# Natural Features Inventory and Management Recommendations for Delhi, Dexter-Huron, Hudson Mills, and Stony Creek Metroparks


**Prepared by:**
**Michael A. Kost, Ecologist**
**Erica G. Choberka, Botanist**

**Michigan Natural Features Inventory**
**P.O. Box 30444**
**Lansing, MI 48909-7944**


**For:**
**Huron-Clinton Metropolitan Authority**


**January 11, 2002**

**Report Number 2002-01**


Michigan DNR

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan Natural Features Inventory

Cover photo: Big bluestem and showy goldenrod in the Dexter-Huron Oxbow Prairie (David Choberka).

# Table of Contents

# List of Figures



# List of Tables



# List of Appendicies

## Introduction

During the summer of 2001 Michigan Natural Features Inventory (MNFI) conducted surveys for rare plants and exemplary natural communities in four Huron-Clinton Metroparks including Stony Creek, Hudson Mills, Dexter-Huron, and Delhi. In addition, unmanaged areas within each of the four parks were evaluated for their potential to become high quality natural communities through restoration and land management activities. This report summarizes the findings of MNFI's surveys and evaluations of Stony Creek, Hudson Mills, Dexter-Huron, and Delhi Metroparks.

### Landscape Context

All of the Huron-Clinton Metroparks occur within the Washtenaw Subsection (VI.1) of southern Lower Michigan (Figure 1) (Albert 1995). The Washtenaw Subsection contains three sub-subsections that differ from each other in their soils, glacial landforms, climate, and vegetation. Stony Creek, Dexter-Huron, and Delhi, occur entirely within the Ann Arbor Moraine Sub-subsection (VI.1.2) (Albert 1995). Hudson Mills lies on the border between two sub-subsections, with the northern portion of the park occurring within the Jackson Interlobate Sub-section (VI.1.3) and the southern portion (e.g., Hudson Mills Golf Course) occurring in the Ann Arbor Moraine Sub-subsection (Albert 1995).

The Ann Arbor Moraine Sub-subsection is characterized by narrow, parallel bands of fine- and medium-textured end and ground moraines (Albert 1995). Soils on the moraines are loam and sandy loam in texture and support a variety of forest types and open, oak-dominated communities including mesic southern forest, dry-mesic southern forest, oak openings (oak savanna), and oak barrens. In many locations, glacial outwash channels dissect the moraines. The outwash channels contain areas of droughty sands which support oak barrens and prairie as well as poorly drained, alluvial sediments and organic deposits (e.g., muck and peat soils) that support a variety of open and forested wetland types. The Ann Arbor Moraine is bordered by the Maumee Lake Plain (VI.1.1) to the east, a flat, sand and clay glacial lake plain, and the Jackson Interlobate (V.I1.3) to the west.

The Jackson Interlobate Sub-section contains broad expanses of glacial outwash sands that surround sandy and gravelly end and ground moraines (Albert 1995). The soils on the moraines are typically well drained or excessively well drained and supported drought-tolerant, fire-dependent communities such as oak barrens, oak forest, and hillside prairie. The outwash soils vary from excessively well drained sands to poorly drained organic deposits, with the well drained sands supporting oak barrens, oak forests, woodland prairies and dry sand prairies, and the poorly drained deposits supporting a variety of open and forested wetland types.

Delhi, Dexter-Huron, and Hudson Mills occur along the Huron River in Washtenaw County. The Huron River flows through a broad, flat, glacial outwash channel near the areas occupied by these metroparks and is bordered by medium-textured end moraine (Farrand and Bell 1982) (Figure 2). Delhi and Dexter Huron occur entirely within this glacial outwash channel, as does all of Hudson Mills except for the western portion of Hudson Mills Golf Coarse, which occurs on medium-textured end moraine.

Stony Creek Metropark occurs on very similar glacial landforms. Stony Creek flows through the center of the metropark within a broad, relatively flat, glacial outwash channel (Farrand and Bell 1982) (Figure 3). Medium-textured end moraines border the outwash channel. Most of the park occurs within the glacial outwash channel, however, several portions of the metropark occur on medium-textured end moraine including: the nature center area, the area north and west of Stony Creek Golf Course, and the area surrounding the park office.

### 1800's Vegetation

By interpreting the General Land Office survey notes for Michigan recorded during the period of 1818-1856, MNFI ecologists were able to piece together a relatively accurate picture of the state's vegetation in the early 1800's (Comer et al. 1995). A digital map of vegetation encountered by the land surveyors during this period shows that fire-dependent, oak-dominated ecosystems occupied portions of Delhi, Dexter-Huron, and Hudson Mills Metroparks (Figures 4 - 7). These oak-dominated communities included black oak barrens, mixed oak forest and oak-hickory forest. Other fire-dependent community types including wet prairie, wet-mesic prairie, prairie fen, and wet meadow were also common along the Huron River and occupied portions of what is now the Hudson Mills Golf Course. Because the original land surveyors did not differentiate between different types of open, grass- and sedge-dominated communities, the areas marked as wet prairie on *circa* 1800's vegetation maps likely supported occurrences of wet-mesic prairie, prairie fen, and wet meadow as well as wet prairies. Mixed hardwood swamp occupied a thin band along the east side of the Huron River in Hudson Mills and Dexter-Huron, while mixed oak forest and oak-hickory forest occupied the opposite (west) side of the river.

Stony Creek Metropark supported similar natural communities in the early to mid 1800's (Figure 8). Fire-dependent black oak barrens occurred throughout the northern portions of the metropark. Mixed oak forest occupied the upland portions of the southern half of the metropark. Mixed conifer swamp occurred in what is now occupied by Stony Creek Lake. Mixed conifer swamp also occurred in the area north of Inwood Road that is presently occupied by hardwood-conifer swamp. Wet prairie occurred along Stony Creek north of Inwood Road and south of the mixed conifer swamp. Several small areas of mixed hardwood swamp occurred in the southwestern portion of the park along stream channels and in the area now occupied by a small, unnamed lake west of Sheldon Road.

**Present Land Cover**

Present land cover was interpreted using 1999, black and white aerial photography at a scale of 1:15,840. Comparisons between *circa* 1800's vegetation and present land use reveal drastic changes across the landscape. At Delhi, Dexter-Huron, and Hudson Mills, the Huron River corridor has been transformed to an urbanized landscape, with the metroparks providing some of the only open natural habitats in the area (Figures 9 - 12). Similar patterns emerge at Stony Creek but the comparison reveals several large forested areas that have remained unchanged, namely the hardwood-conifer swamp north of Inwood Road, the hardwood swamp north of the golf course, and the dry-mesic southern forest west of the golf course (Figure 12). Another striking feature of the present day land use at Stony Creek is the vast amount of acreage occupied by old field.

