# The Superior Mixed Forest Ecoregion: A Conservation Plan

**November 2002**

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# 1 Acknowledgements

A core team of staff from The Nature Conservancy, Nature Conservancy of Canada, Ontario Ministry of Natural Resources, and Manitoba Conservation Data Centre led the planning for the Superior Mixed Forest ecoregion. A number of regional biological experts provided essential input to the planning process during expert workshops and other meetings, and in one-on-one interviews with core team members. A list of participants is provided in Appendix A. The report text was compiled and edited by Nicole Van Helden with assistance from Karen Bassler and Maria Madsen. The Core Team consisted of staff from the following states and provinces:

| | |
|---|---|
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| Minnesota | Jan Slaats, GIS Manager, The Nature Conservancy-Midwest Conservation Science<br>Jenny Brown, Director of Conservation Science, The Nature Conservancy<br>Mary Harkness, Ecoregional Ecologist, The Nature Conservancy-Midwest Conservation Science |
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## 2 Executive Summary

As the name implies, the Superior Mixed Forest ecoregion is located near Lake Superior, and vegetated with a mixed forest of broadleaf and coniferous trees. The ecoregion includes portions of Michigan, Wisconsin, Minnesota, Manitoba, and Ontario. The Superior Mixed Forest ecoregion has five dominant ecosystems: mixed boreal forest, pine-hardwood forest, patterned peatlands, northern hardwood forest, and pine barrens. The ecoregion supports wide-ranging mammals, such as wolves, and is a hotspot for neotropical bird diversity because of the high diversity of tree species and forest types.

The majority (77%) of the ecoregion forested, and over half (55%) of the ecoregion is in public ownership. There are no major cities within the ecoregion; the relatively small population is predominantly located in small rural towns. The economy is primarily supported by revenue from the recreation and timber industries—fishing, hunting and wildlife viewing in Wisconsin alone generates $8 million annually.

The goal of this project was to identify a suite of conservation areas that best represent the ecosystems and species of the ecoregion, to serve as a blueprint for conservation action. This three-year planning process was led by The Nature Conservancy and Nature Conservancy of Canada, with input from over 100 experts from throughout the ecoregion.

The plan identifies 51 conservation areas, totaling 26.8 million acres (11.3 million hectares). Seventy-one percent of the land in these conservation areas is in public ownership. These areas represent the best opportunities for conserving the full diversity of terrestrial and aquatic ecosystems and globally rare or declining species. Descriptions, maps, and information regarding the ecological systems and rare species are provided for each of the conservation areas. Conservation goals were met for 72% of the ecological systems, but for only 33% of the rare species.

The main threats to the conservation areas include forests that are managed outside the natural range of variation, altered fire regimes, intense deer herbivory, shoreline development, invasive species, mining, altered hydrology, habitat conversion, and global climate change. All of these threats are common to the majority of the conservation areas identified in this planning effort and many operate at a scale larger than the ecoregion. A diverse group of partners will need to work collaboratively to abate these threats.

The plan also identifies information gaps and recommends next steps.

## 3 Overview of Document Structure

This document describes the results of a conservation planning effort for the Superior Mixed Forest ecoregion, an area extending from western Michigan through northern Wisconsin and Minnesota into southeastern Manitoba and northwestern Ontario. The planning team has structured this document into the following broad sections in order for this document to meet the needs of a variety of users—including those who are intimately familiar with this planning process, those who have never heard of ecoregional planning, those with interest only in the results, and those with interest in the methods and justifications.

I. **Introduction to Ecoregional Planning:** A description of the goals and process used by The Nature Conservancy and Nature Conservancy of Canada with considerable assistance and support from a wide range of other conservation agencies and organizations.

II. **Overview of the Superior Mixed Forest Ecoregion:** A description of the human and ecological context of the ecoregion and an explanation of the ecoregional boundaries.

III. **Ecoregional Planning Methods in the Superior Mixed Forest:** A detailed description of the methods and rationale used to complete this ecoregional plan, or "conservation blueprint," and how the team integrated approaches used in other concurrent planning efforts throughout the region. The section includes a very detailed description of methods used to delineate conservation areas within each of the smaller, ecologically-defined areas that comprise the ecoregion.

IV. **Evaluation of the Ecoregional Plan:** An assessment of how well the blueprint—the suite of conservation areas—represents the biodiversity of the ecoregion. A description of the regional threats to the biodiversity is included; the plan concludes with suggested next steps.

A series of appendices provide information on the following:

- **Participants in the Superior Mixed Forest Planning Process:** A list of experts that provided essential input to the planning process (Appendix A).
- **Boundary Justification for the Superior Mixed Forest Ecoregion:** A description of how the Superior Mixed Forest ecoregional boundary was delineated (Appendix B).
- **Most Common Aquatic System Types in Each Ecological Drainage Unit:** A summary of the distribution of river ecological systems (Appendix C).
- **Secondary Targets:** A list of species intended to be used to test the effectiveness of the coarse-filter approach of conservation planning. Data were inadequate for the majority of these targets. They should be considered as possible targets for future editions of this ecoregional plan (Appendix D).
- **Priority Bird Areas in the Superior Mixed Forest Ecoregion:** A subset of conservation areas within the ecoregion that is important for bird species (Appendix E).
- **Results of the Superior Mixed Forest Ecoregional Plan:** A summary of the suite of conservation areas identified in this plan, including descriptions of the areas, explanation of the boundaries, caveats, maps, and biodiversity encompassed within the areas ( Appendix F and G). Note: Due to the length of these summaries, they are not included in the printed version. They are available electronically only.
- **Goal Status for Primary Targets:** A summary table of how well the conservation goals were met for each conservation target (Appendix H, J, K, and L).
- **Conservation Area Patch Analysis:** A summary table of landcover statistics for each conservation area (Appendix I). Note: Due to the length of this summary, it is not included in the printed version. It is available electronically only.

A list of references and a glossary of terms follows the appendices.

# 4 Introduction to Ecoregional Planning

## 4.1 Goal of Ecoregional Planning (What is Ecoregional Planning?)

The Nature Conservancy and Nature Conservancy of Canada are dedicated to preserving the plants, animals and natural communities that represent the diversity of life on Earth by conserving the lands and waters that they need to survive. While this effort has met with several decades of extraordinary success in both North America and other continents, it became clear in the early 1990s that continued success in conservation meant clearly identifying the priority areas for focus. As stated in the mission, the conservation goal applies to all biodiversity—the known and unknown, the common and uncommon, the revered and the less appreciated. The Nature Conservancy and Nature Conservancy of Canada embarked on a regional planning effort in 1995 in order to ensure that energy is focused upon both an adequate number of places to ensure the conservation of ALL biodiversity and the specific places where the results will be sustainable over the long-term. The planning unit chosen was the ecoregion—an area with similar geology, vegetation, and climate. Termed "ecoregional planning," the objective of this work was to identify a suite of conservation areas that, taken together, would allow for the conservation of all the biodiversity in the ecoregion.

## 4.2 Ecoregional Planning Process

The methods for ecoregional planning, as developed by The Nature Conservancy (2000a), are outlined in great detail in the document "Designing a Geography of Hope." At its core, this process involves five steps that are outlined below.

i. *Select conservation targets.* Develop a list of the biodiversity representative of the ecoregion. Each element included on this list is a "target." Broad ecological systems or groupings encompassing the range of terrestrial and aquatic communities and unified by common ecological processes are identified. These targets are considered a "coarse filter" because they serve as surrogates that represent the myriad of individual species that inhabit them. "Fine-filter" targets are also identified; these are typically individual species and plant communities which are either not represented by ecological systems or are so vulnerable that they need to be accounted for individually.

ii. *Set conservation goals.* Determine how many examples and what geographic distribution is necessary to ensure each target's long-term survival throughout the ecoregion. The recommended number of examples and geographic distribution is a target's "goal."

iii. *Assess the viability of conservation targets.* Using information from Heritage Programs/Conservation Data Centres, land cover layers, and other data sets, evaluate which occurrences of each target are likely to persist over the long term.

iv. *Select a suite of conservation areas that efficiently meets conservation goals of each target.* Based on each target's conservation goal and occurrences, delineate conservation areas that best meet the conservation goals. Only viable examples are selected for the suite of conservation areas and counted toward each target's conservation goal.

v. *Evaluate the suite of conservation areas.* Assess how well conservation goals are met, and determine whether additional areas should be added to meet any unmet conservation goals. Identify common threats to the biodiversity of the ecoregion.

## 4.3 Multiple Scales of Conservation in the Superior Mixed Forest

Biological diversity occurs at multiple spatial scales, from the small fraction of an acre required by a particular insect species to the tens of millions of acres supporting an entire forest ecosystem. As in any ecoregion, conserving the biodiversity of the Superior Mixed Forest necessitates a multi-scale approach. The opportunities for conservation at larger spatial scales—approaching the scale of forest ecosystems—are significant in the Superior Mixed Forest, due to the relatively intact nature of the region's ecosystems. As a result, the approach used for conservation planning here is somewhat different than that used in more fragmented and converted ecoregions. To address the needs of targets ranging from individual species to entire ecosystems, the ecoregional planning process focused on three spatial scales:

1. **Regional scale.** Many of the matrix forests of the Superior Mixed Forest are maintained by disturbance regimes (e.g. fire, windthrow, and insect outbreaks) that can impact millions of acres in a single catastrophic event. Even in portions of the ecoregion where forest processes operate at finer scales, the conservation of wolves and forest interior

birds requires focus beyond the ecoregion. These ecosystems and wide-ranging species operate at a regional or larger scale. It is not practical to delineate conservation areas that fully encompass the area required to support these ecosystems and wide-ranging species. However, to ensure the long-term survival of these regional-scale ecosystems and species, this plan highlights the need to manage forest ecosystems toward their natural range of variability, while accounting for the needs of the wolves and forest interior birds.

2. **Intermediate scale.** Northern hardwood forests and a variety of wetland ecosystems are supported by disturbance or hydrologic processes occurring at an intermediate scale, comparable to the scale of most conservation areas identified in this plan. Similarly, a variety of individual species (such as pine marten) also operate at this scale. This planning effort focused primarily on delineating conservation areas that can support ecological systems and species operating at this scale. For each of the conservation areas identified through this planning process, conservation objectives will need to be clearly defined and strategies developed to ensure the conservation of the native biological diversity and key natural processes. These objectives and strategies should be consistent with the regional goal of managing the forests within the natural range of variability and supporting the conservation of wolves and forest interior birds.

3. **Local scale.** Fens, seeps, dragonflies, butterflies, and a variety of other plant communities and species require small areas and are affected by more localized ecological processes. The scale at which many of these communities and species occur is comparable to the scale of stand-level forest management. Within each of the conservation areas, there are likely to be smaller areas requiring management or restoration to meet the conservation objectives defined for these finer-scale plant communities and species. Objectives for finer-scale species and communities should be consistent with the objectives of the regional and intermediate-scale biological diversity.

### 4.4 Implications for The Nature Conservancy and Nature Conservancy of Canada

The approach to conservation used by The Nature Conservancy (TNC) and Nature Conservancy of Canada (NCC) has developed significantly over the past few years. The focus has broadened to include not only rare species and communities, but also representative aquatic and terrestrial ecosystems. This has frequently necessitated that we work across landscapes at intermediate, regional, and even larger scales. Clearly neither the purchase by TNC or NCC nor the preservation or "setting aside" from economic use of all lands within these conservation areas is an option or a desired outcome. Instead, our goal in ecoregional planning is to identify conservation areas that represent the ecological diversity of the ecoregion so that this information is available to all natural resource entities. Realization of the vision described in this plan cannot be completed by any one organization. Just as in the planning stages, we will work with a diverse group of partners and local communities to implement the ecoregional plan, balancing the needs of society and nature. Implementation of the ecoregional plan will entail developing strategies to abate threats that affect the majority of conservation areas identified in this plan and also developing strategies specific to each of the conservation areas so that the goals of the ecoregional plan are realized.

## 5 Overview of the Superior Mixed Forest Ecoregion

### 5.1 Social Context

People have been living in—and shaping—the Superior Mixed Forest ecoregion for thousands of years. The Native Americans and First Nations relied on the native forest communities and waterways for food, medicine, transportation, and ritual purposes. In the 1600s, the French were the earliest European settlers to arrive in the region, using the land for exploration, missionary efforts, and fur trading.

As more Europeans moved westward in North America during the 1800s, logging was the main economic activity of the ecoregion, providing lumber for homes and railways, while at the same time clearing lands for farming. White pine was often the first species to be logged because it was easy to cut with hand tools and could be floated on the rivers. Later, hardwoods were cut and shipped on rail and trucks. Many of the open lands that resulted from logging were farmed temporarily, abandoned and then claimed by the government for back taxes. Some of these cleared lands were used for mining peat, iron, copper, and gravel in the U.S. and gold and silver in Canada (Glaser 1987; Oakes 1996; Forest Capital of Canada 2000; U.S. Geological Survey and Wisconsin Geological and Natural History Survey 1976). Timber production remains an important part of the local economy.

The forests, lakes, and rivers of the ecoregion have been a popular destination for hunting, fishing, boating, and wildlife viewing. Today these activities generate a substantial portion of the economy—Great Lakes fishing generates $200 million and fishing, hunting, and wildlife viewing in Wisconsin alone generates $8 million annually (Wisconsin Department of Natural Resources 2002).

## 5.2 Current Ownership and Population

Fifty-five percent of the Superior Mixed Forest ecoregion is in public ownership. The current population is primarily descended from European immigrants and First Nations. There is no large metropolitan area in the ecoregion; scattered rural communities define the demographics. The closest cities are Duluth/Superior, Thunder Bay, and Winnipeg. According to the U.S. Census 2000, counties throughout the region have shown little growth since 1990. The growth that has occurred is primarily in areas with high densities of lakes.

**Table 1. Current Ownership in the Superior Mixed Forest Ecoregion.**

| **Owner** | **Hectares** | **Acres** |
|---|---|---|
| Private (Canada and U.S.) | 9,389,049 | 23,200,340 |
| Tribal (U.S. only) | 677,505 | 1,674,115 |
| Public | | |
| Federal (U.S. only) | 2,240,488 | 5,536,246 |
| Provincial/Crown (Canada only) | 4,708,835 | 11,635,531 |
| State (U.S. only) | 3,036,174 | 7,502,386 |
| County/Local (U.S. only) | 763,216 | 1,885,907 |
| Total Public (Canada and U.S.) | 10,748,713 | 26,560,070 |
| | | |
| **Total Area of Superior Mixed Forest** | **20,814,899** | **51,434,525** |

## 5.3 Ecological Context

Glaciers scoured the Superior Mixed Forest ecoregion during the Wisconsinan glaciation, which ended approximately 10,000 years ago. Outwash plains and channels formed where glacial meltwater flowed; lacustrine deposits and beach ridges were left when meltwaters reached natural dams and formed lakes. Till plains and a variety of morainal features were created in the advance and retreat of the glaciers. Bedrock outcrops occur in parts of the ecoregion blanketed by a very thin layer of glacial till. Together, these landforms support five dominant terrestrial ecosystems: mixed boreal forest, pine-hardwood forest, patterned peatlands, northern hardwood forest, and pine barrens. Differences in landforms, climate, and disturbance from wind, fire, hydrology, and insects drive the natural distribution of these ecosystems. Embedded within these dominant ecosystems are smaller features such as wet meadows, fens, and rock outcrops. This ecoregion is also renowned for its lakes, both large and small. Lake of the Woods and Rainy Lake are among the largest lakes in the ecoregion; northern Wisconsin, northeastern Minnesota, and northwestern Ontario have high concentrations of numerous smaller lakes. Stream and river ecosystems are relatively small, and often connected to lake and wetland ecosystems.

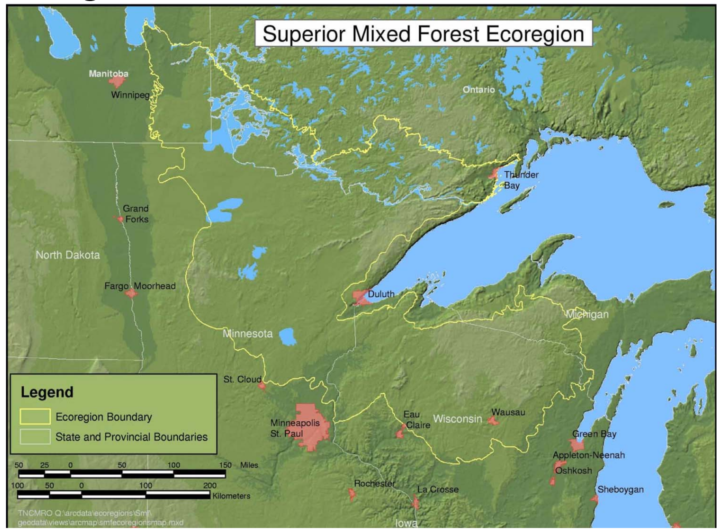
## 5.4 Ecoregional Boundaries and Map Units

Ecoregions are geographic areas defined by similar climate patterns, physical features (topography, bedrock geology, etc.), and vegetation. The boundaries of the Superior Mixed Forest ecoregion were derived from three ecological land classification maps:

- "Ecoregions of the United States" (Bailey 1994);
- "Terrestrial Ecozones, Ecoregions, and Ecodistricts, An Ecological Stratification of Manitoba's Natural Landscapes" (Smith et al. 1998); this map is part of Canada's national ecological framework (Ecological Stratification Working Group 1995); and
- "Ecozones, Ecoregions, and Ecodistricts of Ontario" (Crins 2000).

The resultant ecoregion extends from western Michigan through northern Wisconsin and Minnesota into southern Manitoba and Ontario. The portion of the ecoregion that is within the United States generally follows the boundaries of the Laurentian Mixed Forest Province, an area mapped in Keys et al.'s (1995) "Ecological Units of the Eastern United States," and widely used by the U.S. Forest Service, many state natural resource agencies, and numerous other entities. The primary exception is that the Superior Mixed Forest excludes the Great Lakes ecoregion, which incorporates central portions of the Laurentian Mixed Forest Province. In Manitoba and Ontario, the ecoregion boundary incorporates ecological map units having climate, landforms, and vegetation similar to the Laurentian Mixed Forest portion of the ecoregion. A more detailed justification of the current ecoregional boundary is included in Appendix B.

**Figure 1. Boundary of the Superior Mixed Forest Ecoregion.** Click for full size map




The Superior Mixed Forest ecoregion is subdivided into smaller ecological map units. The terminology describing ecological map units differs between Canada and the United States. The following table summarizes the terrestrial ecological map units used in each country and the standard that will be used in this report.

**Table 2. U.S. and Canadian Ecological Map Units.**

| United States | Canada | Naming convention used in this document |
|---|---|---|
| Ecoregion | Ecozone (larger than U.S. ecoregions) | Ecoregion |
| Section | Ecoregion (larger or comparable to U.S. sections) | Section |
| Subsection | Ecodistrict (comparable to U.S. sections) | Subsection |
| Landtype Association | Ontario Land Inventory (OLI) unit (smaller than U.S. landtype associations; only developed in Ontario: no comparable units have been mapped in Manitoba) | Landtype Association |

A second series of ecological map units was mapped specifically for this planning process: Ecological Drainage Units. Instead of being defined by climate, landforms, and vegetation, Ecological Drainage Units are based on watershed boundaries. Their scale is roughly comparable to ecological sections. A more detailed explanation of these map units is provided in the section "Selecting Aquatic Conservation Areas."

# 6 Ecoregional Planning Methods in the Superior Mixed Forest

## 6.1 Selecting Conservation Targets

The purpose of this step is to select the biodiversity of the ecoregion that this plan seeks to directly conserve. Conservation targets are the terrestrial and aquatic ecological systems, globally rare natural communities, and individual species that are selected to represent the biological diversity of an ecoregion. Targets are selected with the assumption that their conservation will result in the long-term survival of the full range of biodiversity of an ecoregion. The planning team selected conservation targets using a "coarse filter-fine filter" approach (The Nature Conservancy 2000a). Coarse-filter targets are typically larger, interacting ecosystems that are assumed to encompass much of the finer-scale diversity embedded within them. Some species are not adequately addressed by coarse-filter targets. Such species, which may include vulnerable or declining biota or wide-ranging species, are identified and included as targets. The effectiveness of the coarse filter-fine filter approach has not been widely tested yet, but field studies are beginning to offer preliminary support for this approach (Panzer and Schwartz 1998). Despite the lack of field-testing, there is scientific support for the use of ecological systems and communities as surrogates for individual species in conservation planning efforts (Noss and Cooperrider 1994; Howarth and Ramsey 1991).

Although a range of conservation targets were selected, coarse-filter ecological system targets were the primary focus in the Superior Mixed Forest ecoregion for two reasons:

- *Comprehensive, region-wide data on finer-scale targets, such as species and communities, is lacking.* While this is starting to change (e.g., Minnesota County Biological Survey), relatively few element occurrence data points exist for this ecoregion. In addition, different parts of the ecoregion have received widely varying levels of inventory for such species and communities.
- *Over 145 individual plant communities have been described and documented in this ecoregion.* Due to the lack of spatial information documenting the occurrences of these communities, relying on these targets would have been difficult. In addition, many of these communities are spatially and temporally dynamic and are created and maintained by processes larger than individual plant communities. Therefore, it is more appropriate to focus attention on the broader ecological systems comprised by these individual plant communities.

Two groups of targets were identified and used in this plan, *primary* and *secondary* targets. *Primary* targets are those that guide the selection of conservation areas; these include terrestrial ecological systems, aquatic ecological systems, globally rare and/or declining plant communities, and globally rare and/or declining plant and animal species. *Secondary* targets are globally secure but locally declining; at the beginning of the planning process, the Superior Mixed Forest team intended to use these secondary targets as a test to determine if the final suite of conservation areas adequately captured the regional biodiversity. However, not enough information was available to assess how well the species were represented in the conservation areas. Secondary targets are still discussed throughout this document in order to track the species that should be considered for targets in future iterations of this plan.

### *6.1.1 Primary Targets*

#### 6.1.1.1 Terrestrial Ecological Systems

Terrestrial ecological systems are coarse-filter conservation targets. The ecological systems used for the Superior Mixed Forest were based on ecological groups developed by Don Faber-Langendoen for the entire Midwest and incorporated into the National Vegetation Classification (NatureServe 2001). These groups, hereafter referred to as "ecological systems," were defined according to shared physiognomy and composition. Each system includes individual plant communities that share driving ecological processes. The terrestrial ecological systems identified as targets include both upland and wetland systems, but we will refer to these collectively as "terrestrical ecological systems."

A total of 37 terrestrial ecological systems are found in the Superior Mixed Forest ecoregion (Table 3). Most of the systems are fairly widespread in their distribution and occur either within the vast boreal forest region to the north or the extensive northern conifer-hardwood region to the east. A number of systems are peripheral to the Superior Mixed Forest, primarily those coming in from the Prairie-Forest Border, the Aspen Parklands, and the greater central Midwestern region. There are a few systems that are endemic to the Great Lakes region and whose range includes part of the Superior Mixed Forest ecoregion.

**Table 3. Terrestrial Ecological System Targets.**

| FORESTED AND NON-FORESTED WETLANDS AND MEADOWS | FORESTS | CLIFFS | BARRENS, SAVANNAS, AND PRAIRIES |
|---|---|---|---|
| Conifer Bogs and Poor Swamps | Jack Pine-Mixed Pine Sandplain Forests | Acid Rock Outcrops/Barrens | Great Lakes Pine Barrens * |
| Shrub/Graminoid Bogs | Mesic Jack Pine and Black Spruce Forests | Alkaline Cliffs | Deep Soil Oak Savannas ** |
| Patterned Peatland Complex | White Pine-Red Pine Forests * | Acid Cliffs | Sand Oak Savannas/Barrens ** |
| Poor Fens | White Spruce-Fir Forests | Acid Talus | Sand and Gravel Tallgrass Prairies ** |
| Rich Fens | Aspen-Birch Forests | Pine-Spruce Rocky Forests | |
| Shore Fens | Northern Hardwood Forests | | |
| Rich Prairie Fens ** | Hemlock-Hardwood Forests | | |
| Seepage Meadows | White Cedar-Hardwood Forests | | |
| Open and Emergent Marshes | Dry Oak Forests ** | | |
| Wet Meadows | Oak and Oak-Maple Forests ** | | |
| Wet Prairies ** | Midwestern Hardwood Forests ** | | |
| Rich Conifer Swamps | Aspen Parkland Forests and Woodlands ** | | |
| Hardwood Swamps | Northern Great Plains Bur Oak Forests and Woodlands ** | | |
| Rich Shrub Swamps | | | |
| Floodplain Forests | | | |

Note: All ecological systems are widespread unless otherwise noted.
*= Largely limited to the Great Lakes region
**= Peripheral to Superior Mixed Forest

6.1.1.2 Aquatic Ecological Systems

Aquatic ecological systems are also coarse-filter conservation targets. They serve as a surrogate for the individual species inhabiting the ecological systems. While detailed biological data exists on aquatic systems in this ecoregion, very little of it was readily available or encompassed the entire ecoregion. For this reason, a classification of aquatic ecological systems based on the physical characteristics of aquatic habitats was used, under the untested assumption that physical differences (i.e., geomorphology, landscape position, etc.) correlate with or serve as a reasonable surrogate for biological diversity within the systems. Prior to the next iteration of this plan, this assumption needs to be rigorously tested and followed up with the refinement of aquatic conservation planning tools. In addition, a classification of aquatic systems in the Canadian portion of the ecoregion needs to be developed. Although an aquatic system classification for the Canadian portion of the Great Lakes ecoregion is expected to be complete before Fall 2003, that classification will only apply to the small northeast portion of the Superior Mixed Forest ecoregion. The classification of aquatic systems focused solely on stream and riverine systems; a comprehensive classification of lakes also needs to be developed for the ecoregion.

6.1.1.2.1 Rivers

A physical classification of the streams in the U.S. portion of the Superior Mixed Forest was developed in which similar streams were grouped based on the characteristics summarized in Table 4.

**Table 4. Physical Characteristics Used to Classify Aquatic Ecological Systems in the Superior Mixed Forest.**

| Variable | Justification & Data Source | Classes (% of systems in this class) |
|---|---|---|
| Hydrology | Hydrologic regime is a dominant characteristic of freshwater ecosystems and influences the types and distributions of freshwater assemblages (Poff and Ward 1989; Poff and Allan 1995; Lyons 1996).<br><br>Calculated indicators of base flow from daily flow data where available and analyzed the relationship of these indicators to surficial geology and topography. The planning team used these general relationships to interpret relative groundwater inputs for aquatic systems. For example, coarse-textured materials on slopes contribute more groundwater than flat, clayey areas. | Surface-dominated (22%)<br>Surface mixed: surface and low groundwater (63%)<br>Groundwater mixed: moderate groundwater (15%) |
| Size | Stream size is a critical factor for determining biological assemblages (Vannote et al. 1980; Mathews 1998; S. Sowa, personal communication). Stream size is based on link number. Link number is equal to the number of single branch streams above the classified segment.<br><br>Calculated through GIS analysis. | Stream [link 1-50] (66%)<br>River [link >50] (34%) |
| Drainage Network Position | Drainage network position has been shown to correspond to patterns in freshwater community structure (Vannote et al. 1980; Mathews 1998; Lewis and Magnuson 1999; Newall and Magnuson 1999). Network position refers to the size (link) of the next downstream stream segment from the classified segment. It is represented by downstream link number (dlink). Osborne and Wiley (1992) showed that for warmwater streams in Illinois, the downstream-connected habitat (downstream link) was the most influential factor in determining stream fish community structure. The team has chosen the factor dlink to account for position of the aquatic system in the drainage network.<br><br>Calculated through GIS analysis. | Stream [dlink 1-50] (31%)<br>River [dlink >50] (42%)<br>Connected to lake (27%) |
| Gradient | Stream gradient is the slope of the channel and is correlated with flow velocity, substrate material, and types of channel units (e.g., pools and riffles) and their patterns (Rosgen 1994). A gradient of 0.003 generally separates streams with a well-developed pool-riffle-run habitat structure from flat streams (Wang et al. 1998). The presence of riffles is extremely important in determining the types of fish and invertebrate assemblages present (Lyons 1996).<br><br>Calculated through GIS analysis, using digital elevation models. It is a unitless measurement of slope (rise over run). | Low relief [gradient <0.003] (50%)<br>Medium-high relief [gradient >0.003] (50%) |
| Connection to Lakes or Wetlands | Downstream connection is a critical factor for determining fish community (Osborne and Wiley 1992). Connection to lakes and wetlands also provides surface water storage, reducing the "flashiness" of the rivers.<br><br>Calculated using GIS analysis. | No significant surface storage (9%)<br>Surface storage [either lakes or wetlands connected to stream system] (91%) |

The result was the identification of 37 distinct riverine aquatic systems (Table 5) within the 16 Ecological Drainage Units (EDUs) of the ecoregion. The most widespread aquatic system is streams dominated by a mix of surface and groundwater inputs that connect to larger rivers in areas of low relief and high numbers of lakes and wetlands. This type occurs in seven EDUs and has 21 occurrences in the ecoregion. Appendix C provides a summary table of the most common aquatic ecological system within each EDU.

The riverine aquatic ecological systems in Table 5 use the following naming format: hydrology/size/drainage network position/gradient/connection to lakes or wetlands. Connection to lakes or wetlands is expressed as "surface storage" (connected to lakes or wetlands) or "no surface storage" (not connected to lakes or wetlands).

**Table 5. Riverine Aquatic Ecological System Targets.**

| |
|---|
| **GROUNDWATER-DOMINATED SYSTEMS** |
| groundwater mixed / river / large river / low relief / surface storage* |
| groundwater mixed / river / large river / medium-high relief/ no surface storage* |
| groundwater mixed / river / large river / medium-high relief / surface storage |
| groundwater mixed / river / stream / low relief / surface storage |
| groundwater mixed / river / stream / medium-high relief / surface storage* |
| groundwater mixed / stream / lake / low relief / surface storage* |
| groundwater mixed / stream / large river / low relief/ no surface storage* |
| groundwater mixed / stream / large river / low relief / surface storage |
| groundwater mixed / stream / large river / medium-high relief / surface storage |
| groundwater mixed / stream / stream / low relief/ no surface storage* |
| groundwater mixed / stream / stream / low relief / surface storage |
| groundwater mixed / stream / stream / medium-high relief / surface storage |
| **SURFACE WATER-DOMINATED SYSTEMS** |
| surface / river / lake / low relief / surface storage* |
| surface / river / lake / medium-high relief / surface storage* |
| surface / river / large river / low relief / surface storage |
| surface / stream / lake / medium-high relief / surface storage* |
| surface / stream / river / low relief / surface storage |
| surface / stream / river / medium-high relief / surface storage* |
| surface / stream / stream / medium-high relief / surface storage* |
| surface mixed / river / lake / low relief / surface storage |
| surface mixed / river / lake / medium-high relief / surface storage |
| surface mixed / river / large river / low relief/ no surface storage* |
| surface mixed / river / large river / low relief / surface storage |

| |
|---|
| surface mixed / river / large river / medium-high relief/ no surface storage* |
| surface mixed / river / large river / medium-high relief / surface storage |
| surface mixed / river / stream / medium-high relief / surface storage |
| surface mixed / stream / lake / low relief / surface storage |
| surface mixed / stream / lake / medium-high relief / surface storage* |
| surface mixed / stream / large river / low relief / no surface storage |
| surface mixed / stream / large river / low relief / surface storage |
| surface mixed / stream / large river / medium-high relief / no surface storage |
| surface mixed / stream / large river / medium-high relief / surface storage |
| surface mixed / stream / stream / low relief / surface storage |
| surface mixed / stream / stream / medium-high relief / no surface storage |
| surface mixed / stream / stream / medium-high relief / surface storage |

*= System type only occurs in one Ecological Drainage Unit.

6.1.1.2.2 Lakes

Priority lakes were identified only in the United States. Because local variation in chemistry, topography, watershed position, lake depth, fish stocking, and hydrology greatly alters species found in lakes, the planning team did not use a regional classification of lakes. Instead, the team used existing information and expert opinion on lake types and priority occurrences.

Future iterations of the Superior Mixed Forest plan should include a lake classification system based on physical factors such as size, depth, number of surface connections, geology in the drainage area, shoreline complexity, and water chemistry. A prototype of this classification system was developed for this planning process, but it was not used because of limited chemistry data which expert reviewers considered critical to classifying the lakes. Since comprehensive lake classification systems were not available, the team used available local classifications, summarized here.

The Wisconsin Department of Natural Resources (1995a) summarized the diversity and abundance of Wisconsin lakes based on Omernik and Gallant (1988) ecoregions. Of Wisconsin's 14,000+ lakes, over 9,250 are located within two ecoregions, North Central Hardwood Forest and Northern Lakes and Forest regions (Wisconsin Department of Natural Resources 1995a), which correspond to the Wisconsin portion of the Superior Mixed Forest. The Wisconsin Natural Heritage Inventory program classifies lakes based on the following factors: size, depth, hard/soft water, and seepage/drained/drainage. Experts identified priority lake complexes within each Ecological Drainage Unit, based on the prototype lake classification, Wisconsin Department of Natural Resources' wild lake assessment, and expert opinion.

Three frameworks were used to identify the diversity of lake types within Minnesota. One framework describing the lakes of Minnesota (Zumberge 1952) was used in the selection of conservation areas; two other frameworks developed by the Minnesota Department of Natural Resources (K. Myhre, personal communication; Schupp 1992) were used to assess how well the final suite of conservation areas represented the variability of Minnesota's lakes.

*I. Zumberge (1952):* This study divided the state of Minnesota into geomorphically similar geographic units that contain different types of lakes, based largely on the glacial history of the state and the relationship of glaciation to lake form and lake function. The goal was to represent lakes in each of the following geomorphic units within conservation areas.

**Table 6. Geomorphic Units in Minnesota (Zumberge 1952).**

| | |
|---|---|
| Brainerd Outwash<br>Bemidji Outwash<br>Park Rapids Outwash<br>Naytahwaush Outwash | Predominantly ice-block basins in variety of glacial landforms<br>(e.g., outwash plain in a preglacial valley, outwash plain, and till). |
| Aitkin Glacial Lake Bed | Predominantly oxbow lakes on Mississippi River. |
| Agassiz Glacial Lake Bed | Predominantly remnant preglacial lakes (e.g., Red Lakes, Lake of the Woods, Nett Lakes). |
| Northeastern Bedrock | Predominantly bedrock basins in preglacial valleys, not in preglacial valleys, and dammed by drift. |
| End Moraine Belt | Predominantly ice block basins on till and outwash (most common lake type in Minnesota). Mille Lacs and Leech Lake are both examples of lakes formed by moraine dams. |
| Milaca Ground Moraine | Predominantly lakes on moraines formed by continental glaciation and meander scars from the Mississippi River. |

*II. Schupp (1992):* This work classified 5,625 lakes in Minnesota by the physical characteristics that correlate with the fish community characteristics; 44 lake types resulted. A review was conducted at the end of the selection process to ensure that all of these lake types were captured within at least one conservation area.

*III. Myhre (2001):* The Minnesota County Biological Survey has completed some lake surveys for rare aquatic plants, particularly in the Western Superior Uplands ecological section. As none of these species are globally rare, they are not included in the target list, but this assessment serves as a quality assessment of the lakes that are captured within the conservation areas.

The largest concentration of lakes within the Michigan portion of the Superior Mixed Forest is located within the headwaters of the Ontonagon and Presque Isle Rivers. These lakes were identified as priorities during ecoregional planning for the aquatic systems within the Great Lakes basin (The Nature Conservancy 2000b). A more detailed assessment needs to be completed to determine the number of lake types within these headwater lakes, where the best examples occur, and how many occurrences need to be conserved to ensure long-term viability.

#### 6.1.1.3 Globally Rare Plant Communities

All rare (Heritage Ranks G1–G2) native plant communities of the ecoregion were included as conservation targets (Table 7). Plant community types are from NatureServe's National Vegetation Classification (NatureServe 2001; Grossman et al. 1998).

**Table 7. Globally Rare Plant Community Targets.**

| Community Name | GLOBAL CODE | Global Rank | Distribution | Patch Type |
|---|---|---|---|---|
| Northern Oak Barrens | CEGL002160 | G2 | P | LP |
| Northern Tallgrass Calcareous Fen | CEGL002267 | G2 | P | SP |
| Northern White-cedar - Yellow Birch Forest | CEGL002450 | G2Q | L | LP |
| Jack Pine / Prairie Forbs Barrens | CEGL002490 | G2 | P | LP |
| Boreal Extremely Rich Seepage Fen | CEGL002496 | G2Q | W | SP |
| Open Schlenke Bog | CEGL002501 | G2? | W | SP |
| Inland Coastal Plain Marsh | CEGL005108 | G2? | L | SP |
| White Oak - Bur Oak Openings | CEGL005121 | G1 | L | LP |

**Global Rank:**
G1 - Critically imperiled globally due to extreme rarity
G2 - Imperiled globally due to rarity
G3 - Either very rare and local throughout range or found locally in a restricted range
G4 - Apparently globally secure, may be rare in parts of range, esp. at periphery
G5- Demonstrably secure globally, may be rare in parts of range, esp. at periphery
Q after global rank - Species with a questionable taxonomic assignment
? after global rank - Uncertainty with numeric rank

**Distribution:**
E - Endemic
L - Limited
W - Widespread
P - Peripheral
U – Undetermined
N - Not Applicable

**Patch Type:**
MX - Matrix
LP - Large Patch
SP - Small Patch
LI - Linear
U - Undetermined

#### 6.1.1.4 Globally Rare Plant and Animal Species

All species in the ecoregion with Heritage Ranks of G1–G3 or T1–T3 were selected as targets. These species are too rare to rely solely on the coarse-filter approach to adequately conserve these species. In addition, as suggested by experts, bird species with a global Partners in Flight (PIF) score greater than 24 were also included (Partners in Flight 2002). The species that meet this criterion are either globally declining or are declining locally and this region is critical to conserving the overall population. The species on the target list occur in a diverse set of habitats, including shorelines, mature hardwoods, spruce bogs, pine barrens, and large canopy gaps. Species targets for the Superior Mixed Forest are listed in Table 8.

**Table 8. Plant and Animal Species Targets By Taxon.**

| Scientific Name | Common Name | Global Code | Global Rank | Criteria Met |
|---|---|---|---|---|
| **BIRDS** | | | | |
| Scolopax minor | American Woodcock | ABNNF19020 | G5 | PIF >24 |
| Pelecanus erythrorhynchos | American White Pelican | ABNFC01010 | G3 | G1-G3 |
| Cygnus buccinator | Trumpeter Swan | ABNJB02030 | G4 | PIF >24 |
| Tympanuchus cupido | Greater Prairie-chicken | ABNLC13010 | G4 | PIF >24 |
| Charadrius melodus | Piping Plover | ABNNB03070 | G3 | G1-G3 |
| Dendroica kirtlandii | Kirtland's Warbler | ABPBX03180 | G1 | G1-G3 |
| Dendroica cerulea | Cerulean Warbler | ABPBX03240 | G4 | PIF >24 |
| Ammodramus henslowii | Henslow's Sparrow | ABPBXA0030 | G4 | PIF >24 |
| Dendroica caerulescens | Black-throated Blue Warbler | ABPBX03050 | G5 | PIF >24 |
| **FISH** | | | | |
| Moxostoma valenciennesi | Greater Redhorse | AFCJC10170 | G3 | G1-G3 |
| Crystallaria asprella | Crystal Darter | AFCQC01010 | G3 | G1-G3 |
| Cycleptus elongatus | Blue Sucker | AFCJC04010 | G3 | G1-G3 |
| Coregonus zenithicus | Shortjaw Cisco | AFCHA01140 | G2 | G1-G3 |
| Acipenser fulvescens | Lake Sturgeon | AFCAA01020 | G3 | G1-G3 |
| Notropis anogenus | Pugnose Shiner | AFCJB28080 | G3 | G1-G3 |

| **Scientific Name** | **Common Name** | **Global Code** | **Global Rank** | **Criteria Met** |
|---|---|---|---|---|
| Etheostoma clarum | Western Sand Darter | AFCQC01040 | G3 | G1-G3 |
| **INSECTS** | | | | |
| Dubiraphia robusta | Robust Dubiraphian Riffle Beetle | IICOL5A040 | G1G3 | G1-G3 |
| Gomphurus ventricosus | Skillet Clubtail | IIODO08210 | G3 | G1-G3 |
| Ophiogomphus susbehcha | St. Croix Snaketail | IIODOnew01 | G1G2 | G1-G3 |
| Papaipema beeriana | Blazing Star Stem Borer | IILEYC0450 | G3 | G1-G3 |
| Meropleon ambifusca | Newman's Brocade | IILEYBK050 | G2G4 | G1-G3 |
| Speyeria idalia | Regal Fritillary | IILEPJ6040 | G3 | G1-G3 |
| Callophrys irus | Frosted Elfin | IILEPE2220 | G3 | G1-G3 |
| Dolania americana | American Sand Burrowing Mayfly | IIEPH02010 | G2 | G1-G3 |
| Nicrophorus americanus | American Burying Beetle | IICOL42010 | G1 | G1-G3 |
| Hygrotus sylvanus | Sylvan Hygrotus Diving Beetle | IICOL38060 | G1 | G1-G3 |
| Cicindela patruela patruela | A Tiger Beetle | IICOL02232 | G3T3 | G1-G3 |
| Cicindela patruela huberi | A Tiger Beetle | IICOL02231 | G3T2 | G1-G3 |
| Gomphus viridifrons | Green-faced Clubtail | IIODO08460 | G3 | G1-G3 |
| Ophiogomphus howei | Pygmy Snaketail | IIODO12090 | G3 | G1-G3 |
| Ophiogomphus sp. 1 (nr. asperus) | Barrens Snaketail | IIODO12200 | G2G3 | G1-G3 |
| Williamsonia lintneri | Ringed Boghaunter | IIODO34020 | G2 | G1-G3 |
| Stylurus notatus | Elusive Clubtail | IIODO80050 | G3 | G1-G3 |
| Psectraglaea carnosa | Pink Sallow | IILEYFN010 | G3 | G1-G3 |
| Lycaeides melissa samuelis | Karner Blue | IILEPG5021 | G5T2 | T1-T3 |
| Ophiogomphus anomalus | Extra-striped Snaketail | IIODO12020 | G3 | G1-G3 |
| **MOLLUSKS** | | | | |
| Pleurobema cordatum | Ohio Pigtoe | IMBIV35090 | G3 | G1-G3 |
| Quadrula fragosa | Winged Mapleleaf | IMBIV39050 | G1 | G1-G3 |
| Plethobasus cyphyus | Sheepnose | IMBIV34030 | G3 | G1-G3 |
| Lampsilis higginsii | Higgins Eye | IMBIV21100 | G1 | G1-G3 |
| Epioblasma triquetra | Snuffbox | IMBIV16190 | G3 | G1-G3 |
| Cumberlandia monodonta | Spectacle-case | IMBIV08010 | G2G3 | G1-G3 |
| Simpsonaias ambigua | Salamander Mussel | IMBIV41010 | G3 | G1-G3 |
| **PLANTS** | | | | |
| Talinum rugospermum | Prairie Fame-flower | PDPOR080G0 | G3? | G1-G3 |
| Potamogeton hillii | Hill's Pondweed | PMPOT030F0 | G3 | G1-G3 |
| Poa paludigena | Bog Bluegrass | PMPOA4Z1W0 | G3 | G1-G3 |
| Listera auriculata | Auricled Twayblade | PMORC1N010 | G3 | G1-G3 |
| Cypripedium arietinum | Ram's-head Lady's-slipper | PMORC0Q020 | G3 | G1-G3 |
| Leucophysalis grandiflora | Large-flowered Ground-cherry | PDSOL0E010 | G3? | G1-G3 |
| Besseya bullii | Kitten Tails | PDSCR09030 | G3 | G1-G3 |
| Polemonium occidentale ssp. | Western Jacob's-ladder | PDPLM0E0F4 | G5?T1Q | T1-T3 |
| Oxytropis campestris var. chartacea | Fassett's Locoweed | PDFAB2X041 | G5T1 | T1-T3 |
| Botrychium rugulosum | Rugulose Grape-fern | PPOPH010P0 | G3 | G1-G3 |
| Botrychium pallidum | Pale Moonwort | PPOPH01130 | G2 | G1-G3 |
| Botrychium mormo | Little Goblin Moonwort | PPOPH010N0 | G3 | G1-G3 |

| Scientific Name | Common Name | Global Code | Global Rank | Criteria Met |
|---|---|---|---|---|
| Cirsium hillii | Hill's Thistle | PDAST2E1C0 | G3 | G1-G3 |
| Arnica chionopappa | Arnica chionopappa | PDAST0Q0T0 | G1G2Q | G1-G3 |
| Menegazzia terebrata | Port-hole Lichen | NLLEC0T010 | G3 | G1-G3 |
| Carex katahdinensis | Katahdin Sedge | PMCYP03F20 | G2G3Q | G1-G3 |

*PIF= Partners in Flight Score (2002)

**Global Rank:**
G1 - Critically imperiled globally due to extreme rarity
G2 - Imperiled globally due to rarity
G3 - Either very rare and local throughout range or found locally in a restricted range
G4 - Apparently globally secure, may be rare in parts of range, esp. at periphery
G5 - Demonstrably secure globally, may be rare in parts of range, esp. at periphery
Q after global rank - Species with a questionable taxonomic assignment
T plus a number - Subranks for subspecies and varieties
? after global rank - Uncertainty with numeric rank

### *6.1.2 Secondary Targets*

A group of secondary target species was selected to determine how effectively the coarse-filter/fine-filter approach represented a broad suite of species that are characteristic of the ecoregion and globally secure, but either requires large areas to support viable populations or is declining locally.

