this species is late April through late May.

Richardson Sedge

Richardson Sedge (*Carex richardsonii*), a State Special Concern plant, is found in dry prairies and barrens. Blooming occurs late April through early May; fruiting occurs throughout May. The optimal identification period for this species is late April through early May.

Rough Rattlesnake-root

Rough Rattlesnake-root (*Prenanthes aspera*), a State Endangered plant, is found in dryish prairies, usually on the lower slopes of hills. Blooming occurs late August through early October; fruiting occurs throughout September. The optimal identification period for this species is late August through early October.

Roundfruit St. John's-wort

Roundfruit St. John's-wort (*Hypericum sphaerocarpum*), a State Threatened plant, is found in wet prairies and moist sites subject to disturbance. Blooming occurs late June through early August; fruiting occurs late July through late August. The optimal identification period for this species is late June through late August.

Showy Lady's-slipper

Showy Lady's-slipper (*Cypripedium reginae*), a State Special Concern plant, is found in neutral to alkaline forested wetlands; it is also found in rich upland forests in seeps and moist to dry clay bluffs. Blooming occurs late June through late July; fruiting occurs late July through late August. The optimal identification period for this species is late June through early August.

Slender Bog Arrow-grass

Slender Bog Arrow-grass (*Triglochin palustris*), a State Special Concern plant, is found on muddy to marly fen and bog edges, as well as calcareous sedge meadows. Blooming occurs throughout July; fruiting occurs throughout August. The optimal identification period for this species is early July through late August.

Slim-stem Small-reedgrass

Slim-stem Small-reedgrass (*Calamagrostis stricta*), a State Special Concern plant, is found on dry to moist dunes, barrens, and dolomite or sandstone ledges, mostly near the Great Lakes, as well as calcareous wetlands. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is early July through late August.

Small Skullcap

Small Skullcap (*Scutellaria parvula* var. *parvula*), a State Endangered plant, is found on dry, often dolomitic, cliffs and prairies. Blooming occurs throughout June; fruiting occurs early July through late August. The optimal identification period for this species is late June through early August.

Small White Lady's-slipper

Small White Lady's-slipper (*Cypripedium candidum*), a State Threatened plant, is found in calcareous fens and prairies. Blooming occurs late May through early June; fruiting occurs throughout September. The optimal identification period for this species is late May through early June.

Sticky False-asphodel

Sticky false-asphodel (*Tofieldia glutinosa*), listed as a Threatened species in Wisconsin, can be found on marly shorlines, and in cold calcareous seeps and fens. Blooming occurs from June to July with white, starry inflorescence in a terminal cluster on a very sticky stem. Leaves are mostly basal and linear.

Swamp Agrimony

Swamp Agrimony (*Agrimonia parviflora*), a State Special Concern plant, is found in wet woodland patches and ditches, oak-hickory forests, and margins of calcareous marshes. Blooming occurs throughout July; fruiting occurs early August through early September. The optimal identification period for this species is early August through early September.

Torrey Sedge

Torrey Sedge (*Carex torreyi*), a State Special Concern plant, is found in dry dolomite prairies on St. Croix and Mississippi Rivers, as well as white oak savannas in the Southeast. Blooming occurs late May through early June; fruiting occurs early June through early July. The optimal identification period for this species is late June through early July.

Tufted Bulrush

Tufted Bulrush (*Scirpus cespitosus*), a State Threatened plant, is found in fens, sedge meadows, and wet swales of old beach ridges. Blooming occurs early June through early August; fruiting occurs late June through late August. The optimal identification period for this species is early June through late August.

Wafer-ash

Wafer-ash (*Ptelea trifoliata*), a State Special Concern plant, is found on dry dolomite ledges in oak forests. Blooming occurs late May through early June; fruiting occurs throughout July. The optimal identification period for this species is late May through late September.

Whip Nutrush

Whip Nutrush (*Scleria triglomerata*), a State Special Concern plant, is found on the sunny margins between jack pine/Hill's oak barrens and wet acid ditches with coastal plain species. Blooming occurs late June through late July; fruiting occurs early July through late August. The optimal identification period for this species is late June through late August.

White Camas

White Camas (*Zigadenus elegans var. glaucus*), a State Special Concern plant, is found in oak openings, wet-mesic calcareous prairies, limestone-capped sandstone bluffs, cliffs, and outcrops, as well as stabilized dunes along Lake Michigan. Blooming occurs late May through late July; fruiting occurs mid August through early September. The optimal identification period for this species is late May through late July.

Woodland Bluegrass

Woodland Bluegrass (*Poa sylvestris*), a State Special Concern plant, is found in very moist streambanks and mesic forest. Blooming occurs mid-May through June; fruiting occurs June through August. The optimal identification period for this species is early June through late July.

Woolly Milkweed

Woolly Milkweed (*Asclepias lanuginosa*), a State Threatened plant, is found in dry, sandy or gravelly hillside prairies. Blooming occurs late May through late June; fruiting occurs late June through late July. The optimal identification period for this species is late May through late June.

Yellow Evening Primrose

Yellow Evening Primrose (*Calylophus serrulatus*), a State Special Concern plant, is found mostly on steep bluff prairies along the Mississippi and lower St. Croix Rivers, as well as cedar glades and, occasionally, in moister prairies. Blooming occurs late June through early September; fruiting occurs early July through early October. The optimal identification period for this species is late June through early October.

Yellow Gentian

Yellow Gentian (*Gentiana alba*), a State Threatened plant, is found in thin soil in dry, open woodlands, ridges and bluffs (often with dolomite near the surface), as well as moist sand prairies and roadside ditch. Blooming occurs late August through early October; fruiting occurs early September through early October. The optimal identification period for this species is throughout September.

Yellow Water Lily

Yellow Water Lily (*Nuphar advena*), a State Special Concern plant, is found in shallow to deep water of sluggish streams, ponds, and lakes. Blooming occurs June through September; fruiting occurs early July through mid October. The optimal identification period for this species is June through mid-August.