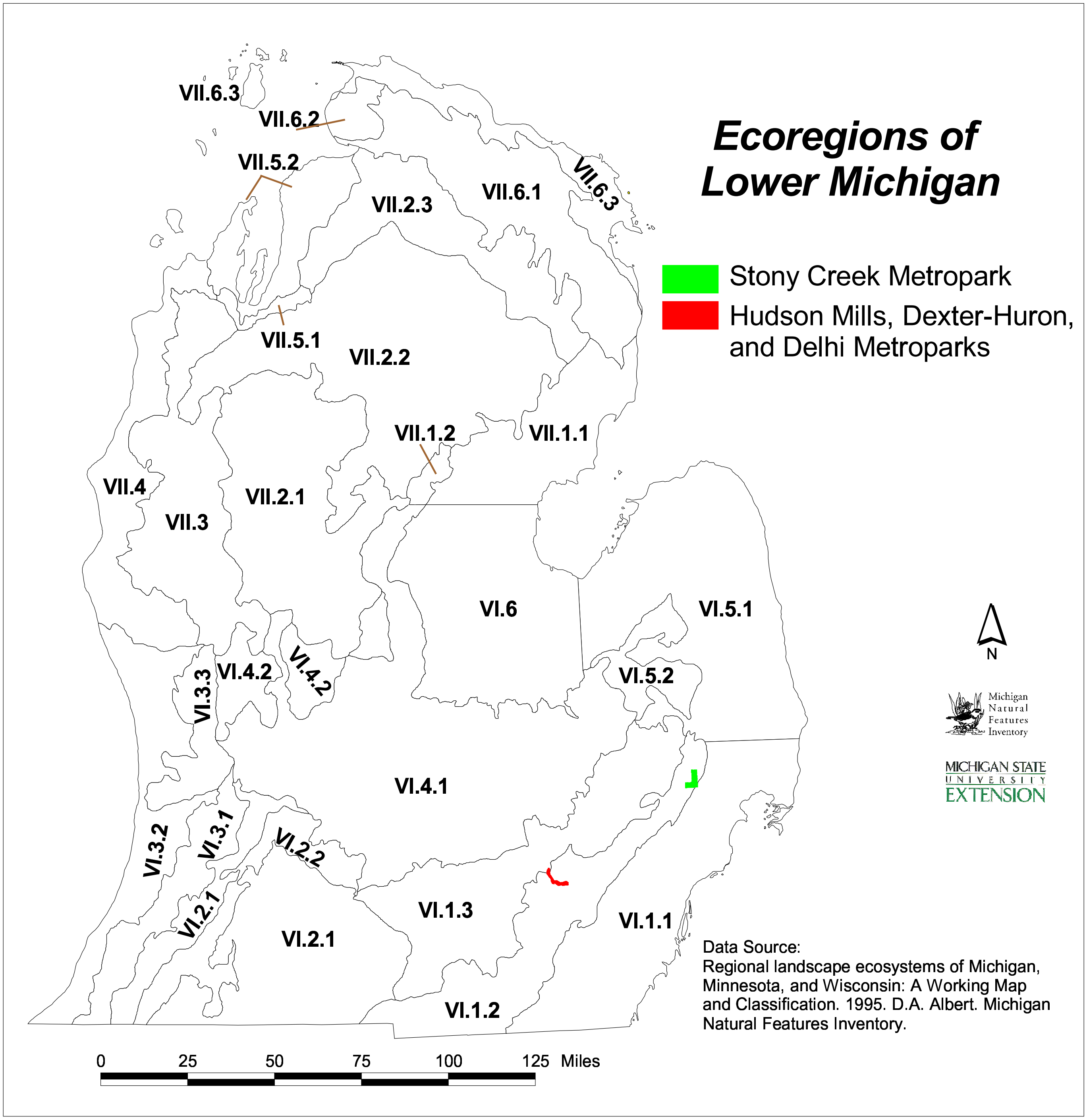



**Figure 1. Ecoregions of Southern Lower Michigan (Albert 1995).**

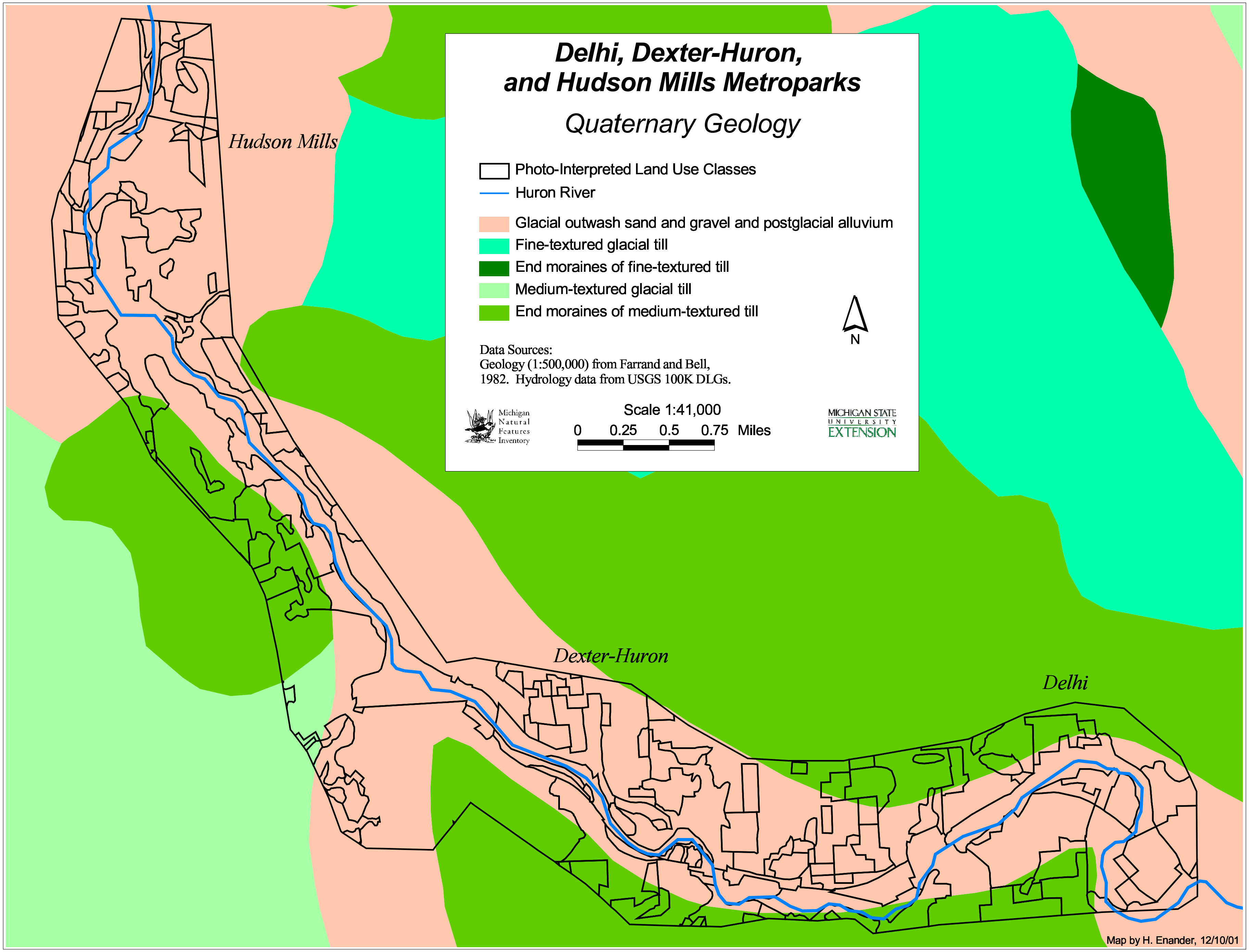



**Figure 2. Surfacial geology of Delhi, Dexter-Huron, and Hudson Mills Metroparks (Farrand and Bell 1982).**

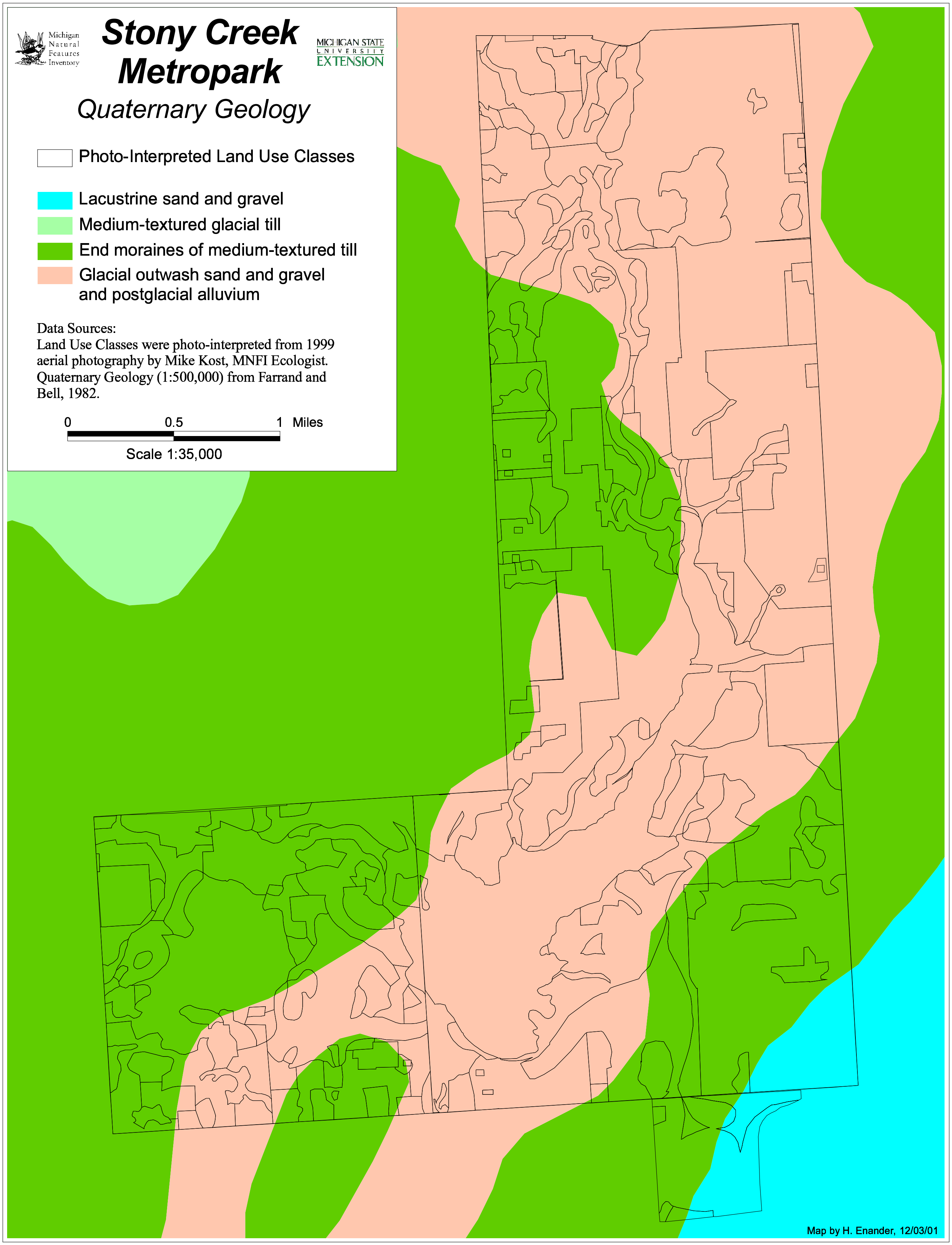



**Figure 3. Surfacial geology of Stony Creek Metropark (Farrand and Bell 1982).**

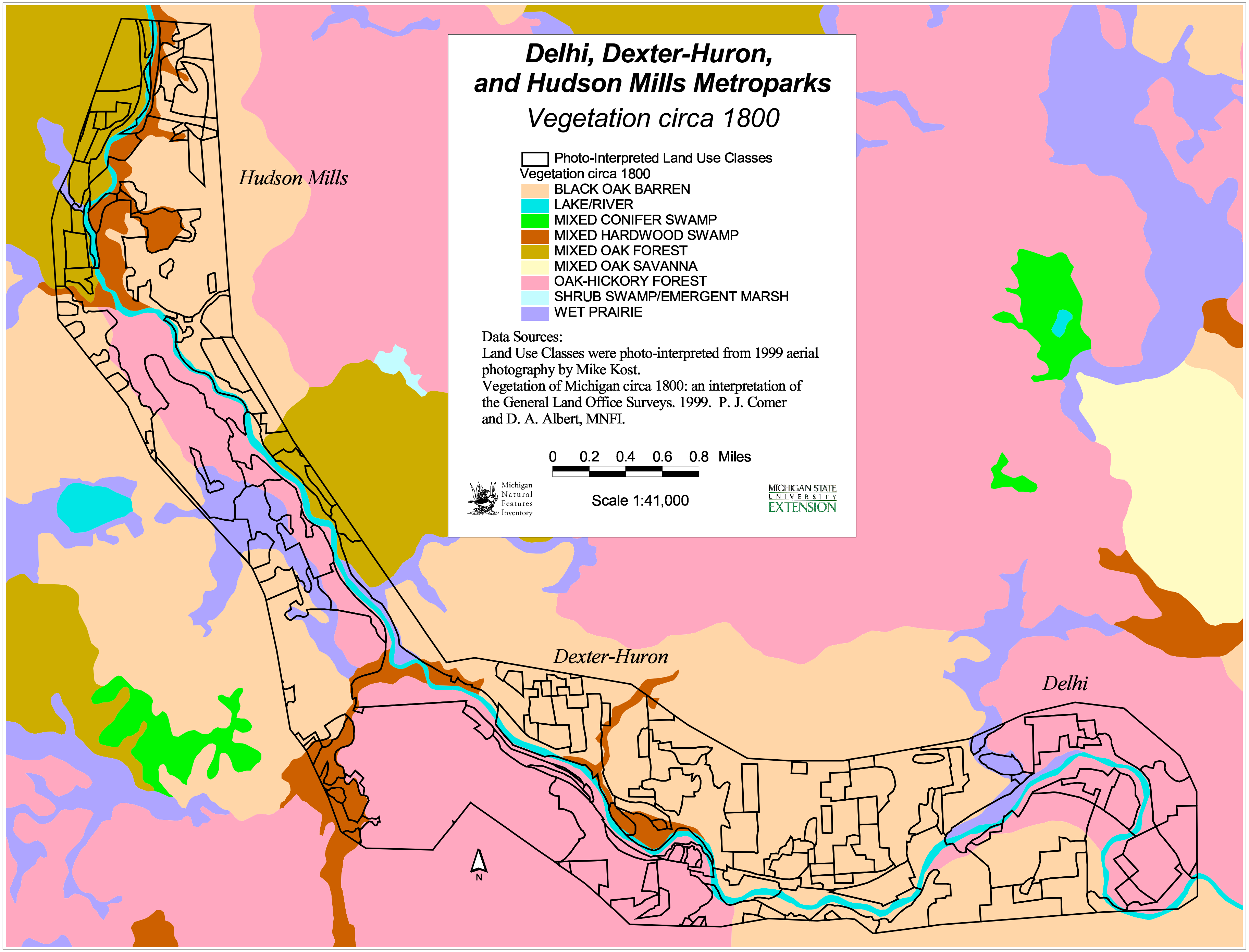



**Figure 4. Delhi, Dexter-Huron, and Hudson Mill Metroparks vegetation *circa* 1800.**

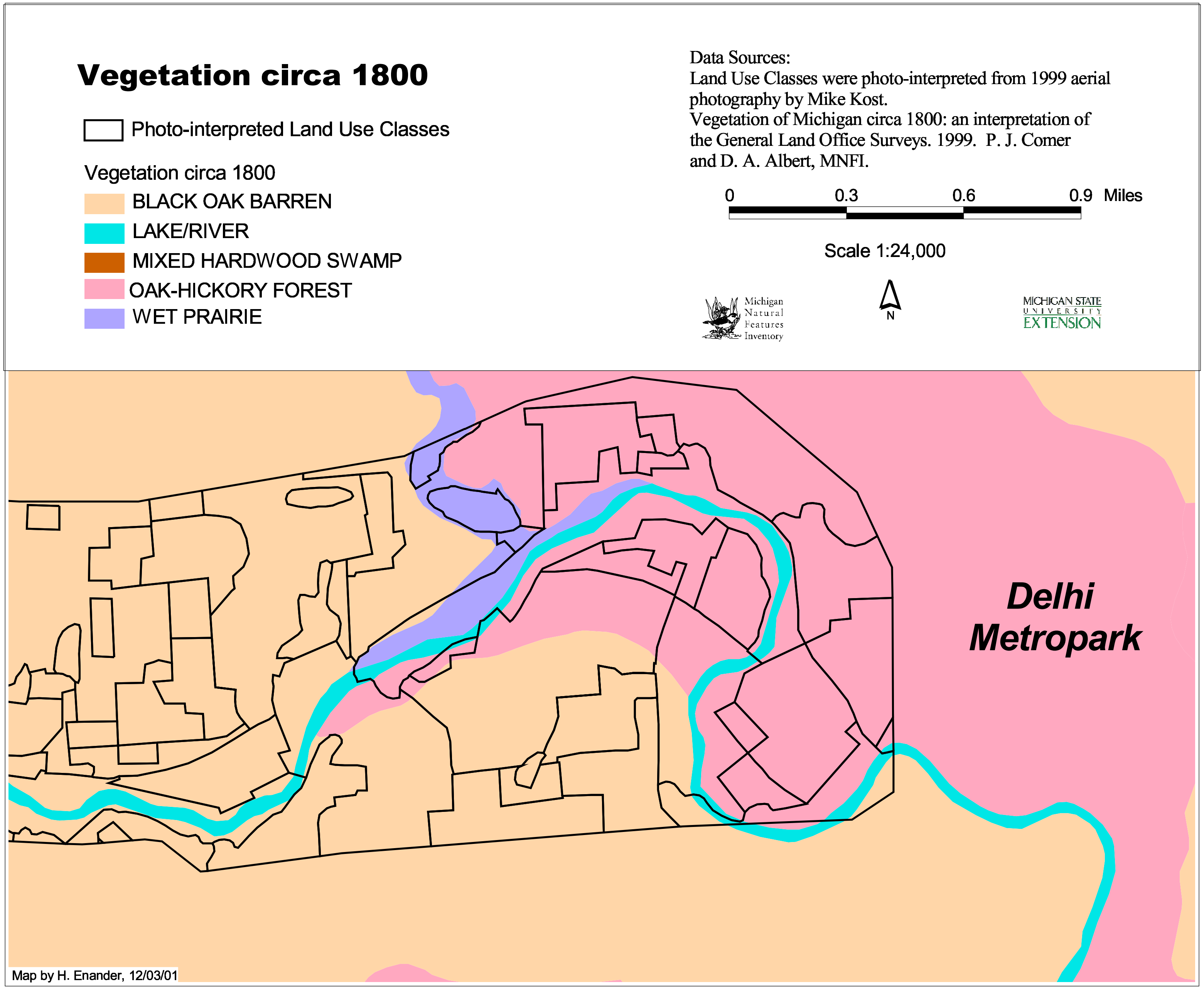



**Figure 5. Delhi Metropark vegetation *circa* 1800.**

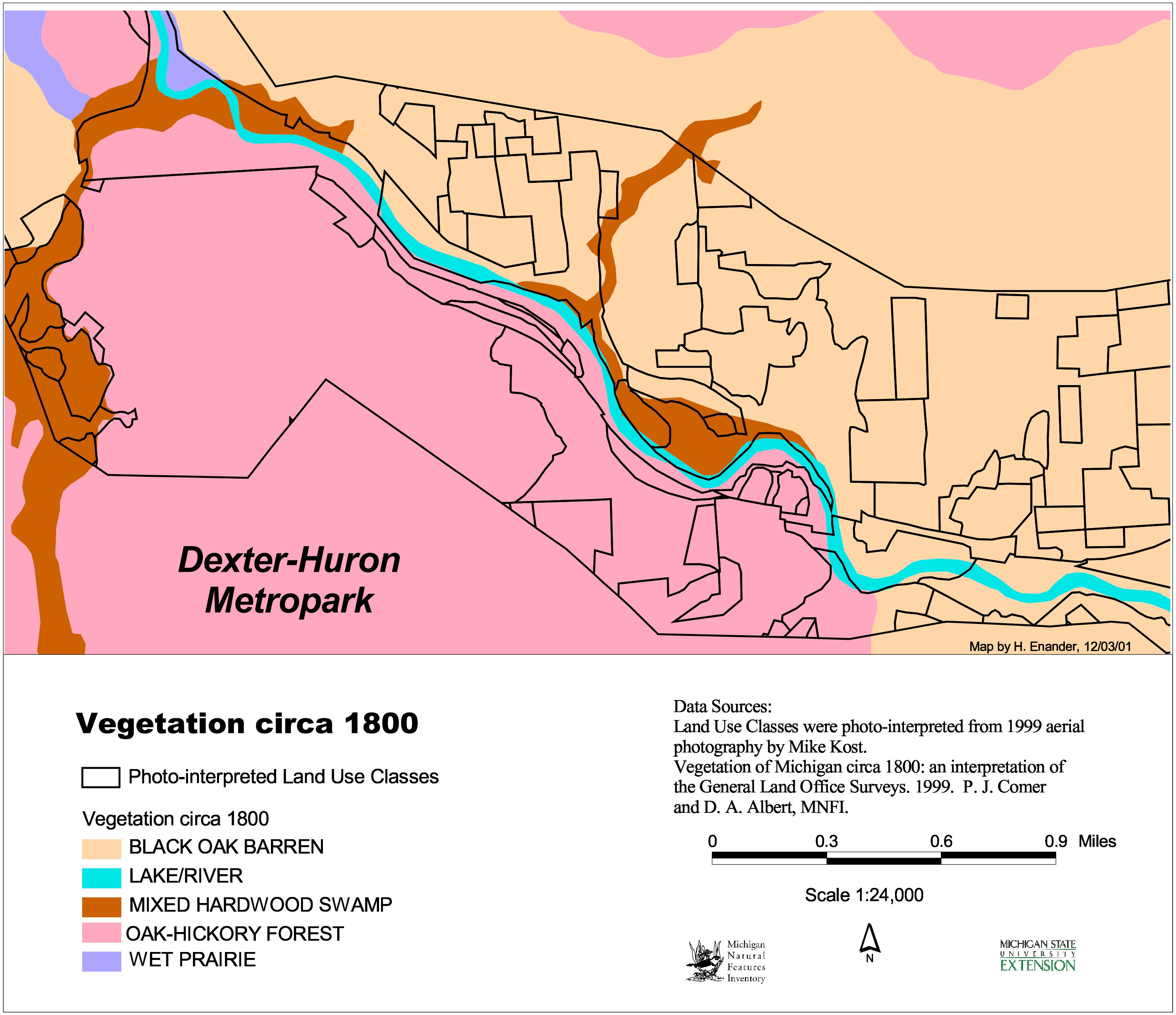



**Figure 6. Dexter-Huron Metropark vegetation *circa* 1800.**

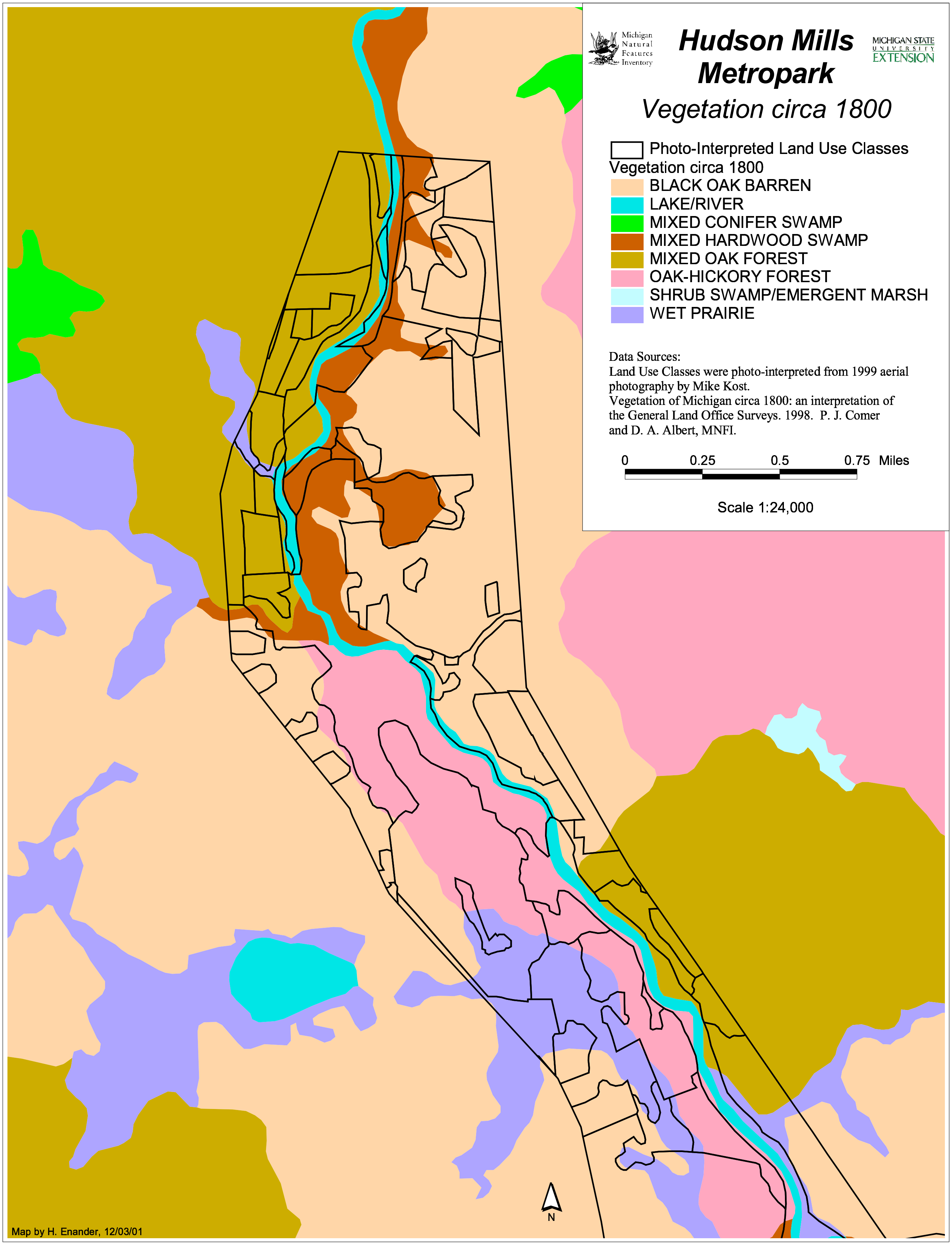



**Figure 7. Hudson Mills Metropark vegetation *circa* 1800.**

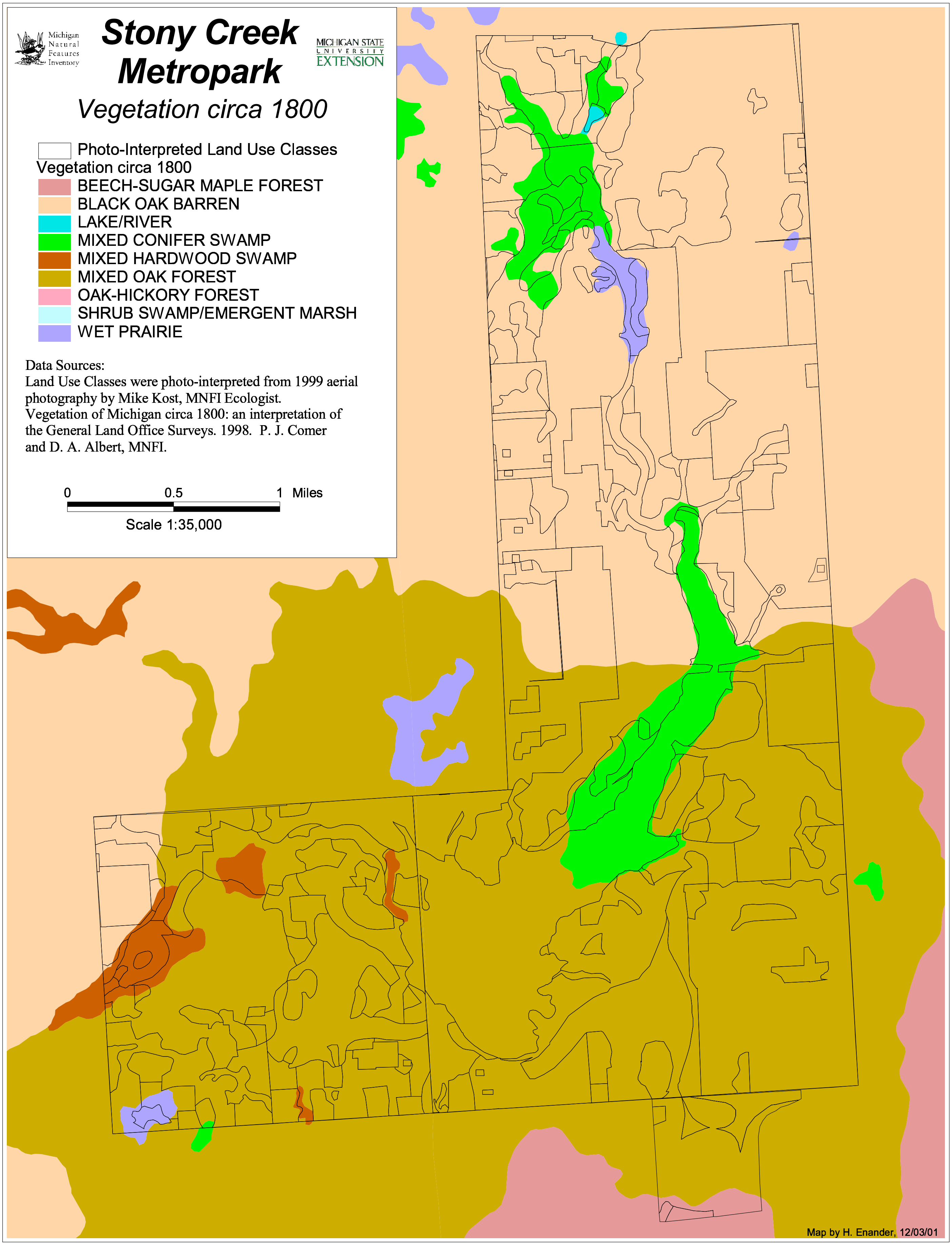



**Figure 8. Stony Creek Metropark vegetation *circa* 1800.**

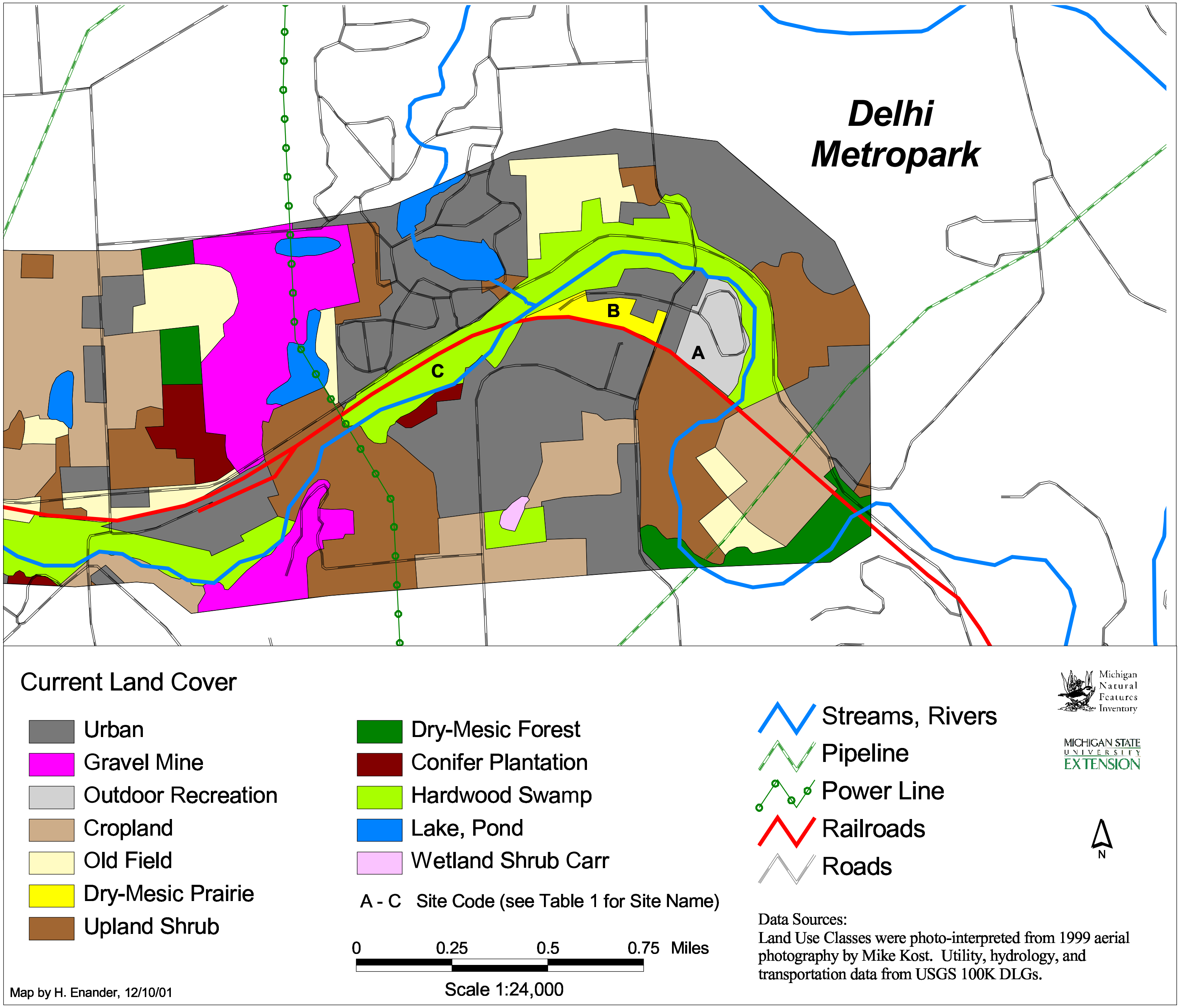



**Figure 9. Delhi Metropark 1999 land cover.**

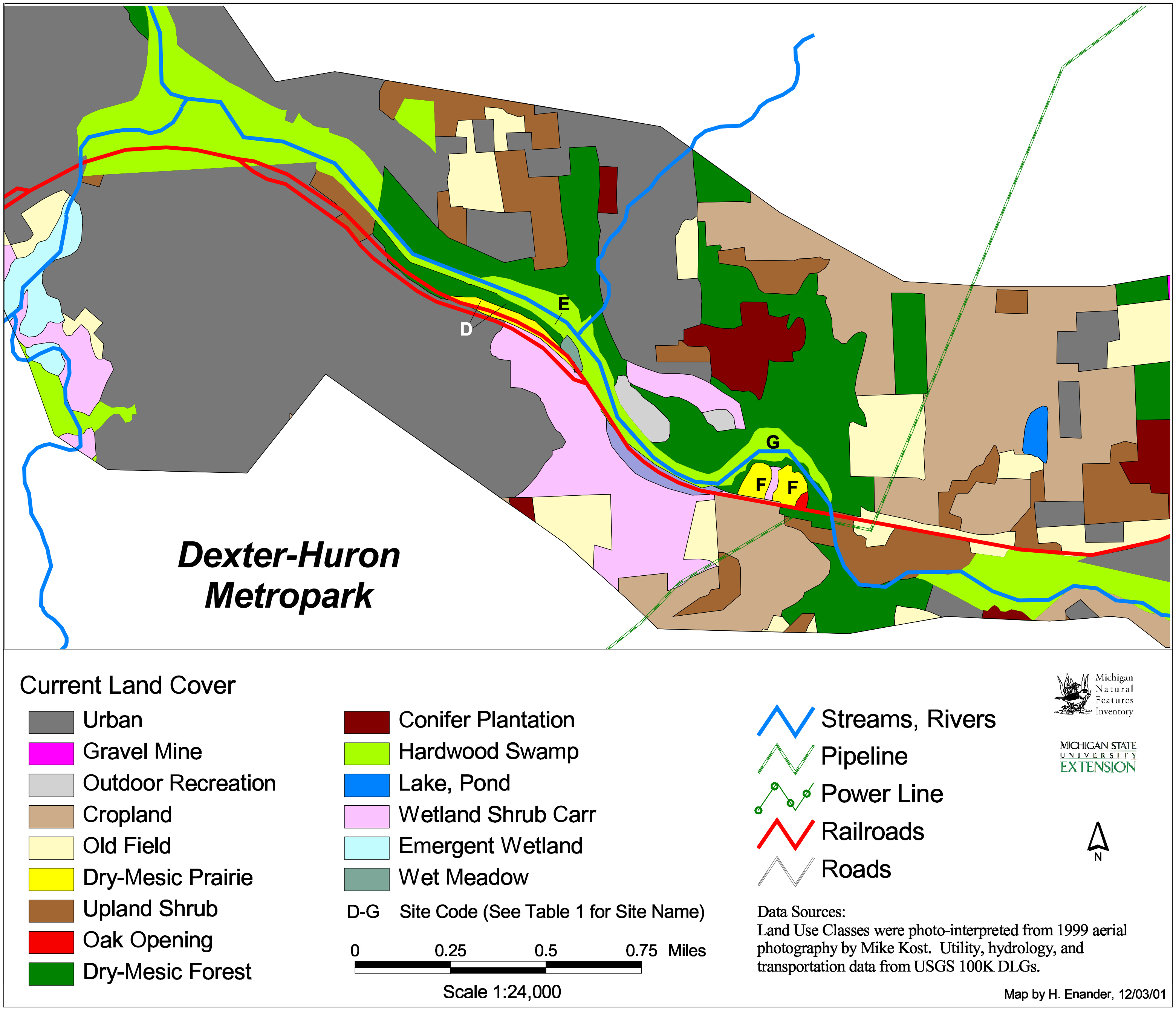



**Figure 10. Dexter-Huron Metropark 1999 land cover.**

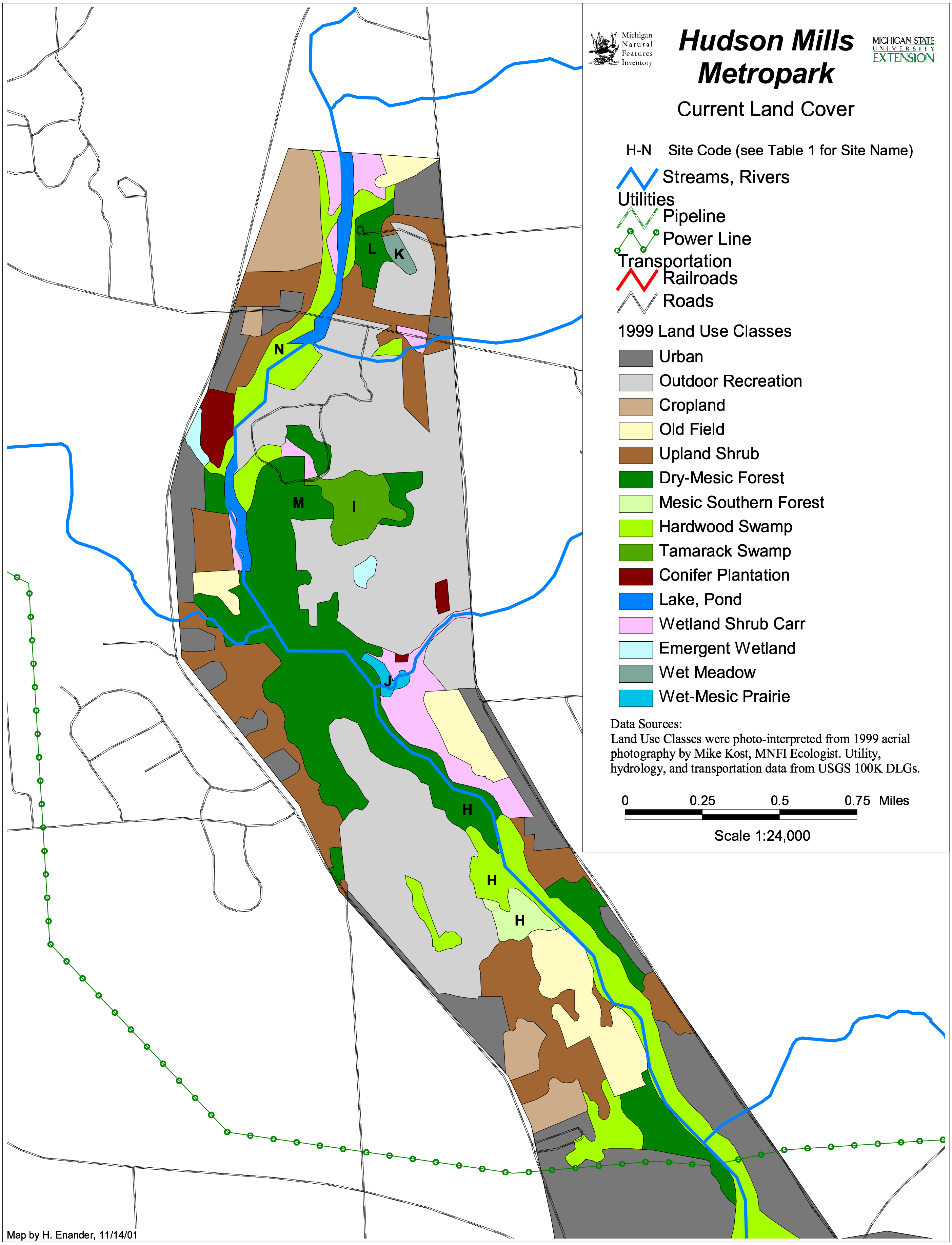



**Figure 11. Hudson Mills Metropark 1999 land cover.**

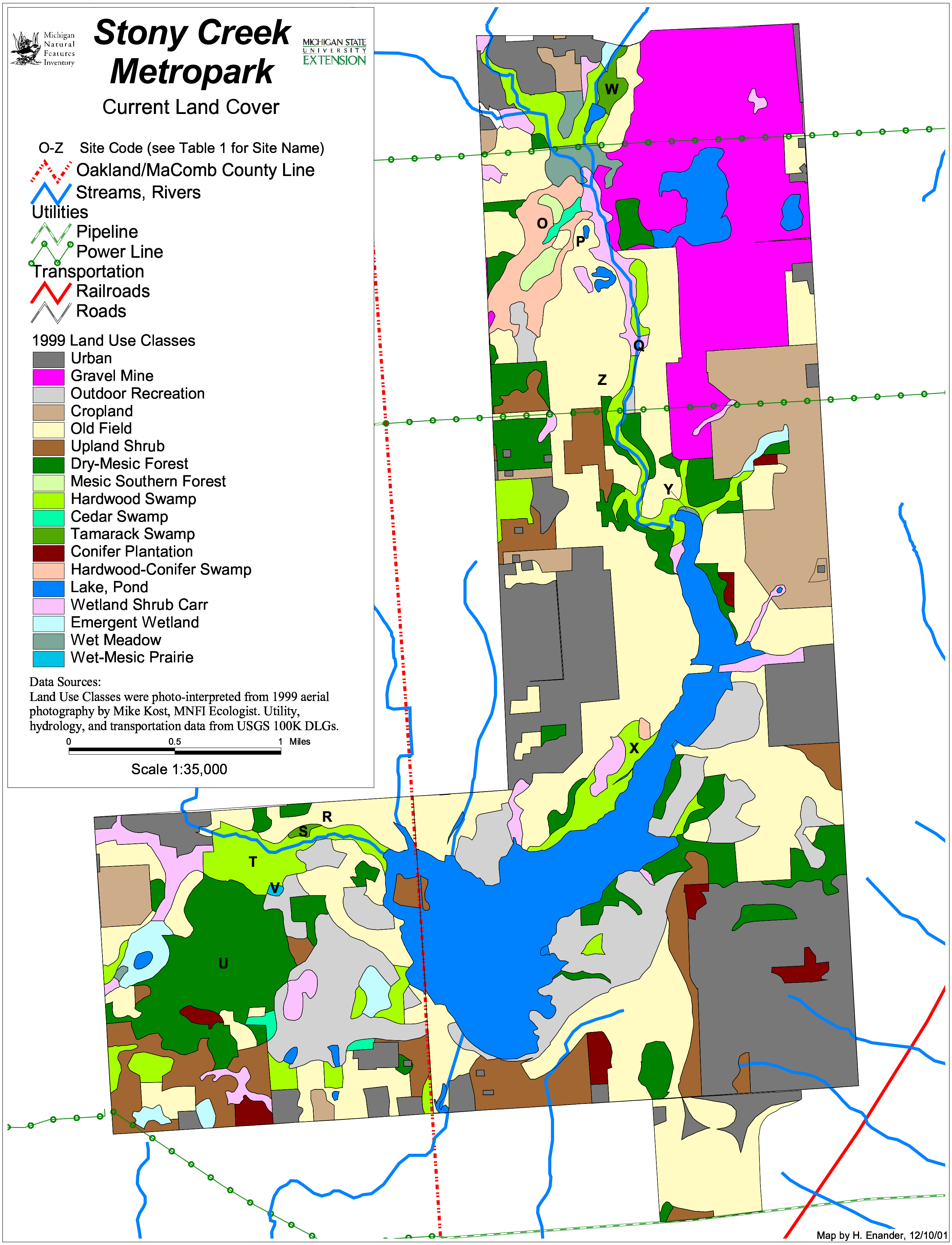



**Figure 12. Stony Creek Metropark 1999 land cover.**

# Methods

## Natural Communities

Natural community surveys were conducted in conjunction with rare plant surveys. Prior to the surveys aerial photos were reviewed to determine the types of natural communities present at the site. Surveys concentrated on identifying high quality natural areas and recording management concerns such as evidence of fire suppression, deer herbivory, hydrologic manipulation, farming, logging, and invasive species. Species lists were compiled for high quality sites and those deemed to have potential to significantly improve with restoration. Site names and site codes used in the accompanying metropark maps (Figures 9 – 12) are listed in Table 1. Partial species lists were recorded for most of the areas visited and are included as appendices for each metropark (Appendices 1 – 4). Site summaries were written for most of the sites visited and for all high quality natural communities and sites having good potential for significant improvement with restoration and management. Species lists for this report were tabulated with the Florist Quality Assessment Program and species nomenclature follows Herman et al (2001).

## Rare Plant Inventories

Rare plant species were targeted for survey based on the natural communities determined to be present in the park through aerial photo review and known rare plant distribution (historical as well as current) patterns within the region. Table 2 lists the rare species by associated natural community that were focused on during surveys. Surveys were performed through meander surveys in appropriate habitat during periods when the plants are most recognizable (usually flowering or fruiting periods). When a rare plant was encountered, a MNFI special plant form was filled out, selected photos were taken, and when necessary a voucher specimen was collected under State of Michigan and Parks Division permits and pressed for later determination.

**Table 1. Survey site names and associated site codes for accompanying maps (Figures 9 – 12).**

| Site Name | Site Code | Site Summary |
|---|---|---|
| **Delhi Metropark** | | |
| Delhi Park Interior | A | yes |
| Delhi Railroad Prairie | B | yes |
| Delhi Floodplain Forest | C | yes |
| **Dexter-Huron Metropark** | | |
| Dexter Railroad Prairie | D | yes |
| Dexter Oak Barrens | D | yes |
| Dexter Floodplain Forest | E | yes |
| Dexter-Huron Oxbow Prairie | F | yes |
| Dexter-Huron Floodplain Forest | G | no |
| **Hudson Mills Metropark** | | |
| Hudson Mills Golf Course Forest | H | yes |
| Hudson Mills Tamarack Swamp | I | yes |
| Hudson Mills Wet-Mesic Prairie | J | yes |
| Hudson Mills Group Camp Wet Meadow | K | yes |
| Hudson Mills Group Camp Forest | L | yes |
| Hudson Mills Dry-Mesic Forest | M | yes |
| North Territorial Road Floodplain Forest | N | no |

**Table 1. continued**

| | | |
|---|---|---|
| **Stony Creek Metropark** | | |
| Stony Creek Cedar Swamp | O | yes |
| Gravel Mine Wet-Mesic Prairie | P | yes |
| Stony Creek Floodplain | Q | no |
| Sheldon Mesic Prairie | R | yes |
| Sheldon Tamarack Fen | S | yes |
| Sheldon Wet-Mesic Forest | T | yes |
| Stony Creek Dry-Mesic Forest | U | yes |
| Sheldon Wet-Mesic Prairie | V | yes |
| 31 Mile Lake Wetland | W | yes |
| Stony Creek Lake Wetland | X | no |
| Stony Creek Lake Wet Meadow | Y | yes |
| Nature Center Old Field | Z | no |

**Table 2. Rare plants surveyed by associated natural communities. State status abbreviations are as follows: E, endangered; T, threatened; SC, special concern.**

| Community | Scientific Name | Common Name | State Status |
|---|---|---|---|
| **Mesic Southern Forest** | | | |
| | *Castanea dentata* | American chestnut | E |
| | *Triphora trianthophora* | three-birds orchid | T |
| | *Spiranthes ovalis* | lesser ladies's tresses | T |
| | *Aristolochia serpentaria* | Virginia snakeroot | T |
| | *Galearis spectabilis* | showy orchis | T |
| | *Carex platyphylla* | broad leaved sedge | T |
| | *Trillium recurvatum* | prairie trillium | T |
| | *Panax quinquefolius* | ginseng | T |
| | *Hydrastis canadensis* | goldenseal | T |
| | *Tipularia discolor* | cranefly orchid | T |
| | *Polymnia uvedalia* | large flowered leaf-cup | T |
| | *Mertensia virginica* | Virginia bluebells | T |
| | *Jeffersonia diphylla* | twinleaf | SC |
| | *Liparis lilifolia* | purple twayblade | SC |
| | *Adlumia fungosa* | climbing fumitory | SC |
| **Southern Floodplain Forest** | | | |
| | *Chelone obliqua* | red turtlehead | E |
| | *Corydalis flavula* | yellow fumewort | T |
| | *Trillium nivale* | snow trillium | T |
| | *Lycopus virginicus* | Virginia water-horehound | T |
| | *Morus rubra* | red mulberry | T |
| | *Carex conjuncta* | sedge | T |
| | *Trillium sessile* | sessile trillium | T |
| | *Wisteria frutescens* | wisteria | T |
| | *Valerianella chenopodifolia* | goosefoot corn-salad | T |
| | *Camassia scilloides* | wild hyacinth | T |
| | *Arabis perstellata* | rock-cress | T |
| | *Polemonium reptans* | Jacob's ladder | T |
| | *Silphium perfoliatum* | cup-plant | T |
| | *Carex lupuliformis* | false hop sedge | T |
| | *Diarrhena americana* | beak grass | T |
| | *Fraxinus profunda* | pumpkin ash | T |

**Table 2. continued**

| | | | |
|---|---|---|---|
| | *Justicia americana* | water-willow | T |
| | *Viburnum prunifolium* | black haw | SC |
| | *Hybanthus concolor* | green violet | SC |
| | *Euonymus atropurpurea* | wahoo | SC |
| | *Gymnocladus dioicus* | Kentucky coffee tree | SC |
| **Southern Swamp** | | | |
| | *Trillium undulatum* | painted trillium | E |
| | *Populus heterophylla* | swamp cottonwood | E |
| | *Isotria verticillata* | whorled pogonia | T |
| | *Poa paludigena* | bog bluegrass | T |
| | *Cypripedium arietinum* | ram's head orchid | SC |
| **Hillside/Woodland Prairie (dry-mesic prairie)** | | | |
| | *Bouteloua curtipendula* | side oats grama grass | T |
| | *Panicum leibergii* | Leiberg's panic grass | T |
| | *Astragalus canadensis* | Canadian milk-vetch | T |
| | *Besseya bullii* | kitten-tails | T |
| | *Zizia aptera* | prairie golden alexanders | T |
| | *Ranunculus rhomboideus* | prairie buttercup | T |
| | *Viola pedatifida* | prairie birdfoot violet | T |
| | *Draba reptans* | creeping whitlow grass | T |
| | *Geum triflorum* | prairie smoke | T |
| **Mesic Prairie** | | | |
| | *Gentiana flavida* | white gentian | E |
| | *Silphium laciniatum* | compass plant | T |
| | *Sporobolus heterolepis* | prairie dropseed | SC |
| **Prairie Fen** | | | |
| | *Cypripedium candidum* | white lady's slipper | T |
| | *Valeriana edulis* var. *ciliata* | edible valerian | T |
| **Dry-Mesic Southern Forest** | | | |
| | *Quercus shumardii* | Shumard's oak | SC |
| | *Agrimonia rostellata* | beaked agrimony | SC |
| | *Angelica venenosa* | hairy angelica | SC |

## Results

The surveys identified 7 new element occurrences (EO's) and reconfirmed 8 previously identified elements (an element refers to a high quality natural community or state-listed species). Natural community surveys resulted in the identification of 3 new high quality community occurrences and 4 previously identified exemplary natural communities were revisited (Table 3). Rare plant surveys resulted in 4 new element occurrences and 4 existing plant records were reconfirmed (Table 4). It is possible that additional rare species may be found in the future, especially with active restoration and management. All new, natural community and rare plant occurrences have been entered into the statewide Biological Conservation Database (BCD) managed by MNFI and all previously existing records have been updated.

### Natural Community Inventory Results

The natural community surveys resulted in the identification of three new natural communities including a wet-mesic prairie and relict conifer swamp at Hudson Mills (Figure 11) and a hardwood-conifer swamp at Stony Creek (Figure 12). Prior to our 2001 surveys, the BCD contained records for both a southern mesic forest and southern swamp (e.g., hardwood swamp) at Stony Creek and an oak barrens and woodland prairie at Dexter-Huron. In addition to these exemplary natural communities, each of the parks also contain areas that have great potential of becoming high quality natural communities with the implementation of restoration. The high quality natural communities and sites with good potential for restoration and are listed below along with their associated stewardship needs (Table 5).

**Table 3. Natural Community Occurrences.**

| Community | **Site Name** (used for report) | Year First Observed | Year Last Observed | Metropark |
|---|---|---|---|---|
| woodland prairie | Dexter Railroad Prairie | 1983 | 2001 | Dexter-Huron |
| oak barrens | Dexter Oak Barrens | 1984 | 2001 | Dexter-Huron |
| relict conifer swamp | Hudson Mills Tamarack Swamp | 2001 | 2001 | Hudson Mills |
| wet-mesic prairie | Hudson Mills Wet-Mesic Prairie | 2001 | 2001 | Hudson Mills |
| hardwood-conifer swamp | Stony Creek Cedar Swamp | 2001 | 2001 | Stony Creek |
| southern swamp | Stony Creek Wet-Mesic Forest | 1987 | 2001 | Stony Creek |
| mesic southern forest | Stony Creek Wet-Mesic Forest | 1987 | 2001 | Stony Creek |

**Table 4. Rare Plant Occurrences.**

| Species | **Site Name** (used for report) | Status | Year First Observed | Year Last Observed | Metropark |
|---|---|---|---|---|---|
| *Chelone obliqua* red turtlehead | Dexter-Huron Floodplain | E | 1904 | 1981 | Dexter-Huron |
| *Euonymus atropurpurea* wahoo | Dexter Floodplain Forest | SC | 2001 | 2001 | Dexter-Huron |
| *Justicia americana* water-willow | Dexter-Huron Floodplain Forest | T | 1984 | 2001 | Dexter-Huron |
| *Panicum leibergii* Leiberg's panic grass | Dexter Railroad Prairie | T | 2001 | 2001 | Dexter-Huron |
| *Euonymus atropurpurea* wahoo | Group Camp Forest | SC | 1992 | 2001 | Hudson Mills |
| *Gymnocladus dioicus* Kentucky coffee tree | Group Camp Forest | SC | 1992 | 2001 | Hudson Mills |
| *Hydrastis canadensis* goldenseal | Hudson Mills Golf Course Forest | T | 2001 | 2001 | Hudson Mills |
| *Hydrastis canadensis* goldenseal | Stony Creek Wet-Mesic Forest | T | 1991 | 2001 | Stony Creek |
| *Panax quinquefolius* ginseng | Stony Creek Wet-Mesic Forest | T | 2001 | 2001 | Stony Creek |

**Rare Plant Inventory Results**

The rare plant surveys resulted in 4 new rare plant occurrences including ginseng (*Panax quinquefolius*) at Stony Creek, golden seal (*Hydrastis canadensis*) at both Stony Creek and Hudson Mills, and Leiberg's panic grass (*Panicum leibergii*) and wahoo (*Euonymus atropurpurea*) at Dexter-Huron (Table 4). In addition, four previously known rare plant records were reconfirmed including goldenseal at Stony Creek, wahoo and Kentucky coffee tree (*Gymnocladus dioicus*) at Hudson Mills, and water-willow (*Justicia americana*) at Dexter-Huron (Table 4). A previously known occurrence of red turtlehead (*Chelone glabra*) was searched for at Dexter-Huron but could not be relocated. Abstracts for ginseng and goldenseal are included as appendices (Appendix 5).

**Delhi, Dexter-Huron, and Hudson Mills**

Rare plants were found in both floodplain forest and prairie habitats at Dexter-Huron and Hudson Mills. Goldenseal, wahoo, Kentucky coffee tree, and water-willow were all located along the Huron River in southern floodplain forest. Goldenseal occurred in a mesic forest zone of the floodplain at Hudson Mills Golf Course (Figure 11, H). Wahoo and Kentucky coffee tree were found in a dry-mesic to mesic forest zone of a floodplain at the Hudson Mills Group Camp Forest (Figure 11, L). Wahoo (E) and water-willow (G) were located along the Huron River at Dexter-Huron (Figure 10). Leiberg's panic grass was located in the Dexter Railroad Prairie, a small remnant of woodland prairie (dry-mesic prairie) along a railroad (Figure 10, D).

**Stony Creek**

At Stony Creek, populations of ginseng and goldenseal were located in the Sheldon Wet-Mesic Forest (Figure 12, T). This is a mesic southern forest natural community that grades into a southern swamp. Because extensive habitat of this type is available within the Sheldon Wet-Mesic Forest, there is potential for additional sub-populations of these species to be located.

A beard-tongue species (*Penstemon* sp.) found within the Gravel Mine Wet-Mesic Prairie (Figure 12, P) was

**Table 5. Management recommendations for high quality natural communities and sites with good potential for improvement through restoration and management.**

| Site Name | Community Type | Metropark | Management Recommendations |
|---|---|---|---|
| Delhi Railroad Prairie | woodland prairie | Delhi | invasive and woody species control, prescribed fire |
| Dexter Railroad Prairie | woodland prairie | Dexter-Huron | invasive and woody species control, prescribed fire |
| Dexter Oak Barrens | oak barrens | Dexter-Huron | invasive species control, selective cutting, prescribed fire |
| Dexter-Huron Oxbow Prairie | woodland prairie | Dexter-Huron | invasive and woody species control, prescribed fire |
| Dexter Floodplain Forest | southern floodplain forest | Dexter-Huron | invasive species control |
| Hudson Mills Tamarack Swamp | relict conifer swamp | Hudson Mills | red maple control, monitoring for glossy buckthorn |
| Hudson Mills Wet-Mesic Prairie | wet-mesic prairie | Hudson Mills | invasive and woody species control, prescribed fire |
| Stony Creek Cedar Swamp | hardwood-conifer swamp | Stony Creek | invasive species control, deer control, selective hardwood thinning |
| Sheldon Wet-Mesic Forest | mesic southern forest and southern swamp | Stony Creek | invasive species control, deer control |
| Sheldon Wet-Mesic prairie | wet-mesic prairie | Stony Creek | invasive and woody species control, prescribed fire |
| Sheldon Tamarack Fen | relict conifer swamp / prairie fen | Stony Creek | invasive and woody species control |
| Stony Creek Lake Wet Meadow | southern wet meadow (sedge meadow) | Stony Creek | invasive and woody species control, prescribed fire |
| 31 Mile Lake Wetland | relict conifer swamp / prairie fen | Stony Creek | invasive and woody species control |

not identified to species during the survey and has the potential to be one of the rare members of the genus (*P. gracilis* or *P. calycosus*). It is recommended that this species be looked for in the future during the month of June.

## Site Summaries and Management Recommendations

### Delhi Metropark

**Delhi Railroad Prairie (Site Code: B)**
The Delhi Railroad Prairie is a small dry-mesic or woodland prairie that occurs between a row of residential houses and a railroad tracks at the southwest edge of the metropark (Figure 9). It contains large patches of prairie grasses such as big bluestem (*Andropogon gerardii*), little bluestem (*A. scoparius*), Indian grass (*Sorghastrum nutans*) and switch grass (*Panicum virgatum*) and several prairie forbs such as stiff goldenrod (*Solidago rigida*), flowering spurge (*Euphorbia corollata*), and prickly pear (*Opuntia humifusa*) (Appendix 1). Numerous large boulders occur throughout the prairie and large holes occur where boulders have been removed. Stewardship issues at the site include controlling several invasive forbs such as spotted knapweed (*Centaurea maculosa*), white and yellow sweet clover (*Melilotus alba* and *M. officinalis*) and invasive shrubs such as morrow honeysuckle (*Lonicera morrowii*) and common buckthorn (*Rhamnus cathartica*). Reducing tree and shrub encroachment at the site will increase the amount of prairie habitat. If possible, the prairie should be managed with prescribed fire to help bolster the native prairie grasses and forbs and reduce tree and shrub cover. The railroad tracks along the south side of the prairie provide an ideal firebreak.

**Delhi Park Interior (Site Code: A)**
The wooded edges of the park contain numerous invasive species such as garlic mustard (*Alliaria petiolata*), autumn olive (*Elaeagnus umbellata*), morrow honeysuckle, white mulberry (*Morus alba*), and common buckthorn (Appendix 1). Removing these species from the park will help prevent their spread to other less disturbed portions of the surrounding landscape.

**Delhi Floodplain Forest (Site Code: C)**
Floodplain forest occurs in several locations along the Huron River within Delhi (Figure 9). While no rare species were found within these areas, the small band of floodplain forest south of the railroad tracks at the southwest portion of Delhi contained a diverse group of species including butternut (*Juglans cinerea*) (Figure8) (Appendix 1). Garlic mustard also occurs in this area and if allowed to spread will likely contribute to a significant decline in species diversity for the site.

### Dexter-Huron Metropark

**Dexter Railroad Prairie (Site Code: D)**
The Dexter Railroad Prairie was identified as an exemplary occurrence of woodland prairie (dry-mesic prairie) in 1984. The site consists of a thin band of dry-mesic prairie located north of the railroad tracks and south of the Huron River, just east of the town of Dexter (Figure 10). Native prairie grasses such as big bluestem, little bluestem and Indian grass dominate the site. Other prairies species found at the site include New Jersey tea (*Ceanothus americanus*), bastard toad flax (*Comandra umbellata*), pale coneflower (*Echinacea pallida*), rough blazing star (*Liatris aspera*), and stiff goldenrod (Appendix 2). A state-threatened species, Leiberg's panic grass, also occurs at the site. Spotted knapweed, an aggressive invasive species is present and should be controlled. The site borders a remnant oak barrens to the south (see Dexter Oak Barrens below). Because of their close proximity and similar species composition, a single species list was compiled for both sites (Appendix 2). If possible, the prairie and oak barrens should be managed with prescribed fire to reduce woody plant encroachment and stimulate native prairie species. The railroad tracks along the southern edge of the site provide an excellent firebreak. Selective cutting of tree and shrub species in both areas is also an important management tool that should be considered for these sites.

**Dexter Oak Barrens (Site Code: D)**
In 1984, MNFI located an exemplary occurrence of oak barrens adjacent to the Dexter Railroad Prairie (Figure 10). This occurrence is one of only 10 known occurrences of oak barrens within the state. Oak barrens is a fire-dependent natural community and rapidly succeeds to dry-mesic or dry southern forest in absence of fire or thinning (see Appendix 5 for oak barrens natural community abstract). Since being surveyed in 1984 the oak barrens has become overgrown with woody species and many shade-intolerant prairie forbs now occur only along its southern edge where it borders open prairie. If possible, the site should be managed with prescribed fire to stimulate the growth of prairie grasses and forbs and reduce woody species cover. The site boarders the Dexter Railroad Prairie to the south and if possible, the hard edge between the two communities should be

softened through the use of regular prescribed burning and selective cutting. Selective cutting will be an important management tool for thinning the tree canopy and understory. If selective cutting is used, it should be especially focused on removing the maples (*Acer* spp.), ashes (*Fraxinus* spp.), and cherries (*Prunus* spp.) because of their ability to cast dense shade and rapidly colonize a site.

**Dexter Floodplain Forest (Site Code: E)**
Floodplain forest borders the Huron River in several locations within Dexter-Huron Metropark (Figure 10). The floodplain forest that borders the oak barrens mentioned above was especially diverse with 87 species recorded including wahoo, a rare shrub species (Appendix 2). Unfortunately, garlic mustard occurs within the floodplain and is a threat to species diversity at the site. If possible, garlic mustard should be removed from the site to prevent it from spreading and negatively impacting species diversity. A small southern wet meadow borders the eastern edge of the floodplain, and if possible, should be managed with prescribed fire to help maintain the community's open condition and species diversity (see Appendix 5 for southern wet meadow natural community abstract).

**Dexter-Huron Oxbow Prairie (Site Code: F)**
A large woodland prairie occurs within an oxbow of the Huron River and north of the railroad tracks at Dexter-Huron (Figure 10). The prairie contains several different types of habitat including a large area of dry-mesic prairie (woodland prairie), a small patch of wet-mesic prairie in the northern portion of the site and a small area of oak savanna (oak opening) in the southeastern corner near the railroad tracks. Prairie grasses such as big bluestem, little bluestem and Indian grass dominate much of the site and prairie forbs include: smooth aster (*Aster laevis*), bastard toadflax, pale spiked lobelia (*Lobelia spicata*), prairie dock (*Silphium terebinthinaceum*), slender ladies' tresses (*Spiranthes cernua*), showy goldenrod (*Solidago speciosa*), and stiff goldenrod (Appendix 2). If possible, prescribed fire should be used to manage the site to help reduce woody species encroachment and stimulate the prairie grasses and forbs. Because the site borders the Huron River and a railroad tracks, implementing a prescribed fire may be less complicated than many other sites. A drainage ditch bisects the site and provides an opportunity to create two separate management units. If possible, the management units should be burned in alternate years to allow fire-sensitive species, particularly non-mobile invertebrates, to recolonize the most recently burned management unit.

## Hudson Mills Metropark

**Hudson Mills Tamarack Swamp (Site Code: I)**
A large, species-rich, relict conifer swamp occurs within Hudson Mills (Figure 11) (see Appendix 5 for relict conifer swamp natural community abstract). This site, which is dominated by tamarack (*Larix laricina*), black ash (*Fraxinus nigra*), and poison sumac (*Toxicodendron vernix*), qualifies as an exemplary natural community of statewide significance because of its large size, high species diversity, and lack of invasive species. During a survey in early September, 73 species were recorded from the site including many species commonly found in prairie fens including tall flat top white aster (*Aster umbellatus*), grass of parnassus (*Parnassia glauca*), cowbane (*Oxypolis rigidior*), swamp betony (*Pedicularis lanceolata*), shrubby cinquefoil (*Potentilla fruticosa*), hoary willow (*Salix candida*), Ohio goldenrod (*Solidago ohioensis*), and Riddell's goldenrod (*S. riddellii*) (Appendix 3). Because tamarack is shade-intolerant the community is rapidly degraded when hardwoods such as red maple invade. Following conversion to hardwood dominance, relict conifer swamps typically loose many of the shade-intolerant species, such as those common to prairie fens mentioned above, and undergo a drastic reduction in shrub-layer cover that can negatively impact bird and small mammal species that rely on the fruits of shrubs (Kost 2001). The long-term viability of the site will depend on preventing red maple invasion. Presently, red maple appears to be restricted to edges of the tamarack swamp. Red maple can be controlled through cutting or girdling, accompanied by herbicide application to the cut stump or surrounding bark to prevent root sprouting. Because soils of relict conifer swamps are high in alkalinity they are especially susceptible to invasion by glossy buckthorn (*Rhamnus frangula*), which can completely alter community structure and negatively impact species diversity. The site should be monitored annually for glossy buckthorn and the species should be eradicated if found. An oak-hickory forest surrounds the tamarack swamp (see Hudson Mills Dry-Mesic Forest (M) below).

**Hudson Mills Dry-Mesic Forest (Site Code: M)**
The dry-mesic southern forest that surrounds the tamarack swamp is a fire-dependent natural community (Figure 11, Appendix 3). In the absence of

fire, the Hudson Mills Dry-Mesic Forest has been invaded by red maple and lacks oak regeneration. Because of its proximity to a high quality, relict conifer swamp (Hudson Mills Tamarack Swamp (I) above), it is especially important that red maple be removed from this site. If possible, prescribed fire should be used to manage this site so that red maple, which is fire sensitive, can be controlled and prevented from spreading to the tamarack swamp. Prescribed fire will also help create canopy light gaps, which enable oak regeneration.

**Hudson Mills Wet-Mesic Prairie (Site Code: J)**
A small, species-diverse, wet-mesic prairie occurs along the east bank of the Huron River in the southern portion of Hudson Mills (Figure 11). This site has been entered into the BCD as an exemplary natural community because of its high diversity. The wet-mesic prairie is one of only 9 known occurrences for this community type in Michigan. Wet-mesic prairie is a groundwater-influenced, fire-dependent community type that is dominated by prairie and wetland species, many of which also occur in prairie fens. In all, 79 species were recorded during an October survey including big bluestem, Indian grass, prairie cordgrass (*Spartina pectinata*), slender wheat grass (*Agropyron trachycaulum*), New England aster (*Aster novae-angliae*), small fringed gentian (*Gentianopsis procera*), bog lobelia (*Lobelia kalmii*), whorled loosestrife (*Lysimachia quadriflora*), shrubby cinquefoil, and prairie dock (Appendix 3). Shrub and tree encroachment is severe in the southern portions of the community where the wet-mesic prairie grades into a small pocket of prairie fen. If possible, the site should be managed with prescribed fire to stimulate the native grasses and forbs and reduce woody species encroachment. Several invasive species occur within the site and are presently at minimal levels and therefore may be relatively easy to control if acted upon in the near future. If left unchecked, these invasive species will likely dominate the site in the future and the unique diversity of the site will be lost. The invasive species include purple loosestrife, glossy buckthorn, and common buckthorn, which are all found growing in a sedge-dominated patch between two larger areas of wet-mesic prairie, as well as reed canary grass (*Phalaris arundinacea*) and morrow honeysuckle. Management should initially concentrate on removing purple loosestrife and buckthorn as these species pose the most immediate threat to the long-term viability of the site. While cutting accompanied by herbicide application may be the most effective method to control these species (Reinartz 1997, Jack McGowan-Stinski pers. comm. 1999), prescribed fire is an important component of any long-term management solution for the site.

**Hudson Mills Group Camp Wet Meadow (Site Code: K)**
A small southern wet meadow occurs within the group camp at Hudson Mills (Figure 11). Southern wet meadow is a sedge-dominated, fire-dependent wetland community type (see Appendix 5 natural community abstract for southern wet meadow). The open areas of this site are dominated by sedges such as *Carex stricta* and *C. lacustris*, and forbs such as eastern lined aster (*Aster puniceus*), tall swamp marigold (*Bidens coronatus*), Joe pye weed (*Eupatorium maculatum*), boneset (*E. perfoliatum*), water smartweed (*Polygonum amphibium*), and marsh fern (*Thelypteris palustris*) (Appendix 3). Shrub encroachment threatens the long-term viability of the site. If possible, the site should be managed with prescribed fire to reduce shrub encroachment and facilitate seed bank expression and rejuvenation. In the absence of fire, native wetland shrub species, especially gray dogwood (*Cornus foemina*) will continue to colonize the open areas of meadow.

**Hudson Mills Group Camp Forest (Site Code: L)**
A broad floodplain forest occurs along the Huron River within the Hudson Mills Group Camp (Figure 11). The area contains two rare plant species, Kentucky coffee tree and wahoo. The floodplain contains a thin, first bottom that occurs directly along the river and supports a variety of wetland plants including native, wetland species such as cardinal flower (*Lobelia cardinalis*), silver maple (*Acer saccharinum*), and black willow (*Salix nigra*), as well as several invasive species such as moneywort (*Lysimachia nummularia*) and reed canary grass (*Phalaris arundinacea*) (Appendix 3). The first bottom rises abruptly to meet an oak-dominated, second bottom that may be characterized as dry-mesic to mesic forest. Characteristic species in the second bottom include black oak (*Quercus velutina*), white oak (*Quercus alba*), black walnut (*Juglans nigra*), Kentucky coffee tree, black cherry (*Prunus serotina*), witch hazel (*Hamamelis virginiana*), hazelnut (*Corylus americana*), jumpseed (*Polygonum virginianum*), and sedge (*Carex pensylvanica*). The area also contains several exotic, landscape cultivars such as Golden Bells (*Forsythia* x *intermedia*) and lily of the valley (*Convallaria majalis*), indicating that a homestead may have once occurred at the site. Invasive species in this area include autumn olive and multiflora rose (*Rosa multiflora*). Garlic mustard was not encountered during our survey but should be removed if observed in the future. Several pole-size sugar

maples occur within the site, indicating that in the absence fire the site may become dominated by shade tolerant, mesic forest species. No oak regeneration was observed at the site.

**Hudson Mills Golf Course Forest (Site Code: H)**
The Hudson Mills Golf Course forest is composed of several different types of forested communities (Figure 11). Much of the area is floodplain forest and is dominated by silver maple, red maple, and green ash (*Fraxinus pennsylvanica*) (Appendix 3). Common ground layer species within the floodplain include wild ginger (*Asarum canadense*), wood nettle (*Laportea canadensis*), and jumpseed. Small, sandy rises or islands within the floodplain forest contain remnant oak barrens and dry-mesic southern forest. These areas are characterized by a sedge-dominated (*Carex pensylvanica*) ground layer and an overstory and shrub layer of white oak, shagbark hickory (*Carya ovata*), bitternut hickory (*Carya cordiformis*), hazelnut, and witch hazel. A mesic southern forest borders the southern portion of the floodplain. Numerous large red oaks (*Quercus rubra*) dominate the canopy and a variety of fern species occur in the ground layer including maidenhair fern (*Adiantum pedatum*), lady fern (*Athyrium filix-femina*), rattlesnake fern (*Botrychium virginianum*), and spinulose woodfern (*Dryopteris carthusiana*). Goldenseal , a rare mesic forest species, also occurs in this area. The mesic forest also contains a hillside, groundwater seep. Garlic mustard infestation is severe along the western side of the floodplain forest and mesic forest where these areas border golf course fairways. Management to control garlic mustard should focus on preventing it from spreading throughout the forested areas. Common buckthorn and autumn olive also occur in this area and like garlic mustard, should be removed to prevent their spread to uninfested portions of the forest.