#### 6.1.2.1 Wide-Ranging Species

Studies have shown that carnivores provide a critical ecosystem function, regulating the abundance or vigor of species lower on the food chain (McLaren and Peterson 1994). The intention of having these species as targets was to assess how well the portfolio addressed the requirements of these species. Ecological system targets, such as northern hardwoods, are clearly not a good surrogate for these species because their home ranges, dispersal patterns, and the areas needed to support viable populations are usually substantially larger than even the extent of the largest coarse-scale target. Some of the species below are very common in the ecoregion. The planning team selected the following species, representing a diversity of taxonomic groups:

- wolf (see below regarding scientific name),
- black bear (*Ursus americanus*),
- moose (*Alces alces*),
- Canada lynx (*Lynx canadensis*),
- pine marten (*Martes americana*), and
- forest interior birds.

There currently is disagreement over whether wolves in the Superior Mixed Forest are pure *Canis lupus* or *Canis lupus* X *C. lycaon* crosses. The current most accepted taxonomy for wolves in Wisconsin, Upper Peninsula of Michigan, and Minnesota are *Canis lupus nubilus* (Nowak et al. 1995). Researchers in Ontario classify the species in southern Ontario as *Canis lycaon*, and these may have mixed with *Canis lupus* in the western Great Lakes region. Thus there might be some eastern Canadian wolf (*Canis lycaon*) mixed with gray wolves (*Canus lupus*) in the U.S. (see Wilson et al. 2000). In this report, we refer to the species as “wolf.”

Forest interior birds were selected as a secondary target because the ecoregion supports a high diversity of species and supports the highest concentrations of some species, such as golden-winged warbler (Pashley et al. 2000). More than 60 species breed in the northern forests of northern Michigan, Wisconsin and Minnesota and adjacent Ontario (Price et al. 1995). In particular, this region has a high diversity of warblers, flycatchers, and thrushes (Price et al. 1995). The entire mixed forest belt from Saskatchewan east through the Lake Superior region and northern lower Michigan to New England and Nova Scotia had the highest average number of species (60 to 67) per Breeding Bird Survey route in the United States and Canada (Robbins et al. 1986).

Woodland caribou (*Rangifer tarandus caribou*) was considered for inclusion, but since its current range does not extend to the Superior Mixed Forest (Rebizant et al. 2000; U.S. Fish and Wildlife Service 1998), it was not included as a target. Woodland caribou historically occurred in the northwestern part of this ecoregion and once ranged from the Manitoba-Minnesota border north to the Winnipeg River (Rebizant et al. 2000). Future planning efforts may want to consider whether restoring this species to its former range is appropriate and feasible.

#### 6.1.2.2 Local and Intermediate-scale Species

Secondary targets that are generally not considered area-sensitive are listed in Appendix D. The list includes species in one or more of the following categories:

- Not yet ranked G1-G3, but, according to experts in the region, are likely to be in the future.
- Endemic to the ecoregion.
- Found in the ecoregion but are significantly disjunct from the main portion of their range.
- Listed as federally threatened and endangered species in U.S.
- In taxonomic groups not represented in the primary targets.
- Locally declining and have strong political support for protection.
- Bird species with Partners In Flight scores greater than 20 but less than 25 (2002).

The list also includes the plant communities that were treated as secondary targets.

## 6.2 Setting Conservation Goals

A conservation goal is the number and geographic distribution of populations or examples required to ensure the long-term survival of a conservation target across an ecoregion. The purpose of this step is to develop some reasonable hypotheses of "how much is enough" for each conservation target. While some reasonable hypotheses exist to address these questions for a few individual species, currently there is no comparable guidance for ecological systems, plant communities, and most species. Therefore, Nature Conservancy ecologists and biologists have established general minimum guidelines for conservation goals for ecological systems, plant communities, and species. There is currently very little scientific justification to support these guidelines; they are working hypotheses representing the current best judgement of ecologists and biologists familiar with these conservation targets. It is expected that advances in the field of conservation biology will eventually provide the knowledge necessary to develop meaningful conservation goals. The following paragraphs describe the conservation goals for each category of conservation targets.

### *6.2.1 Primary Targets*

#### 6.2.1.1 Terrestrial and Aquatic Ecological Systems

Nature Conservancy guidelines for ecological systems suggest that one system example per ecological section or Ecological Drainage Unit (EDU) is a minimum goal for widespread systems; more restricted ecological systems should have a higher goal (The Nature Conservancy 2000a). The planning team elected to have a minimum goal of one example per section, for sections within the natural geographic range of the conservation target, and to represent the diversity of landforms upon which these systems occur (in many cases, this results in more than one per section). The team agreed it was appropriate to exceed the minimum conservation goals for systems because it would better represent the variability of the fine-scale features that comprise the ecological systems. Future planning iterations should review these minimum conservation goals; it will likely be appropriate to revise the minimum to a larger number or to better define which landforms need to be represented for each ecological system to ensure that all variations of each system are represented.

#### 6.2.1.2 Globally Rare Plant Communities

Only eight plant communities in the Superior Mixed Forest ecoregion are globally rare or declining. None of the plant communities are restricted to the Superior Mixed Forest—all are either widespread or are most prevalent in an adjacent ecoregion. The planning team agreed to use a minimum goal of two examples in each ecological section in the community's geographic range within the Superior Mixed Forest, and ten examples across the entire range of each community. This general conservation goal is based on earlier guidelines for plant communities developed by Nature Conservancy ecologists (The Nature Conservancy 2000a). It is also consistent with goals established to date in adjacent ecoregions. Again, it is expected that improved information will allow future planners to ensure that these goals are ecologically meaningful and refine them if necessary.

#### 6.2.1.3 Globally Rare Plant and Animal Species

The team adopted The Nature Conservancy guideline of a minimum of two populations per ecological section in which the species occurs, and a minimum of ten populations across the entire range of the species. This rule is based on work by Cox et al. (1994); they studied eleven vertebrate species and concluded that establishing ten relatively secure populations of a species should provide a 90% probability of at least one population persisting for more than 100 years.

Only one primary species target has a federal recovery plan available, the American burying beetle (*Nicrophorus americanus*). The recovery plan (USFWS 1991) defines success as maintaining the three extant populations and re-establishing populations greater than 500 individuals in each of the four portions of its range: northeastern U.S., southeastern U.S., Midwest, and the Great Lakes states. Since the desired number of populations is not defined in the recovery plan, the general goal of two populations per section was adopted. For this species, that results in two populations being re-established within the Southern Superior Uplands section, where historical occurrences are documented. A recovery plan for the Great Lakes population of piping plover is scheduled to be published sometime during the second half of 2002; this plan should be incorporated into future iterations of ecoregional planning in the Superior Mixed Forest.

The State of Wisconsin has prepared a Habitat Conservation Plan (HCP) for the Karner blue butterfly (*Lycaeides melissa samuelis*) (Wisconsin Department of Natural Resources 1999). One of the goals of this HCP was to maintain "current Karner blue butterfly populations in Wisconsin and [encourage] practices that do not contribute to population declines in the state...Further, it is hoped that encouragement of additional land management practices that favor habitat for Karner blue butterflies will result from the attention created by this HCP." The HCP identified primary or core areas in order to maintain this species. The Superior Mixed Forest plan included the two focus areas that were identified in the HCP and are within the ecoregion.

### *6.2.2 Secondary Targets*

#### 6.2.2.1 Wide-Ranging Species

For the wolf, the team used the U.S. Fish and Wildlife Service's "Recovery Plan for the Eastern Timber Wolf" (1992) to set more specific conservation goals for this species. Recovery of the wolf will be achieved when the following two criteria are met:

1) Assure the survival of the wolf in Minnesota, and
2) Re-establish at least one viable population of wolf outside Minnesota and Isle Royale in the contiguous 48 states of the United States. A viable population of wolves outside Minnesota must meet one of the following two descriptions, based upon late winter counts:
   - An isolated wolf population in the United States must average at least one wolf per 50 square miles (128 $km^2$) (a self-sustaining population of at least 200 wolves) distributed within a minimum area of at least 10,000 contiguous square miles (25,600 $km^2$) of suitable habitat over a period of five successive years, or
   - A wolf population in the United States, located within 100 miles (160 km) of a self –sustaining wolf population (as described in item 1), must average at least one wolf per 50 square miles (128 $km^2$) or consists of 100 wolves distributed within an area of at least 5,000 contiguous square miles (12,800 $km^2$) of suitable habitat over a period of five consecutive years. These 100 wolves do not have to be evenly distributed (U.S. Fish and Wildlife Service 1992).

It was challenging to set conservation goals for the remaining wide-ranging species because the area requirements and dispersal habitats for many of these species make it difficult to distinguish separate populations. In addition, there is limited data on viability for these species. As a result of this challenge, the team chose not to develop numeric conservation goals for these species and not to use these species to guide selection of the suite of conservation areas. The planning team established the following qualitative goals for moose, bear, lynx, marten, and forest interior birds:

- Maintain habitat linkages for movement that is necessary for foraging, breeding, and rearing of young.

- Secure populations of wide-ranging mammals maintained throughout their range in the Superior Mixed Forest.
- Maintain enough habitat to support source populations of forest interior birds (see next section "Assessing Viability").

#### 6.2.2.2 Local and Intermediate-scale Species
For this group of species, the team used a goal of at least two populations per section within the species' geographic range in the Superior Mixed Forest, with at least ten populations rangewide (see "Globally Rare or Declining Plant and Animal Species" above for explanation).

## 6.3 Assessing Viability
To meet the conservation goals of each target and ensure the conservation of the biodiversity in this ecoregion, it is critical to select viable examples of each target. By assessing the condition of the species or systems and including only those examples with high integrity and viability, the team can be confident that the biodiversity within the selected conservation areas will persist into the future. Viability is the measure of a population's or ecological system's ability to persist in the long-term. Currently, few quantitative methods for assessing viability are available, and those that are available require spatially and temporally comprehensive datasets that simply do not exist for most conservation targets. Therefore, qualitative rankings of viability are typically used.

Qualitative viability rankings are based on three factors: size, condition, and landscape context. Each of these factors is defined by several characteristics:

**Size**
- Population size
- Size of area occupied by plant community or ecological system
- Population density
- Size of area occupied by population
- Average population size
- Probability that population will drop below a threshold from which it cannot recover

**Condition**
- Regularity and success of reproduction
- Age class structure
- Diversity and composition of species
- Lack of non-native species
- Diversity of physical structure (i.e., downed woody debris and snags in a hardwood forest)
- Intactness of ecological processes (i.e., hydrologic regime, fire regime, nutrient cycling)
- Intactness of abiotic features (i.e., soil substrate quality, water quality)
- Intensity and scope of existing habitat alteration or disturbance due to past human activities
- Ability to manage threats

**Landscape context**
- Landscape connectivity (lack of fragmentation; plant or animal species can disperse from one natural area to another)
- Surrounding landscape condition

Natural Heritage Programs and Conservation Data Centres apply qualitative viability ranks to the plant communities and species that they track and inventory. However, these agencies generally do not track terrestrial and aquatic ecological systems, and other coarse-filter targets. Since ecological systems are an integral part of this plan, alternative methods for assessing viability of these targets need to be developed.

### *6.3.1 Primary Targets*
#### 6.3.1.1 Terrestrial Ecological Systems
Matrix-forming ecological systems are those systems that dominate a landscape or region, and they may cover millions of acres. Boreal forest and northern conifer-hardwood forest are two of the matrix-forming ecological systems in this

ecoregion.  In assessing the viability of "occurrences" of such large-scale systems, size is the most important criteria because it is a primary determinant of whether the ecological processes (such as fire or blowdowns) that define and support the ecosystem can function within their natural range of variation.

In a largely forested ecoregion such as the Superior Mixed Forest, it is difficult to define where one "occurrence" of boreal forest ends and another begins.  Therefore, the team did not attempt to map occurrences of matrix-forming ecological systems and then assess the viability of those occurrences.  Team members developed size criteria for matrix-forming ecological systems, based on the scale and frequency of natural disturbance events in those ecosystems.  Using those size criteria, vegetation maps, and numerous other data sets, team members delineated conservation areas to be of adequate shape, size, and position relative to features on the landscape to permit the functioning or replication of critical ecological processes and natural disturbance regimes.

The planning team made the assumption that if conservation areas are large enough to be resilient to natural disturbances such as fire, flooding, and windthrow, and are managed within their natural range of variation, that the finer-scale diversity within the matrix-forming ecological systems also has good ecological integrity.

#### 6.3.1.2 Aquatic Ecological Systems

An assessment of the integrity of the aquatic systems was conducted through an evaluation of indicators (Table 9) for river conditions; no similar assessment was conducted for lakes.  Within each Ecological Drainage Unit, all systems were prioritized for inclusion in the plan based upon a quality assessment; preference was given to aggregations of high quality segments.

**Table 9. River Condition Indicators.**

See *www.freshwaters.org/pub_docs/litrev.pdf* for a more thorough review of the information summarized in this table.

| Indicator | Data Source | Thresholds |
|---|---|---|
| Low number of dams | National Inventory of Dams from the U.S. Army Corps of Engineers (2001) | Threshold varies. A relative comparison was made to other systems of the same type and expert opinion was used. |
| Low number of road crossings | U.S. Geological Survey Digital Line Graphs | Threshold varies. A relative comparison was made to other systems of the same type and expert opinion was used. |
| High percentage of the contributing area in natural landcover | National Land Cover Data Set<br><br>*landcover.usgs.gov/nationallandcover.html* | Surface water runoff is increased 2x when >2/3 of the contributing area is cleared or trees are <15 years old (Verry 1986).<br><br>8-12% of a contributing area in connected impervious surface results in species richness loss (Wang et al. 2001). |
| Minnesota Pollution Control Agency rating | Minnesota Pollution Control Agency (2001 and 2002) | Since the designated use categories did not include biodiversity, a rating of "supporting" was used. The planning team did not assume that this rating meant intact biotic community. Rivers rated as "threatened" were not included unless they were specifically designated as restoration areas. |
| Presence of aquatic target species | Data records from Natural Heritage Programs and Conservation Data Centres | Not applicable. |
| Connectivity with other priority systems | The Nature Conservancy's aquatic system classification and results of indicators listed above | Not applicable. |

If an aquatic system was the only one of its kind in the ecoregion or Ecological Drainage Unit, it was automatically included regardless of the results of the integrity assessment. This assessment generated a draft list of priority river systems that was then reviewed by experts. The expert review process was accomplished by meeting with fisheries biologists and hydrologists in small groups or as individuals. These experts used personal experience, local planning, and research to review the classification framework, the integrity assessment process, and the draft map of priority systems.

#### 6.3.1.3 Globally Rare Plant Communities

The viability assessment of globally imperiled plant community occurrences was based upon the rankings assigned by Natural Heritage Programs in the United States and Conservation Data Centres in Canada. These qualitative rankings generally only incorporate the size and condition factors, although many programs are now trying to incorporate landscape context into the rankings as well. Plant community occurrences with viability rankings of A-C and located in a good landscape context (based on land cover data) were considered viable. The core team used expert opinion for database records that were not ranked.

6.3.1.4 Globally Rare Plant and Animal Species

The viability assessment of individual species occurrences was similarly based on a combination of Natural Heritage Program and Conservation Data Centre rankings, and landscape context information from land cover data.

*6.3.2 Secondary Targets*

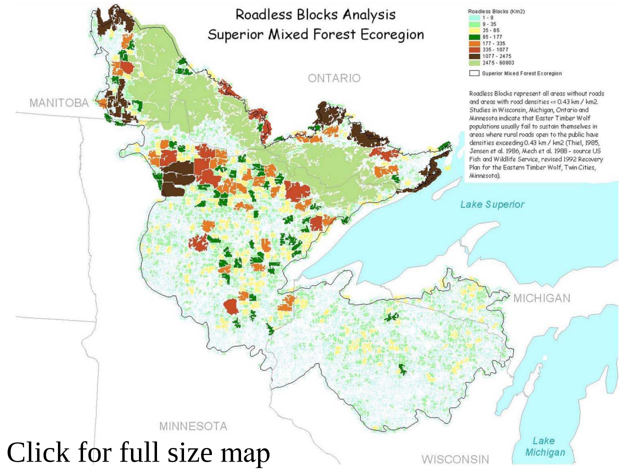
6.3.2.1 Wide-Ranging Species

6.3.2.1.1 Wolves

Five main factors are critical to the long-term survival of the wolf (U.S. Fish and Wildlife Service 1992):

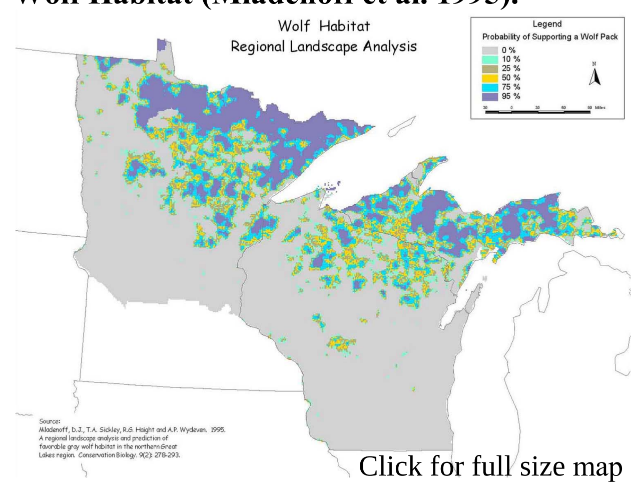
1) large tracts of wild land with low human densities and minimal accessibility by humans;
2) ecologically sound management: habitat protection, depredation control, restocking, research, and prey diversity;
3) availability of adequate wild prey;
4) adequate understanding of wolf ecology and management; and
5) maintenance of populations that are either free of, or resistant to, parasites and diseases new to wolves or are large enough to successfully contend with their adverse effects.

**Figure 2. Analysis of Roadless Blocks in the Superior Mixed Forest Ecoregion (The Nature Conservancy).**




Click for full size map

**Figure 3. Regional Landscape Analysis of Wolf Habitat (Mladenoff et al. 1995).**




Click for full size map

The planning team used road density and existing wolf habitat models as indicators of the five factors listed above. Low road density serves as a good surrogate for wilderness potential for some species (Wydeven et al. 2001; Barry et al. 2001). The planning team mapped road density for the Superior Mixed Forest using the United States Fish and Wildlife Service's wolf recovery plan threshold measures of road density (U.S. Fish and Wildlife Service 1992). According to the recovery plan, wolf populations usually fail to sustain themselves in areas where rural roads have densities exceeding 0.56km / km². Using road density as an indicator of suitable habitat for area-sensitive species allowed us to identify important habitat areas for species where inventory data were absent. Wolf habitat probability models provided a more accurate assessment of wolf habitat probability but were only used where available (U.S. portion of the Great Lakes region) (Wydeven et al. 2001; Mladenoff et al. 1999; Mladenoff et al. 1995). Since wolves utilize a wide variety of habitats, these probability models represent areas where wolves can thrive and have a low mortality rate, rather than depicting habitat quality (A. Wydeven, personal communication).

6.3.2.1.2 Other Mammals

The planning team interviewed experts to assess how well the suite of conservation areas is likely to sustain the bear, moose, lynx, and marten.

6.3.2.1.3 Forest Interior Birds

Two factors were used to assess the integrity of forest interior bird populations:

1) *Presence of at least 70% forest cover in the Superior Mixed Forest.* At the regional scale, bird species composition is a function of landscape patterns, rather than stand structure (Drapeau et al. 2000). For example, the amount of high quality habitats for scarlet tanagers within a 2,500-acre (1,012 ha) block of forest decreased as the forest cover decreased below 70% (Rosenberg et al. 1999). Other studies have also suggested that 70% forest cover correlates with bird source population areas (Robinson et al. 1995; Flaspohler et al 2002; Hall 2002, Hamady 2000).
2) *Deer density is less than 10 per square mile (10 per 25 $km^2$).* Shrub-nesting species, such as black-throated blue warbler, decline at densities above 8 deer per square mile (3 deer / $km^2$). At densities greater than 20 deer per square mile (7-8 deer/ $km^2$), there are significant declines in eastern wood peewees, least flycatchers, and cerulean warblers (deCalesta 1994). At densities greater than 38 deer per square mile (15 deer/ $km^2$), eastern phoebes are greatly reduced, as are ground-nesting species, such as ovenbird, whippoorwill, and ruffed grouse (deCalesta 1994).

#### 6.3.2.2 Local and Intermediate-scale Species

As discussed in the "Globally Rare Plant Communities" section above, the team relied on viability rankings from the Natural Heritage Programs and Conservation Data Centres to assess the integrity of these populations.

## *6.4* Selecting Conservation Areas

The Superior Mixed Forest ecoregion presents an unusual conservation opportunity for midwestern North America, particularly in the United States. Much of the area is still in natural vegetation, unlike the prairie ecoregions where vast areas have been converted to agriculture or development. Today's forests often have a different composition both in terms of species and growth stages than forests of the past. However, the fact that this area is still forested—and that an ecosystem management approach is being adopted by government agencies and private organizations and companies—creates a very real possibility that this region can be managed to conserve much of its terrestrial and aquatic biodiversity. In order to be consistent with the landscape or watershed approach being used by others (e.g., Minnesota Forest Resources Council, Departments of Natural Resources in Minnesota, Wisconsin, and Michigan, U.S. Forest Service, National Park Service, Ontario Ministry of Natural Resources) and to address the scale at which this region's ecosystems naturally function, most of the conservation areas identified in this plan are large landscapes.

Although the steps taken to complete this ecoregional plan are consistent with the The Nature Conservancy's guidelines (The Nature Conservancy 2000a), the approach taken for this particular step—selecting conservation areas for terrestrial and aquatic ecological system, community, and species targets—was somewhat different from other ecoregional planning efforts. Many previous ecoregional planning efforts took a "bottom-up" approach: they focused on identifying intact examples of individual plant associations and species and then considered whether these aggregations comprised an ecosystem with the potential to function within its natural range of variation. Since the Superior Mixed Forest is relatively intact, the team was able to take a "top-down" approach: team members first identified areas supporting the dominant ecosystems and having the potential to function within their natural range of variation, and then determined whether the range of smaller-scale components of each ecosystem was present. A practical consideration also directed the team toward a top-down approach: species and plant association data are extremely limited or non-existent in much of the Superior Mixed Forest ecoregion.

### *6.4.1 Selecting Terrestrial Conservation Areas*

While most of this ecoregion is still forested, the focus on pulp production and other forest products has led to the dominance of early successional growth stages and sometimes to forest-type conversion. Such forests are outside their natural range of ecological variation and are therefore considered to be in poor condition; however, they are also assumed to generally be restorable to conditions within their natural range of variation. As a result, the identification of terrestrial conservation areas began with locating concentrations of high-quality examples of ecological systems. These concentrations served as a core around which to delineate landscape-scale conservation areas. As is further described in the detailed discussions of each ecological section, numerous indicators of high quality examples of ecological systems were used:

- areas with low road density;
- Special Management Complexes and Proposed Research Natural Areas (U.S. Forest Service);
- Important Peatlands, and designated old growth stands (Minnesota Department of Natural Resources);

- GIS analyses indicating areas where late successional species of the potential matrix forest remain;
- sites identified in bird conservation planning in Great Lakes states (Ewert 1999; see Appendix E);
- Landscape Study Areas and Sites of Biodiversity Significance (Minnesota County Biological Survey);
- State Natural Areas (Wisconsin Department of Natural Resources); and
- landscape-scale management opportunity analysis of Wisconsin (The Nature Conservancy 1993).

After locating concentrations of ecological systems in good condition, conservation areas were delineated around the cores to allow the dominant ecological processes and natural disturbance regimes to function at appropriate scales and capture the variability in the physical environment and biological components of each ecological subsection. Team members determined the "minimum dynamic area" for the major ecosystems, using Pickett and Thompson's (1978) suggested rules of thumb: 50 x the average disturbance patch size, or 4 x the catastrophic disturbance patch size. These numbers served as rough guidelines for determining the size of the area required to support the ecosystems' processes. This ensured that the suite of conservation areas contains functional (or potentially functional) examples of dominant ecosystems. Four ecological processes dominate terrestrial ecological systems in this ecoregion: fire, hydrology, wind, and insect outbreaks. Table 10 summarizes the relationship between the four driving ecosystem processes and the overall method for delineating conservation areas. A summary of the terrestrial conservation areas identified in this plan, including descriptions of the areas, explanation of the boundaries, caveats, maps, and biodiversity encompassed within the areas, is provided in Appendix F.

**Table 10. Summary of Conservation Area Boundary Delineation Methods for Terrestrial Ecological Systems.**

| Ecological System | Major Ecological Process | Boundary Delineation | Comments |
|---|---|---|---|
| Mixed Boreal Forest | Fire, Wind | Land Type Associations (Minnesota Department of Natural Resources 1999) and Ontario Land Inventory | Fire extent and pattern is influenced by landforms. Conservation areas were delineated to include core areas and to incorporate the range of landforms in the fire-prone landscape, oriented in the typical direction of fire movement; boundaries ended at adjacent, less fire-prone Land Type Associations (LTAs) or major water bodies. |
| Northern Hardwoods; Pine-Hardwoods | Wind | Intact vegetation, Land Type Associations (Wisconsin LTA Project Team 1999), and watersheds | Core areas identified by intact vegetation. Conservation areas were delineated based on LTA boundaries and watershed boundaries (when conservation area included a priority aquatic conservation area.) |
| Patterned Peatlands | Hydrology | Watersheds | Upstream watershed of the wetland of interest was delineated to encompass the hydrology and other processes that govern water quality/quantity and surface/groundwater interactions. |
| Pine Barrens | Fire, Insects | Land Type Associations (Wisconsin LTA Project Team 1999) | Fire extent and pattern is influenced by landforms. Conservation areas were delineated to include core areas and to incorporate the range of landforms in the fire-prone landscape, oriented in the typical direction of fire movement; boundaries ended at adjacent, less fire-prone Land Type Associations (LTAs) or major water bodies. |

The conservation areas resulting from this approach are often quite extensive. It is not in the region's economic or social interest to "set aside" such large areas from all uses except the preservation of biological diversity. In addition, representing biological diversity necessitates supporting or replicating natural ecosystem processes. Therefore, it is expected that some economic uses, such as timber harvests that mimic natural disturbances, will continue; the goal will be to manage such uses within the ecosystems' natural range of variation. Further refinement of these boundaries is postponed for planning efforts within individual conservation areas, when more detailed information will be available and interpretable.

6.4.1.1 Section-Specific Methods For Selecting Terrestrial Conservation Area

Data availability and quality were extremely variable across the ecoregion. In some parts of the ecoregion, on both the American and Canadian side, no community element occurrence records have been documented. The most detailed landcover layer contained 45 cover classes just within this ecoregion, while the least detailed land cover layer had only 16 cover classes within the ecoregion. The planning team agreed that the best available data should be used throughout the ecoregion, rather than using only those layers that were available for the entire region. Because data availability was so variable, different data layers were used for delineating terrestrial conservation areas in different ecological sections. This section describes how the variety of individual data layers were incorporated in the overall approach of delineating conservation areas based on ecosystem type and function.

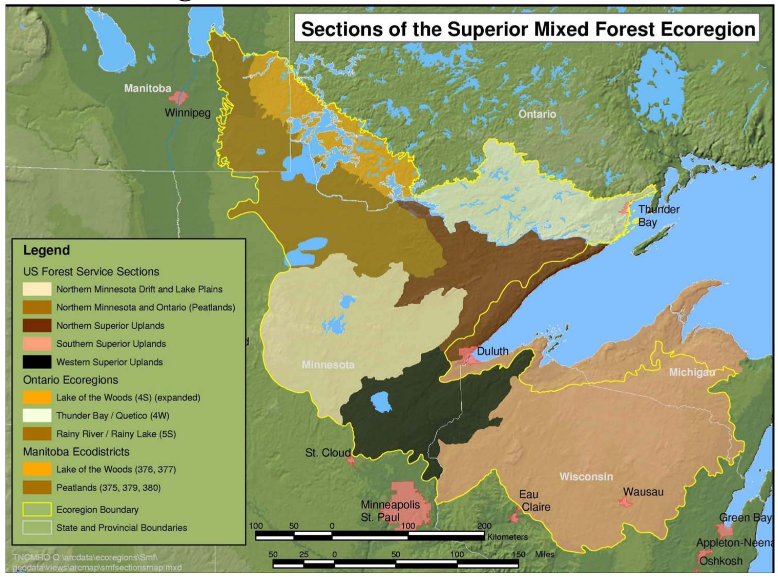
The Superior Mixed Forest ecoregion is divided into eight ecological sections. View full size map of sections. The following paragraphs describe- the geology, vegetation, and major ecological processes of each section, and summarize the variety of data layers and methods that were used to delineate the conservation areas. The descriptions are organized starting from the southernmost section and moving north.

#### 6.4.1.1.1 Southern Superior Uplands

The Southern Superior Uplands section of the Superior Mixed Forest comprises most of the Wisconsin portion of the ecoregion as well as the entire Michigan portion of the ecoregion. Most of northern Wisconsin lies within this section.

***Geology:*** Large exposures of Precambrian bedrock are found throughout the northern portion of this section. Continental glaciers have overridden the section many times. This created a diverse landscape of glacially scoured bedrock ridges and irregularly overlain glacial features. Ground and end moraine ridges are the most common feature. Near Lake Superior, there are clayey glacial lake plains. There are also several extensive outwash plains, including one near Lac Vieux Desert along the Wisconsin/Michigan boundary and another along the Michigamme River in Michigan.

**Figure 4. Ecological Sections in the Superior Mixed Forest Ecoregion.** Click for full size map




***Vegetation:*** This section is dominated by hardwood forests—particularly forests including sugar maple (*Acer saccharum*), eastern hemlock (*Tsuga canadensis*), and yellow birch (*Betula alleghaniensis*). There is a high concentration of inland lakes in this section. There are local large patches of red pine and white pine (*Pinus resinosa* and *P. strobus*), the red pine occurring more frequently on sandy areas of the section. One subsection (212Jm) includes significant areas of pitted outwash, where the matrix system is conifer forest. There are many large river systems in the section, including the Flambeau River and the headwaters of the Wisconsin River. There are relatively few extensive peatlands, none over 10,000 acres (4,046 ha). Wetlands in this section are primarily small-patch communities like rich and poor conifer-hardwood swamps, bogs, poor and rich fens and emergent marshes. Significant areas of northern hardwood forests are in an early successional stage dominated by aspen. In the southern part of this section, some areas have been converted from forest cover to agricultural or urban uses.

***Major Ecological Processes:*** Windthrow, fire, and insects are the major disturbances in this section. The average windthrow in the northern hardwoods forest impacts 230 acres (93 ha) (Canham and Loucks 1984). Catastrophic blowdowns impacting multiple patches totaling up to 60,000 acres (24,281 ha) have been documented in these forests (Canham and Loucks 1984). These larger patches were generally approximately 4,400ha (Schulte and Mladneoff *in review*). The average rotation period (or return interval) for blowdowns varies in the literature: 1,210 years (Canham and Loucks 1984); 450- 10,500 years (Schulte and Mladenoff *in review*); and 1,183 years for both blowdown and fire (Frelich and Lorimer 1991). These reported return intervals vary because Frelich and Lorimer (1991) studied Wisconsin and the Upper Peninsula, whereas Canham and Loucks (1984) averaged disturbance patterns across northern Wisconsin, and Shulte and Mladenoff (*in review*) reported their results by subsection. A recent analysis by Frelich (1999) indicates that 83-91% of northern hardwood forests would be in advanced stages of stand development (or “old-growth”) at any given time if ecosystem processes are operating within their natural range of variation. According to Albert (1995), fire is important on droughty outwash plains, bedrock ridges, and conifer-dominated wetlands, all of which are dominated by upland and wetland conifer species. Ground fires are common in pine forest communities, and the pine barrens in northeastern Wisconsin and the western Upper Peninsula of Michigan have frequent fires. Similar jack pine and mixed pine communities in the eastern Upper Peninsula had average stand-replacing fire rotations of 134 and 163 years, respectively (Zhang et al. 1999). Infrequent but catastrophic fires occur in the hardwood forests, affecting an average of 500 acres (202 ha) and having a return interval of >2,500 years (Zhang et al. 1999).

Variability of patch size and return interval is correlated with substrate and vegetation. For example, Schulte and Mladenoff (*in review*) report that wind frequency is higher on glacial till plains, organic soils, and stands dominated by yellow birch (*Betula allegheniansis*). Similarly, fire frequency was higher on sandy outwash plains and areas dominated by pines (Schulte and Mladenoff *in review*). These return intervals only reflect catastrophic events, underestimating canopy turnover from local wind disturbance and downplaying the role of frequent ground fires in pine stands. Finally, these two disturbances are interrelated—windthrow events make stands more susceptible to fire disturbance.

***Data Layers Used to Delineate Conservation Areas:***
Land Type Associations
Wisconsin and Michigan Watersheds
The Nature Conservancy Aquatic System Classification and priority setting
WISCLAND (Land cover layer; 33 cover classes)
Wisconsin Department of Natural Resources State Natural Areas
Heritage Program Biotic inventories for Wisconsin State Forests: Northern Highlands-American Legion, Brule River, and Flambeau.
U.S. Forest Service Ecosystem Reference Areas identified through the Landscape Analysis and Design process
The Nature Conservancy Landscape Opportunity Analysis (1993) (Wisconsin only)
Low Road Density Areas
Wisconsin and Michigan Heritage Program Element Occurrences

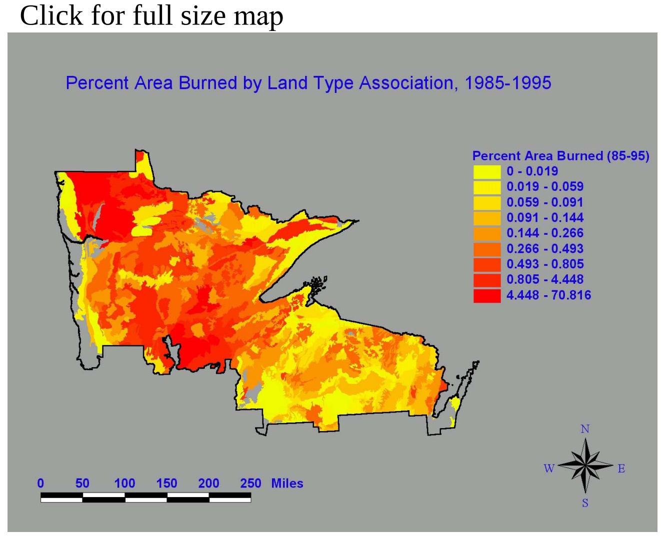
***Conservation Area Delineation Methods:*** This section is dominated by the northern hardwood forest ecosystem. Although fire and hydrology play an important role in a few areas, small-scale windthrow events are the dominant disturbance in this ecosystem. Areas containing high quality matrix forest were identified using State Natural Areas, Ecosystem Reference Areas, State Forest Biotic Inventory Reports, and The Nature Conservancy's 1993 Landscape Opportunity Assessment. Conservation area boundaries were either delineated around Land Type Association boundaries, or they were delineated around existing, high quality, natural vegetation and were then modified to meet the size requirements suggested by the minimum dynamic area for this ecosystem. In cases where the area supporting high quality natural vegetation fell inside aquatic conservation areas, boundaries of those aquatic conservation areas informed the boundaries of the conservation area supporting terrestrial ecological systems.

6.4.1.1.2 Western Superior Uplands

The Western Superior Uplands section crosses the Minnesota-Wisconsin border; the majority of the section is in Minnesota.

***Geology:*** In Minnesota, the western portion of this section is dominated by the glacial end and ground moraines of the Superior Lobe, which have created rolling tillplains and drumlin fields as the dominant landforms. One end moraine serves as the dam that formed Mille Lacs Lake. The eastern-most subsection (212Ka) is an extensive sandy outwash plain with a high concentration of lakes. The dominant drainage in this section is that of the St. Croix River; due to the recent glaciation, this drainage network is young and contains extensive areas of wetlands. To the north, the major drainage into Lake Superior is the Nemadji River; it runs through a gorge and has a different hydrologic regime than rivers to the south since it crosses a geologic divide, rapidly changing its gradient.

**Figure 5. Percent Area Burned by Land Type Association (Minnesota and Wisconsin only).**
(Great Lakes Assessment: www.nrri.umn.edu/gla/Fire%20Assessment.htm)
Click for full size map




***Vegetation:*** The dominant vegetation in this section includes fire-dependent pine-oak forests, mesic hardwood forests, floodplain forests, and both nutrient-rich and acid peat wetlands (Minnesota Department of Natural Resources, Ecological

Classification System). The Bayfield Sandplains subsection (212Ka) is characterized by jack pine (*Pinus banksiana*) and mixed pine barrens. Approximately 10-20% of the section is in lowland or wetland cover while 20-40% of it has been converted from forest cover to agricultural or residential land use [GAP data from Minnesota Department of Natural Resources—Division of Forestry (2000)]

***Major Ecological Processes:*** Fire, windthrow, and hydrologic patterns are the driving ecological processes in this section. A fire regime description, developed by the U.S. Forest Service and the Great Lakes Assessment (Shadis 2000) indicates that the western and southeastern portion of the section were dominated by maintenance fires which recurred on average every 5 to 150 years, depending upon topography and location. Stand-replacement fires with average return intervals varying from 150 to 1,000 years dominated the northern and south-central portions of the section. The eastern portion of the section burned far less frequently with the exception of pine barren areas that saw stand-replacement fires every 50-75 years. The largest fires in the pine barrens during the 1900s were 13,467 acres (5,450 ha) (1977) and 74,130 acres (30,000 ha) (1931) (Radeloff et al. 2000; Vogl 1964). Windthrow is the dominant disturbance process in the less fire-prone areas to the east, due to the thin and often wet soils (Minnesota Department of Natural Resources, Ecological Classification System). Insects are an important disturbance factor within the jack pine barrens. Jack pine budworm outbreaks occur in 4-6 year cycles (Volney and McCollough 1994) and span over 400,000 acres (161,875 ha) during a cycle (Radeloff et al. 2000).

***Data Layers Used to Delineate Conservation Areas:***
Land Type Associations (U.S. only)
Watersheds (Minnesota and Wisconsin)
Minnesota County Biological Survey Landscape Study Areas
Minnesota County Biological Survey Sites of Important Biological Diversity
The Nature Conservancy Aquatic Landscapes (U.S. only)
Minnesota Department of Natural Resources Old Growth
The Nature Conservancy Low Road Density Areas of the Superior Mixed Forest
Minnesota Heritage Program Element Occurrences
Minnesota County Biological Survey rare aquatic features data

***Conservation Area Delineation Methods:*** The mix of dominant ecosystems in this section is variable and includes both upland and wetland systems. Conservation areas were delineated to represent these ecosystems and their driving processes of fire, windthrow, and hydrology. Prior to delineating conservation area boundaries, data layers indicating areas of high quality ecological systems were reviewed to identify core areas within each subsection. The Minnesota County Biological Survey's Landscape Study Areas and Sites of Biodiversity Significance were important indicators of undisturbed native vegetation and served as starting points for delineating conservation areas in this section. Indicators of high quality matrix forest also included areas with low road density and designated old growth stands identified by the Minnesota Department of Natural Resources.