Natural Communities

Bog Relict

'Bog relict' is a term that has been used to describe tamarack-dominated forests and associated patches of "northern" shrubs, mosses, and other acid peatland herbs in the southernmost regions of Wisconsin, including some that are close to the Illinois border. Many of these sites are nearing the extreme southern range limits for many of the species they support and are also quite isolated from one another. They support many nutrient-demanding species, but may include a limited subset of the more northern peatland associates (e.g., Sphagnum mosses, ericaceous shrubs, and "bog" sedges). The tamarack canopy is often quite open and discontinuous, due to windthrow, beaver activity, or for other reasons. Poison sumac is often present, and is sometimes the most abundant tall shrub. Speckled alder, nannyberry, willows, and dogwoods are often common associates. See southern tamarack swamp for additional details on plant composition.

These sites are typically small, in kettle depressions on outwash or sometimes ground moraine landforms. Many of these stands are fed by groundwater seepage. The surface may include areas of relatively firm peat, but watery muck is often present as well.

Conceptually, bog relict is broader and more encompassing than southern tamarack swamp, as it includes the full mosaic of northern peatland vegetation (forest, shrub, and herb) occurring within a given kettle wetland. In addition, the term has generally been applied to small discrete and disjunct sites, located far to the south of the typical range of the acid peatland communities.

Calcareous Fen

Calcareous fens occur mostly in southern Wisconsin, on sites that are fed by carbonate-enriched groundwater. Most fens are small, covering no more than a few acres, and are often associated and can intergrade with more abundant and widespread wetland communities such as southern sedge meadow, wet prairie, shrub-carr, emergent marsh, and southern tamarack swamp. An accumulation of peat can raise the fen surface to a height of several meters above the adjoining lands.

The diverse fen flora is distinctive, containing many calciphiles of restricted distribution. Common or representative plants include sedges, marsh fern, shrubby cinquefoil, shrubby St. John's-wort, Ohio goldenrod, grass-of-parnassus, twig-rush, brook lobelia, boneset, swamp thistle, and asters. Many fens have a significant number of prairie or sedge meadow components, and some contain plants often associated with bogs, such as tamarack, bog birch and pitcher plant.

Fens occur in several landscape settings, including the bases of morainal slopes, on sloping deposits of glacial outwash, in the headwaters regions of spring runs and small streams, and on the shores of alkaline drainage lakes.

Cedar Glade

Curtis (1959) described the cedar glade community as a type of savanna. Most cedar glades occur on steep, dry sandstone, quartzite, rhyolite, or dolomite bluffs. The dominant tree is eastern red cedar, which may occur as scattered trees or shrubs, or, in thickets, interspersed with prairie-like openings. Red maple, paper birch and black and bur oaks may also be present. Apart from rocky bluffs, cedar glade may also occur on very dry, gravelly slopes on south- or west-facing morainal ridges, or on coarse-textured sandy terraces along major rivers in western Wisconsin.

Today's dense "cedar thickets" are usually, if not always, the result of fire suppression on dry prairies. Prior to European settlement the cedar glade may have occurred only where extensive cliffs, rivers, or lakes served as firebreaks. Common herbs include native bluestem and grama grasses, prickly-pear cactus, flowering spurge, stiff sandwort, and gray goldenrod. The associated flora strongly resembles those of the dry prairie and sand prairie communities, with elements of dry cliff, oak barrens, and oak openings also present.

A variant of this community that is dominated by northern white cedar, rather than the eastern red cedar typically associated with cedar glades, has been included in the Wisconsin Strategy for Species of Greatest Conservation Need. Cedar glades dominated by northern white cedar are most prevalent in northeast Wisconsin, especially in Door County. Unlike the "eastern red cedar glades", "northern white cedar glades" are not the result of fire suppression on dry prairies. Instead, they occur in areas where dolomite bedrock is exposed or thinly covered by soil. These "northern white cedar glades" may also have openings interspersed among the white cedar with characteristics similar to alvar, boreal rich fen, dry cliff, or moist cliff communities.

Dry Prairie

This dry grassland community usually occurs on steep south or west facing slopes or at the summits of river bluffs with sandstone or dolomite bedrock near the surface. Short to medium-sized prairie grasses such as little bluestem, side-oats grama, hairy grama, and prairie dropseed are the dominants in this community. Common shrubs and forbs include lead plant, silky aster, flowering spurge, purple prairie-clover, cylindrical blazing-star, and gray goldenrod. Stands on knolls in the Kettle Moraine region of southeastern Wisconsin, and on bluffs along the St. Croix River on the Minnesota-Wisconsin border, occur on gravelly substrates and may warrant recognition as distinctive subtypes of "Dry Prairie."

Because Dry Prairie occurs on sites that are not well suited to other uses, it is better represented in today's landscape than any other prairie community. It is still a relatively rare natural community that is more abundant in Wisconsin than anywhere else because of the many steep-sided bluffs in the extensive Driftless Area, the rough terrain of the kettle interlobate moraine, and the north-south orientation of several major river valleys such as the Mississippi, the Chippewa, and the St. Croix. These topographic attributes provide suitable sites for the development and persistence of this prairie type.

Emergent Marsh

These open, marsh, lake, riverine and estuarine communities with permanent standing water are dominated by robust emergent macrophytes, in pure stands of single species or in various mixtures. Dominants include cattails, bulrushes (particularly *Scirpus acutus*, *S. fluviatilis*, and *S. validus*), bur-reeds, giant reed, pickerel-weed, water-plantains, arrowheads, the larger species of spikerush (such as *Eleocharis smallii*), and wild rice.

Aquatic plants, including both emergent and submergent aquatic vegetation, form the foundation of healthy and flourishing aquatic ecosystems - both within lakes and rivers and on the shores and wetlands around them. They not only protect water quality, but they also produce life-giving oxygen. Aquatic plants are a lake's own filtering system, helping to clarify the water by absorbing nutrients like phosphorus and nitrogen that could stimulate algal blooms. Plant beds stabilize soft lake and river bottoms and reduce shoreline erosion by reducing the effect of waves and current.