## Stony Creek Metropark

**Stony Creek Cedar Swamp (Site Code: O)**
The Stony Creek Cedar Swamp is located north of Inwood Road and has been entered into the BCD as an exemplary occurrence of hardwood-conifer swamp (Figure 12). Unlike most conifer-dominated swamps, which occur on deep organic soils (e.g., peat and muck), this site occurs on mineral soil (gleyed coarse sand). The site is botanically diverse with over 100 species recorded during a spring survey including: naked miterwort (*Mitella nuda*), bishop's cap (*M. diphylla*), starflower (*Trientalis borealis*), richweed (*Collinsonia canadensis*), bulblet fern (*Cystopteris bulbifera*), fragile fern (*C. fragilis*), and New York fern (*Thelypteris noveboracensis*) (Appendix 4). Common shrub species include smooth highbush blueberry (*Vaccinium corymbosum*), prickly ash (*Zanthoxylum americanum*), spicebush (*Lindera benzoin*), and bladdernut (*Staphylea trifolia*). The canopy is made up of both conifers such as white cedar (*Thuja occidentalis*), white pine (*Pinus strobus*), and tamarack (*Larix laricina*) and hardwoods such as black ash, yellow birch (*Betula alleghениensis*), paper birch (*Betula papyrifera*), and swamp white oak (*Quercus bicolor*). Cut stumps of white cedar are common in several parts of the swamp. Several canopy-sized white cedars were aged with a tree corer to approximately 114 years old. While conifers are common within the canopy, the understory is completely dominated by hardwoods such as red maple and no evidence of successful conifer regeneration was observed. Dead, standing conifers, especially tamarack, were also abundant as a result of dense shading from hardwoods. All white cedar seedlings observed were heavily browsed, apparently by white-tailed deer. Deer browse sign was also abundant on many herbaceous species including Jack in the pulpit (*Arisaema triphyllum*). The swamp also contains sand and gravel islands that are dominated by mesic forest species including red oak, sugar maple, American beech (*Fagus grandifolia*), and tulip tree (*Liriodendron tulipifera*). Garlic mustard was observed along the southeast border of the swamp and should be removed to prevent it from spreading throughout the site. If left unmanaged, garlic mustard will likely eventually dominate the forest floor of both the hardwood-conifer swamp and mesic forest islands. In addition to preventing the spread of garlic mustard, management for the hardwood-conifer swamp should include reducing deer densities to help facilitate conifer regeneration and prevent the loss of preferentially grazed herbaceous species (Waller and Alverson 1997). Another management option to consider for encouraging conifer regeneration is thinning or girdling hardwoods such as red maple in concert with reducing deer densities.

**Sheldon Wet-Mesic Forest (Site Code: T)**
The Sheldon Wet-Mesic Forest site consists of a hardwood swamp and mesic southern forest that intermix north and west of the West Branch Picnic area (Figure 12). Each of these communities has previously been entered into the BCD as an exemplary natural community occurrence. Because the communities are

so closely associated, a single species list was recorded for both sites (Appendix 4). Two rare species, goldenseal and ginseng, were observed here. The overstory is diverse and includes: silver maple, American beech, basswood (*Tilia americana*), yellow birch, American elm (*Ulmus americana*), sugar maple, swamp white oak, red oak, shagbark hickory, and white oak. Spicebush is common within the shrub layer. Common ground flora species include: skunk cabbage (*Symplocarpus foetidus*), Jack in the pulpit, broad-leaved goldenrod (*Solidago flexicaulis*), wild ginger, and naked miterwort. In addition, numerous fern species were observed including: maidenhair fern, lady fern, New York fern, Christmas fern (*Polystichum acrostichoides*), silvery spleenwort (*Athyrium thelypterioides*), and broad beech fern (*Thelypteris hexagonoptera*). According to Stony Creek Metropark Naturalist, Roger Bajorek, the diversity of fern species at the site was likely enhanced by volunteers who transplanted wildflowers to the site from the area now occupied by Stony Creek Lake. Vernal pools are abundant and provide critical breeding habitat for the numerous frogs and salamanders that inhabit the site. A small stream also flows through the north end of the site. While we did not observe garlic mustard within the site, the species would thrive in this habitat if introduced because of the moist conditions (Meekins and McCarthy 2001). Therefore, it will be important to monitor the site annually for garlic mustard and remove it if found. Another invasive species, Japanese barberry (*Berberis thunbergii*) was observed near the stream and should be removed to prevent its further spread. Heavy deer browse was evident throughout the site on both woody and herbaceous plants. Deer herbivory may also be responsible for the scarcity of female Jack in the pulpit plants observed at the site. If possible, deer densities should be reduced within the metropark to prevent further ecological damage.

**Sheldon Tamarack Fen (Site Code: S)**

A small tamarack-dominated fen occurs north of the Sheldon Wet-Mesic Forest, above the West Branch Picnic area (Figure 12). The site borders a small creek to the south and an old field with many native species (Sheldon Mesic Prairie, R) to the north. Numerous, species commonly found in prairie fen occur within the site including: shrubby cinquefoil, poison sumac, round leaved sundew (*Drosera rotundifolia*), grass of parnassus, starry false solomon seal (*Smilacina stellata*), marsh wild timothy (*Muhlenbergia glomerata*), and sedges (*Carex stricta* and *C. sterilis*) (Appendix 4). This site was probably an open prairie fen in the past and has become dominated by tamarack as a result of fire suppression. The viability of the site is threatened by invasive shrub species including glossy buckthorn, common buckthorn, and multiflora rose. Glossy buckthorn, in particular, has completely colonized similar sites in southern Michigan. Buckthorn can be controlled by winter cutting in conjunction with herbicide application to control stump sprouting (Reinartz 1997). For more information about the community see the relict conifer swamp and prairie fen natural community abstracts (Appendix 5).

**Sheldon Mesic Prairie (Site Code: R)**

An old field with many native species occurs northeast of the Sheldon Tamarack Fen (S) (Figure 12). Native species found here include shrubby St. john's wort (*Hypericum prolificum*), mountain mint (*Pycnanthemum virginiana*), wild bergamot (*Monarda fistulosa*), and butterfly weed (*Asclepias tuberosa*) (Appendix 4). Restoring this site to prairie will likely improve the hydrology of the adjacent fen. Restoration of the site will require controlling shrub and tree encroachment and the introduction of additional native prairie grasses and forbs. Wet-mesic prairie species will grow well along the site's lower slopes where it border the tamarack-dominated fen (S), while dry-mesic prairie species will grow best on the site's upper slopes and hilltop.

**Sheldon Wet-Mesic Prairie (Site Code: V)**

A small wet-mesic prairie occurs near the Sheldon Wet-Mesic Forest, north of parking lot C in the West Branch Picnic area (Figure 12). Nearly forty species were observed at this site during an early summer survey including big bluestem, little bluestem, smooth aster, sedge (*Carex stricta*), pale spiked lobelia, bottle gentian (*Gentiana andrewsii*), whorled loosestrife, black eyed susan (*Rudbeckia hirta*), Riddell's goldenrod, Culver's root (*Veronicastrum virginicum*), shrubby cinquefoil, and tamarack (Appendix 4). The site is currently mowed and this form of management is probably responsible for the perpetuation of wet-mesic prairie at the site. However, while mowing may be very effective at controlling shrub and tree encroachment, it also acts to reduce diversity by selecting against species that are in flower when mowing occurs. Mowing during the late fall (e.g., mid November), after flowering has finished, is likely to cause the least impact to native prairie species. If possible, the site should be managed with prescribed fire to enhance seed germination and establishment and stimulate prairie grasses and forbs. Controlling woody species encroachment through hand cutting accompanied by herbicide application to cut stumps may also be needed in portions of the site where tree and shrub encroachment are severe. Seed from this site may be useful for adding species diversity to the lower slopes of the Sheldon Mesic Prairie (R, above).

**Stony Creek Dry-Mesic Forest (Site Code: U)**
A degraded, oak-dominated, dry-mesic southern forest occurs west of the Stony Creek Golf Course (Figure 12). The forest encompasses several small wetlands and borders a mesic southern forest and southern swamp (Sheldon Wet Mesic Forest). The species list for the site includes species from the wetlands and neighboring communities (Appendix 4). Many small, prairie openings occur along the forest's steep slopes and hilltops. These openings contain species such as Indian grass, little bluestem, butterfly weed, round headed bush clover (*Lespedeza capitata*), flowering spurge (*Euphorbia corollata*), and red cedar (*Juniperus virginiana*), which indicate the area supported oak barrens in the past (Appendix 4). Restoring oak barrens to a portion of the area will increase the diversity of habitats within the metropark. However, the area contains many invasive species that will be time consuming to eradicate including: common buckthorn, autumn olive, oriental bittersweet (*Celastrus orbiculata*), morrow honeysuckle, and border privet (*Ligustrum* X *intermedia*). Invasion by oriental bittersweet is especially severe. Because of the droughty nature of the soils along the site's upper slopes, prescribed fires may be very effective in helping to control the invasive, woody species. The area also contains several pine plantations that should be removed if the area is to be restored. Another management consideration for the site is the lack of oak regeneration. While white oak and black oak are common canopy species, few seedlings and saplings of either species were observed. In addition to helping to control invasive species, the use of prescribed fire may also help increase the number of light gaps and facilitate oak regeneration.

**Gravel Mine Wet-Mesic Prairie (Site Code: P)**
The abandoned gravel mines north of Inwood Road now contain several moist areas where wet-mesic prairie species have become common including: big bluestem, little bluestem, tall flat top white aster, common boneset, pale spiked lobelia, Ohio goldenrod, Riddell's goldenrod, Loesel's twayblade (*Liparis loeselii*), and oval ladies' tresses (*Spiranthes ovalis*) (Figure 12, Appendix 4). Tamarack and white cedar also occur in these low areas, indicating their potential to convert to conifer swamp if the practice of mowing were to be abandoned. Threats to these areas include the presence of invasive species such as purple loosestrife, autumn olive, morrow honeysuckle, and white sweet clover. The site could be managed as a wet-mesic prairie by abandoning mowing in favor of using prescribed fire and selective woody plant removal to keep it an open condition. Another alternative is to allow the site to succeed to hardwood-conifer swamp, which borders the site, by abandoning mowing and allowing white cedar, tamarack and white pine colonization. If mowing is abandoned, manual cutting of woody invasive species, accompanied by herbicide application to cut stumps, will need to be implemented to prevent the site from becoming dominated by exotic woody species.

**31 Mile Lake Wetland (Site Code: W)**
A large wetland complex occurs from 31 Mile Road south until it reaches a small, unnamed lake (Figure 12). A small, groundwater fed stream flows through the wetland complex. Tamarack is common throughout the wetland and many fen species occur along the creek including: shrubby cinquefoil, common mountain mint, sedge (*Carex lasiocarpa*), and poison sumac (Appendix 4). While the area contains a good diversity of wetland species, it also supports a large population of the invasive shrub, glossy buckthorn. Because of the severe invasion of glossy buckthorn at this site, controlling its further spread within the wetland may be difficult. Cutting accompanied by herbicide application to control root sprouting can be an effective method of control (Reinartz 1997), especially when followed the next growing season by spot burning to eliminate seedlings (Jack McGowan-Stinski pers. comm. 1999). Other invasive species that occur here include reed canary grass, morrow honeysuckle, and moneywort.

**Stony Creek Lake Wet Meadow (Site Code: Y)**
A small southern wet meadow (sedge meadow) occurs along the north edge of Stony Creek Lake (Figure 12). The wet meadow is dominated by sedges (*Carex stricta* and *C. lacustris*) and contains many other native, wetland species including blue joint grass (*Calamagrostis canadensis*), Joe pye weed, boneset, sensitive fern (*Onoclea sensibilis*), and marsh fern (*Thelypteris palustris*) (Appendix 4). The sedge meadow borders a thin band of shrub-carr to the north that may slowly encroach upon the wet meadow. Controlling shrub encroachment with prescribed burning or manual cutting accompanied by herbicide application to control root sprouting will increase the long-term viability of the site. Reed canary grass, an aggressive, invasive grass species occurs at the site but is not wide spread. Another wet meadow with similar species composition occurs southwest of a small, unnamed lake near Sheldon Road, west of the Stony Creek Golf Course (Figure 12). This meadow is also threatened by native shrub invasion and would benefit from prescribed fire management and manual cutting of woody species accompanied by herbicide application to control root sprouting. For more information see the southern wet meadow natural community abstract in Appendix 5.

Plate 1. Shrub encroachment threatens Delhi Railroad Prairie.

Plate 2. Big bluestem prairie grass is abundant at Delhi Railroad Prairie.

Plate 3. Dexter Railroad Prairie borders an overgrown oak barrens and railroad track.

Plate 5. A southern wet meadow borders the southern edge of the Dexter Floodplain Forest.

Plate 6. The Dexter-Huron Oxbow Prairie is a large, open grassland with many native prairie species.

Plate 7. Pale spiked lobelia carpets the Gravel Mine Wet-Mesic Prairie at Stony Creek in June.

## Discussion

### Rare Plants

Ginseng and goldenseal are both state-threatened plants. Prior to this study, there were 88 known occurrences of ginseng (1 in Oakland County). Goldenseal was known from 62 locations in Michigan (2 in Washtenaw County and 7 in Oakland and Macomb Counties combined). Both of these species have declined throughout their range due to exploitation of their roots for herbal medicine and significant habitat loss and modification. In Michigan, both of these species' known occurrences are concentrated in the southern three tiers of counties in the Lower Peninsula. Typical habitat for these species includes rich hardwood forests with beech-sugar maple-basswood or red oak-sugar maple canopies and occasionally upland rises in floodplain forests. It is easiest to survey for both of these species while in fruit (August and September). Conservation strategies include the conservation and restoration of ecologically viable tracts of rich woodland habitat, monitoring known populations to determine if plants are being poached, and educating the public about the detrimental effects on a species distribution caused by poaching and the use of "wild" herbs in the herbal market.

Water-willow is a state-threatened plant. It is currently only known from a section of the Huron River between Dexter and Ann Arbor. Prior to this study, there were 14 known records of water-willow (4 in Washtenaw County). A total of 10 pre-1960 records exist from Livingston, Monroe, and Wayne counties, but several searches at these sites have failed to locate extant populations. Water willow has been known to inhabit muddy riverbanks and shallow muddy margins of inland lakes and Lake Erie. The plants are usually growing in up to a foot of water with common associates such as arrow arum (*Peltandra virginica*) and bur reed (*Sparganium* sp.). This perennial forms dense clones that spread by rhizomes and leafy stolons. It flowers in August and September. Alterations of river hydrology and impoundments can be detrimental to this species. Conservation strategies include protecting the hydrology and water quality of the Huron River as well as preventing the spread of invasive plant species such as purple loosestrife. In addition, it is recommended that the distribution pattern of water-willow within the metroparks be closely mapped and monitored to determine if the population changes over time.

Leiberg's panic grass is state threatened. Prior to this study, 22 occurrences of this species were known from Michigan (6 records in Washtenaw County). This species ranges across the southern two tiers of counties of the Lower Peninsula. It inhabits a variety of dry to wet prairie remnants and is commonly associated with big bluestem, little bluestem, and Indian grass. It is easiest to recognize this species in fruit (July). Conservation and management suggestions include prescribed burning to maintain the species vitality and prevent woody encroachment and to control invasive species.

Wahoo is listed as a species of special concern and has only recently begun being tracked. Plants are given the status of special concern when the status of the species is unknown. A species remains on the special concern list until specialists are able to determine whether the species should be elevated to state threatened or endangered status or is common enough to remain untracked. Wahoo is known from 3 locations in Michigan (2 in Washtenaw County). This study added an additional occurrence in the Dexter-Huron floodplain forest. This species is easily identified throughout the growing season. Conservation strategies include protecting the hydrology and water quality of the Huron River, and maintaining/restoring high quality flood plain forests by minimizing fragmentation and removing invasive species. It is possible that additional sub-populations of this population may be located within the metroparks.

Kentucky coffee tree is listed as a species of special concern and is known from 37 locations in Michigan (4 in Washtenaw County). Its known occurrences are concentrated in the southern four tiers of counties in the Lower Peninsula. This species is easy to recognize throughout the growing season. Conservation strategies include protecting the hydrology and water quality of the Huron River, and maintaining/restoring high quality flood plain forests by minimizing fragmentation and controlling the spread of invasive species. It is possible that additional sub-populations of this population may be located within the metroparks.

A known record for the state endangered red turtlehead was not relocated. However, the species may still be present in the site's thick undergrowth or seed bank. Including this record, there are only two known occurrences of this species in Michigan. The habitat of the known location in Dexter-Huron Metropark has become severely degraded by multiple invasive species including purple loosestrife, glossy buckthorn, common buckthorn, and garlic mustard. Eradicating the invasive species at the site will improve conditions for red turtlehead if it still exists. It is recommend that surveys for the species be conducted in September when it is in flower.

Due to these parks close proximity to organizations with an interest in rare species, such as the University of Michigan and the Michigan Natural Areas Association, they have long been searched by botanists with considerable expertise. For this reason, and the fact that some of the natural communities in these parks have been exposed to fragmentation and degradation, it is unlikely that a large number of additional rare plants will be discovered. However, the documentation of additional species, especially in a large park like Stony Creek, is very possible. If efforts to restore natural communities and ecological processes (e.g., prescribed fire) are undertaken, the prospects for finding additional rare species will increase.

**Fire as an Ecological Process**

The vast majority of area within the metroparks we surveyed once supported fire-dependent ecosystems such as wet prairies, wet meadows, prairie fens, oak barrens, and oak forests. In the past, lightening- and human-induced fires frequently spread over large areas of southern Michigan and other Midwestern states (Curtis 1959, Grimm 1984, Dorney 1981). Large rivers such as the Huron River sometimes acted as local fire-breaks, accounting for differences in vegetation types on opposite sides of a river (Gleason 1913, Curtis 1959, Dorney 1981). This can be seen at Delhi where several large oxbows of the Huron River separate oak barrens from oak-hickory forest (Figure 4). Similarly, at Dexter-Huron and Hudson Mills the Huron River and its associated flood plain forest (e.g., mixed hardwood swamp) separate oak barrens from oak hickory forest and oak barrens from mixed oak forest (Figure 4). In the absence of frequent fires, open oak barrens convert to forested communities such as oak-hickory forest or mixed oak forest (see oak barrens abstract, Appendix 5)). The reduction of wildfires in Midwestern states following the loss of indigenous cultures in the early 1800's is well documented and resulted in a loss of fire-dependent natural communities through both active conversion for farming and succession from open barrens and prairie to forest (Curtis 1959).

The conversion of open barrens and prairie to forested communities continues today and often results in a loss of species and habitat diversity (Curtis 1959, McCune and Cottam 1985, McClain et al. 1993). This was evident at many of the sites we surveyed in each of the metroparks. At Stony Creek, wet prairie, wet meadow, prairie fen, and small openings within dry-mesic southern forest were all actively succeeding to shrub- and tree-dominated communities. As a result, both species diversity and habitat heterogeneity are being reduced. Similar changes are occurring at the Huron River metroparks (Delhi, Dexter-Huron, and Hudson Mills) where dry-mesic prairie and wet-mesic prairie are being invaded by woody species and oak barrens is succeeding to oak forest. As light levels are reduced because of woody species encroachment and canopy closure, light-demanding species such as prairie forbs and grasses are unable to remain viable and are lost. Some of the biggest changes as a result of canopy closure may be taking place within the oak forests. At present, oaks dominate the canopies of dry-mesic southern forests at Stony Creek, Dexter-Huron, and Hudson Mills. However, oak regeneration within these forests is absent and shade-tolerant species such as red maple are common within the forest understory. In the absence of active management such as prescribed fire or tree thinning, these forested communities are likely to convert to red maple domination as the oaks slowly senesce.

The proliferation of red maple within the oak forests also results in significant changes in adjacent wetland communities. For example, at Hudson Mills red maple has become established within a dry-mesic southern forest that borders a high quality relict conifer swamp and has begun to invade the relict conifer swamp. Species loss following invasion of relict conifer swamp by red maple can be significant. The shift from conifer-dominance to hardwood-dominance also results in a drastic reduction in shrub cover (Kost 2001). Because many animal species rely of the fruit of these wetland shrubs during fall migration and winter, the reduction of shrub cover that results from red maple invasion can adversely impact a wide range of both animal and plant species. The hardwood-conifer swamp at Stony Creek is experiencing similar changes with many dead, standing, and severely shade-pruned conifers occurring under the dense hardwood-canopy.

In the past, fires prevented thin-barked red maples from establishing in oak forests (Abrams 1998). Today, active management such as prescription burning or selective harvesting will be needed to maintain and regenerate the oaks. Maintaining functioning oak and prairie ecosystems will also help protect adjacent wetland conifer forests.

Plant communities benefit from prescribed fire in several ways. Depending on the season and intensity of a burn, prescribed fire may be used to decrease the cover of exotic, cool-season grasses and woody species, and increase the cover of warm-season grasses and native forbs (White 1983, Abrams and Hulbert 1987, Tester 1989, Anderson and Schwegman 1991, Collins and Gibson 1990, Glenn-Lewin et al. 1990). Prescribed fire helps reduce litter levels, allowing sunlight to reach the soil surface and stimulate seed germination and enhance seedling establishment (Daubenmire 1968, Hulbert 1969, Knapp 1984, Tester 1989, Anderson and Schwegman 1991, Warners 1997). Important plant nutrients (e.g., N, P, K, Ca, and Mg) are elevated following prescribed fire (Daubenmire 1968, Viro 1974, Reich et al. 1990, Schmalzer and Hinkle 1992). Prescribed fire has been shown to result in increased plant biomass, flowering, and seed production (Laubhan 1995, Abrams et al 1986, Warners 1997, Kost and De Steven 2000). Prescribed fire can also help express and rejuvenate seed banks, which may be especially important for maintaining species diversity (Leach and Givnish 1996, Kost and De Steven 2000).

**Invasive Species**

Invasive species also pose a major threat to species and habitat diversity within the metroparks. While numerous invasive species occur within the metroparks, garlic mustard, glossy buckthorn, and purple loosestrife are likely to pose the greatest threat because of the intact nature of the communities in which they occur and their ability to quickly dominate an area. Information on methods of controlling invasive species and invasive species abstracts can be obtained at http://tncweeds.ucdavis.edu/.

Garlic mustard threatens to significantly reduce species diversity in the forested communities, especially the mesic and wet sites (Meekins and McCarthy 2001) such as the Huron River floodplain communities and the three high quality communities at Stony Creek (e.g., Stony Creek Cedar Swamp and Stony Creek Wet-Mesic Forest, which contains both a high quality southern swamp and mesic southern forest). While overall species reductions are alarming, the loss of a population of rare plants from a site can significantly reduce the long-term viability for a species. For example, at Dexter-Huron, a population of red turtlehead originally found in 1904 and reconfirmed in 1981 could not be relocated. If this species is not reconfirmed at the site, only one population of red turtle will remain in the state. The site where it was last seen is now infested with garlic mustard, glossy buckthorn, common buckthorn, and purple loosestrife. Information about garlic mustard biology and control is available at: http://tncweeds.ucdavis.edu/esadocs/allipeti.html.

Glossy buckthorn can severely reduce species diversity, especially in alkaline, wetland habitats. The species occurs within several sites such as 31 Mile Lake Wetland and Stony Creek Wetland at Stony Creek, and the high quality, Hudson Mills Wet Mesic Prairie. While glossy buckthorn may be difficult to control at the Stony Creek sites because of the level of infestation, the species appears to be easily eradicated from the Hudson Mills Wet-Mesic Prairie at the present time. Because the species thrives in alkaline wetlands, the high quality Hudson Mills Tamarack Swamp should be monitored for glossy buckthorn and if found eradicated. Information about glossy buckthorn biology and control is available at: http://tncweeds.ucdavis.edu/esadocs/franalnu.html.

Purple loosestrife also occurs within the high quality, Hudson Mills Wet Mesic Prairie but is not presently widespread. Like glossy buckthorn, if left unmanaged this species has the potential to spread throughout the site and neighboring wetlands, significantly altering community structure and reducing diversity. Purple loosestrife also occurs in a wet meadow within the Dexter-Huron Oxbow Prairie and the Gravel Mine Wet-Mesic Prairie at Stony Creek. The level of purple loosestrife invasion at each of these sites is minimal at the present time, affording managers the opportunity to make significant progress in biodiversity protection by removing purple loosestrife with minimal costs. Information about purple loosestrife biology and control is available at: http://tncweeds.ucdavis.edu/esadocs/lythsali.html.

**Deer Densities**

Many studies have shown high deer densities to adversely impact local ecosystems and vegetation (Alverson et al. 1988, Balgooyen and Waller 1995, Waller and Alverson 1997). Heavy deer browse was evident throughout the metroparks and appears to be contributing to a lack of white cedar regeneration within the Stony Creek Cedar Swamp and to be negatively impacting seed production in Jack in the pulpit within the Sheldon Wet-Mesic Forest. The absence of common trillium (*Trillium grandiflora*), a common mesic forest plant, from the Sheldon Wet-Mesic Forest may also be a sign that deer densities within the metropark are too high. Deer herbivory may also be contributing to the lack of oak regeneration within the metroparks' oak forests. Through preferential grazing of native species, high deer densities are also thought to contribute to the spread of invasive, exotic species such as garlic mustard (Victoria Nuzzo pers. comm. 1998). It is recommended that the Huron-Clinton Metropolitan Authority work cooperatively with the Michigan Department of Natural Resources to assess deer densities and to reduce deer numbers if determined to threaten the ecological integrity of metropark natural communities.

## Conclusion

The Huron-Clinton Metropolitan Authority owns a significant portion of the Huron River floodplain forest in Washtenaw County. Multiple rare plant species are associated with floodplain forests in southern Michigan. Four of these rare species have been documented within metroparks we surveyed. Because floodplain forests provide habitat for many rare species, controlling the spread of invasive species within these areas will contribute significantly to biodiversity protection in southern Michigan.

In addition to the floodplain forests, the metroparks contain some of the few remaining prairie and oak barrens remnants. Though small in total acreage, these areas contribute significantly to the region's biodiversity by harboring species found in few other places and by adding to the diversity of ecosystems occurring in southern Michigan. With active management such as prescription burning, invasive species control, and woody species removal, these communities will continue to contribute significantly to the region's biodiversity in the future.

Another important group of natural communities are the conifer swamps. The conifer swamps at Stony Creek and Hudson Mills contribute significantly to the region's biodiversity by providing a unique set of habitat conditions that help sustain a wide variety of species during critical periods like fall migration and winter. Finding ways to maintain the conifer components of these ecosystems is critical. Reducing deer densities at the metroparks may help facilitate conifer regeneration, especially at Stony Creek. Reducing hardwood dominance, especially red maple, through thinning or girdling accompanied by herbicide application to control root sprouting may also help in maintaining the conifers at these sites.

The metroparks support a diverse set of rare species and high quality natural communities. They also harbor a wide variety of natural communities that will be significantly improved with active management. In the future, the metroparks will play an increasingly greater role in providing habitat for rare species and natural communities in southern Michigan. Identifying the presence of rare species and high quality natural areas within the metroparks will enable land mangers to protect these natural features and provide naturalists with critical information for educating the public about the importance of rare species, biodiversity, and land stewardship.

### Acknowledgements

Funding for the project was provided by the Huron-Clinton Metropolitan Authority and the Michigan Department of Natural Resources. We are grateful to Paul Muelle and Dave Moilanen, HCMA, for their support and assistance throughout the project. We thank Roger Bajorek, HCMA Naturalist, for providing valuable natural history information on Stony Creek Metropark. We thank Dr. Tony Reznicek, University of Michigan Herbarium, for assisting with rare species identification. A sincere thanks is extended to the following MNFI staff: Helen Enander produced all maps contained in this report; Josh Cohen and Claire Romanski assisted with field inventories, Mike Penskar and Phyllis Higman assisted with plant identification, Dennis Albert helped edit this report, and Michael Fashoway formatted the report.

## Literature Cited


Abrams, M.D. 1998. The red maple paradox: What explains the widespread expansion of red maple in eastern forests? BioScience 48: 355-363.

Albert, D.A. 1995. Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification. North Central Forest Experiment Station, Forest Service – U.S. Department of Agriculture. St. Paul, MN.

Alverson, W.S., D.M. Waller and S.L. Solheim. 1988. Forest too deer: Edge effects in northern Wisconsin. Conservation Biology 2: 348-358.

Abrams, M. D., A. K. Knapp and L. C. Hulbert. 1986. A ten year record of aboveground biomass in a Kansas tallgrass prairie: effects of fire and topographic position. American Journal of Botany 73: 1509-1515.

Abrams, M. D. and L. C. Hulbert. 1987. Effect of topographic position and fire on species composition in tallgrass prairie in northeast Kansas. The American Midland Naturalist 117: 442-445.

Anderson, R. C. and J. E. Schwegman. 1991. Twenty years of vegetational change on a Southern Illinois barren. Natural Areas Journal 11: 100-107.

Balgooyen, C.P. and D.M. Waller. 1995. The use of Clintonia borealis and other indicators to gauge impacts of white-tailed deer on plant in communities in northern Wisconsin, USA. Natural Areas Journal 15: 308-318.

Collins, S. L. and D. J. Gibson. 1990. Effects of fire on community structure in tallgrass and mixed grass prairie. Pp. 81-98 in S. L. Collins and L. L. Wallace (eds.), Fire in North American tallgrass prairies, University of Oklahoma Press, Norman, OK.

Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Corner and D.W. Schuen. 1995. Michigan's presettlement vegetation, as interpreted from the General Land Office Surveys 1816-1856. Michigan Natural Features Inventory, Lansing, MI. Digital Map.

Curtis, J.T. 1959. Vegetation of Wisconsin. The University of Wisconsin Press, Madison, WI.

Daubenmire, R. 1968. Ecology of Fire in Grasslands. Advances in Ecological Research 5: 209-66.

Dorney, J.R. 1981. The impact of Native Americans on presettlement vegetation in Southeastern Wisconsin. Transactions of the Wisconsin Academy of Science, Arts, and Letters. 69: 26-36.

Farrand, W.R., and D.L. Bell. 1982. Quaternary geology of southern Michigan. Dept. of Geological Sciences, The University of Michigan, Ann Arbor, MI. Map.

Gleason, H.A. 1913. The relation of forest distribution and prairie fires in the Middle West. Torreya. 13: 173-179.

Glenn-Lewin, D. C., L. A. Johnson, T W. Jurik, A. Akey, M. Leoschke, and T. Rosberg. 1990. Fire in central North American grasslands: vegetative reproduction, seed germination, and seedling establishment. Pp. 28-45 in S. L. Collins and L. L. Wallace (eds.), Fire in North American tallgrass prairies, University of Oklahoma Press, Norman, OK.

Grimm, E. C. 1984. Fire and other factors controlling the big woods vegetation of Minnesota in the mid-nineteenth century. Ecological Monographs 54: 291-311.

Herman, K.D., L.A. Masters, M.R. Penskar, A.A. Reznicek, G.S. Wilhelm, W.W. Brodowicz, and K.P. Gardiner. 2001. Floristic quality assessment with wetland categories and computer application programs for the state of Michigan. Michigan Dept. of Natural Resources, Wildlife Division, Natural Heritage Program. Lansing, MI.

Hulbert, L.C. 1969. Fire and litter effects in undisturbed bluestem prairie in Kansas. Ecology 50: 874-877.

Kost, M.A. and D. De Steven. 2000. Plant community responses to prescribed burning in Wisconsin sedge meadows. Natural Areas Journal 20:36-49.

Kost, M.A. 2001. Potential indicators for assessing biological integrity of forested, depressional wetlands in southern Michigan. Michigan Natural Features Inventory, Lansing, MI. 69 pp.

Knapp, A. K. 1984. Post-burn differences in solar radiation, leaf temperature and water stress influencing production in a lowland tallgrass prairie. American Journal of Botany 71: 220-227.

Laubhan, M. K. 1995. Effects of prescribed fire on moist-soil vegetation and macronutrients. Wetlands 15:159-166.

Leach, M.K. and T.J. Givnish. 1996. Ecological determinants of species loss in remnant prairies. Science 273: 1555-1558.

McClain, W. E., M. A. Jenkins, S. E. Jenkins, and J. E. Ebinger. 1993. Changes in the woody vegetation of a bur oak savanna remnant in central Illinois. Natural Areas Journal 13:108-114.

McCune, B. and G. Cottam. 1985. The successional status of a southern Wisconsin oak woods. Ecology 66:1270-1278.

McGowan-Stinski, J. 1999. The Nature Conservancy, Michigan Chapter, East Lansing, MI.

Meekins, F.J. and B.C. McCarthy. 2001. Effect of environmental variation on the invasive success of a nonindigenous forest herb. Ecological Applications 11: 1336-1348.

Nuzzo, V. 1998. Natural Area Consultants, Groton, NY.

Reich, P. B. and M. D. Abrams et. al. 1990. Fire affects ecophysiology and community dynamics of Central Wisconsin oak forest regeneration. Ecology 71: 2179-2190.

Reinartz, J.A. 1997. Controlling Glossy buckthorn (Rhamnus frangula L.) with winter herbicide treatments of cut stumps. Natural Areas Journal 17: 38-41.

Schmalzer, P. A. and C. R. Hinkle. 1992. Soil dynamics following fire in Juncus and Spartina marshes. Wetlands 12: 8-21.

Tester, J. R. 1989. Effects of fire frequency on oak savanna in east-central Minnesota. Bulletin of the Torrey Botanical Club 116: 134-144.

Viro, P. J. 1974. Effects of forest fire on soil. Pp. 7-45 in T. T. Kozlowski and C. E. Ahlgren (eds.), Fire and Ecosystems, Academic Press, New York, NY.

Waller, D.M. and W.S. Alverson. 1997. The white-tailed deer: a keystone herbivore. Wildlife Society Bulletin 25: 217-226.

Warners, D. P. 1997. Plant diversity in sedge meadows: effects of groundwater and fire. Ph.D. dissertation, University of Michigan, Ann Arbor, MI. 231 pp.

White, A. S. 1983. The effects of thirteen years of annual prescribed burning on a Quercus ellipsoidalis community in Minnesota. Ecology 64: 1081-1085.

**Appendix 1.** Plant species observed at Delhi Metro Park. "X" indicates the species occurred within the site. "-" indicates species was not observed at the site. Capitalized scientific names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "C" is the Coefficient of Conservation for each species (Herman et al. 2001).

| | | | Site Name | Delhi Park Interior | Delhi Railroad Prairie | Delhi Floodplain Forest |
|---|---|---|---|---|---|---|
| | | | Sited Code | A | B | C |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | |
| Acer negundo | BOX ELDER | Nt Tree | 0 | - | x | - |
| Acer saccharinum | SILVER MAPLE | Nt Tree | 2 | - | - | x |
| AGROPYRON REPENS | QUACK GRASS | Ad P-Grass | 0 | - | x | - |
| ALLIARIA PETIOLATA | GARLIC MUSTARD | Ad B-Forb | 0 | x | - | x |
| Andropogon gerardii | BIG BLUESTEM | Nt P-Grass | 5 | x | x | - |
| Andropogon scoparius | LITTLE BLUESTEM GRASS | Nt P-Grass | 5 | - | x | - |
| ARCTIUM MINUS | COMMON BURDOCK | Ad B-Forb | 0 | x | - | - |
| Arisaema triphyllum | JACK IN THE PULPIT | Nt P-Forb | 5 | - | - | x |
| Asarum canadense | WILD GINGER | Nt P-Forb | 5 | - | - | x |
| Asclepias syriaca | COMMON MILKWEED | Nt P-Forb | 1 | - | x | - |
| Asclepias tuberosa | BUTTERFLY WEED | Nt P-Forb | 5 | - | x | - |
| Asclepias verticillata | WHORLED MILKWEED | Nt P-Forb | 1 | - | x | - |
| Aster lanceolatus | EASTERN LINED ASTER | Nt P-Forb | 2 | - | - | x |
| BERBERIS VULGARIS | COMMON BARBERRY | Ad Shrub | 0 | - | - | x |
| Botrychium virginianum | RATTLESNAKE FERN | Nt Fern | 5 | - | - | x |
| BROMUS INERMIS | SMOOTH BROME | Ad P-Grass | 0 | x | x | - |
| CARDAMINE IMPATIENS | BITTER CRESS | Ad A-Forb | 0 | - | - | x |
| Carex pensylvanica | SEDGE | Nt P-Sedge | 4 | - | x | - |
| Carex stipata | SEDGE | Nt P-Sedge | 1 | - | - | x |
| Carex stricta | SEDGE | Nt P-Sedge | 4 | - | - | x |
| CENTAUREA MACULOSA | SPOTTED KNAPWEED | Ad B-Forb | 0 | - | x | - |
| CHRYSANTHEMUM LEUCANTHEMUM | OX EYE DAISY | Ad P-Forb | 0 | - | x | - |
| Cicuta maculata | WATER HEMLOCK | Nt B-Forb | 4 | - | - | x |
| Cinna arundinacea | WOOD REEDGRASS | Nt P-Grass | 7 | - | - | x |
| CIRSIUM ARVENSE | CANADIAN THISTLE | Ad P-Forb | 0 | - | x | - |
| Coptis trifolia | GOLDTHREAD | Nt P-Forb | 5 | - | - | x |
| Cornus alternifolia | ALTERNATE LEAVED | Nt Tree | 5 | - | - | x |

**Appendix 1.** continued

| | | | Site Name | Delhi Park Interior | Delhi Railroad Prairie | Delhi Floodplain Forest |
|---|---|---|---|---|---|---|
| | | | **Sited Code** | **A** | **B** | **C** |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | |
| Cornus foemina | GRAY DOGWOOD | Nt Shrub | 1 | - | x | - |
| Corylus americana | HAZELNUT | Nt Shrub | 5 | - | x | - |
| DACTYLIS GLOMERATA | ORCHARD GRASS | Ad P-Grass | 0 | x | - | - |
| DAUCUS CAROTA | QUEEN ANNE'S LACE | Ad B-Forb | 0 | - | x | - |
| Desmodium sp. | TICK-TREFOIL | Nt P-Forb | | x | - | - |
| ELAEAGNUS UMBELLATA | AUTUMN OLIVE | Ad Shrub | 0 | x | - | - |
| Erigeron sp. | FLEABANE | Nt B-Forb | | - | x | - |
| Eupatorium maculatum | JOE PYE WEED | Nt P-Forb | 4 | - | x | x |
| Euphorbia corollata | FLOWERING SPURGE | Nt P-Forb | 4 | - | x | - |
| Fragaria virginiana | WILD STRAWBERRY | Nt P-Forb | 2 | - | x | - |
| Fraxinus nigra | BLACK ASH | Nt Tree | 6 | - | - | x |
| Fraxinus pennsylvanica | RED ASH | Nt Tree | 2 | - | - | x |
| GALIUM MOLLUGO | WHITE BEDSTRAW | Ad P-Forb | 0 | - | - | x |
| Gleditsia triacanthos | HONEY LOCUST | Nt Tree | 8 | x | - | - |
| Glyceria striata | FOWL MANNA GRASS | Nt P-Grass | 4 | - | - | x |
| HESPERIS MATRONALIS | DAME'S ROCKET | Ad P-Forb | 0 | - | x | x |
| Hypericum punctatum | SPOTTED ST. JOHN'S WORT | Nt P-Forb | 4 | - | x | - |
| Iris virginica | SOUTHERN BLUE FLAG | Nt P-Forb | 5 | - | - | x |
| Juglans cinerea | BUTTERNUT | Nt Tree | 5 | - | - | x |
| Juglans nigra | BLACK WALNUT | Nt Tree | 5 | - | - | x |
| Juniperus virginiana | RED CEDAR | Nt Tree | 3 | - | x | - |
| Laportea canadensis | WOOD NETTLE | Nt P-Forb | 4 | - | - | x |
| LEONURUS CARDIACA | MOTHERWORT | Ad P-Forb | 0 | x | - | - |
| LONICERA MORROWII | MORROW HONEYSUCKLE | Ad Shrub | 0 | x | x | x |
| Lycopus americanus | COMMON WATER | Nt P-Forb | 2 | - | - | x |
| LYSIMACHIA NUMMULARIA | MONEYWORT | Ad P-Forb | 0 | - | - | - |
| MELILOTUS ALBA | WHITE SWEET CLOVER | Ad B-Forb | 0 | - | x | - |
| MELILOTUS OFFICINALIS | YELLOW SWEET CLOVER | Ad B-Forb | 0 | - | x | - |
| Mirabilis sp. | UMBRELLA-WORT | Ad P-Forb | 0 | x | - | - |
| Monarda fistulosa | WILD BERGAMOT | Nt P-Forb | 2 | - | x | - |
| MORUS ALBA | WHITE MULBERRY | Ad Tree | 0 | x | - | - |
| MYOSOTIS SCIRPOIDES | FORGET-ME-NOT | Ad P-Forb | 0 | - | - | x |