In the fire-driven part of the section, boundaries were drawn around these core areas to encompass an area that will allow fire to begin within a Land Type Association (LTA) having relatively frequent maintenance or stand-replacement fires (generally in the southwestern part of the conservation area), and move through the conservation area in a northeasterly direction until being stopped by a less fire-prone forest type, or natural fire breaks such as lakes or landforms. In fire-driven ecosystems, conservation area boundaries correspond to LTA boundaries. While this may make the conservation areas larger than actually needed, further refinement of these boundaries is postponed for site-level planning when more detailed information will be available and interpretable.

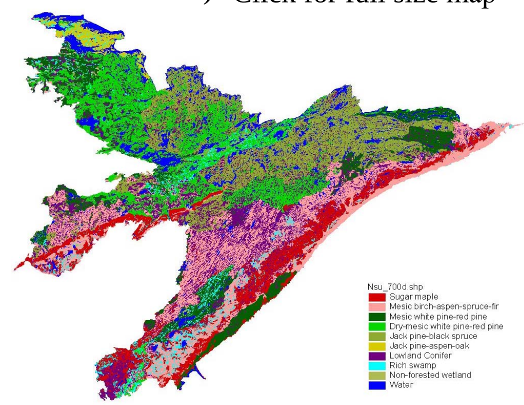
Some areas of this section are dominated by lowland ecosystems, and the fire regime map indicates that fire was not a frequent disturbance in this area. In these areas, hydrology was identified as the dominant ecological process and the upper part of the watersheds supporting the high quality matrix ecosystems were used to form the boundary of the conservation area.

6.4.1.1.3 Northern Superior Uplands

The Northern Superior Uplands section lies in northeastern Minnesota. In future iterations of planning for the Superior Mixed Forest ecoregion, planners should consider treating the Northern Superior Uplands and Thunder Bay-Quetico as a single ecological section.

***Geology:*** A diversity of landforms are present in this section. The northern portion is a land of lakes and rocky ridges formed by glacial erosion of bedrock, while the central and southern parts include end moraines, outwash plains, lake plains, and an extensive drumlin field. This section is home to the Iron Range (Giants Ridge), a granite outcropping overtopped with a thin layer of till where much of the iron ore mining in Minnesota occurs. Two major drainages occur in this section; the headwaters of the Rainy River, which flows west to the Red River of the North, and the headwaters of the St. Louis River watershed, which flows into Lake Superior. In addition, the headwaters of many smaller Lake Superior tributaries are found on the eastern edge of this section. Large lakes cover about 13% of the Border Lakes subsection; other parts of this section are not similarly dominated by lakes.

**Figure 6. Potential Natural Vegetation of Northern Superior Uplands (White and Host 2000).** Click for full size map




***Vegetation:*** Eight different forest types have been identified in the Northern Superior Uplands (White and Host 2000). Matrix-forming types are mesic birch-aspen-spruce-fir (near boreal forest), dry-mesic white-red pine, jack pine-black spruce, and jack pine-aspen-oak. Large patch forest types are sugar maple (northern hardwoods), mesic white pine-red pine, and lowland conifer. Rich swamp forests occur as small patches embedded within these larger systems. Over 80% of northeastern Minnesota (an area slightly larger than this section) is forested (i.e., not converted to other land uses) (Minnesota Forest Resources Council 1999).

***Major Ecological Processes:*** Fire and windthrow are the dominant disturbances in all of the forest types with two exceptions. Lowland conifer and rich swamp forests are shaped primarily by hydrologic processes, and the northern hardwood forest, which is often referred to as the asbestos forest due to its inability to burn, is structured largely by localized windthrow. The Border Lakes subsection is the most fire-dependent area in the Northern Superior Uplands. The historic fire regime was that of frequent stand-maintenance and stand-replacement fires that occurred in patches of 400,000 acres (162,000 ha) (L. Frelich, personal communication) on the high end and about 12,000 acres (5,000 ha) on average (Heinselman 1981). There is also significant evidence that the boreal forest of the Border Lakes area (Baker 1989), and even areas larger in size by an order of magnitude, are insufficient to support this forest system in stable equilibrium (Cumming et al. 1996). This suggests that there will always be the possibility that not all successional stages can be represented in this forest ecosystem in the same proportions at a given point in time, or that the concept of "stability" as we usually think of it may not be applicable to these forests. The July 4, 1999 windstorm in the Boundary Waters Canoe Wilderness Area was a good reminder that wind is also an important disturbance in this part of the ecoregion; in that storm, the largest patch size found was 138,000 acres (55,870 ha) (L. Frelich, personal communication).

***Data Layers Used to Delineate Conservation Areas:***

- The Nature Conservancy Unconverted Forest Areas (Results of analysis comparing potential natural vegetation (White and Host 2000) with Minnesota GAP layer to identify areas that have not been converted to other forest types or land uses)
- Land Type Associations
- Minnesota Watersheds
- Minnesota County Biological Survey Landscape Study Areas
- The Nature Conservancy Aquatic Landscapes

- Minnesota Department of Natural Resources Old Growth coverage
- U.S. Forest Service Old Growth
- U.S. Forest Service Research Natural Areas
- U.S. Forest Service Potential Research Natural Areas
- U.S. Forest Service Candidate Special Management Complexes
- The Nature Conservancy Low Road Density Areas of the Superior Mixed Forest
- Minnesota Heritage Program Element Occurrences

***Conservation Area Delineation Methods:*** Fire-driven ecosystems are predominant in this section, although smaller-scale systems that rely on windthrow or hydrology are also important. Conservation areas were delineated to represent these ecosystems and their driving processes of fire, windthrow, and hydrology. Prior to delineating boundaries, data layers indicating high quality matrix forest were reviewed to identify core areas within each subsection. Indicators of high quality matrix forest include U.S. Forest Service (USFS) Research Natural Areas, USFS Potential Research Natural Areas, USFS Special Management Complexes, USFS Potential Candidate Special Management Complexes, areas of low road density, and designated old growth stands identified by the Minnesota Department of Natural Resources and USFS. In addition, the Minnesota County Biological Survey's Landscape Study Areas and Sites of Biodiversity Significance were incorporated into this analysis whenever possible as further indicators of undisturbed native vegetation.

Conservation area boundaries for the fire-driven ecosystems are defined by Land Type Association boundaries and were drawn to allow for fire to begin in the southwest and move through to the northeast in a natural manner. Conservation areas in the fire-dependent portions of the section were built around areas containing indicators of high quality ecological systems. Calculations of minimum dynamic area suggests the conservation area should be on the scale of 1,600,000 acres (about 650,000 ha). However, as mentioned previously, evidence suggests that areas this size (Baker, 1989) or an order of magnitude larger are insufficient to support a forest system in stable equilibrium (Cumming et al. 1996). Therefore, the conservation area boundary for the fire-driven ecosystems was delineated based on landforms and landscape patterns that could support the natural fire regime. The boundary includes an arrangement of Land Type Associations that should support movement of fire from west to east; fires would often begin in the west in areas which burn frequently (5-50 year return interval), move through areas which are maintained by fairly frequent crown fires (50-75 year return interval), and continue into areas which burn less regularly (25-100 year return interval) with less intense fires.

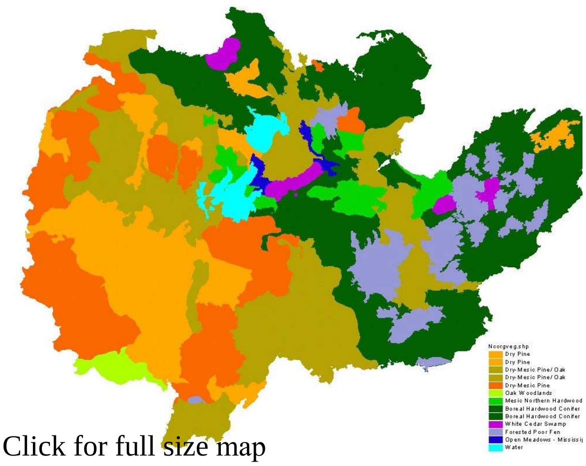
Large patches of both northern hardwood forests, which are not fire-tolerant, and lowland conifer and rich swamp forests, which are driven largely by hydrology, are embedded within the matrix boreal forest. Conservation areas focused on these forest types were delineated largely by the occurrence of hardwood forests and watershed boundaries and their scale requirements for blowdowns and hydrology.

6.4.1.1.4 Northern Minnesota Drift and Lake Plains

This section is located in north central Minnesota.

***Geology:*** This section is dominated by glacial features ranging from moraines, outwash plains, and drumlin fields in the west and south to remnant glacial lakes in the Tamarack Lowlands subsection to the east. It contains numerous small and medium rivers that form the headwaters of the Mississippi River and the mid-watershed portion of the St. Louis River. Several large lakes (Leech Lake, Lake Winnibigoshish, and Cass Lake) occur in the northwest portion of the section in the headwaters of the Mississippi River. Hundreds of smaller lakes cover this section, particularly in the pitted outwash plains and moraines (Minnesota Department of Natural Resources, Ecological Classification System).

**Figure 7. Potential Natural Vegetation of the Northern Minnesota Drift and Lake Plains (Shadis 1998).**

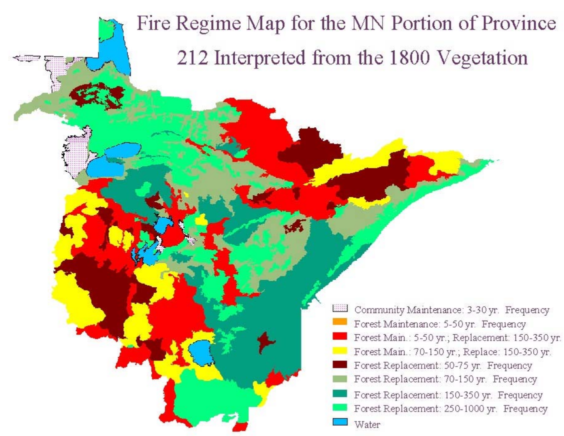



Click for full size map

***Vegetation:*** Five fire-dependent forest types have been identified as matrix systems in the Drift and Lake Plains section (Shadis 1998): dry pine, dry-mesic pine-oak, and dry-mesic pine forests, oak woodland, and open meadows (on the floodplain of the Mississippi River). Less fire-dependent ecological systems are the mesic northern hardwood forest, white cedar swamp, and forested poor fen. Oak woodlands were historically a matrix-forming ecological system in the southern-most portion of the section, where they have been largely eliminated. Large areas in the southern part of this section have been converted to agriculture, primarily corn and potatoes, or residential and resort areas.

***Major Ecological Processes:*** Fire is the dominant disturbance for much of this section, although hydrologic processes and windthrow are locally important, too. The size of fires in this section is much smaller than that found in the Northern Superior Uplands section, largely due to the roughness or graininess of the landscape – fine-scale patterns of topography and water act as fire breaks, thus preventing the spread of huge fires. Mesic northern hardwood forests in this ecological section depend upon small-scale surface fires, slope erosion, or windfall to create openings for the regeneration of trees (Almendinger and Hanson 1998). In the Tamarack Lowland subsection to the east, white cedar swamps and forested poor fens are structured more by hydrologic processes and windthrow than by fire; this area has a longer return interval for fire, varying between 50 and 1000 years.

**Figure 8. Fire Regime Map for the Minnesota Portion of Province 212 (Shadis 2000).**




Click for full size map

**Table 11. Fire-Dependent Forest Systems in the Drift and Lake Plains Section.**

| Forest Type | Fire Type | Maximum size |
|---|---|---|
| Dry pine forest | Crown and Surface | 10,000 acres (4,000 ha) |
| Dry-mesic pine/oak forest | Surface | <1,000 acres (400ha) |
| Dry-mesic pine forest | Crown and Surface | 10,000 acres (4,000 ha) |
| Oak woodland | Crown and Surface | 10,000 acres (4,000 ha) |
| Open meadows | Surface | Several thousand acres |

From Almendinger and Hanson 1998

***Data Layers Used to Delineate Conservation Areas:***

- The Nature Conservancy Unconverted Forest Areas (Results of analysis comparing potential natural vegetation (Shadis 1998) with Minnesota GAP layers to identify areas that have not been converted to other forest types or land uses)
- Land Type Associations
- Minnesota Watersheds
- Minnesota County Biological Survey Landscape Study Areas
- Minnesota County Biological Survey Sites of Important Biological Diversity
- The Nature Conservancy Aquatic Landscapes
- Minnesota Department of Natural Resources Old Growth
- U.S. Forest Service Research Natural Areas
- U.S. Forest Service Potential Research Natural Areas
- U.S. Forest Service Candidate Special Management Complexes
- The Nature Conservancy Low Road Density Areas of the Superior Mixed Forest
- Minnesota Heritage Program Element Occurrences
- Minnesota County Biological Survey Rare aquatic features

***Conservation Area Delineation Methods:*** Fire-driven ecosystems are predominant in this section, although smaller-scale systems that rely on windthrow or hydrology are also important. Conservation areas were delineated to represent these ecosystems and their driving processes of fire, windthrow, and hydrology. Prior to delineating conservation area boundaries, data layers indicating high quality matrix forest were reviewed to identify core areas within each subsection. Indicators of high quality matrix forest include U.S. Forest Service (USFS) Research Natural Areas, USFS Potential Research Natural Areas, USFS Special Management Complexes, USFS Potential Candidate Special Management Complexes, areas of low road density, and designated old growth stands identified by the Minnesota Department of Natural Resources and USFS. In addition, the Minnesota County Biological Survey's Landscape Study Areas and Sites of Biodiversity Significance were incorporated into this analysis whenever possible as further indicators of undisturbed native vegetation.

Conservation areas throughout the section were built around areas containing indicators of high quality ecological systems. Conservation areas delineated to represent fire-dominated ecosystems were drawn to include an arrangement of Land Type Associations that can support the movement of fire in the typical southwest to northeast direction. Since northern hardwood forests in this section depend on small-scale processes, conservation areas supporting this type were drawn at scales much smaller than watersheds or Land Type Associations; they were generally delineated according to areas supporting that forest type. White cedar swamps and forested poor fens are driven primarily by hydrology, not by fire; conservation areas representing these systems were drawn according to surface watershed boundaries.

6.4.1.1.5 Southern Agassiz Peatlands and Lake Plains

The Southern Agassiz Peatlands and Lake Plains section is located on the southern part of the lake plain left by Glacial Lake Agassiz and is dominated by the largest patterned peatland complex in the contiguous United States. The section extends in a broad, northwest-to-southeast band from the southeastern shore of Lake Winnipeg down to the Upper and

Lower Red Lakes and across to Vermilion Lake. In future iterations of planning for the Superior Mixed Forest ecoregion, the Rainy River ecodistrict should be considered for inclusion within this section.

***Geology:*** Three remnants of Glacial Lake Agassiz still exist in this section: Upper and Lower Red Lake and Lake of the Woods. The entire section is dominated by organic deposits (peat) overlaying clayey lacustrine deposits from Glacial Lake Agassiz. Moraines were modified by the lake to form beach ridges, terraces and other formations; these ridges are the main uplands in this section. An area of unmodified ground moraine is also within this section. Sand, gravel, and silt lacustrine deposits are present in some areas. Outwash channels and other fluvial deposits are also found in this section. The drainage basin of the Winnipeg River is the major drainage in this section. The Rainy River flows through this section into Lake of the Woods, a large, bedrock-controlled lake; the river is fed by a number of tributaries that run through peatlands, including the Little Fork, Big Fork, Rapid, and Black Rivers. Lake of the Woods drains into the Winnipeg River, which flows into Lake Winnipeg near the northwestern tip of this section.

***Vegetation:*** Patterned peatlands composed of open and treed fens and bogs form the dominant ecosystem in this section, although some areas have been converted to agricultural and other human uses. Deep layers of accumulated peat that are no longer connected to groundwater or surface water runoff create low-nutrient, acidic conditions and form raised bogs dominated by *Sphagnum* species, ericaceous shrubs, and black spruce (*Picea mariana*). Surface water runoff forms channels through peatlands called water tracks, which may support patterned fens, or sedge meadows flanked by swamp forest (Wright et al. 1992). The richer conditions in the fens or sedge meadows may support a variety of sedges (*Carex* spp.), brown mosses, ericaceous shrubs, and tamarack (*Larix laricina*), depending on water depth and flow. Poor swamps are dominated by black spruce, while richer swamps may be dominated by red maple (*Acer rubrum*) or some combination of balsam fir (*Abies balsamea*), white cedar (*Thuja occidentalis*), and black ash (*Fraxinus nigra*) (Boise Cascade 1999). Spring fens form on peat layers that are still connected to groundwater and surface water runoff; islands of richer swamp forest are drained by a fine network of open channels. Dry to mesic balsam fir (*Abies balsamea*) forests occur in the upland morainal areas and on relict beach ridges; white spruce (*Picea glauca*) is often associated with the balsam fir. Jack pine (*Pinus banksiana*) is predominant on dry uplands such as the bedrock outcrops. Trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) are successional components of the various upland forests (Boise Cascade 1999; Albert 1995). White pine and red pine forests were historically present on ground moraine and other upland areas. Bur oak (*Quercus macrocarpa*), elm (*Ulmus americana*) and green ash (*Fraxinus pennsylvanica*) are found in wetter areas along streams in the northern part of this section (Smith et al. 1998). Many areas in this section have been extensively ditched, with varying degrees of success. Some peatlands have been converted to sod farms or other uses; others are mined for peat.

***Major Ecological Processes:*** Peatlands are shaped by both groundwater and surface water hydrologic regimes. The depth of the peat layer, its surface topography, and underlying landform all determine the hydrologic connections in a given location. Bogs are present where there is no longer a connection to groundwater, often where the peat layer is very deep; precipitation is the sole input of water and nutrients to the system. Fens are present where there is still a connection to groundwater or runoff from surface water, which often has higher nutrient levels. As peat layers continue to develop under cool, anaerobic conditions, the connection to groundwater may be lost, and fens are gradually converted to bogs. Fires burn occasionally, during very dry periods, but hydrology is the dominant process determining the composition of the peatlands. The associated swamps are also dependent primarily on hydrologic regime and see stand-replacing fires only every century or two (Boise Cascade 1999). Blowdowns and insect infestations also occur within the peatlands, as well as the surrounding upland forest systems. The dry fir forests are subjected to stand-replacement fires on 40-80 year return intervals and surface fires on 20-40 year return intervals. These fire-prone areas are located in the northwesterly portion of this section on relict beach ridges (Boise Cascade 1999).

***Data Layers Used to Delineate Conservation Areas:***
Peat and Mineral Soils for Minnesota (Minnesota Department of Natural Resources)
Map of important peatland areas in Minnesota (Minnesota Department of Natural Resources)
Minnesota Gap Analysis Program (GAP) Vegetation Mapping (45 cover classes)
Manitoba Land Use/Land Cover (16 cover classes)
The Nature Conservancy Low Road Density Areas of the Superior Mixed Forest

Minnesota Watersheds
Surficial Geology of Manitoba

***Conservation Area Delineation Methods:*** Since this section is generally dominated by the peatland ecosystem, conservation areas were delineated to represent these wetland ecosystems and their driving process, hydrology. Where data were available on best examples of peatland systems, they were used as a starting point to select areas containing functioning peatland systems; otherwise, general land cover data, road density and expert opinion were used to identify extensive, unfragmented peatland systems. Boundaries of aquatic conservation areas, identified in a separate and parallel process, were available for the Minnesota portion of this section and also served as a starting point for selecting functioning peatland systems. Once the general area of peatlands was selected, the planning team followed the boundary of the surface watershed encompassing the peatland to delineate the boundary of the conservation area. In some areas of this section, watershed boundaries were not available at the time of this planning effort. In those cases, the entire peatland complex was included; future revisions to these boundaries should first focus on the boundary of the surrounding watershed.

Although peatlands are the dominant ecosystem, surrounding upland forests are an important component as well. As conservation areas were delineated for peatland systems, planners also ensured that upland forests were adequately represented within the conservation area boundaries. In southeastern Manitoba, near the border of this section, jack pine-mixed pine sandplain forest is the dominant ecological system. Therefore, one conservation area was drafted to represent this ecosystem. This jack pine system occurs in the transitional zone between boreal forest, aspen parkland, and tallgrass prairie and covers a small area. Consequently, the size of this conservation area does not reflect the large scale of disturbances that would occur in the main range of boreal jack pine forest systems. The conservation area boundary was delineated using land cover and landforms.

#### 6.4.1.1.6 Lake of the Woods

The Lake of the Woods section extends from Lac du Bonnet in southeastern Manitoba to the east side of Rainy Lake on the Canada-United States border.

***Geology:*** This section is dominated by Precambrian bedrock that was scoured during the Wisconsinan glaciation. A thin layer of silty to sandy glacial till covers most areas, but areas of bare bedrock are common. Topography can be relatively rugged in the upland areas. Small areas of lacustrine deposits are scattered about the section, particularly in the northwestern portion. In the northwest portion, these deposits include beaches and bars from ancient shorelines of Glacial Lake Agassiz. Peat-filled depressions are also found throughout the section, usually overlaying clayey lacustrine deposits. Small to medium-sized rock-bound lakes are numerous throughout this section, and many are linked by bedrock-controlled networks of streams and drainages flowing into Rainy Lake or Lake of the Woods. Lake of the Woods and Rainy Lake are the largest lakes remaining of the former Glacial Lake Agassiz in this section (Upham 1895), and are part of the larger Hudson Bay drainage basin.

***Vegetation:*** This section is home to southern boreal forest systems, dominated by jack pine (*Pinus banksiana*) and black spruce (*Picea mariana*) in some areas, and white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*) in others. Trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) are important components of the southern boreal forest as well. Mosses and ericaceous shrubs form the herbaceous layer. The boreal forest ecosystem is predominant throughout this section. Eastern white pine (*Pinus strobus*) and red pine (*Pinus resinosa*) were historically a significant component throughout this section, increasing in frequency from north to south; they are mainly found along lakeshores today. This section approaches the western limit in Canada for red and eastern white pine. Warm, dry areas support red pine and jack pine, as well as paper birch. Smaller patches of northern hardwoods, including red maple (*Acer rubrum*), basswood (*Tilia americana*), bur oak (*Quercus macrocarpa*), and elm (*Ulmus americana*), are found in warmer, more mesic areas. Bur oak savannas are common on south-facing rock outcrops on Lake of the Woods. Small patches of peatlands are common throughout this section; they are most extensive around Lake of the Woods. Bogs are dominated by black spruce and mosses (*Sphagnum* spp.), while fens are vegetated with sedges (*Carex* spp.), tamarack (*Larix laricina*), alder (*Alnus incana*) and bog birch (*Betula pumila*). River floodplain forests consist of black ash (*Fraxinus* *nigra*) and balsam poplar (*Populus balsamea*) stands. Vegetation of beaver-controlled streams typically consists of willow (*Salix* species) and alder thickets along with sedge and grass meadow marshes.

***Major Ecological Processes:*** Fire, blowdowns and insect outbreaks are the dominant processes shaping the boreal forests throughout this section. These processes are not independent of each other; blowdowns and insect outbreaks can create significant fuel loads and greatly increase the likelihood of fire in an affected area. In northwestern Ontario, Suffling et al. (1982) estimate that the average presettlement fire rotation was as low as 45 years in uplands and 77 years in lowlands. Their estimates are lower than Donnelly and Harrington (1978), whose compilation of forest fire history across Ontario suggested that the rotation in northwestern Ontario was approximately 167 years. Swain (1973) calculated a frequency of 60-70 years in an area just across the international border from Quetico Provincial Park. Although these estimates were derived from Ontario data, they should generally apply to this entire section. Rowe and Scotter (1973) cite estimates ranging between 100 and 300 years for Canadian boreal forests in general. Heinselman (1981) notes that severe crown or surface fires in Canadian boreal forests are "often more than 10,000 hectares, and sometimes more than 400,000 hectares" (25,000-1,000,000 acres). A provincial land surveyor recorded a large fire dating to 1845 in the area between Rainy Lake and Lake Superior (Lynham 1985). Although the acreage was not recorded, this fire presumably burned an area at a scale of one million to several million acres. Such large-scale fires occurred less frequently than smaller fires, but because of their size, they were responsible for burning most of a landscape's area during an average rotation period. In this section, Rainy Lake, Lake of the Woods, and the numerous smaller lakes act as fire breaks, preventing most fires from achieving catastrophic proportions. Fire will cross natural firebreaks only in severe fire years, when climatic and fuel conditions are right. Sand outwash plains and extensive areas of bedrock outcrop are drier and more prone to burning. Fire suppression since the 1930s has altered the natural fire regime.

Catastrophic blowdowns in this section are likely to be similar in scale to the July 4 windstorm of 1999. That blowdown affected 477,000 acres (193,036 ha) in northern Minnesota alone; the blowdown extended into northwestern Ontario and northern Wisconsin (Mattson and Shriner 2001). As mentioned in the Northern Superior Uplands section description, the largest patch size found was 138,000 acres (55,847 ha) (L. Frelich, personal communication). The 1973 windstorm in northwest Ontario affected an area of approximately 86,000 acres (34,803 ha) (Schindler et al. 1980). The frequency of blowdowns and their average patch size in this section are unclear.

Spruce budworm outbreaks cause widespread tree mortality and affect fire regimes and successional pathways in the main range of the Canadian boreal forest (and boreal forests around the globe). These outbreaks can occur on a scale of tens of millions of acres; it is unclear whether forestry practices, fire suppression and other human influences have caused outbreaks to increase in both frequency and size (Attiwill 1994). However, spruce budworm appears to be less significant here than east of Thunder Bay (A. Harris, personal communication).

***Data Layers Used to Delineate Conservation Areas:***
Ontario Land Use/Land Cover (17 cover classes)
Surficial Geology of Ontario
Manitoba Land Use/Land Cover (16 cover classes)
Surficial Geology of Manitoba
The Nature Conservancy Low Road Density Areas of the Superior Mixed Forest
Ontario Living Legacy

***Conservation Area Delineation Methods:*** Since this section is generally dominated by the boreal forest ecosystem, conservation areas were delineated to represent this ecosystem and support its driving processes: fire, blowdown, and insect outbreaks. Data layers indicating high quality natural areas were not available; therefore, conservation areas were not delineated around core areas known to be in good condition. Instead, conservation areas were delineated around dominant ecological systems using land cover, surficial geology, road density and information on the scale of forest disturbance regimes. Areas that were forested, not recently cut or burned, and not heavily dominated by aspen were preliminarily identified. Such areas were compared to the surficial geology layer and road density layer to ensure that the range of landforms was represented in areas with lower road density. The team delineated conservation area boundaries by following land cover patterns and ensuring that the conservation area was at a scale consistent with that of disturbance processes. The conservation areas were compared with existing protected areas and with the results of Ontario's land use planning process, the Ontario Living Legacy (OLL). Data layers that would have guided the further refinement of conservation area boundaries (such as Land Type Association polygons or Ontario Land Inventory polygons) were not readily usable at the time of the initial mapping effort. Ecologists familiar with this section modified the first draft of conservation areas. It is assumed that these conservation areas will be further assessed and refined prior to initiating any conservation actions.

#### 6.4.1.1.7 Rainy River Clay Plain

The south side of the Rainy River Clay Plain section lies along Rainy River and the international border, between Lake of the Woods and Rainy Lake in Ontario. In future iterations of planning for the Superior Mixed Forest ecoregion, the Rainy River section should be considered for inclusion within the Southern Agassiz Peatlands and Lake Plains section.

***Geology:*** This section is located on silt and clay till modified or deposited by Glacial Lake Agassiz. The edge of the Canadian Shield roughly approximates the northeasterly border of this section; areas of bedrock covered by thin layers of till occur throughout. Bedrock outcrops are also common in lake-modified morainal till. Peat has developed over much of the lacustrine deposits and covers a significant portion of this section. Sand and gravel beach ridges and other nearshore deposits are present in the extreme east and west of this section. This section is drained by Rainy River and Lake of the Woods. Bedrock-controlled lakes are occasionally present, but not nearly as common as in adjacent sections.

***Vegetation:*** This section was formerly dominated by both peatlands and upland forest systems. Approximately one-third of the land cover has been successfully converted to agricultural uses. Although peatlands were not quite as extensive as those to the south in Minnesota, they still covered a significant portion of this section, and many are still present today. Low-nutrient, acidic conditions support bogs or poor fens dominated by *Sphagnum* spp., ericaceous shrubs, and black spruce (*Picea mariana*). Rich fens with sedges (*Carex* spp.), brown mosses, ericaceous shrubs, and tamarack (*Larix laricina*) are found where there is contact with nutrient-rich groundwater. Bogs and fens sometimes form large patterned peatland complexes. Poor swamps are dominated by black spruce, while richer swamps are dominated by white cedar (*Thuja occidentalis*) and black ash (*Fraxinus nigra*). Dry to mesic balsam fir forests occur in the upland morainal areas and on relict beach ridges; white spruce (*Picea glauca*) is sometimes present. Jack pine (*Pinus banksiana*) is predominant on dry uplands. Bur oak savannas are common on south-facing rock outcrops on Rainy Lake. Trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) are successional components of the various upland forests. Occasional patches of northern hardwoods, dominated by red maple (*Acer rubrum*), basswood (*Tilia americana*), and elm (*Ulmus americana*), are present in warmer, mesic areas. White pine (*Pinus strobus*) and red pine (*P. resinosa*) were once more frequent among upland forests on a range of site conditions; today they are found primarily along the shores of Rainy Lake and Lake of the Woods. Early successional aspen forest is common following logging.

***Major Ecological Processes:*** Hydrology is the primary process shaping the composition and pattern of the remaining peatlands and other wetlands in this section, although they would normally experience fire in extremely dry periods. Surrounding upland forests are shaped by fire and other disturbances. It is assumed here that the frequency and scale of these disturbances is very similar to those described by Boise-Cascade (1999) for the Minnesota peatlands region immediately to the south. Based on that assumption, the drier upland forests would have experienced stand-replacement fires on 40-80 year return intervals and surface fires on 20-40 year return intervals. White pine and red pine are somewhat better adapted for surviving fires and presumably experienced stand-replacement fires over a longer return interval. Peatland areas and Lake of the Woods were likely good firebreaks. The scale of catastrophic fires prior to European settlement is unclear.

***Data Layers Used to Delineate Conservation Areas:***
Ontario Land Use/Land Cover (17 cover classes)
Surficial Geology of Ontario
The Nature Conservancy Low Road Density Areas of the Superior Mixed Forest

***Conservation Area Delineation Methods:*** This section was historically dominated by both peatland and boreal forest ecological systems. Current land cover data indicate that the Rainy River section is dominated by pasture and grasslands. Early successional aspen forest is very common as a result of forestry practices. Road density is also relatively high. Compared to the corresponding section in Minnesota and Manitoba, this section is fairly fragmented. For this reason, no conservation areas were initially identified within this section. However, ecologists familiar with the Rainy River Clay Plain noted that there are numerous smaller-scale examples of ecological systems that should be part of a functional network. Therefore, a rough boundary was delineated around this section to indicate the collection of important conservation areas within this functional network.

6.4.1.1.8 Thunder Bay—Quetico

The Thunder Bay—Quetico section extends westward from Thunder Bay and the Lake Superior coastline to Sioux Lookout and Rainy Lake in northwestern Ontario. In future iterations of planning for the Superior Mixed Forest ecoregion, planners should consider treating the Northern Superior Uplands and Thunder Bay-Quetico as a single ecological section.

***Geology:*** This section is dominated by Precambrian bedrock that was scoured during the Wisconsinan glaciation. A thin layer of silty to sandy glacial till covers most areas, but bedrock outcroppings are common. In the northern part of the section, there is an area of wind-deposited loess. An area of lacustrine deposits lies around the Thunder Bay area, near Lake Superior. Two series of major end moraines run in a northwest to southeast direction through the central part of the section. Small to medium-sized rock-bound lakes are more numerous in the western section, and many are linked by bedrock-controlled networks of streams and drainages flowing westward into Rainy Lake. These western drainages are part of the larger Hudson Bay drainage basin. The Pigeon River is a Lake Superior tributary draining the southeastern part of this section.

***Vegetation:*** This section is home to southern boreal forest systems, dominated by jack pine (*Pinus banksiana*) and black spruce (*Picea mariana*) on dry, shallow soils, and white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*) on richer soils. Trembling aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) are important components of the southern boreal forest as well. The boreal forest ecosystem is predominant throughout this section, with the white spruce-balsam fir type increasing in frequency from west to east, due to increasing moisture availability. Eastern white pine (*Pinus strobus*) and red pine (*Pinus resinosa*) were historically a significant component throughout this section, increasing in frequency from north to south; they are mainly found along lakeshores today. Warm, dry areas support red pine and jack pine, as well as paper birch. Smaller isolated stands of northern hardwoods, including sugar maple (*Acer saccharum*) and yellow birch (*Betula alleghaniensis*), are found in warmer, more mesic areas associated with the Nor'Wester Mountains south of Thunder Bay. Small patches of peatlands, dominated by black spruce and tamarack (*Larix laricina*), are common throughout this section. River floodplain forests consist of black ash (*Fraxinus nigra*) and balsam poplar (*Populus balsamea*) stands. Vegetation of beaver-controlled streams typically consists of willow (*Salix* species) and alder (*Alnus incana*) thickets along with sedge (*Carex* species) and grass meadow marshes. A large portion of the Thunder Bay subsection is now forested with early successional aspen. Some land near the city of Thunder Bay has successfully been converted to agricultural uses.

***Major Ecological Processes:*** Fire, blowdowns and insect outbreaks are the dominant processes shaping the boreal forests throughout this section. These processes are not independent of each other; blowdowns and insect outbreaks can create significant fuel loads and greatly increase the likelihood of fire in an affected area. In northwestern Ontario, Suffling et al. (1982) estimate that the presettlement fire rotation was as low as 45 years in uplands and 77 years in lowlands. Their estimates are lower than Donnelly and Harrington (1978), whose compilation of forest fire history across Ontario suggest that the rotation in northwestern Ontario was approximately 167 years. Swain (1973) calculates a frequency of 60-70 years in an area just across the international border from Quetico Provincial Park. Rowe and Scotter (1973) cite estimates ranging between 100 and 300 years for Canadian boreal forests in general. Heinselman (1981) notes that severe crown or surface fires in Canadian boreal forests are "often more than 10,000 hectares, and sometimes more than 400,000 hectares" (25,000-1,000,000 acres). A provincial land surveyor recorded a large fire dating to 1845 in the area between Rainy Lake and Lake Superior (Lynham 1985). Although the acreage was not recorded, this fire presumably burned an area at a scale of one to several million acres. Such large-scale fires occurred less frequently than smaller fires, but because of their size, were responsible for burning most of a landscape's area during an average rotation period. In the Thunder Bay-Quetico section, the numerous lakes act as firebreaks, preventing most fires from achieving catastrophic proportions. Fire will cross natural firebreaks only in severe fire years, when climatic and fuel conditions are right. Sand outwash plains and extensive areas of bedrock outcrop are drier and more prone to burning. Fire suppression since the 1930s has altered the natural fire regime.

Catastrophic blowdowns in northwestern Ontario are likely to be similar in scale to the July 4 windstorm of 1999. That blowdown affected 477,000 acres (193,036 ha) in northern Minnesota alone; the blowdown extended into northwestern Ontario and northern Wisconsin (Mattson and Shriner 2001). As mentioned in the Northern Superior Uplands section description, the largest patch size found was 138,000 acres (55,847 ha) (L. Frelich, personal communication). The 1973 windstorm in northwest Ontario affected an area of approximately 86,000 acres (34,803 ha) (Schindler et al. 1980). The frequency of blowdowns and their average patch size in northwestern Ontario are unclear.

Spruce budworm outbreaks cause widespread tree mortality and affect fire regimes and successional pathways in the main range of the Canadian boreal forest (and boreal forests around the globe). These outbreaks can occur on a scale of tens of millions of acres; it is unclear whether forestry practices, fire suppression, and other human influences have caused outbreaks to increase in both frequency and size (Attiwill 1994). However, spruce budworm is less significant here than east of Thunder Bay (A. Harris, personal communication).

***Data Layers Used to Delineate Conservation Areas:***
Ontario Land Use/Land Cover (17 cover classes)
Surficial Geology of Ontario
Road Density in Superior Mixed Forest (available for entire ecoregion)
Ontario Living Legacy

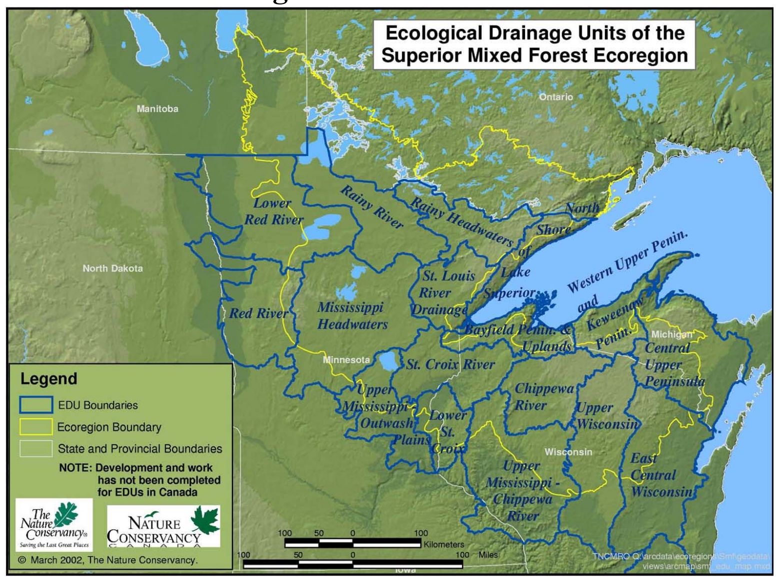
***Conservation Area Delineation Methods:*** Since this section is generally dominated by the boreal forest ecosystem, conservation areas were delineated to represent this ecosystem and support its driving processes: fire, blowdown, and insect outbreaks. Data layers indicating high quality natural areas were not available; therefore, conservation areas were not delineated around core areas known to be in good condition. Conservation areas were delineated around dominant ecological systems using land cover, surficial geology, road density, and information on the scale of forest disturbance regimes. Areas that were forested, not recently cut or burned, and not heavily dominated by aspen were preliminarily identified. Such areas were compared to the surficial geology layer and road density layer to ensure that the range of landforms was represented in areas with lower road density. The team delineated conservation area boundaries by following land cover patterns and ensuring that the conservation area was at a scale consistent with that of disturbance processes. The conservation areas were compared with existing protected areas and with the results of Ontario's land use planning process, the Ontario Living Legacy (OLL). Data layers that would have guided the further refinement of conservation area boundaries (such as Land Type Association polygons or Ontario Land Inventory polygons) were not readily usable at the time of the initial mapping effort. Ecologists familiar with this section modified the first draft of conservation areas. It is assumed that these conservation areas will be further assessed and refined prior to initiating any conservation actions.

### *6.4.2 Selecting Aquatic Conservation Areas*
The Superior Mixed Forest intersects three major drainages—the Red River that drains North to the Hudson, the Mississippi River, and the Great Lakes drainage basin. The aquatic features of this ecoregion are striking and plentiful—from the countless small lakes in pitted glacial plains to the spectacular fault lakes bordered by dramatic escarpments of the boundary waters regions. Glaciation shaped the aquatic landscape of the Superior Mixed Forest and is still a primary determinant of present-day aquatic species distribution. While the distinctions in drainage basins are important in terms of the future dispersal and evolution of species, the drainages were all connected at times during the Wisconsinan period

of glaciation (Bailey and Smith 1981). The relatively recent isolation means that within the Superior Mixed Forest ecoregion there are few faunistic differences between the major drainages. However, the movements of the glaciers created the great variety of landforms and materials deposited that help define this ecoregion today.

The approach to selecting aquatic conservation areas in the Superior Mixed Forest was consistent with other ecoregional planning efforts. After developing the classification of aquatic ecological systems, the assessment team mapped sixteen Ecological Drainage Units (EDUs)—a series of map units defined by physiographic differences and based on subwatershed boundaries—in the U.S. portion of the ecoregion (the Canadian portion will be completed at a later date). Similar to ecological sections used with terrestrial conservation targets, EDUs serve as geographic stratification units across which aquatic targets should be represented to capture their full range of genetic and ecological variability. EDUs account for regional variation in aquatic ecosystems due to zoogeographic, climatic, and physiographic influences. The planning team made preliminary selections of viable aquatic systems and attempted to efficiently meet the conservation goals of each system. The team consulted experts to review and refine the selections. Approximate watershed boundaries were used to map the selected river systems within the Great Lakes and Mississippi River basins, and the Red River and Rainy River basins. On very large river systems, like the Wisconsin, Chippewa, and Flambeau, aquatic conservation areas are indicated by highlighting the mainstem and not the entire watershed.

**Figure 9. Ecological Drainage Units in the Superior Mixed Forest Ecoregion.** Click for full size map




A comprehensive aquatic assessment has not been completed for the Canadian portion of the Superior Mixed Forest ecoregion due to issues relating to data and other resource availability. The ecoregional planning effort for the Canadian portion of the Great Lakes ecoregion will include an aquatic assessment, but that effort will only cover the watershed which extends 93 miles (150 km) west of Thunder Bay, south to roughly the Canada/U.S. border and north to roughly the northern portion of Lake Nipigon. Therefore, this aquatic assessment will only overlap with the small northeast portion of the Superior Mixed Forest ecoregion. The estimated date of completion for the Great Lakes Canadian ecoregional plan is Fall 2003.

A summary of the aquatic conservation areas identified in this plan, including descriptions of the areas, explanation of the boundaries, caveats, maps, and biodiversity encompassed within the areas, can be found in Appendix G. The following descriptions of the Ecological Drainage Units are grouped by the three major drainage basins in the Superior Mixed Forest and include major streams and, where available, characteristic fish fauna.

#### 6.4.2.1 Descriptions of the Ecological Drainage Units

##### 6.4.2.1.1 Red River Basin Ecological Drainage Units

*Rainy River Headwaters*

The Rainy River Headwaters EDU drains an extensive area of glacially scoured granitic bedrock and peatlands located in the Northern Superior Uplands. The surface waters are predominantly bedrock-controlled lakes with short lengths of connecting streams. Distinct fauna include ninespine stickleback (*Pungitius pungitius*), slimy sculpin (*Cottus cognatus*), trout perch (*Percopsis omniscomaycus*), and lake sturgeon (*Acipenser fulvescens*). Major systems include the Vermillion River, Isabella River, Rainy Lake, and Rainy River headwaters.

*Rainy River*
The lake plain and till physiography of this EDU makes it distinct from the Rainy River Headwaters to the east. From east to west, the EDU is a transition from a thin clayey lake plain interspersed with peat and loamy till to a peat-dominated area with some silty till. This area is poorly drained and has been extensively channelized. The fish fauna includes shorthead redhorse (*Moxostoma macrolepidotum*), bullhead and channel catfish (*Ameiurus nebulosus* and *Ictalurus punctatus*), muskellunge (*Esox masquinongy*), silver redhorse (*Moxostoma anisurum*), quillback carpsucker (*Carpoides cyprinus*), and lake sturgeon (*Acipenser fulvescens*). Major systems include the Little Fork River, Big Fork River, Rapid River, and mainstem Rainy River.