Aquatic plants also serve as spawning habitat for fish and amphibians, as shelter for various life stages of a variety of species, and as nesting habitat for birds. Plant beds support populations of aquatic insects that serve as a food base for other species. Seeds and other plant parts provide vital nutrition to a number of waterfowl and other bird species. Healthy, native aquatic plant communities also help prevent the establishment of invasive exotic plants like Eurasian watermilfoil.

Floodplain Forest

This lowland hardwood forest community type occurs along large rivers, usually of Stream Order 3 or higher. Most of these rivers originate in northern Wisconsin and flow southward, growing in size as the volume of water they carry increases. As the stream gradients diminish, the floodplains become broader. Periodic floods, particularly in the spring, are the key natural disturbance event to which species of this community are adapted. Silt deposition and development of microtopography during flood events creates suitable sites for tree germination and establishment, and floods also carry seeds and propagules of plant species. The most extensive occurrences of floodplain forest are found along the large rivers of southern Wisconsin, but the community also occurs at scattered locations in the north. The type was uncommon historically, occupying only about 3% of the Western Coulees and Ridges Ecological Landscape and even smaller percentages of other Ecological Landscapes (Finley 1976). Canopy dominants vary, but may include silver maple, river birch, green and black ashes, hackberry, swamp white oak, and eastern cottonwood. Black willow, basswood, red oak, and red maple are associated tree species found in these forests. Historically, the elms were highly significant components of the floodplain forests, but Dutch elm disease has eliminated most large elm trees that formerly provided supercanopy structure, snag and den sites, and large woody debris. Northern occurrences of this type tend to be less extensive, are often discontinuous, and are relatively species-poor compared to those in the south. Silver maple and green ash remain among the dominant species, with balsam-poplar, bur oak, and box elder replacing some of the many missing southern trees.

Understory composition is also quite variable, and follows the pattern exhibited by the canopy species, with the most extensive stands and highest plant species diversity occurring in southwestern Wisconsin. Buttonbush is a locally dominant shrub that may form dense thickets on the margins of oxbow lakes,

sloughs and ponds, which are often important aquatic habitats within these forests. Wood nettle, stinging nettle, sedges (e.g., *Carex grayii*, *C. lupulina*, *C. hystericina*, *C. tuckermanii*), native grasses (e.g., *Cinna arundinacea*, *Elymus villosus*, *Leersia virginica*), ostrich fern and green-headed coneflower are important understory herbs, and lianas such as Virginia creepers, grapes, Canada moonseed, and poison-ivy are often common. Among the more striking herbs of this community are cardinal flower, fringed loosestrife, and green dragon.

The sprawling floodplains found along the largest rivers sometimes consist of several terraces capable of supporting forests. These are subject to floods with differing frequencies and levels of inundation, and support patches of varying floristic composition depending upon local elevation differences, edaphic factors, and disturbance history. The lower terraces experience the most frequent, severe, and long-lasting floods; the uppermost terraces flood infrequently, and the rich alluvial soils can support mesophytic trees species and rich groundlayers similar to those of the mesic hardwood forests.

Northern Hardwood Swamp

The northern hardwood swamp is a deciduous forested wetland that occurs along lakes or streams, or in insular basins in poorly drained morainal landscapes. This community occurs across the state, but is most common in the northern Ecological Landscapes. The dominant tree species is black ash, but in some stands red maple, yellow birch, and (formerly) American elm are also important. The tall shrub speckled alder may be locally common. The herbaceous flora is often diverse and may include many of the same species found in alder thickets. Typical species are marsh-marigold, swamp raspberry, skullcap, orange jewelweed, and many sedges. Soils may be mucks or mucky sands.

Mesic Prairie

Although common historically, this type is extremely rare today. This grassland community occurs on rich, moist, well-drained sites, usually on level or gently rolling glacial topography. The dominant plant is the tall grass, big bluestem. The grasses little bluestem, Indian grass, needle grass, prairie dropseed, and switch grass are also frequent. The forb layer is diverse in the number, size, and physiognomy of the species. Common taxa include the prairie docks, lead plant, heath and smooth asters, prairie coreopsis, prairie sunflower, rattlesnake-master, flowering spurge, bee-balm, prairie coneflower, and spiderwort.

At the time of European settlement it is estimated that this type occupied over 800,000 acres in southern Wisconsin. Today one would be hard pressed to make the case that even 100 acres of intact tallgrass prairie still exists. The present rarity of this type is due to its high productivity for agricultural uses, such as corn and soybean production. It was associated with other tallgrass prairie communities, various wetland types, and oak openings.

Northern Sedge Meadow

This open wetland community is dominated by sedges and grasses and occurs primarily in northern Wisconsin. There are several common, fairly distinctive, subtypes: Tussock meadow, dominated by tussock sedge and Canada bluejoint grass; Broad-leaved sedge meadow, dominated by the robust sedges (*Carex lacustris* and/or *C. utriculata*); and Wire-leaved sedge meadow, dominated by woolly sedge and/or few-seeded sedge. Frequent associates include blue flag, marsh fern, marsh bellwort, manna grasses, paniced aster, Joe-Pye weed, and the bulrushes (*Schoenoplectus tabernaemontani* and *Scirpus cyperinus*). Sphagnum mosses are either absent or they occur in scattered, discontinuous patches. Sedge meadows occur on a variety of landforms and in several ecological settings that include depressions in outwash or

ground moraine landforms in which there is groundwater movement and internal drainage, on the shores of some drainage lakes, and on the margins of streams and large rivers.

Northern Wet Forest

Northern wet forest encompasses a group of weakly minerotrophic, conifer-dominated, acid peatlands located mostly north of the Tension Zone. The dominant trees are black spruce and tamarack. Jack pine is a significant component in parts of the type's range. This community is found primarily in kettle depressions or partially filled basins, on glacial outwash landforms, moraines, and till plains, where the water table is near the surface or where drainage is somewhat impeded. The community also occurs along the margins of lakes and low-gradient streams. On the wetter side of the moisture gradient, this community tends to grade into muskeg, open bog, or poor fen. On the drier side, the spruce-tamarack swamps may grade into "rich" swamp forests of northern white cedar or black ash, if a source of nutrient-enriched groundwater is present. In much of the type's current range the adjacent uplands are still forested, most often with second-growth stands of northern hardwoods, pine, or aspen. A minerotrophic "moat" (or "lagg") may occur at the upland-wetland interface, and can support a diverse assemblage of tall shrubs, swamp hardwoods, and "rich" swamp conifers such as northern white cedar.