**Appendix 1.** continued

| | | | Site Name | Delhi Park Interior | Delhi Railroad Prairie | Delhi Floodplain Forest |
|---|---|---|---|---|---|---|
| | | | Sited Code | A | B | C |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | |
| Oenothera biennis | COMMON EVENING | Nt B-Forb | 2 | - | x | - |
| Opuntia humifusa | PRICKLY PEAR | Nt Shrub | 7 | - | x | - |
| Osmorhiza longistylis | SMOOTH SWEET CICELY | Nt P-Forb | 3 | - | - | x |
| Panicum capillare | WITCH GRASS | Nt A-Grass | 1 | - | x | - |
| Panicum virgatum | SWITCH GRASS | Nt P-Grass | 4 | - | x | - |
| Parthenocissus quinquefolia | VIRGINIA CREEPER | Nt W-Vine | 5 | - | - | x |
| Peltandra virginica | ARROW ARUM | Nt P-Forb | 6 | - | - | x |
| Phalaris arundinacea | REED CANARY GRASS | Nt P-Grass | 0 | - | - | x |
| Pilea pumila | CLEARWEED | Nt A-Forb | 5 | - | - | x |
| Pinus strobus | WHITE PINE | Nt Tree | 3 | x | - | - |
| PINUS SYLVESTRIS | SCOTCH PINE | Ad Tree | 0 | - | x | - |
| Poa palustris | FOWL MEADOW GRASS | Nt P-Grass | 3 | - | - | x |
| Podophyllum peltatum | MAY APPLE | Nt P-Forb | 3 | - | - | x |
| Polygonum amphibium | WATER SMARTWEED | Nt P-Forb | 6 | - | - | x |
| Populus tremuloides | QUAKING ASPEN | Nt Tree | 1 | - | x | - |
| Potentilla simplex | OLD FIELD CINQUEFOIL | Nt P-Forb | 2 | - | x | - |
| Ptelea trifoliata | HOP TREE | Nt Shrub | 4 | - | x | - |
| Pteridium aquilinum | BRACKEN FERN | Nt Fern | 0 | x | x | - |
| Quercus alba | WHITE OAK | Nt Tree | 5 | - | x | - |
| Quercus imbricaria | SHINGLE OAK | Nt Tree | 5 | - | x | - |
| RHAMNUS CATHARTICA | COMMON BUCKTHORN | Ad Tree | 0 | x | x | - |
| Rhus glabra | SMOOTH SUMAC | Nt Tree | 2 | - | x | - |
| Ribes sp. | GOOSEBERRY | Nt Shrub | | - | - | x |
| ROBINIA PSEUDOACACIA | BLACK LOCUST | Ad Tree | 0 | - | - | x |
| Rosa blanda | WILD ROSE | Nt Shrub | 3 | - | x | - |
| Rubus occidentalis | BLACK RASPBERRY | Nt Shrub | 1 | x | - | - |
| Rudbeckia hirta | BLACK EYED SUSAN | Nt P-Forb | 1 | - | x | - |
| Rudbeckia laciniata | CUT LEAVED CONEFLOWER | Nt P-Forb | 6 | - | - | x |
| Senecio aureus | GOLDEN RAGWORT | Nt P-Forb | 5 | - | - | x |
| Smilacina stellata | STARRY FALSE SOLOMON | Nt P-Forb | 5 | - | - | - |
| SOLANUM DULCAMARA | BITTERSWEET NIGHTSHADE | Ad P-Forb | 0 | x | - | - |
| Solidago altissima | TALL GOLDENROD | Nt P-Forb | 1 | - | x | - |

**Appendix 1.** continued

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | Site Name | Delhi Park Interior | Delhi Railroad Prairie | Delhi Floodplain Forest |
| | | | Sited Code | A | B | C |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | |
| Solidago canadensis | CANADA GOLDENROD | Nt P-Forb | 1 | - | x | - |
| Solidago gigantea | LATE GOLDENROD | Nt P-Forb | 3 | - | x | - |
| Solidago juncea | EARLY GOLDENROD | Nt P-Forb | 3 | - | x | - |
| Solidago nemoralis | OLD FIELD GOLDENROD | Nt P-Forb | 2 | - | x | - |
| Solidago rigida | STIFF GOLDENROD | Nt P-Forb | 5 | - | x | - |
| Sorghastrum nutans | INDIAN GRASS | Nt P-Grass | 6 | - | x | - |
| SPOROBOLUS ASPER | ROUGH DROPSEED | Ad P-Grass | 0 | - | x | - |
| Symplocarpus foetidus | SKUNK CABBAGE | Nt P-Forb | 6 | - | - | x |
| Thalictrum dasycarpum | PURPLE MEADOW RUE | Nt P-Forb | 3 | - | - | x |
| Tilia americana | BASSWOOD | Nt Tree | 5 | - | - | x |
| Toxicodendron radicans | POISON IVY | Nt W-Vine | 2 | - | - | x |
| Tradescantia ohiensis | COMMON SPIDERWORT | Nt P-Forb | 5 | - | x | - |
| TRAGOPOGON DUBIUS | GOAT'S BEARD | Ad B-Forb | 0 | - | x | - |
| Typha latifolia | BROAD LEAVED CATTAIL | Nt P-Forb | 1 | - | - | x |
| Ulmus americana | AMERICAN ELM | Nt Tree | 1 | - | - | x |
| ULMUS PUMILA | SIBERIAN ELM | Ad Tree | 0 | - | x | - |
| VERBASCUM THAPSUS | COMMON MULLEIN | Ad B-Forb | 0 | - | x | - |
| Viburnum lentago | NANNYBERRY | Nt Shrub | 4 | - | - | x |
| VINCETOXICUM NIGRUM | BLACK SWALLOW WORT | Ad P-Forb | 0 | x | x | - |
| Vitis riparia | RIVERBANK GRAPE | Nt W-Vine | 3 | - | - | x |
| **Total number of species observed in sampled areas** | | | | **18** | **54** | **47** |
| **Total number of species observed in Delhi Metropark: 100** | | | | | | |

**Appendix 2.** Plant species observed at Dexter-Huron Metro Park. "X" indicates the species occurred within the site. "-" indicates species was not observed at the site. Capitalized scientific names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "C" is the Coefficient of Conservation for each species (Herman et al. 2001).

| | | | Site Name | Dexter Railroad Prairie | Huron Oxbow Prairie | Dexter Floodplain Forest | Dexter- Huron Floodplain Forest |
|---|---|---|---|---|---|---|---|
| | | | Site Code | D | F | E | G |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | |
| Acer negundo | BOX ELDER | Nt Tree | 0 | x | - | x | x |
| Acer rubrum | RED MAPLE | Nt Tree | 1 | - | - | x | - |
| Acer saccharinum | SILVER MAPLE | Nt Tree | 2 | - | - | x | x |
| Achillea millefolium | YARROW | Nt P-Forb | 1 | x | x | - | - |
| ALLIARIA PETIOLATA | GARLIC MUSTARD | Ad B-Forb | 0 | x | x | x | x |
| Amphicarpaea bracteata | HOG PEANUT | Nt A-Forb | 5 | - | x | x | - |
| Andropogon gerardii | BIG BLUESTEM | Nt P-Grass | 5 | x | x | - | - |
| Andropogon scoparius | LITTLE BLUESTEM GRASS | Nt P-Grass | 5 | x | x | - | - |
| Anemone cylindrica | THIMBLEWEED | Nt P-Forb | 6 | x | - | - | - |
| Anemone virginiana | THIMBLEWEED | Nt P-Forb | 3 | - | x | - | - |
| Apios americana | GROUNDNUT | Nt P-Forb | 3 | x | - | x | - |
| Apocynum androsaemifolium | SPREADING DOGBANE | Nt P-Forb | 3 | - | x | - | - |
| Apocynum cannabinum | INDIAN HEMP | Nt P-Forb | 3 | - | x | - | - |
| ARCTIUM MINUS | COMMON BURDOCK | Ad B-Forb | 0 | - | x | - | x |
| Arisaema triphyllum | JACK IN THE PULPIT | Nt P-Forb | 5 | x | - | x | - |
| Asarum canadense | WILD GINGER | Nt P-Forb | 5 | - | - | x | x |
| Asclepias syriaca | COMMON MILKWEED | Nt P-Forb | 1 | x | x | - | - |
| Asclepias tuberosa | BUTTERFLY WEED | Nt P-Forb | 5 | - | x | - | - |
| Aster laevis | SMOOTH ASTER | Nt P-Forb | 5 | - | x | - | - |
| Aster lanceolatus | EASTERN LINED ASTER | Nt P-Forb | 2 | - | - | x | - |
| Aster sagittifolius | ARROW LEAVED ASTER | Nt P-Forb | 2 | x | - | - | - |
| BERBERIS THUNBERGII | JAPANESE BARBERRY | Ad Shrub | 0 | - | - | x | x |
| Boehmeria cylindrica | FALSE NETTLE | Nt P-Forb | 5 | - | - | x | - |
| Botrychium virginianum | RATTLESNAKE FERN | Nt Fern | 5 | - | - | x | - |
| Calamagrostis canadensis | BLUE JOINT GRASS | Nt P-Grass | 3 | - | - | - | x |
| Carex pensylvanica | SEDGE | Nt P-Sedge | 4 | x | - | x | - |
| Carex rosea | CURLY STYLED WOOD SEDGE | Nt P-Sedge | 2 | x | - | - | - |
| Carpinus caroliniana | BLUE BEECH | Nt Tree | 6 | - | - | x | - |

**Appendix 2.** continued

| Scientific Name | Common name | Life Form | C | Dexter Railroad Prairie (D) | Huron Oxbow Prairie (F) | Dexter Floodplain Forest (E) | Dexter- Huron Floodplain Forest (G) |
|---|---|---|---|---|---|---|---|
| Carya glabra | PIGNUT HICKORY | Nt Tree | 5 | x | x | x | - |
| Carya ovata | SHAGBARK HICKORY | Nt Tree | 5 | - | x | x | - |
| Caulophyllum thalictroides | BLUE COHOSH | Nt P-Forb | 5 | - | - | x | - |
| Ceanothus americanus | NEW JERSEY TEA | Nt Shrub | 8 | x | - | - | - |
| CENTAUREA MACULOSA | SPOTTED BLUET | Ad B-Forb | 0 | x | - | - | - |
| Cephalanthus occidentalis | BUTTONBUSH | Nt Shrub | 7 | - | - | x | - |
| Cicuta maculata | WATER HEMLOCK | Nt B-Forb | 4 | - | - | x | x |
| Circaea lutetiana | ENCHANTER'S NIGHTSHADE | Nt P-Forb | 2 | - | - | - | x |
| CIRSIUM ARVENSE | CANADIAN THISTLE | Ad P-Forb | 0 | x | - | - | - |
| Clematis virginiana | VIRGIN'S BOWER | Nt W-Vine | 4 | - | - | - | x |
| Comandra umbellata | BASTARD TOADFLAX | Nt P-Forb | 5 | x | x | - | - |
| Cornus alternifolia | ALTERNATE LEAVED DOGWOOD | Nt Tree | 5 | - | - | - | x |
| Cornus amomum | SILKY DOGWOOD | Nt Shrub | 2 | x | - | - | - |
| Cornus foemina | GRAY DOGWOOD | Nt Shrub | 1 | x | x | x | - |
| Cornus stolonifera | RED OSIER DOGWOOD | Nt Shrub | 2 | - | - | x | - |
| Corylus americana | HAZELNUT | Nt Shrub | 5 | x | x | x | - |
| Crategus sp. | HAWTHORN | Nt Tree | | x | x | - | - |
| Desmodium canadense | SHOWY TICK TREFOIL | Nt P-Forb | 3 | x | - | - | - |
| Desmodium glutinosum | CLUSTERED LEAVED TICK TREFOIL | Nt P-Forb | 5 | x | - | - | - |
| Desmodium sp. | TICK TREFOIL | Nt P-Forb | | - | x | - | - |
| Dioscorea villosa | WILD YAM | Nt P-Forb | 4 | x | - | x | x |
| ECHINACEA PALLIDA | PALE CONEFLOWER | Ad P-Forb | 0 | x | - | - | - |
| ELAEAGNUS UMBELLATA | AUTUMN OLIVE | Ad Shrub | 0 | x | - | - | - |
| Equisetum arvense | COMMON HORSETAIL | Nt Fern Ally | 0 | - | - | x | - |
| Erigeron annuus | ANNUAL FLEABANE | Nt B-Forb | 0 | x | - | - | - |
| Euonymus atropurpurea | WAHOO; BURNING BUSH | Nt Shrub | 8 | - | - | x | - |
| Eupatorium maculatum | JOE PYE WEED | Nt P-Forb | 4 | - | x | x | - |
| Euphorbia corollata | FLOWERING SPURGE | Nt P-Forb | 4 | x | x | - | - |
| Euthamia graminifolia | GRASS LEAVED GOLDENROD | Nt P-Forb | 3 | - | x | - | - |
| Fragaria virginiana | WILD STRAWBERRY | Nt P-Forb | 2 | x | x | - | - |
| Fraxinus americana | WHITE ASH | Nt Tree | 5 | x | - | - | x |
| Fraxinus nigra | BLACK ASH | Nt Tree | 6 | - | - | x | x |

**Appendix 2.** continued

| | | | Site Name | Dexter Railroad Prairie | Huron Oxbow Prairie | Dexter Floodplain Forest | Dexter- Huron Floodplain Forest |
|---|---|---|---|---|---|---|---|
| | | | Site Code | D | F | E | G |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | |
| Fraxinus pennsylvanica | RED ASH | Nt Tree | 2 | - | - | x | x |
| Galium aparine | ANNUAL BEDSTRAW | Nt A-Forb | 0 | x | - | x | - |
| Galium asprellum | ROUGH BEDSTRAW | Nt P-Forb | 5 | x | - | - | - |
| GALIUM MOLLUGO | WHITE BEDSTRAW | Ad P-Forb | 0 | - | x | - | - |
| Geranium maculatum | WILD GERANIUM | Nt P-Forb | 4 | x | - | x | x |
| Geum canadense | WHITE AVENS | Nt P-Forb | 1 | x | - | x | x |
| GLECHOMA HEDERACEA | GROUND IVY | Ad P-Forb | 0 | - | - | x | - |
| Gleditsia triacanthos | HONEY LOCUST | Nt Tree | 8 | - | - | x | - |
| Glyceria striata | FOWL MANNA GRASS | Nt P-Grass | 4 | - | - | x | x |
| Hamamelis virginiana | WITCH HAZEL | Nt Shrub | 5 | x | - | x | - |
| Helianthus tuberosus | JERUSALEM ARTICHOKE | Nt P-Forb | 6 | - | x | x | - |
| HEMEROCALLIS FULVA | ORANGE DAY LILY | Ad P-Forb | 0 | - | x | - | x |
| Hepatica americana | ROUND LOBED HEPATICA | Nt P-Forb | 6 | x | - | - | - |
| HESPERIS MATRONALIS | DAME'S ROCKET | Ad P-Forb | 0 | x | - | x | - |
| Hieracium sp. | HAWK WEED | Ad P-Forb | 0 | - | x | - | - |
| HYPERICUM PERFORATUM | COMMON ST. JOHN'S WORT | Ad P-Forb | 0 | - | - | - | - |
| Hypericum punctatum | SPOTTED ST. JOHN'S WORT | Nt P-Forb | 4 | - | - | - | - |
| HYPERICUM PERFORATUM | COMMON ST. JOHN'S WORT | Ad P-Forb | 0 | x | - | - | - |
| Impatiens capensis | SPOTTED TOUCH ME NOT | Nt A-Forb | 2 | - | - | x | x |
| Iris virginica | SOUTHERN BLUE FLAG | Nt P-Forb | 5 | - | - | x | - |
| Juglans cinerea | BUTTERNUT | Nt Tree | 5 | - | - | x | - |
| Juglans nigra | BLACK WALNUT | Nt Tree | 5 | x | - | x | - |
| Laportea canadensis | WOOD NETTLE | Nt P-Forb | 4 | - | - | x | x |
| Lathyrus palustris | MARSH PEA | Nt P-Forb | 7 | - | x | - | - |
| Leersia virginica | WHITE GRASS | Nt P-Grass | 5 | - | - | x | - |
| LEONURUS CARDIACA | MOTHERWORT | Ad P-Forb | 0 | - | - | - | x |
| Lespedeza capitata | ROUND HEADED BUSH CLOVER | Nt P-Forb | 5 | x | - | - | - |
| Liatris aspera | ROUGH BLAZING STAR | Nt P-Forb | 4 | x | - | - | - |
| LINARIA VULGARIS | BUTTER AND EGGS | Ad P-Forb | 0 | x | x | - | - |
| Liriodendron tulipifera | TULIP TREE | Nt Tree | 9 | - | - | - | x |
| Lobelia cardinalis | CARDINAL FLOWER | Nt P-Forb | 7 | - | - | x | - |
| Lobelia spicata | PALE SPIKED LOBELIA | Nt P-Forb | 4 | - | x | - | - |

**Appendix 2.** continued

| Scientific Name | Common name | Life Form | C | Dexter Railroad Prairie (D) | Huron Oxbow Prairie (F) | Dexter Floodplain Forest (E) | Dexter- Huron Floodplain Forest (G) |
|---|---|---|---|---|---|---|---|
| LONICERA MORROWII | MORROW HONEYSUCKLE | Ad Shrub | 0 | x | x | - | x |
| Lysimachia ciliata | FRINGED LOOSESTRIFE | Nt P-Forb | 4 | - | - | x | - |
| LYSIMACHIA NUMMULARIA | MONEYWORT | Ad P-Forb | 0 | - | - | x | - |
| LYTHRUM SALICARIA | PURPLE LOOSESTRIFE | Ad P-Forb | 0 | - | x | - | x |
| MELILOTUS ALBA | WHITE SWEET CLOVER | Ad B-Forb | 0 | x | x | - | - |
| Menispermum canadense | MOONSEED | Nt W-Vine | 5 | - | - | x | - |
| MENTHA XVILLOSA | MINT | Ad P-Forb | 0 | - | x | - | - |
| Monarda fistulosa | WILD BERGAMOT | Nt P-Forb | 2 | x | x | - | - |
| Onoclea sensibilis | SENSITIVE FERN | Nt Fern | 2 | - | - | x | - |
| Panicum leibergii | LEIBERG'S PANIC GRASS | Nt P-Grass | 10 | x | - | - | - |
| Parthenocissus quinquefolia | VIRGINIA CREEPER | Nt W-Vine | 5 | - | - | x | - |
| Peltandra virginica | ARROW ARUM | Nt P-Forb | 6 | - | - | x | - |
| Penstemon hirsutus | HAIRY BEARD TONGUE | Nt P-Forb | 5 | - | x | - | - |
| Phalaris arundinacea | REED CANARY GRASS | Nt P-Grass | 0 | - | x | x | - |
| Phlox pilosa | PRAIRIE PHLOX | Nt P-Forb | 7 | x | - | - | - |
| Platanus occidentalis | SYCAMORE | Nt Tree | 7 | - | - | - | x |
| POA COMPRESSA | CANADA BLUEGRASS | Ad P-Grass | 0 | x | x | - | - |
| POA PRATENSIS | KENTUCKY BLUEGRASS | Ad P-Grass | 0 | x | x | - | - |
| Podophyllum peltatum | MAY APPLE | Nt P-Forb | 3 | - | - | x | x |
| Polygonatum biflorum | SOLOMON SEAL | Nt P-Forb | 4 | - | - | - | - |
| Polygonatum pubescens | DOWNY SOLOMON SEAL | Nt P-Forb | 5 | x | - | - | - |
| Polygonum virginianum | JUMPSEED | Nt P-Forb | 4 | - | - | x | - |
| Populus deltoides | COTTONWOOD | Nt Tree | 1 | - | - | x | x |
| Populus heterophylla | SWAMP COTTONWOOD | Nt Tree | 10 | - | - | - | x |
| Populus tremuloides | QUAKING ASPEN | Nt Tree | 1 | - | x | - | - |
| POTENTILLA ARGENTEA | SILVERY CINQUEFOIL | Ad P-Forb | 0 | - | x | - | - |
| POTENTILLA RECTA | ROUGH FRUITED CINQUEFOIL | Ad P-Forb | 0 | - | x | - | - |
| Potentilla simplex | OLD FIELD CINQUEFOIL | Nt P-Forb | 2 | x | - | - | - |
| Prenanthes alba | WHITE LETTUCE | Nt P-Forb | 5 | x | - | - | - |
| Prunus serotina | WILD BLACK CHERRY | Nt Tree | 2 | - | x | x | x |
| Prunus virginiana | CHOKE CHERRY | Nt Shrub | 2 | x | - | - | - |
| Ptelea trifoliata | HOP TREE | Nt Shrub | 4 | x | - | - | - |

**Appendix 2.** continued

| | | | Site Name | Dexter Railroad Prairie | Huron Oxbow Prairie | Dexter Floodplain Forest | Dexter- Huron Floodplain Forest |
|---|---|---|---|---|---|---|---|
| | | | Site Code | D | F | E | G |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | |
| Pteridium aquilinum | BRACKEN FERN | Nt Fern | 0 | x | - | - | - |
| Pycnanthemum virginianum | COMMON MOUNTAIN MINT | Nt P-Forb | 5 | - | x | - | - |
| Quercus alba | WHITE OAK | Nt Tree | 5 | x | - | x | - |
| Quercus bicolor | SWAMP WHITE OAK | Nt Tree | 8 | - | x | x | x |
| Quercus macrocarpa | BUR OAK | Nt Tree | 5 | x | x | x | - |
| Quercus muehlenbergii | CHINQUAPIN OAK | Nt Tree | 5 | - | x | - | - |
| Quercus prinoides | DWARF CHINQUAPIN OAK | Nt Tree | 7 | - | x | - | - |
| Quercus rubra | RED OAK | Nt Tree | 5 | - | x | x | - |
| Quercus velutina | BLACK OAK | Nt Tree | 6 | x | x | x | - |
| RHAMNUS CATHARTICA | COMMON BUCKTHORN | Ad Tree | 0 | - | x | x | x |
| RHAMNUS FRANGULA | GLOSSY BUCKTHORN | Ad Shrub | 0 | - | - | - | x |
| Rhus glabra | SMOOTH SUMAC | Nt Tree | 2 | x | x | - | - |
| Ribes cynosbati | PRICKLY or WILD GOOSEBERRY | Nt Shrub | 4 | - | - | x | - |
| Rosa blanda | WILD ROSE | Nt Shrub | 3 | - | x | - | - |
| Rosa carolina | PASTURE ROSE | Nt Shrub | 4 | x | - | - | - |
| ROSA MULTIFLORA | MULTIFLORA ROSE | Ad Shrub | 0 | - | x | x | x |
| Rubus allegheniensis | COMMON BLACKBERRY | Nt Shrub | 1 | - | - | x | - |
| Rubus occidentalis | BLACK RASPBERRY | Nt Shrub | 1 | - | - | x | - |
| Rudbeckia hirta | BLACK EYED SUSAN | Nt P-Forb | 1 | - | x | - | - |
| Rudbeckia laciniata | CUT LEAVED CONEFLOWER | Nt P-Forb | 6 | - | - | x | x |
| Sambucus canadensis | ELDERBERRY | Nt Shrub | 3 | - | x | x | x |
| Sassafras albidum | SASSAFRAS | Nt Tree | 5 | - | - | x | - |
| Saururus cernuus | LIZARD'S TAIL | Nt P-Forb | 9 | - | - | x | - |
| Scirpus cyperinus | WOOL GRASS | Nt P-Sedge | 5 | - | x | - | - |
| Scutellaria lateriflora | MAD DOG SKULLCAP | Nt P-Forb | 5 | - | - | x | x |
| Senecio aureus | GOLDEN RAGWORT | Nt P-Forb | 5 | - | - | - | x |
| Silphium terebinthinaceum | PRAIRIE DOCK | Nt P-Forb | 6 | - | x | - | - |
| Sium suave | WATER PARSNIP | Nt P-Forb | 5 | - | - | x | - |
| Smilacina racemosa | FALSE SPIKENARD | Nt P-Forb | 5 | - | - | x | x |
| Smilacina stellata | STARRY FALSE SOLOMON SEAL | Nt P-Forb | 5 | x | x | - | x |
| Smilacina trifolia | FALSE MAYFLOWER | Nt P-Forb | 10 | - | - | x | - |
| Solidago canadensis | CANADA GOLDENROD | Nt P-Forb | 1 | x | x | - | - |

**Appendix 2.** continued

| Scientific Name | Common name | Life Form | C | D | F | E | G |
|---|---|---|---|---|---|---|---|
| | | | Site Name | **Dexter Railroad Prairie** | **Huron Oxbow Prairie** | **Dexter Floodplain Forest** | **Dexter- Huron Floodplain Forest** |
| | | | Site Code | **D** | **F** | **E** | **G** |
| Solidago gigantea | LATE GOLDENROD | Nt P-Forb | 3 | - | - | x | - |
| Solidago juncea | EARLY GOLDENROD | Nt P-Forb | 3 | x | x | - | - |
| Solidago rigida | STIFF GOLDENROD | Nt P-Forb | 5 | x | x | - | - |
| Solidago speciosa | SHOWY GOLDENROD | Nt P-Forb | 5 | - | x | - | - |
| Sorghastrum nutans | INDIAN GRASS | Nt P-Grass | 6 | x | x | - | - |
| Spiranthes cernua | NODDING LADIES' TRESSES | Nt P-Forb | 4 | - | x | - | - |
| Staphylea trifolia | BLADDERNUT | Nt Shrub | 9 | - | - | x | x |
| Stipa spartea | PORCUPINE GRASS | Nt P-Grass | 10 | - | x | - | - |
| Symplocarpus foetidus | SKUNK CABBAGE | Nt P-Forb | 6 | - | - | x | x |
| Thalictrum dasycarpum | PURPLE MEADOW RUE | Nt P-Forb | 3 | - | - | x | x |
| Tilia americana | BASSWOOD | Nt Tree | 5 | - | - | x | x |
| Toxicodendron radicans | POISON IVY | Nt W-Vine | 2 | x | - | x | x |
| Tradescantia ohiensis | COMMON SPIDERWORT | Nt P-Forb | 5 | x | - | - | - |
| TRAGOPOGON DUBIUS | GOAT'S BEARD | Ad B-Forb | 0 | x | - | - | - |
| Triosteum aurantiacum | HORSE GENTIAN | Nt P-Forb | 5 | - | x | - | - |
| Typha latifolia | BROAD LEAVED CATTAIL | Nt P-Forb | 1 | - | x | x | - |
| Ulmus americana | AMERICAN ELM | Nt Tree | 1 | - | - | x | x |
| Urtica dioica | NETTLE | Nt P-Forb | 1 | - | - | x | - |
| VERBASCUM THAPSUS | COMMON MULLEIN | Ad B-Forb | 0 | x | x | - | - |
| Veronicastrum virginicum | CULVER'S ROOT | Nt P-Forb | 8 | x | - | - | - |
| Viburnum lentago | NANNYBERRY | Nt Shrub | 4 | - | - | x | - |
| VIBURNUM OPULUS | EUROPEAN HIGHBUSH CRANBERRY | Ad Shrub | 0 | - | - | x | x |
| VINCETOXICUM ROSSICUM | WHITE SWALLOW WORT | Ad P-Forb | 0 | - | x | - | - |
| Viola sororia | COMMON BLUE VIOLET | Nt P-Forb | 1 | - | - | - | - |
| Vitis riparia | RIVERBANK GRAPE | Nt W-Vine | 3 | - | - | x | x |
| Zanthoxylum americanum | PRICKLY ASH | Nt Shrub | 3 | - | - | x | - |
| Zizia aurea | GOLDEN ALEXANDERS | Nt P-Forb | 6 | - | x | - | x |
| **Total number of species observed in sampled areas park** | | | | **70** | **71** | **87** | **49** |
| **Total number of species observed in Dexter-Huron Metropark: 183** | | | | | | | |

**Appendix 3.** Plant species observed at Hudson Mills Metro Park. "X" indicates the species occurred within the site. "-" indicates species was not observed at the site. Capitalized scientific names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "C" is the Coefficient of Conservation for each species (Herman et al. 2001).

| | | | Site Name | Hudson Mills Golf Course Forest | Hudson Mills Tamarack Swamp | Hudson Mills Wet-Mesic Prairie | Hudson Mills Group Camp Wet Meadow | Hudson Mills Group Camp Forest | Hudson Mills Dry Mesic Forest | North Territorial Road Floodplain Forest |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Site Code | H | I | J | K | L | M | N |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | |
| Acer rubrum | RED MAPLE | Nt Tree | 1 | x | x | - | - | - | x | x |
| Acer saccharinum | SILVER MAPLE | Nt Tree | 2 | x | - | - | - | x | - | - |
| Acer saccharum | SUGAR MAPLE | Nt Tree | 5 | x | - | - | - | x | - | - |
| Achillea millefolium | YARROW | Nt P-Forb | 1 | - | - | - | - | - | - | x |
| Actaea rubra | RED BANEBERRY | Nt P-Forb | 7 | x | - | - | - | - | - | - |
| Adiantum pedatum | MAIDENHAIR FERN | Nt Fern | 6 | x | - | - | - | - | - | - |
| Agrimony sp. | AGRIMONY | Nt P-Forb | | - | - | - | - | - | x | - |
| AGROPYRON REPENS | QUACK GRASS | Ad P-Grass | 0 | - | - | - | - | - | - | - |
| Agropyron trachycaulum | SLENDER WHEAT GRASS | Nt P-Grass | 8 | - | - | x | - | - | - | - |
| ALLIARIA PETIOLATA | GARLIC MUSTARD | Ad B-Forb | 0 | x | - | - | - | x | x | - |
| Amelanchier sp. | SERVICE-BERRY | Nt Tree | | - | - | - | - | x | - | - |
| Amphicarpaea bracteata | HOG PEANUT | Nt A-Forb | 5 | - | x | - | - | - | - | - |
| Andropogon gerardii | BIG BLUESTEM | Nt P-Grass | 5 | - | - | x | - | - | - | - |
| Anemonella thalictroides | RUE ANEMONE | Nt P-Forb | 8 | - | - | x | - | - | - | - |
| Apios americana | GROUNDNUT | Nt P-Forb | 3 | x | x | - | - | - | - | - |
| ARCTIUM MINUS | COMMON BURDOCK | Ad B-Forb | 0 | - | - | - | - | - | - | x |
| Arisaema triphyllum | JACK IN THE PULPIT | Nt P-Forb | 5 | x | - | - | - | - | x | - |
| Asarum canadense | WILD GINGER | Nt P-Forb | 5 | x | - | - | - | - | - | - |
| Asclepias incarnata | SWAMP MILKWEED | Nt P-Forb | 6 | - | x | - | - | - | - | - |
| Aster borealis | NORTHERN BOG ASTER | Nt P-Forb | 9 | - | x | - | - | - | - | - |
| Aster lanceolatus | EASTERN LINED ASTER | Nt P-Forb | 2 | - | x | - | - | - | - | - |
| Aster lateriflorus | SIDE FLOWERING ASTER | Nt P-Forb | 2 | - | x | x | - | x | - | - |
| Aster novae-angliae | NEW ENGLAND ASTER | Nt P-Forb | 3 | - | - | x | - | - | - | - |
| Aster puniceus | SWAMP ASTER | Nt P-Forb | 5 | - | x | x | x | - | - | - |
| Aster umbellatus | TALL FLAT TOP WHITE ASTER | Nt P-Forb | 5 | - | x | - | - | - | - | - |
| Athyrium filix-femina | LADY FERN | Nt Fern | 4 | x | - | - | - | - | - | - |

**Appendix 3.** continued

| Scientific Name | Common name | Life Form | C | Hudson Mills Golf Course Forest (H) | Hudson Mills Tamarack Swamp (I) | Hudson Mills Wet-Mesic Prairie (J) | Hudson Mills Group Camp Wet Meadow (K) | Hudson Mills Group Camp Forest (L) | Hudson Mills Dry Mesic Forest (M) | North Territorial Road Floodplain Forest (N) |
|---|---|---|---|---|---|---|---|---|---|---|
| BERBERIS VULGARIS | COMMON BARBERRY | Ad Shrub | 0 | x | - | - | - | - | - | - |
| Betula pumila | BOG BIRCH | Nt Shrub | 8 | - | x | - | - | - | - | - |
| Bidens comosus | SWAMP TICKSEED | Nt A-Forb | 5 | - | x | - | - | - | - | - |
| Bidens coronatus | TALL SWAMP MARIGOLD | Nt A-Forb | 7 | - | - | - | x | - | - | - |
| Boehmeria cylindrica | FALSE NETTLE | Nt P-Forb | 5 | x | x | - | - | - | x | - |
| Botrychium virginianum | RATTLESNAKE FERN | Nt Fern | 5 | x | - | - | - | - | - | - |
| Bromus ciliatus | FRINGED BROME | Nt P-Grass | 6 | - | x | x | - | - | - | - |
| Calamagrostis canadensis | BLUE JOINT GRASS | Nt P-Grass | 3 | x | x | x | x | - | - | - |
| Caltha palustris | MARSH MARIGOLD | Nt P-Forb | 6 | - | - | x | - | - | - | - |
| Carex aquatilis | SEDGE | Nt P-Sedge | 7 | - | x | - | - | - | - | - |
| Carex comosa | SEDGE | Nt P-Sedge | 5 | - | x | - | - | - | - | - |
| Carex hystericina | SEDGE | Nt P-Sedge | 2 | - | x | x | - | - | - | - |
| Carex lacustris | SEDGE | Nt P-Sedge | 6 | - | x | - | x | - | x | - |
| Carex lasiocarpa | SEDGE | Nt P-Sedge | 8 | - | x | - | - | - | - | - |
| Carex leptalea | SEDGE | Nt P-Sedge | 5 | - | x | - | - | - | - | - |
| Carex pensylvanica | SEDGE | Nt P-Sedge | 4 | x | - | - | - | x | x | - |
| Carex radiata | SEDGE | Nt P-Sedge | 2 | - | x | x | - | - | x | - |
| Carex stricta | SEDGE | Nt P-Sedge | 4 | - | - | x | x | - | - | x |
| Carpinus caroliniana | BLUE BEECH | Nt Tree | 6 | x | x | - | - | - | x | x |
| Carya cordiformis | BITTERNUT HICKORY | Nt Tree | 5 | x | - | - | - | - | x | - |
| Carya glabra | PIGNUT HICKORY | Nt Tree | 5 | - | - | - | - | - | x | - |
| Carya ovata | SHAGBARK HICKORY | Nt Tree | 5 | x | - | - | - | - | - | x |
| CENTAUREA MACULOSA | SPOTTED KNAPWEED | Ad B-Forb | 0 | - | - | - | - | - | - | - |
| Cephalanthus occidentalis | BUTTONBUSH | Nt Shrub | 7 | - | - | - | x | - | x | - |
| Cercis canadensis | REDBUD | Nt Tree | 8 | - | - | - | - | x | - | - |
| Chelone glabra | TURTLEHEAD | Nt P-Forb | 7 | - | x | - | - | - | - | - |
| Cicuta bulbifera | WATER HEMLOCK | Nt P-Forb | 5 | - | x | - | - | - | - | - |
| Cicuta maculata | WATER HEMLOCK | Nt B-Forb | 4 | - | - | x | - | - | - | - |
| Cinna arundinacea | WOOD REEDGRASS | Nt P-Grass | 7 | - | x | - | - | - | x | - |
| Circaea lutetiana | ENCHANTER'S NIGHTSHADE | Nt P-Forb | 2 | x | - | - | - | - | - | - |

**Appendix 3.** continued

| | | | Site Name | Hudson Mills Golf Course Forest | Hudson Mills Tamarack Swamp | Hudson Mills Wet-Mesic Prairie | Hudson Mills Group Camp Wet Meadow | Hudson Mills Group Camp Forest | Hudson Mills Dry Mesic Forest | North Territorial Road Floodplain Forest |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Site Code | H | I | J | K | L | M | N |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | |
| Cirsium muticum | SWAMP THISTLE | Nt B-Forb | 6 | - | x | - | - | - | - | - |
| Collinsonia canadensis | RICHWEED | Nt P-Forb | 8 | x | - | - | - | - | x | - |
| CONVALLARIA MAJALIS | LILY OF THE VALLEY | Ad P-Forb | 0 | - | - | - | - | x | - | - |
| Cornus alternifolia | ALTERNATE LEAVED DOGWOOD | Nt Tree | 5 | x | - | - | - | - | - | - |
| Cornus amomum | SILKY DOGWOOD | Nt Shrub | 2 | - | x | x | x | - | - | - |
| Cornus florida | FLOWERING DOGWOOD | Nt Tree | 8 | x | - | - | - | - | - | - |
| Cornus foemina | GRAY DOGWOOD | Nt Shrub | 1 | - | - | - | x | - | - | x |
| Corylus americana | HAZELNUT | Nt Shrub | 5 | x | x | x | - | x | - | - |
| DAUCUS CAROTA | QUEEN ANNE'S LACE | Ad B-Forb | 0 | - | - | - | - | - | - | - |
| Desmodium glutinosum | CLUSTERED LEAVED TICK TREFOIL | Nt P-Forb | 5 | x | - | - | - | - | - | - |
| Desmodium sp. | TICK TREFOIL | Nt P-Forb | | - | - | - | - | x | - | - |
| Dioscorea villosa | WILD YAM | Nt P-Forb | 4 | x | - | - | - | - | - | - |
| Dryopteris carthusiana | SPINULOSE WOODFERN | Nt Fern | 5 | x | - | - | - | - | - | - |
| ECHINOCHLOA CRUSGALLI | BARNYARD GRASS | Ad A-Grass | 0 | - | - | - | - | - | x | - |
| ELAEAGNUS UMBELLATA | AUTUMN OLIVE | Ad Shrub | 0 | x | - | - | - | x | - | x |
| Eleocharis sp. | SPIKE RUSH | Nt Sedge | | - | - | - | - | - | x | - |
| Elymus canadensis | CANADA WILD RYE | Nt P-Grass | 7 | x | - | x | - | - | - | - |
| Elymus virginicus | VIRGINIA WILD RYE | Nt P-Grass | 4 | - | - | - | - | x | x | - |
| Epilobium coloratum | CINNAMON WILLOW HERB | Nt P-Forb | 3 | - | - | - | x | - | - | - |
| Equisetum fluviatile | WATER HORSETAIL | Nt Fern Ally | 7 | - | x | - | - | - | - | - |
| Erigeron strigosus | DAISY FLEABANE | Nt P-Forb | 4 | - | - | - | - | x | - | - |
| Eupatorium maculatum | JOE PYE WEED | Nt P-Forb | 4 | - | x | x | x | - | - | - |
| Eupatorium perfoliatum | COMMON BONESET | Nt P-Forb | 4 | - | x | x | x | - | - | - |
| Euthamia graminifolia | GRASS LEAVED GOLDENROD | Nt P-Forb | 3 | - | - | x | - | - | - | - |
| FORSYTHIA X INTERMIDIA | GOLDEN BELLS | Ad Shrub | 0 | - | - | - | - | x | - | - |
| Fragaria virginiana | WILD STRAWBERRY | Nt P-Forb | 2 | - | - | x | - | - | - | - |
| Fraxinus americana | WHITE ASH | Nt Tree | 5 | x | - | - | - | x | x | - |
| Fraxinus nigra | BLACK ASH | Nt Tree | 6 | x | x | x | - | x | - | x |