*Red River*
Both the Superior Mixed Forest and the Prairie-Forest Border ecoregions include a small part of the Red River drainage. This EDU comprises headwater watersheds that drain glacial drift in the Minnesota and Northeast Iowa Moraine Section (Prairie-Forest Border) and the western portion of the Minnesota Drift and Lake Plains section (Superior Mixed Forest). The glacial deposits in this region are similar to the other groups in this part of the ecoregion—ground and end moraine, outwash, and peat. The aquatic resources of this group are similar to the Mississippi Headwaters ecological group. The drainage network is not well developed. There are numerous lakes and wetlands. Though part of a different river drainage, the fish characteristic of this group are very similar to the Mississippi Headwater group: bowfin (*Amia calva*), northern hogsucker (*Hypentelium nigricans*), silver redhorse (*Moxostoma anisurum*), golden redhorse (*Moxostoma erythrurum*), central stoneroller (*Campostoma anomalum*), hornyhead chub (*Nocomis biguttatus*), blackchin shiner (*Notropis heterodon*), spottail shiner (*Notropis hudsonius*), weed shiner (*Notropis texanus*), bluntnose minnow (*Pimephales notatus*), longnose dace (*Rhinichthys cataractae*), yellow bullhead (*Ictalurus natalis*), brown bullhead (*Ictalurus nebulosus*), tadpole madtom (*Notorus gyrinus*), northern pike (*Esox lucius*), banded killifish (*Fundulus diaphanus*), rock bass (*Ambloplites rupestris*), pumpkin seed (*Lepomis gibbosus*), largemouth bass (*Micropterus salmoides*), rainbow darter (*Etheostoma caeruleum*), and blackside darter (*Percina maculata*) (Koel 1997).

*Lower Red River*
The Lower Red River EDU includes the headwaters of four rivers – Red Lake, Roseau, Thief, and Clearwater. This EDU drains the Southern Agassiz Peatlands and Lake Plains section, a flat lake plain with black spruce bog in which elevation is provided by relict beach ridges of Glacial Lake Agassiz. This area has been extensively ditched.

#### 6.4.2.1.2 Mississippi Basin Ecological Drainage Units

*St. Croix Headwaters*
This EDU drains coarse-textured outwash and ice-contact glacial deposits in the Western and Southern Superior Uplands sections. There are extensive wetlands and many small lakes. The relief is moderate and the hydrology of the streams is influenced by inputs of groundwater, particularly in areas adjacent to end moraine hills. Major systems include the Namekagon River, St. Croix River, Totagatic River, Kettle River, and Snake River. This EDU has higher fish species richness than other drainage units in the eastern portion of the ecoregion due to lack of barriers and large size. Some rare invertebrates, such as the dragonfly species St. Croix snaketail (*Ophiogomphus subaeshna*) and pygmy snaketail (*Ophiogomphus howei*), are restricted to this EDU.

*Chippewa River*
The Chippewa River EDU drains sandy loamy till and ice contact in the Southern Superior Uplands. The distance of the streams in this EDU from the mainstem Mississippi, the headwater lakes, and the extensive wetlands distinguish this EDU from the Upper Mississippi-Chippewa River group to the south. The fauna reflects this distinction and includes many cool/cold water species and larger lake fish such as brook trout (*Salvelinus fontinalis*), muskellunge (*Esox masquinongy*), northern pike (*Esox lucius*), grass pickerel (*Esox americanus vermiculatus*), northern redbelly dace (*Phoxinus eos*) and

central mudminnow (*Umbra limi*). Groundwater contribution to streams is significant, particularly in the Flambeau tributaries and east fork of the Chippewa. There are many high-gradient stretches along the Upper Flambeau; many of the major falls now have hydropower dams. Major systems include the Flambeau River, Jump River, and Chippewa River.

*Upper Wisconsin*

Although the Wisconsin River watershed cuts through three distinct physiographic settings, the planning team has identified only two EDUs, splitting out the northern two-thirds of the watershed from the lower Wisconsin, which drains the driftless areas adjacent to the Mississippi River. The Upper Wisconsin EDU drains glacial deposits including coarse sandy loamy till and ice contact areas with moderate relief and many kettle lakes in the headwaters, and the middle section of the Wisconsin River that is in a flatter sandy plain. The southern portion of the drainage unit has similar landforms and species that have more affinity with the Prairie-Forest Border ecoregion. This drainage unit has been much more altered than the other drainage units in the eastern portion of the Superior Mixed Forest as a result of pollution from pulp production areas and other industrial uses of the river. Water quality has been improving over the last 30 years; fish sampling indicates good recovery, but some species may have been lost. Major systems include the Wisconsin River, Tomahawk River, Big Rib River, and Big Eau Plaine River.

*Mississippi Headwaters*

This EDU is a low to moderate-gradient area with coarse glacial deposits, many small lakes, and extensive wetlands. The major systems include the Mississippi River, Prairie River, Crow Wing River, Pine River, and several large lakes. The landforms of this region are consistent with its glacial history—ice-stagnation moraines, end moraines, ground moraines and outwash plains. Surficial deposits also reflect this complex history in a mosaic of morainal material, outwash, lake sand, lake clay, and peat. Kettle lakes and wetlands are very common while there are but a few major rivers. This region is the headwaters for the Mississippi River. The fish species typical or characteristic of this section of the drainage include bowfin (*Amia calva*), northern hogsucker (*Hypentelium nigricans*), silver redhorse (*Moxostoma anisurum*), golden redhorse (*Moxostoma erythrurum*), central stoneroller (*Campostoma anomalum*), hornyhead chub (*Nocomis biguttatus*), blackchin shiner (*Notropis heterodon*), spottail shiner (*Notropis hudsonius*), weed shiner (*Notropis texanus*), bluntnose minnow (*Pimephales notatus*), longnose dace (*Rhinichthys cataractae*), yellow bullhead (*Ictalurus natalis*), brown bullhead (*Ictalurus nebulosus*), tadpole madtom (*Notorus gyrinus*), northern pike (*Esox lucius*), banded killifish (*Fundulus diaphanus*), rock bass (*Ambloplites rupestris*), pumpkin seed (*Lepomis gibbosus*), largemouth bass (*Micropterus salmoides*), rainbow darter (*Etheostoma caeruleum*), and blackside darter (*Percina maculata*).

*Upper Mississippi – Chippewa*

This EDU is predominantly in the driftless region of the Prairie-Forest Border ecoregion, but the upper portions of several drainages begin in the Superior Mixed Forest in sandy loamy till and outwash sand and gravel. These headwaters have more relief and wetlands than the portions of the watersheds in the Prairie-Forest Border.

*Upper Mississippi – Outwash Plains*

As its name suggests, this EDU contains a large outwash plain with areas of fine ground moraine, peat, and lake sand. The portion of the EDU in the Superior Mixed Forest is primarily fine ground moraine and peatlands and contains few lakes and numerous wetlands. The fish found in this EDU are representative of both warm and cool water assemblages. They include brook trout (*Salvelinus fontinalis*), brook stickleback (*Culaea inconstans*), central mudminnow (*Umbra limi*), northern pike (*Esox lucius*), black bullhead (*Ictalurus melas*), johnny darter (*Etheostoma nigrum*), rock bass (*Ambloplites rupestris*), hornyhead chub (*Nocomis biguttatus*), blacknose dace (*Rhinichthys atratulus*), longnose dace (*Rhinichthys cataractae*), creek chub (*Semotilus atromaculatus*), walleye (*Stizostedion vitreum*), yellow perch (*Perca flavescens*), northern hogsucker (*Hypentelium nigricans*), golden redhorse (*Moxostoma erythrurum*), shorthead redhorse (*Moxostoma macrolepidotum*), smallmouth bass (*Micropterus dolomieui*), and logperch (*Percina caprodes*).

6.4.2.1.3 Great Lakes Basin Ecological Drainage Units[1]

*St. Louis River Drainage*
This EDU drains the Northern Minnesota Drift and Lake Plains section to the west, the Northern Superior Uplands section to the east, and a small part of the Western Superior Uplands section to the southwest. The western part is low-gradient lake plain and peatlands, while the east has more relief with rolling plains, high hills, drumlins fields, and pothole lakes. This EDU is dominated by surface water and low-gradient wetlands.

*North Shore of Lake Superior*
The Superior Mixed Forest portion of the EDU drains the headwaters of several coastal streams up on the escarpment of Lake Superior. This area of the Northern Superior Uplands section has extensive wetlands and lakes and drains a thin layer of till over granitic bedrock, with bedrock outcrops common. It includes the headwaters of the Brule and Temperance Rivers.

*Bayfield Peninsula and Uplands*
Similar to the Superior Mixed Forest portion of the North Shore of Lake Superior EDU, this is the upland for several streams flowing into Lake Superior. Poorly developed stream networks and frequent kettle lakes characterize the uplands. This portion of the EDU is in the Western Superior Uplands section, and the geology is mainly sandy loamy till moraines, and flat to steep outwash plains with ice contact features.

*East Central Wisconsin*
Several large Great Lakes streams originate in the Superior Mixed Forest portion of this EDU in the Southern Superior Uplands section. This headwater area drains primarily low-gradient morainal till plains with some outwash features and is dominated by lakes and wetlands. Major rivers include the Wolf, Oconto, Peshtigo, and Embarrass.

*Central Upper Peninsula*
This EDU in the Superior Mixed Forest is in the Southern Superior Uplands and is dominated by the Menominee drainage, which has numerous lakes and streams, spring ponds, springs and wetlands. The surficial geology is mainly gently rolling ground moraine and end moraine ridges, with large areas of outwash.

*Western Upper Peninsula and Keweenaw Peninsula*
The headwaters of the Ontonagon and Presque Isle Rivers occur in the Superior Mixed Forest portion of this EDU. They originate in the Southern Superior Uplands section, which is characterized by thin till over bedrock, outwash sand and gravel, and common bedrock outcrops.

# 7 Evaluation of the Suite of Conservation Areas

Three types of conservation areas resulted from the terrestrial and aquatic conservation area selection processes:

- **Landscape-scale terrestrial conservation areas:** Areas where the dominant terrestrial ecosystem and its key ecological factors and processes can still be supported or replicated at an appropriate scale. Many of these areas support ecosystems that are currently well outside the natural range of variation, but they have excellent potential to be managed to bring the ecosystems back into that range of variability.
- **Restoration areas:** Areas containing either relict ecosystems or communities that no longer can persist without significant restoration, or stream systems in need of restoration according to U.S. Forest Service experts. Where the natural ecosystem was partially or largely converted to other land uses, conservation areas were selected for the highest quality remnants of those ecosystems and delineated based on remaining vegetation. The ecosystems in these areas are well outside the natural range of variation and are usually too small and fragmented to be resilient to the disturbance regime that would naturally have shaped them. Conservation areas in this category include oak woodlands in

[1] These Ecological Drainage Units also occur in the Great Lakes ecoregion. More extensive information about these areas is available in the Great Lake Ecoregional Plan (The Nature Conservancy 2000b).

Minnesota and Manitoba, the Rainy River clay plain in Ontario, and pine barrens in northeastern Wisconsin/northwestern Michigan. Specific restoration needs are discussed in the summaries developed for each of the conservation areas.

- **Aquatic conservation areas:** Areas where aquatic ecosystems, their hydrology, and other supporting processes can be supported. Many aquatic conservation areas are included within the larger terrestrial conservation areas. However, additional aquatic conservation areas were included in the plan in order to represent the full diversity of the aquatic systems. Watershed boundaries above the selected stream or river segments were used to delineate these areas.

After identifying conservation areas to represent terrestrial and aquatic ecological systems, the planning team evaluated how well the suite of conservation areas met the goals for all conservation targets identified in this plan. This section summarizes the suite of conservation areas identified during the planning process, how well the conservation targets are represented within these areas, and the threats facing the biodiversity of the conservation areas.

## 7.1 Summary of the Suite of Conservation Areas

The planning process identified 51 conservation areas (Figure 10). These conservation areas range in size from 5,490 to 3,467,000 acres (or 2,222 to 1,403,600 hectares). These conservation areas are not intended to all be wilderness areas. They are intended to represent the diversity within the landscape and the scale at which the processes that shape these landscapes operate. Table 12 summarizes the total acres and average size of the conservation areas. Over 70% of the portfolio is currently in public ownership.

**Figure 10. Conservation Areas.**

Click on this text to go to "Appendix F - Terrestrial Conservation Areas" for specific information on Conservation Areas.
Click on this text to go to Figure 10. A map of the Conservation Areas.

**Table 12. Number and Size of Conservation Areas in the Superior Mixed Forest Ecoregion.**

| | |
|---|---|
| Number of Conservation Areas in Ecoregional Portfolio | 51 |
| Total Acres in Portfolio | 26,848,384 |
| Total Hectares in Portfolio | 11,347,269 |
| Average Acres/Conservation Area | 526,439 |
| Average Hectares/Conservation Area | 222,495 |
| Percent of Portfolio in Public Ownership | 71% |

## 7.2 Representation of Conservation Targets

The planning team assessed how well the conservation goals were met by evaluating the number of occurrences of each target that was captured within all the conservation areas. A "goal status" was assigned to each conservation target based on how well the suite of conservation areas met each target's goal. The goal status categories were modeled after the Great Lakes ecoregional plan (The Nature Conservancy 2000b). The intention was to provide more detail on why conservation goals were not met in order to better facilitate updates to the plan. The following categories were used:

*Goal Met 1*: The conservation goal for this target was met or exceeded.
*Goal Met 2*: There is a 95% or greater likelihood that the goal is actually met. The goal appears to be unmet due to the inability to map individual occurrences or due to lack of inventory. For example, most ecological systems were only tracked once per conservation area, but the majority of the conservation areas support numerous occurrences of the large and small patch types, and often more than one occurrence of matrix-forming systems.
*Goal Unmet 1*: All known viable occurrences of the target are included within the portfolio. It is unclear whether additional inventory will identify more occurrences. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of

conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 3*: There are no known viable occurrences in at least one section in which it is known to occur.

### *7.2.1 Primary Targets*

Using the categories above, the conservation goals were met for 44% of the primary conservation targets. A higher percentage of the goals for the ecological systems (72%) were met than for the species (33%). None of the goals were met for the globally rare or declining plant communities.

#### 7.2.1.1 Terrestrial Ecological Systems

Of the 37 terrestrial ecological systems identified in the Superior Mixed Forest, conservation goals were met for 29 systems (33%). The results of the goal assessment varied based on landscape pattern for terrestrial systems: matrix (100%), large patch (80%), small patch (69%), and linear (100%). Appendix H summarizes the goal status for each terrestrial ecological system.

In order to determine how well the suite of conservation areas met the conservation goals for ecological system targets, it was necessary to evaluate the occurrences of each system within each conservation area. Since there is no single, comprehensive data set in this ecoregion that directly documents the occurrences of ecological systems, a series of data sets were used to assess the representation of ecological systems within each conservation area.

Land cover layers were one of the primary data sets used to assess representation of terrestrial ecological systems. An ArcView script was developed to calculate land cover statistics for each conservation area. These statistics summarized the land cover classes present in the conservation area and provided the minimum, maximum, and average patch size of each land cover class present. The patch analysis methods and results are detailed in Appendix I.

Ecologists assessed which ecological systems were represented within each of the conservation areas based on land cover, the patch statistics associated with the land cover, and personal experience. Ecologists also used ancillary data layers, including Natural Heritage element occurrence records, surficial geology, land type associations, and other layers to inform this assessment. Confidence rankings were assigned to reflect the level of certainty regarding the presence of a given ecological system in each conservation area.

In the Canadian portion of the ecoregion, land cover layers provided general land cover categories such as coniferous forest, deciduous forest, and mixed coniferous-deciduous forest. Although the patch analysis was completed for Ontario and Manitoba, the land cover classes were too general to indicate which ecological systems might be present in each conservation area. Instead, ecologists who attended an experts workshop in Thunder Bay provided the majority of the information on the ecological systems present in each conservation area. However, land cover data were reviewed in conjunction with surficial geology to see whether any ecological systems may have been overlooked; ecologists familiar with the conservation areas then reviewed these additions.

#### 7.2.1.2 Aquatic Ecological Systems

Of the 37 aquatic ecological systems identified in the U.S. portion of the Superior Mixed Forest, goals were met for 24 systems (65%). The percentage of aquatic systems for which goals were met was approximately equal between the two size classes; 13 out of 20 (65%) stream system types were captured, and 11 out of 17 (65%) river types were represented. The reason that goals were not met for 35% of the aquatic ecological systems were also similar between the size classes—the known occurrences in at least one ecological drainage unit were judged to be non-viable. Appendix J summarizes the goal status for each aquatic ecological system.

Three other factors should be noted for the next iteration of the ecoregional plan. First, the system classification that was applied for this iteration was entirely abiotic, and there was no credible method of testing the correspondence of this classification with aquatic species assemblages. At this time, there is not a uniform lake classification system to compare types across the ecoregion so the lake results are not reported here. Efforts to test the classification with existing biological data are underway and should result in considerable refinements. Second, NatureServe and the Conservancy's Freshwater Initiative are in the process of updating the aquatic classification system in the Upper Mississippi River drainage and new conservation goals will be developed to reflect the updated classification. Finally, there is no aquatic classification system for the Canadian portion of the ecoregion, and the next iteration of the plan will be considerably improved if this gap can be filled.

#### 7.2.1.3 Globally Rare Plant Communities

Using data from the Natural Heritage Programs and the Conservation Data Centres, U.S. Forest Service inventory data, and interviews with field biologists, the presence and viability of rare plant communities were assessed. The conservation goals of two per ecological section were not met for any of the eight individual plant communities that were included as conservation targets. Generally, goals were not met because there were no **documented** occurrences in one or more sections within the geographic range of the plant communities. It is possible that additional inventory may locate occurrences of these communities in such sections. Numerous factors contributed to the inability to meet conservation goals for this group of targets. Rarity is clearly an issue; all of the communities are G1 or G2. In addition, most of these communities are near the edge of their geographic range in the Superior Mixed Forest; their range overlaps only slightly with this ecoregion. Lack of inventory may also be a reason why some have not yet been recorded in sections within their geographic range. Finally, some of these communities are not yet well-described or understood by terrestrial ecologists. Appendix K summarizes the goal status for each globally rare or declining plant community.

#### 7.2.1.4 Globally Rare Plant and Animal Species

Using data from the Natural Heritage Programs and the Conservation Data Centres, bird conservation plans completed for the Great Lakes ecoregion, U.S. Forest Service inventory data, and interviews with field biologists, the presence and viability of rare species were assessed. In the Superior Mixed Forest ecoregion, conservation goals were met for 33% of all the primary species targets. More specifically, goals were met or exceeded for 27% of the plant species, 50% of the bird species, 33% of the fish species, 22% of the insect species and 71% of the mollusk species. Appendix L summarizes the goal status for each globally rare plant and animal species.

Conservation goals were not met for 67% of all primary species targets. The suite of conservation areas did capture all known, viable occurrences for 52% of all primary species targets, but the goal of two populations per ecological section in which the species occurs, and a minimum of ten populations across the entire range of the species was still not met. The remaining 15% of the primary species targets are not known to be represented anywhere in the suite of conservation areas.

The data used in the goal assessment for these species targets is influenced by several factors. The most critical factor influencing this assessment is the highly variable level of inventory effort across the ecoregion. Although this assessment is based on the most accurate and up-to-date information from Conservation Data Centres, Heritage Programs, and experts, the amount of data available varies greatly among jurisdictions. Species occurrence data are not consistently comprehensive across the ecoregion. Data availability is primarily reflective of the capacity of Conservation Data Centres and Heritage Programs to complete field inventory work. Lack of data may have contributed to the unmet goal status of some species targets.

The Superior Mixed Forest ecoregion is at the edge of the geographic range of many species targets. For example, numerous species in the Southern Superior Uplands have their northern limit on the border of the Superior Mixed Forest. This edge-of-range issue likely explains the unmet goal status of many species targets.

*7.2.2 Secondary Targets*

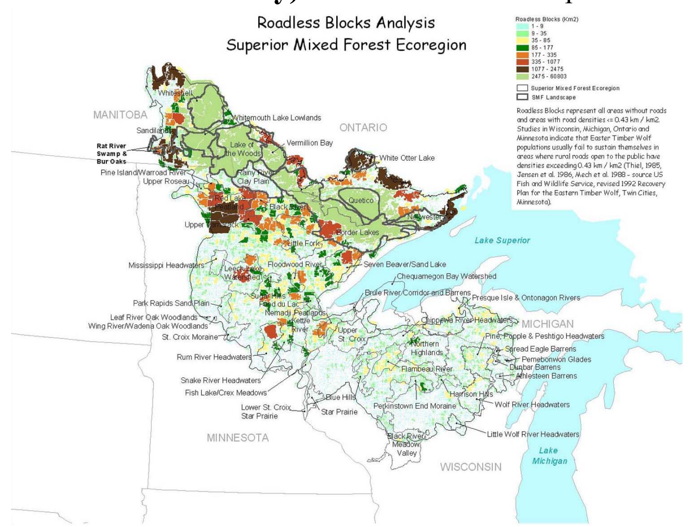
7.2.2.1 Wide-Ranging Species

With the exception of pine martens, the individual conservation areas selected are not large enough to support viable populations of wide-ranging species targets (wolf, black bear, moose, and lynx). Many of these species are habitat generalists, such as bear, while others have more specific habitat requirements. To maintain long-term population viability of these species in this region, the habitat requirements may need to be addressed in the management of the landscape matrix in which the conservation areas are embedded. Using habitat models, the planning team was able to make a more detailed assessment of how the suite of conservation areas addressed conservation for the wolf. For the other species, the core team relied heavily on interviews with experts on these species. The team asked the following questions:

1. Does the suite of conservation areas provide enough habitat to maintain this species?
2. What structural characteristics within the conservation areas are needed to maintain these species?

Updates to this plan need to develop quantitative conservation goals for these species and likely need to address conservation goals at a scale much larger than this ecoregion. In addition to representation and viability, the functional role of the species in its ecosystem should be factored into the goals. For example, planners should consider the number of wolves needed for this species to reestablish its functional role as a top predator in this region.

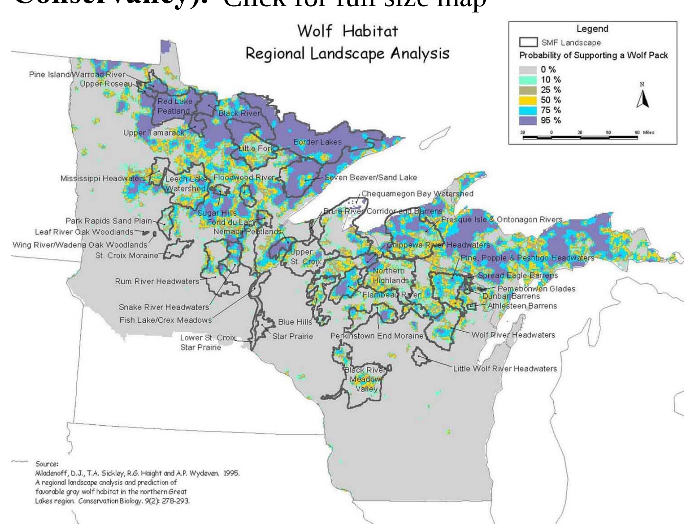
**Figure 11. Roadless Blocks Analysis and Superior Mixed Forest Conservation Areas (The Nature Conservancy).** Click for full size map




7.2.2.1.1 Wolves

The planning team used a wolf habitat suitability model (Mladenoff et al. 1999) and a road density assessment produced by The Nature Conservancy to compare the portfolio to high probability wolf habitat. Within the ecoregion, the majority of the high quality wolf habitat is in Ontario and northern Minnesota. Greater efforts likely will need to be made in the southern and eastern portions of the ecoregion to reduce mortality and conflicts with people by conserving core areas that can support several wolf packs (A. Wydeven, personal communication).

**Figure 12. Regional Landscape Analysis of Wolf Habitat and Superior Mixed Forest Conservation Areas (Mladenoff et al. 1995, The Nature Conservancy).** Click for full size map




While wolf densities may be declining in Manitoba (V. Crichton, personal communication), they are increasing throughout the remainder of the ecoregion. None of the conservation areas identified in the plan are likely to be capable of supporting a viable population of wolves. However, conservation areas and the forested matrix in which they are embedded may support a viable population. If the portfolio of conservation areas can be maintained in forested cover and remain connected, the wolf population should remain viable. Large blocks of forested habitat with low road density are structural characteristics that are an indirect measure of mortality rather than habitat preference (A. Wydeven, personal communication).

7.2.2.1.2 Other Mammals

For the rest of the wide-ranging species targets, the planning team relied on expert opinion on how well the goals for these species were met. Table 13 summarizes the area requirements and structural characteristics of the landscape that these species need.

**Table 13. Representation of Bear, Moose, Lynx, and Marten within the Suite of Conservation Areas.**

| Species | Area requirements | Structural Characteristics | General trend comments |
|---|---|---|---|
| Black bear (*Ursus americanus*) | Most conservation areas are not large enough to support viable, isolated populations. | Habitat generalist | This species is common and should be re-evaluated as a target for plan updates, unless "functional role" of the species is not met at low densities. |
| Moose (*Alces alces*) | An adult moose may require 8-15.5 $mi^2$ (20-40 $km^2$) (Ontario Ministry of Natural Resources 1990). Varies greatly depending on habitat quality. Most conservation areas are not large enough to support viable, isolated populations. | Prefers landscapes with abundant early successional forests and wetlands (Ontario Ministry of Natural Resources 1990). | The population is decreasing in Manitoba as a result of brainworm (V. Crichton, personal communication).<br><br>There are approximately 175 moose in Michigan's Upper Peninsula, the result of a reintroduction begun in 1985 (Smith 1999).<br><br>Small populations in Wisconsin supported by Michigan and Minnesota (A. Wydeven, personal communication).<br><br>As many as 2,000 moose in Minnesota/Ontario. |
| Canada lynx (*Lynx canadensis*) | Home range size varies considerably, depending on availability of prey and suitable mates (in males). Home range size averages 6-11.5 $mi^2$ (15-30 $km^2$) but can be as large as a hundred square miles (several hundred square km) (NatureServe Explorer 2002). Most conservation areas are not large enough to support viable, isolated populations. | Requires large conifers for denning and a mosaic of lowland and upland conifer stands that provides suitable habitat for the snowshoe hare, which is its primary prey (J. Hammil, personal communication). Much of the eastern portion of the Superior Mixed Forest is thus marginal habitat. | Population trend is described as "regionally variable" (NatureServe Explorer 2002); NatureServe also notes that it appears to be "relatively abundant in most of historic range, though population data are lacking for many areas." Species is still trapped in Canada. |
| Pine marten (*Martes americana*) | Some of the conservation areas are large enough to support viable populations as long as the structural characteristics are met. | Prefers mixed conifer-hardwood forests to pure northern hardwoods. | Within the Michigan portion of the Superior Mixed Forest, marten varies in abundance from common to rare; Wisconsin may be serving as sink habitat for emigrating animals (Earle et al. 2001). There is marginal habitat in Manitoba. Population numbers are much higher further east in the Lake of the Woods area, particularly the Aulneau Peninsula (V. Crichton, personal communication). |

7.2.2.1.3 Forest Interior Birds

The majority of the ecoregion is forested, providing a good context for forest-dwelling songbirds. A GIS assessment determined that 77% of the ecoregion is forested, surpassing the goal of 70% (see "Assessing Viability" section). Table 18 provides a breakdown of forest cover by political unit. Even though the total area of forest cover remains high, the majority of the forests are outside the natural range of variation. Drapeau et al. (2000) concluded that:

> "Overall, our results indicated that the large-scale conversion of the southern portion of the boreal forest from a mixed to a deciduous cover may be one of the most important threats to the integrity of bird communities in these forest mosaics. Negative effects of changes in bird communities could be attenuated if current forestry practices are modified toward maintaining forest types (deciduous, mixed-wood, and coniferous) at levels similar to those observed under natural disturbances."

These large shifts in age structure and species composition will likely have major impacts on forest birds throughout the hardwoods portion of the ecoregion as well. In addition to changes in tree species composition and age classes, deer densities are much higher than thresholds identified in the viability assessment, particularly for the southern and eastern portions of the ecoregion (see following "Ecoregional Threats" section).

**Table 14. Summary of Forest Cover within the Superior Mixed Forest.**

| Political Unit | Forest Acres | Forested Hectares |
|---|---|---|
| Manitoba | 2,551,069 | 1,032,403 |
| Michigan | 1,691,391 | 684,496 |
| Minnesota | 16,399,116 | 6,636,631 |
| Ontario | 9,349,010 | 3,783,492 |
| Wisconsin | 9,352,220 | 3,784,791 |
| Total Forested Area | 39,342,809 | 15,921,816 |
| Total Area of the Superior Mixed Forest (forested and non-forested) | 51,434,525 | 20,815,267 |
| Percentage of Superior Mixed Forest in forest cover | 77% | 77% |

7.2.2.2 Local and Intermediate-scale Species

While our intention was to use this set of conservation targets to assess the effectiveness of the coarse-filter approach at representing all biodiversity, this was not practical in application. There is very limited or no data for the majority of these species. Those species with data generally only have data for one political jurisdiction within the ecoregion. This set of conservation targets should be refined for future planning efforts to focus on species with geographically comprehensive data or to be used to help direct collection of additional data.

## 7.3 Ecoregional Threats

Threats are past, current, or potential activities that interfere with the ability of species, communities, or ecological systems to persist and remain viable. The purpose of this section is to summarize the scope and severity of these threats on the ecoregion. These threats are common to the majority of the conservation areas identified in this planning effort and many operate at a scale larger than the ecoregion. A diverse group of partners will need to work collaboratively to abate these threats.

The planning team identified the most critical threats based on scope, severity, urgency, and likelihood of occurrence. The following threats are considered to have the greatest impact on the biodiversity of the Superior Mixed Forest:

- Forest outside of natural range of variation
- Altered fire regime
- Intense deer herbivory
- Shoreline development
- Invasive species
- Mining
- Altered hydrology
- Habitat Conversion
- Climate change

### *7.3.1 Forest Outside of Natural Range of Variation*

Maintaining the composition and structure of the ecosystems and the patterns of ecological processes within the natural range of variation maintains biodiversity within dynamic systems. If the forest composition and/or structure is outside of the natural range of variation, the landscape may no longer be able to support adequate habitat for many of the species that depend on the ecosystem.

In portions of the Superior Mixed Forest that remain forested, alteration of the composition and age class (or vegetative growth stage) distribution of the tree species beyond the natural range of variation is a major threat to the integrity of the forest systems. By far the largest shift that has occurred is in the increase in young growth stages dominated by aspen (*Populus grandidentata* and *P. tremuloides*) and the decline of older growth stages in most forest types. Much of it extends over the landscape previously occupied by mesic hardwoods. The primary cause of this shift has been the management of forests for younger growth stages to support the pulp wood industry. In the Northern Superior Uplands section of the Superior Mixed Forest, the abundance of aspen increased 17% between the late 1800s and 1990 (Minnesota Forest Resources Council 1999). Likewise, in the Drift and Lake Plains section of the Superior Mixed Forest, C. Adams (personal communication) found that the age distribution of five of the six upland forest types was outside of the natural range of variation; more trees are in the younger age classes now than were historically. The forests of the Southern Superior Uplands are also outside the natural range of variation. Aspen abundance has dramatically increased in the landscape and pine has been selectively removed (Wisconsin Department of Natural Resources 1995b). These shifts are prevalent throughout the ecoregion. These younger, patchier forests of different composition present different habitats for plant and animal species, resulting in a greater abundance of species such as white-tailed deer (*Odocoileus virginianus*) that prefer early successional forests.

Furthermore, in the eastern portion of the ecoregion, hemlock (*Tsuga canadensis*) has been eliminated from portions of the forest, and throughout the ecoregion, white and red pine (*Pinus strobus* and *P. resinosa*) have been lost as a major component of the forest. Some species prefer or rely on mature or old-growth conifer or mixed conifer-hardwood forests for denning (in the case of black bear; J. Hammil, personal communication) or foraging (in the case of the red crossbill; D. Ewert, personal communication). As the proportion of the Superior Mixed Forest that is in these age classes decreases, habitat for such species also decreases, and some species may become rare or extirpated from the region.

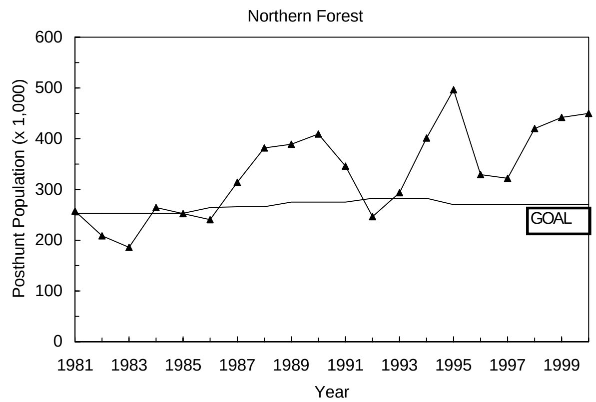
### *7.3.2 Altered Fire Regime*

Many of the forest types in the Superior Mixed Forest were maintained historically by stand-maintaining and stand-replacing fires that occurred across a broad range of return intervals from less than 30 years to well over 2,000 years (Shadis 2000; Zhang et al. 1999). The use of the forest for timber production, recreation, housing, and agriculture has meant that the intensity, frequency, and scale of fires have been greatly reduced in recent history (e.g., Heinselman 1996). The scope of these changes has been enormous, covering large areas of forest from the Upper Peninsula of Michigan up into the boreal forest of Canada (Great Lakes Ecological Assessment 2002). This shift in fire occurrences and fire characteristics has consequences not only for the integrity of the forests in terms of species composition and age structure, but also in terms of the spatial patterns to which the biota of these forests are adapted.

*7.3.3 Intense Deer Herbivory*

White-tailed deer populations are at levels beyond the carrying capacity of their habitat over much of the ecoregion. For example, the Michigan Department of Natural Resources (2001) estimates that the statewide deer population is 20-25% above their goal, and southern counties and those along the Wisconsin border (mostly outside the Superior Mixed Forest ecoregion) are among the most densely populated. Within the Superior Mixed Forest in Michigan, deer densities are at or above goals. The Wisconsin Department of Natural Resources reports that deer populations in the northern forest region exceed target management goals (Figure 13) (Rolley and McCaffery 2001).

**Figure 13. Regional White-tailed Deer Population Trends in Wisconsin, 1981-2000 (Rolley and McCaffery).**

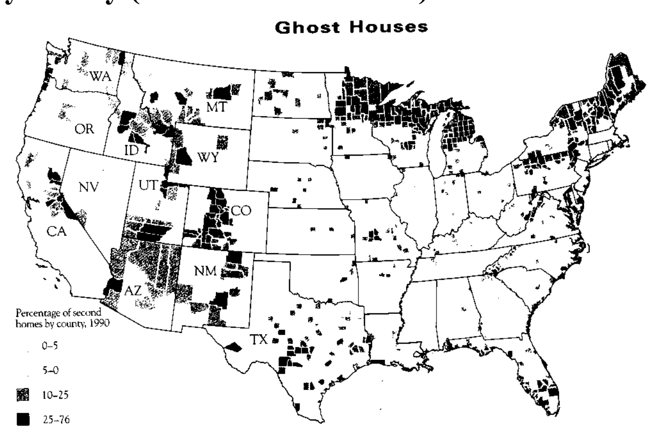



The ecological effects of this overpopulation can be seen in distinct browse lines in cedar stands, lack of shrubs in hardwood forests, lack of seedlings and saplings of preferred browse species, and depauperate ground floras (Balgooyen and Waller 1995). Changes in forest structure result in changes to animal populations. Deer densities greater than 20 per square mile (7-8 per square kilometer) result in a decrease of many bird species characteristic of the northern hardwoods, such as eastern wood peewees, least flycatchers, and cerulean warblers (deCalesta 1994). These negative impacts are likely to affect the abundance of a variety of other species, including ground-feeding small mammals and herps, as well as innumerable insects.

*7.3.4 Shoreline Development*

Lakes are important aquatic ecosystems in the Superior Mixed Forest, and one of the primary threats to lake integrity is the simplification of the shoreline habitat through vegetation removal and shifts in water chemistry that are often associated with residential development. In northeast Minnesota, where 65% of the shoreline is publicly owned, 27% of the private shoreline contained greater than 5 housing units per mile in 1982 (Minnesota Forest Resources Council 1999). Much of this pressure is due to seasonal use of lakes; for example, the Minnesota Department of Natural Resources estimates that the city of Brainerd with a population of 14,000 people swells to 140,000 people during the summer season (Minnesota Department of Natural Resources, Ecological Classification System). Northern Minnesota, Wisconsin, and the Upper Peninsula of Michigan are hotspots for second home development, partly because of the high density of lakes (Riebsame et al. 1997). For example, from 1985 to 1995, lakefront homes in Forest County have increased by 700% (Wisconsin Department of Natural Resources 1995b). According to the U.S. Census (2000), 26% of the housing in the Superior Mixed Forest region of Wisconsin are second homes (Vilas County has the highest percentage of seasonal homes with 56.2%). The Wisconsin Department of Natural Resources (1995b) summarizes the impacts of shoreline development in the following way:

**Figure 14. Percentage of Second Homes in the U.S., by county (Riebsame et al. 1997)**




> "With riparian development came extensive loss and simplification of aquatic habitats…. Disruption of the natural shoreline changed gradations in water depth in lakes, thereby eliminating natural formation of plant communities (Keddy 1983), and similar developments

along streams causes changes in the structure of the macroinvertebrates (Cummins et al. 1984, Sweeney 1993)….Isolated cases of shoreline modification may have little potential for affecting the aquatic community, but the cumulative effects of numerous alterations can have significant and long-lasting impacts due to habitat loss and simplification (Panek 1979)."

### *7.3.5 Invasive Species*

The annual cost of harmful invasive species in the U.S. is estimated to be $123 billion (Pimental et al. 1999). The direct costs to the Superior Mixed Forest are unknown. Invasive species in the ecoregion range from plants on the land to earthworms in the soil to animals in the waters. These invasive species alter the composition of natural communities, displacing native species and altering habitat structure.

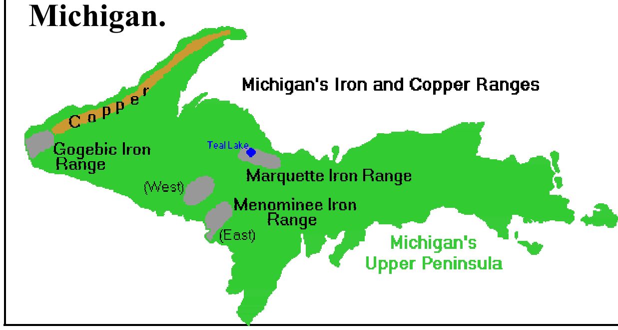
While there are numerous plant species that are invasive within the Superior Mixed Forest, only a few, such as purple loosestrife (*Lythrum salicaria*), are abundant enough to be severe problems. Significant impacts are also due to non-native aquatic animals, both fish and invertebrates. Many of these species have entered the ecoregion through the Great Lakes shipping industry or introductions (intentional or unintentional) by recreationists.

While many of the species are non-native, some are native species that have different genetics or are game species that have been stocked into areas that historically did not support them. The scope of fish stocking is staggering. For example, nearly every lake (14,000) and major river (33,000 river miles) has been stocked in Wisconsin, either by the Department of Natural Resources or private individuals (Wisconsin Department of Natural Resources 1995b). This is comparable to fish stocking efforts in many other parts of this ecoregion as well. Stocking can alter the genetics of a population, either reducing its vigor (Phillip 1991) or "infecting" evolutionary significant units of fishes. Stocking can also alter the trophic structure in a lake. A change in the top predators in a lake system results in a potential decline or shift in the rest of the food web (Carpenter and Kitchell 1988; Carpenter and Kitchell 1993).

### *7.3.6 Mining*

Large peat deposits are found in the Minnesota and Ontario portions of the Superior Mixed Forest ecoregions. These deposits lie primarily in the Southern Agassiz Peatlands and Lake Plains section, the northeast portion of the Drift and Lake Plains section, and the Rainy River lowland of Ontario, although smaller deposits are present throughout the ecoregion. Mining peat for horticultural and fuel purposes currently is ongoing in several of the conservation areas (e.g., Floodwood). Despite the extensive documentation of peat resources in the Ontario portion of this ecoregion, virtually no peat is currently or has historically been extracted from the area; apparently both drying and transportation costs to major economic centers prevents mining from being economically profitable (Riley and Michaud 1989). According to the Mining Journal (1998), Minnesota is the third largest source of peat in the U.S. In addition to the obvious habitat destruction effects of peat mining in which a peat wetland is converted to an open water wetland, poorly planned mining activities can have devastating consequences to water quality, including the introduction of sediment, nutrients, and heavy metals to downstream waterways (Minnesota Pollution Control Agency 1996), and to the surrounding hydrologic regimes of the landscape. These changes have the potential to extend beyond the area directly impacted by the mining.

**Figure 15. Iron and Copper Ranges in Michigan.**




Mining of iron has occurred for over a century in the Superior Mixed Forest (Michigan Historical Museum 2002). In the Michigan portion, mining in the east and west portions of the Menominee Range (Figure 15) started around 1870 and was completed by the 1970s. Iron was extracted through deep, subsurface mining in the Menominee Range, so destruction of ecosystems on the land surface was limited to the mine entrance areas and associated roads, railroads, and support facilities. Mining of the Mesabi Range in Minnesota started about the same time and, unlike in Michigan, persists as open-pit mining. Iron mining in Minnesota currently provides 26.5 million tons per year, or two-thirds of the iron used to produce steel in the United States (Iron Mining Association of Minnesota 2002). This open-pit mining is a historical and ongoing source of habitat destruction in the Superior Mixed Forest, though the rate of expansion of the mines is not clear. In addition, open-pit mining can be a significant source of leaching of heavy metals into surface and ground water systems (Garbarino et al. 1995). These heavy metals can reach concentrations that are toxic to aquatic organisms and people.

#### *7.3.7 Altered Hydrology*

The natural flood pulse is a critical component to maintaining the biodiversity of river systems (Poff et al. 1997). The flooding cycle in many of the rivers and lakes in the Superior Mixed Forest has been altered by dams and changes in landcover. Historic log runs have changed the morphology of the rivers, altering the water and sediment transport.