Northern wet forest was widespread and relatively common historically, although due to the landforms with which it was associated, it did not typically occur in large patches in Wisconsin. Northern wet forest remains relatively common in much of its range today. WDNR's Natural Heritage Inventory Program has recently split northern wet forest into two types (described below) to better reflect community variability. Community composition and water chemistry were used as the primary factors that differentiate the types. Because the Natural Heritage Inventory Program's older inventory information did not consider those factors when classifying coniferous wetlands, northern wet forest (Curtis 1959) has been retained as a type.

Northern Wet-mesic Forest

This forested minerotrophic wetland is dominated by northern white cedar, and occurs on rich, neutral to alkaline peats and mucks throughout much of northern Wisconsin. Balsam fir, black ash, and spruces are among the many potential canopy associates. The understory is rich in mosses, lichens, liverworts, ferns, sedges, orchids, and wildflowers such as goldthread, fringed polygala, and naked miterwort, and trailing sub-shrubs such as twinflower and creeping snowberry. A number of rare plants occur more frequently in the cedar swamps than in any other habitat. Older cedar swamps are often structurally complex, as the easily wind-thrown cedars are able to root from their branch tips. Some of the canopy associates have the potential to reach heights considerably beyond those usually attained by cedar, producing a multi-layered canopy. The tall shrub layer is often well-developed and may include speckled alder, alder-leaved buckthorn, wild currants, and mountain maple. Canada yew was formerly an important tall shrub in cedar swamps but is now rare or local.

Seepages, springs, and spring runs contribute to stand complexity and provide critical habitat for additional plants and animals. Cedar swamps are relatively common in depressions that receive mineral-enriched groundwater, and can be associated with both ground moraine and outwash landforms.

Oak Opening

As defined by Curtis, this is an oak-dominated savanna community in which there is less than 50% tree canopy coverage. Historically, oak openings were very abundant and occurred on wet-mesic to dry sites. Today, very few examples of this type exist. The few extant remnants are mostly on drier sites, with the mesic and wet-mesic oak openings almost totally destroyed by conversion to agricultural or residential uses, and by the encroachment of other woody plants due to fire suppression. Bur, white, and black oaks

are dominant in mature stands, typically as large, open-grown trees with distinctive limb architecture. Shagbark hickory is sometimes present. American hazelnut is a common understory shrub. The herb layer is similar to those found in oak forests and prairies, with many of the same grasses and forbs present. There are some plants and animals that reach their optimal abundance in the openings (e.g., red-headed woodpecker, orchard oriole, eastern bluebird, kittentails).

Oak Woodland

The oak woodland community occupies a position on the vegetation continuum that is intermediate between the oak savannas (especially oak openings) and the oak forests (especially southern dry forest). Oak woodland differs from oak savanna types in the limb architecture of its trees (which are not characterized by wide, spreading crowns over short thick boles), and greater crown closure (with an approximate range of 50% to as much as 95%). As presently understood, the latter attribute is not simply the result of the canopy closure that affected most savannas following the implementation of wildfire suppression policies earlier in the twentieth century. As soon as fire suppression policies were widely implemented in southern Wisconsin, the rapid proliferation of shrubs and saplings would have quickly altered stand structure, causing the open understories of the oak woodland communities to disappear. Describing the differences between woodland and forest is difficult because of the absence of intact reference stands, but the oak woodland was subjected to frequent (annual) wildfires of low intensity, lacked the dense woody understory that characterizes most oak forests, and often had relatively lower canopy closure than true forest.

Dominant trees included white oak, bur oak, and black oak, sometimes mixed with red oak and shagbark hickory. The denser growth of trees did not allow for the exaggerated crown spread demonstrated by oaks in true savannas (which in a natural state would usually exhibit less than 50% canopy cover). Under a characteristic fire regime, shrub and sapling representation in oak woodlands would be minimal. The herb layer is potentially diverse, including some members of the prairie, oak savanna, and oak forest communities, but also featuring grasses, legumes, composites and other forbs that are best adapted to light conditions of high filtered shade. Representative herbs are thought to include upland boneset, violet bush-clover, Virginia bush-clover, Culver's-root, rough-leaved sunflower, Eastern shooting-star, Short's aster, pimpinell, bottlebrush grass, silky wild-rye, and bracted tick-trefoil.

Many of the same plants and animals that reach their optimal abundance in the oak openings also occur in oak woodland, including red-headed woodpecker, orchard oriole, eastern bluebird, and kittentails. Oak woodland can also support forest species, such as yellow-throated vireo, scarlet tanager, tufted titmouse, and blue-gray gnatcatcher, and in large stands, some species that are restricted to forest interior conditions, such as the cerulean warbler.

The geographic range historically occupied by oak woodland would be virtually the same as that of oak openings and prairies in southern Wisconsin. Oak woodland would have been most common on sites that experienced frequent, low-intensity ground fires. Moisture conditions would have included dry, dry-mesic, mesic, and, possibly, wet-mesic sites. Today oak woodland is most likely to occur in those parts of southern Wisconsin that continue to support relatively large areas of natural vegetation that include prairie and savanna remnants in proximity to oak-dominated forests. Portions of the Driftless Area, the kettle interlobate moraine of southeastern Wisconsin, and perhaps portions of the Central Sand Hills, offer the best potential. This type is extraordinarily rare today.

Sand Prairie

Sand prairie is a dry native grassland community dominated by grasses such as little bluestem, junegrass, panic grasses, and poverty-oat grass. Common herbaceous associates are sand cress, field sage-wort,

western ragweed, several sedges (e.g., *Carex muhlenbergii*, *Cyperus filiculmis*, and *Cyperus schweinitzii*), flowering spurge, frostweed, round-headed bush-clover, western sunflower, false-heather, long-bearded hawkweed, stiff goldenrod, horsebalm, and spiderwort. Drought-adapted fungi, lichens, and mosses are significant components of sand prairie communities.