**Appendix 3.** continued

| | | | Site Name | Hudson Mills Golf Course Forest | Hudson Mills Tamarack Swamp | Hudson Mills Wet-Mesic Prairie | Hudson Mills Group Camp Wet Meadow | Hudson Mills Group Camp Forest | Hudson Mills Dry Mesic Forest | North Territorial Road Floodplain Forest |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Site Code | H | I | J | K | L | M | N |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | |
| Fraxinus pennsylvanica | RED ASH | Nt Tree | 2 | x | - | - | - | - | - | x |
| Galium asprellum | ROUGH BEDSTRAW | Nt P-Forb | 5 | x | x | - | - | - | - | - |
| Galium circaezans | WHITE WILD LICORICE | Nt P-Forb | 4 | x | - | - | - | - | - | - |
| Galium tinctorium | STIFF BEDSTRAW | Nt P-Forb | 5 | - | x | - | - | - | x | - |
| Gentianopsis procera | SMALL FRINGED GENTIAN | Nt A-Forb | 8 | - | - | x | - | - | - | - |
| Geranium maculatum | WILD GERANIUM | Nt P-Forb | 4 | x | - | - | - | - | x | - |
| Geum canadense | WHITE AVENS | Nt P-Forb | 1 | x | - | - | - | - | x | - |
| Glyceria striata | FOWL MANNA GRASS | Nt P-Grass | 4 | x | - | - | - | - | - | - |
| Gymnocladus dioicus | KENTUCKY COFFEE TREE | Nt Tree | 9 | - | - | - | - | x | - | - |
| Hamamelis virginiana | WITCH HAZEL | Nt Shrub | 5 | x | - | - | - | x | x | - |
| Helenium autumnale | SNEEZEWEED | Nt P-Forb | 5 | - | - | x | - | - | - | - |
| Helianthus giganteus | TALL SUNFLOWER | Nt P-Forb | 5 | - | x | - | - | - | - | - |
| Hepatica americana | ROUND LOBED HEPATICA | Nt P-Forb | 6 | x | - | - | - | - | - | - |
| Hydrastis canadensis | GOLDENSEAL | Nt P-Forb | 10 | x | - | - | - | - | - | |
| Hystrix patula | BOTTLEBRUSH GRASS | Nt P-Grass | 5 | x | - | - | - | - | x | - |
| Impatiens capensis | SPOTTED TOUCH ME NOT | Nt A-Forb | 2 | - | x | x | x | - | - | - |
| Iris virginica | SOUTHERN BLUE FLAG | Nt P-Forb | 5 | x | - | x | x | - | - | - |
| Juglans nigra | BLACK WALNUT | Nt Tree | 5 | - | - | - | - | x | x | - |
| Juncus brachycephalus | RUSH | Nt P-Forb | 7 | - | - | x | - | - | - | - |
| Laportea canadensis | WOOD NETTLE | Nt P-Forb | 4 | x | - | - | - | - | - | - |
| Larix laricina | TAMARACK | Nt Tree | 5 | - | x | - | - | - | - | - |
| Leersia oryzoides | CUT GRASS | Nt P-Grass | 3 | - | x | - | - | - | - | - |
| Lemna minor | SMALL DUCKWEED | Nt A-Forb | 5 | - | x | - | - | - | - | - |
| Liatris spicata | MARSH BLAZING STAR | Nt P-Forb | 8 | - | - | x | - | - | - | - |
| Lobelia cardinalis | CARDINAL FLOWER | Nt P-Forb | 7 | x | - | - | - | x | - | - |
| Lobelia kalmii | BOG LOBELIA | Nt P-Forb | 10 | - | - | x | - | - | - | - |
| Lobelia siphilitica | GREAT BLUE LOBELIA | Nt P-Forb | 4 | x | x | x | - | - | - | x |
| Lonicera dioica | RED HONEYSUCKLE | Nt W-Vine | 5 | - | x | - | - | - | - | - |
| LONICERA MORROWII | MORROW HONEYSUCKLE | Ad Shrub | 0 | - | - | x | - | - | - | x |

**Appendix 3.** continued

| Scientific Name | Common name | Life Form | C | Hudson Mills Golf Course Forest | Hudson Mills Tamarack Swamp | Hudson Mills Wet-Mesic Prairie | Hudson Mills Group Camp Wet Meadow | Hudson Mills Group Camp Forest | Hudson Mills Dry Mesic Forest | North Territorial Road Floodplain Forest |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Site Code | H | I | J | K | L | M | N |
| Lycopus americanus | COMMON WATER HOREHOUND | Nt P-Forb | 2 | - | - | x | - | - | - | - |
| Lycopus uniflorus | NORTHERN BUGLE WEED | Nt P-Forb | 2 | - | x | x | - | - | x | - |
| LYSIMACHIA NUMMULARIA | MONEYWORT | Ad P-Forb | 0 | - | - | - | - | x | - | - |
| Lysimachia quadriflora | WHORLED LOOSESTRIFE | Nt P-Forb | 10 | x | - | x | - | - | - | - |
| LYTHRUM SALICARIA | PURPLE LOOSESTRIFE | Ad P-Forb | 0 | - | - | x | - | - | - | - |
| Maianthemum canadense | CANADA MAYFLOWER | Nt P-Forb | 4 | - | x | - | - | - | - | - |
| MENTHA PIPERITA | PEPPERMINT | Ad P-Forb | 0 | - | - | x | - | - | - | - |
| MENTHA SPICATA | SPEARMINT | Ad P-Forb | 0 | - | - | x | - | - | - | - |
| MORUS ALBA | WHITE MULBERRY | Ad Tree | 0 | - | - | - | - | - | - | x |
| Muhlenbergia glomerata | MARSH WILD TIMOTHY | Nt P-Grass | 10 | - | - | x | - | - | - | - |
| Muhlenbergia mexicana | LEAFY SATIN GRASS | Nt P-Grass | 3 | - | x | x | - | - | - | - |
| Onoclea sensibilis | SENSITIVE FERN | Nt Fern | 2 | x | - | - | - | - | - | x |
| Osmorhiza claytonii | HAIRY SWEET CICELY | Nt P-Forb | 4 | x | - | - | - | - | - | - |
| Osmorhiza longistylis | SMOOTH SWEET CICELY | Nt P-Forb | 3 | x | - | - | - | - | - | - |
| Osmunda regalis | ROYAL FERN | Nt Fern | 5 | x | - | - | x | - | - | - |
| Ostrya virginiana | IRONWOOD; HOP HORNBEAM | Nt Tree | 5 | x | - | - | - | x | x | - |
| Oxypolis rigidior | COWBANE | Nt P-Forb | 6 | - | x | x | - | - | - | - |
| Parnassia glauca | GRASS OF PARNASSUS | Nt P-Forb | 8 | - | x | - | - | - | - | - |
| Parthenocissus quinquefolia | VIRGINIA CREEPER | Nt W-Vine | 5 | x | - | x | - | - | x | - |
| Pedicularis lanceolata | SWAMP BETONY | Nt P-Forb | 8 | - | x | x | - | - | - | - |
| Phalaris arundinacea | REED CANARY GRASS | Nt P-Grass | 0 | - | - | x | - | x | - | - |
| Phragmites australis | REED | Nt P-Grass | 0 | - | x | - | - | - | - | - |
| Physocarpus opulifolius | NINEBARK | Nt Shrub | 4 | - | - | x | - | x | - | - |
| Pilea pumila | CLEARWEED | Nt A-Forb | 5 | - | x | - | - | - | - | - |
| Poa palustris | FOWL MEADOW GRASS | Nt P-Grass | 3 | - | x | x | - | - | - | - |
| Polygonatum pubescens | DOWNY SOLOMON SEAL | Nt P-Forb | 5 | - | - | - | - | x | x | - |
| Polygonum amphibium | WATER SMARTWEED | Nt P-Forb | 6 | - | - | - | x | - | - | - |
| Polygonum hydropiper | WATER PEPPER | Nt A-Forb | 1 | - | x | - | - | - | - | - |
| Polygonum virginianum | JUMPSEED | Nt P-Forb | 4 | x | - | - | - | x | - | - |

**Appendix 3.** continued

| Scientific Name | Common name | Life Form | C | Hudson Mills Golf Course Forest | Hudson Mills Tamarack Swamp | Hudson Mills Wet-Mesic Prairie | Hudson Mills Group Camp Wet Meadow | Hudson Mills Group Camp Forest | Hudson Mills Dry Mesic Forest | North Territorial Road Floodplain Forest |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Site Code | H | I | J | K | L | M | N |
| Populus deltoides | COTTONWOOD | Nt Tree | 1 | - | - | - | - | - | - | x |
| Populus tremuloides | QUAKING ASPEN | Nt Tree | 1 | - | - | x | - | - | - | - |
| Potentilla fruticosa | SHRUBBY CINQUEFOIL | Nt Shrub | 10 | - | x | x | - | - | - | - |
| Potentilla simplex | OLD FIELD CINQUEFOIL | Nt P-Forb | 2 | - | - | - | - | x | - | - |
| PRUNELLA VULGARIS | LAWN PRUNELLA | Nt P-Forb | 0 | x | x | x | - | - | - | - |
| Prunus serotina | WILD BLACK CHERRY | Nt Tree | 2 | x | - | x | - | x | x | - |
| Pteridium aquilinum | BRACKEN FERN | Nt Fern | 0 | x | - | - | - | - | - | - |
| Pycnanthemum virginianum | COMMON MOUNTAIN MINT | Nt P-Forb | 5 | - | x | x | - | - | - | - |
| Quercus alba | WHITE OAK | Nt Tree | 5 | x | - | - | - | x | x | - |
| Quercus bicolor | SWAMP WHITE OAK | Nt Tree | 8 | x | - | - | - | - | - | - |
| Quercus macrocarpa | BUR OAK | Nt Tree | 5 | x | - | - | - | x | - | - |
| Quercus rubra | RED OAK | Nt Tree | 5 | x | - | - | - | - | - | x |
| Quercus velutina | BLACK OAK | Nt Tree | 6 | - | - | - | - | x | x | - |
| Rhamnus alnifolia | ALDER LEAVED BUCKTHORN | Nt Shrub | 8 | - | x | - | - | - | - | - |
| RHAMNUS CATHARTICA | COMMON BUCKTHORN | Ad Tree | 0 | x | - | x | - | - | - | - |
| RHAMNUS FRANGULA | GLOSSY BUCKTHORN | Ad Shrub | 0 | - | - | x | - | - | - | - |
| Rhynchospora capillacea | BEAK RUSH | Nt P-Sedge | 10 | - | - | x | - | - | - | - |
| Ribes sp. | GOOSEBERRY | Nt Shrub | | - | - | - | - | - | x | - |
| Rorippa palustris | YELLOW CRESS | Nt A-Forb | 1 | - | - | x | - | - | - | - |
| ROSA MULTIFLORA | MULTIFLORA ROSE | Ad Shrub | 0 | x | - | - | - | x | - | - |
| Rosa palustris | SWAMP ROSE | Nt Shrub | 5 | - | x | - | - | - | - | - |
| Rubus pubescens | DWARF RASPBERRY | Nt P-Forb | 4 | - | x | - | - | - | - | - |
| Rudbeckia hirta | BLACK EYED SUSAN | Nt P-Forb | 1 | - | - | x | - | - | - | - |
| Rumex orbiculatus | GREAT WATER DOCK | Nt P-Forb | 9 | - | x | x | x | - | x | - |
| Salix candida | HOARY WILLOW | Nt Shrub | 9 | - | x | - | - | - | - | - |
| Salix discolor | PUSSY WILLOW | Nt Shrub | 1 | - | - | x | - | - | - | - |
| Salix nigra | BLACK WILLOW | Nt Tree | 5 | - | - | - | - | x | - | - |
| Salix sp. | WILLOW | | | - | - | - | - | - | x | - |
| Sanicula canadensis | BLACK SNAKEROOT | Nt B-Forb | 8 | x | - | - | - | - | - | - |
| Sanicula gregaria | BLACK SNAKEROOT | Nt P-Forb | 2 | - | - | - | - | x | - | - |

**Appendix 3.** continued

| | | Site Name | | Hudson Mills Golf Course Forest | Hudson Mills Tamarack Swamp | Hudson Mills Wet-Mesic Prairie | Hudson Mills Group Camp Wet Meadow | Hudson Mills Group Camp Forest | Hudson Mills Dry Mesic Forest | North Territorial Road Floodplain Forest |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Site Code | | H | I | J | K | L | M | N |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | |
| Sassafras albidum | SASSAFRAS | Nt Tree | 5 | x | - | - | - | - | - | - |
| Schoenoplectus pungens | THREE SQUARE | Nt P-Sedge | 5 | - | x | - | - | - | - | - |
| Scirpus atrovirens | BULRUSH | Nt P-Sedge | 3 | - | x | x | - | - | - | - |
| Selaginella eclipes | SELAGINELLA | Nt Fern Ally | 5 | - | - | x | - | - | - | - |
| Senecio aureus | GOLDEN RAGWORT | Nt P-Forb | 5 | - | - | x | - | - | - | - |
| Silphium terebinthinaceum | PRAIRIE DOCK | Nt P-Forb | 6 | - | - | x | - | - | - | - |
| Smilacina racemosa | FALSE SPIKENARD | Nt P-Forb | 5 | x | - | - | - | - | - | - |
| Smilacina stellata | STARRY FALSE SOLOMON SEAL | Nt P-Forb | 5 | - | - | x | - | - | - | - |
| Smilax sp. | GREEN BRIAR | | | - | - | - | - | - | - | - |
| Solidago altissima | TALL GOLDENROD | Nt P-Forb | 1 | - | - | x | x | - | - | - |
| Solidago canadensis | CANADA GOLDENROD | Nt P-Forb | 1 | - | - | - | - | - | - | x |
| Solidago gigantea | LATE GOLDENROD | Nt P-Forb | 3 | - | - | x | x | - | - | x |
| Solidago ohioensis | OHIO GOLDENROD | Nt P-Forb | 8 | - | - | x | - | - | - | - |
| Solidago patula | SWAMP GOLDENROD | Nt P-Forb | 6 | - | x | x | - | - | - | - |
| Solidago riddellii | RIDDELL'S GOLDENROD | Nt P-Forb | 6 | - | x | - | - | - | - | - |
| Solidago rigida | STIFF GOLDENROD | Nt P-Forb | 5 | - | - | x | - | - | - | - |
| Solidago rugosa | ROUGH GOLDENROD | Nt P-Forb | 3 | - | x | - | - | - | - | - |
| Sorghastrum nutans | INDIAN GRASS | Nt P-Grass | 6 | - | - | x | - | - | - | - |
| Spartina pectinata | CORDGRASS | Nt P-Grass | 5 | - | - | x | - | - | - | - |
| Sphagnum moss | SPHAGNUM MOSS | Nt Moss | | - | x | - | - | - | - | - |
| Staphylea trifolia | BLADDERNUT | Nt Shrub | 9 | x | - | - | - | x | - | - |
| Symplocarpus foetidus | SKUNK CABBAGE | Nt P-Forb | 6 | x | x | x | - | - | x | - |
| SYRINGA VULGARIS | COMMON LILAC | Ad Shrub | 0 | - | - | - | - | x | - | - |
| Thalictrum dasycarpum | PURPLE MEADOW RUE | Nt P-Forb | 3 | - | - | x | - | - | - | - |
| Thalictrum dioicum | EARLY MEADOW RUE | Nt P-Forb | 6 | x | - | x | - | - | - | - |
| Thelypteris hexagonoptera | BROAD BEECH FERN | Nt Fern | 8 | x | - | - | - | - | - | - |
| Thelypteris palustris | MARSH FERN | Nt Fern | 2 | x | x | x | x | - | x | - |
| Tilia americana | BASSWOOD | Nt Tree | 5 | x | - | - | - | x | x | x |
| Toxicodendron radicans | POISON IVY | Nt W-Vine | 2 | x | x | - | - | x | x | - |

**Appendix 3.** continued

| | | | Site Name | Hudson Mills Golf Course Forest | Hudson Mills Tamarack Swamp | Hudson Mills Wet-Mesic Prairie | Hudson Mills Group Camp Wet Meadow | Hudson Mills Group Camp Forest | Hudson Mills Dry Mesic Forest | North Territorial Road Floodplain Forest |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Site Code | H | I | J | K | L | M | N |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | |
| Toxicodendron vernix | POISON SUMAC | Nt Shrub | 6 | - | x | x | - | - | - | - |
| TYPHA ANGUSTIFOLIA | NARROW LEAVED CATTAIL | Ad P-Forb | 0 | - | x | - | - | - | x | - |
| Typha latifolia | BROAD LEAVED CATTAIL | Nt P-Forb | 1 | - | - | x | - | - | - | - |
| Ulmus americana | AMERICAN ELM | Nt Tree | 1 | x | x | x | x | x | - | x |
| Utricularia sp. | BLADDERWORT | Nt P-Forb | | - | x | - | - | - | - | - |
| Verbena hastata | BLUE VERVAIN | Nt P-Forb | 4 | - | - | - | x | - | - | - |
| Vernonia missurica | MISSOURI IRONWEED | Nt P-Forb | 4 | - | - | x | - | - | - | - |
| Viburnum dentatum | SMOOTH ARROW WOOD | Nt Shrub | 6 | x | - | - | - | x | x | - |
| Viburnum lentago | NANNYBERRY | Nt Shrub | 4 | - | x | - | - | - | - | - |
| Viburnum opulus var. americanum | HIGHBUSH CRANBERRY | Nt Shrub | 5 | - | - | x | - | - | - | - |
| Viola sp | VIOLET | Nt P-Forb | | - | - | - | - | - | x | - |
| Vitis riparia | RIVERBANK GRAPE | Nt W-Vine | 3 | x | - | x | - | - | - | - |
| Zanthoxylum americanum | PRICKLY ASH | Nt Shrub | 3 | x | - | - | - | x | - | x |
| Zigadenus glaucus | WHITE CAMAS | Nt P-Forb | 10 | - | - | x | - | - | - | - |
| **Total number of species observed in sampled areas park** | | | | **75** | **73** | **79** | **21** | **40** | **41** | **21** |
| **Total number of species observed in Hudson Mills Metropark: 215** | | | | | | | | | | |

**Appendix 4.** Plant species observed at Stony Creek Metropark. "X" indicates the species occurred within the site. "-" indicates species was not observed at the site. Capitalized scientific names indicate non-native species. Life form acronyms are as follows: Nt, native; P, perennial; Ad, adventive; B, biannual; A, annual. "C" is the Coefficient of Conservation for each species (Herman et al. 2001). Site names, site abbreviations, and site codes are listed below.

| Site Name | Site Abbreviation | Site Code |
|---|---|---|
| Stony Creek Cedar Swamp | HCS | O |
| Gravel Mine Wet-Mesic Prairie | GMP | P |
| Sheldon Wet-Mesic Prairie | SWP | V |
| Sheldon Mesic Prairie | SMP | R |
| Sheldon Tamarack Fen | STF | S |
| Sheldon Wet-Mesic Forest | SMF | T |
| Stony Creek Dry Mesic Forest | DMF | U |
| Stony Creek Floodplain | SCF | Q |
| 31 Mile Lake Wetland | 31M | W |
| Stony Creek Lake Wetland | SCW | X |
| Stony Creek Nature Center | SWM | Y |
| Nature Center Old Field | NCF | Z |

| | | | Site Name | HCS | GMP | SWP | SMP | STF | SMF | DMF | SCF | 31M | SCW | SWM | NCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Site Code | O | P | V | R | S | T | U | Q | W | X | Y | Z |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | | | | | | |
| Acer negundo | BOX ELDER | Nt Tree | 0 | - | - | - | - | - | - | - | x | - | - | - | - |
| Acer rubrum | RED MAPLE | Nt Tree | 1 | x | - | x | - | - | x | x | - | x | - | - | - |
| Acer saccharinum | SILVER MAPLE | Nt Tree | 2 | - | - | x | - | - | x | x | - | - | - | - | - |
| Acer saccharum | SUGAR MAPLE | Nt Tree | 5 | x | - | - | - | - | x | x | - | - | - | - | - |
| Achillea millefolium | YARROW | Nt P-Forb | 1 | - | x | - | x | - | - | x | - | - | - | - | x |
| Actaea pachypoda | DOLL'S EYES | Nt P-Forb | 7 | - | - | - | - | - | x | - | - | - | - | - | - |
| Adiantum pedatum | MAIDENHAIR FERN | Nt Fern | 6 | x | - | - | - | - | x | x | - | - | - | - | - |
| AGROPYRON REPENS | QUACK GRASS | Ad P-Grass | 0 | - | - | - | - | - | - | - | - | - | - | - | x |
| Alisma plantago-aquatica | WATER PLANTAIN | Nt P-Forb | 1 | - | - | - | - | - | - | - | - | x | - | - | - |
| ALLIARIA PETIOLATA | GARLIC MUSTARD | Ad B-Forb | 0 | x | - | - | - | - | - | - | - | - | - | - | - |
| Amelanchier arborea | JUNEBERRY | Nt Tree | 4 | - | - | - | - | x | - | x | - | - | - | - | - |
| Amphicarpaea bracteata | HOG PEANUT | Nt A-Forb | 5 | - | - | - | - | - | x | - | - | - | - | - | - |
| Andropogon gerardii | BIG BLUESTEM | Nt P-Grass | 5 | - | x | x | - | - | - | x | - | - | - | - | - |
| Andropogon scoparius | LITTLE BLUESTEM GRASS | Nt P-Grass | 5 | - | x | x | - | - | - | x | - | - | - | - | x |
| Anemone quinquefolia | WOOD ANEMONE | Nt P-Forb | 5 | x | - | - | - | - | - | x | - | - | - | - | - |
| Anemone virginiana | THIMBLEWEED | Nt P-Forb | 3 | - | - | - | x | - | - | x | - | - | - | - | - |

**Appendix 4.** continued

| | | Site Name | | HCS | GMP | SWP | SMP | STF | SMF | DMF | SCF | 31M | SCW | SWM | NCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Site Code | | O | P | V | R | S | T | U | Q | W | X | Y | Z |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | | | | | | |
| Apios americana | GROUNDNUT | Nt P-Forb | 3 | x | - | - | - | - | - | - | - | - | - | - | - |
| Apocynum cannabinum | INDIAN HEMP | Nt P-Forb | 3 | - | - | x | x | - | - | - | - | x | x | - | - |
| Apocynum sibiricum | CLASPING DOGBANE | Nt P-Forb | 3 | - | x | - | - | - | - | - | - | - | - | - | - |
| Aquilegia canadensis | WILD COLUMBINE | Nt P-Forb | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| Aralia nudicaulis | WILD SARSAPARILLA | Nt P-Forb | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| Aralia racemosa | SPIKENARD | Nt P-Forb | 8 | x | - | - | - | - | - | - | - | - | - | - | - |
| Arisaema triphyllum | JACK IN THE PULPIT | Nt P-Forb | 5 | x | - | - | - | - | x | x | - | x | - | - | - |
| Asarum canadense | WILD GINGER | Nt P-Forb | 5 | x | - | - | - | - | x | - | - | - | - | - | - |
| Asclepias incarnata | SWAMP MILKWEED | Nt P-Forb | 6 | - | x | x | - | - | - | - | - | x | - | - | - |
| Asclepias syriaca | COMMON MILKWEED | Nt P-Forb | 1 | - | - | - | - | - | - | x | - | - | - | - | x |
| Asclepias tuberosa | BUTTERFLY WEED | Nt P-Forb | 5 | - | - | x | x | - | - | x | - | - | - | - | x |
| Aster lanceolatus | EASTERN LINED ASTER | Nt P-Forb | 2 | x | - | x | - | x | - | - | - | - | - | - | - |
| Aster laevis | SMOOTH ASTER | Nt P-Forb | 5 | - | - | x | - | - | - | - | - | - | - | - | - |
| Aster novae-angliae | NEW ENGLAND ASTER | Nt P-Forb | 3 | - | - | - | - | - | - | - | - | - | x | - | - |
| Aster puniceus | SWAMP ASTER | Nt P-Forb | 5 | - | x | - | - | - | - | - | - | - | - | - | - |
| Aster umbellatus | TALL FLAT TOP WHITE ASTER | Nt P-Forb | 5 | - | x | - | - | - | - | - | - | - | - | - | - |
| Athyrium filix-femina | LADY FERN | Nt Fern | 4 | x | - | - | - | - | x | x | - | - | - | - | - |
| Athyrium thelypterioides | SILVERY SPLEENWORT | Nt Fern | 6 | - | - | - | - | - | x | - | - | - | - | - | - |
| BERBERUS THUNGBERGII | JAPANESE BARBERRY | Ad Shrub | 0 | - | - | - | - | - | x | - | - | - | - | - | - |
| Betula alleghaniensis | YELLOW BIRCH | Nt Tree | 7 | x | - | - | - | - | x | x | - | - | - | - | - |
| Betula papyrifera | PAPER BIRCH | Nt Tree | 2 | x | - | - | - | - | - | - | - | - | - | - | - |
| Betula pumila | BOG BIRCH | Nt Shrub | 8 | - | - | - | - | x | - | - | - | - | - | - | - |
| Boehmeria cylindrica | FALSE NETTLE | Nt P-Forb | 5 | - | - | - | - | - | - | x | x | - | - | x | - |
| Botrychium virginianum | RATTLESNAKE FERN | Nt Fern | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| BRASSICA NIGRA | BLACK MUSTARD | Ad A-Forb | 0 | - | - | - | - | - | - | x | - | - | - | - | - |
| BROMUS INERMIS | SMOOTH BROME | Ad P-Grass | 0 | - | x | - | - | - | - | - | - | - | - | - | x |
| Calamagrostis canadensis | BLUE JOINT GRASS | Nt P-Grass | 3 | - | - | - | - | - | - | - | x | x | - | x | - |
| Caltha palustris | MARSH MARIGOLD | Nt P-Forb | 6 | x | - | - | - | - | - | - | x | - | - | x | - |
| Campanula aparinoides | MARSH BELLFLOWER | Nt P-Forb | 7 | - | - | - | - | - | - | - | - | x | - | x | - |
| Cardamine bulbosa | SPRING CRESS | Nt P-Forb | 4 | - | - | - | - | - | - | x | - | - | - | - | - |
| Cardamine pensylvanica | PENNSYLVANIA BITTER CRESS | Nt B-Forb | 1 | x | - | - | - | x | x | x | - | - | - | - | - |
| Carex aurea | SEDGE | Nt P-Sedge | 3 | - | - | x | - | x | - | - | - | - | - | - | - |
| Carex gracillima | SEDGE | Nt P-Sedge | 4 | x | - | - | - | - | - | x | - | - | x | - | - |
| Carex hystericina | SEDGE | Nt P-Sedge | 2 | - | - | x | - | x | - | - | - | x | - | - | - |

**Appendix 4.** continued

| | | Site Name | | HCS | GMP | SWP | SMP | STF | SMF | DMF | SCF | 31M | SCW | SWM | NCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Site Code | | O | P | V | R | S | T | U | Q | W | X | Y | Z |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | | | | | | |
| Carex lacustris | SEDGE | Nt P-Sedge | 6 | - | - | - | - | - | - | - | x | - | x | x | - |
| Carex lasiocarpa | SEDGE | Nt P-Sedge | 8 | - | - | - | - | - | - | - | - | x | - | - | - |
| Carex leptalea | SEDGE | Nt P-Sedge | 5 | - | - | x | - | x | - | - | - | x | - | - | - |
| Carex pensylvanica | SEDGE | Nt P-Sedge | 4 | x | - | - | x | - | - | x | - | - | - | - | - |
| Carex plantaginea | SEDGE | Nt P-Sedge | 8 | - | - | - | - | - | - | - | - | - | - | - | - |
| Carex prairea | SEDGE | Nt P-Sedge | 10 | - | - | - | - | x | - | - | - | - | - | - | - |
| Carex radiata | STRAIGHT STYLED WOOD SEDGE | Nt P-Sedge | 2 | x | - | - | - | - | - | - | x | - | - | - | - |
| Carex retrorsa | SEDGE | Nt P-Sedge | 3 | - | - | - | - | - | - | - | - | x | - | - | - |
| Carex rosea | CURLY STYLED WOOD SEDGE | Nt P-Sedge | 2 | - | - | - | - | - | - | x | - | - | - | - | - |
| Carex sterilis | SEDGE | Nt P-Sedge | 10 | - | - | - | - | x | - | - | - | - | - | - | - |
| Carex stipata | SEDGE | Nt P-Sedge | 1 | - | - | - | - | x | - | x | - | x | x | - | - |
| Carex stricta | SEDGE | Nt P-Sedge | 4 | - | x | x | - | - | - | - | - | - | - | x | - |
| Carex vulpinoidea | SEDGE | Nt P-Sedge | 1 | - | - | - | - | - | - | - | - | x | x | - | - |
| Carpinus caroliniana | BLUE BEECH | Nt Tree | 6 | x | - | - | - | - | - | - | - | x | - | - | - |
| Carya cordiformis | BITTERNUT HICKORY | Nt Tree | 5 | - | - | - | - | - | x | - | - | - | - | - | - |
| Carya ovata | SHAGBARK HICKORY | Nt Tree | 5 | x | - | - | - | - | x | x | - | - | - | - | - |
| CELASTRUS ORBICULATA | ORIENTAL BITTERSWEET | Ad W-Vine | 0 | - | - | - | x | - | - | x | - | - | - | - | - |
| CENTAUREA MACULOSA | SPOTTED KNAPWEED | Ad B-Forb | 0 | - | x | - | - | - | - | - | - | - | - | - | x |
| CHRYSANTHEMUM LEUCANTHEMUM | OX EYE DAISY | Ad P-Forb | 0 | - | x | - | x | - | - | x | - | - | - | - | x |
| Cicuta bulbifera | WATER HEMLOCK | Nt P-Forb | 5 | - | - | - | - | - | - | - | - | x | - | x | - |
| Cicuta maculata | WATER HEMLOCK | Nt B-Forb | 4 | - | - | x | - | x | - | - | - | - | x | - | - |
| Cinna arundinacea | WOOD REEDGRASS | Nt P-Grass | 7 | x | - | - | - | - | x | - | - | - | - | - | - |
| Circaea alpina | SMALL ENCHANTER'S | Nt P-Forb | 4 | x | - | - | - | - | x | - | - | x | - | - | - |
| Circaea lutetiana | ENCHANTER'S NIGHTSHADE | Nt P-Forb | 2 | x | - | - | - | - | x | x | - | - | - | - | - |
| Cirsium discolor | PASTURE THISTLE | Nt B-Forb | 4 | x | - | - | - | x | - | - | x | x | - | - | - |
| Cirsium muticum | SWAMP THISTLE | Nt B-Forb | 6 | - | - | - | - | - | - | x | - | - | - | - | - |
| Claytonia virginica | SPRING BEAUTY | Nt P-Forb | 4 | - | - | - | - | - | - | x | - | - | - | - | - |
| Clematis virginiana | VIRGIN'S BOWER | Nt W-Vine | 4 | - | - | - | - | x | - | - | - | - | - | - | - |
| Collinsonia canadensis | RICHWEED | Nt P-Forb | 8 | x | - | - | - | - | x | - | - | - | - | - | - |
| Coptis trifolia | GOLDTHREAD | Nt P-Forb | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| Cornus alternifolia | ALTERNATE LEAVED DOGWOOD | Nt Tree | 5 | x | - | - | - | - | - | - | - | - | - | - | - |

**Appendix 4.** continued

| | | Site Name | | HCS | GMP | SWP | SMP | STF | SMF | DMF | SCF | 31M | SCW | SWM | NCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Site Code | | O | P | V | R | S | T | U | Q | W | X | Y | Z |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | | | | | | |
| Cornus amomum | SILKY DOGWOOD | Nt Shrub | 2 | - | - | - | - | x | - | - | - | x | x | - | - |
| Cornus florida | FLOWERING DOGWOOD | Nt Tree | 8 | - | - | - | - | - | x | - | - | - | - | - | - |
| Cornus foemina | GRAY DOGWOOD | Nt Shrub | 1 | - | - | - | x | x | - | - | x | x | x | x | - |
| Corylus americana | HAZELNUT | Nt Shrub | 5 | - | - | - | - | x | - | - | x | - | - | x | - |
| Creategus sp. | HAWTHORN | Tree | | - | - | - | x | - | - | - | - | - | - | - | - |
| Cryptotaenia canadensis | HONEWORT | Nt P-Forb | 2 | x | - | - | - | - | - | - | - | - | - | - | - |
| Cystopteris bulbifera | BULBLET FERN | Nt Fern | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| Cystopteris fragilis | FRAGILE FERN | Nt Fern | 4 | x | - | - | - | - | - | - | - | - | - | - | - |
| DACTYLIS GLOMERATA | ORCHARD GRASS | Ad P-Grass | 0 | - | x | - | - | - | - | x | - | - | - | - | - |
| Dentaria diphylla | TWO LEAVED TOOTHWORT | Nt P-Forb | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| Dentaria laciniata | CUT LEAVED TOOTHWORT | Nt P-Forb | 5 | - | - | - | - | - | - | x | - | - | - | - | - |
| Desmodium illinoense | PRAIRIE TICK TREFOIL | Nt P-Forb | 6 | - | - | - | - | - | x | x | - | - | - | - | - |
| DIANTHUS ARMERIA | DEPTFORD PINK | Ad A-Forb | 0 | - | x | - | x | - | - | - | - | - | - | - | - |
| Dioscorea villosa | WILD YAM | Nt P-Forb | 4 | - | - | - | - | x | - | - | - | - | - | - | - |
| Drosera rotundifolia | ROUND LEAVED SUNDEW | Nt P-Forb | 6 | - | - | - | - | x | - | - | - | - | - | - | - |
| Dryopteris carthusiana | SPINULOSE WOODFERN | Nt Fern | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| Dryopteris cristata | CRESTED SHIELD FERN | Nt Fern | 6 | - | - | - | - | x | - | - | - | - | - | - | - |
| Dryopteris intermedia | EVERGREEN WOODFERN | Nt Fern | 5 | x | - | - | - | - | - | - | - | x | - | - | - |
| ELAEAGNUS UMBELLATA | AUTUMN OLIVE | Ad Shrub | 0 | - | x | x | - | - | - | x | - | - | x | - | x |
| EPIPACTIS HELLEBORINE | HELLEBORINE | Ad P-Forb | 0 | x | - | - | - | - | - | - | - | - | - | - | - |
| Equisetum fluviatile | WATER HORSETAIL | Nt Fern Ally | 7 | x | - | - | - | x | - | - | x | x | x | - | - |
| Equisetum sp. | HORSE TAIL | Nt Fern Ally | | - | x | - | - | - | - | - | - | - | - | - | - |
| Erigeron annuus | ANNUAL FLEABANE | Nt B-Forb | 0 | - | - | - | x | - | - | x | - | - | - | - | - |
| Eupatorium maculatum | JOE PYE WEED | Nt P-Forb | 4 | - | x | x | - | x | - | x | x | x | x | x | - |
| Eupatorium perfoliatum | COMMON BONESET | Nt P-Forb | 4 | - | x | - | - | - | - | x | x | - | - | x | - |
| Euphorbia corollata | FLOWERING SPURGE | Nt P-Forb | 4 | - | - | - | - | - | - | x | - | - | - | - | - |
| Euthamia graminifolia | GRASS LEAVED GOLDENROD | Nt P-Forb | 3 | - | x | x | x | - | - | x | - | - | x | - | - |
| Fagus grandifolia | AMERICAN BEECH | Nt Tree | 6 | x | - | - | - | - | x | x | - | - | - | - | - |
| Fragaria virginiana | WILD STRAWBERRY | Nt P-Forb | 2 | x | x | x | - | - | - | x | - | - | - | - | - |
| Fraxinus americana | WHITE ASH | Nt Tree | 5 | x | - | - | - | - | x | x | x | - | - | - | - |
| Fraxinus nigra | BLACK ASH | Nt Tree | 6 | x | - | x | - | x | x | x | x | x | x | - | - |
| Fraxinus pennsylvanica | RED ASH | Nt Tree | 2 | - | - | x | - | - | - | x | - | - | - | - | - |
| Galium asprellum | ROUGH BEDSTRAW | Nt P-Forb | 5 | x | - | - | - | x | x | - | x | - | - | x | - |
| Galium circaezans | WHITE WILD LICORICE | Nt P-Forb | 4 | - | - | - | - | - | x | - | - | - | - | - | - |

**Appendix 4.** continued

| | | Site Name | | HCS | GMP | SWP | SMP | STF | SMF | DMF | SCF | 31M | SCW | SWM | NCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Site Code** | | **O** | **P** | **V** | **R** | **S** | **T** | **U** | **Q** | **W** | **X** | **Y** | **Z** |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | | | | | | |
| Galium concinnum | SHINING BEDSTRAW | Nt P-Forb | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| Galium triflorum | FRAGRANT BEDSTRAW | Nt P-Forb | 4 | x | - | - | - | - | - | - | - | - | - | - | - |
| Gentiana andrewsii | BOTTLE GENTIAN | Nt P-Forb | 5 | - | - | x | - | - | - | - | - | - | - | - | - |
| Geranium maculatum | WILD GERANIUM | Nt P-Forb | 4 | x | - | - | - | - | x | x | - | - | - | - | - |
| Geum canadense | WHITE AVENS | Nt P-Forb | 1 | - | - | - | - | - | x | - | - | - | - | - | - |
| Geum rivale | PURPLE AVENS | Nt P-Forb | 7 | x | - | - | - | - | - | - | - | - | - | - | - |
| Glyceria striata | FOWL MANNA GRASS | Nt P-Grass | 4 | x | - | - | - | x | - | x | x | x | - | - | - |
| Hamamelis virginiana | WITCH HAZEL | Nt Shrub | 5 | x | - | - | - | - | x | - | - | - | - | - | - |
| Hepatica acutiloba | SHARP LOBED HEPATICA | Nt P-Forb | 8 | x | - | - | - | - | x | - | - | - | - | - | - |
| Hepatica americana | ROUND LOBED HEPATICA | Nt P-Forb | 6 | x | - | - | - | - | - | - | - | - | - | - | - |
| HESPERIS MATRONALIS | DAME'S ROCKET | Ad P-Forb | 0 | x | - | - | - | - | - | - | - | - | - | - | - |
| Hieracium sp. | HAWK WEED | Ad P-Forb | 0 | - | x | - | x | - | - | - | - | - | - | - | - |
| Hydrastis canadensis | GOLDENSEAL | Nt P-Forb | 10 | - | - | - | - | - | x | - | - | - | - | - | - |
| Hypericum prolificum | SHRUBBY ST. JOHN'S WORT | Nt Shrub | 5 | - | - | - | x | - | - | - | - | - | - | - | - |
| Ilex verticillata | MICHIGAN HOLLY | Nt Shrub | 5 | - | - | - | - | - | - | - | - | x | - | - | - |
| Impatiens capensis | SPOTTED TOUCH ME NOT | Nt A-Forb | 2 | x | - | - | - | - | x | x | x | x | - | x | - |
| Iris virginica | SOUTHERN BLUE FLAG | Nt P-Forb | 5 | - | - | - | - | - | - | - | - | x | x | x | - |
| Juglans nigra | BLACK WALNUT | Nt Tree | 5 | - | - | - | x | - | - | - | x | - | - | - | - |
| Juncus dudleyi | DUDLEY'S RUSH | Nt P-Forb | 1 | - | - | x | - | - | - | - | - | - | - | - | - |
| Juncus effusus | SOFT STEMMED RUSH | Nt P-Forb | 3 | - | - | - | - | - | - | - | - | - | x | - | - |
| Juncus tenuis | PATH RUSH | Nt P-Forb | 1 | - | x | - | - | - | - | - | - | - | - | - | - |
| Juniperus virginiana | RED CEDAR | Nt Tree | 3 | - | x | - | - | - | - | x | - | - | - | - | - |
| Laportea canadensis | WOOD NETTLE | Nt P-Forb | 4 | x | - | - | - | - | x | - | x | - | - | - | - |
| Larix laricina | TAMARACK | Nt Tree | 5 | x | x | - | - | x | - | - | x | x | x | - | - |
| Lespedeza capitata | ROUND HEADED BUSH | Nt P-Forb | 5 | - | x | - | x | - | - | x | - | - | - | - | - |
| LIGUSTRUM OBTUSIFOLIUM | BORDER PRIVET | Ad Shrub | 0 | - | - | - | x | - | - | x | - | - | - | - | - |
| Lindera benzoin | SPICEBUSH | Nt Shrub | 7 | x | - | - | - | - | x | x | - | - | - | - | - |
| Liparis loeselii | LOESEL'S TWAYBLADE | Nt P-Forb | 5 | x | x | - | - | - | - | - | - | - | - | - | - |
| Liriodendron tulipifera | TULIP TREE | Nt Tree | 9 | x | - | - | - | - | - | - | - | - | - | - | - |
| Lobelia siphilitica | GREAT BLUE LOBELIA | Nt P-Forb | 4 | - | x | x | - | - | - | - | - | - | - | - | - |
| Lobelia spicata | PALE SPIKED LOBELIA | Nt P-Forb | 4 | - | x | x | - | - | - | - | - | - | - | - | - |
| LONICERA MORROWII | MORROW HONEYSUCKLE | Ad Shrub | 0 | - | - | - | x | - | - | x | - | x | x | - | x |
| Lycopus americanus | COMMON WATER HOREHOUND | Nt P-Forb | 2 | - | x | - | - | x | - | - | x | x | x | - | - |