The Army Corps of Engineers' database (2001) lists 1,051 dams in the U.S. portion of the Superior Mixed Forest ecoregion. Many of the dams were constructed to generate power, commonly for paper mills, and to create recreational opportunities. These dams alter the natural hydrograph (timing and extent of flooding and drawdown) and movement of sediment and coarse woody debris through the river system. Dams also can act as a barrier to migration for fish and other aquatic organisms.

Hydrologic patterns within a watershed are likely affected by changes in upland land cover. Work by Verry (1983) in northern Minnesota suggests that reducing the age class of forests to less than 15 years in more than two-thirds of a watershed results in a doubling of snowmelt flood peak size; furthermore, this effect remains for 15 years after the forest harvest activity. Changes in upland land cover and land use, such as an increase in impervious surfaces, construction of poorly drained roads, and removal of riparian vegetation, have been associated with a variety of changes to aquatic habitats due to an increase in peak flows, an increase in sediment delivery to a channel, reductions in the input of large woody debris to a river, and increases in temperature. A Wisconsin study concluded that the diversity of fish species decreased as the amount of impervious surface within a watershed reached 8-12% (Wang et al. 2001). While difficult to study, there is an increasing recognition of the importance of the cumulative effects of these landuse changes on aquatic habitats and hydrologic regimes (Bunn and Arthington 2002).

#### *7.3.8 Habitat Conversion*

Much of the Superior Mixed Forest ecoregion remains in forested landcover; however, a significant portion of this ecoregion, especially in the south, has been converted to agriculture during the last century. This has numerous consequences for conserving biodiversity: restoring natural fire regimes becomes complicated, adaptation or migration in response to global climate change becomes difficult, and natural flooding regimes can either be altered or become less tolerated as they interfere with agricultural production. Furthermore, some of these forests may become so fragmented that the viability of species dependent upon larger areas of forest may be threatened. Within the northern portion of this ecoregion, the effect and scale of habitat conversion is quite different; in general, large expanses are not converted out of forest cover and instead cabins or housing units are interspersed within the woods. The consequence of this can potentially be severe in places where restoring or emulating natural fire regimes, particularly in size and intensity, is made very difficult by the presence of human dwellings within the forest.

#### *7.3.9 Climate Change*

According to the National Assessment Synthesis Team (2000), the average annual U.S. temperature has risen by almost 1°F (0.6°C) and precipitation has increased by 5-10% over the last century. It is likely that the increase in temperature in the 20th century was the largest in the last 1,000 years and that even more dramatic changes will occur in the 21$^{st}$ century. In the Great Lakes region, increases in temperature and precipitation have exceeded the national figures and are predicted to mimic that trend in the coming century (National Assessment Synthesis Team 2000).

Rapid climate change is expected to have a significant impact on biodiversity. In the upper Great Lakes region, as in other glaciated regions, climatic changes have been a constant reality as glaciers advanced and receded during glacial and interglacial cycles. Plants and animals have had to both disperse in response to these climatic changes and adapt to newly created landforms and soils. It is widely accepted that the composition of natural communities has not remained constant but has been continually changing as species disperse and expand or contract their ranges at differing rates. Therefore, the climatic changes that are currently underway should be expected to result in different plant and animal communities in ecosystems of the Superior Mixed Forest. For forests, the most fundamental effect is a likely shift in the ranges of dominant tree species. Scenarios developed under various ecological and climatic models indicate that conditions in the Superior Mixed Forest will, by the end of the current century, be more suited for oak-hickory forests than northern hardwood and boreal forests (National Assessment Team 2000). For that change to occur, dramatic die-offs of some trees and northward expansion by other species would have to occur. It is hard to imagine that the current forests would all be replaced within the century, but it is becoming clearer that some changes will happen; the exact nature of those changes is very hard to know.

As we compare the current changes to past ones, two important differences are apparent, both of which have bearing on biological diversity. First, the climate is warming and is expected to continue to warm at a rate faster than at any time in the past. Second, the ecoregions through which plants and animals will need to disperse or migrate are far less hospitable and traversable due to the drastic changes wrought by human activities. The combined effects of these two factors could result in greater rates of extinction than might have occurred in the past.

Using a regression analysis for 33 variables and assuming a 1-4.5°C increase in temperature resulting from a doubling of $CO_2$ by 2100, Iverson and Prasad (1998) estimate that many common species, such as sugar maple, will shift northward and be restricted to only portions of the ecoregion. Changes in vegetation will also result in changes in disturbance patterns, such as insect outbreaks, fire, and susceptibility to windthrow. Since many of the tree species of the Superior Mixed Forest are long-lived, these changes may not occur for several centuries. In addition, as the name of the ecoregion implies, the Superior Mixed Forest has a high diversity of tree species in the forest and high habitat heterogeneity. These two factors, as well as some local regulation of the climate by the Great Lakes, may make the Superior Mixed Forest more resilient to climate change than other ecoregions.

Changes in animal species distributions are expected to coincide with changes in vegetation. For example, Price's (2000) model predicts that many characteristic northern hardwood species may be extirpated from Michigan. The Superior Mixed Forest functions as a source for some of the species that possibly will be extirpated, such as Black-throated Blue Warbler and Canada Warbler.

Climate change is also expected to impact aquatic systems. Increases in water temperature and changes in precipitation patterns are a likely result of climate change (Poff et al. 2002). Increases in water temperature will likely displace cool, deep-water fish species from small inland lakes. Changes in precipitation will alter the frequency, intensity, and duration of flooding events (Poff et al. 2002). Maintaining a natural flow regime is critical for long-term integrity of river systems (Richter et al. 1997; Sparks 1995). Many species may have limited opportunities to adapt or move to suitable habitat as a result of compounding factors such as decreased water quality and fragmentation of river systems by dams (Poff et al. 2002).

## 7.4 Information Management

Numerous data sets were used or created in this ecoregional planning process. Both tabular and spatial data sets were compiled. The GIS team at The Nature Conservancy's Midwest Resource office were the primary managers of spatial data. Spatial data were managed using ArcView 3.2a and ArcInfo 8.1.2 software. Metadata records were created using ArcCatalog software and meet the Federal Geographic Data Committee (FGDC) standard for metadata. All public GIS data will be available soon at www.conserveonline.org. For GIS data used in the Superior Mixed Forest ecoregional planning effort, contact:

The Nature Conservancy
Midwest Resource Office
1101 West River Parkway
Minneapolis, MN 55454
Jan Slaats (jslaats@tnc.org) (612) 331-0700

Tabular data gathered in the planning process were compiled and managed using Microsoft Access. This included information on conservation targets, element occurrence records (from Natural Heritage Programs, Conservation Data Centres, and expert input), the suite of selected conservation areas, conservation partners, landcover statistics, threats to conservation areas, participants in the planning process, and other data gathered during this planning effort. Although the element occurrence records are only available through the respective Natural Heritage Programs or Conservation Data Centres, the rest of the tabular database is available from the Wisconsin Field Office:

The Nature Conservancy
Wisconsin Chapter
633 W. Main St.
Madison, WI 53703
(608) 251-8140
John Wagner (jwagner@tnc.org)

A copy of the tabular database (minus element occurrence records) is also kept at The Nature Conservancy's Midwest Resource Office.

## 7.5 Next Steps

Identifying conservation targets, conservation goals, and the suite of conservation areas that need to be conserved only lays the groundwork for conservation action in the ecoregion. This ecoregional plan identifies the critical places for conserving biodiversity, but it does not address how to implement conservation efforts for each of the conservation areas. More detailed planning (often called site planning) will need to be done for each of the conservation areas. In some cases, it will be more efficient to simultaneously plan for many conservation areas that share similar threats or targets.

Those leading the implementation of the Superior Mixed Forest ecoregional plan not only need to determine how to best conserve the suite of conservation areas identified in this plan but must also remember the critical need to focus efforts on the ecoregion as a whole. There are at least four reasons why ecoregion-wide conservation efforts are critical:

1. *To support the forest ecosystems of this ecoregion,* conservation strategies will need to extend well beyond the conservation areas delineated in this plan. These forests should be managed towards their natural range of variation of species composition, growth stage distribution, and disturbance spatial patterns, not only within conservation areas, but ideally across their geographic range.
2. *To support the viability of the wolf population*, conservation efforts will need to focus across the entire geographic range of this mammal. Evidence gathered by the U.S. Fish and Wildlife Service's wolf recovery team suggests that wolves in the Superior Mixed Forest ecoregion may essentially be from one population; the source of recovery for wolves in Wisconsin and Michigan has been the remnant (and now growing) population of wolves in Minnesota (U.S. Fish and Wildlife Service 1992). Vast areas are needed to support wolf packs (214 $mi^2$ or 549 $km^2$) and dispersing wolves (1,000 $mi^2$ or 2,564 $km^2$) (U.S. Fish and Wildlife Service 1992).
3. *To support a regionally significant group of forest interior birds,* conservation efforts should be coordinated at three scales: (1) *stand-level* management to address structural requirements of the diversity of forest birds, (2) *ecoregion-level* efforts to address landscape structure attributes, such as percentage of forest cover (Drapeau et al. 2000), that foster regional source populations, and (3) *rangewide* planning for each of the species of concern. The majority of the birds of the Superior Mixed Forest are neotropical migrants. Birds like the Black-throated Blue Warbler (*Dendroica caerulescens*) breed in the Superior Mixed Forest and then migrate through Florida and the eastern Gulf Coast to wintering grounds in the West Indies. Other species overwinter in Central America (e.g., Golden-winged Warblers (*Vermivora*

*chrysoptera*)) or South America (e.g., Connecticut Warblers (*Oporornis agilis*)) but return to the Superior Mixed Forest area in spring.

4. *To abate critical threats to the suite of conservation areas*, a diverse group of partners will need to work together to develop and implement strategies for the ecoregion (or larger) scale as well as for specific conservation areas.

## 7.6 Information Gaps and Suggestions for Future Revisions

The core team identified the suite of conservation areas based on an incomplete dataset. In future iterations, the following data gaps should be addressed:

- Develop more refined and defensible conservation goals (number and distribution of occurrences);
- Identify important bird areas for Minnesota, Ontario, and Manitoba;
- Develop an aquatic classification system for Ontario and Manitoba;
- Develop forest quality indicators for Ontario and Manitoba, and improve and standardize indicators across the ecoregion;
- Develop detailed land cover layers with a standard set of cover classes for the entire ecoregion;
- Develop a lake classification system for the entire ecoregion;
- Improve the viability assessment for the Minnesota portion of the aquatic conservation area selection;
- Revise the aquatic conservation areas after NatureServe and The Nature Conservancy's Upper Mississippi River Basin assessment is complete;
- Refine the list of secondary target species for use in an assessment of the effectiveness of the coarse-filter approach. This may require inventory data for many of the species;
- Review global ranks for species targets. As inventory for these species is updated, the global ranks may change. For example, the global rank for the green-faced clubtail (*Gomphus viridifrons*) will likely be changed from G3 to G3G4, removing it from the primary target list.

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## 9 Glossary

**association**—The finest level of biological community organization in the U.S. National Vegetation Classification, defined as a plant community with a definite floristic composition, uniform habitat conditions, and uniform physiognomy. With the exception of a few associations that are restricted to specific and unusual environmental conditions, associations generally repeat across the landscape. They also occur at variable spatial scales depending on the steepness of environmental gradients and the patterns of distribution.

**aquatic ecological system**—Dynamic spatial assemblages of ecological communities that 1) occur together in an aquatic landscape with similar geomorphological patterns; 2) are tied together by similar ecological processes (e.g., hydrologic and nutrient regimes, access to floodplains and other lateral environments) or environmental gradients (e.g., temperature, chemical and habitat volume); and 3) form a robust, cohesive and distinguishable unit on a hydrography map.

**biological diversity**—The variety of living organisms considered at all levels of organization including the genetic, species, and higher taxonomic levels. Biological diversity also includes the variety of habitats, ecosystems, and natural processes occurring therein.

**coarse filter-fine filter approach**—A working hypothesis that assumes that conservation of multiple, viable examples of all coarse-filter targets (communities and ecological systems) will also conserve the majority of species (fine-filter targets). The term coarse filter refers to targets at the community or system level of biological organization whereas coarse-scale refers to spatial scale of, for example, terrestrial targets that roughly cover 20,000–1,000,000 acres.

**coarse-scale approach—**Ecological systems or matrix communities are spatially large terrestrial targets referred to as coarse-scale. The coarse-scale approach is the first step in the portfolio assembly process where all coarse-scale targets are represented or "captured" in the ecoregion (including those that are feasibly restorable).

**community—**Terrestrial or plant communities of definite floristic composition, uniform habitat conditions, and uniform physiognomy. Terrestrial communities are defined by the finest level of classification, the "plant association" level of the National Vegetation Classification. Like ecological systems, terrestrial communities are characterized by both ~~a~~ biotic and abiotic components. Even though they are classified based upon dominant vegetation, we use them as inclusive conservation units that include all component species (plant and animal) and the ecological processes that support them.

**connectivity**—Conservation areas or reserves have permeable boundaries and thus are subject to inflows and outflows from the surrounding landscapes. Connectivity in the selection and design of nature reserves relates to the ability of species to move across the landscape to meet basic habitat requirements. Natural connecting features within the ecoregion may include river channels, riparian corridors, ridge-lines, or migratory pathways.

**conservation areas**—Although the term "conservation site" is often used to describe areas chosen through the process of ecoregional planning, in actuality these are conservation areas and are different from sites as defined in site conservation planning. Although ecoregional plans may delineate rough or preliminary site boundaries or use other systematic units such as watersheds or hexagons as site selection units, the boundaries and the target occurrences contained within these areas are first approximations that will be dealt with in more specificity and accuracy in the site conservation planning process.

**conservation blueprint—**Another term for an ecoregional plan.

**conservation focus**—Those targets that are being protected and the scale at which they are protected (local-scale species and small patch communities; intermediate-scale species and large-patch communities; coarse-scale species and matrix communities; and regional-scale species).

**conservation goal**—In ecoregional planning, the number and spatial distribution of on-the-ground occurrences of targeted species, communities, and ecological systems that are needed to adequately conserve the target in an ecoregion.

**conservation status**—Refers to the category assigned to a conservation target such as threatened, endangered, imperiled, vulnerable, and so on.

**conservation target** (see target)

**corridor**—A route that allows movement of individuals or taxa from one region or place to another. In ecoregional planning, it is important to establish corridors among conservation areas for targets that require such areas for dispersal and movement

**decline/declining**—For conservation targets, the historical or recent decline through all of part or its range. Declining species exhibit significant, long-term declines in habitat/and or numbers, are subject to a high degree of threat, or may have unique habitat or behavioral requirements that expose them to great risk.

**disjunct**—Disjunct species have populations that are geographically isolated from that of other populations.

**distribution pattern**—The overall pattern of occurrence for a particular conservation target. In ecoregional conservation projects, often referred to as the relative proportion of the target's natural range occurring within a given ecoregion (e.g., endemic, widespread, limited, disjunct, peripheral).

**driver**—A conservation target for which an Ecologically Significant Area was selected, and which must be conserved within that ESA to meet the conservation goal for the target.

**ecological backdrop**—Large areas of intact natural vegetation that occur in portions of an ecoregion but outside of conservation areas and are recognized as having critical importance in connectivity, ecological context, and function of natural processes. Ecological backdrops are differentiated from conservation areas by the anticipated lower level of on-the-ground conservation and strategies that may focus on large-scale policy issues, such as multi-site threat abatement.

**ecological communities** (see community)

**ecological drainage units (EDU)**—Aggregates of watersheds that share ecological and biological characteristics. Ecological drainage units contain sets of aquatic systems with similar patterns of hydrologic regime, gradient, drainage density, & species distribution. Used to spatially stratify ecoregions according to environmental variables that determine regional patterns of aquatic biodiversity and ecological system characteristics.

**ecological integrity**—The probability of an ecological community or ecological system to persist at a given site is partially a function of its integrity. The ecological integrity or viability of a community is governed primarily by three factors: demography of component species populations; internal processes and structures among these components; and intactness of landscape-level processes which sustain the community or system.

**ecological section**—An ecological unit in a hierarchical classification. Sections are the next subdivision finer than ecoregions. The term "section" in this report is equivalent to the term "ecoregion" in Canada.

**ecological system** (see terrestrial ecological systems or aquatic ecological system).

**ecoregion**—A relatively large area of land and water that contains geographically distinct assemblages of terrestrial communities. These communities (1) share a large majority of their species, dynamics, and environmental conditions, and (2) function together effectively as a conservation unit at global and continental scales. Ecoregions were defined by Robert Bailey as major ecosystems resulting from large-scale predictable patterns of solar radiation and moisture, which in turn affect the kinds of local ecosystems and animals and plant found within.

**efficiency**—In portfolio design, a principle in which occurrences of coarse-scale ecological systems that contain multiple targets at other scales are given priority. This is accomplished through identification of functional sites and landscapes. In more academic literature, efficiency refers to conserving the greatest amount of biological diversity in the least amount of land area.

**element**—A term originating from the methodology of the Natural Heritage Network that refers to species, communities, and other entities (e.g., migratory bird stopovers) of biodiversity that serve as both conservation targets and as units for organizing and tracking information.

**element occurrence (EO)**—A term originating from methodology of the Natural Heritage Network that refers to a unit of land or water on which a population of a species or example of an ecological community occurs. For communities, these EOs represent a defined area that contains a characteristic species composition and structure.

**endangered species**—A species that is federally listed or proposed for listing as Endangered by the U.S. Fish and Wildlife Service under the Endangered Species Act.

**endemic**—Species that are restricted to an ecoregion (or a small geographic area within an ecoregion), depend entirely on a single area for survival, and are therefore often more vulnerable.

**exotic**—A species which was introduced to a region accidentally or purposefully by human action. See "invasive."

**fine filter**—To ensure that the coarse-fine filter strategy adequately captures all viable, native species and ecological communities, ecoregional planning teams also target species that cannot be reliably conserved through the coarse-filter approach and may require individual attention through the fine-filter approach. Wide-ranging, very rare, extremely localized, narrowly endemic, or keystone species are all likely to need fine-filter strategies.

**focal species**—Focal species have spatial, compositional and functional requirements that may encompass those of other species in the region and may help address the functionality of ecological systems. Focal species may not always be captured in the portfolio through the coarse filter. In the Conservancy's ecoregional planning efforts wide-ranging and keystone are examples of focal species.

**fragmentation**—Process by which habitats are increasingly subdivided into smaller units, resulting in their increased insularity as well as losses of total habitat area.

**functional landscape**—A conservation area selected for both coarse-scale terrestrial and aquatic targets. The conservation targets are intended to represent many other ecological systems, communities, and species (i.e., "all" biodiversity).

**functional site**—A conservation area selected for one or more small-patch or large-patch terrestrial communities, or an aquatic system target; species targets may or may not be present.

**functionality**—In portfolio assembly, a principle where we ensure all conservation areas are functional or feasibly restorable to a functional condition. Functional conservation areas maintain the size, condition, and landscape context within the natural range of variation of the respective conservation targets.

**GAP (National Gap Analysis Program)**—Gap analysis is a scientific method for identifying the degree to which native animal species and terrestrial communities are represented in the present-day mix of conservation lands. Those species and communities not adequately represented in the existing network of conservation lands constitute conservation "gaps." The purpose of the Gap Analysis Program (GAP) is to provide broad geographic information on the status of stable, non-vulnerable species and their habitats in order to provide land managers, planners, scientists, and policy makers with the information they need to make better-informed decisions.

**GIS (Geographic Information System)**—A computerized system of organizing and analyzing any spatial array of data and information.

**Global Code**— A unique identifying code assigned to individual species, plant communities, and other elements of biological diversity that are tracked by NatureServe and the network of Natural Heritage Programs and Conservation Data Centres; NatureServe and the network use the term "GELCODE," an abbreviation for Global ELement CODE.

**global rank**—A numeric ranking of a biological element's relative imperilment and conservation status across its range of distribution ranging from G1 (critically imperiled) to G5 (secure). Assigned by the Natural Heritage Network, global ranks for species and communities are determined primarily by the number of occurrences or total area of coverage (communities only), modified by other factors such as condition, historic trend in distribution or condition, vulnerability, and threats.

**growth stages**—Refers to the pattern of species dominance and stand structure which result as forest stands are initiated and develop to a mature state. The exact pattern and timing of growth stages varies considerably with all of the variables which influence ecosystem development—ecoregion, climate, topography, geology, soils and forest type.

**habitat**—The place or type of site where species and species assemblages are typically found and/ or successfully reproducing. In addition, marine communities and systems are referred to as habitats. They are named according to the features that provide the underlying structural basis for the community.

**Heritage**—A term used loosely to describe the Network of Natural Heritage Programs and Conservation Data Centres or to describe the standardized methodologies used by these programs.

**imperiled species**—Species which have a global rank of G1-G2 by Natural Heritage Programs/ Conservation Data Centres. Regularly reviewed and updated by experts, these ranks take into account number of occurrences, quality and condition of occurrences, population size, range of distribution, threats and protection status.

**imperilment**—A term from Natural Heritage methodology referring to the degree to which an element of biodiversity (e.g., species or community) is considered at risk of extinction or elimination. Three factors can be considered part of the term: 1) evidence of current or historic decline; 2) threat, or likelihood, that human action will result in future decline; and 3) rarity.

**indigenous**—A species that naturally occurs in a given area.

**invasive**—A species, either native or introduced, that reduces the biological integrity of the ecosystem in which it is located by outcompeting other native species or altering natural processes.

**keystone species**—A species whose impacts on its community or ecosystem are much greater than would be expected from its abundance.

**landscape**—A heterogeneous land area composed of a cluster of interacting ecosystems that are repeated in similar form throughout.

**large patch**—Used to describe communities that form large areas of interrupted cover. Individual occurrences of this community patch type typically range in size from 50 to 2,000 hectares. Large patch communities are associated with environmental conditions that are more specific than those of matrix communities, and that are less common or less extensive in the landscape. Like matrix communities, large-patch communities are also influenced by large-scale processes, but these tend to be modified by specific site features that influence the community.

**linear communities**—Communities that occur as linear strips are often, but not always, ecotonal between terrestrial and aquatic systems. Examples include coastal beach strands, bedrock lakeshores, and narrow riparian communities. Similar to small patch communities, linear communities occur in very specific ecological settings, and the aggregate of all linear communities covers, or historically covered, only a small percentage of the natural vegetation of a ecoregion. They also tend to support a specific and restricted set of associated flora and fauna. Linear communities differ from small patch communities in that both local-scale processes and large-scale processes strongly influence community structure and function.

**macrohabitats**—Macrohabitats are the finest-scale biophysical aquatic classification unit used as conservation targets. Examples are lakes and stream/river segments that are delineated, mapped, and classified according to the environmental factors that determine the types and distributions of aquatic species assemblages.

**matrix communities**—Communities that form extensive and contiguous cover may be categorized as matrix (or matrix-forming) community types. Matrix communities occur on the most extensive landforms and typically have wide ecological tolerances. They may be characterized by a complex mosaic of successional stages resulting from characteristic disturbance processes. Individual occurrences of the matrix type typically range in size from 2000 to 500,000 hectares. In most ecoregions, the aggregate of all matrix communities covers, or historically covered, as much as 75-80% of the natural vegetation of the ecoregion. Matrix community types are often influenced by large-scale processes (e.g., climate patterns, fire) and are important habitat for wide-ranging or large area-dependent fauna, such as large herbivores or birds.

**metadata**—Metadata documents the content, source, reliability, and other characteristics of data. Metadata are particularly important in the iterative ecoregional planning process because this documentation will expedite the review of existing tabular and geospatial data sets when an ecoregional plan is revisited and will minimize the likelihood of “lost” data.

**metapopulation**—A network of semi-isolated populations with some level of regular or intermittent migration and gene flow among them, in which individual populations may go extinct but can then be recolonized from other source populations.

**minimum dynamic area**—The area needed to insure survival or re-colonization of a site following disturbance that removes most or all individuals. This is determined by the ability of some number of individuals or patches to survive, and the size and severity of stochastic events.

**mosaic**—An interconnected patchwork of distinct vegetation types.

**native**—Those species and communities that were not introduced accidentally or purposefully by people but that are found naturally in an area. Native communities are those characterized by native species and maintained by natural processes. Native includes both endemic and indigenous species.

**natural range of variation**—The variability of size, structure, composition, or other key ecological factors through time and space, under "natural" conditions.

**network of preserves**—An integrated set of functional sites and conservation areas designed to conserve regional species. Portfolios of sites in regions of the country that still support wide-ranging species like the grizzly bear should be based upon functional networks of sites.

**occurrence**—Spatially referenced examples of species, communities, or ecological systems. May be equivalent to Heritage Element Occurrences, or may be more loosely defined locations delineated through 1) the definition and mapping of other spatial data or 2) the identification of areas by experts.

**patch community**—Communities nested within matrix communities and maintained primarily by specific environmental features rather than disturbance processes.

**plant community**—Community types of definite floristic composition, uniform habitat conditions, and uniform physiognomy. These communities are defined by the finest level of classification, the "plant association" level of the National Vegetation Classification.

**portfolio of sites**—In ecoregional plans, these are the suite of conservation areas within an ecoregion that would collectively conserve the native species and communities of the ecoregion.

**population viability analysis (PVA)**—A collection of quantitative tools and methods for predicting the likely future status (i.e., likelihood of extinction or persistence) of a population or collection of populations of conservation concern.

**rangewide**—Referring to the entire distribution of a species, community, or ecological system.

**representation**—A principle of reserve selection and design referring to the capture the full spectrum of biological and environmental variation within a network of reserves or conservation areas, including all genotypes, species, communities, ecosystems, habitats, and landscapes.

**representativeness**—Captures multiple examples of all conservation targets across the diversity of environmental gradients appropriate to the ecoregion (e.g., ecoregional section or subsection, ecological land unit (ELU), or some other physical gradient).

**restoration driver**—A conservation target for which a conservation area was selected, but which is degraded or absent from the ESA and for which habitat must be restored in order to meet conservation goals for the target.

**restoration landscape**—A conservation area selected for both coarse-scale terrestrial community and aquatic ecological system targets, but where the site is degraded, so conservation strategies are focused on restoration actions.

**section**—Areas of similar physiography within an ecoregional province; a hierarchical level with the U.S. Forest Service ECOMAP framework for mapping and classifying ecosystems at multiple geographic scales.

**shifting mosaic**—An interconnected patchwork of distinct vegetation types that may shift across the land surface as a result of dynamic ecosystem processes, such as periodic wildfire or flooding.

**small patch**—Communities that form small, discrete areas of vegetation cover. Individual occurrences of this community type typically range in size from 1 to 50 hectares. Small patch communities occur in very specific ecological settings, such as on specialized landform types or in unusual microhabitats. The specialized conditions of small patch communities, however, are often dependent on the maintenance of ecological processes in the surrounding matrix and large patch communities. In many ecoregions, small patch communities contain a disproportionately large percentage of the total flora, and also support a specific and restricted set of associated fauna (e.g., invertebrates or herptofauna) dependent on specialized conditions.

**source (of stress)**—An extraneous factor, either human (e.g., activities, policies, land uses) or biological (e.g., non-native species), that infringes upon a conservation target in a way that results in stress.

**spatial pattern**—Within an ecoregion, natural terrestrial communities may be categorized into four functional groups on the basis of their current or historical patterns of occurrence, as correlated with the distribution and extent of landscape features and ecological processes. These groups are identified as matrix communities, large-patch communities, small-patch communities, and linear communities.

**stratification**—A hierarchical division of an ecoregion into nested, progressively smaller geographic units. Spatial stratification is used to represent each conservation target across its range of variation (in internal composition and landscape setting) within the ecoregion, to ensure long-term viability of the type by buffering against degradation in one portion of its range, and to allow for possible geographic variation.

**stress**—Something which impairs or degrades the size, condition, or landscape context of a conservation target, resulting in reduced viability.

**surrogate**—In conservation planning, surrogates are generally referred to as any conservation target being used to capture or represent targets or elements of biological diversity (both known and unknown) that occur at finer scales of spatial resolution or finer levels of biological organization. For example, communities and ecological systems are often labeled as surrogate measures of biodiversity which are intended to represent the many species that occur within these types of targets.

**target**—Also called conservation target. An element of biodiversity selected as a focus for conservation planning or action. The three principle types of targets in Nature Conservancy planning projects are species, ecological communities, and aquatic ecological systems.

**terrestrial ecological system**—Dynamic spatial assemblages of ecological communities that 1) occur together on the landscape; 2) are tied together by similar ecological processes (e.g., fire, hydrology); and 3) form a robust, cohesive and distinguishable unit on the ground. Ecological systems are characterized by both biotic and abiotic (environmental) components.

**threat**—The combined concept of ecological stresses to a target and the sources of that stress to the target.

**threatened species**—Species federally listed or proposed for listing as Threatened by the U.S. Fish and Wildlife Service under the Endangered Species Act.

**umbrella species**—Typically wide-ranging species that require large blocks of relatively natural or unaltered habitat to maintain viable populations. Protection of the habitats of these species may protect the habitat and populations of many other more restricted or less wide ranging species.

**viable/viability**—The ability of a species to persist for many generations or an ecological community or system to persist over some time period. An assessment of viability will often focus on the minimum area and number of occurrences necessary for persistence. However, conservation goals should not be restricted to the minimum but rather should extend to the size, distribution, and number of occurrences necessary for a community to support its full complement of native species.

**vulnerable**—Vulnerable species are usually abundant, may or may not be declining, but some aspect of their life history makes them especially vulnerable (e.g., migratory concentration or rare/endemic habitat). For example, sandhill cranes are a vulnerable species because a large percentage of the entire population aggregates during migration along a portion of the Platte River in Nebraska.

## 10 APPENDIX A. Participants in the Superior Mixed Forest Planning Process.

A core team of staff from The Nature Conservancy, Nature Conservancy of Canada, Ontario Ministry of Natural Resources, and Manitoba Conservation led planning for the Superior Mixed Forest ecoregion. A number of regional biological experts provided input to the planning process during expert workshops and other meetings, and in one-on-one interviews with core team members. Below is a list of people who contributed to this ecoregional plan.

| Participant | Organization | Division | State/ Prov. |
|---|---|---|---|
| Aaseng, Norm | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Adams, Cheryl | Blandin Paper Company | | MN |
| Albanese, Michelle | Nature Conservancy of Canada | National Office | ON |
| Albert, Dennis | Michigan State University Extension | Michigan Natural Features Inventory | MI |
| Almendinger, John | Minnesota Department of Natural Resources | Division of Forestry | MN |
| Anderson, Chel | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Bakowsky, Wasyl | Ontario Ministry of Natural Resources | Natural Heritage Information Centre | ON |
| Bannerman, Bonnie | Ontario Ministry of Natural Resources | Ontario Parks | ON |
| Bassler, Karen | Gathering Waters Conservancy | | WI |
| Beechey, Tom | Ontario Ministry of Natural Resources | Ontario Parks | ON |
| Brown, Jenny | The Nature Conservancy | Minnesota Chapter | MN |
| Callaghan, Phyllis & Dale | Rainy Lake Conservancy | | ON |
| Carlson, Bruce | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Chaplin, Steve | The Nature Conservancy | Midwest Resource Office | MN |
| Converse, Carmen | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Cook, Chantel | U.S. Forest Service | | MN |
| Cornett, Meredith | The Nature Conservancy | Northeast Minnesota | MN |
| Crichton, Vince | Manitoba Conservation | Wildlife and Ecosystem Protection Branch | MB |
| Crins, Bill | Ontario Ministry of Natural Resources | Ontario Parks | ON |
| Crooks, Kevin | University of Wisconsin-Madison | Department of Wildlife Ecology | WI |
| Dallman, Matt | The Nature Conservancy | Wisconsin Chapter | WI |
| DeLong, Paul | Wisconsin Department of Natural Resources | Bureau of Forestry | WI |
| Doolittle, Tom | | | WI |
| Duffus, Tom | The Nature Conservancy | Northeast Minnesota | MN |
| Dunning, Kara | Boise Cascade | | MN |
| Ebbers, Mark | Minnesota Department of Natural Resources | Division of Fisheries | MN |
| Edde, Jerry | Ottawa National Forest | | MI |
| Elkin, Vicki | Gathering Waters Conservancy | | WI |
| Epstein, Eric | Wisconsin Department of Natural Resources | Bureau of Endangered Resources | WI |
| Ewert, Dave | The Nature Conservancy | Great Lakes Program | MI |
| Fago, Don | Wisconsin Department of Natural Resources | Integrated Science Services | WI |
| Fitzhugh, Tom | The Nature Conservancy | Freshwater Initiative | IL |
| Fortney, Gene | Nature Conservancy of Canada | Manitoba Region | MB |
| Frelich, Lee | University of Minnesota | | MN |
| Garry, Clarke | University of Wisconsin-River Falls | Department of Biology | WI |
| Gerdes, Lawson | Minnesota Department of Natural Resources | County Biological Survey | MN |

| Participant | Organization | Division | State/ Prov. |
|---|---|---|---|
| Gerdes, Lynden | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Glaser, Paul | University of Minnesota | Limnological Research Center | MN |
| Gluck, Michael | Ontario Ministry of Natural Resources | Northwest Region | ON |
| Greenall, Jason | Wildlife Branch, Manitoba Conservation | Manitoba Conservation Data Centre | MB |
| Grover, Melissa | U.S. Forest Service | | MN |
| Gruendler, Deirdre | The Nature Conservancy | Wisconsin Chapter | WI |
| Hall, Carol | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Hammil, Jim | Michigan Department of Natural Resources | Wildlife Division | MI |
| Hanson, Dan | Minnesota Department of Natural Resources | Division of Forestry | MN |
| Harkness, Mary | The Nature Conservancy | Midwest Resource Office | MN |
| Harris, Allan | Northern Bioscience | | ON |
| Henderson, Rich | Wisconsin Department of Natural Resources | Integrated Science Services | WI |
| Hoffman, Randy | Wisconsin Department of Natural Resources | Bureau of Endangered Resources | WI |
| Holenstein, Julian | Federation of Ontario Naturalists | | ON |
| Host, George | University of Minnesota-Duluth | NRRI | MN |
| Jalava, Jarmo | Ontario Ministry of Natural Resources | Natural Heritage Information Centre | ON |
| Jennings, Martin | Wisconsin Department of Natural Resources | Northern Regional Headquarters - Science Services | WI |
| Judziewicz, Emmet | University of Wisconsin-Stevens Point | | WI |
| Kallemyn, Larry | National Park Service | Voyageurs National Park | MN |
| Kearns, Kelly | Wisconsin Department of Natural Resources | Bureau of Endangered Resources | WI |
| Kelner, Dan | Minnesota Department of Natural Resources | | MN |
| Krause, John | | | WI |
| Lammert, Mary | The Nature Conservancy | Freshwater Initiative | IL |
| LeeKam, Ron | Ontario Ministry of Natural Resources | Northwest Region | ON |
| Lipsett-Moore, Catherine | Ontario Ministry of Natural Resources, Species at Risk | Northwest Region | ON |
| Lipsett-Moore, Geoff | Ontario Ministry of Natural Resources, Ontario Parks | Northwest Region | ON |
| Lyons, John | Wisconsin Department of Natural Resources | Integrated Science Services | WI |
| Mackenzie, Jim | Ontario Ministry of Natural Resources | Natural Heritage Information Centre | ON |
| Madsen, Maria | University of Wisconsin-Madison | | WI |
| Martin, Mark | Wisconsin Department of Natural Resources | Bureau of Endangered Resources | WI |
| Meeker, Jim | Northland College | | WI |
| Meyer, Thomas | Wisconsin Department of Natural Resources | Bureau of Endangered Resources | WI |
| Mladenoff, David | University of Wisconsin-Madison | Forest Ecology | WI |
| Myhre, Karen | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Nelson, Sharron | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Niese, Jeff | | | WI |

| Participant | Organization | Division | State/ Prov. |
|---|---|---|---|
| Norquist, Gerda | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Oldham, Mike | Ontario Ministry of Natural Resources | Natural Heritage Information Centre | ON |
| Padley, Eunice | Wisconsin Department of Natural Resources | Bureau of Forestry | WI |
| Parker, Linda | U.S. Forest Service | Chequamegon-Nicolet National Forest | WI |
| Pearsall, Doug | The Nature Conservancy | Michigan Chapter | MI |
| Penskar, Mike | Michigan State University Extension | Michigan Natural Features Inventory | MI |
| Peterson, Bruce | Environment North | | ON |
| Pohlman, John | Wisconsin Department of Natural Resources | Bureau of Forestry | WI |
| Punter, Liz | University of Manitoba | Department of Botany | MB |
| Rabe, Mary | Michigan State University Extension | Michigan Natural Features Inventory | MI |
| Ratcliff, Brian | Thunder Bay Field Naturalists Club | | ON |
| Reschke, Carol | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Richter, Steve | The Nature Conservancy | Wisconsin Chapter | WI |
| Rigelman, Sara | The Nature Conservancy | Wisconsin Chapter | WI |
| Riley, John | Nature Conservancy of Canada | National Office | ON |
| Rusterholtz, Kurt | Minnesota Department of Natural Resources | County Biological Survey | MN |
| Sculpen, Tina | U.S. Forest Service | | WI |
| Shadis, Dave | U.S. Forest Service | Chippewa National Forest | MN |
| Shedd, Mary | U.S. Forest Service | Superior National Forest | MN |
| Slaats, Jan | The Nature Conservancy | Midwest Resource Office | MN |
| Smith, Bill | Wisconsin Department of Natural Resources | Bureau of Endangered Resources | WI |
| Solomon, Nancy | U.S. Forest Service | | MN |
| Sutherland, Beth | University of Wisconsin-Madison | Conservation Biology and Sustainable Development | WI |
| Sutherland, Don | Ontario Ministry of Natural Resources | Natural Heritage Information Centre | ON |
| van den Broeck, John | Ontario Ministry of Natural Resources | Northwest Region | ON |
| Van Helden, Nicole | The Nature Conservancy | Wisconsin Chapter | WI |
| Wagner, John | The Nature Conservancy | Wisconsin Chapter | WI |
| West, Paul | The Nature Conservancy | Wisconsin Chapter | WI |
| Westad, Kristin | Wisconsin Department of Natural Resources | Bureau of Endangered Resources | WI |
| Winters, Jerry | Sawyer County Lakes Forum | | WI |
| Wyant, Desiree | Ontario Ministry of Natural Resources | Geomatics Service Centre | ON |
| Wydeven, Adrian | Wisconsin Department of Natural Resources | Bureau of Endangered Resources | WI |
| Zager, Scott | Minnesota Department of Natural Resources | County Biological Survey | MN |

## 11 APPENDIX B. Boundary Justification for the Superior Mixed Forest Ecoregion.

The northern boundary of the Superior Mixed Forest ecoregion originally stopped at the U.S.-Canadian border because the first iteration of the North American ecoregional map only included the U.S. It was assumed that eventually the Superior Mixed Forest and other border ecoregions would eventually be revised to include ecologically appropriate areas across international boundaries. This boundary justification reflects the first effort to delineate the northern ecological boundary of the Superior Mixed Forest ecoregion.

In the Ontario portion of the ecoregion, the northern boundary of the Superior Mixed Forest generally follows the northern-most range of red pine and white pine as major constituents of the forest. Although red pine and white pine do occur north of this boundary, it is only as minor components in true boreal forests. This is the primary factor that determines the northern boundary between this mixed forest ecoregion and the true boreal ecoregions. This northern boundary also roughly coincides with a one degree Celsius temperature isocline. There is a significant dip in the temperature isocline, thus at one point, the ecoregion boundary almost touches the international border. The temperature isocline came from a model developed by Mackey et al. (1996). Annual precipitation in this part of Ontario ranges from 560 to 660 mm, from west to east. The growing season is 175-185 days. The extreme maximum and minimum temperatures in this area are reflective of the ecoregion's continental climate (25 degree C maximum temperature for the hottest month, -26 degree C minimum temperature for the coldest month).

This boundary constitutes ecodistricts 5S-2, 4S-6, 4W-1, and 4W-2 in Ontario's recently revised Ecological Land Classification system (Crins 2000). Ecodistrict 4S-6 is part of Ontario's 4S ecoregion, and it is the only ecodistrict from that ecoregion that is included within the Superior Mixed Forest ecoregion. This is because this ecodistrict meets the criteria outlined above. The use of this boundary also ensures that all of the Lake of the Woods, including the Agassiz clay deposits on various islands and at the northwest end of the lake, are included within the ecoregion.

The northern boundary is drawn with much greater precision than that of tree species ranges or climate isoclines. The specific lines are based on the Ontario Land Inventory (OLI) layer that defines and attributes small land units with surficial geology, bedrock where it is at the surface, soil characteristics (texture, depth, moisture) and the ruggedness of terrain at a scale of 1:250,000. The OLI polygons are nested within Ontario's ecodistrict boundaries, similar to how Landtype Association polygons are nested within subsections in the U.S. Forest Service ecological mapping system in the U.S.

In the Manitoba portion of the ecoregion, the western boundary follows that developed by the Northern Tallgrass Prairie ecoregion team. It marks the transition between mixed forest and prairie ecosystems. The northern boundary in the Manitoba portion was drawn using lines from the National Ecological Framework for Canada (Ecological Stratification Working Group 1995). The boundaries in the Manitoba portion also roughly follows the line separating organic surficial deposits from exposed bedrock and thin till to the north, and calcareous till and beach deposits to the west.

The Manitoba lines do not match up evenly with Ontario's 4S-6 ecoregion lines. For a short segment between the Manitoba-Ontario border and the northwesternmost corner of 4S-6, a handful of OLI polygons (outside of ecodistrict 4S-6) were used to outline that portion of the boundary.

Later in the planning process, the Superior Mixed Forest ecoregional team realized that the boundary between the Superior Mixed Forest and Northern Tallgrass Prairie might not be an ecologically appropriate boundary. There is a transitional area of open woodland, comparable to the Aspen Parklands and Prairie Forest Border, that lies generally in the northwest corner of the Superior Mixed Forest ecoregion. These transitional areas do not have a strong affinity to the flora of the mixed/Great Lakes forests across the rest of the Superior Mixed Forest ecoregion. On the Manitoba side, aspen and bur oak are predominant in these more open woodlands. This aspen and oak component extends into Minnesota, in the Northern Tallgrass Prairie ecoregion. It is unclear where that transitions to oak and other deciduous woodland types that do not include aspen as a major component. The team agreed that the adjoining boundaries of

Superior Mixed Forest, Prairie Forest Border, Northern Tallgrass Prairie, and Aspen Parkland ecoregions should be revisited after their first iteration ecoregional plans are complete, but before second iterations begin.