At least some stands classified as sand prairie are oak or pine barrens remnants that now lack appreciable woody cover. Extensive stands may have occurred historically on broad sand terraces bordering the Mississippi, Wisconsin, Black, and Chippewa Rivers. Sand prairie may be more prevalent now in some areas than it was in historical times. Failed attempts to farm many of these prairies created blowouts, and may have even reactivated small dunes once the prairie sod was removed. We have included the 'sand barrens' community described by Curtis (1959) with this type.

Shrub-Carr

This wetland community is dominated by tall shrubs such as red-osier dogwood, silky dogwood, meadowsweet, and various willows. Canada bluejoint grass is often very common. Associates are similar to those found in alder thickets and tussock-type sedge meadows. This type occupies areas that are transitional between open wetlands such as wet prairie, calcareous fen, or southern sedge meadow, and forested wetlands such as floodplain forest or southern hardwood swamp. Shrub-carr can persist at a given site for a very long time if natural hydrologic cycles are maintained. This type often occurs in bands around lakes or ponds, on the margins of river floodplains, or, more extensively, in glacial lakebeds. It is common and widespread in southern Wisconsin but also occurs in the north. In the south, shrub-carr was often an integral part of prairie-savanna landscapes, though it also occurred in wetlands within more forested regions. In the north, the landscape matrix around the shrub-carr type was usually upland forest. Statewide, shrub-carr remains quite common, and has fared considerably better than many of the other native wetland types within its range.

Past drainage and marsh hay mowing likely had a negative effect on shrub-carr, whereas clearing of conifer swamps likely produced more of this habitat. Once fire was controlled and hay mowing was discontinued in lowland meadows, shrub-carr likely increased in extent. Drainage of meadows and marshes has also allowed shrub-carr habitats to increase in some areas. As a result of wetland drainage and fire suppression, shrub-carr now occupies many sites that formerly supported much more extensive marsh, wet meadow, prairie, and fen vegetation, and therefore, it is sometimes targeted for elimination. However, it is an important native wetland type that has its place on our landscape and should be protected, managed, and restored at appropriate locations.

Southern Dry Forest

Oaks are the dominant species in this upland forest community of dry sites. White oak and black oak are dominant, often with admixtures of northern red and bur oaks and black cherry. In the well-developed shrub layer, brambles (*Rubus* spp.), gray dogwood, and American hazelnut are common. Frequent herbaceous species are wild geranium, false Solomon's-seal, hog-peanut, and rough-leaved sunflower. This community type intergrades to oak woodland, which has similar canopy composition but a more open forest floor due to relatively frequent ground fires and possibly also due to grazing by elk, bison, or deer prior to EuroAmerican settlement.

Southern Dry-mesic Forest

Red oak is a common dominant tree of this upland forest community type. White oak, basswood, sugar and red maples, white ash, shagbark hickory, and black cherry are also important. The herbaceous understory flora is diverse and includes many species listed under southern dry forest plus jack-in-the-

pulpit, enchanter's-nightshade, large-flowered bellwort, interrupted fern, lady fern, tick-trefoils, and hog peanut.

Southern dry-mesic forests occur on loamy soils of glacial till plains and moraines, and on erosional topography with a loess cap, south of the tension zone. This community type was common historically, although white oak was considerably more dominant than red oak, and the type is still common today. However, to the detriment of the oaks, mesophytic tree species are becoming increasingly important under current management practices and fire suppression policies. Oak forests are succeeding to more mesic species (e.g., central and northern hardwood forest types), or to brush.

Southern Hardwood Swamp

This is a deciduous forested wetland community type found in insular basins with seasonally high water tables. This type is best developed in glaciated southeastern Wisconsin, but was not of large extent even prior to EuroAmerican settlement. Finley (1976) classified less than 1% of southeastern Wisconsin as lowland hardwood forest, and this figure includes bottomland forests along rivers as well as hardwood swamps in closed basins. Dominant tree species are red maple, green and black ashes, and formerly, American elm. Another species that also occurs in these forests is silver maple, as well as hybrids of red and silver maples. Southern hardwood swamps are noted for a high component of lianas, including poison ivy, Virginia creepers, and grapes. In the relatively undisturbed sites, there can be a rich spring flora. Microtopographic differences account for the existence of patches of spring ephemerals as well as many wetland species. The exotic reed canary grass has become dominant in the understory of many hardwood swamps.

This Natural Heritage Inventory community type partly includes the southern wet-mesic forest of the Curtis (1959) classification. Curtis describes these types as occurring on lake plains, both around the margins of larger existing lakes and on extinct glacial lakes. He referred to them as “lacustrine forests”, and noted that their soils have a high organic matter content, approaching peat conditions. This differentiates them in part from floodplain forests where processes of flooding and scouring tend to remove organic detritus. Also, in floodplains, much of the water movement is lateral, while in hardwood swamps the water table tends to fluctuate vertically. Southern hardwood swamps are not necessarily restricted to lake plains; some occur in lower-lying portions of till plains that may not have held ponded water for any significant length of time during or after glaciation.

Southern Mesic Forest

This upland forest community occurs on rich, well-drained loamy soils, mostly on glacial till plains or loess-capped sites south of the tension zone. The dominant tree species is sugar maple, but basswood, and near Lake Michigan, American beech may be co-dominant. Many other trees are found in these forests, including those of the walnut family, ironwood, red oak, red maple, white ash, and slippery elm. The understory is typically open, or sometimes brushy with species of gooseberry on sites with a history of grazing, and supports fine spring ephemeral displays. Characteristic herbs are spring-beauty, trout-lilies, trilliums, violets, bloodroot, blue cohosh, mayapple, and Virginia waterleaf.

Historically, southern mesic forests were quite common throughout southern Wisconsin. For example, forests dominated by sugar maple or beech occupied 41% of the Southern Lake Michigan Coastal, 25% of the Southeast Glacial Plains, and 18% of the Western Coulees and Ridges Ecological Landscapes (Finley 1976). Most of these forests were cleared for agriculture, as the soils are very fertile.