**Appendix 4.** continued

| | | Site Name | | HCS | GMP | SWP | SMP | STF | SMF | DMF | SCF | 31M | SCW | SWM | NCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Site Code | | O | P | V | R | S | T | U | Q | W | X | Y | Z |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | | | | | | |
| Lycopus uniflorus | NORTHERN BUGLE WEED | Nt P-Forb | 2 | - | - | - | - | x | - | - | - | x | - | x | - |
| LYSIMACHIA NUMMULARIA | MONEYWORT | Ad P-Forb | 0 | - | - | - | - | - | - | - | - | x | - | - | - |
| Lysimachia quadriflora | WHORLED LOOSESTRIFE | Nt P-Forb | 10 | - | - | x | - | - | - | - | - | - | - | - | - |
| LYTHRUM SALICARIA | PURPLE LOOSESTRIFE | Ad P-Forb | 0 | - | x | - | - | - | - | - | - | - | - | - | - |
| Maianthemum canadense | CANADA MAYFLOWER | Nt P-Forb | 4 | x | - | - | - | - | x | - | - | - | - | - | - |
| MELILOTUS ALBA | WHITE SWEET CLOVER | Ad B-Forb | 0 | - | x | - | - | - | - | - | - | - | - | - | - |
| MELILOTUS OFFICINALIS | YELLOW SWEET CLOVER | Ad B-Forb | 0 | - | - | - | - | - | - | - | - | - | - | - | x |
| Menispermum canadense | MOONSEED | Nt W-Vine | 5 | - | - | - | - | - | - | - | - | - | - | - | - |
| Mentha arvensis | WILD MINT | Nt P-Forb | 3 | - | - | - | - | x | - | x | - | - | - | x | - |
| Mitella diphylla | BISHOP'S CAP | Nt P-Forb | 8 | x | - | - | - | - | x | - | - | - | - | - | - |
| Mitella nuda | NAKED MITERWORT | Nt P-Forb | 8 | x | - | - | - | - | - | - | - | - | - | - | - |
| Monarda fistulosa | WILD BERGAMOT | Nt P-Forb | 2 | - | - | x | x | - | - | - | - | - | x | - | - |
| Muhlenbergia glomerata | MARSH WILD TIMOTHY | Nt P-Grass | 10 | - | - | - | - | x | - | - | - | - | - | - | - |
| MYOSOTIS SCORPIOIDES | FORGET ME NOT | Ad P-Forb | 0 | - | - | - | - | - | - | - | x | - | - | x | - |
| Onoclea sensibilis | SENSITIVE FERN | Nt Fern | 2 | x | - | - | - | x | x | x | x | x | x | x | - |
| Osmorhiza claytonii | HAIRY SWEET CICELY | Nt P-Forb | 4 | x | - | - | - | - | x | x | - | - | - | - | - |
| Osmunda cinnamomea | CINNAMON FERN | Nt Fern | 5 | x | - | - | - | - | x | - | - | - | - | - | - |
| Osmunda regalis | ROYAL FERN | Nt Fern | 5 | x | - | - | - | - | x | - | - | - | - | - | - |
| Ostrya virginiana | IRONWOOD; HOP HORNBEAM | Nt Tree | 5 | x | - | - | - | - | x | x | - | - | - | - | - |
| Panax quinquefolius | GINSENG | Nt P-Forb | 10 | - | - | - | - | - | x | - | - | - | - | - | - |
| Parnassia glauca | GRASS OF PARNASSUS | Nt P-Forb | 8 | - | - | - | - | x | - | - | - | - | - | - | - |
| Parthenocissus quinquefolia | VIRGINIA CREEPER | Nt W-Vine | 5 | x | - | - | x | x | x | x | - | x | - | - | - |
| Pedicularis lanceolata | SWAMP BETONY | Nt P-Forb | 8 | - | - | - | - | - | - | - | - | - | - | - | - |
| Penstemon hirsutus | HAIRY BEARD TONGUE | Nt P-Forb | 5 | - | - | - | - | - | - | - | - | - | x | - | - |
| Phalaris arundinacea | REED CANARY GRASS | Nt P-Grass | 0 | - | x | - | - | - | - | - | x | x | x | x | - |
| PHLEUM PRATENSE | TIMOTHY | Ad P-Grass | 0 | - | - | x | x | - | - | x | - | - | - | - | x |
| Phlox divaricata | WOODLAND PHLOX | Nt P-Forb | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| Phlox pilosa | PRAIRIE PHLOX | Nt P-Forb | 7 | - | - | - | - | - | - | x | - | - | - | - | - |
| Phragmites australis | REED | Nt P-Grass | 0 | - | x | - | - | - | - | - | - | - | - | - | - |
| Physocarpus opulifolius | NINEBARK | Nt Shrub | 4 | - | - | - | - | - | - | - | x | x | - | - | - |
| Pilea pumila | CLEARWEED | Nt A-Forb | 5 | x | - | - | - | - | - | - | x | - | x | x | - |
| Pinus resinosa | RED PINE | Nt Tree | 6 | - | - | - | - | - | - | x | - | - | - | - | - |
| Pinus strobus | WHITE PINE | Nt Tree | 3 | x | - | - | - | - | - | - | - | - | - | - | - |
| POA PRATENSIS | KENTUCKY BLUEGRASS | Ad P-Grass | 0 | - | - | - | - | - | - | x | - | - | - | - | x |

**Appendix 4.** continued

| | | Site Name | | HCS | GMP | SWP | SMP | STF | SMF | DMF | SCF | 31M | SCW | SWM | NCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Site Code | | O | P | V | R | S | T | U | Q | W | X | Y | Z |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | | | | | | |
| Podophyllum peltatum | MAY APPLE | Nt P-Forb | 3 | x | - | - | - | x | x | x | - | - | - | - | - |
| Polygonatum biflorum | SOLOMON SEAL | Nt P-Forb | 4 | x | - | - | - | - | x | - | - | x | - | - | - |
| Polygonum amphibium | WATER SMARTWEED | Nt P-Forb | 6 | - | - | - | - | - | - | - | x | - | - | x | - |
| Polygonum virginianum | JUMPSEED | Nt P-Forb | 4 | - | - | - | - | - | x | - | - | x | - | - | - |
| Polymnia canadensis | LEAFCUP | Nt P-Forb | 6 | x | - | - | - | - | - | - | - | - | - | - | - |
| Polystichum acrostichoides | CHRISTMAS FERN | Nt Fern | 6 | x | - | - | - | - | x | x | - | - | - | - | - |
| POPULUS ALBA | WHITE POPLAR | Ad Tree | 0 | - | x | - | - | - | - | - | - | - | - | - | - |
| Populus balsamifera | BALSAM POPLAR | Nt Tree | 2 | - | - | - | - | - | - | x | - | - | - | - | - |
| Populus deltoides | COTTONWOOD | Nt Tree | 1 | x | - | - | - | - | - | - | - | - | x | - | - |
| Populus tremuloides | QUAKING ASPEN | Nt Tree | 1 | - | - | x | - | - | - | - | x | - | x | - | - |
| Potentilla fruticosa | SHRUBBY CINQUEFOIL | Nt Shrub | 10 | - | - | x | - | x | - | - | - | x | - | - | - |
| Potentilla simplex | OLD FIELD CINQUEFOIL | Nt P-Forb | 2 | - | x | x | - | - | - | x | - | - | - | - | - |
| Prenanthes alba | WHITE LETTUCE | Nt P-Forb | 5 | x | - | - | - | - | x | x | - | - | - | - | - |
| Prunus serotina | WILD BLACK CHERRY | Nt Tree | 2 | x | - | - | x | - | x | x | - | - | - | - | - |
| Prunus virginiana | CHOKE CHERRY | Nt Shrub | 2 | x | - | - | - | - | - | - | - | - | - | - | - |
| Pteridium aquilinum | BRACKEN FERN | Nt Fern | 0 | - | - | - | - | - | x | x | - | - | - | - | - |
| Pycnanthemum virginianum | COMMON MOUNTAIN MINT | Nt P-Forb | 5 | - | x | x | x | - | - | - | - | x | x | - | - |
| Quercus alba | WHITE OAK | Nt Tree | 5 | - | - | - | - | - | x | x | - | - | - | - | - |
| Quercus bicolor | SWAMP WHITE OAK | Nt Tree | 8 | x | - | - | - | x | x | - | x | x | x | x | - |
| Quercus rubra | RED OAK | Nt Tree | 5 | x | - | - | - | - | x | x | - | - | - | - | - |
| Quercus velutina | BLACK OAK | Nt Tree | 6 | - | - | - | x | - | - | x | - | - | - | - | - |
| Ranunculus abortivus | SMALL FLOWERED BUTTERCUP | Nt A-Forb | 0 | - | - | - | - | - | - | x | - | - | - | - | - |
| Rhamnus alnifolia | ALDER LEAVED BUCKTHORN | Nt Shrub | 8 | - | - | - | - | x | - | - | - | - | - | - | - |
| RHAMNUS CATHARTICA | COMMON BUCKTHORN | Ad Tree | 0 | - | - | - | - | x | - | x | - | - | - | - | - |
| RHAMNUS FRANGULA | GLOSSY BUCKTHORN | Ad Shrub | 0 | - | - | - | - | x | - | - | - | x | x | - | x |
| Ribes hirtellum | SWAMP GOOSEBERRY | Nt Shrub | 6 | - | - | - | - | x | - | - | - | - | - | x | - |
| ROSA MULTIFLORA | MULTIFLORA ROSE | Ad Shrub | 0 | - | - | - | - | x | - | - | - | - | - | - | - |
| Rosa palustris | SWAMP ROSE | Nt Shrub | 5 | - | - | - | - | - | - | - | - | x | - | - | - |
| Rubus flagellaris | NORTHERN DEWBERRY | Nt Shrub | 1 | - | - | - | x | - | - | - | - | - | - | - | - |
| Rubus pubescens | DWARF RASPBERRY | Nt P-Forb | 4 | x | - | - | - | x | - | - | x | - | - | x | - |
| Rubus strigosus | WILD RED RASPBERRY | Nt Shrub | 2 | - | - | - | x | - | - | - | - | - | - | - | - |
| Rudbeckia hirta | BLACK EYED SUSAN | Nt P-Forb | 1 | - | x | x | - | - | - | - | - | - | - | - | - |
| Rudbeckia laciniata | CUT LEAVED CONEFLOWER | Nt P-Forb | 6 | x | - | - | - | - | - | - | - | - | - | - | - |

**Appendix 4.** continued

| | | Site Name | | HCS | GMP | SWP | SMP | STF | SMF | DMF | SCF | 31M | SCW | SWM | NCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Site Code | | O | P | V | R | S | T | U | Q | W | X | Y | Z |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | | | | | | |
| RUMEX ACETOSELLA | SHEEP SORREL | Ad P-Forb | 0 | - | - | - | - | - | - | x | - | - | - | - | x |
| Sagittaria latifolia | COMMON ARROWHEAD | Nt P-Forb | 1 | - | - | - | - | - | - | - | - | x | - | - | - |
| Salix bebbiana | BEBB'S WILLOW | Nt Shrub | 1 | - | x | - | - | - | - | - | x | x | - | - | - |
| Salix candida | HOARY WILLOW | Nt Shrub | 9 | - | - | - | - | x | - | - | - | - | - | - | - |
| Salix discolor | PUSSY WILLOW | Nt Shrub | 1 | - | x | - | - | - | - | - | - | - | - | - | - |
| Salix exigua | SANDBAR WILLOW | Nt Shrub | 1 | - | x | - | - | - | - | - | - | - | x | - | - |
| Salix pedicellaris | BOG WILLOW | Nt Shrub | 8 | - | x | - | - | - | - | - | - | - | - | - | - |
| Sanicula gregaria | BLACK SNAKEROOT | Nt P-Forb | 2 | x | - | - | - | - | x | - | - | x | - | - | - |
| Sassafras albidum | SASSAFRAS | Nt Tree | 5 | x | - | - | - | - | - | x | - | - | - | - | - |
| Scirpus atrovirens | BULRUSH | Nt P-Sedge | 3 | - | - | x | - | x | - | - | x | - | x | x | - |
| Scirpus cyperinus | WOOL GRASS | Nt P-Sedge | 5 | - | x | x | - | x | - | - | - | - | - | - | - |
| Scutellaria galericulata | COMMON SKULLCAP | Nt P-Forb | 5 | - | - | - | - | - | - | - | - | x | - | - | - |
| Senecio aureus | GOLDEN RAGWORT | Nt P-Forb | 5 | x | - | - | - | - | - | - | - | x | - | - | - |
| Sium suave | WATER PARSNIP | Nt P-Forb | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| Smilacina stellata | STARRY FALSE SOLOMON SEAL | Nt P-Forb | 5 | - | - | - | - | x | - | - | - | - | - | - | - |
| SOLANUM DULCAMARA | BITTERSWEET NIGHTSHADE | Ad P-Forb | 0 | - | - | - | - | x | - | - | - | - | - | - | - |
| Solidago altissima | TALL GOLDENROD | Nt P-Forb | 1 | - | - | - | - | - | - | - | - | - | x | - | - |
| Solidago flexicaulis | BROAD LEAVED GOLDENROD | Nt P-Forb | 6 | x | - | - | - | - | - | - | - | - | - | - | - |
| Solidago gigantea | LATE GOLDENROD | Nt P-Forb | 3 | - | - | x | - | - | - | - | x | x | x | x | - |
| Solidago juncea | EARLY GOLDENROD | Nt P-Forb | 3 | - | - | - | - | - | - | - | - | - | - | - | x |
| Solidago nemoralis | OLD FIELD GOLDENROD | Nt P-Forb | 2 | - | - | - | x | - | - | - | - | - | - | - | - |
| Solidago ohioensis | OHIO GOLDENROD | Nt P-Forb | 8 | - | x | - | - | - | - | - | - | - | - | - | - |
| Solidago patula | SWAMP GOLDENROD | Nt P-Forb | 6 | x | x | - | - | x | - | - | - | - | - | - | - |
| Solidago riddellii | RIDDELL'S GOLDENROD | Nt P-Forb | 6 | - | x | - | - | - | - | - | - | - | - | - | - |
| Solidago uliginosa | BOG GOLDENROD | Nt P-Forb | 4 | - | - | - | - | x | - | - | - | - | - | - | - |
| Sorbus americana | AMERICAN MOUNTAIN ASH | Nt Tree | 4 | - | - | - | - | x | - | - | - | x | - | - | - |
| Sorghastrum nutans | INDIAN GRASS | Nt P-Grass | 6 | - | - | - | - | - | - | x | - | - | - | - | - |
| Sparganium eurycarpum | COMMON BUR REED | Nt P-Forb | 5 | - | - | - | - | - | - | - | - | x | - | - | - |
| Spiraea alba | MEADOWSWEET | Nt Shrub | 4 | - | - | - | - | - | - | - | x | x | - | x | - |
| Spiranthes ovalis | OVAL LADIES' TRESSES | Nt P-Forb | 9 | - | x | - | - | - | - | - | - | - | - | - | - |
| Staphylea trifolia | BLADDERNUT | Nt Shrub | 9 | x | - | - | - | - | - | - | - | - | - | - | - |
| Symplocarpus foetidus | SKUNK CABBAGE | Nt P-Forb | 6 | x | - | - | - | x | x | - | x | - | x | x | - |
| TARAXACUM OFFICINALE | COMMON DANDELION | Ad P-Forb | 0 | - | - | - | x | - | - | - | - | - | - | - | - |

**Appendix 4.** continued

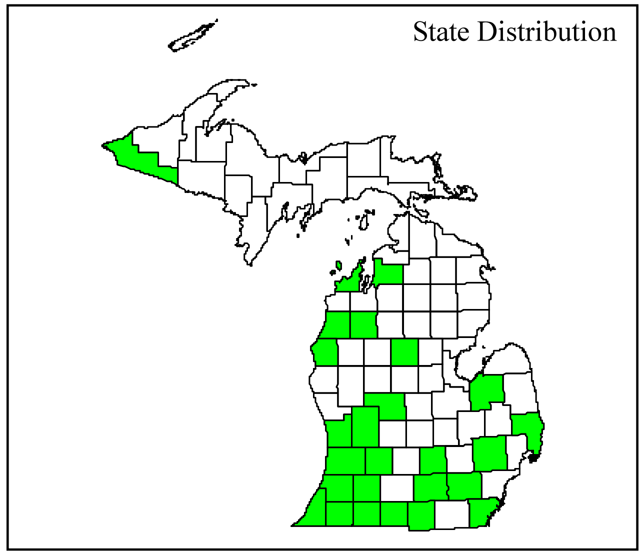
| | | | Site Name | HCS | GMP | SWP | SMP | STF | SMF | DMF | SCF | 31M | SCW | SWM | NCF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Site Code | O | P | V | R | S | T | U | Q | W | X | Y | Z |
| **Scientific Name** | **Common name** | **Life Form** | **C** | | | | | | | | | | | | |
| Thalictrum dasycarpum | PURPLE MEADOW RUE | Nt P-Forb | 3 | - | - | - | - | x | - | - | - | - | - | - | - |
| Thalictrum dioicum | EARLY MEADOW RUE | Nt P-Forb | 6 | x | - | - | - | x | x | x | x | x | x | x | - |
| Thelypteris hexagonoptera | BROAD BEECH FERN | Nt Fern | 8 | - | - | - | - | - | x | - | - | - | - | - | - |
| Thelypteris noveboracensis | NEW YORK FERN | Nt Fern | 5 | x | - | - | - | - | x | - | - | x | - | - | - |
| Thelypteris palustris | MARSH FERN | Nt Fern | 2 | - | - | - | - | x | - | - | x | x | - | x | - |
| Thuja occidentalis | WHITE CEDAR | Nt Tree | 4 | x | x | - | - | - | - | - | - | - | x | - | - |
| Tilia americana | BASSWOOD | Nt Tree | 5 | x | - | - | - | - | x | x | - | - | - | - | - |
| Toxicodendron radicans | POISON IVY | Nt W-Vine | 2 | x | - | x | x | x | x | x | x | - | - | - | - |
| Toxicodendron vernix | POISON SUMAC | Nt Shrub | 6 | - | - | - | - | x | - | - | - | x | - | - | - |
| Trientalis borealis | STARFLOWER | Nt P-Forb | 5 | x | - | - | - | - | - | - | - | - | - | - | - |
| TRIFOLIUM DUBIUM | LITTLE HOP CLOVER | Ad A-Forb | 0 | - | - | - | - | - | - | - | - | - | - | - | x |
| TYPHA ANGUSTIFOLIA | NARROW LEAVED CATTAIL | Ad P-Forb | 0 | - | - | - | - | x | - | - | - | - | x | - | - |
| Typha latifolia | BROAD LEAVED CATTAIL | Nt P-Forb | 1 | - | x | - | - | - | - | x | - | x | x | - | - |
| Ulmus americana | AMERICAN ELM | Nt Tree | 1 | x | - | - | x | x | x | x | x | x | x | - | - |
| Urtica dioica | NETTLE | Nt P-Forb | 1 | - | - | - | - | - | x | - | - | - | - | - | - |
| Utricularia | BLADDERWORT | Nt Forb | | - | x | - | - | - | - | - | - | - | - | - | - |
| Uvularia grandiflora | BELLWORT | Nt P-Forb | 5 | x | - | - | - | - | x | - | - | - | - | - | - |
| Vaccinium corymbosum | SMOOTH HIGHBUSH BLUEBERRY | Nt Shrub | 6 | x | - | - | - | - | - | - | - | - | - | - | - |
| Valeriana uliginosa | BOG VALERIAN | Nt P-Forb | 10 | - | - | - | - | x | - | - | - | - | - | - | - |
| VERBASCUM THAPSUS | COMMON MULLEIN | Ad B-Forb | 0 | - | - | - | - | - | - | - | - | - | - | - | x |
| Veronicastrum virginicum | CULVER'S ROOT | Nt P-Forb | 8 | - | - | x | - | - | - | - | - | - | - | - | - |
| Viburnum acerifolium | MAPLE LEAVED ARROW WOOD | Nt Shrub | 6 | x | - | - | - | - | - | - | - | - | - | - | - |
| Viburnum lentago | NANNYBERRY | Nt Shrub | 4 | - | - | - | - | x | - | - | - | x | - | - | - |
| VIBURNUM OPULUS | EUROPEAN HIGHBUSH | Ad Shrub | 0 | - | - | - | - | x | - | - | - | x | - | - | - |
| Vitis riparia | RIVERBANK GRAPE | Nt W-Vine | 3 | x | - | - | - | x | - | - | - | - | x | - | - |
| Zanthoxylum americanum | PRICKLY ASH | Nt Shrub | 3 | x | - | - | - | - | - | - | - | - | x | - | - |
| Zizia aurea | GOLDEN ALEXANDERS | Nt P-Forb | 6 | - | - | x | - | x | - | x | - | - | - | - | - |
| **Total number of species observed in survey site** | | | | **102** | **48** | **38** | **30** | **62** | **63** | **40** | **39** | **60** | **41** | **30** | **18** |
| **Total number of species observed in Stony Creek Metropark: 274** | | | | | | | | | | | | | | | |

Appendix 5.
Rare Plant and Natural Community Abstracts for:

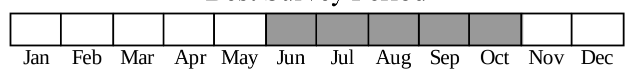
- Ginsing
- Goldenseal
- Oak Barrens
- Relict Conifer Swamp
- Southern Wet Meadow
- Prairie Fen

For additional rare species and natural community abstracts go to:
http://www.dnr.state.mi.us/wildlife/heritage/mnfi/abstracts.htm

# *Panax quinquefolius* L. — ginseng


Best Survey Period




**Status**: state threatened, federal species of concern

**Global and state rank**: G4/S2S3

**Other common names**: "seng"

**Family**: Araliaceae

**Taxonomy**: There are eight species of ginseng in the world, seven in the genus *Panax* and one in the genus *Eleutherococcus*, the latter an Asian group of shrubs. Only three species, however, are widely used in herbal medicine, for which ginseng is widely known. These include American ginseng (*Panax quinquefolius)*, native to North America, Oriental ginseng (*P. ginseng*) native to Manchuria and Korea, and Siberian ginseng (*Eleutherococcus* [*Acanthopanax*] *senticosus*), native to Siberia (Castleman 1990). Populations of the latter two species, once abundant throughout Siberia, Korea, and Central China, have seriously declined due to intensive collection over centuries. This decline, in part initiated the advent of the trade in North American ginseng.

**Total range**: *Panax quinquefolius* ranges from the province of Quebec west to Minnesota and south to Georgia and Oklahoma. It has declined considerably throughout much of its range due to exploitation of the root for export to the Far East. Although it is listed as threatened in the State of Michigan, there has been sufficient concern over its status in the United States such that the U.S. Endangered Species Scientific Authority banned its export during the 1977-78 season from all states except Michigan. Michigan was exempted because of its permit system governing the collection of ginseng (Laycock 1978). Currently, American ginseng export is regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) agreement. It can only be exported if it is shown to be legally obtained and determined not detrimental to the survival of the species. States are given control over the management and certification for export of ginseng within their boundaries and are required to develop and implement a ginseng management program. They are required to submit specific export findings on a three year schedule.

**State distribution**: Michigan occurrences of ginseng are concentrated in the southern three tiers of counties in the Lower Peninsula, primarily in woodlots and wooded coastal dunes, where populations typically are small, sometimes consisting of only a few individuals. The small population size is likely due to extensive woodlot grazing and to the considerable exploitation of this species for the ginseng trade over the years. There are scattered occurrences of ginseng in the northern Lower Peninsula counties, including the northwestern region where it is quite rare, and the thumb region where it is infrequent. Documented occurrences in the thumb region often include a wider age-range of plants than in the south, usually including the presence of some large, old individuals. In the Upper Peninsula, ginseng has been found only in Gogebic County.

**Recognition**: *Panax quinquefolius* grows from a **fleshy and often forked taproot** for which it is widely known. At maturity it has a **single whorl** (growing from the same point along the stem) **of 3-5 palmately compound leaves**

**each with 3-5 stalked and toothed leaflets**. The leaflets are widest just before they reach the abruptly pointed tip; typically there are 3 large and 2 small leaflets. **A central cluster (umbel) of small greenish-white flowers** rises above the leaves and produces **bright crimson, berry-like fruits** at maturity, each bearing from 1-3 seeds. Ginseng is perhaps most frequently confused with Virginia creeper *(Parthenocissus* spp.), one of its most frequent associates, due to its similar palmately compound leaves with five leaflets. As can be seen in the upper right-hand corner of the photo, the leaflets of Virginia creeper are more coarsely toothed than those of ginseng and are of equal size. Ginseng is also easily confused with such look-alike plants as black snakeroot species (*Sanicula* spp.) and honewort (*Cryptotaenia canadensis*), especially when plants are in juvenile stages characterized by a single leaf with three leaflets. Ginseng can be distinguished from these look-alikes by the small unbranched hairs along the major veins of its leaves; these are usually lacking in the other species. Another look-alike plant is wild sarsaparilla (*Aralia nudicaulis*) which is of superficially similar size and form. The leaves of wild sarsaparilla, however, are alternate (arising from different points along the stem) instead of whorled and the leaflets are arranged in either side of a central axis (pinnately compound) instead of radiating from a central point. Finally, ginseng is also easily confused with young hickory seedlings which have similar palmately-compound leaves and can at first glance appear herbaceous.

**Best survey time/phenology**: Although *Panax quinquefolius* can, upon close inspection, be recognized during the entire growing season, it is much more difficult to find amongst its associates when not in flower or fruit. It is most reliably sought during the flowering and fruiting stages which typically occur from June to October. This species, however, is notably difficult to find even during these stages according to the numerous accounts of collectors.

**Habitat**: This species is predominantly found in rich hardwoods, often on slopes or ravines, ranging even into swampy portions. It also occurs in wooded dune hollows and leeward slopes along the Lake Michigan shoreline. According to Duane Honsowetz, a long time ginseng hunter in Michigan, Floyd Swink provides the best description of its habitat in *Plants of the Chicago Region* (1974): "in rich woods, with greater occurrence on north-facing slopes. Associates include sugar maple (*Acer saccharum*), white baneberry (*Actaea pachypoda*), maidenhair fern (*Adiantum pedatum*), rattlesnake fern (*Botrychium virginianum*) (known in the south for its ability to indicate "seng" habitat), bitternut hickory (*Carya cordiformis*), blue cohosh (*Caulophyllum thalictroides*), toothwort (*Dentaria* spp.), Dutchman's breeches (*Dicentra cucullaria*), running strawberry bush (*Euonymous obovata*), sharp-lobed hepatica (*Hepatica acutiloba*), red oak (*Quercus rubra*), bloodroot (*Sanguinaria canadensis*), false Solomon's seal (*Smilacina* spp.), basswood (*Tilia americana*), and bellwort (*Uvularia grandiflora*)." Honsowetz adds red maple (*Acer* rubrum) and white ash (*Fraxinus americana*) to the list of associates. He further states that ginseng grows best in heavy soils (clay mixed with gravel) covered with leaf mold or rotted wood. It also grows in clay, sandy-loam or sometimes silt; however, the roots of plants growing in these soils may be considered lower in quality by ginseng collectors.

**Biology**: Ginseng is a long-lived perennial herb, germinating from seed in early spring 18-22 months after the seeds drop to the ground. The embryo is inactive during the first winter, matures during the next growing season, and then endures a second winter before it is able to germinate (Hu *et al*. 1980). A special underground stem known as a verticle rhizome sits on top of the main root and sends up the above-ground stem each year. During the first year, it grows to approximately 2-5 inches and produces one leaf (commonly termed a "prong") composed of 2-3 leaflets. Additional leaves and leaflets are produced during successive years as the plant ages, depending upon environmental conditions. Typical mature plants develop three leaves, each with five leaflets. Older plants may produce four or even five leaves. Flowering may occur during the fourth year; however, often it is not until the fifth year or later that mature fruit is produced. Flowering occurs during June and July, with the flowers developing small green fruits in late July and early August. In late August and September the fruits ripen, becoming bright crimson in color, with each berry-like fruit containing one to two or rarely three seeds.

When the above-ground stem dies with the onset of frost, a scar remains on the rhizome where the stem was attached. Each successive above-ground stem leaves a scar above the last year's scar and by counting these scars the approximate age of the plant can be determined. The mass of the root increases with each successive year such that the size of the above-ground plant serves to predict the size of the root (Anderson *et al*. no date).

Known pollinators of ginseng include halicted sweat bees (*Dialictus* spp.) and syrphid hover-flies (*Toxomerus geminatus*) (Duke 1980). Ginseng has also been shown to be capable of self-pollination. Data as to the relative proportion of each breeding system for sample populations have been mixed. It is likely correlated to local environmental conditions and availablility of pollinators. Seed survival has been shown to be low and the number of offspring produced (fecundity) has been shown to be correlated with age and size, and regulated by the availability of resources (Lewis *et al.* 1982; Schlessman 1985).

**Conservation/management**: The primary cause of decline for this species is that of exploitation by collectors in response to consumer demand, particularly in the Orient where ginseng is esteemed and highly prized as an herbal elixir or tonic with numerous uses. Its use as a medicinal herb in the Far East dates back thousands of years. The occasional resemblance of the roots to the human form led to the belief that ginseng had curative properties for the entire body. Ginseng root is consumed in teas, powders, pills, soft drinks, and many other products, comprising a highly valued trade product. As the Far Eastern species began seriously declining, the American ginseng trade became lucrative. The demand for wild ginseng remains high, and not unexpectedly, American populations have shown significant declines as well. Although cultivation of ginseng does occur, the demand for the cultivated root remains well below that which is of wild origin, and thus is not likely to significantly deter the harvesting of natural populations. In Michigan, owing to a lack of knowledge of the current status of this species' recorded occurrences, it is unlikely that harvesting will be legally permitted until the statewide status is reliably assessed.

In addition to widespread exploitation, ginseng has also declined due to significant habitat loss and modification. This has resulted from extensive timber cutting and disturbance through habitat fragmentation, especially in southern Michigan. Although little specific research and monitoring has been conducted to establish that ginseng populations suffer in response to disturbance, the majority of documented populations in Michigan are found in relatively undisturbed habitat and appear vulnerable to overstory removal. According to one Michigan collector (Honsowetz), ginseng has never been found in grazed woodlots. The conservation of relatively large, ecologically viable tracts of rich woodland habitat is critical to the maintenance of this species in Michigan.

**Comments**: The Michigan Ginseng Act, Public Act 184 of 1994, was passed at the encouragement of the Michigan Department of Agriculture to assist in the certification and legal export of cultivated ginseng.

**Research needs**: Perhaps the primary research need at the present is a comprehensive state inventory to determine the status and extent of the state's ginseng population, such that harvesting of wild stock may be considered or continue to be prohibited.

**Related abstracts**: mesic northern forest, assiniboia sedge, fairy bells, goblin fern, green spleenwort, Hart's-tongue fern, large toothwort, showy orchis walking fern, red-shouldered hawk

**Selected references**


Anderson, R.C., H.S. Fralish, H. Armstrong, P. Benjamin. No date. Biology of Ginseng (*Panax quinquefolium*) in Illinois. In cooperation with the Illinois Dept. of Conservation - Div. of Forest Res. and Natural Heritage, Springfield, IL 62706.

Castleman, M. 1990. Ginseng revered and reviled. The Herb Quarterly, Winter 1990. pp. 17-24.

Denny, G.C. and J. Glover. 1988. American ginseng; green gold of Ohio's woodlands. 14 page pamphlet for Ohio DNR - Div. of Natural Areas and Preserves, Ginseng Mgmt. Program, Columbus, OH.

Duke, J.A. 1980. Pollinators of *Panax*? Castanea 45:141.

Fountain, M.S. 1982. Site factors associated with natural populations of ginseng in Arkansas. Castanea 47:261-265.

Honsowetz, D.C. 1978. Confessions of a ginseng hunter. Michigan Out-of-Doors. pp. 32-35, 86-87.

Hu, S.Y., L. Rudenberg, and P.D. Tredici. 1980. Studies of American ginseng. Rhodora 82:627-636.

Laycock, G. 1978. Earthlog. Audubon Mag. July. p. 6.

Lewis, W.H. 1984. Population structure and environmental corollaries of *Panax quinquefolium* (Araliaceae) in Delaware county, New York. Rhodora 86:431-438.

Lewis, W.H. and V.E. Zenger. 1982. Population dynamics of the American ginseng (*Panax quinquefolium*) (Araliaceae). Am. J. of Bot. 69:1483-1490.

Lewis, W.H. and V.E. Zenger. 1983. Breeding systems and fecundity in the American ginseng, *Panax quinquefolium* (Araliaceae). Am. J. Bot. 70(3):466-468.

Schlessman, M.A. 1985. Floral biology of American ginseng (*Panax quinquefolium*). Bull. Torrey Bot. Club. Vol 112:129-133.

Singer S.R. 1990. Current status of the U.S. ginseng export program. End. Sp. Tech. Bull. 15(1):9.

Swenk F. and G. Wilhelm. 1974. *Plants of the Chicago Region*. The Morton Arboretum, Lisle, Il 922 pp.


**Abstract citation**

Michigan Natural Features Inventory. 1996. Special plant abstract for *Panax quinquefolius* (ginseng). Lansing, MI. 3 pp.

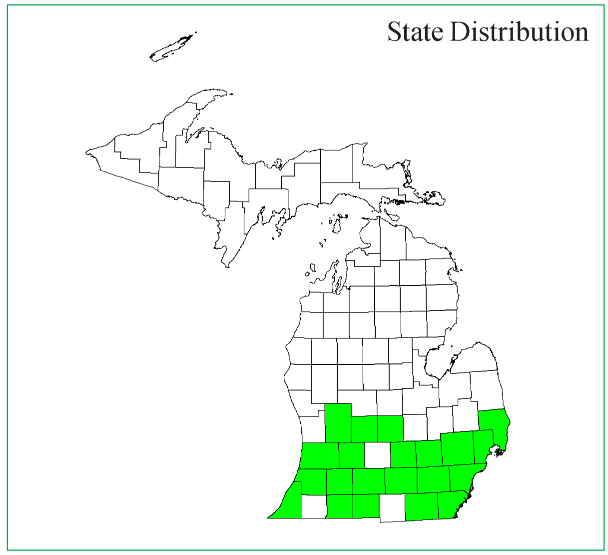
Funding for abstract provided by Michigan Department of Natural Resources - Wildlife Division, Nongame Program.

9-99/mrp

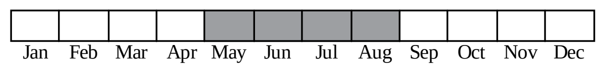
**Michigan Natural Features Inventory**
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

# *Hydrastis canadensis* L. goldenseal


Photo by Daniel Nepstad




Best Survey Period




**Legal status:** State threatened

**Global and state rank:** G4/S2

**Family:** Ranunculaceae (buttercup family)

**Total range:** Goldenseal occurs throughout the eastern half of North America, occurring from Vermont to Minnesota and ranging south to Nebraska, Kansas, Arkansas, Georgia, and Alabama. It is considered rare over several portions of its range, including Connecticut, Delaware, Iowa, Massachusetts, Maryland, Minnesota, Mississippi, Vermont, North Carolina, New York, Virginia, Alabama, Indiana, Tennessee, Wisconsin, and Ontario.

**State distribution:** Goldenseal is currently known from 53 sites in 21 counties, where it is concentrated in the southern three tiers. Nine counties are represented by only a single locality. The species has been discovered or confirmed extant since 1980 at twenty-five localities; eight sites are based on records from 1930 or earlier, many in areas now with widespread development, and where the status of these historical records is largely unknown. Nine occurrences are reported to support more than 100 shoots and only two of those occurrences comprise populations with more than 1000 shoots.

**Recognition:** Goldenseal has an unbranched, hairy stem reaching 20-50 cm in height. Each stem produces one or two leaves near the top. These leaves are **palmately divided (maple-like)** into **five to nine sharply-pointed lobes with toothed margins**. Young leaves are small (3-10 cm wide), **shiny**, and **wrinkled**. When fully flushed, the leaves become dull green, the veins appear deeply impressed on the upper leaf surface, and they expand up to about 25 cm wide. A solitary flower about 15 mm in width terminates the stem. Below the flower is a very reduced bract-like leaf similar in shape to the other leaves. The flower of goldenseal has no petals, although there are **three pale, greenish-white sepals** at the base. These sepals are very ephemeral and **drop as soon as the flower opens**, revealing a **dense spray of conspicuous showy stamens with white, expanded filaments.** The berry-like fruit (8-18 mm) is green when immature, ripening to a **bright red color** and somewhat resembling a large raspberry in appearance. Goldenseal has a thick, knotty rhizome (4-7 cm long, 0.5-2cm wide) that is brown on the surface, with a bright yellow pigment inside, from which the common name is presumably derived.

**Best survey time/phenology:** Goldenseal is most easily identified when in flower or in fruit, but sterile plants can also be reliably determined by those experienced with this clone-forming, rich woodland species. The distinctive flowers are visible from approximately late April through early May. The fruits, first appearing green and then ripening to form a bright red aggregate of achenes, are visible from mid to late-season, about June to early August and perhaps later in some localities.

**Habitat:** Goldenseal typically inhabits shady, rich, mesic southern forests, usually under a canopy of beech-sugar maple or red oak-sugar maple. It frequently occurs in moist microhabitats near vernal pools, along forested streams, and also in southern floodplain forests, often in moist sandy loam, clay loam, or even organic (muck) soils. Overstory species include *Acer saccharum* (sugar maple), *Fagus grandifolia* (American beech), *Quercus rubra* (red oak), *Betula alleghaniensis* (yellow birch ), *Acer saccharinum* (silver maple), *Tilia americana* (American basswood), *Juglans nigra* (black walnut), *Juglans cinerea* (butternut), *Celtis occidentalis* (hackberry), and *Fraxinus pennsylvanica* and *F. nigra* (red and black ash). Common mesic woodland herbs that are associated with goldenseal include *Arisaema triphyllum* (jack-in-the-pulpit), *Asarum canadense* (wild ginger), *Carex hirtifolia* (sedge), *Carex plantaginea* (plantain-leaved sedge), *Claytonia virginica* (spring beauty), *Erythronium americanum* (trout-lily), *Caulophyllum thalictroides* (blue cohosh), *Geranium maculatum* (wild geranium), *Uvularia perfoliata* (wild-oats), *Trillium grandiflorum* (common trillium), and *Hepatica acutiloba* (hepatica), among many other forbs typical of the ground layer in mesic forests.

**Biology:** Goldenseal is a perennial which, in Michigan, flowers in early May and produces fruits through September (Albert and Penskar 1984). Colonies of up to several hundred shoots can occur, with the smallest or late-flowering ones on the edges and the taller plants more central, suggesting that colonies expand by vegetative propagation. Colonies may be long-lived, slowly increasing in size through the years (Charette 1964).

**Conservation/management:** The knotty root (actually a rhizome) of this species is considered to have great medicinal value, and a large part of the great reduction in goldenseal populations can be attributed to exploitation by commercial harvesters (Swink and Wilhelm 1994). Protection from over-harvesting is a necessary first step to insure this species' survival. Habitat protection is also essential. At least three Michigan populations are in nature preserves under protective ownership of The Nature Conservancy, Michigan Nature Association, and Michigan Audubon Society. Two others are within University designated natural areas, one in a county park natural area, three in city parks, two in metropolitan parks, one in a state park, and one within a university woodlot. Other populations are on various tracts of private land. In addition to exploitation, this plant is vulnerable to removal of the forest canopy and probably to drainage or extended flooding of its habitat. The species is reportedly difficult to cultivate (Mitchell and Dean 1982).

**Comments:** Although goldenseal populations have been severely diminished and fragmented through over-harvesting and habitat destruction, it is also a species that can be easily overlooked when obscured by the typical lush vegetation of its forest habitat. Since more than one-half of the populations known to be extant have been discovered in the last several years, it is likely that others have yet to be discovered. Observations of a large population within a Nature Conservancy preserve (Albert and Penskar 1984) indicate that the fruit is highly palatable to animals, who appear to readily seek out this species as soon as the fleshy achenes are ripened.

**Research needs:** Investigation of the biology and ecology of goldenseal would assist in the management and protection of this species. Status inventories are also needed to provide better data on known populations, as well as to determine the condition of any existing historically documented localities.

**Related abstracts:** Ginseng, large toothwort, showy orchis, cerulean warbler, northern goshawk, red-shouldered hawk

**Selected references**:

Albert, D. A. and M. R. Penskar. 1984. The ecosystems and rare plant elements of Sharon Hollow forest. Unpubl. rept. to The Nature Conservancy. 57 pp.

Argus, G. W. and D. J. White. 1983. Atlas of the rare vascular plants of Ontario. National Museum of

Natural Sciences, Nat. Mus. of Canada.

Charette, L. A. 1964. *Hydrastis canadensis* L. in New England. Rhodora 66: 94-96.