Superior Mixed Forest boundaries (including internal section and subsection boundaries) should be generally revisited prior to a second iteration. Minnesota, Wisconsin and Michigan have their own versions of section and subsection-level map units, and the U.S. Forest Service has also updated its national version of those units sometime during 2002. It is unclear how the U.S. Forest Service revisions relate to the various current state versions. Between those updates, and continued ecological mapping efforts in Canada, boundary revisions will be an important first step in the next iteration.

## 12 APPENDIX C. Most Common System Type in Each Ecological Drainage Unit.

| Ecological Drainage Unit | Most Common System Type |
|---|---|
| Rainy River Headwaters | Surface water, stream connected to lake, medium-high relief, with significant surface storage |
| Mississippi River Headwaters | Surface mixed, stream connected to stream, low relief, with significant surface storage |
| St. Croix | Surface mixed, stream connected to stream, low relief, with significant surface storage |
| Rainy River | Surface mixed, stream connected to stream, low relief, with significant surface storage |
| Chippewa | Groundwater mixed, stream connected to large river, medium to high relief, with significant surface storage |
| Lower Red | Surface mixed, stream connected to lake, low relief, with significant surface storage |
| Upper Wisconsin | Groundwater mixed, stream connected to large river, medium to high relief, with significant surface storage |
| Lower St. Croix | Surface mixed, stream connected to large river, low relief, with significant surface storage |
| Great Lakes Basin – Green Bay | Groundwater mixed, stream connected to stream, low relief, with significant surface storage |
| Upper Mississippi River – Chippewa | Surface mixed, river connected to large river, low relief, with significant surface storage |
| Upper Mississippi River – Outwash Plains | Surface mixed, stream connected to large river, low relief, with significant surface storage |

## 13 APPENDIX D. Additional Secondary Targets.

The following table includes local and intermediate-scale secondary targets, as well as some other secondary targets. The planning team developed this additional set of targets for use in assessing the effectiveness of the coarse-filter approach. There is not adequate data for the majority of these targets, making it difficult to use them as intended. This list should serve as a list of potential primary or secondary targets for updates to this ecoregional plan.

Although wide-ranging mammals are secondary targets, they are not included in the table because each species is addressed individually in the text. Some of the bird species listed are forest interior birds. Others are local and intermediate-scale species. The planning team interviewed over two dozen ecologist and taxonomists within the ecoregion to select local and intermediate-scale species. Secondary species were chosen based on the following criteria:

- Not yet ranked G1-G3, but, according to experts in the region, are likely to be in the future;
- Endemic to the ecoregion;
- Found in the ecoregion but are significantly disjunct from the main portion of their range;
- Listed as federally threatened and endangered species in the United States;
- From taxonomic groups not represented in the primary targets;
- Locally declining and have strong political support for protection;
- Bird species with Partners In Flight scores greater than 20 but less than 25 (2002).

In addition, plant communities were included as secondary targets because they have the potential to serve as good indicators for how well the suite of conservation areas represent the variability of ecological systems. Although some of these plant communities are matrix-forming, they are included on this because they are secondary targets.

| Scientific Name | Common Name | Global Code | Global Rank |
|---|---|---|---|
| **Amphibians** | | | |
| Acris crepitans blanchardi | Blanchard's Cricket Frog | AAABC01011 | G5T5 |
| Hemidactylium scutatum | Four-toed Salamander | AAAAD08010 | G5 |
| **Birds** | | | |
| Contopus virens | Eastern Wood Pewee | ABPAE32060 | G5 |
| Icterus galbula | Baltimore Oriole | ABPBXB9190 | G5 |
| Euphagus carolinus | Rusty Blackbird | ABPBXB5010 | G5 |
| Ammodramus leconteii | Le Conte's Sparrow | ABPBXA0040 | G4 |
| Ammodramus savannarum | Grasshopper Sparrow | ABPBXA0020 | G5 |
| Pheucticus ludovicianus | Rose-breasted Grosbeak | ABPBX61030 | G5 |
| Wilsonia citrina | Hooded Warbler | ABPBX16010 | G5 |
| Oporornis formosus | Kentucky Warbler | ABPBX11010 | G5 |
| Lanius ludovicianus migrans | Loggerhead Shrike | ABPBR01037 | G5T3Q |
| Catharus fuscescens | Veery | ABPBJ18080 | G5 |
| Cistothorus platensis | Sedge Wren | ABPBG10010 | G5 |
| Empidonax virescens | Acadian Flycatcher | ABPAE33020 | G5 |
| Falco peregrinus | Peregrine Falcon | ABNKD06070 | G4 |
| Podiceps grisegena | Red-necked Grebe | ABNCA03020 | G5 |
| Ardea alba | Great Egret | ABNGA04040 | G5 |
| Lophodytes cucullatus | Hooded Merganser | ABNJB20010 | G5 |
| Pandion haliaetus | Osprey | ABNKC01010 | G5 |
| Empidonax minimus | Least Flycatcher | ABPAE33070 | G5 |
| Buteo lineatus | Red-shouldered Hawk | ABNKC19030 | G5 |
| Contopus cooperi | Olive-sided Flycatcher | ABPAE32010 | G5 |

| Scientific Name | Common Name | Global Code | Global Rank |
|---|---|---|---|
| Falcipennis canadensis | Spruce Grouse | ABNLC09010 | G5 |
| Sterna hirundo | Common Tern | ABNNM08070 | G5 |
| Tyto alba | Barn Owl | ABNSA01010 | G5 |
| Caprimulgus vociferus | Whip-poor-will | ABNTA07070 | G5 |
| Melanerpes erythrocephalus | Red-headed Woodpecker | ABNYF04040 | G5 |
| Accipiter gentilis | Northern Goshawk | ABNKC12060 | G5 |
| **Fish** | | | |
| Lythrurus umbratilis | Redfin Shiner | AFCJB52080 | G5 |
| Moxostoma carinatum | River Redhorse | AFCJC10040 | G4 |
| Percina evides | Gilt Darter | AFCQC04090 | G4 |
| Lepomis megalotis | Longear Sunfish | AFCQB11080 | G5 |
| Moxostoma duquesnei | Black Redhorse | AFCJC10070 | G5 |
| Hybopsis amnis | Pallid Shiner | AFCJB15010 | G4 |
| Salvelinus namaycush siscowet | Wisconsin Lake Trout | AFCHA05052 | G5T? |
| Hiodon alosoides | Goldeye | AFCGA01010 | G5 |
| Noturus exilis | Slender Madtom | AFCKA02250 | G5 |
| Notropis nubilus | Ozark Minnow | AFCJB28680 | G5 |
| Alosa chrysochloris | Skipjack Herring | AFCFA01030 | G5 |
| **Insects** | | | |
| Neurocordulia molesta | Smoky Shadowdragon | IIODO31030 | G4 |
| Attaneuria ruralis | a stonefly | IIPLEIM010 | G4 |
| Stylurus scudderi | Zebra Clubtail | IIODO80090 | G4 |
| Somatochlora incurvata | Emerald Curvetail | IIODO32130 | G4 |
| Aeshna subartica | Subartic Darner | IIODO14170 | G5 |
| Schinia indiana | Phlox Moth | IILEYMP130 | GU |
| Lycaeides idas nabokovi | Nabokov's Blue | IILEPG501B | G5TU |
| Pieris virginiensis | West Virginia White | IILEPA2020 | G3G4 |
| Cicindela denikei | Denike's Tiger Beetle | IICOL026M0 | G4 |
| Williamsonia fletcheri | Ebony Boghaunter | IIODO34010 | G3G4 |
| Polyamia dilata | Net-veined Leafhopper | IIHOM29010 | G? |
| **Mammals** | | | |
| Synaptomys borealis | Northern Bog Lemming | AMAFF17020 | G4 |
| **Mollusks** | | | |
| Alasmidonta viridis | Slippershell Mussel | IMBIV02110 | G4G5 |
| Venustaconcha ellipsiformis | Ellipse | IMBIVA4010 | G3G4 |
| Tritogonia verrucosa | Pistolgrip | IMBIV44010 | G4 |
| Quadrula metanevra | Monkeyface | IMBIV39080 | G4 |
| Pleurobema sintoxia | Round Pigtoe | IMBIV35070 | G4 |
| Megalonaias nervosa | Washboard | IMBIV29020 | G5 |
| Cyclonaias tuberculata | Purple Wartyback | IMBIV09010 | G5 |
| Alasmidonta marginata | Elktoe | IMBIV02040 | G4 |
| Actinonaias ligamentina | Mucket | IMBIV01020 | G5 |
| Ellipsaria lineolata | Butterfly | IMBIV13010 | G4 |
| **Reptiles** | | | |
| Clemmys insculpta | Wood Turtle | ARAAD02020 | G4 |
| Sistrurus catenatus catenatus | Eastern Massasauga | ARADE03011 | G3G4 |
| Thamnophis sauritus | Eastern Ribbon Snake | ARADB36120 | G5 |

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|---|---|---|---|
| Thamnophis proximus | Western Ribbon Snake | ARADB36090 | G5 |
| Emydoidea blandingii | Blanding's Turtle | ARAAD04010 | G4 |
| **Plants** | | | |
| Carex obtusata | Blunt Sedge | PMCYP039L0 | G5 |
| Carex prasina | Drooping Sedge | PMCYP03B10 | G4 |
| Carex rossii | Ross' Sedge | PMCYP03BN0 | G5 |
| Carex saximontana | Rocky Mountain Sedge | PMCYP03C20 | G5 |
| Carex supina ssp. spaniocarpa | Weak Arctic Sedge | PMCYP03DB1 | G5T? |
| Lipocarpha micrantha | Dwarf Bulrush | PMCYP0H040 | G5 |
| Carex xerantica | White-scaled Sedge | PMCYP03EX0 | G5 |
| Carex torreyi | Torrey's Sedge | PMCYP03DT0 | G4 |
| Carex lenticularis | Shore Sedge | PMCYP037A0 | G5 |
| Carex laeviconica | Smooth Cone Sedge | PMCYP036X0 | G4G5 |
| Carex assiniboinensis | Assiniboine Sedge | PMCYP03140 | G4G5 |
| Viola sagittata var. ovata | Sand Violet | PDVIO041Z1 | G5T5 |
| Valeriana uliginosa | Marsh Valerian | PDVAL030J0 | G4 |
| Tiarella cordifolia | Heart-leaved Foam-flower | PDSAX10010 | G5 |
| Saxifraga cernua | Nodding Saxifrage | PDSAX0U0B0 | G4 |
| Potentilla gracilis | Fanleaf Cinquefoil | PDROS1B0T0 | G5 |
| Catabrosa aquatica | Brook Grass | PMPOA19010 | G5 |
| Ranunculus lapponicus | Lapland Buttercup | PDRAN0L1G0 | G5 |
| Ranunculus gmelinii | Small Yellow Water-crowfoot | PDRAN0L110 | G5 |
| Parnassia palustris | Marsh Grass-of-Parnassus | PDSAX0P090 | G5 |
| Diarrhena americana | American Beak-grain | PMPOA23010 | G4? |
| Woodsia glabella | Smooth Cliff-fern | PPDRY0U040 | G5 |
| Silene nivea | Snowy Campion | PDCAR0U120 | G4? |
| Anemone patens | American Pasque-flower | PDRAN0K020 | G5 |
| Polystichum braunii | Braun's Holly-fern | PPDRY0R040 | G5 |
| Cystopteris laurentiana | Laurentian Bladder-fern | PPDRY07040 | G3G4 |
| Asplenium trichomanes-ramosum | Green Spleenwort | PPASP02250 | G4 |
| Potamogeton pulcher | Spotted Pondweed | PMPOT030W0 | G5 |
| Potamogeton confervoides | Alga-like Pondweed | PMPOT03050 | G3G4 |
| Platanthera flava var. herbiola | Tubercled Orchid | PMORC1Y082 | G4T4Q |
| Festuca hallii | Rough Fescue | PMPOA2V1A0 | G4 |
| Rhynchospora scirpoides | Long-beaked Bald-rush | PMCYP0N3A0 | G4 |
| Calamagrostis purpurascens | Purple Reed-grass | PMPOA17100 | G5? |
| Calypso bulbosa | Calypso | PMORC0D010 | G5 |
| Amerorchis rotundifolia | Round-leaved Orchis | PMORC01010 | G5 |
| Disporum trachycarpum | Rough-fruited Mandarin | PMLIL0R060 | G5 |
| Luzula parviflora | Small-flowered Wood-rush | PMJUN020G0 | G5 |
| Juncus stygius | Moor Rush | PMJUN012N0 | G5 |
| Scleria reticularis | Reticulate Nut-rush | PMCYP0R0K0 | G3G4 |
| Trichophorum cespitosum var. Callosum | Tussock Club-rush | PMCYP0Q06001 | G5T? |
| Stipa comata | Needle-and-thread | PMPOA5X080 | G5 |
| Cirsium flodmanii | Flodman's Thistle | PDAST2E140 | G5 |
| Moehringia macrophylla | Large-leaved Sandwort | PDCAR0H020 | G4 |
| Opuntia fragilis | Brittle Prickly-pear | PDCAC0D0H0 | G4G5 |

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|---|---|---|---|
| Armoracia lacustris | Lake Cress | PDBRA07010 | G4? |
| Senecio indecorus | Plains Ragwort | PDAST8H1R0 | G5 |
| Senecio eremophilus | Desert Groundsel | PDAST8H160 | G5 |
| Prenanthes aspera | Rough Rattlesnake-root | PDAST7K040 | G4? |
| Petasites sagittatus | Arrow-leaved Sweet Coltsfoot | PDAST71040 | G5 |
| Callitriche heterophylla | Large Water-starwort | PDCLL01040 | G5 |
| Erigeron glabellus | Smooth Fleabane | PDAST3M1P0 | G5 |
| Vaccinium cespitosum | Dwarf Huckleberry | PDERI18060 | G5 |
| Cirsium drummondii | Drummond's Thistle | PDAST2E0Z0 | G5 |
| Aster sericeus | Western Silvery Aster | PDAST0T2X0 | G5 |
| Artemisia frigida | Prairie Sagebrush | PDAST0S0L0 | G5? |
| Antennaria rosea | Rosy Pussy-toes | PDAST0H0X0 | G4G5 |
| Asclepias lanuginosa | Woolly Milkweed | PDASC022A0 | G4? |
| Asclepias ovalifolia | Dwarf Milkweed | PDASC021D0 | G5? |
| Adoxa moschatellina | Musk-root | PDADO01010 | G5 |
| Huperzia appalachiana | Appalachian Fir-clubmoss | PPLYC020J0 | G4G5 |
| Liatris punctata var. nebraskana | Dotted Blazing-star | PDAST5X0M2 | G5T3T5 |
| Ribes oxyacanthoides | Canada Gooseberry | PDGRO02180 | G5 |
| Anemone caroliniana | Carolina Anemone | PDRAN04030 | G5 |
| Pyrola minor | Lesser Wintergreen | PDPYR04060 | G5 |
| Primula incana | Jones' Primrose | PDPRI080A0 | G4G5 |
| Lysimachia hybrida | Lance-leaved Loosestrife | PDPRI070A0 | G5 |
| Lechea stricta | Upright Pinweed | PDCIS040D0 | G4? |
| Phacelia franklinii | Franklin's Phacelia | PDHYD0C1J0 | G5 |
| Viburnum edule | Squashberry | PDCPR07070 | G5 |
| Gentiana alba | Yellow Gentian | PDGEN06020 | G4 |
| Oxytropis borealis var. viscida | Sticky Locoweed | PDFAB2X0Z5 | G5T? |
| Glycyrrhiza lepidota | Wild Licorice | PDFAB1W020 | G5 |
| Dalea purpurea | Purple Prairie-clover | PDFAB1A1D0 | G5 |
| Astragalus crassicarpus | Ground-plum | PDFAB0F2G0 | G5 |
| Astragalus alpinus | Alpine Milkvetch | PDFAB0F0D0 | G5 |
| Vaccinium vitis-idaea ssp. minus | Mountain Cranberry | PDERI18121 | G5T5 |
| Scutellaria parvula var. parvula | Small Skullcap | PDLAM1U111 | G4T? |
| **Plant Communities** | | | |
| Populus tremuloides - Betula papyrifera / (Abies balsamea, Picea glauca) Forest | Aspen-Birch/Boreal Conifer Forest | CEGL002466 | G5 |
| Pinus banksiana / Abies balsamea Forest | Jack Pine / Balsam Fir Forest | CEGL002437 | G5 |
| Alnus incana Swamp Shrubland | Speckled Alder Swamp | CEGL002381 | G5? |
| Zizania (aquatica, palustris) Herbaceous Vegetation | Wild Rice Marsh | CEGL002382 | G3G4 |
| Carex lasiocarpa - Calamagrostis spp. - (Eleocharis rostellata) Herbaceous Vegetation | Prairie Transition Rich Fen | CEGL002383 | G3? |
| Symplocarpus foetidus Herbaceous Vegetation | Skunk Cabbage Seepage Meadow | CEGL002385 | G4? |
| Nuphar lutea ssp. advena - Nymphaea odorata Herbaceous Vegetation | Water Lily Aquatic Wetland | CEGL002386 | G4G5 |
| Granite/Metamorphic Talus Northern Sparse Vegetation | Northern Granite/Metamorphic Talus | CEGL002409 | G4G5 |

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|---|---|---|---|
| Polygonum spp. - Mixed Forbs Herbaceous Vegetation | Midwest Ephemeral Pond | CEGL002430 | G4G5 |
| Thuja occidentalis - (Picea mariana, Abies balsamea) / Alnus incana Forest | White-cedar - (Mixed Conifer) / Alder Swamp | CEGL002456 | G4 |
| Pinus strobus - Populus tremuloides / Corylus cornuta Forest | White Pine-Aspen-Birch Forest | CEGL002479 | G4? |
| Pinus banksiana - (Pinus resinosa) - Quercus ellipsoidalis / Carex pensylvanica Forest | Jack Pine - Northern Pin Oak Forest | CEGL002478 | G4G5 |
| Picea glauca - Abies balsamea - Populus tremuloides / Mixed Herbs Forest | Spruce - Fir - Aspen Forest | CEGL002475 | G5 |
| Abies balsamea - Betula papyrifera / Diervilla lonicera Forest | Balsam Fir - Paper Birch Forest | CEGL002474 | G5 |
| Larix laricina / Aronia melanocarpa / Sphagnum spp. Forest | Central Tamarack Poor Swamp | CEGL002472 | G4? |
| Larix laricina / Alnus incana Forest | Northern Tamarack Rich Swamp | CEGL002471 | G4 |
| Populus tremuloides - Betula papyrifera / Acer saccharum - Mixed Hardwoods Forest | Aspen - Birch / Sugar Maple - Mixed Hardwoods Forest | CEGL002468 | G5 |
| Populus tremuloides - Betula papyrifera - (Acer rubrum, Populus grandidentata) Forest | Aspen - Birch - Red Maple Forest | CEGL002467 | G5 |
| Carex lasiocarpa - Carex oligosperma / Sphagnum spp. Herbaceous Vegetation | Northern Sedge Poor Fen | CEGL002265 | G3G4 |
| Betula papyrifera / Acer saccharum - Mixed Hardwoods Forest | Paper Birch / Sugar Maple - Mixed Hardwoods Forest | CEGL002464 | G4? |
| Schizachyrium scoparium - Danthonia spicata - Carex pensylvanica - (Viola pedata) Herbaceous Vegetation | Midwest Dry Sand Prairie | CEGL002318 | G2G3 |
| Quercus rubra - Quercus alba - (Quercus velutina, Acer rubrum) / Viburnum acerifolium Forest | Northern Red Oak - White Oak - (Maple) Forest | CEGL002462 | G? |
| Quercus rubra - Acer saccharum Forest | Northern Red Oak - Sugar Maple Forest | CEGL002461 | G4G5 |
| Betula papyrifera / Diervilla lonicera - (Abies balsamea) Forest | Paper Birch / Fir Forest | CEGL002463 | G4? |
| Picea mariana / Pleurozium schreberi Forest | Black Spruce / Feathermoss Forest | CEGL002447 | G5 |
| Pinus banksiana / (Quercus rubra, Quercus ellipsoidalis) Forest | Jack Pine / Scrub Oak Forest | CEGL002440 | G4? |
| Pinus banksiana / Vaccinium spp. / Pleurozium schreberi Forest | Jack Pine / Blueberry / Feathermoss Forest | CEGL002441 | G4G5 |
| Pinus banksiana - (Pinus resinosa) / Corylus cornuta Forest | Jack Pine / Hazel Forest | CEGL002442 | G4? |
| Pinus resinosa / Vaccinium spp. Forest | Red Pine / Blueberry Dry Forest | CEGL002443 | G3 |
| Pinus strobus / Vaccinium spp. Forest | White Pine / Blueberry Dry-mesic Forest | CEGL002444 | G3G4 |
| Acer saccharum - Tilia americana / Ostrya virginiana / Lonicera canadensis Forest | Northern Maple - Basswood Forest | CEGL002458 | G3? |
| Picea glauca - Abies balsamea / Acer spicatum / Rubus pubescens Forest | Spruce - Fir / Mountain Maple Forest | CEGL002446 | G4G5 |

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| --- | --- | --- | --- |
| Acer saccharum - Betula alleghaniensis - (Tilia americana) Forest | Maple - Yellow Birch Northern Hardwoods Forest | CEGL002457 | G3G4 |
| Pinus banksiana - Picea mariana / Vaccinium spp. / Pleurozium schreberi Forest | Jack Pine - Black Spruce / Feathermoss Forest | CEGL002448 | G5 |
| Thuja occidentalis / Abies balsamea - Acer spicatum Forest | White-cedar - Boreal Conifer Mesic Forest | CEGL002449 | G4 |
| Thuja occidentalis Cliff Woodland | White-cedar Cliff Woodland | CEGL002451 | G3 |
| Picea mariana / Alnus incana / Sphagnum spp. Forest | Black Spruce / Alder Rich Swamp | CEGL002452 | G5 |
| Thuja occidentalis - (Larix laricina) Seepage Forest | White-cedar Seepage Swamp | CEGL002455 | G3G4 |
| Pinus banksiana / Arctostaphylos uva-ursi Forest | Jack Pine / Bearberry Forest | CEGL002438 | G4G5 |
| Pinus strobus / Acer spicatum - Corylus cornuta Forest | White Pine / Mountain Maple Mesic Forest | CEGL002445 | G3G4 |
| Acer rubrum - Fraxinus spp. - Betula papyrifera / Cornus canadensis Forest | Red Maple - Ash - Birch Swamp Forest | CEGL002071 | G4 |
| Cornus sericea - Salix (bebbiana, discolor, petiolaris) / Calamagrostis stricta Shrubland | Dogwood - Mixed Willow Shrub Meadow | CEGL002187 | G3G4 |
| Cornus sericea - Salix spp. - (Rosa palustris) Shrubland | Dogwood - Willow Swamp | CEGL002186 | G5 |
| Quercus alba - Quercus macrocarpa - Quercus rubra / Corylus americana Woodland | North-Central Dry-mesic Oak Woodland | CEGL002142 | G3G4 |
| Quercus macrocarpa / Corylus cornuta Woodland | Northwestern Great Plains Bur Oak Woodland | CEGL002137 | G2G3 |
| Fraxinus nigra - Mixed Hardwoods - Conifers / Cornus sericea / Carex spp. Forest | Black Ash - Mixed Hardwood Swamp | CEGL002105 | G4 |
| Populus tremuloides - Populus balsamifera / Calamagrostis canadensis Forest | Aspen Prairie Lowland Forest | CEGL002097 | G3G4 |
| Fraxinus pennsylvanica - Ulmus americana - (Acer negundo, Tilia americana) Northern Forest | Northern Ash - Elm Floodplain Forest | CEGL002089 | G3G4 |
| Sandstone Moist Cliff Sparse Vegetation | Midwest Sandstone Moist Cliff | CEGL002287 | G4G5 |
| Quercus ellipsoidalis - (Quercus macrocarpa) Forest | Northern Pin Oak - (Bur Oak) Forest | CEGL002077 | G4? |
| Schizachyrium scoparium - Sorghastrum nutans - Andropogon gerardii - Lespedeza capitata Sand Herbaceous Vegetation | Midwest Dry-mesic Sand Prairie | CEGL002210 | G3 |
| Quercus alba - Quercus rubra - Carya ovata Glaciated Forest | Midwestern White Oak - Red Oak Forest | CEGL002068 | G4? |
| Populus tremuloides / Corylus americana Forest | Aspen / American Hazel Forest | CEGL002063 | G5 |
| Acer saccharum - Tilia americana / Ostrya virginiana - Carpinus caroliniana Forest | North-Central Maple - Basswood Forest | CEGL002062 | G3G4 |
| Riverine Sand Flats-Bars Sparse Vegetation | Riverine Sand Flats | CEGL002049 | G4G5 |
| Spartina pectinata - Calamagrostis stricta - Carex spp. Herbaceous Vegetation | Northern Cordgrass Wet Prairie | CEGL002027 | G3? |
| Scirpus tabernaemontani - Typha spp. - (Sparganium spp., Juncus spp.) Herbaceous Vegetation | Bulrush - Cattail - Burreed Shallow Marsh | CEGL002026 | G4G5 |

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|---|---|---|---|
| Quercus macrocarpa / Corylus americana - Amelanchier alnifolia Woodland | Bur Oak/Hazelnut Woodland | CEGL000556 | G3 |
| Northern Patterned Poor Fen Complex | Northern Patterned Poor Fen Complex | CECX002006 | G4 |
| Fraxinus pennsylvanica - Celtis occidentalis - Tilia americana - (Quercus macrocarpa) Forest | Ash - Elm - Mixed Lowland Hardwood Forest | CEGL002081 | G4? |
| Carex stricta - Carex spp. Herbaceous Vegetation | Tussock Sedge Wet Meadow | CEGL002258 | G4? |
| Lake Mud Flats Sparse Vegetation | Lake Mud Flats | CEGL002313 | G? |
| Inland Freshwater Strand Beach Sparse Vegetation | Inland Freshwater Strand Beach | CEGL002310 | G4G5 |
| Igneous/Metamorphic Cobble - Gravel River Shore Sparse Vegetation | Riverine Igneous/Metamorphic Cobble-gravel Shore | CEGL002304 | G4G5 |
| Igneous/Metamorphic Cobble - Gravel Inland Lake Shore Sparse Vegetation | Inland Lake Igneous/Metamorphic Cobble-gravel Shore | CEGL002303 | G4G5 |
| Sandstone Bedrock River Shore Sparse Vegetation | River Ledge Sandstone Pavement | CEGL002302 | G? |
| Igneous/Metamorphic Bedrock Inland Lake Shore Sparse Vegetation | Inland Lake Igneous/Metamorphic Bedrock Shore | CEGL002301 | G4G5 |
| Igneous Northern Dry Cliff Sparse Vegetation | Northern (Laurentian) Igneous/Metamorphic Dry Cliff | CEGL002300 | G? |
| Pinus strobus - (Pinus resinosa) - Quercus rubra Forest | White Pine - Red Oak Forest | CEGL002480 | G3 |
| Betula pumila - Salix spp. Prairie Fen Shrubland | Bog Birch - Willow Prairie Fen | CEGL002189 | G3 |
| Betula pumila - Pentaphylloides floribunda / Carex lasiocarpa - Eriophorum alpinum Shrubland | Bog Birch - Shrubby-cinquefoil Rich Boreal Fen | CEGL002495 | G3G5 |
| Populus tremuloides - Quercus (ellipsoidalis, macrocarpa) / Andropogon gerardii Shrubland | Aspen - Oak Scrub Barrens | CEGL002197 | G? |
| Carex rostrata - Carex lacustris - (Carex vesicaria) Herbaceous Vegetation | Northern Sedge Wet Meadow | CEGL002257 | G4G5 |
| Carex lacustris Herbaceous Vegetation | Lake Sedge Wet Meadow | CEGL002256 | G4G5 |
| Typha spp. Midwest Herbaceous Vegetation | Midwest Cattail Deep Marsh | CEGL002233 | G5 |
| Typha spp. - Scirpus acutus - Mixed Herbs Midwest Herbaceous Vegetation | Midwest Mixed Emergent Deep Marsh | CEGL002229 | G4? |
| Scirpus acutus - (Scirpus fluviatilis) Freshwater Herbaceous Vegetation | Freshwater Bulrush Marsh | CEGL002225 | G4G5 |
| Spartina pectinata - Carex spp. - Calamagrostis canadensis - Lythrum alatum - (Oxypolis rigidior) Herbaceous Vegetation | Central Cordgrass Wet Prairie | CEGL002224 | G3? |
| Schizachyrium scoparium - Bouteloua curtipendula Gravel Herbaceous Vegetation | Midwest Dry Gravel Prairie | CEGL002215 | G3 |
| River Mud Flats Sparse Vegetation | River Mud Flats | CEGL002314 | G? |
| Potamogeton spp. - Ceratophyllum spp. Midwest Herbaceous Vegetation | Midwest Pondweed Submerged Aquatic Wetland | CEGL002282 | G5 |
| Larix laricina / Chamaedaphne calyculata / Carex lasiocarpa Shrubland | Tamarack Scrub Poor Fen | CEGL005226 | G4G5 |

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|---|---|---|---|
| Tsuga canadensis - Acer saccharum - Betula alleghaniensis Forest | North Central Hemlock - Hardwood Forest | CEGL005044 | G4? |
| (Pinus strobus, Quercus rubra) / Danthonia spicata Acid Bedrock Wooded Herbaceous Vegetation | White Pine - Oak Acid Bedrock Glade | CEGL005101 | G3G4 |
| Pinus banksiana - Pinus resinosa - (Quercus ellipsoidalis) / Carex pensylvanica Wooded Herbaceous Vegetation | Jack Pine - Red Pine Barrens | CEGL005124 | G3G4 |
| Pentaphylloides floribunda / Carex sterilis - Andropogon gerardii - Arnoglossum plantagineum Shrub Herbaceous Vegetation | Cinquefoil - Sedge Prairie Fen | CEGL005139 | G3G4 |
| Pteridium aquilinum - Bromus kalmii Herbaceous Vegetation | Bracken Grassland | CEGL005142 | G? |
| Potamogeton zosteriformis - Ceratophyllum demersum - Elodea canadensis Southern Great Lakes Shore Herbaceous Vegetation | Southern Great Lakes Submergent Marsh | CEGL005152 | G3G4 |
| Thuja occidentalis - Fraxinus nigra Forest | White-cedar - Black Ash Swamp | CEGL005165 | G? |
| Pinus banksiana - (Picea mariana) - Mixed Hardwoods / Sphagnum spp. Forest | Jack Pine Swamp | CEGL005166 | G?Q |
| Calamagrostis canadensis - Phalaris arundinacea Herbaceous Vegetation | Bluejoint Wet Meadow | CEGL005174 | G4G5 |
| Tsuga canadensis - Fagus grandifolia - (Acer saccharum) Great Lakes Forest | Great Lakes Hemlock - Beech - Hardwood Forest | CEGL005042 | G4G5 |
| Thuja occidentalis - Larix laricina / Sphagnum spp. Forest | White-cedar - Tamarack Peat Swamp | CEGL005225 | G? |
| Picea mariana - (Larix laricina) / Ledum groenlandicum / Sphagnum spp. Forest | Black Spruce - (Tamarack) / Labrador Tea Poor Swamp | CEGL005271 | G5 |
| Chamaedaphne calyculata - Myrica gale / Carex lasiocarpa Dwarf-shrubland | Leatherleaf-Sweetgale Shore Fen | CEGL005228 | G4G5 |
| Carex lasiocarpa - (Carex rostrata) - Equisetum fluviatile Herbaceous Vegetation | Wiregrass Sedge Shore Fen | CEGL005229 | G? |
| Boreal Glaciere Talus Sparse Vegetation | Glaciere Talus | CEGL005243 | G2G3 |
| Quercus ellipsoidalis - Quercus macrocarpa - (Pinus banksiana) Rocky Woodland | Boreal Oak - (Pine) Rocky Woodland | CEGL005246 | G? |
| Carex oligosperma - Carex pauciflora - Eriophorum vaginatum / Sphagnum spp. Herbaceous Vegetation | Open Graminoid / Sphagnum Bog | CEGL005256 | G4G5 |
| Equisetum fluviatile - (Eleocharis smallii) Herbaceous Vegetation | Water Horsetail-Spikerush Marsh | CEGL005258 | G4 |
| Chamaedaphne calyculata / Carex oligosperma / Sphagnum spp. Poor Fen Dwarf-shrubland | Leatherleaf Poor Fen | CEGL005277 | G5 |
| Pinus strobus - Quercus alba / (Corylus americana, Gaylussacia baccata) Forest | White Pine - White Oak Sand Forest | CEGL002481 | G3 |
| Quercus velutina - (Quercus alba) - Quercus ellipsoidalis / Schizachyrium scoparium - Lupinus perennis Wooded Herbaceous Vegetation | Black Oak / Lupine Barrens | CEGL002492 | G3 |
| Picea mariana / Chamaedaphne calyculata / Sphagnum spp. Dwarf-shrubland | Black Spruce/Leatherleaf Semi-treed Bog | CEGL005218 | G4G5 |

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|---|---|---|---|
| Betula pumila / Chamaedaphne calyculata / Carex lasiocarpa Shrubland | Bog Birch-Leatherleaf Rich Fen | CEGL002494 | G4G5 |
| Chamaedaphne calyculata - Ledum groenlandicum - Kalmia polifolia Bog Dwarf-shrubland | Leatherleaf Bog | CEGL005278 | G5 |
| Pinus strobus - (Acer rubrum) / Osmunda spp. Forest | White Pine - Red Maple Swamp | CEGL002482 | G3G4 |
| Pinus banksiana - (Picea mariana, Pinus strobus) / Vaccinium spp. Rocky Woodland | Boreal Pine Rocky Woodland | CEGL002483 | G4? |
| Picea mariana / Ledum groenlandicum / Carex trisperma / Sphagnum spp. Forest | Black Spruce Bog | CEGL002485 | G5 |
| Populus tremuloides - (Populus grandidentata) Rocky Woodland | Mixed Aspen Rocky Woodland | CEGL002487 | G? |
| Acer (rubrum, saccharinum) - Fraxinus spp. - Ulmus americana Forest | Maple-Ash-Elm Swamp Forest | CEGL005038 | G4? |
| Pinus banksiana - Pinus strobus - (Quercus rubra) / Cladina spp. Nonvascular Vegetation | Mixed Pine - (Oak) Igneous/Metamorphic Rock Outcrop | CEGL002491 | G3G5 |
| Pinus banksiana - Pinus resinosa / Quercus ellipsoidalis Woodland | Jack Pine - Red Pine / Scrub Oak Woodland | CEGL002484 | G3G4 |
| Carex lasiocarpa - Carex buxbaumii - Scirpus cespitosus Boreal Herbaceous Vegetation | Boreal Sedge Rich Fen | CEGL002500 | G4G5 |
| Pinus banksiana - Populus tremuloides / Diervilla lonicera Forest | Jack Pine-Aspen/Bush Honeysuckle Forest | CEGL002518 | G4G5 |
| Acer saccharum - Fagus grandifolia - Betula spp. / Maianthemum canadense Forest | Beech - Maple - Northern Hardwoods Forest | CEGL005004 | G4G5 |
| Nymphaea odorata - Nuphar lutea (ssp. pumila, ssp. variegata) Herbaceous Vegetation | Northern Water Lily Aquatic Wetland | CEGL002562 | G5 |
| Nymphaea tetragona - Nuphar lutea (ssp. pumila, ssp. variegata) Herbaceous Vegetation | Boreal Water Lily Aquatic Wetland | CEGL002563 | G4G5 |
| Acer saccharinum - Ulmus americana - (Populus deltoides) Forest | Silver Maple - Elm - (Cottonwood) Forest | CEGL002586 | G4? |
| Pinus strobus - Tsuga canadensis Great Lakes Forest | Great Lakes White Pine - Hemlock Forest | CEGL002590 | G3? |
| Thuja occidentalis - (Betula alleghaniensis, Tsuga canadensis) Forest | White-cedar - (Hemlock) Mesic Forest | CEGL002595 | G3? |
| Tsuga canadensis - (Betula alleghaniensis) Forest | Hemlock Mesic Forest | CEGL002598 | G3G4 |
| Tsuga canadensis - Betula alleghaniensis Saturated Forest | Hemlock - Yellow Birch Swamp Wet-mesic Forest | CEGL005003 | G3 |
| Pinus resinosa - Populus tremuloides / Diervilla lonicera - Vaccinium spp. Forest | Red Pine-Aspen-Birch Forest | CEGL002520 | G? |
| Acer saccharum - Fraxinus spp. - Tilia americana / Osmorhiza claytonii - Caulophyllum thalictroides Forest | Sugar Maple - Ash - Basswood Rich Mesic Forest | CEGL005008 | G? |
| Acer saccharum - Pinus strobus / Acer pensylvanicum Forest | Sugar Maple - White Pine Forest | CEGL005005 | G? |

# 14 APPENDIX E. Priority Bird Areas of the Superior Mixed Forest.

The following list contains the priority bird areas within the Superior Mixed Forest identified in "Great Lakes bird ecoregional planning: A final report" by Ewert (1999). The complete report and a list of all priority bird areas can be viewed at *www.conserveonline.org*. A "*" indicates that the conservation area was not included in the suite of conservation areas because of limited contribution to goals for other species. The area should be considered for future iterations of ecoregional planning.

**Site: Bear Lake Sedge Meadow**
**Conservation Priority Area: Nemadji Peatlands**

| | |
|---|---|
| LeConte's Sparrow: | 30-40 |

**Site: Black Lake/Belden Swamp**
**Conservation Priority Area: Nemadji Peatlands**

| | |
|---|---|
| Black-throated Blue Warbler: | 10-20 |
| LeConte's Sparrow: | 40-50 |
| Sedge Wren: | 50-60 |
| American Woodcock: | >25 |
| Eastern Wood-pewee: | >25 |
| Least Flycatcher: | >25 |
| Rose-breasted Grosbeak: | >25 |
| Whip-poor-will: | >25 |

**Site: Brule Jack Pines**
**Conservation Priority Area: Upper St. Croix**

| | |
|---|---|
| Red-headed Woodpecker: | 10 |
| Sedge Wren: | 10 |

**Site: Crex Meadows**
**Conservation Priority Area: Fish Lake/Crex Meadows**

| | |
|---|---|
| Grasshopper Sparrow: | 5-10 |
| LeConte's Sparrow: | 50 |
| Sedge Wren: | >200 |
| Trumpeter Swan: | 4 |
| American Woodcock: | >25 |
| Baltimore Oriole: | >25 |
| Eastern Wood-pewee: | >25 |
| Hooded Merganser: | >25 |
| Least Flycatcher: | >25 |
| Northern Harrier: | >25 |
| Rose-breasted Grosbeak: | >25 |
| Whip-poor-will: | >25 |

**Site: Deerskin River**
**Conservation Priority Area: Not within CPA***

| | |
|---|---|
| Black-throated Blue Warbler: | >50 |
| Sedge Wren: | 10 |

**Site: Fence River**
**Conservation Priority Area: Not within CPA***

| | |
|---|---|
| Black-throated Blue Warbler: | 25 |
| Sedge Wren: | 25 |
| Hooded Merganser: | 25 |
| Least Flycatcher: | 500 |
| Olive-sided Flycatcher: | 25 |
| Rose-breasted Grosbeak: | 200 |
| Veery: | 200 |

**Site: Fish Lake**
**Conservation Priority Area: Fish Lake/Crex Meadows**

| | |
|---|---|
| Grasshopper Sparrow: | 5-10 |
| LeConte's Sparrow: | 25 |
| Sedge Wren: | >200 |
| Trumpeter Swan: | 2-3 |
| American Woodcock: | >25 |
| Baltimore Oriole: | >25 |
| Eastern Wood-pewee: | >25 |
| Hooded Merganser: | >25 |
| Least Flycatcher: | >25 |
| Rose-breasted Grosbeak: | >25 |
| Whip-poor-will: | >25 |

**Site: George Mead**
**Conservation Priority Area: Not within CPA***

| | |
|---|---|
| Cerulean Warbler: | 5-10 |
| Greater Prairie Chicken: | 79 |
| Sedge Wren: | 25 |
| Trumpeter Swan: | 1 |

**Site: Headwaters Wilderness**
**Conservation Priority Area: Pine, Popple & Peshtigo Headwaters**

| | |
|---|---|
| Sedge Wren: | <10 |
| Baltimore Oriole: | >25 |
| Eastern Wood-pewee: | >25 |
| Least Flycatcher: | >25 |
| Olive-sided Flycatcher: | >25 |
| Rose-breasted Grosbeak: | >25 |
| Veery: | >25 |
| Whip-poor-will: | >25 |

**Site: Lost Lake**
**Conservation Priority Area: Pine, Popple & Peshtigo Headwaters**

| | |
|---|---|
| Black-throated Blue Warbler: | 500 |
| Sedge Wren: | 5 |

**Site: Manitowish Wetlands**
**Conservation Priority Area: Northern Highlands**

| | |
|---|---|
| Black-throated Blue Warbler: | >5 |
| LeConte's Sparrow: | 25 |
| Sedge Wren: | >100 |
| American Woodcock: | >25 |
| Eastern Wood-pewee: | >25 |
| Hooded Merganser: | >25 |
| Least Flycatcher: | >25 |
| Rose-breasted Grosbeak: | >25 |

**Site: Menominee**
**Conservation Priority Area: Wolf River Headwaters**

| | |
|---|---|
| Black-throated Blue Warbler: | >1,000 |
| American Woodcock: | >25 |
| Baltimore Oriole: | >25 |
| Eastern Wood-pewee: | >25 |
| Hooded Merganser: | >25 |
| Hooded Warbler: | >25 |
| Least Flycatcher: | >25 |
| Olive-sided Flycatcher: | >25 |
| Rose-breasted Grosbeak: | >25 |
| Veery: | >25 |
| Whip-poor-will: | >25 |

**Site: Michigamme**
**Conservation Priority Area: Not within CPA***

| | |
|---|---|
| Black-throated Blue Warbler: | 25 |
| Sedge Wren: | 25 |
| Hooded Merganser: | 25 |
| Least Flycatcher: | 300 |
| Veery: | 100 |

**Site: Moose River Forested Wetlands**
**Conservation Priority Area: Chippewa River Headwaters**

| | |
|---|---|
| Black-throated Blue Warbler: | 10-20 |
| Sedge Wren: | 10 |
| American Woodcock: | >25 |
| Baltimore Oriole: | >25 |
| Eastern Wood-pewee: | >25 |
| Least Flycatcher: | >25 |
| Olive-sided Flycatcher: | >25 |
| Rose-breasted Grosbeak: | >25 |
| Veery: | >25 |
| Whip-poor-will: | >25 |

**Site: Mt. Whittlesey**
**Conservation Priority Area: Chequamegon Bay Watershed**

| | |
|---|---|
| Black-throated Blue Warbler: | >25 |

**Site: Namekagon Barrens**
**Conservation Priority Area: Upper St. Croix**

| | |
|---|---|
| Grasshopper Sparrow: | 30-40 |
| Sedge Wren: | 5-10 |
| Northern Harrier: | >25 |
| Whip-poor-will: | >25 |

**Site: Paul Olson**
**Conservation Priority Area: Black River-Meadow Valley**

| | |
|---|---|
| Greater Prairie Chicken: | 129 |
| Grasshopper Sparrow: | X |
| Henslow's Sparrow: | X |
| Sedge Wren: | X |

**Site: St. Croix/Cedar Bend**
**Conservation Priority Area: Lower St. Croix**

| | |
|---|---|
| Cerulean Warbler: | 20-30 |
| Grasshopper Sparrow: | 5-10 |
| Red-headed Woodpecker: | 10-15 |
| Sedge Wren: | 30-40 |

**Site: Sylvania**
**Conservation Priority Area: Presque Isle & Ontonagon Rivers**

| | |
|---|---|
| Black-throated Blue Warbler: | >25 |

**Site: Upper Peshtigo River**
**Conservation Priority Area: Pine, Popple & Peshtigo Headwaters**

| | |
|---|---|
| Black-throated Blue Warbler: | 50-100 |
| Sedge Wren: | 5-10 |

## 15 APPENDIX F. Terrestrial Conservation Areas.

Note: Due to the length of these summaries, they are not included in the printed version. They are available electronically only.