Southern Sedge Meadow

Widespread in southern Wisconsin, this open wetland community is most typically dominated by tussock sedge and Canada bluejoint grass. Common associates of relatively undisturbed sedge meadows are other sedges (e.g., *Carex diandra*, *C. sartwellii*), marsh bellflower, marsh wild-timothy, water horehound, panicked aster, swamp aster, blue flag, spotted Joe-Pye weed, marsh fern, and swamp milkweed. Reed canary grass may be dominant in grazed and/or ditched stands, sometimes to the exclusion of virtually all other species.

Sedge meadows are most common in glaciated landscapes, where they often border streams or drainage lakes. The southern sedge meadow community occurred with prairie, savanna, and hardwood forest communities, and many of them apparently burned periodically. In the absence of fire, shrubs and trees are able to readily encroach on the open wetlands; encroachment can be exacerbated when wetlands are drained. Many sedge meadows in southeastern Wisconsin are influenced by alkaline groundwater, and occur in complexes with emergent marsh, calcareous fen, wet prairie, wet-mesic prairie, and shrub-carr. Differentiating between these communities can be difficult, as they frequently intergrade.

Southern Tamarack Swamp (rich)

The 'southern tamarack swamp' community is similar to 'northern wet forest' but less acidic, supporting understory associates that are more nutrient-demanding and tolerant of higher pH levels. Tamarack is the dominant tree, though in some stands hardwoods such as paper birch, red maple, black ash, or American elm may be present as associates, saplings, or as subcanopy trees. The understory is more diverse and structurally complex than in the more acid spruce-dominated swamps and includes nutrient-demanding species such as speckled alder, bog holly, winterberry holly, and black ash. Poison sumac is the most abundant tall shrub in many southern Wisconsin tamarack forests. The bryophytes may include many genera other than *Sphagnum*.

Stands that are fed by spring seepage sometimes support plants such as marsh-marigold, cinnamon fern, royal fern, and skunk-cabbage. These seepage stands have been separated out as a distinct type or subtype in some nearby states and provinces. In Wisconsin, the tamarack seepage swamps occur statewide but may be more common south of the tension zone. Historically, tamarack swamps occurred extensively in parts of southeastern Wisconsin and on the margins of Glacial Lake Wisconsin. Many of the swamps were drained and cleared for agricultural purposes. Intact examples are now uncommon but occur in a wide variety of settings, such as on the margins of lakes or streams, at the base of moraines, in outwash areas, and in a few Driftless Area stream valleys.

Southern Tamarack Swamp (Rich)

The 'southern tamarack swamp' community is similar to 'northern wet forest' but less acidic, supporting understory associates that are more nutrient-demanding and tolerant of higher pH levels. Tamarack is the dominant tree, though in some stands hardwoods such as paper birch, red maple, black ash, or American elm may be present as associates, saplings, or as subcanopy trees. The understory is more diverse and structurally complex than in the more acid spruce-dominated swamps and includes nutrient-demanding species such as speckled alder, bog holly, winterberry holly, and black ash. Poison sumac is the most abundant tall shrub in many southern Wisconsin tamarack forests. The bryophytes may include many genera other than *Sphagnum*.

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Wet-mesic Prairie

This herbaceous grassland community is dominated by tall grasses, including big bluestem, Canada bluejoint grass, cordgrass, and Canada wild-rye. The forb component is diverse and includes azure aster, Eastern shooting-star, sawtooth sunflower, prairie blazing-star, prairie phlox, prairie coneflower, prairie docks, late and stiff goldenrods, and culver's-root. This community type was common historically but now is rare. Well over 99% of our tallgrass prairies – including wet-mesic prairie – have been destroyed.

Wet-mesic prairie sometimes occurred in large wetland complexes with wet prairie, southern sedge meadow, calcareous fen, and emergent marsh communities. It was most abundant on level or gently rolling glacial moraine or outwash landforms where there were few natural barriers to wild fire, and where the upland vegetation was composed mostly of fire-dependent communities such as Mesic prairie and Oak opening.

Appendix D

Wisconsin Natural Heritage Working List Explanation

The Wisconsin Natural Heritage Working List contains species known or suspected to be rare in the state and natural communities native to Wisconsin. It includes species legally designated as "Endangered" or "Threatened" as well as species in the advisory "Special Concern" category. Most of the species and natural communities on the list are actively tracked and we encourage data submissions on these species. This list is meant to be dynamic - it is updated as often as new information regarding the biological status of species becomes available. See the Endangered Resources Program web site for the most recent Natural Heritage Inventory Working List (<http://dnr.wi.gov/org/land/er/wlist/>).

Key

Scientific Name: Scientific name used by the Wisconsin Natural Heritage Inventory Program.

Common Name: Standard, contrived, or agreed upon common names.

Global Rank: Global element rank. See the rank definitions below.

State Rank: State element rank. See the rank definitions below.

US Status: Federal protection status in Wisconsin, designated by the Office of Endangered Species, U.S. Fish and Wildlife Service through the U.S. Endangered Species Act. LE = listed endangered; LT = listed threatened; XN = non-essential experimental population(s); LT,PD = listed threatened, proposed for de-listing; C = candidate for future listing.

WI Status: Protection category designated by the Wisconsin DNR. END = endangered; THR = threatened; SC = Special Concern.

WDNR and federal regulations regarding Special Concern species range from full protection to no protection. The current categories and their respective level of protection are SC/P = fully protected; SC/N = no laws regulating use, possession, or harvesting; SC/H = take regulated by establishment of open closed seasons; SC/FL = federally protected as endangered or threatened, but not so designated by WDNR; SC/M = fully protected by federal and state laws under the Migratory Bird Act.

Special Concern species are those species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become threatened or endangered.

Global & State Element Rank Definitions

Global Element Ranks:

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 = Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single state or physiographic region) or because of other factors making it vulnerable to extinction throughout its range; in terms of occurrences, in the range of 21 to 100.

G4 = Apparently globally secure, though it may be quite rare in parts of its range, especially at the periphery.

G5 = Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

GH = Of historical occurrence throughout its range, i.e., formerly part of the established biota, with the expectation that it may be rediscovered.