Eichenberger, M. D. and G. R. Parker. 1976. Goldenseal (*Hydrastis canadensis* L.) distribution, phenology, and biomass in an oak-hickory forest. Ohio J. Sci. 76(5): 204-210.

Mitchell, R. S. & J. K. Dean. 1982. Ranunculaceae (Crowfoot Family) of New York State. Contrib. Flora of N.Y. State IV, Bull. No. 446. N.Y. State Museum, Albany. 100 pp.

Swink, F. & G. Wilhelm. 1994. Plants of the Chicago Region, 4th ed. Indiana Acad. Sci., Indianapolis. 921

**Abstract citation:**

M.R. Penskar, E.G. Choberka, and P.J. Higman 2001. Special Plant Abstract for *Hydrastis canadensis* (goldenseal). Michigan Natural Features Inventory. Lansing, MI. 3 pp.

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

**Michigan Natural Features Inventory**
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

# Oak Barrens

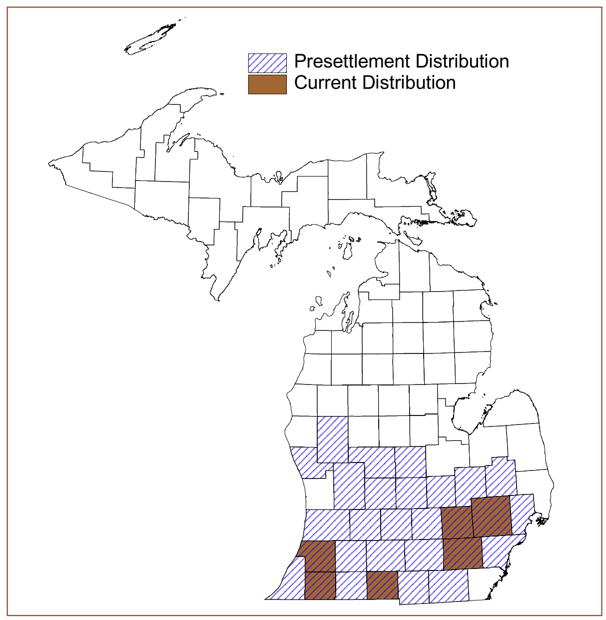
## Community Abstract

Photo by: Susan R. Crispin

**Overview:** Oak barrens is a fire-dependent, savanna type dominated by oaks, having between 5 and 60 percent canopy, with or without a shrub layer. The predominantly graminoid ground layer is composed of species associated with both prairie and forest communities. Oak barrens are found on droughty soils and occur typically on nearly level to slightly undulating sandy glacial outwash, and less often on sandy moraines or ice contact features.

**Global and State Rank:** G2?/S2

**Range:** Barrens and prairie communities reached their maximum coverage in Michigan approximately 4,000-6,000 years before present, when postglacial climatic conditions were comparatively warm and dry. During this time, xerothermic conditions allowed for the invasion of fire-dependent, xeric vegetation types into a large portion of the Lower Peninsula and into sections of the Upper Peninsula. With the subsequent shift of more mesic climatic conditions southward, there has been a recolonization of mesic vegetation throughout Michigan. The distribution of fire-dominated communities, such as oak barrens, has been reduced typically to isolated patches concentrated along the climatic tension zone. In the 1800s, oak barrens were located in the interior of the southeastern Lower Peninsula on sandy glacial outwash and coarse-textured, moraines (Comer et al. 1995). Presently the distribution of this community has been reduced to degraded remnants throughout its original range. In addition to southern Michigan, oak barrens remnants occur south of the tension




zone through Wisconsin and southeastern Minnesota, and in the glaciated portions of Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, and Nebraska (Chapman et al. 1995, NatureServe 2001).

**Rank Justification:** At the time of European settlement, oak savanna communities covered some 11-13 million hectares of the Midwest. Presently oak savanna remnants occur on just 0.02% of their presettlement extent (Nuzzo 1986). The notes of the original land surveyors of Michigan

**Michigan Natural Features Inventory**
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

reveal that in the 1800s, oak barrens covered approximately 719,042 acres or 1.9% of the state, distributed patchily across the four lower tiers of counties. In Allegan and Ottawa Counties, savanna communities where typically oak-pine barrens, while lakeplain oak openings were prevalent in the thumb region (Huron, Bay, and Tuscola Counties). Oak openings shared the same range as oak barrens but occurred on dry-mesic to mesic soils as opposed to droughty sites. Surveyors' notes indicate that high concentrations of oak barrens occurred in the following counties: Oakland County (28% or 200,557 acres), Jackson County (12% or 84,204 acres), Livingston County (11% or 81,176), and Washtenaw County (9% or 62,966 acres). Today merely a few hundred acres of oak barrens remain in Michigan with small, restorable remnants occurring in Cass, Branch, Livingston, Jackson, Washtenaw, and Van Buren Counties. This rare community constitutes less than 0.0005% of the present vegetation of Michigan.

Oak barrens have been cleared for sand mining, agriculture, and residential and urban development (Chapman et al. 1995). Alteration of historic fire regimes has shifted most barrens types into woodlands and forest (Curtis 1959, Faber-Langendoen 1993). Wildfire suppression policies instituted in the 1920s in concert with road construction, expansion of towns, and increased agriculture caused a dramatic decrease in fire frequency and intensity (Abrams 1992). The reduction of fire in the landscape resulted in the succession of open oak barrens to closed-canopy forests dominated by black and white oaks with little advanced regeneration of oaks and a vanishing graminoid component (Chapman et al. 1995). In addition, timber exploitation of oaks in the 1920s destroyed or degraded oak barrens across Michigan (Michigan Natural Features Inventory 1995). Many oak barrens fragments are currently completely dominated by black oak as the result of selective harvest of canopy white oak (Minc and Albert 1990). In addition to simplified overstory structure, these communities are often depauperate in floristic diversity as the result of fire suppression and subsequent woody encroachment, livestock grazing, off-road vehicle activity, and the invasion of exotic species (Michigan Natural Features Inventory 1995).

**Landscape and Abiotic Context:** Oak barrens occur on well-drained, nearly level to slightly undulating sandy glacial outwash, and less often on sandy moraines or ice contact features. Oak barrens typically occur in the driest landscape positions, such as ridge tops, steep slopes, south and west facing slopes, and flat sand plains. This xeric, fire-prone community is characterized by soils that are infertile, coarse-textured, well-drained sand or loamy sand with medium to slightly acid pH and low water retaining capacity. Soils contain low organic matter and lack the fine-textured illuvial horizon associated with soils of the oak openings and are thus droughtier. Oak barrens and oak-pine barrens typically occur in bands surrounding prairie (Michigan Natural Features Inventory 1990, Chapman et al. 1995).

Oak barrens are distributed in Michigan's Region I, Southern Lower Michigan (Albert et al. 1986). This region has a warm, temperate, rainy to cool, snow-forest climate with hot summers and no dry season. The daily maximum temperature in July ranges from 29° to 32° C (85° to 90° F) and the daily minimum temperature in January ranges from -9° to -4° C (15° to 25° F). The number of freeze-free days is between 120 and 220, and the average number of days per year with snow cover of 2.5 cm or more is between 10 and 60. The mean annual total precipitation for Region I is 820 mm (Albert et al. 1986, Barnes 1991).

**Natural Processes:** Curtis (1959) suggested that oak barrens originated when prairie fires spread into surrounding closed oak forest with enough intensity to create open barrens. Repeated low intensity fires working in concert with drought then maintain these barrens (Curtis 1959, Faber-Langendoen and Tester 1993). Oak barrens persist when fire disturbance and/or drought prevents canopy closure and the dominance of woody vegetation. Presently, the prevalent catalyst of fires is lighting strike but historically, Native Americans played an integral role in the fire regime, accidentally and/or intentionally setting fire to prairie ecosystems (Day 1953, Chapman 1984). Where large-scale herbivores are abundant, grazing may help inhibit the succession of grass-dominated oak barrens to woodland (Ritchie et al. 1998).

The character of oak barrens can differ dramatically, primarily as the result of varying fire intensity and frequency, which are influenced by climatic conditions, soil texture, topography, and landscape context (i.e., proximity to water bodies and fire-resistant and fire-conducing plant communities) (Bowles et al. 1994, Chapman et al. 1995). Infrequent, high-intensity fires kill mature oaks and produce barrens covered by abundant scrubby oak sprouts. Park-like barrens with widely spaced trees and an open grass understory are maintained by frequent low-intensity fires, which occur often enough to restrict maturation of oak seedlings (Chapman et al. 1995, Faber-Langendoen and

Davis 1995, Peterson and Reich 2001). Canopy oaks within these barrens rarely burn because of low fuel loads beneath their crowns, which shade out light-demanding vegetation (Anderson and Brown 1983). Frequent low-intensity fires also maintain high levels of grass and forb diversity by deterring the encroachment of woody vegetation and limiting single species dominance. Absence of fire in oak barrens causes increased litter layer and fuel loads, decreased herb layer diversity, increased canopy and subcanopy cover, invasion of fire-intolerant species, and ultimately the formation of a closed-canopy oak community, often within 20-40 years (Curtis 1959, Chapman et al. 1995, Faber-Langendoen and Davis 1995).

**Vegetation Description:** The oak barrens community is a heterogeneous savanna vegetation type with variable physiognomy in time and space. Structurally, oak barrens range from dense thickets of brush and understory scrub oak within a matrix of grassland to park-like open woods of widely spaced mature oak with virtually no shrub or sub-canopy layer above the open forb and graminoid understory (Michigan Natural Features Inventory 1990, Bowles and McBride 1994, Chapman et al. 1995). The physiognomic variations, which occur along a continuum, are the function of the complex interplay between fire frequency and intensity (Chapman et al. 1995). Typically, oak barrens grade into prairie on one edge and dry forest on the other. As noted by Bray (1958) and Curtis (1959), the flora of this community is a mixture of prairie and forest species, with prairie forbs and grasses more abundant in high light areas and forest forbs and woody species in the areas of low light.

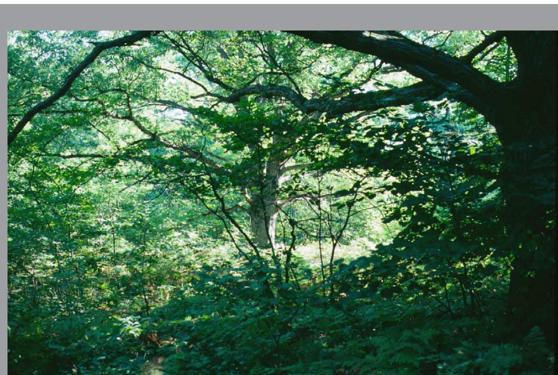


Photo by: Gary Reese

Canopy closure and woody encroachment in a fire suppressed oak barrens.

The canopy layer generally varies from 5 to 60 percent cover (Chapman et al. 1989) and is dominated or co-dominated by *Quercus velutina* (black oak) and *Quercus alba* (white oak). These species of oak are also prevalent in the sub-canopy in shrubby clumps, especially where fire intensity is high. In addition, *Acer rubra* (red maple), *Prunus serotina* (black cherry), *Populus grandidentata* (bigtooth aspen), *Populus tremuloides* (trembling aspen), and *Quercus ellipsoidalis* (pin oak) are often found in the overstory and sub-canopy of this community. Pin oak is especially common on excessively well-drained sites. Prevalent species of the subcanopy layer include: *Carya* spp. (hickory species), *Cornus* spp. (dogwood species), *Corylus americana* (American hazelnut), *Prunus* spp. (cherry species), and *Sassafras albidum* (sassafras).

Characteristic shrubs include: *Amelanchier* spp. (serviceberry), *Arctostaphylos uva-ursi* (bearberry), *Ceanothus americanus* (New Jersey tea), *Comptonia peregrina* (sweetfern), *Corylus americana*, *Cornus* spp., *Corylus cornuta* (beaked hazelnut), *Crataegus* spp. (hawthorn species), *Gaultheria procumbens* (wintergreen), *Gaylussacia baccata* (huckleberry), *Prunus americana* (wild plum), *Prunus virginiana* (choke cherry), *Prunus pumila* (sand cherry), *Quercus prinoides* (dwarf chestnut or dwarf chinkapin oak), *Rhus copalina* (shining sumac), *Rosa carolina* (pasture rose), *Rubus flagellaris* (northern dewberry), *Salix humilis* (prairie or upland willow), and *Vaccinium angustifolium* (low sweet blueberry).

The ground layer is dominated by graminoids and forbs. Common species include: *Scizhachyrium scoparium* (little bluestem), *Andropogon gerardii* (big bluestem), and *Carex pensylvanica* (Pennsylvania sedge), with Pennsylvania sedge often replacing the bluestems in shaded areas and fire-suppressed communities. Other prevalent herbs of the oak barrens include: *Aster oolentangiensis* (sky-blue aster), *Aureolaria* spp. (false foxglove), *Coreopsis lanceolata* (tickseed), *Cyperus filiculmis* (nut grass), *Danthonia spicata* (poverty oats), *Deschampsia flexuosa* (hair grass), *Euphorbia corollata* (flowering spurge), *Helianthus divaricatus* (tall sunflower), *Hypericum perforatum* (St. John's-wort), *Koeleria macrantha* (June grass), *Krigia biflora* (dwarf dandelion), *Lathyrus ochroleucus* (white pea), *Lespedeza hirta* (hairy lespedeza), *Liatris aspera* (blazing star), *Liatris cylindrica* (dwarf blazing star), *Lupinus perennis* (wild lupine), *Monarda fistulosa* (wild bergamot), *Panicum implicatum* (grass panicum), *Pedicularis canadensis* (wood betony), *Stipa avenacea* (needle grass), *Stipa spartea* (needle grass), *Tephrosia virginiana* (goats-rue), and *Viola pedata* (birdfoot violet).

In the absence of fire and with the prevalence of anthropogenic disturbance such as logging, off-road vehicle recreation, and livestock grazing, the following exotic species may be dominant components of the herbaceous layer of oak barrens: *Agropyron repens* (quack grass), *Agrostis stolonifera* (creeping bent), *Asparagus officinalis* (wild asparagus), *Centaurea maculosa* (spotted knapweed), *Hieracium* spp. (hawkweeds), *Poa compressa* (Canada bluegrass), *Poa pratensis* (Kentucky bluegrass), *Rumex acetosella* (sheep sorrel), and *Tragopogon dubius* (goat's beard).

**Michigan indicator species:**

**Spring/Early Summer**
*Comandra umbellata* (bastard toadflax), *Coreopsis lanceolata* (lanceolate coreopsis), *Geum triflorum* (prairie smoke, state threatened), *Lithospermum canescens* (hoary puccon), *Lupinus perennis*, *Krigia biflora*, *Pedicularis canadensis*, *Potentilla simplex* (common cinquefoil), *Senecio plattensis* (prairie ragwort), *Stipa spartea*, and *Viola pedata*.

**Summer**
*Anenome cylindrica* (thimbleweed), *Asclepias tuberosa* (butterfly weed), *Asclepias verticillata* (whorled milkweed), *Ceanothus americanus*, *Helianthus occidentalis* (woodland sunflower), *Helianthus divaricatus*, *Linum sulcatum* (furrowed flax, state special concern), *Monarda punctata* (horsemint), *Monarda fistulosa*, *Opuntia humifusa* (prickly pear), and *Trichostema dichotomum* (blue curls, state threatened).

**Fall**
*Andropogon gerardii*, *Aristida purpurascens* (three awn grass), *Aster oolentangiensis*, *Aster ericoides* (many flowered aster), *Aster sericeus* (silky aster, state threatened), *Aureolaria flava* (false foxglove), *Aureolaria pedicularia* (false foxglove), *Aureolaria virginica* (false foxglove), *Bouteloua curtipendula* (side oats gramma, state threatened), *Liatris aspera* (rough blazing star), *Liatris cylindrica* (dwarf blazing star), *Scizhachyrium scoparium*, *Silphium terebinthinaceum* (prairie dock), *Solidago speciosa* (showy goldenrod), *Solidago rigida* (stiff goldenrod), and *Stipa avenacea*.

**Other noteworthy species:** Rare plants associated with oak barrens include: *Aster sericeus* (silky aster, state threatened), *Bouteloua curtipendula* (side-oats gramma grass, state threatened), *Cirsium hillii* (Hill's thistle, state special concern), *Geum triflorum* (prairie-smoke, state threatened), *Linum sulcatum* (furrowed flax, state special concern), *Prunus alleghaniensis var davisii* (alleghany or sloe plum, state special concern), and *Sisyrinchium strictum* (blue-eyed grass, state special concern).

Oak barrens frequently support numerous lichens and mosses. Oak trunks provide substrate for foliose lichens (i.e., *Punctelia rudecta, Physcia millegrana,* and *Candelaria concolor*) and crutose lichens (i.e., *Candelariella xanthostigma* and *Rinodina papillata*). In addition to the cryptogamus communities thriving on tree boles, oak barrens often contain patches of microbiotic soil crust composed of lichens, mosses, and cyanobacteria (Will-Wolf and Stearns 1999).

The oak barrens and surrounding prairie habitat share a rich diversity of invertebrates including numerous butterflies, skippers, grasshoppers, and locusts. However, the fragmented and degraded status of midwestern oak barrens/savannas and prairies has resulted in the drastic decline of numerous insect species associated with dry, open habitats or obligates of barrens and prairie host plants (Chapman et al. 1995). Rare butterflies, skippers, and moths include: *Atrytonopsis hianna* (dusted skipper, state threatened), *Catocala amestris* (three-staff underwing, state endangered), *Erynnis p. persius* (persius duskywing, state threatened), *Hesperia ottoe* (ottoe skipper, state threatened), *Incisalia henrici* (Henry's elfin, state special concern), *Incisalia irus* (frosted elfin, state threatened), *Lycaeides melissa samuelis* (Karner blue, state threatened/federal endangered), *Papaipema sciata* (Culver's root borer, state special concern), *Pygarctia spraguei* (Sprague's pygarctia, state special concern), *Pyrgus centaureae wyandot* (grizzled skipper, state special concern), *Schinia indiana* (phlox moth, state endangered), *Schinia lucens* (leadplant flower moth, state endangered), *Spartiniphaga inops* (Spartina moth, state special concern), and *Speyeria idalia* (regal fritillary, state endangered).

Other rare invertebrates include *Lepyronia gibbosa* (Great Plains spittlebug, state threatened), *Oecanthus pini* (Pinetree cricket, state special concern), *Orphulella p. pelidna* (barrens locust, state special concern), *Prosapia ignipectus* (red-legged spittlebug, state special concern), and *Scudderia fasciata* (pine katydid, state special concern).

Numerous songbirds utilize oak barrens. Rare species include *Ammodramus savannarum* (grasshopper sparrow, state special concern) and *Dendroica discolor* (prairie warbler, state endangered). Typical songbirds include: *Melospiza lincolnii* (Lincoln's sparrow), *Passerina cyanea* (indigo bunting), *Pooecetes gramineus* (vesper sparrow), *Sial sialis* (eastern bluebird)*, Spizella passerina* (chipping sparrow), *Spizella pusilla* (field sparrow), *Toxostoma rufum* (brown thrasher), *Vermivora pinus* (blue-winged warbler) and *Vermivora ruficapilla* (Nashville warbler). Additional avian species that utilize this habitat include: *Accipter striatus* (sharp-shinned hawk), *Bartamia longicauda* (upland sandpiper), *Bonasa umbellus* (ruffed grouse), *Buteo jamaicensis* (red-tailed hawk), *Carduelis tristis* (American goldfinch), *Charadrius vociferus* (killdeer), *Chondestes grammacus* (lark sparrow), *Falco sparverius* (American kestrel), *Icterus galbula* (Baltimore oriole), *Melanerpes erythrocephalus* (red-headed woodpecker), *Meleagris gallopavo* (wild turkey), *Otus asio* (Eastern screech-owl), *Tyrannus tyrannus* (eastern kingbird), and *Zenaida macroura* (mourning dove). Savanna restoration with prescribed fire in Minnesota resulted in the increase in the abundance of open- country bird species, including many species that have been declining in central and eastern North America (Davis et al. 2000).

*Cryptotis parva* (least shrew, state threatened) and *Microtus ochrogaster* (prairie vole, state endangered) are rare mammals that may be found in oak-pine barrens. Additional mammals commonly associated with the oak barrens community include: *Canis latrans* (coyote), *Microtus pennsylvanicus* (meadow vole), *Odocoileus virginianus* (white-tailed deer*), Scirus niger* (fox squirrel*)*, *Spermophilus tridecemlineatus* (thirteen-lined ground squirrel), *Taxidea taxus* (badger), *Vulpes vulpes* (red fox), and *Zapus hudsonia* (jumping meadow mouse).

Several rare reptiles are known from this community type. They include: *Elaphe o. obsoleta* (black rat snake, state special concern), *Sistrurus c. catenatus* (eastern massasauga, state special concern, federal candidate species), and *Terrapene c. carolina* (eastern box turtle, state special concern). Some of the more common amphibians and reptiles that frequent the oak barrens include: *Bufo a. americanus* (eastern American toad), *Bufo fowleri* (Fowler's toad)*, Heterodon platirhinos* (eastern hog-nosed snake), and *Opheodrys vernalis* (smooth green snake).

**Conservation/management:** Fire is the single most significant factor in preserving the oak barrens landscapes. Where remnants of oak barrens persist, the use of prescribed fire is an imperative management tool for maintaining an open canopy, promoting high levels of grass and forb diversity, deterring the encroachment of woody vegetation and invasive exotics, and limiting the success of dominants. Numerous studies have indicated that fire intervals of 1-3 years bolster graminoid dominance, increase overall grass and forb diversity, and remove woody cover of saplings and shrubs (White 1983, Tester 1989). Burning at longer time intervals will allow for seedling establishment and the persistence of woody plants. Where rare invertebrates are a management concern, burning strategies should allow for ample refugia to facilitate effective postburn recolonization (Michigan Natural Features Inventory 1995, Siemann et al. 1997).

Though most of the historical oak barrens have been degraded by selective logging, livestock grazing, and fire suppression or destroyed by development, agricultural clearing, sand mining, and extensive timber harvest, there is much opportunity for restoration of this community type. Plant species of oak barrens can persist through cycles of canopy closure and removal (Chapman et al. 1995). The occurrence of oak barrens indicator species in closed-canopy forests reveals the presence of a native seedbank and highlights that area as a target for restorative management. Also indicative of a site's potential for restoration is the prevalence of oak "wolf trees." "Wolf trees" are large open-grown trees with wide-spreading limbs that are often associated with oak barrens' plants or seedbank (Michigan Natural Features Inventory 1995).

Photo by: Kim Chapman

Prescribed fire in remnant oak barrens maintains open canopy conditions, promotes high levels of grass and forb diversity and deters the encroachment of woody vegetation and exotics.

Where canopy closure has degraded the savanna character, one can restore the oak barrens community by selectively cutting the majority of trees (White 1986), leaving an average of 4 trees/acre. Degraded barrens that have been long deprived of fire often contain a heavy overstory component of shade tolerant species, which can be removed by mechanical thinning (Peterson and Reich 2001). Reconstructed sites will need to be maintained by periodic prescribed fire and may require investment in native plant seeding where seed and plant banks are inadequate (Packard 1988). Depending on the physiognomic target of the management, one can manipulate the intensity, seasonality, and frequency of the prescribed burns: low-intensity and high-frequency burns for the park-like end of the barrens continuum and low-frequency and high-intensity burns for shrubby oak barrens. Fall burns typically are slow moving, low-intensity fires due to high relative humidity and slow wind speed, while late spring and summer burns are often more intense due to higher wind speeds and lower relative humidity (King 2000). Summer burning can be employed to simulate naturally occurring lightning season burns. Early spring burns often carry irregularly through barrens influenced by high spring water tables. Such patchy burns can be useful tool for establishing refugia for fire-sensitive species and may permit oak seedling establishment (Chapman et al. 1995). Patchy burns are often the result of frequent low-intensity fires, which carry sporadically through areas with low fuel loads. In contrast, infrequent fires are often more uniform in coverage, spreading evenly through areas of high fuel accumulation (Ladd 1991).

In many circumstances the effective use of prescribed fire is precluded due to monetary constraints or safety concerns. In areas where fire is undesirable or unfeasible, mowing or selective cutting can be utilized and should be carried forth in late fall or winter to minimize detrimental impact to herbaceous species and rare invertebrates (Chapman et al. 1995, Michigan Natural Features Inventory 1995, King 2000). Management of oak barrens communities should be orchestrated in conjunction with the management of adjacent communities such as dry sand prairie, dry southern forest, and coastal plain marsh.

**Research needs:** As noted by Nuzzo (1986), Minc and Albert (1990), Faber-Langendoen (1993), and Bowles and McBride (1994), no single definition of Midwest oak savanna or oak barrens is universally accepted, and numerous distinct community types have been lumped under the phrase "Midwest oak savanna." Misunderstanding and misuse of the term can be alleviated by the continued refinement of regional classifications that correlate species composition, site productivity, ecological process, and landscape context. Understanding spatial and temporal variability of oak barrens is also crucial for determining the direction of management.

Management of oak barrens remnants can be determined by site-specific research of site characteristics and presettlement composition and structure (Minc and Albert 1990, Bowles et al. 1994, Bowles and McBride 1998). Investigation into the frequency, periodicity (seasonality), and intensity of fires in oak barrens is needed to guide restoration and management activities. In addition, because limitations imposed by safety concerns can hamper the effectiveness of prescribed fire as a management tool, maintaining the ecological integrity of oak barrens requires experimentation with different disturbance combinations (King 2000). Effects of management need to be monitored to allow for assessment and refinement.

Since all of Michigan's oak barrens are degraded, it is essential to determine what role seedbanks, vegetative reproduction, and external seed sources play in restoration of remnant barrens. Numerous rare Lepidoptera have host plants occurring on oak barrens. The effects of fire and alternative management techniques on rare faunal populations and their host vegetation need to be studied (Chapman et al. 1995, Siemann et al. 1997). In addition, because of the daunting problem of exotic species encroachment, research needs to examine management strategies that minimize invasive species introduction and dominance.

**Similar communities:** Bur oak plains, dry sand prairie, dry southern forest, lakeplain oak openings, oak openings, oak-pine barrens, and pine barrens.

**Other Classifications:**

**Michigan Natural Features Inventory Presettlement Vegetation (MNFI):**
Black Oak Barren and Mixed Oak Savanna

**Michigan Department of Natural Resources (MDNR):** G-grass and O0(zero)-oak with <100 trees per acre.

**Michigan Resource Information Systems (MIRIS):** 33 (Pine or Oak Opening), 412 (Central Hardwood), 4122 (White Oak), 4123 (Black Oak), 4129 (Other Oak).

**The Nature Conservancy National Classification:**

CODE; ALLIANCE; ASSOCIATION; COMMON NAME

II.B.2.N.a.12; *Quercus alba - (Quercus velutina)* Woodland Alliance; *Quercus velutina - (Quercus ellipsoidalis) - Quercus alba/Deschampsia flexuosa* Woodland; Black Oak- Northern Pin Oak / Common Hairgrass Woodland

V.A.6.N.c.3; *Quercus velutina - (Quercus ellipsoidalis)* Wooded Herbaceous Alliance; *Quercus velutina - (Quercus alba) - Quercus ellipsoidalis/Schizachyrium scoparium - Lupinus perennis* Wooded Herbaceous Vegetation; Black Oak/Lupine Barrens

**Related Abstracts:** Alleghany plum, Culver's root borer, Hill's thistle, karner blue butterfly, oak-pine barrens, pine barrens, prairie smoke, and red-legged spittlebug.

**Selected References**:


Abrams, M.D. 1992. Fire and the development of oak forests. BioScience 42(5): 346-353.

Albert, D.A. 1995. Regional landscape ecosystems of MI, MN and WI: A working map and classification. USFS-North Central Forest Experiment Station. 1992 Folwell Ave. St. Paul, MN 55108. 250 pp.

Albert, D.A., S.R. Denton, and B.V. Barnes. 1986. Regional landscape ecosystems of Michigan. Ann Arbor, MI: University of Michigan, School of Natural Resources. 32pp & map.

Anderson, M.D., and L.E. Brown. 1983. Comparative effects of fire on trees in a midwestern savannah and an adjacent forest. Bulletin of the Torrey Botanical Club 119(1): 19-28.

Barnes, B.V. 1991. Deciduous forests of North America. Pp 219-344 *in* E. Röhrig and B. Ulrich (eds.) Ecosystems of the World 7: Temperate Deciduous Forests. Elsevier, Amsterdam.

Botts, P., A. Haney, K. Holland, S. Packard. 1994. Midwest oak ecosystems recovery plan. Technical report for the 1993 Midwest Oak Savanna Conference, Chicago, 112 pp.

Bowles, M.L., M.D. Hutchinson, and J.L. McBride. 1994. Landscape pattern and structure of oak savanna, woodland and barrens in northeastern Illinois at the time of European settlement. Pp. 65-74 *in* J.S. Fralish, R.C. Anderson, J.E. Ebinger, and R. Szafoni (eds.) Proceedings of the North American Conference on Barrens and Savannas, October 15-16, 1994, Illinois State University, Normal, IL.

Bowles, M.L., and J.L. McBride. 1994. Presettlement barrens in the glaciated prairie region of Illinois. Pp. 75-85 *in* J.S. Fralish, R.C. Anderson, J.E. Ebinger, and R. Szafoni (eds.) Proceedings of the North American Conference on Barrens and Savannas, October 15-16, 1994, Illinois State University, Normal, IL.

Bowles, M.L., and J.L. McBride. 1998. Vegetation composition, structure, and chronological change in a decadent midwestern North American savanna remnant. Natural Areas Journal 18(1): 14-27

Bray, J.R. 1958. The distribution of savanna species in relation to light intensity. Canadian Journal of Botany 36: 671-681.

Chapman, K.A. 1984. An ecological investigation of native grassland in Southern Lower Michigan. M.A. thesis, Western Michigan University. 235 pp.

Chapman, K.A., M.A. White, and M.R. Huffman. 1989. Draft: Oak barrens stewardship abstract. Midwest Heritage Task Force, The Nature Conservancy. Minneapolis, MN.

Chapman, K.A., M.A. White, M.R. Huffman, and D. Faber-Langendoen. 1995. Ecology and stewardship guidelines for oak barrens landscapes in the upper Midwest. Pp. 1-29 *in* F. Stearns and K. Holland, eds., Proceedings of the Midwest Oak Savanna Conference, 1993. U.S. Environmental Protection Agency, Internet Publications. Available: http://www.epa.gov/glnpo/oak/oak93/chapman.html (Accessed: September 21, 2000).

Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Corner, and D.W. Schuen. 1995. Michigan's presettlement vegetation, as interpreted from the General Land Office Surveys 1816-1856. Michigan Natural Features Inventory, Lansing MI. Digital map.

Corner, R.A. 1996. Natural community abstract for pine barrens. Michigan Natural Features Inventory, Lansing, MI 3 pp.

Curtis, J.T. 1959. Vegetation of Wisconsin: An Ordination of Plant Communities. University of Wisconsin Press, Madison, WI. 657 pp.

Davis, A.M., W.D. Peterson, B.P. Reich, M. Crozier, T. Query, E. Mitchell, J.Huntington, and P. Bazakas. 2000. Restoring savanna using fire: impact on the breeding bird community. Restoration Ecology 8(1): 30-40.

Day, G.M. 1953. The Indian as an ecological factor in the Northeastern forest. Ecology 34(2): 329-346.

Faber-Langendoen, D. 1993. A proposed classification for savannas in the Midwest. Background paper for the Midwest oak savanna conference. 18 pp.

Faber-Langendoen, D. (editor). 1999. International classification of ecological communities: Terrestrial vegetation of the Midwestern United States. The Nature Conservancy, Midwest Conservation Science Department, Minneapolis MN.

Faber-Langendoen, D. (editor). 2001. Plant communities of the Midwest: Classification in an ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp + appendix (705 pp.).

Faber-Langendoen, D., and M.A. Davis. 1995. Effects of fire frequency on tree canopy cover at Allison Savanna, eastcentral Minnesota, USA. Natural Areas Journal 15(4): 319-328.

Faber-Langendoen, D., and J.R. Tester. 1993. Oak mortality in sand savannas following drought in east-central Minnesota. Bulletin of the Torrey Botanical Club 120 (3): 248-256.

Heikens, A.L., and P.A. Robertson. 1994. Barrens of the Midwest: a review of the literature. Castanea 59(3): 184 194.

King, R. 2000. Effects of single burn events on degraded oak savanna. Ecological Restoration 18:4 Winter. 228-233.

Ladd, D. 1991. Reexamination of the role of fire in Missouri oak woodlands. Pp 67-80 In Burger G.V., J.E. Ebinger, and G.S. Wilhelm, eds., Proceedings of the oak woods management workshop. Eastern Illinois University, Charleston, IL.

Michigan Natural Features Inventory. 1990. Draft description of Michigan natural community types. (Unpublished manuscript revised April 2,1990). Michigan Natural Features Inventory, Lansing, MI. 34 pp. Available: http://www.dnr.state.mi.us/WILDLIFE/Heritage/Mnfi/lists/natural_community_types.pdf.

Michigan Natural Features Inventory. 1995. Forest stewardship training materials for oak-pine barrens ecosystem. (Unpublished manuscript.) Michigan Natural Features Inventory, Lansing, MI.

Minc, L.D., and D.A. Albert. 1990. Oak-dominated communities of Southern Lower Michigan: floristic and abiotic comparisons. Michigan Natural Features Inventory, Lansing MI (Unpublished manuscript). 103 pp.

NatureServe: An online encyclopedia of life [web application]. 2001. Version 1.4 . Arlington (VA): Association for Biodiversity Information. Available: http://www.natureserve.org/. (Accessed: August 10, 2001.)

Nuzzo, V. 1986. Extent and status of Midwest oak savanna: presettlement and 1985. Natural Areas Journal 6: 6-36.

Packard, S. 1988. Just a few oddball species: restoration and the rediscovery of the tallgrass savanna. Restoration and Management Notes 6(1): 13-20.

Peterson, D.W., and P.B. Reich. 2001. Prescribed fire in oak savanna: fire frequency effects on stand structure and dynamics. Ecological Applications 11(3): 914-927.

Ritchie, M.E., D. Tilman, and J.M.H Knops. 1998. Herbivore effects on plant and nitrogen dynamics in oak savanna. Ecology 79(1), 165-177.

Siemann, E., J. Haarstad, and D. Tilman. 1997. Short-term and long-term effects of burning on oak savanna arthropods. American Midland Naturalist 137(2): 349-361.

Tester, J.R. 1989. Effects of fire frequency on oak savanna in east-central Minnesota. Bulletin of the Torrey Botanical Club 116(2): 134-144.

White, A.S. 1983. The effects of thirteen years of annual prescribed burning on a Quercus ellipsoidalis community in Minnesota. Ecology 64(5): 1081-108.

White, A.S. 1986. Prescribed burning for oak savanna restoration in central Minnesota. Research Paper NC-266, U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station, St. Paul, Minn. 12 pp.

Will-Wolf, S., and F. Stearns. 1999. Dry soil oak savanna in the Great Lakes region. Pp. 135-154 in R.C. Anderson, J.S. Fralish, and J.M. Baskin (eds.) Savannas, Barrens, and Rock Outcrop Plant Communities of North America. Cambridge, United Kingdom.

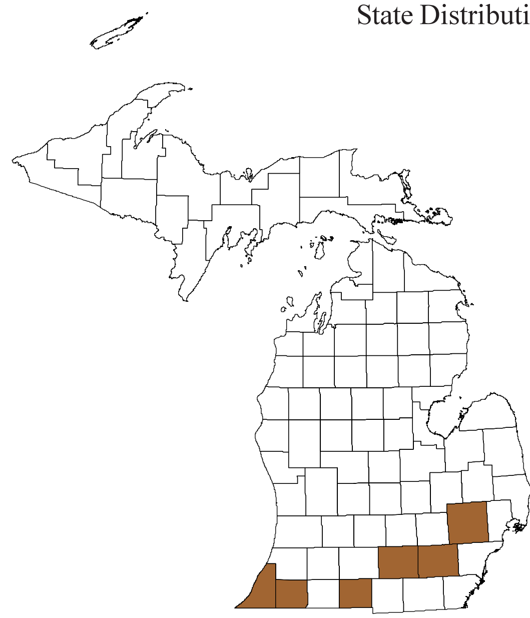
**Abstract Citation:**

Cohen, J.G. 2001. Natural community abstract for oak barrens. Natural Features Inventory, Lansing, MI. 8 pp.

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

# Relict conifer swamp — Community Abstract

Photo by David Cuthrell




**Overview:** Relict conifer swamp is a groundwater-influenced, or minerotrophic, forested wetland community that is typically dominated by tamarack (*Larix laricina*) and occurs on deep organic soils (e.g., peat and muck) in southern Michigan.

**Global and State Rank: G2G3/S3**

**Range:** Relict conifer swamp occurs in Minnesota, Wisconsin, Indiana, Michigan and Ontario. In Michigan, relict conifer swamp is thought to be restricted to the southern Lower Peninsula, although no statewide survey for the community has been conducted. Relict conifer swamp represents a type of rich conifer swamp, a more widespread, minerotrophic, forested wetland that is usually dominated by northern white cedar (see MNFI 1990). Throughout northern Michigan and near the tension zone in Mid Michigan, northern white cedar (*Thuja occidentalis*) replaces tamarack as the dominant tree species in groundwater-influenced, forested wetlands. Acidic, rainwater-influenced (ombrotrophic) tamarack and black spruce swamps also occur in southern Michigan and are classified as poor conifer swamp (see MNFI 1990). Many large wetland complexes contain zones of both minerotrophic tamarack swamp (e.g. relict conifer swamp) near the upland edge where groundwater seeps occur, as well as ombrotrophic tamarack swamp (e.g., poor conifer swamp) near the center of the complex. In the ombrotrophic zone, deep peat separates the vegetation from the influence of groundwater and sphagnum mosses acidify the surface water and peat.

**Rank Justification:** Analysis of the General Land Office (GLO) survey notes reveals that tamarack-dominated wetlands were common throughout southern Lower Michigan during the mid 1800s (Comer et al. 1995). In fact, tamarack swamps were the most common type of conifer swamp in all sub-subsections (Albert 1995) of southern Lower Michigan expect for those occupying the thumb region (e.g., Huron Lapeer, Sanilac and Tuscola Counties), where mixed conifer swamps were more abundant (Comer et al. 1995). While information is not readily available for deciphering the type of tamarack swamp (e.g., relict conifer swamp or poor conifer swamp) from the GLO data, tamarack-dominated wetlands overall occupied 196,526 ha (485,624 acres) of southern Lower Michigan. Comparisons between the GLO and 1978 MIRIS land cover data reveal that less than 1% or 1,149 ha (2,839 acres) of tamarack swamp remain in southern Lower Michigan (Albert 2001). Tamarack swamps were frequently drained and logged and subsequently used for agriculture, mined for peat, or abandoned and converted to wet meadow, shrub-carr or hardwood swamp. Tamarack logs were commonly utilized for fence posts,

**Michigan Natural Features Inventory**
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

house and barn beams, and the early auto industry used tamarack for wheel spokes.

**Landscape and Abiotic Context:** Relict conifer swamp occurs in outwash channels, outwash plains, and kettle depressions throughout southern Lower Michigan. The community typically occurs in association with headwater streams and/or adjacent to inland lakes. Relict conifer swamps are often found where groundwater seeps occur at the base of moraines. The organic soils underlying relict conifer swamp are typically composed of a thin layer of muck overlying 2 – 5 m of fibric and woody peat (Kost 2001). Underlying the peat there is usually a layer of marl, a calcium carbonate precipitate that accumulates as sediment on lake bottoms.

**Natural Processes:** Relict conifer swamp is a groundwater-dependent, tamarack-dominated, wetland community. Its hydrology is maintained by calcareous groundwater that permeates the muck and peat soils. Because the glacial till in southern Michigan is typically high in calcium and magnesium, the groundwater that reaches the surface has high levels of alkalinity and dissolved nutrients. The pH values of the muck and peat soils underlying relict conifer swamp are typically near 8.0, with surface water alkalinity measuring near 300 mg $CaCO_3$/L and conductivity values near 600 uS (Kost 2001, Merkey 2001).

Because of the strong influence of groundwater on the community, water levels in relict conifer swamps tend to fluctuate less than in many other wetland types (Merkey 2001). However, seasonal water fluctuations are common and may be related to the varied microtopography of tamarack swamps. The tamarack roots form large hummocks that stand elevated above adjacent mudflats. During the winter and spring water typically fills the spaces between the tamarack root-hummocks, while in summer and fall, exposed mud flats occupy these areas.

Windthrow, insect outbreak, beaver flooding, and fire are all important forms of natural disturbance for relict conifer swamp. Because tamarack is shade-intolerant (Curtis 1959), disturbance events that result in increased light to the understory and ground layer are especially important for maintaining the tamarack component of the community.