These reports are available in a file named "SMF Terrestrial Reports.pdf" or by **clicking here**. In this report, the first item in the Bookmarks to the left is "Returnt to Superior Mixed Forest Ecoregional Plan". Clicking on that item will return you here.

To view a full page map of the Superior Mixed Forest Ecoregion Conservation Areas **click here**.

## 16 APPENDIX G. Aquatic Conservation Areas.

Note: Due to the length of these summaries, they are not included in the printed version. They are available electronically only.

These reports are available in a file named "SMF Aquatic Reports.pdf" or by **clicking here**. In this report, the first item in the Bookmarks to the left is "Returnt to Superior Mixed Forest Ecoregional Plan". Clicking on that item will return you here.

The Great Lakes Ecoregion Plan Aquatic Sites within the Superior Mixed Forest Ecoregion are also included in this appendix.

# 17 APPENDIX H. Goal Status for Terrestrial Ecological Systems

## Terrestrial Ecological System Target Occurences Captured within Conservation Areas by Section

| Scientific/Global Name | Common Name | Global Code | Target Goal Evaluation † | Lake of the Woods | N MN and ONT Peatlands | Northern Minnesota Drift and Lake Plains | Northern Superior Uplands | Southern Superior Uplands | Thunder Bay / Quetico | Western Superior Uplands |
|---|---|---|---|---|---|---|---|---|---|---|
| | Patterned Peatland Complex | ECOGRP0003 | Met 2 | 2 | 4 | 1* | 1* | 0 | 1* | 0 |
| | Mesic Jack Pine and Black Spruce Forests | ECOGRP0022 | Met 2 | 1* | 2 | 0 | 2 | 0 | 2 | 0 |
| | Hemlock-Hardwood Forests | ECOGRP0024 | Met 1 | NIS** | NIS** | NIS** | NIS** | 8 | NIS** | 2 |
| | White Spruce-Fir Forests | ECOGRP0026 | Met 2 | 4 | 2 | 0 | 2 | 0 | 1* | 4 |
| | Northern Hardwood Forests | ECOGRP0028 | Met 2 | 0 | 1* | 4 | 0 | 8 | 1* | 7 |
| | Shrub/Graminoid Bogs | ECOGRP0002 | Met 2 | 4 | 3 | 0 | 1* | 5 | 3 | 6 |
| | Rich Conifer Swamps | ECOGRP0012 | Met 2 | 1* | 4 | 2 | 1* | 13 | 3 | 6 |
| | Hardwood Swamps | ECOGRP0013 | Met 1 | 8 | 6 | 3 | 2 | 7 | 2 | 8 |
| | Rich Shrub Swamps | ECOGRP0014 | Met 2 | 6 | 3 | 2 | 2 | 1* | 3 | 5 |
| | Pine-Spruce Rocky Forests | ECOGRP0020 | Met 1 | 3 | 1* | NIS** | 1* | NIS** | 2 | NIS** |
| | Jack Pine-Mixed Pine Sandplain Forests | ECOGRP0021 | Met 2 | 2 | 2 | 6 | 0 | 1 | 1* | 2 |

† Conservation goals for terrestrial ecological system, plant community, and primary species targets are 2 occurrences per ecological section, and at least 10 occurrences rangewide; goal for aquatic ecological system targets is 1 occurrence per Ecological Drainage Unit.

*Goal Met 1*: The conservation goal for this target was met or exceeded.
*Goal Met 2*: There is a 95% or greater likelihood that the goal is actually met. The goal appears to be unmet due to the inability to map individual occurrences or due to lack of inventory. For example, most ecological systems were only tracked once per conservation area, but the majority of the conservation areas support numerous occurrences of the large and small patch types, and often more than one occurrence of matrix-forming systems.
*Goal Unmet 1*: All known viable occurrences of the target are included within the portfolio. It is unclear whether or not additional inventory will identify more occurrences. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 3*: There are no known viable occurrences in at least one section in which it is known to occur.

* = Only one target occurrence has been recorded for this section, and it is captured in a conservation area.
NIS** = Target does not occur in section; this section is not a part of the target's range and not counted toward the goal evaluation.
"0" indicates that the target is present in the section, but not captured within any of the conservation areas.

## Terrestrial Ecological System Target Occurences Captured within Conservation Areas by Section

| Scientific/Global Name | Common Name | Global Code | Target Goal Evaluation † | Lake of the Woods | N MN and ONT Peatlands | Northern Minnesota Drift and Lake Plains | Northern Superior Uplands | Southern Superior Uplands | Thunder Bay / Quetico | Western Superior Uplands |
|---|---|---|---|---|---|---|---|---|---|---|
| | White Pine-Red Pine Forests | ECOGRP0023 | Met 1 | 4 | 3 | 5 | 2 | 8 | 3 | 7 |
| | Aspen-Birch Forests | ECOGRP0027 | Met 1 | 2 | 5 | 6 | 2 | 5 | 2 | 7 |
| | Dry Oak Forests | ECOGRP0029 | Met 2 | NIS** | NIS** | 4 | NIS** | 4 | NIS** | 6 |
| | Oak and Oak-Maple Forests | ECOGRP0030 | Met 2 | 2 | NIS** | 0 | 1* | 8 | 0 | 1* |
| | Midwestern Hardwood Forests | ECOGRP0031 | Met 2 | NIS** | NIS** | 2 | NIS** | 1* | NIS** | 6 |
| | Aspen Parkland Forests and Woodlands | ECOGRP0032 | Unmet 3 | NIS** | 0 | 0 | NIS** | NIS** | NIS** | NIS** |
| | Northern Great Plains Bur Oak Forests and Woodlands | ECOGRP0033 | Unmet 1 | 1* | 0 | 0 | NIS** | NIS** | NIS** | NIS** |
| | Great Lakes Pine Barrens | ECOGRP0034 | Met 1 | NIS** | NIS** | 3 | NIS** | 1 | NIS** | 4 |
| | Sand and Gravel Tallgrass Prairies | ECOGRP0037 | Unmet 1 | 3 | 1* | 2 | NIS** | 0 | NIS** | 0 |
| | Conifer Bogs and Poor Swamps | ECOGRP0001 | Met 1 | 4 | 4 | 3 | 2 | 8 | 3 | 11 |

† Conservation goals for terrestrial ecological system, plant community, and primary species targets are 2 occurrences per ecological section, and at least 10 occurrences rangewide; goal for aquatic ecological system targets is 1 occurrence per Ecological Drainage Unit.

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*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 3*: There are no known viable occurrences in at least one section in which it is known to occur.

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"0" indicates that the target is present in the section, but not captured within any of the conservation areas.

## Terrestrial Ecological System Target Occurences Captured within Conservation Areas by Section

| Scientific/Global Name | Common Name | Global Code | Target Goal Evaluation † | Lake of the Woods | N MN and ONT Peatlands | Northern Minnesota Drift and Lake Plains | Northern Superior Uplands | Southern Superior Uplands | Thunder Bay / Quetico | Western Superior Uplands |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rich Fens | ECOGRP0004 | Met 2 | 3 | 1* | 1* | 0 | 1 | 2 | 3 |
| | Poor Fens | ECOGRP0005 | Met 2 | 4 | 1* | 2 | 0 | 1* | 3 | 5 |
| | Shore Fens | ECOGRP0006 | Met 2 | 3 | 1* | 0 | 0 | 0 | 3 | 0 |
| | Rich Prairie Fens | ECOGRP0007 | Unmet 3 | NIS** | 0 | 0 | NIS** | 0 | NIS** | 0 |
| | Seepage Meadows | ECOGRP0008 | Unmet 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Open and Emergent Marshes | ECOGRP0009 | Met 2 | 8 | 2 | 3 | 1* | 4 | 0 | 5 |
| | Wet Meadows | ECOGRP0010 | Met 2 | 2 | 1* | 2 | 1* | 0 | 3 | 5 |
| | Wet Prairies | ECOGRP0011 | Unmet 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Acid Rock Outcrops/Barrens | ECOGRP0016 | Met 2 | 4 | 1* | NIS** | 0 | 5 | 2 | 2 |
| | Alkaline Cliffs | ECOGRP0017 | Met 2 | 1* | NIS** | NIS** | NIS** | 0 | 1* | NIS** |
| | Acid Cliffs | ECOGRP0018 | Met 2 | 3 | 1* | NIS** | 0 | 4 | 0 | 1* |
| | Acid Talus | ECOGRP0019 | Met 2 | 1* | 1* | NIS** | 0 | 1* | 0 | NIS** |

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*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
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"0" indicates that the target is present in the section, but not captured within any of the conservation areas.

## Terrestrial Ecological System Target Occurences Captured within Conservation Areas by Section

| Scientific/Global Name | Common Name | Global Code | Target Goal Evaluation † | Lake of the Woods | N MN and ONT Peatlands | Northern Minnesota Drift and Lake Plains | Northern Superior Uplands | Southern Superior Uplands | Thunder Bay / Quetico | Western Superior Uplands |
|---|---|---|---|---|---|---|---|---|---|---|
| | White Cedar-Hardwood Forests | ECOGRP0025 | Met 2 | 3 | 2 | 1* | 1* | 1* | 3 | 1* |
| | Deep Soil Oak Savannas | ECOGRP0035 | Unmet 1 | 1* | NIS** | NIS** | NIS** | 0 | NIS** | NIS** |
| | Sand Oak Savannas/Barrens | ECOGRP0036 | Unmet 3 | NIS** | 0 | 0 | NIS** | 0 | NIS** | 0 |
| | Floodplain Forests | ECOGRP0015 | Met 2 | 3 | 1* | 0 | NIS** | 7 | NIS** | 2 |

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*Goal Met 2*: There is a 95% or greater likelihood that the goal is actually met. The goal appears to be unmet due to the inability to map individual occurrences or due to lack of inventory. For example, most ecological systems were only tracked once per conservation area, but the majority of the conservation areas support numerous occurrences of the large and small patch types, and often more than one occurrence of matrix-forming systems.
*Goal Unmet 1*: All known viable occurrences of the target are included within the portfolio. It is unclear whether or not additional inventory will identify more occurrences. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
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## 18 APPENDIX I. Conservation Area Patch Analysis.

Note: Due to the length of these summaries, they are not included in the printed version. They are available electronically only.

The patch analysis was completed to assist team members in identifying occurrences of terrestrial ecological systems in each conservation area and to provide a summary of land cover for each conservation area. An ArcView script was developed to calculate land cover statistics for each conservation area. The statistics summarized the area and percent area occupied by each land cover class present in the conservation area, as well as the minimum, maximum, and average patch size of each land cover class present. Patches were defined as clusters of grid cells of the same cover type that connect to each other only on their sides, not on their corners.

Land cover data sets are available according to political jurisdictions. Some land cover layers extend slightly into the adjoining jurisdiction; for example, Minnesota's land cover layer extends a small and consistent distance into Wisconsin, Ontario, and Manitoba. For the purposes of these general assessments, land cover layers were not clipped to political boundaries. Some conservation areas cross political jurisdictions. In such conservation areas, two patch analyses were completed, one for each jurisdiction. As a result of the overlap, there is a slight redundancy in the information summarized in those patch analyses conducted for areas crossing political boundaries. For example, if someone summed the acreages of open water from the two sets of results from the Border Lakes conservation area (in Ontario and Minnesota), that total would be slightly larger than the actual total area of water in the Border Lakes conservation area.

The following patch analysis reports are sorted by state/province, then by conservation area name.

These reports are available in a file named "SMF Patch Analysis Reports.pdf" or by **clicking here**. In this report, the first item in the Bookmarks to the left is "Returnt to Superior Mixed Forest Ecoregional Plan". Clicking on that item will return you here.

# 19 APPENDIX J. Goal Status for Aquatic Ecological Systems.

## Aquatic Ecological Systems Target Occurrences Captured within Conservation Areas by Ecological Drainage Units

| | | | BASIN | Chippewa River | | Mississippi River Headwaters | | Rainy River | | Red River | | St. Croix River | | Wisconsin River |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common Name | Global Code | Target Goal Evaluation † | EDU | Chippewa River | Upper Mississippi Chippewa | Mississipp iHead-waters | Upper Mississippi Outwash plains | Rainy River | Rainy Head-waters | Red River | Lower Red River | St Croix River | Lower St Croix | Upper Wisconsin |
| surface mixed / stream / stream / medium-high relief / no surface storage | 21120 | Met 1 | | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** |
| surface mixed / river / stream / low relief / surface storage | 22111 | Unmet 3 | | 3 | NIS** | NIS** | NIS** | 2 | NIS** | NIS** | 0 | 2 | NIS** | NIS** |
| surface mixed / stream / lake / medium-high relief / surface storage | 21321 | Met 1 | | NIS** | NIS** | NIS** | NIS** | NIS** | 2 | NIS** | NIS** | NIS** | NIS** | NIS** |
| surface mixed / stream / lake / low relief / surface storage | 21311 | Met 1 | | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** | 1 | NIS** | NIS** | NIS** |
| surface mixed / stream / large river / medium-high relief / surface storage | 21221 | Met 1 | | 5 | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** |
| surface mixed / stream / large river / medium-high relief / no surface storage | 21220 | Unmet 3 | | 0 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1 |

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*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 3*: There are no known viable occurrences in at least one section in which it is known to occur.

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NIS** = Target does not occur in section; this section is not a part of the target's range and not counted toward the goal evaluation.
"0" indicates that the target is present in the section, but not captured within any of the conservation areas.

## Aquatic Ecological Systems Target Occurrences Captured within Conservation Areas by Ecological Drainage Units

| | | | BASIN | Chippewa River | | Mississippi River Headwaters | | Rainy River | | Red River | | St. Croix River | | Wisconsin River |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common Name | Global Code | Target Goal Evaluation † | EDU | Chippewa River | Upper Mississippi Chippewa | Mississipp iHead-waters | Upper Mississippi Outwash plains | Rainy River | Rainy Head-waters | Red River | Lower Red River | St Croix River | Lower St Croix | Upper Wisconsin |
| surface mixed / stream / large river / low relief / surface storage | 21211 | Unmet 3 | | 5 | NIS** | 1 | 0 | 1 | NIS** | NIS** | NIS** | 1 | 0 | 1 |
| surface / stream / stream / medium-high relief / surface storage | 11121 | Met 1 | | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** |
| surface mixed / stream / stream / medium-high relief / surface storage | 21121 | Met 1 | | 1 | NIS** | 1 | NIS** | 1 | 1 | NIS** | NIS** | 2 | NIS** | NIS** |
| surface mixed / river / large river / low relief / surface storage | 22211 | Met 1 | | 1 | 1 | 4 | NIS** | 2 | NIS** | NIS** | NIS** | 2 | NIS** | 1 |
| surface mixed / stream / stream / low relief / surface storage | 21111 | Met 1 | | NIS** | NIS** | 4 | NIS** | 3 | NIS** | NIS** | NIS** | 3 | NIS** | 2 |
| surface / river / lake / medium-high relief / surface storage | 12321 | Met 1 | | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** |

† Conservation goals for terrestrial ecological system, plant community, and primary species targets are 2 occurrences per ecological section, and at least 10 occurrences rangewide; goal for aquatic ecological system targets is 1 occurrence per Ecological Drainage Unit.

*Goal Met 1*: The conservation goal for this target was met or exceeded.
*Goal Met 2*: There is a 95% or greater likelihood that the goal is actually met. The goal appears to be unmet due to the inability to map individual occurrences or due to lack of inventory. For example, most ecological systems were only tracked once per conservation area, but the majority of the conservation areas support numerous occurrences of the large and small patch types, and often more than one occurrence of matrix-forming systems.
*Goal Unmet 1*: All known viable occurrences of the target are included within the portfolio. It is unclear whether or not additional inventory will identify more occurrences. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 3*: There are no known viable occurrences in at least one section in which it is known to occur.

* = Only one target occurrence has been recorded for this section, and it is captured in a conservation area.
NIS** = Target does not occur in section; this section is not a part of the target's range and not counted toward the goal evaluation.
"0" indicates that the target is present in the section, but not captured within any of the conservation areas.

## Aquatic Ecological Systems Target Occurrences Captured within Conservation Areas by Ecological Drainage Units

| | | | BASIN | Chippewa River | | Mississippi River Headwaters | | Rainy River | | Red River | | St. Croix River | | Wisconsin River |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common Name | Global Code | Target Goal Evaluation † | EDU | Chippewa River | Upper Mississippi Chippewa | Mississipp iHead-waters | Upper Mississippi Outwash plains | Rainy River | Rainy Head-waters | Red River | Lower Red River | St Croix River | Lower St Croix | Upper Wisconsin |
| surface / river / lake / low relief / surface storage | 12311 | Met 1 | | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** |
| surface / river / large river / low relief / surface storage | 12211 | Unmet 3 | | NIS** | 0 | 0 | 0 | NIS** | NIS** | NIS** | 1 | NIS** | 1 | 1 |
| surface / stream / lake / medium-high relief / surface storage | 11321 | Unmet 3 | | NIS** | NIS** | NIS** | NIS** | NIS** | 0 | NIS** | NIS** | NIS** | NIS** | NIS** |
| surface / stream / river / medium-high relief / surface storage | 11221 | Met 1 | | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** |
| surface / stream / river / low relief / surface storage | 11211 | Unmet 3 | | NIS** | 0 | 0 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** |
| surface mixed / stream / large river / low relief / no surface storage | 21210 | Unmet 3 | | 1 | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | 0 |

† Conservation goals for terrestrial ecological system, plant community, and primary species targets are 2 occurrences per ecological section, and at least 10 occurrences rangewide; goal for aquatic ecological system targets is 1 occurrence per Ecological Drainage Unit.

*Goal Met 1*: The conservation goal for this target was met or exceeded.
*Goal Met 2*: There is a 95% or greater likelihood that the goal is actually met. The goal appears to be unmet due to the inability to map individual occurrences or due to lack of inventory. For example, most ecological systems were only tracked once per conservation area, but the majority of the conservation areas support numerous occurrences of the large and small patch types, and often more than one occurrence of matrix-forming systems.
*Goal Unmet 1*: All known viable occurrences of the target are included within the portfolio. It is unclear whether or not additional inventory will identify more occurrences. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
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"0" indicates that the target is present in the section, but not captured within any of the conservation areas.

## Aquatic Ecological Systems Target Occurrences Captured within Conservation Areas by Ecological Drainage Units

| | | | **BASIN** | Chippewa River | | Mississippi River Headwaters | | Rainy River | | Red River | | St. Croix River | | Wisconsin River |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common Name | Global Code | Target Goal Evaluation † | **EDU** | Chippewa River | Upper Mississippi Chippewa | Mississipp iHead-waters | Upper Mississippi Outwash plains | Rainy River | Rainy Head-waters | Red River | Lower Red River | St Croix River | Lower St Croix | Upper Wisconsin |
| groundwater mixed / stream / stream / low relief / surface storage | 31111 | Met 1 | | NIS** | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** |
| groundwater mixed / river / large river / medium-high relief / no surface storage | 32220 | Met 1 | | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** |
| groundwater mixed / river / large river / low relief / surface storage | 32211 | Met 1 | | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** |
| groundwater mixed / river / stream / medium-high relief / surface storage | 32121 | Met 1 | | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** |
| groundwater mixed / river / stream / low relief / surface storage | 32111 | Met 1 | | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | 2 |
| groundwater mixed / stream / lake / low relief / surface storage | 31311 | Met 1 | | NIS** | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** |

† Conservation goals for terrestrial ecological system, plant community, and primary species targets are 2 occurrences per ecological section, and at least 10 occurrences rangewide; goal for aquatic ecological system targets is 1 occurrence per Ecological Drainage Unit.

*Goal Met 1*: The conservation goal for this target was met or exceeded.

*Goal Met 2*: There is a 95% or greater likelihood that the goal is actually met. The goal appears to be unmet due to the inability to map individual occurrences or due to lack of inventory. For example, most ecological systems were only tracked once per conservation area, but the majority of the conservation areas support numerous occurrences of the large and small patch types, and often more than one occurrence of matrix-forming systems.

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*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.

*Goal Unmet 3*: There are no known viable occurrences in at least one section in which it is known to occur.

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## Aquatic Ecological Systems Target Occurrences Captured within Conservation Areas by Ecological Drainage Units

| | | **BASIN** | Chippewa River | | Mississippi River Headwaters | | Rainy River | | Red River | | St. Croix River | | Wisconsin River |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common Name | Global Code | Target Goal Evaluation † / **EDU** | Chippewa River | Upper Mississippi Chippewa | Mississippi Head-waters | Upper Mississippi Outwash plains | Rainy River | Rainy Head-waters | Red River | Lower Red River | St Croix River | Lower St Croix | Upper Wisconsin |
| groundwater mixed / stream / large river / medium-high relief / surface storage | 31221 | Met 1 | 2 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | 2 |
| groundwater mixed / stream / large river / low relief / surface storage | 31211 | Unmet 3 | 4 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 0 |
| surface mixed / river / stream / medium-high relief / surface storage | 22121 | Unmet 3 | 0 | NIS** | NIS** | NIS** | 2 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** |
| groundwater mixed / stream / stream / medium-high relief / surface storage | 31121 | Met 1 | NIS** | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | 2 |
| surface mixed / river / large river / low relief / no surface storage | 22210 | Met 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 3 |
| groundwater mixed / stream / stream / low relief / no surface storage | 31110 | Met 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** |

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*Goal Met 1*: The conservation goal for this target was met or exceeded.
*Goal Met 2*: There is a 95% or greater likelihood that the goal is actually met. The goal appears to be unmet due to the inability to map individual occurrences or due to lack of inventory. For example, most ecological systems were only tracked once per conservation area, but the majority of the conservation areas support numerous occurrences of the large and small patch types, and often more than one occurrence of matrix-forming systems.
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*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 3*: There are no known viable occurrences in at least one section in which it is known to occur.

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NIS** = Target does not occur in section; this section is not a part of the target's range and not counted toward the goal evaluation.
"0" indicates that the target is present in the section, but not captured within any of the conservation areas.

## Aquatic Ecological Systems Target Occurrences Captured within Conservation Areas by Ecological Drainage Units

| | | BASIN | Chippewa River | | Mississippi River Headwaters | | Rainy River | | Red River | | St. Croix River | | Wisconsin River |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common Name | Global Code | Target Goal Evaluation † / EDU | Chippewa River | Upper Mississippi Chippewa | Mississipp iHead-waters | Upper Mississippi Outwash plains | Rainy River | Rainy Head-waters | Red River | Lower Red River | St Croix River | Lower St Croix | Upper Wisconsin |
| surface mixed / river / lake / medium-high relief / surface storage | 22321 | Met 1 | NIS** | NIS** | 2 | NIS** | NIS** | 2 | NIS** | 1 | NIS** | NIS** | NIS** |
| surface mixed / river / lake / low relief / surface storage | 22311 | Unmet 3 | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | NIS** | 0 | NIS** | NIS** | NIS** |
| surface mixed / river / large river / low relief / no surface storage | 22310 | Met 1 | NIS** | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** |
| surface mixed / river / large river / medium-high relief / surface storage | 22221 | Unmet 3 | 0 | NIS** | 1 | NIS** | NIS** | NIS** | NIS** | NIS** | 9 | NIS** | 4 |
| surface mixed / river / large river / medium-high relief / no surface storage | 22220 | Unmet 3 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 0 |
| groundwater mixed / river / large river / medium-high relief / surface storage | 32221 | Met 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1 | NIS** | 2 |

† Conservation goals for terrestrial ecological system, plant community, and primary species targets are 2 occurrences per ecological section, and at least 10 occurrences rangewide; goal for aquatic ecological system targets is 1 occurrence per Ecological Drainage Unit.

*Goal Met 1*: The conservation goal for this target was met or exceeded.
*Goal Met 2*: There is a 95% or greater likelihood that the goal is actually met. The goal appears to be unmet due to the inability to map individual occurrences or due to lack of inventory. For example, most ecological systems were only tracked once per conservation area, but the majority of the conservation areas support numerous occurrences of the large and small patch types, and often more than one occurrence of matrix-forming systems.
*Goal Unmet 1*: All known viable occurrences of the target are included within the portfolio. It is unclear whether or not additional inventory will identify more occurrences. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 3*: There are no known viable occurrences in at least one section in which it is known to occur.

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## Aquatic Ecological Systems Target Occurrences Captured within Conservation Areas by Ecological Drainage Units

| | | | BASIN | Chippewa River | | Mississippi River Headwaters | | Rainy River | | Red River | | St. Croix River | | Wisconsin River |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Common Name | Global Code | Target Goal Evaluation † | EDU | Chippewa River | Upper Mississippi Chippewa | Mississipp iHead-waters | Upper Mississippi Outwash plains | Rainy River | Rainy Head-waters | Red River | Lower Red River | St Croix River | Lower St Croix | Upper Wisconsin |
| groundwater mixed / stream / large river / low relief / no surface storage | 31210 | Unmet 3 | | 0 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** |

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*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
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## Plant Community Target Occurences Captured within Conservation Areas by Section

| Scientific/Global Name | Common Name | Global Code | Target Goal Evaluation † | Lake of the Woods | N MN and ONT Peatlands | Northern Minnesota Drift and Lake Plains | Northern Superior Uplands | Southern Superior Uplands | Thunder Bay / Quetico | Western Superior Uplands |
|---|---|---|---|---|---|---|---|---|---|---|
| Quercus macrocarpa - (Quercus ellipsoidalis) / Schizachyrium scoparium - Koeleria macrantha Wooded Herbaceous Vegetation | Northern Oak Barrens | CEGL002160 | Unmet 3 | 3 | 0 | 0 | 1* | NIS** | 1* | 1 |
| Thuja occidentalis - Betula alleghaniensis Forest | Northern White-cedar - Yellow Birch Forest | CEGL002450 | Unmet 3 | NIS** | 0 | 0 | 1 | 0 | NIS** | NIS** |
| Pinus banksiana - (Quercus ellipsoidalis) / Schizachyrium scoparium - Prairie Forbs Wooded Herbaceous Vegetation | Jack Pine / Prairie Forbs Barrens | CEGL002490 | Unmet 3 | NIS** | NIS** | 0 | NIS** | 2 | NIS** | 5 |
| Quercus alba - Quercus macrocarpa / Andropogon gerardii Wooded Herbaceous Vegetation | White Oak - Bur Oak Openings | CEGL005121 | Unmet 3 | NIS** | NIS** | NIS** | NIS** | 0 | NIS** | NIS** |
| Carex prairea - Scirpus pungens - Rhynchospora capillacea Herbaceous Vegetation | Northern Tallgrass Calcareous Fen | CEGL002267 | Unmet 3 | NIS** | NIS** | 0 | NIS** | NIS** | NIS** | NIS** |
| Carex lasiocarpa - Scirpus cespitosus - Rhynchospora capillacea / Andromeda polifolia Herbaceous Vegetation | Boreal Extremely Rich Seepage Fen | CEGL002496 | Unmet 3 | NIS** | 0 | NIS** | 0 | NIS** | 1* | NIS** |

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## Plant Community Target Occurences Captured within Conservation Areas by Section

| Scientific/Global Name | Common Name | Global Code | Target Goal Evaluation † | Lake of the Woods | N MN and ONT Peatlands | Northern Minnesota Drift and Lake Plains | Northern Superior Uplands | Southern Superior Uplands | Thunder Bay / Quetico | Western Superior Uplands |
|---|---|---|---|---|---|---|---|---|---|---|
| Carex lasiocarpa - Rhynchospora alba - Scheuchzeria palustris Herbaceous Vegetation | Open Schlenke Bog | CEGL002501 | Unmet 3 | NIS** | 0 | NIS** | 0 | NIS** | NIS** | NIS** |
| Rhynchospora capitellata - Rhexia virginica - Rhynchospora scirpoides - Scirpus hallii Herbaceous Vegetation | Inland Coastal Plain Marsh | CEGL005108 | Unmet 3 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 0 |

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*Goal Unmet 1*: All known viable occurrences of the target are included within the portfolio. It is unclear whether or not additional inventory will identify more occurrences. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
*Goal Unmet 2*: All known viable occurrences of the target are included within the portfolio. Other good occurrences are unlikely to be discovered with additional inventory. In future updates to this plan, the detailed geographic range of conservation targets in this goal status category should be further clarified. If the target is peripheral to a given section, the goal of two per section may be inappropriate.
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## 21 APPENDIX L. Goal Status for Globally Rare Plant and Animal Species.

### Primary Species Target Occurences Captured within Conservation Areas by Section

| Scientific/Global Name | Common Name | Global Code | Target Goal Evaluation † | Lake of the Woods | N MN and ONT Peatlands | Northern Minnesota Drift and Lake Plains | Northern Superior Uplands | Southern Superior Uplands | Thunder Bay / Quetico | Western Superior Uplands |
|---|---|---|---|---|---|---|---|---|---|---|
| Pelecanus erythrorhynchos | American White Pelican | ABNFC01010 | Met 1 | 4 | NIS** | NIS** | 2 | NIS** | NIS** | NIS** |
| Cygnus buccinator | Trumpeter Swan | ABNJB02030 | Unmet 1 | NIS** | NIS** | NIS** | 1* | NIS** | NIS** | 3 |
| Tympanuchus cupido | Greater Prairie-chicken | ABNLC13010 | Met 1 | NIS** | NIS** | NIS** | NIS** | 4 | NIS** | 0 |
| Charadrius melodus | Piping Plover | ABNNB03070 | Unmet 2 | 4 | 0 | NIS** | NIS** | NIS** | NIS** | NIS** |
| Dendroica kirtlandii | Kirtland's Warbler | ABPBX03180 | Unmet 3 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 4 |
| Dendroica cerulea | Cerulean Warbler | ABPBX03240 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | 7 | NIS** | 1* |

| Scientific/Global Name | Common Name | Global Code | Target Goal Evaluation † | Lake of the Woods | N MN and ONT Peatlands | Northern Minnesota Drift and Lake Plains | Northern Superior Uplands | Southern Superior Uplands | Thunder Bay / Quetico | Western Superior Uplands |
|---|---|---|---|---|---|---|---|---|---|---|
| Acipenser fulvescens | Lake Sturgeon | AFCAA01020 | Unmet 1 | 1 | 2 | 1* | 6 | 9 | 3 | 21 |
| Coregonus zenithicus | Shortjaw Cisco | AFCHA01140 | Unmet 1 | 0 | NIS** | NIS** | 1 | NIS** | 0 | NIS** |
| Notropis anogenus | Pugnose Shiner | AFCJB28080 | Unmet 2 | NIS** | NIS** | NIS** | NIS** | 0 | NIS** | 2 |

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"0" indicates that the target is present in the section, but not captured within any of the conservation areas.

## Primary Species Target Occurences Captured within Conservation Areas by Section

| Scientific/Global Name | Common Name | Global Code | Target Goal Evaluation † | Lake of the Woods | N MN and ONT Peatlands | Northern Minnesota Drift and Lake Plains | Northern Superior Uplands | Southern Superior Uplands | Thunder Bay / Quetico | Western Superior Uplands |
|---|---|---|---|---|---|---|---|---|---|---|
| Cycleptus elongatus | Blue Sucker | AFCJC04010 | Met 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 2 |
| Moxostoma valenciennesi | Greater Redhorse | AFCJC10170 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | 6 | NIS** | 3 |
| Crystallaria asprella | Crystal Darter | AFCQC01010 | Met 2 | NIS** | NIS** | NIS** | NIS** | 2 | NIS** | 0 |

| Scientific/Global Name | Common Name | Global Code | Target Goal Evaluation † | Lake of the Woods | N MN and ONT Peatlands | Northern Minnesota Drift and Lake Plains | Northern Superior Uplands | Southern Superior Uplands | Thunder Bay / Quetico | Western Superior Uplands |
|---|---|---|---|---|---|---|---|---|---|---|
| Cicindela patruela huberi | A Tiger Beetle | IICOL02231 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | 1* | NIS** | NIS** |
| Cicindela patruela patruela | A Tiger Beetle | IICOL02232 | Met 1 | NIS** | NIS** | NIS** | NIS** | 1* | NIS** | 2 |
| Hygrotus sylvanus | Sylvan Hygrotus Diving Beetle | IICOL38060 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1* |
| Nicrophorus americanus | American Burying Beetle | IICOL42010 | Unmet 3 | NIS** | NIS** | NIS** | NIS** | 0 | NIS** | NIS** |
| Dubiraphia robusta | Robust Dubiraphian Riffle Beetle | IICOL5A040 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | 1* | NIS** | NIS** |

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|---|---|---|---|---|---|---|---|---|---|---|
| Dolania americana | American Sand Burrowing Mayfly | IIEPH02010 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1* |
| Lycaeides melissa samuelis | Karner Blue | IILEPG5021 | Met 1 | NIS** | NIS** | NIS** | NIS** | 13 | NIS** | 19 |
| Speyeria idalia | Regal Fritillary | IILEPJ6040 | Unmet 3 | NIS** | NIS** | NIS** | NIS** | 0 | NIS** | NIS** |
| Meropleon ambifusca | Newman's Brocade | IILEYBK050 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1* |
| Papaipema beeriana | Blazing Star Stem Borer | IILEYC0450 | Met 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 1* |
| Psectraglaea carnosa | Pink Sallow | IILEYFN010 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | 1* | NIS** | 1* |
| Gomphurus ventricosus | Skillet Clubtail | IIODO08210 | Unmet 1 | NIS** | NIS** | NIS** | 1* | 11 | 1* | 2 |
| Gomphus viridifrons | Green-faced Clubtail | IIODO08460 | Unmet 1 | NIS** | NIS** | NIS** | 1* | 9 | 1* | 1 |
| Ophiogomphus anomalus | Extra-striped Snaketail | IIODO12020 | Unmet 1 | NIS** | NIS** | NIS** | 1* | 6 | NIS** | NIS** |
| Ophiogomphus howei | Pygmy Snaketail | IIODO12090 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | 11 | NIS** | 2 |
| Ophiogomphus subaeshna | St. Croix Snaketail | IIODO12180 | Met 1 | NIS** | NIS** | NIS** | NIS** | 2 | NIS** | 2 |

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|---|---|---|---|---|---|---|---|---|---|---|
| Ophiogomphus sp. 1 (nr. asperus) | Barrens Snaketail | IIODO12200 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | 1* | NIS** | NIS** |
| Stylurus notatus | Elusive Clubtail | IIODO80050 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | NIS** | 1* | NIS** |

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|---|---|---|---|---|---|---|---|---|---|---|
| Cumberlandia monodonta | Spectacle-case | IMBIV08010 | Met 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 6 |
| Epioblasma triquetra | Snuffbox | IMBIV16190 | Met 1 | NIS** | NIS** | NIS** | NIS** | 2 | NIS** | 11 |
| Lampsilis higginsii | Higgins Eye | IMBIV21100 | Met 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 6 |
| Plethobasus cyphyus | Sheepnose | IMBIV34030 | Unmet 3 | NIS** | NIS** | NIS** | NIS** | 1* | NIS** | NIS** |
| Pleurobema cordatum | Ohio Pigtoe | IMBIV35090 | Met 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 2 |
| Quadrula fragosa | Winged Mapleleaf | IMBIV39050 | Met 1 | NIS** | NIS** | NIS** | NIS** | NIS** | NIS** | 7 |
| Simpsonaias ambigua | Salamander Mussel | IMBIV41010 | Unmet 1 | NIS** | NIS** | NIS** | NIS** | 1* | NIS** | 6 |

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|---|---|---|---|---|---|---|---|---|---|---|
| Menegazzia terebrata | Port-hole Lichen | NLLEC0T010 | Unmet 3 | NIS** | NIS** | NIS** | NIS** | 0 | NIS** | NIS** |
| Arnica chionopappa | Arnica chionopappa | PDAST0Q0T0 | Unmet 1 | NIS** | NIS** | NIS** | 1* | NIS** | 1* | NIS** |
| Cirsium hillii | Hill's Thistle | PDAST2E1C0 | Unmet 1 | NIS** | NIS** | 1 | NIS** | 1 | NIS** | 0 |
| Oxytropis campestris var. chartacea | Fassett's Locoweed | PDFAB2X041 | Met 1 | NIS** | NIS** | NIS** | NIS** | 2 | NIS** | NIS** |
| Polemonium occidentale ssp. lacustre | Western Jacob's-ladder | PDPLM0E0F4 | Unmet 3 | NIS** | NIS** | 0 | 2 | 0 | NIS** | NIS** |
| Talinum rugospermum | Prairie Fame-flower | PDPOR080G0 | Met 1 | NIS** | NIS** | NIS** | NIS** | 2 | NIS** | 5 |
| Besseya bullii | Kitten Tails | PDSCR09030 | Unmet 1 | NIS** | NIS** | 0 | NIS** | 8 | NIS** | 3 |
| Leucophysalis grandiflora | Large-flowered Ground-cherry | PDSOL0E010 | Unmet 1 | 1 | 3 | NIS** | 1* | 1 | 2 | 1 |
| Carex katahdinensis | Katahdin Sedge | PMCYP03F20 | Met 1 | NIS** | NIS** | NIS** | 7 | NIS** | 4 | NIS** |
| Cypripedium arietinum | Ram's-head Lady's-slipper | PMORC0Q020 | Unmet 3 | 3 | 4 | 8 | 4 | 1 | 2 | NIS** |
| Listera auriculata | Auricled Twayblade | PMORC1N010 | Unmet 3 | NIS** | NIS** | NIS** | 2 | NIS** | 0 | NIS** |

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|---|---|---|---|---|---|---|---|---|---|---|
| Poa paludigena | Bog Bluegrass | PMPOA4Z1W0 | Unmet 1 | NIS** | NIS** | 1* | NIS** | 3 | NIS** | 18 |
| Botrychium mormo | Little Goblin Moonwort | PPOPH010N0 | Met 1 | NIS** | 0 | 20 | 0 | 17 | NIS** | NIS** |
| Botrychium rugulosum | Rugulose Grape-fern | PPOPH010P0 | Unmet 1 | NIS** | NIS** | 3 | 1* | 4 | NIS** | 3 |
| Botrychium pallidum | Pale Moonwort | PPOPH01130 | Unmet 1 | NIS** | NIS** | 1* | 2 | NIS** | NIS** | NIS** |

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## 22.Appendix M - GIS Data Sources

Numerous data sets were used or created in this ecoregional planning process. Both tabular and spatial data sets were compiled. The GIS team at The Nature Conservancy's Midwest Resource office were the primary managers of spatial data. Spatial data were managed using ArcView 3.2a and ArcInfo 8.1.2 software. Metadata records were created using ArcCatalog software and meet the Federal Geographic Data Committee (FGDC) standard for metadata. All public GIS data will be available soon at www.conserveonline.org. For GIS data used in the Superior Mixed Forest ecoregional planning effort, contact:

The Nature Conservancy
Midwest Resource Office
1101 West River Parkway
Minneapolis, MN 55454
(612) 331-0700
Jan Slaats (jslaats@tnc.org)