GU = Possibly in peril range-wide, but their status is uncertain. More information is needed.

GX = Believed to be extinct throughout its range (e.g. Passenger pigeon) with virtually no likelihood that it will be rediscovered.

G? = Not ranked.

Species with a questionable taxonomic assignment are given a "Q" after the global rank.

Subspecies and varieties are given subranks composed of the letter "T" plus a number or letter. The definition of the second character of the subrank parallels that of the full global rank. (Examples: a rare subspecies of a rare species is ranked G1T1; a rare subspecies of a common species is ranked G5T1.)

State Element Ranks

S1 = Critically imperiled in Wisconsin because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation from the state.

S2 = Imperiled in Wisconsin because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

S3 = Rare or uncommon in Wisconsin (21 to 100 occurrences).

S4 = Apparently secure in Wisconsin, with many occurrences.

S5 = Demonstrably secure in Wisconsin and essentially ineradicable under present conditions.

SA = Accidental (occurring only once or a few times) or casual (occurring more regularly although not every year); a few of these species (typically long-distance migrants such as some birds and butterflies) may have even bred on one or more of the occasions when they were recorded.

SE = An exotic established in the state; may be native elsewhere in North America.

SH = Of historical occurrence in Wisconsin, perhaps having not been verified in the past 20 years, and suspected to be still extant. Naturally, an element would become SH without such a 20-year delay if the only known occurrence were destroyed or if it had been extensively and unsuccessfully looked for.

SN = Regularly occurring, usually migratory and typically non-breeding species for which no significant or effective habitat conservation measures can be taken in Wisconsin. This category includes migratory birds and bats that pass through twice a year or, may remain in the winter (or, in a few cases, the summer) along with certain lepidoptera which regularly migrate to Wisconsin where they reproduce, but then completely die out every year with no return migration. Species in this category are so widely and unreliably distributed during migration or in winter that no small set of sites could be set aside with the hope of significantly furthering their conservation.

SZ = Not of significant conservation concern in Wisconsin, invariably because there are no definable occurrences in the state, although the taxon is native and appears regularly in the state. An SZ rank will generally be used for long-distance migrants whose occurrence during their migrations are too irregular (in terms of repeated visitation to the same locations), transitory, and dispersed to be reliably identified, mapped, and protected. Typically, the SZ rank applies to a non-breeding population.

SR = Reported from Wisconsin, but without persuasive documentation which would provide a basis for either accepting or rejecting the report. Some of these are very recent discoveries for which the program hasn't yet received first-hand information; others are old, obscure reports that are hard to dismiss because the habitat is now destroyed.

SRF = Reported falsely (in error) from Wisconsin but this error is persisting in the literature.

SU = Possibly in peril in the state, but their status is uncertain. More information is needed.

SX = Apparently extirpated from the state.

State Ranking of Long-Distance Migrant Animals:

Ranking long distance aerial migrant animals presents special problems relating to the fact that their non-breeding status (rank) may be quite different from their breeding status, if any, in Wisconsin. In other words, the conservation needs of these taxa may vary between seasons. In order to present a less ambiguous picture of a migrant's status, it is necessary to specify whether the rank refers to the breeding (B) or non-breeding (N) status of the taxon in question. (e.g. S2B,S5N).

Appendix E

	Major																Important						Present				
	Bog Relict	Calcareous Fen	Dry Prairie	Emergent Marsh	Floodplain Forest	Inland lakes	Mesic Prairie	Oak Opening	Oak Woodland	Shrub Carr	Southern Dry Forest	Southern Dry-mesic Forest	Southern Sedge Meadow	Southern Tamarack Swamp (rich)	Surrogate Grasslands	Warmwater streams	Wet-mesic Prairie	Cedar Glade	Northern Hardwood Swamp	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Southern Hardwood Swamp	Southern Mesic Forest	Coldwater streams	Sand Prairie	
Species that are Significantly Associated with the Southeast Glacial Plains Landscape																											
Acadian Flycatcher					M						L	H													H		
American Bittern				H						L			M		L						H						
American Golden Plover				M			M						L		M		M				L						
American Woodcock	M	M			L					L				M	L					M	L	L	L	L			
Black Tern				H		M								L							M						
Black-billed Cuckoo					M			L		H				M						L	L	L		L			
Blanding's Turtle			H	H	M	H	M	H	M	M		M	M	M		M	M	M			M			M	M	M	H
Blue-winged Teal			L	H	M	M	M							M		M					M			L			L
Blue-winged Warbler	M				M			M	M	M	M	M		M										L	M		
Bobolink		L					H	L						M		H					H						
Brown Thrasher			M					H								M											H
Buff-breasted Sandpiper				M											M		M										
Butler's Garter Snake		H		H	M		H			H			H								H						
Species that are Significantly Associated with the Southeast Glacial Plains Landscape																											
Canvasback				L		M																					

	Major																Important						Present			
	Bog Relict	Calcareous Fen	Dry Prairie	Emergent Marsh	Floodplain Forest	Inland lakes	Mesic Prairie	Oak Opening	Oak Woodland	Shrub Carr	Southern Dry Forest	Southern Dry-mesic Forest	Southern Sedge Meadow	Southern Tamarack Swamp (rich)	Surrogate Grasslands	Warmwater streams	Wet-mesic Prairie	Cedar Glade	Northern Hardwood Swamp	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Southern Hardwood Swamp	Southern Mesic Forest	Coldwater streams	Sand Prairie
Cerulean Warbler					H			M		L	H													M		
Common Tern				M		L																				
Dickcissel			L				H	L							H		L									
Dunlin				M																						
Eastern Massasauga Rattlesnake		H	H	H	H		H			H		H					H						M			H
Eastern Meadowlark		L	M				H	M				M			H		M									M
Field Sparrow			H				M	H							M		M	H								H
Forster's Tern				H		L						L														
Four-toed Salamander	H			H	H					H		M	M						M	M	M	H	H	H	M	
Franklin's Ground Squirrel			L				M	H	M						M		M									H
Grasshopper Sparrow			H				L	L							H			L								H
Gravel Chub																										
Greater Redhorse						M										H										
Henslow's Sparrow							H	M				L			H		M			L						
Hooded Warbler												H												H		
Hudsonian Godwit				H																						
King Rail				H								M								L						
Lake Chubsucker						M										L										