Trees growing in the anaerobic conditions associated with a high water table and muck and peat soils tend to be shallowly rooted and are thus, especially prone to windthrow. The light gaps created by windthrow help to regenerate tamarack and maintain the community's dense shrub layer. In addition, the coarse woody debris that results from windthrow also adds to the community's complex structure and microtopography.

Periodic outbreaks of the larch sawfly (*Pristophora erichsonii*) and tamarack casebearer (*Coleophora laricella*), both native insect species, may result in a significant reduction in tamarack cover. The defoliation associated with an insect outbreak results in increased light reaching the understory and ground layer, and like windthrow, may promote tamarack regeneration and shrub-layer density. However, in relict conifer swamps where red maple is widely distributed, these defoliation events may alter community structure by promoting the growth of red maple. Once red maple reaches the overstory its broad canopy effectively reduces the amount of light available to the understory and results in a significant reduction in shrub-layer cover and species richness as well as a loss of many shade-intolerant ground flora species (Kost 2001).

Long-term flooding resulting from beaver dams or other forms of blocked drainage such as road construction through a wetland can cause mass tamarack mortality and a conversion of relict conifer swamp or other forested wetlands to wet meadow or marsh. However, beaver may have also contributed to the establishment of relict conifer swamp when sources of tamarack seeds were accessible for colonization of abandoned beaver floodings. Tamarack may have also colonized sites where beaver flooding destroyed a hardwood-dominated swamp forest community.

Like long-term flooding, fire may cause extensive tamarack mortality (Curtis 1959) and create new opportunities for seedling establishment on freshly exposed organic soils. While fire is not a frequent form of disturbance directly within relict conifer swamps, its influence on the surrounding landscape is very important to the long-term viability of the community.

The role of fire in maintaining relict conifer swamp is especially important in the interlobate region of southern Michigan where fire was responsible for maintaining the open condition of many of the region's natural communities including oak barrens, prairies, wet meadows, and prairie fens. With the widespread absence of fire in southern Michigan, tamarack, a common prairie fen species, has completely colonized many sites that were previously occupied by prairie fen, thus forming many of the relict conifer swamps we see today. The photo on the first page shows relict conifer swamp encroaching on prairie fen in the foreground. In addition to maintaining many community types in an open condition, fire also severely restricted the distribution of thin-barked, fire-intolerant tree species such as red maple. Aided by fire suppression, red maple has come to assume a leading role in the understory of many southern Michigan oak forests and frequently occurs in the canopy as well. In the past, the lack of red maple in the surrounding uplands meant disturbance events such as windthrow and insect outbreaks, which create light gaps, helped facilitate tamarack regeneration and the long-term viability of relict conifer swamp. With red maple now abundant in the surrounding uplands and widely distributed in many relict conifer swamps, these disturbance events may not be enough to maintain the tamarack component of the ecosystem and many former conifer swamps are now dominated by hardwoods. As evidence of this conversion, it is common to find dead, standing and downed tamarack in hardwood swamps that occur on deep, organic soils in southern Michigan (Kost 2001). The conversion of these conifer swamps to hardwood swamps also results in a severe reduction in shrub-layer cover and the loss of many species. Because many of the dominant shrub species are prolific fall, fruit producers, migrating and over-wintering songbirds as well as small mammals that rely on the fruit may be adversely impacted by the conversion to hardwood swamp.

**Vegetation Description:** The structure of the community is largely shaped by tamarack, the dominant tree species. The roots of tamarack often form extensive mats that stand elevated above pools of water or mudflats and provide a substrate for a diverse wetland ground flora. In addition, the tamarack root mats form a varied microtopography, adding to the biocomplexity and high species richness of the community. Tamarack windthrows also add to the heterogeneous structure of ground layer as well as the shrub layer. Because of the open branching and spire-shape of tamarack, the shrub layer of relict conifer swamp receives a high level of light and is typically both very dense and diverse. In fact, the shrub layer may contain as many as 28 species, with multiple species intertwined and over topping one another so that total shrub-layer cover may reach 90 – 130% (Kost 2001).

In addition to tamarack, other common tree species include: black ash (*Fraxinus nigra*), yellow birch (*Betula alleghaniensis*), American elm (*Ulmus americana*), red maple, swamp white oak (*Quercus bicolor*), quaking aspen (*Populus tremuloides*), red cedar (*Juniperus virginiana*), and in some locations white pine (*Pinus strobus*), and northern white cedar.

**Photo by Michael Kost**

Poison sumac is one of several dominant shrub species in relict conifer swamp that provide critical food resources to wildlife during the fall migration and winter.

Common tall shrub species include: poison sumac (*Toxicodendron vernix*), winterberry (*Ilex verticillata*), smooth highbush blueberry (*Vaccinium corymbosum*), grey dogwood (*Cornus foemina*), silky dogwood (*Cornus amomum*), swamp rose (*Rosa palustris*), hazelnut (*Corylus americana*), nannyberry (*Viburnum lentago*), juneberry (*Amelanchier arborea*), black chokeberry (*Aronia prunifolia*), and pussy willow (*Salix discolor*). Other large shrubs that may occasionally occur in relict conifer swamp include spice bush (*Lindera benzoin*), mountain holly (*Nemopanthus mucronata*), hornbeam (*Carpinus caroliniana*), alternate-leaved dogwood

(*Cornus alternifolia*), Bebb's willow (*Salix bebbiana*), and elderberry (*Sambucus canadensis*).

Low shrub species common to relict conifer swamp include: swamp gooseberry (*Ribes hirtellum*), dwarf raspberry (*Rubus pubescens*), bog birch (*Betula pumila*), wild raspberry (*Rubus* spp.), sage willow (*Salix candida*), swamp fly honeysuckle (*Lonicera oblongifolia*), alder-leaved buckthorn (*Rhamnus alnifolia*), common juniper (*Juniper communis*), shrubby cinquefoil (*Potentilla fruticosa*), and bog willow (*Salix pedicellaris*).

Common woody vines include: poison ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), and riverbank grape (*Vitis riparia*).

Because of the high frequency of canopy disturbance and open structure of tamarack, the ground flora is composed of a heterogeneous mixture of shade-tolerant and -intolerant wetland plants. In addition, the stark difference in moisture levels between the elevated root hummocks and saturated mudflats also significantly increases the diversity of wetland species found in the ground flora. While mosses are prevalent throughout ground layer, the sphagnum mosses (*Sphagnum* spp.) are relatively uncommon and locally distributed. The following list contains common ground flora species occurring in relict conifer swamp:

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| *Aster puniceus* (*A. firmus*) | smooth swamp aster |
| *Aster lanceolatus* | eastern lined aster |
| *Bidens cernuus* | nodding bur-marigold |
| *Bidens coronatus* | tall swamp-marigold |
| *Boehmeria cylindrica* | false nettle |
| *Calamagrostis canadensis* | blue-joint grass |
| *Caltha palustris* | marsh-marigold |
| *Campanula aparinoides* | marsh bellflower |
| *Cardamine pensylvanica* | Pennsylvania bitter cress |
| *Carex alata* | winged sedge |
| *Carex comosa* | sedge |
| *Carex hystericina* | sedge |
| *Carex lacustris* | sedge |
| *Carex leptalea* | sedge |
| *Carex stricta* | sedge |
| *Cicuta bulbifera* | water hemlock |
| *Dryopteris carthusiana* | spinulose woodfern |
| *Equisetum fluviatile* | water horsetail |
| *Galium asprellum* | rough bedstraw |
| *Galium labradoricum* | bog bedstraw |
| *Galium tinctorium* | stiff bedstraw |
| *Glyceria striata* | fowl manna grass |
| *Impatiens capensis* | spotted touch-me-not |
| *Leersia oryzoides* | cut grass |
| *Lemna minor* | small duckweed |
| *Lycopus uniflorus* | northern bugle weed |
| *Lysimachia thyrsiflora* | tufted loosestrife |
| *Maianthemum canadense* | Canada mayflower |
| *Onoclea sensibilis* | sensitive fern |
| *Osmunda regalis* | royal fern |
| *Pilea pumila* | clearweed |
| *Rubus pubescens* | dwarf raspberry |
| *Sagittaria latifolia* | common arrowhead |
| *Scutellaria lateriflora* | mad-dog skullcap |
| *Senecio aureus* | golden ragwort |
| *Solidago patula* | swamp goldenrod |
| *Solidago rugosa* | rough goldenrod |
| *Symplocarpus foetidus* | skunk-cabbage |
| *Thelypteris palustris* | marsh fern |
| *Trientalis borealis* | starflower |
| *Viola* spp. | violet |

**Michigan indicator species:** Tamarack, poison sumac, smooth highbush blueberry, winterberry, black chokeberry, alder-leaved buckthorn, black ash, yellow birch, and sedge (*Carex leptalea*).

**Other noteworthy species:** Many of the rare plants associated with relict conifer swamp include species that are more commonly found in open prairie fen. These shade-intolerant species may occur on the edges of relict conifer swamp or within light gaps that have remained in an open condition. Species that fit this group include water parsnip (*Berula erecta*), tuberous Indian plantain (*Cacalia plantaginea*), narrow leaved reedgrass (*Calamagrostis stricta*), white lady's lipper (*Cypripedium candidum*), English sundew (*Drosera anglica*), queen-of-the-prairie (*Filipendula rubra*), mat muhly (*Muhlenbergia richardsonis*), sweet william phlox (*Phlox maculata*), Jacob's ladder (*Polemonium reptans*), prairie dropseed (*Sporobolus heterolepis*), and edible valerian (*Valeriana edulis* var. *ciliata*). Bog bluegrass (*Poa paludigena*), a rare species most commonly found in hardwood-dominated swamps and floodplains, may also occur in relict conifer swamp.

Rare animal species associated with relict conifer swamp include: tamarack tree cricket (*Oecanthus laricis*), Mitchell's satyr butterfly (*Neonympha mitchellii*), eastern massasauga (*Sistrurus catenatus*), Blanding's turtle (*Emydoidea blandingii*), and spotted turtle (*Clemmys guttata*).

**Conservation/management:** The presence of conifer-dominated wetlands in southern Michigan contributes significantly to the region's overall biodiversity. The relict conifer swamps in southern Michigan represent the southern range of the minerotrophic conifer swamps in the Midwest. Because they are dominated by tamarack and not by northern white cedar like their more widespread, northern counterpart, the relict conifer swamps in southern Michigan represent a unique type of minerotrophic conifer swamp.

Protection of relict conifer swamp includes protecting the site's hydrology. This may include avoiding surface water inputs to the community from drainage ditches and agricultural fields, and protecting groundwater recharge areas by maintaining native vegetation types in the uplands around relict conifer swamps. Long-term flooding from road construction through the center of a relict conifer swamp or clogged road culverts can result in mass tamarack mortality. Because relict conifer swamp is a groundwater-dependent community, protecting the quantity and quality of the groundwater is critical.

Invasion by red maple can cause a relict conifer swamp to shift to hardwood domination. This shift begins to occur as red maple reaches the overstory. The broad canopy of red maple prevents direct sunlight from reaching smaller tamaracks and results in a rapid loss of tamarack and other shade-intolerant species. The dense shrub layer, which is characteristic of relict conifer swamp, is significantly reduced under a hardwood canopy and thus, species that rely on fruit during the fall migration and winter are adversely impacted.

Reducing red-maple cover in relict conifer swamps by girdling red maple in conjunction with herbicide application may be effective in preventing the loss of the shrub layer and shade-intolerant species such as tamarack. Ideally, this type of management would accompany the use of prescribed fire in the upland forests adjacent to the swamp and hydrologic restoration where necessary. Significantly reducing red maple cover in both the upland and lowland forests will help ensure that characteristic natural disturbance events, such as windthrow and insect outbreaks, result in tamarack regeneration.

Invasive species that occur in relict conifer swamp include: glossy buckthorn (*Rhamnus frangula*), purple loosestrife (*Lythrum salicaria*), reed canary grass (*Phalaris arundinacea*), reed (*Phragmites australis*), and bittersweet nightshade (*Solanum dulcamara*). While bittersweet nightshade is not typically a threat to a site's overall species richness, each of the other invasive species listed above can negatively influence species richness and alter community structure. Glossy buckthorn, in particular, is probably the greatest threat to species diversity and community structure in relict conifer swamp. This species has colonized similar habitats throughout the Midwest and can completely dominate the shrub and ground layers. Treatment for removing glossy buckthorn can be accomplished with cutting, accompanied by herbicide application (Reinartz 1997) and by using spot-burning to eliminate seedlings (Jack McGowan-Stinski 1999 pers. comm.).

**Research needs:** Because tamarack plays a critical role in structuring relict conifer swamp, studies aimed at better understanding the factors that influence its ability to regenerate will help managers maintain the long-term viability of this community type. The role of red maple and other hardwoods in altering community structure is also an important research topic. An historical study, using GLO notes, of the distribution of red maple in relation to tamarack-dominated swamps as well as other types of conifer swamp would help managers to better understand the differences between past successional processes and those observed today. Gaining an understanding of the effects of fire and other forms of natural disturbance on relict conifer swamp will also help managers better understand the ecosystem. Little attention has been given to the importance of relict conifer swamp for maintaining certain rare plant and animal species. In addition, the role of relict conifer swamp in providing both thermal cover and important food reserves during fall migration and winter will be useful for understanding the significance of this community type in maintaining regional biodiversity.

**Similar communities:** Rich conifer swamp, conifer-hardwood swamp, southern swamp, poor conifer swamp, prairie fen, and southern wet meadow.

**Other Classifications:**

**Michigan Natural Features Inventory Pre-settlement Vegetation (MNFI):**
Lowland Conifer – Tamarack

**Michigan Department of Natural Resources (MDNR):** T-Tamarack.

**Michigan Resource Information Systems (MIRIS):** 4233 (Tamarack).

**The Nature Conservancy National Classification** (Faber-Langendoen 2001, Natureserve 2001):

CODE; ALLIANCE; ASSOCIATION; COMMON NAME

I.B.2.N.g.3; *Larix laricina* Saturated Forest Alliance; *Larix laricina – Acer rubrum* / (*Rhamnus alnifolia*, *Vaccinium corymbosum*) Forest; Tamarack – Red Maple / (Alderleaf Buckthorn, Highbush Blueberry) Forest; Central Tamarack – Red Maple Rich Swamp.

**Related Abstracts**: prairie fen, southern wet meadow, prairie-Indian-plantain, white lady-slipper, English sundew, mat muhly, prairie dropseed, tamarack tree cricket, eastern massasauga, Mitchell's satyr butterfly, Blanding's turtle, spotted turtle.

**Selected References**:

Albert, D.A. 1995. Regional landscape ecosystems of MI, MN and WI: A working map and classification. USFS – North Central Forest Experiment Station, St. Paul, MN 55108. 250 pp.

Albert, D.A. 2001. Regional Characterization and Quantification of Wetland Types. Michigan Natural Features Inventory, Lansing, MI. 35 pp.

Faber-Langendoen, D. editor. 2001. Plant communities of the Midwest: Classification in and ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. + appendix (705 pp.).

Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Corner and D.W. Schuen. 1995. Michigan's presettlement vegetation, as interpreted from the General Land Office Surveys 1816-1856. Michigan Natural Features Inventory, Lansing MI. Digital map.

Curtis, J.T. 1959. Vegetation of Wisconsin. The University of Wisconsin Press, Madison, WI.

Kost, M.A. 2001. Potential Indicators for assessing biological integrity of forested, depressional wetlands in southern Michigan. Michigan Natural Features Inventory, Lansing, MI. 69 pp. Available: http://www.dnr.state.mi.us/wildlife/ Heritage/Mnfi/pubs/ibi_final.pdf

Merkey, D.A. 2001. Dominant water sources of six conifer swamps of southeastern Michigan. Report submitted to Michigan Natural Features Inventory, Lansing, MI. 13 pp.

Michigan Natural Features Inventory. 1990. Draft description of Michigan natural community types. Michigan Natural Features Inventory, Lansing, MI. 34 pp. (Unpublished manuscript revised April 2, 1990). Available: http://www.dnr.state.mi.us/WILDLIFE/Heritage/Mnfi/lists/natural_community_types.pdf

McGowan-Stinski, J. 1999. Land Steward. The Nature Conservancy, Michigan Chapter, East Lansing, MI.

NatureServe: An online encyclopedia of life [web application]. 2001. Version 1.4. Arlington (VA): Association for Biodiversity Information. Available: http://www.natureserve.org/. (Accessed: August 30, 2001).

Reinartz, J.A. 1997. Controlling glossy buckthorn (Rhamnus frangula L.) with winter herbicide treatment of cut stumps. Natural Areas Journal 17:38-41.

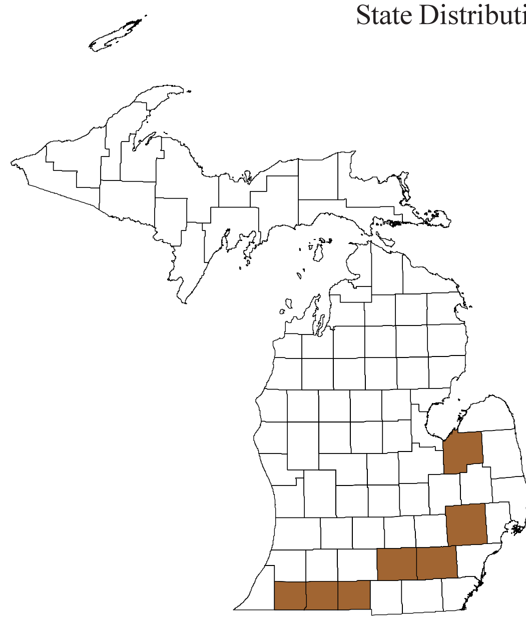
**Abstract Citation:**

Kost, M.A. 2001. Natural community abstract for relict conifer swamp. Michigan Natural Features Inventory, Lansing, MI. 6 pp.

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

Photo by Diane De Steven

State Distribution



**Overview:** Southern wet meadow is an open, groundwater-influenced (minerotrophic), sedge-dominated wetland that occurs in mid and southern Lower Michigan. Sedges in the genus *Carex*, in particular *Carex stricta*, dominate the community.

**Global and State Rank: G4?/S3?**

**Range:** Southern wet meadow, which is commonly referred to as sedge meadow, occurs in Iowa, Illinois, Indiana, Michigan, Minnesota, North Dakota, Wisconsin and Ontario. In Michigan, southern wet meadow is thought to be restricted to the southern Lower Peninsula and to differ from sedge meadows in northern Michigan (see northern wet meadow, MNFI 1990). However, no detailed study of the differences between northern and southern types has been undertaken. Curtis (1959) studied sedge meadows in northern and southern Wisconsin and found them to be floristically similar but concluded that northern meadows had consistently lower soil pH values and were frequently wetter and smaller than many southern wet meadows. Another sedge-dominated natural community, poor fen, also occurs in Michigan but differs markedly from southern wet meadow because of its strongly acidic, organic soils and the prevalence of *Carex oligosperma* and other open bog species (MNFI 1990).

**Rank Justification:** Because southern wet meadow often occurs as a zone within large wetland complexes, information on its presettlement extent and present acreage is not readily available. However, in Wisconsin, where 459,000 ha (1,130,000 acres) of sedge meadow are thought to have existed prior to settlement (Curtis 1959), it is estimated that less than 1 percent remain intact (Reuter 1986). It is likely southern wet meadow acreage has declined similarly in other Midwest states, such as Michigan, where similar agricultural methods have been practiced.

Southern wet meadows have been extensively utilized for agriculture. Prior to the 1950s mowing for marsh hay was widely practiced (Stout 1914, Curtis 1959). Wet meadows were frequently tiled, ditched, drained, and converted to pasture, row crops or mined for peat (Costello 1936, Curtis 1959, Reuter 1986). In addition, fire suppression has facilitated shrub encroachment with many southern wet meadows converting to shrub-carr (Curtis 1959, Davis 1979). This is especially evident where the water table has been lowered though tiling or ditching and the practice of mowing for marsh hay has been abandoned (White 1965).

**Landscape and Abiotic Context:** Southern wet meadow occurs on glacial lakebeds, and in depressions on glacial outwash and moraines (Curtis 1959). The community

**Michigan Natural Features Inventory**
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

frequently occurs along the margins of lakes and streams where seasonal flooding or beaver-induced flooding is common.

Southern wet meadow typically occurs on organic soils such as muck and peat (Curtis 1959) but saturated mineral soil may also support the community (Costello 1936). Because of the calcareous nature of the glacial drift in the regions occupied by southern wet meadow, its wet soils contain high levels of dissolved minerals such as calcium and magnesium. Southern wet meadow soil pH values range between 7.0 to 7.8 in southeastern Michigan and 7.2 to 8.5 in southern Wisconsin and indicate that the community typically occurs on neutral to strongly alkaline soils (Costello 1939, Curtis 1959, Warners 1993).

Southern wet meadow typically occurs adjacent to other wetland communities in large wetland complexes. In southern Michigan's interlobate region where ground water seeps occur at the base of moraines, southern wet meadow often borders prairie fen. In depressions on ground moraine or lakeplain, southern wet meadow may grade into wet prairie or lakeplain wet prairie up slope and emergent marsh in lower areas. On the edges of inland lakes, southern wet meadow often borders emergent marsh. It may also occur along the Great Lakes shoreline within extensive areas of Great Lakes marsh. In all of these landscape settings, southern wet meadow may border shrub-carr and swamp forest.

**Natural Processes:** Southern wet meadow is a groundwater-dependent, *Carex stricta*-dominated, wetland community. Water levels in southern wet meadow fluctuate seasonally, reaching their peak in spring and lows in late summer (Costello 1936, Warners 1993). However, water levels typically remain at or near the soil's surface throughout the year (Costello 1936, Curtis 1959, Warners 1993). The community's structure may depend on maintaining a consistently high water table. Costello (1936) states that the *Carex stricta* tussocks disappeared within 10 years from a meadow where the water levels were reduced to 2 to 4 feet below the surface as a result of tiling.

In addition to seasonal flooding, beaver-induced flooding may also play an important role in maintaining the community by occasionally raising water levels and killing encroaching trees and shrubs. Beaver may also help create new southern wet meadows by flooding swamp forests and shrub-carr and thus creating suitable habitat for the growth of shade-intolerant wet meadow species such as *Carex stricta*.

Evidence from wetland peat cores and presettlement maps indicate that southern wet meadow is a fire-dependent natural community (Curtis 1959, Davis 1979). Analysis of wetland peat cores shows that charcoal fragments are consistently associated with sedge and grass pollen (Davis 1979). Conversely, charcoal fragments are lacking from sections of peat cores dominated by shrub pollen. Additional evidence for the role of fire in maintaining sedge meadows in an open condition comes from presettlement maps. In southern Wisconsin, where prevailing westerly winds carry fires eastward, sedge meadow frequently occurred adjacent to fire-dependent natural communities such as oak savannas and prairies on the west side (i.e., windward) of large rivers. While directly east (i.e., leeward) of these same rivers, similar topography supported fire-intolerant tamarack swamps and mesic forests (Zicker 1955 in Curtis 1959).

By reducing leaf litter and allowing light to reach the soil surface and stimulate seed germination, fire can play an important role in maintaining southern wet meadow seed banks (Warners 1997, Kost and De Steven 2000). Fire also plays a critical role in preventing declines in species richness in many community types by creating micro-niches for small species (Leach and Givnish 1996). Another critically important attribute of fire for maintaining open sedge meadow is its ability to temporarily reduce shrub cover (Reuter 1986).

In the absence of fire or flooding, all but the wettest sedge meadows typically convert to shrub-car and eventually swamp forest (Curtis 1959). Because many of the species that inhabit southern wet meadow are shade-intolerant, species richness usually declines following shrub and tree invasion (Curtis 1959, White 1965).

**Vegetation Description:** Southern wet meadow is typically dominated by *Carex stricta* (Stout 1914, Costello 1936, Curtis 1959, Warners 1997, Kost and De Steven 2000). Because the roots of *Carex stricta* form large hummocks or tussocks, the species is responsible for the community's hummock and hollow structure. Individual culms of *Carex stricta* grow from the tussocks, which may reach more than 1 m in height and .5 m in diameter and live for more than 50 years (Costello 1936). The


Early spring photo of *Carex stricta* tussocks and encroaching shrubs. A prescribed fire removed the litter from tussocks in the background, while a thick layer of litter remains on unburned tussocks in the foreground.

*Carex stricta* tussocks can occur at very high densities (1 to 4 per $m^2$) and occupy more than 40% of a meadow's area (Costello 1936). Because the shaded areas between tussocks are often covered with standing water and leaf litter, many of the shorter species inhabiting sedge meadows grow almost exclusively from the sides or tops of *Carex stricta* tussocks.

Other sedges that commonly occur in southern wet meadow include: *Carex aquatilis*, *C. comosa*, C. *bebbii*, *C. hystericina*, *C. lacustris*, *C. lanuginosa*, *C. lasiocarpa*, *C. prairea*, *C. rostrata*, *C. sartwellii*, *C. stipata* and *C. vulpinoidea*. Although most of the associated sedge species tend to be randomly interspersed, *Carex lacustris* often occurs in dense patches.

The most dominant grass species in southern wet meadow is blue joint grass (*Calamagrostis canadensis*) (Stout 1914, Kost and De Steven 2000). Other common grasses include: fringed brome (*Bromus ciliatus*), fowl mana grass (*Glyceria striata*), marsh wild timothy (*Muhlenbergia glomerata*), leafy satin grass (*Muhlenbergia mexicana*), and fowl meadow grass (*Poa palustris*).

A wide variety of wetland forbs occur in southern wet meadow. The following table contains many of the more commonly occurring southern wet meadow species.

| SCIENTIFIC NAME | COMMON NAME |
|---|---|
| *Asclepias incarnata* | swamp milkweed |
| *Aster puniceus* (*A. firmus*) | swamp aster |
| *Aster lanceolatus* | eastern lined aster |
| *Aster lateriflorus* | side flowering aster |
| *Calamagrostis canadensis* | blue joint grass |
| *Campanula aparinoides* | marsh bellflower |
| *Carex aquatilis* | sedge |
| *Carex hystericina* | sedge |
| *Carex lacustris* | sedge |
| *Carex lanuginosa* | sedge |
| *Carex lasiocarpa* | sedge |
| *Carex prairea* | sedge |
| *Carex sartwellii* | sedge |
| *Carex stipata* | sedge |
| *Carex stricta* | sedge |
| *Cicuta bulbifera* | water hemlock |
| *Cirsium muticum* | swamp thistle |
| *Eleocharis erythropoda* | spike rush |
| *Equisetum fluviatile* | water horsetail |
| *Eupatorium maculatum* | joe pye weed |
| *Eupatorium perfoliatum* | common boneset |
| *Galium asprellum* | rough bedstraw |
| *Glyceria striata* | fowl manna grass |
| *Impatiens capensis* | jewelweed |
| *Iris virginica* | southern blue flag |
| *Lathyrus palustris* | marsh pea |
| *Lycopus uniflorus* | northern bugle weed |
| *Lysimachia thyrsiflora* | tufted loosestrife |
| *Mentha arvensis* | wild mint |
| *Muhlenbergia glomerata* | marsh wild timothy |
| *Muhlenbergia mexicana* | leafy satin grass |
| *Onoclea sensibilis* | sensitive fern |
| *Pilea pumila* | clearweed |
| *Polygonum amphibium* | water smartweed |
| *Pycnanthemum virginianum* | mountain mint |
| *Rumex orbiculatus* | great water dock |
| *Sagittaria latifolia* | common arrowhead |
| *Scutellaria galericulata* | common skullcap |
| *Solidago canadensis* | canada goldenrod |
| *Solidago gigantea* | late goldenrod |
| *Solidago patula* | swamp goldenrod |
| *Thalictrum dasycarpum* | purple meadow rue |
| *Thelypteris palustris* | marsh fern |
| *Triadenum fraseri* | marsh st. john's wort |
| *Typha latifolia* | broad leaved cattail |
| *Viola cucullata* | marsh violet |

**Michigan Natural Features Inventory**
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

**Michigan indicator species:** *Carex stricta*, *Carex lacustris*, blue joint grass, swamp aster, joe pye weed, common boneset, northern bugleweed, great water dock, marsh bellflower, and tufted loosestrife.

**Other noteworthy species:** The small white lady's slipper (*Cypripedium candidum*) may occur in southern wet meadow. Rare animal species associated with southern wet meadow include: swamp metalmark (*Calephelis mutica*), Mitchell's satyr butterfly (*Neonympha mitchellii*), eastern massasauga (*Sistrurus catenatus*), Blanding's turtle (*Emydoidea blandingii*), spotted turtle (*Clemmys guttata*), marsh wren (*Cistothorus palustris*), northern harrier (*Circus cyaneus*), short eared owl (*Asio flammeus*), and American bittern (*Botaurus lentiginosus*).

**Conservation/management:**
Southern wet meadows contribute significantly to the overall biodiversity of southern Michigan by providing habitat to a wide variety of plant and animal species including many rare species.

Protecting the hydrology of southern wet meadow is imperative for the community's continued existence. This may include avoiding surface water inputs to the meadow from drainage ditches and agricultural fields, and protecting groundwater recharge areas by maintaining native vegetation types in the uplands around the community.

Management for southern wet meadow should include the use of prescribed fire (Curtis 1959). Prescribed fire can help reduce litter, stimulate seed germination, promote seedling establishment, and bolster grass, sedge, and perennial and annual forb cover (Bowles et al. 1996, Warners 1997, Kost and De Steven 2000). While prescribed fire can be an important tool for rejuvenating southern wet meadow seed banks, it can also help ensure that the community remains in an open condition by temporarily setting back invading woody species (Reuter 1986). Using prescribed fire to control shrub invasion in sedge meadows has also been shown to be 85% less expensive to implement than manual cutting (Reuter 1986). The use of prescribed fire should be avoided during periods of drought to avoid igniting the community's organic soils (Curtis 1959, Vogl 1969).

Invasive species that can occur in southern wet meadow include purple loosestrife (*Lythrum salicaria*), reed canary grass (*Phalaris arundinacea*), reed (*Phragmites australis*), and glossy buckthorn (*Rhamnus frangula*). Each of these species is capable of significantly altering community structure and dramatically reducing species richness. Management should strive to prevent the further spread of these invasive species and implement control measures when possible.

Restoration of degraded southern wet meadows depends on the occurrence of water-saturated peat and muck soils, maintaining waters levels very near the soil surface throughout the year, providing protection from shrub encroachment and invasive species, and the availability of appropriate seed stock (Reuter 1986). Finding viable seed for *Carex stricta*, the species responsible for the overall structure of southern wet meadow, may be a difficult task. Costello (1936) reports that in more than six years of studying *Carex stricta*-dominated sedge meadows he did not find a single seedling of the species. Because of the difficulty of restoring southern wet meadow in the absence of favorable hydrology and intact organic soils, conservation efforts should focus on protecting the remaining community occurrences (Reuter 1986).

**Research needs:** Research on methods for establishing and maintaining *Carex stricta* in wetland mitigation or degraded sites will facilitate restoration efforts for southern wet meadow. Further work on community classification is needed to elucidate differences among sedge meadow types both within and among ecoregions. Research is needed on plant and animal community responses to the frequency and seasonal timing of prescribed burning. Research on the importance of the community for maintaining certain rare species will help stimulate southern wet meadow conservation and management.

**Similar communities:** emergent marsh, northern wet meadow, poor fen, prairie fen, wet prairie, lakeplain wet prairie, Great Lakes marsh and southern shrub-carr.

**Other Classifications:**

**Michigan Natural Features Inventory Pre-settlement Vegetation (MNFI):**
wet meadow (6224)

**Michigan Department of Natural Resources (MDNR):** L, lowland brush; N, marsh; V, bog or muskeg.

**Michigan Resource Information Systems (MIRIS):** 622 (emergent wetland).

**The Nature Conservancy National Classification** (Faber-Langendoen 2001, Natureserve 2001)**:**

CODE; ALLIANCE; ASSOCIATION;
COMMON NAME

V.A.5.N.k; Carex stricta Seasonally Flooded Herbaceous Alliance; *Carex stricta – Carex* spp. Herbaceous Vegetation; Tussock Sedge – Sedge Species Herbaceous Vegetation; Tussock Sedge Wet Meadow.

**Related Abstracts:** small white lady's slipper, mat muhly, prairie dropseed, short-eared owl, northern harrier, spotted turtle, Blanding's turtle, Mitchell's satyr butterfly, eastern massasauga, lakeplain wet prairie, prairie fen, Great Lakes marsh, and relict conifer swamp.

**Selected References**:

Bowles, M., J. McBride, N. Stynoff, and K. Johnson. 1996. Temporal changes in vegetation composition and structure in a fire-managed prairie fen. Natural Areas Journal 16: 275-278.

Costello, D. F. 1936. Tussock meadows in southeastern Wisconsin. Botanical Gazette 97: 610-48.

Curtis, J.T. 1959. Vegetation of Wisconsin: An ordination of plant communities. The University of Wisconsin Press, Madison, WI.

Davis, A. M. 1979. Wetland succession, fire and the pollen record: A Midwestern example. The American Midland Naturalist 102: 86-94.

Faber-Langendoen, D. editor. 2001. Plant communities of the Midwest: Classification in and ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. + appendix (705 pp.).

Leach, M.K. and T.J. Givnish. 1996. Ecological determinants of species loss in remnant prairies. Science 273: 1555-1558.

Kost, M.A. and D. De Steven. 2000. Plant community responses to prescribed burning in Wisconsin sedge meadows. Natural Areas Journal 20: 36-49.

Michigan Natural Features Inventory. 1990. Draft description of Michigan natural community types. Michigan Natural Features Inventory, Lansing, MI. 34 pp. (Unpublished manuscript revised April 2, 1990). Available: http://www.dnr.state.mi.us/WILDLIFE/Heritage/Mnfi/lists/natural_community_types.pdf

NatureServe: An online encyclopedia of life [web application]. 2001. Version 1.4. Arlington (VA): Association for Biodiversity Information. Available: http://www.natureserve.org/. (Accessed: September 4, 2001).

Reuter, D.D. 1986. Sedge meadows of the upper Midwest: A stewardship abstract. Natural Areas Journal 6: 27-34.

Stout, A. B. 1914. A biological and statistical analysis of the vegetation of a typical wild hay meadow. Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 17: 405-57.

Vogl, R. J. 1969. One hundred and thirty years of plant succession in a Southeastern Wisconsin lowland. Ecology 50: 248-55.

Warners, D. P. 1993. Species diversity in southern Michigan sedge meadows: Unpublished report to The Nature Conservancy, Michigan Chapter, East Lansing, MI 35 pp.

Warners, D. P. 1997. Plant diversity in sedge meadows: Effects of groundwater and fire. Ph.D. dissertation, University of Michigan, Ann Arbor, MI. 231 pp.

White, K. L. 1965. Shrub-carrs of southeastern Wisconsin. Ecology 46: 286-304.

Zicker, W.A. 1955. An analysis of Jefferson County vegetation using surveyor's records and present day data. M.S. thesis, University of Wisconsin, Madison, WI.

**Abstract Citation:**

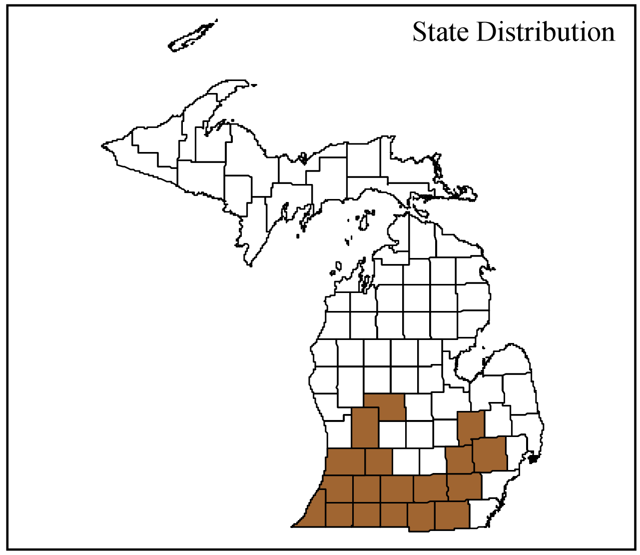
Kost, M.A. 2001 Natural community abstract for southern wet meadow. Natural Features Inventory, Lansing, MI. 5 pp.

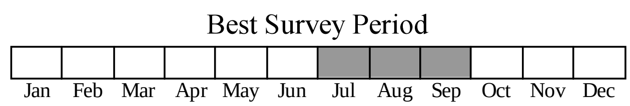
Funding for abstract provided by Michigan Department of Natural Resources-Forest Management Division and Wildlife Division.

**Michigan Natural Features Inventory**
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552

# Prairie fen — Community Abstract

Photo by Dennis A. Albert.




**Global and state rank**: G4/S4

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

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

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

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

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

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

Prior to European settlement, dry, open upland communities such as mixed oak barrens or white oak savannas were often adjacent to prairie fens (Comer et al. 1995). Native American or lightning strike fires burned uplands and likely spread into adjacent prairie fens (Vogl 1969). These fires burned surface vegetation, inhibited shrub invasion, and maintained the open prairie fen community structure (Curtis 1959).

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

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

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

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

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

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

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

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

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


Photo by William W. Brodowicz.

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

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

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

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

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

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

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

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

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

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

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

**Other classifications**

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

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

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

National Wetland Inventory (NWI): not specifically mentioned.

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

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

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

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

**Selected references**

Aaseng, N.E., J.C. Almendinger, R.P. Dana, B.C. Delaney, H.L. Dunevitz, K.A. Rusterholz, N.P. Sather, and D.S. Worcha. 1993. Minnesota's native vegetation: A Key to natural communities. Minn. DNR Natural Heritage Program. Biological Report No. 20.

Albert, D.A. 1995. Regional landscape ecosystems of MI, MN, and WI: A Working map and classification. USFS - North Central Forest Experiment Station.

Almendinger, J., J. Anderson, J. Bell, E. Berglund, R. Dana, S. Eggers, E. Gorham, J. Janssens, S. Komor, G. Larson, J. Leete, N. Sather, and S. Verry. 1994. Technical criteria for identifying and delineating calcareous fens in Minnesota. Minn. DNR.

Bowles, M., J. McBride, N. Stoynoff, and K. Johnson. 1996. Temporal change in vegetation structure in a fire-managed prairie fen. Nat. Areas J. Oct. v16, N4. pp. 275-288.

Chapman K.A. 1986. Natural community description: fen. Michigan Natural Features Inventory, Lansing, MI. 2 pp.

Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Corner, and D.W. Schuen. 1995. Michigan's Presettlement Vegetation, as Interpreted from the General Land Office Surveys 1816-1856. Michigan Natural Features Inventory, Lansing, MI. Digital map.

Curtis, J.T. 1959. Vegetation of Wisconsin: An Ordination of Plant Communities. U. of Wis. Press, Madison, WI. 657 pp.

Kohring, M.A. 1982. Effect of a fall burn on Bakertown Fen, Berrien Co., Michigan. Master's Thesis. Mich. State Univ., East Lansing, MI.

Moore (Raab), J.B., M.S. Hugan, and L.P. Bruederle. 1993. Comparison of three prairie fens in southern Michigan. Report to MNFI. U. of Mich. - Flint Biology Dept., Flint, Michigan. 42 pp.

Moran, R.C. 1981. Prairie fens in northeastern Illinois: Floristic composition and disturbance. In, Proceedings Sixth North American Prairie Conference. R.L. Stuckey and K.J. Reese (eds.). Ohio State U., Columbus, OH. Ohio Bio. Survey Notes No. 15.

Orzell, S.L. and D.R. Kurz. 1984. Floristic analysis of prairie fens in the southeastern Missouri Ozarks. In, Proceedings of the 9th North American Prairie Conference. Tri-College Univ. Center for Environ. Studies, Fargo, ND. pp. 50-58.

Panno, S.V., V.A. Nuzzo, K. Cartwright, B.R. Hensel, and I.G. Krapac. 1999. Impact of urban development on the chemical composition of groundwater in a fen-wetland complex. Wetlands 19:1.

White, M.A. and K.A. Chapman. 1988. Element stewardship abstract for alkaline shrub/herb fen, lower Great Lakes type. TNC - Midwest Heritage Task Force. 14 pp.

Zimmerman, J.H. 1983. The Revegetation of a small Yahara Valley prairie fen. WI Acad. of Science, Arts, and Letters 71. pp. 87-102.

**Abstract citation**

Michigan Natural Features Inventory. 1997. Natural community abstract for prairie fen. Lansing, MI. 4 pp.

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

7-99/rac

**Michigan Natural Features Inventory**
P.O. Box 30444 - Lansing, MI 48909-7944
Phone: 517-373-1552