**Figure 1. Boundary of the Superior Mixed Forest Ecoregion.**

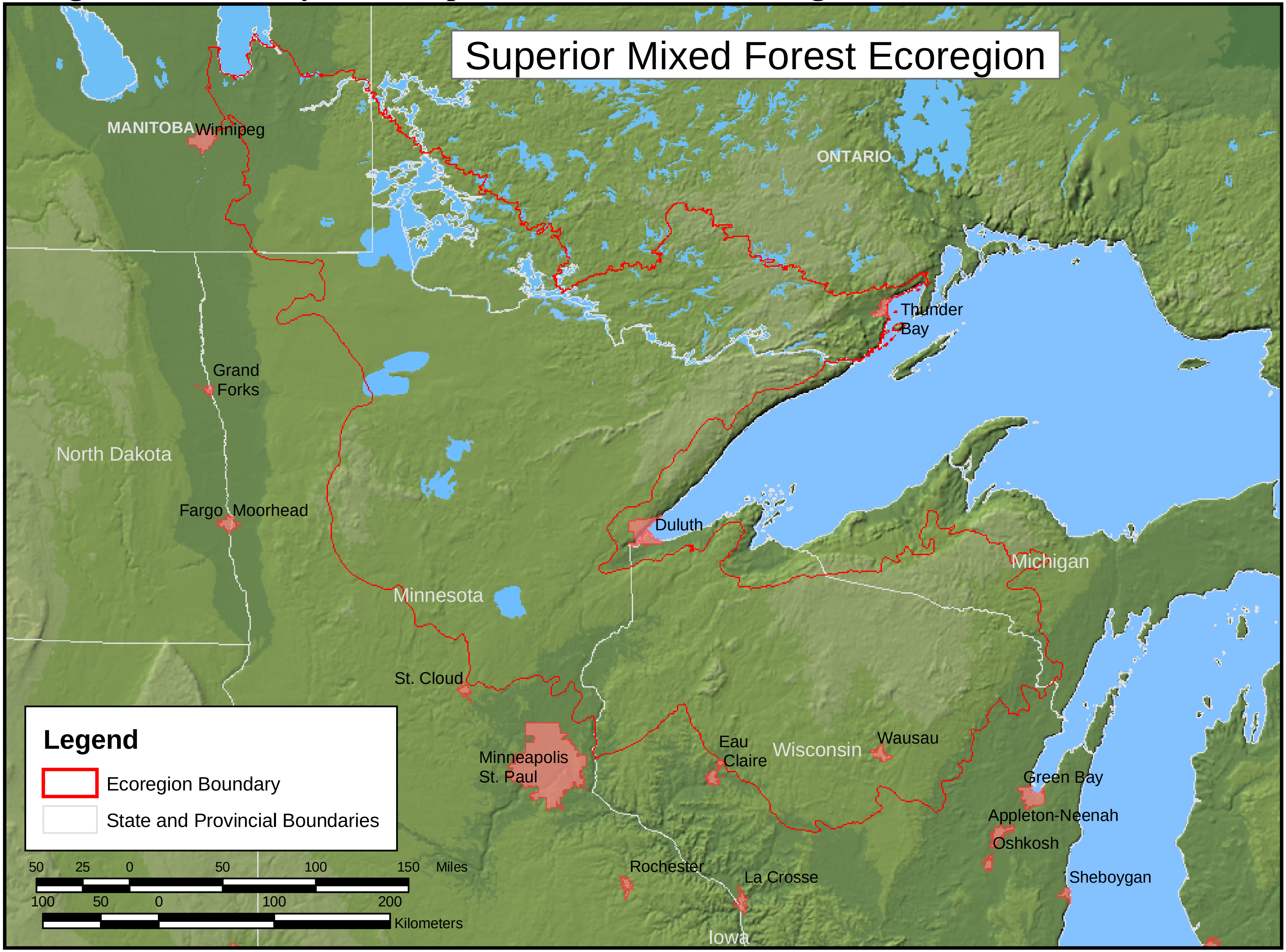


**Figure 2. Analysis of Roadless Blocks in theSuperior Mixed Forest Ecoregion**

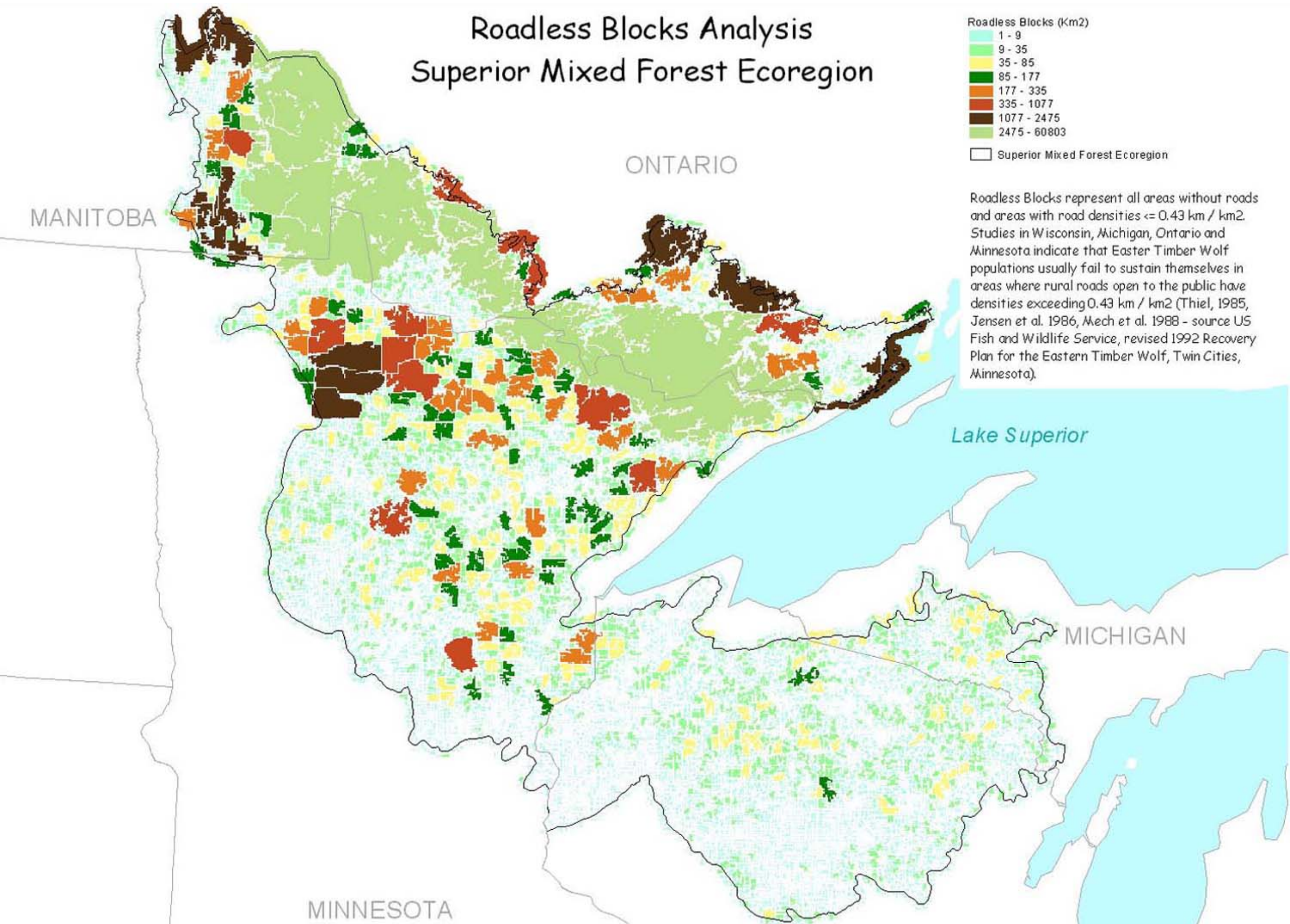


**Figure 3. Regional Landscape Analysis of Wolf Habitat (Mladenoff et al. 1995).**

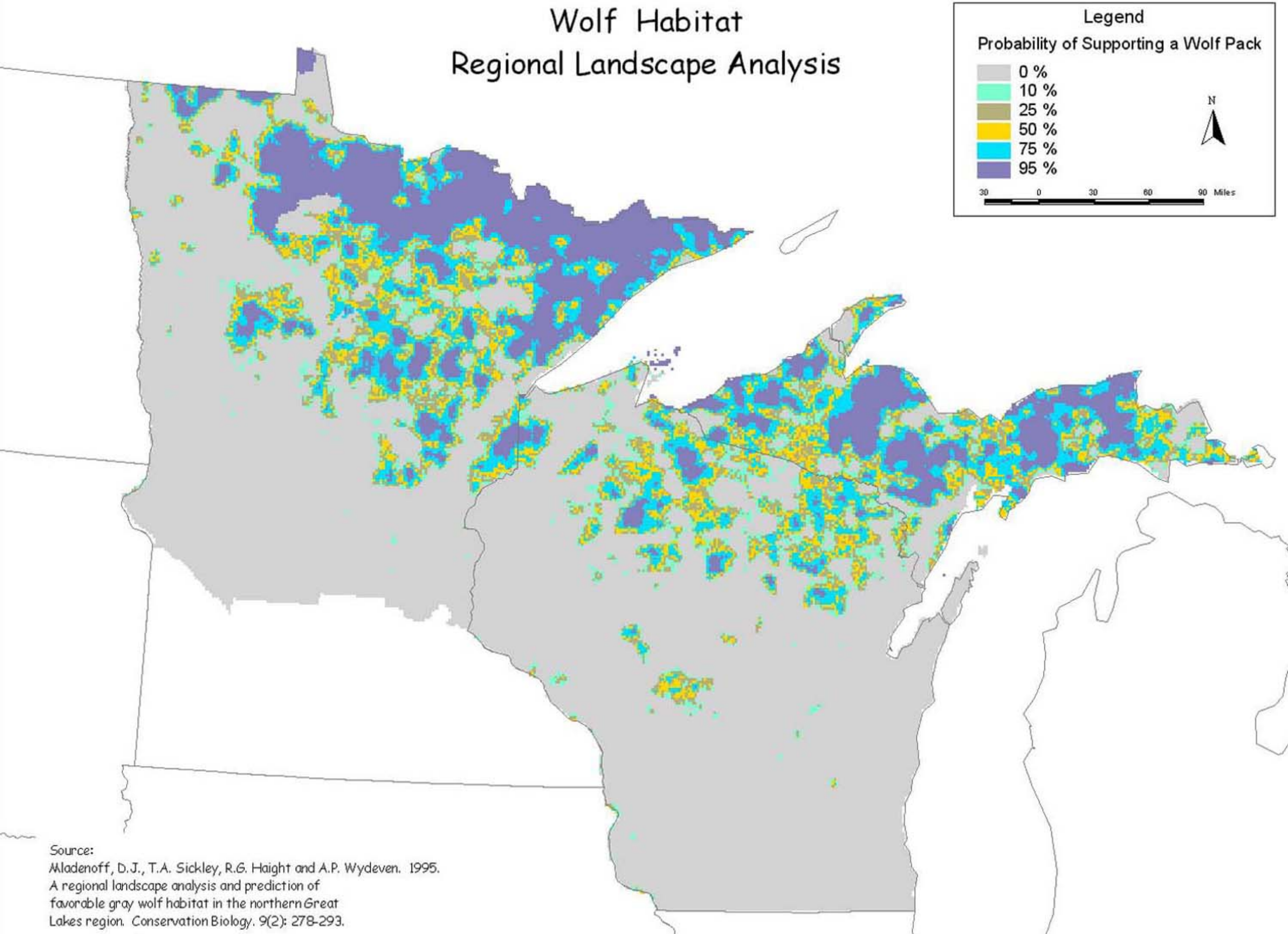


**Figure 4. Ecological Sections in the Superior Mixed Forest Ecoregion.**

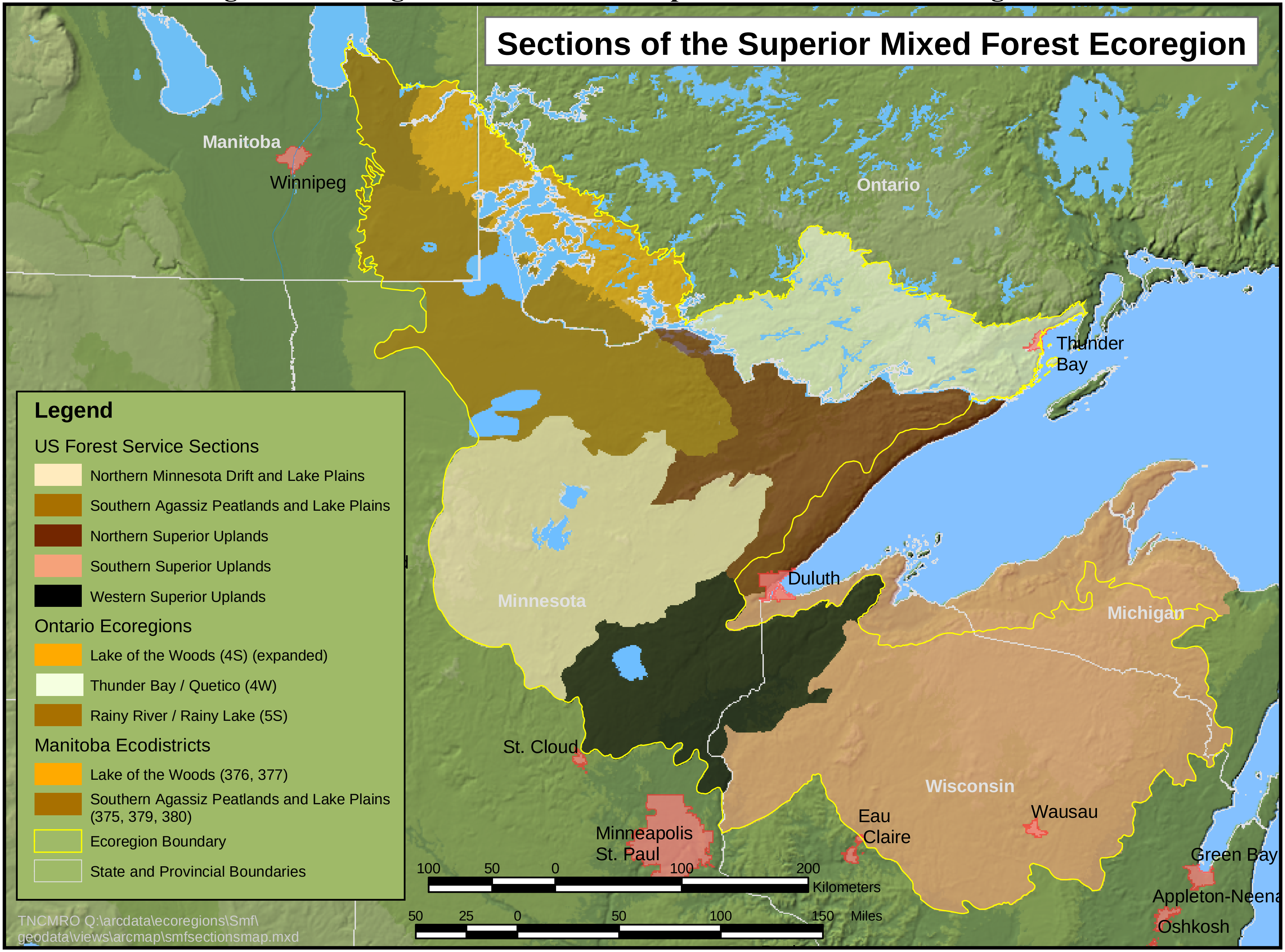


**Figure 5. Percent Area Burned by Land Type Association (Minnesota and Wisconsin only).**

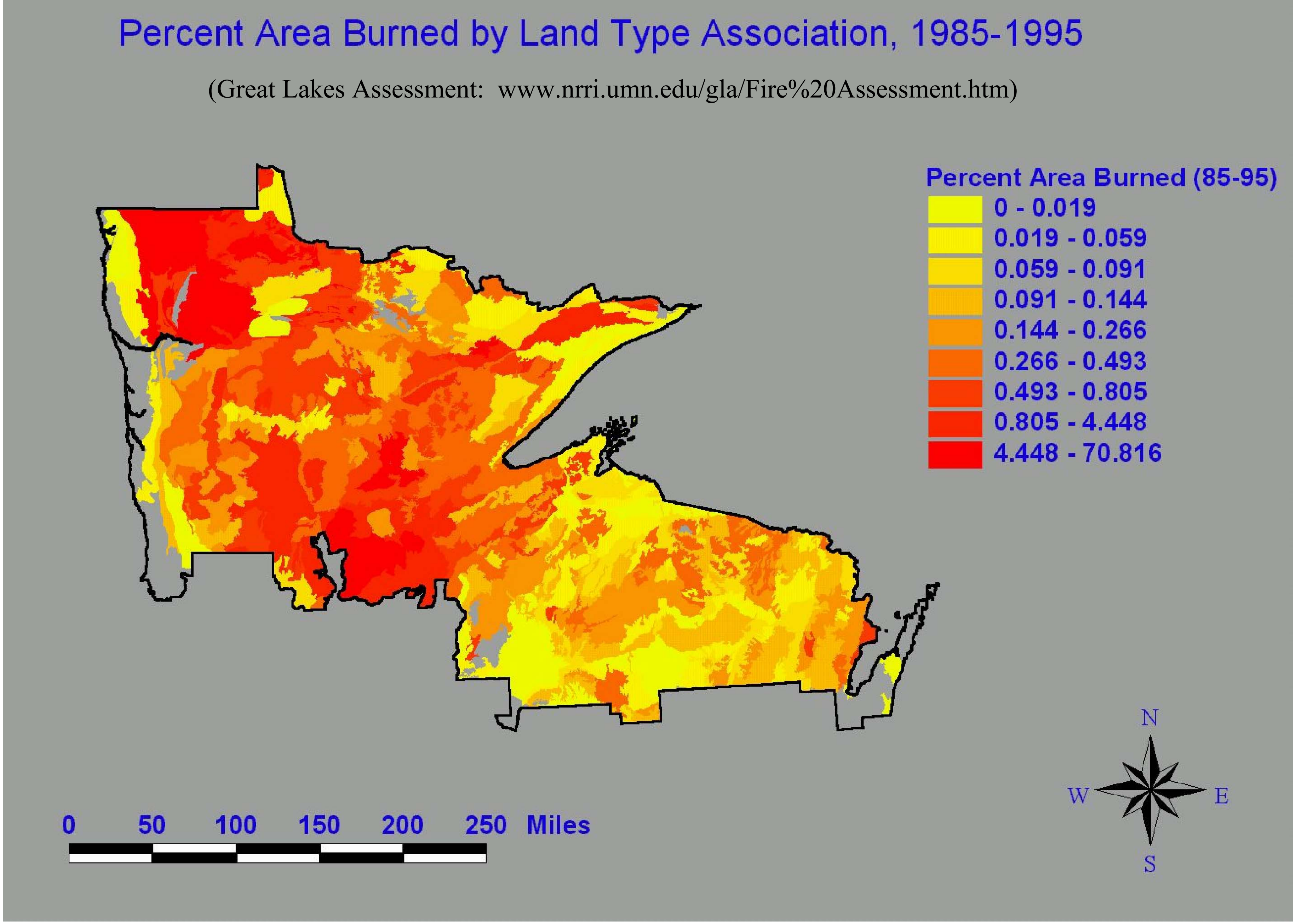


**Figure 6. Potential Natural Vegetation of Northern Superior Uplands (White and Host 2000).**

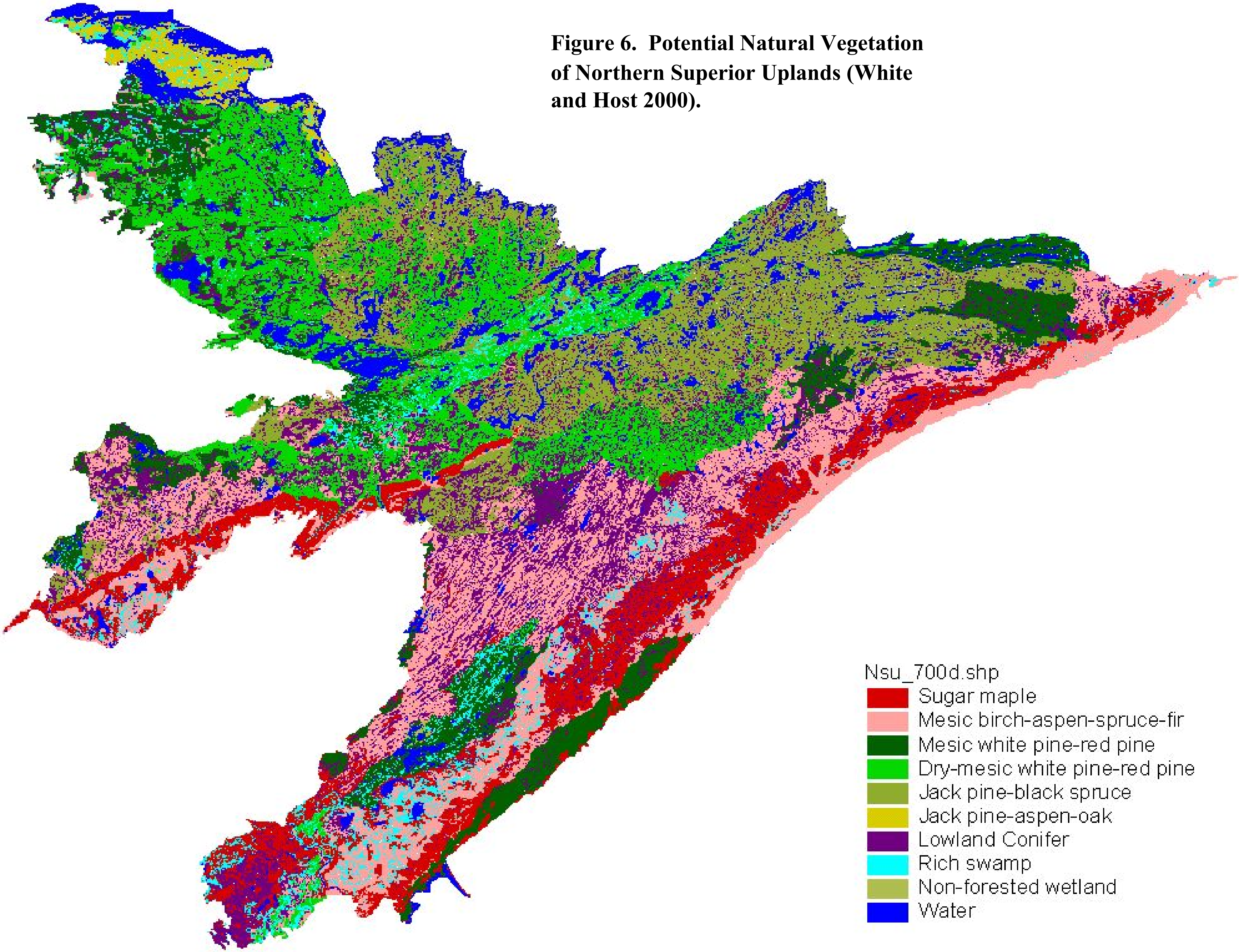


**Figure 7. Potential Natural Vegetation of the Northern Minnesota Drift and Lake Plains (Shadis 1998).**

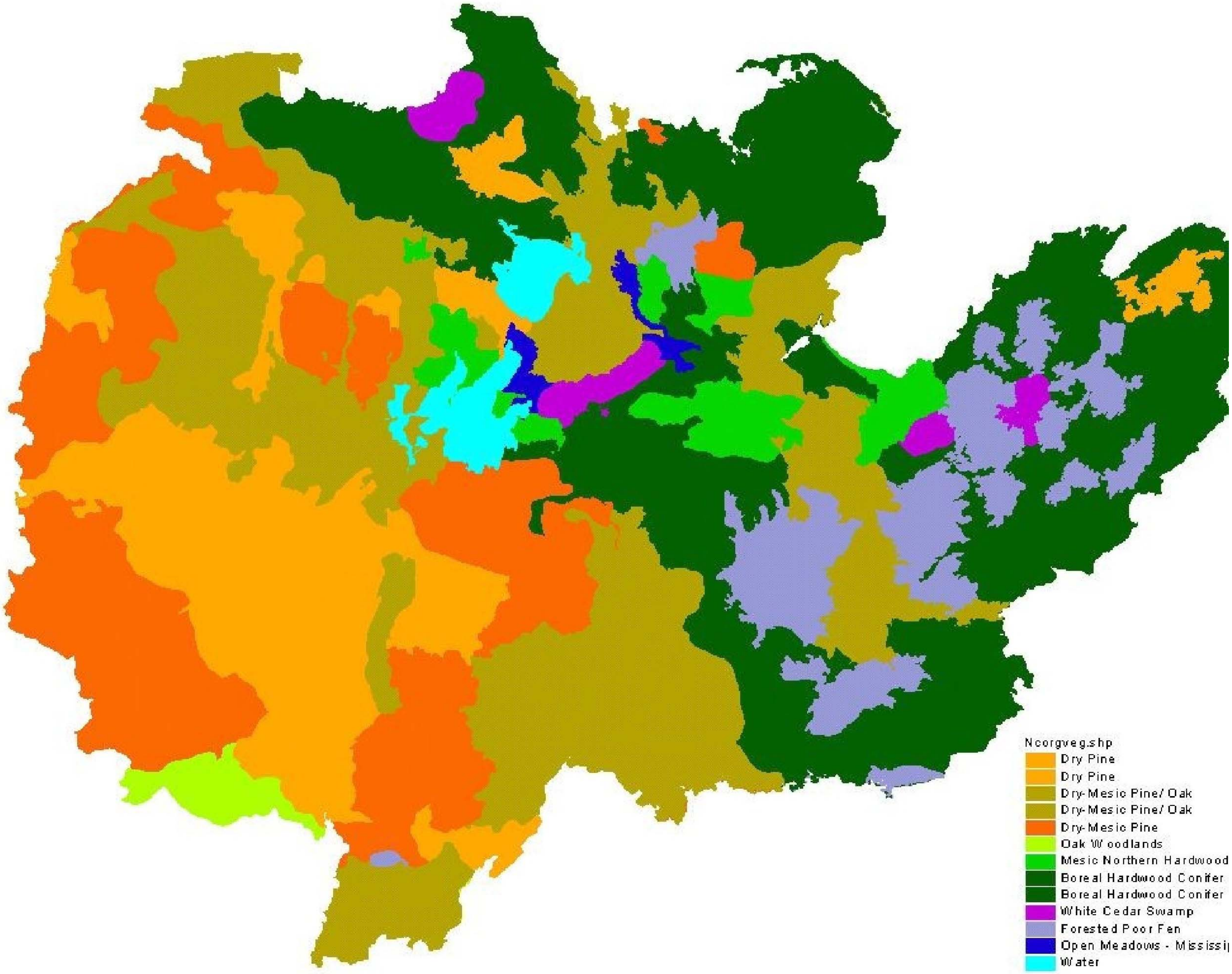


**Figure 8. Fire Regime Map for the Minnesota Portion of Province 212 (Shadis 2000).**

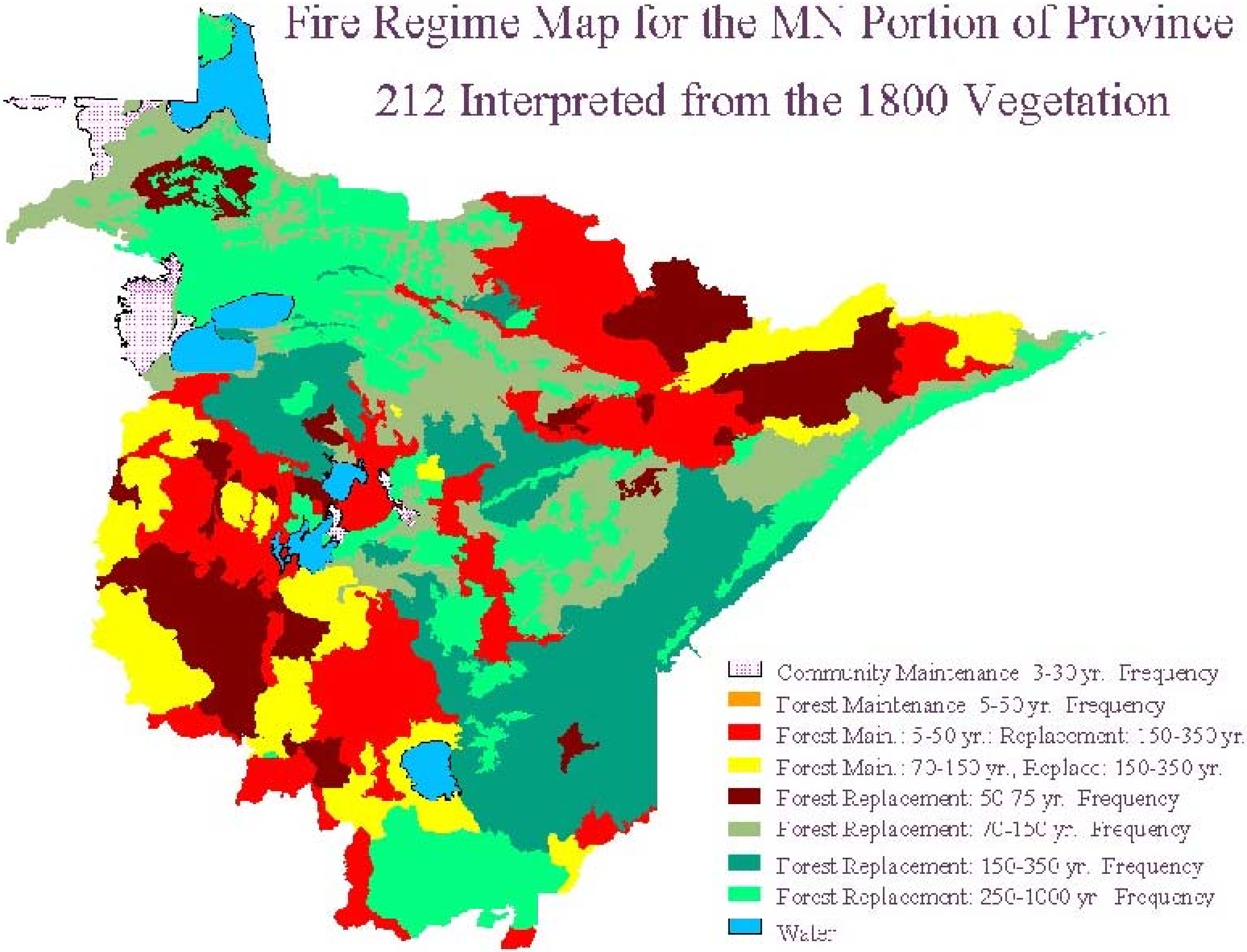
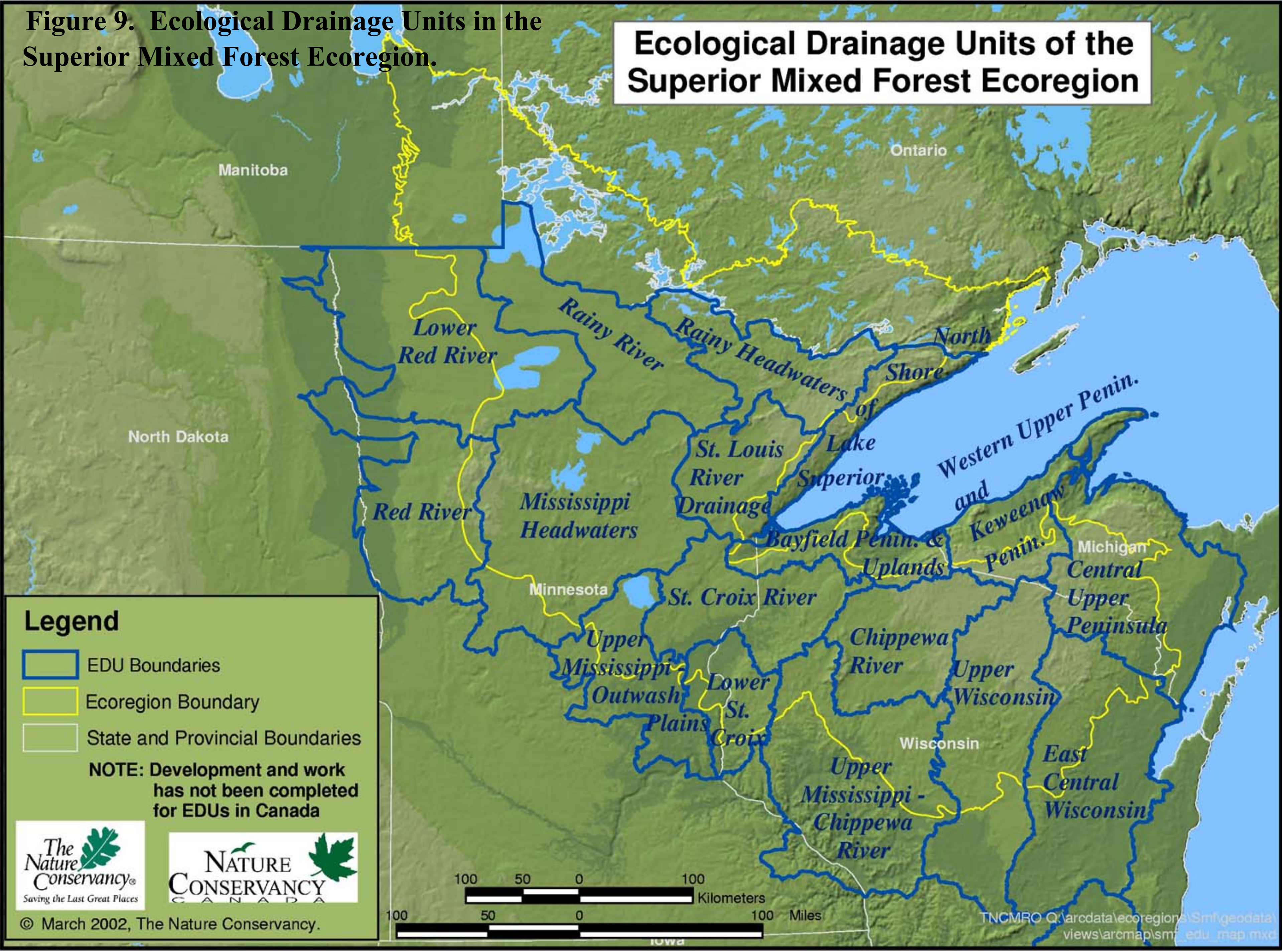


**Figure 9. Ecological Drainage Units in the Superior Mixed Forest Ecoregion.**



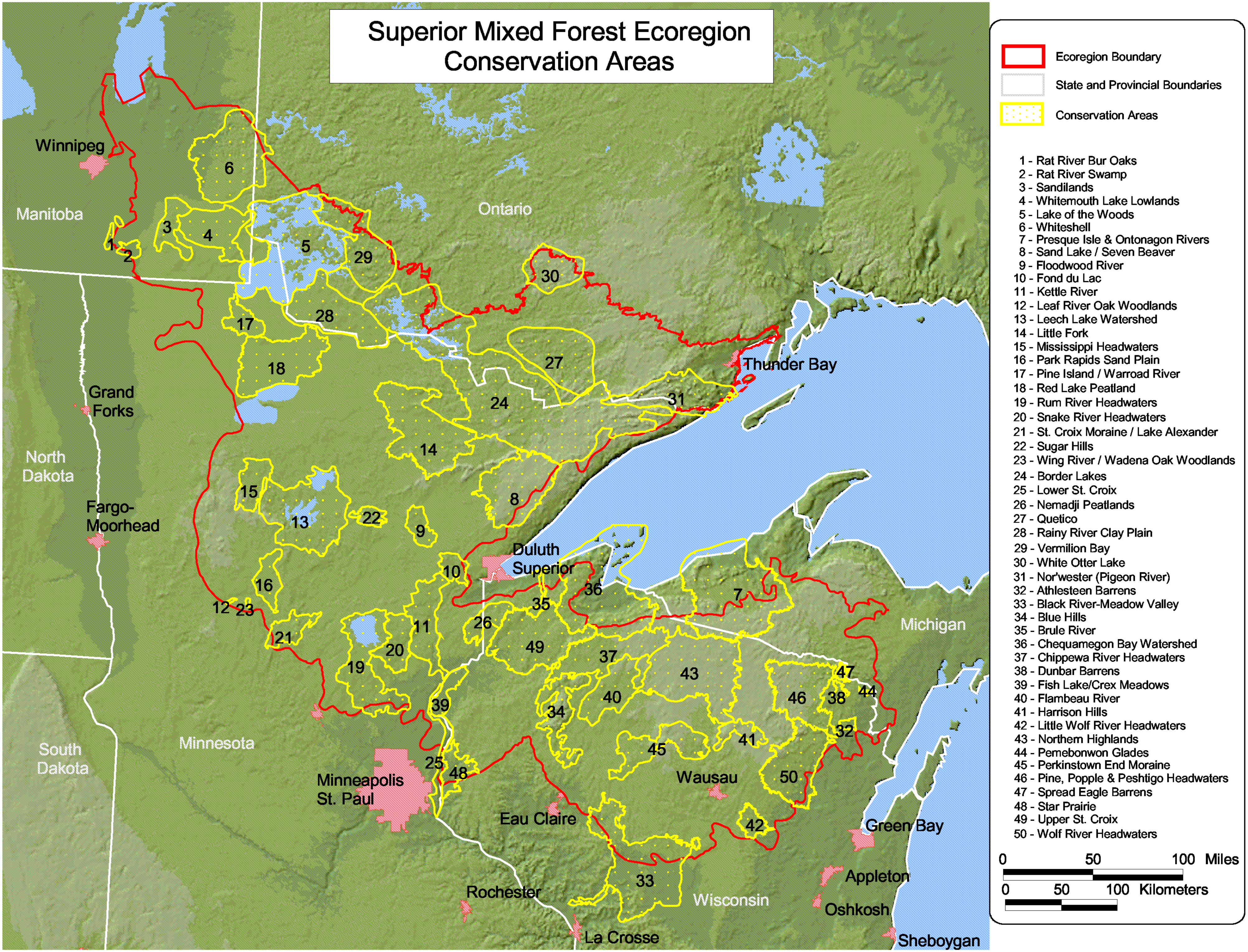

Superior Mixed Forest Ecoregion
Conservation Areas
Ecoregion Boundary
State and Provincial Boundaries
Conservation Areas
1 - Rat River Bur Oaks
2 - Rat River Swamp
3 - Sandilands
4 - Whitemouth Lake Lowlands
5 - Lake of the Woods
6 - Whiteshell
7 - Presque Isle & Ontonagon Rivers
8 - Sand Lake / Seven Beaver
9 - Floodwood River
10 - Fond du Lac
11 - Kettle River
12 - Leaf River Oak Woodlands
13 - Leech Lake Watershed
14 - Little Fork
15 - Mississippi Headwaters
16 - Park Rapids Sand Plain
17 - Pine Island / Warroad River
18 - Red Lake Peatland
19 - Rum River Headwaters
20 - Snake River Headwaters
21 - St. Croix Moraine / Lake Alexander
22 - Sugar Hills
23 - Wing River / Wadena Oak Woodlands
24 - Border Lakes
25 - Lower St. Croix
26 - Nemadji Peatlands
27 - Quetico
28 - Rainy River Clay Plain
29 - Vermilion Bay
30 - White Otter Lake
31 - Nor'wester (Pigeon River)
32 - Athlesteen Barrens
33 - Black River-Meadow Valley
34 - Blue Hills
35 - Brule River
36 - Chequamegon Bay Watershed
37 - Chippewa River Headwaters
38 - Dunbar Barrens
39 - Fish Lake/Crex Meadows
40 - Flambeau River
41 - Harrison Hills
42 - Little Wolf River Headwaters
43 - Northern Highlands
44 - Pemebonwon Glades
45 - Perkinstown End Moraine
46 - Pine, Popple & Peshtigo Headwaters
47 - Spread Eagle Barrens
48 - Star Prairie
49 - Upper St. Croix
50 - Wolf River Headwaters
0 50 100 Miles
0 50 100 Kilometers
Winnipeg
Manitoba
Ontario
Thunder Bay
Grand Forks
North Dakota
Fargo-Moorhead
Duluth
Superior
Michigan
Minnesota
South Dakota
Minneapolis St. Paul
Eau Claire
Wausau
Green Bay
Appleton
Oshkosh
Rochester
Wisconsin
La Crosse
Sheboygan

**Figure 11. Roadless Blocks Analysis and Superior Mixed Forest Conservation Areas (The Nature Conservancy).**

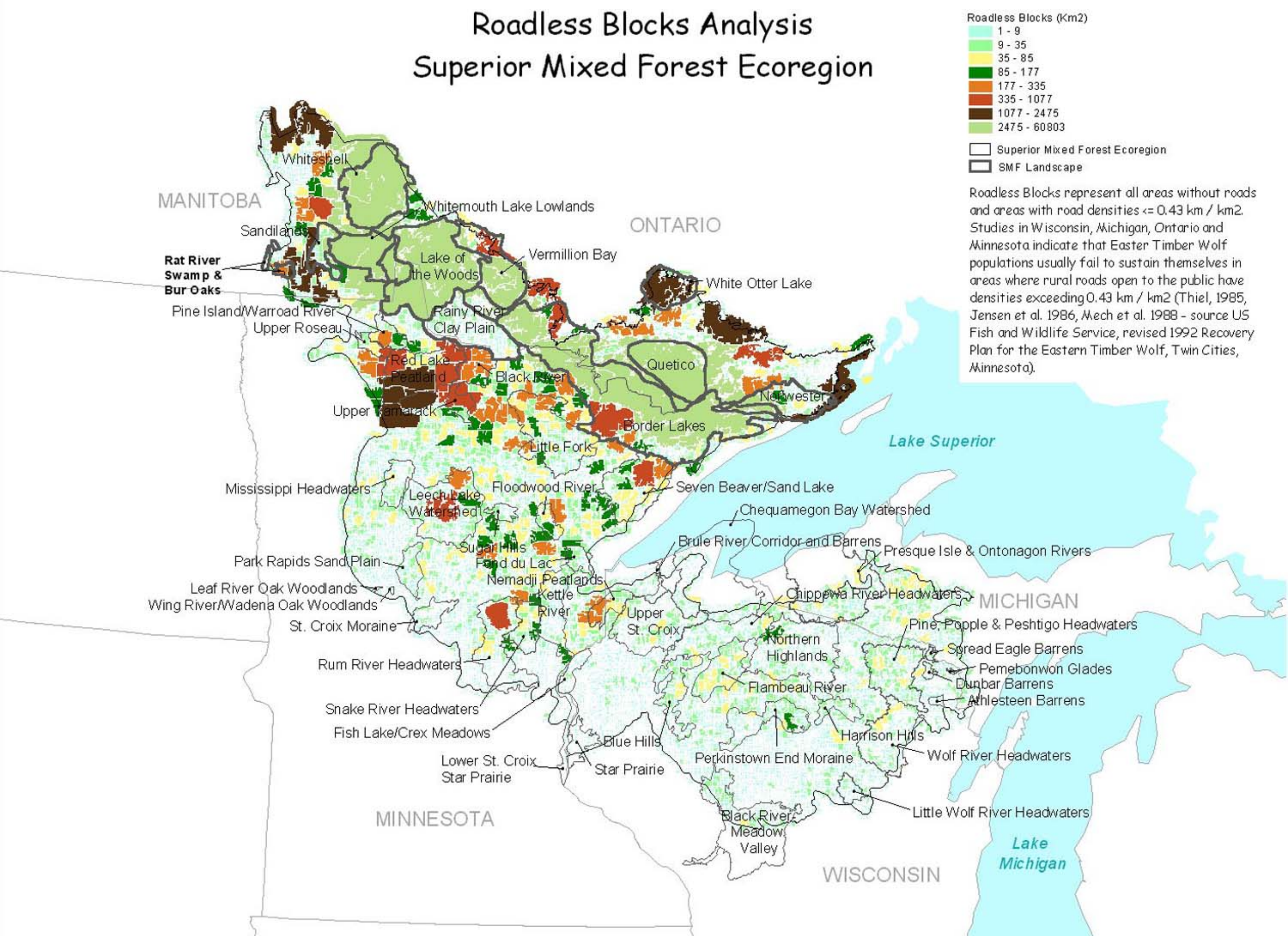


**Figure 12. Regional Landscape Analysis of Wolf Habitat and Superior Mixed Forest Conservation Areas (Mladenoff et al. 1995, The Nature Conservancy).**