	Major																Important						Present				
	Bog Relict	Calcareous Fen	Dry Prairie	Emergent Marsh	Floodplain Forest	Inland lakes	Mesic Prairie	Oak Opening	Oak Woodland	Shrub Carr	Southern Dry Forest	Southern Dry-mesic Forest	Southern Sedge Meadow	Southern Tamarack Swamp (rich)	Surrogate Grasslands	Warmwater streams	Wet-mesic Prairie	Cedar Glade	Northern Hardwood Swamp	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Southern Hardwood Swamp	Southern Mesic Forest	Coldwater streams	Sand Prairie	
Lake Sturgeon						H																					
Least Darter						M										M											
Least Flycatcher					M			L	L	L	L								M			L	L	L			
Lesser Scaup				L		M																					
Longear Sunfish						M										M											
Louisiana Waterthrush											H													H	H		
Northern Harrier		L	M	L			H			L			M		H		H			H						L	
Northern Ribbon Snake	H					H				M																	
Species that are Significantly Associated with the Southeast Glacial Plains Landscape																											
Ornate Box Turtle			H					H	H		H	H						H							M		H
Ozark Minnow																H											
Pickereel Frog		M		H	M	M	M			M		H			H	H				H	M	M	M	M	M	H	
Prothonotary Warbler					H																						
Queen Snake				H		M				H		H			H												
Redfin Shiner						L										M											
Redhead				H																							
Red-headed Woodpecker					M			H	H		M	M															
Red-necked Grebe				H																							

	Major																Important						Present				
	Bog Relict	Calcareous Fen	Dry Prairie	Emergent Marsh	Floodplain Forest	Inland lakes	Mesic Prairie	Oak Opening	Oak Woodland	Shrub Carr	Southern Dry Forest	Southern Dry-mesic Forest	Southern Sedge Meadow	Southern Tamarack Swamp (rich)	Surrogate Grasslands	Warmwater streams	Wet-mesic Prairie	Cedar Glade	Northern Hardwood Swamp	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Southern Hardwood Swamp	Southern Mesic Forest	Coldwater streams	Sand Prairie	
Redside Dace															M										M		
River Redhorse																											
Rusty Blackbird	M	M		M	H				M				M										H				
Short-billed Dowitcher				H																							
Short-eared Owl			M	L			H		M			M		H		H				M						L	
Slender Madtom															H												
Starhead Topminnow						H									H												
Vesper Sparrow			H				M							L												H	
Western Meadowlark			M				L							H												M	
Whooping Crane				H								M								M							
Willow Flycatcher	M	M	L		L		M	L		H		M	L	M		M							L			L	
Wood Thrush					M				M		M	H		L					L		L	L	L	L	H		
Yellow-billed Cuckoo					H				L	M	L	M		L									M	M			
Species that are Moderately Associated with the Southeast Glacial Plains Landscape																											
Banded Killifish						M									L												
Bell's Vireo			M				L	L		M					M		M										M
Black Buffalo																											
Eastern Red Bat	M	M		M	M	M		M	M	M	M	M	L		M			L	M	M	M	M	M	M	M	H	

Major																Important						Present			
Bog Relict	Calcareous Fen	Dry Prairie	Emergent Marsh	Floodplain Forest	Inland lakes	Mesic Prairie	Oak Opening	Oak Woodland	Shrub Carr	Southern Dry Forest	Southern Dry-mesic Forest	Southern Sedge Meadow	Southern Tamarack Swamp (rich)	Surrogate Grasslands	Warmwater streams	Wet-mesic Prairie	Cedar Glade	Northern Hardwood Swamp	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Southern Hardwood Swamp	Southern Mesic Forest	Coldwater streams	Sand Prairie

Species that are Moderately Associated with the Southeast Glacial Plains Landscape

Golden-winged Warbler	L								H	L	L		L					M		M	L	L	L			
Hoary Bat	M	M		M	M	M		L	L	M	L	L	M	L		M		L	M	M	M	M	L	L	H	
Lark Sparrow			M														H								H	
Loggerhead Shrike			M				L	L						H		L									M	
Marbled Godwit				H			M							M		M										
Mudpuppy						H																		M		
Northern Bobwhite			M				M	M	L					H		M									L	
Northern Long-eared Bat	M	M		M	M	M		L	M	M	M	M			M		L	M	M	L	L	M	M	H		
Prairie Vole			H				M	M						M											H	
Pugnose Shiner						M									M											
Red-shouldered Hawk					H							M	L					L			L	L	M			
Silver-haired Bat	M	M		M	M	M		L	L	M	L	L	M	L		M		L	M	M	M	M	L	L	H	
Snowy Egret				H																						
Solitary Sandpiper				H	H					L		L			M					L			L		M	
Upland Sandpiper			H				M	L				L		H		M			L						M	
Veery					M				L	H		M	L					H		M	L	L	M			
Western Sand Darter																										

	Major																Important						Present				
	Bog Relict	Calcareous Fen	Dry Prairie	Emergent Marsh	Floodplain Forest	Inland lakes	Mesic Prairie	Oak Opening	Oak Woodland	Shrub Carr	Southern Dry Forest	Southern Dry-mesic Forest	Southern Sedge Meadow	Southern Tamarack Swamp (rich)	Surrogate Grasslands	Warmwater streams	Wet-mesic Prairie	Cedar Glade	Northern Hardwood Swamp	Northern Sedge Meadow	Northern Wet Forest	Northern Wet-mesic Forest	Southern Hardwood Swamp	Southern Mesic Forest	Coldwater streams	Sand Prairie	
Whimbrel				M																							
Whip-poor-will	M				L				H		H	H													L		
Wilson's Phalarope				H								L								H							
Woodland Vole					L			H	H		H	H												L			
Yellow-bellied Racer			H								M	M						H									H
Yellow-crowned Night-Heron				M	H					M														M			
Yellow-throated Warbler					H							M															