Forest Resource Management Plan

Northern Landscape

Minnesota Forest Resources Council
May 25, 2004
Amended September 15, 2010

Minnesota Forest Resources Council
Landscape Program

Minnesota Forest Resources Council (MFRC)

© 2010 Minnesota Forest Resources Council

This document is on the Internet at http://www.frc.state.mn.us/Info/MFRCdocs.html. Information about the Minnesota Forest Resources Council and the Landscape Program can be found at http://www.frc.state.mn.us.

Equal opportunity to participate in and benefit from Minnesota Forest Resources Council programs is available to all individuals regardless of race, color, creed, religion, national origin, sex, marital status, status with regard to public assistance, age, sexual orientation, or disability. Discrimination inquiries should be sent to the Minnesota Forest Resources Council, 2003 Upper Buford Circle, St. Paul, MN 55108; or the Equal Opportunity Office, Department of the Interior, Washington, D.C. 20240.

Document Prepared By: Northern Regional Landscape Committee.

Table of Contents

Section	Title	Page
	Part 1: Where have we been and where are we today?	
1	**Introduction**	**1 – 1**
	Sustainable Forest Resources Act	1 – 1
	Regional Forest Resources Committees	1 – 2
2	**Process Summary**	**2 – 1**
	Formation of the Northern Regional Landscape Committee	2 – 1
	Planning Process Overview	2 – 2
	2010 Plan Amendment	2 – 2
3	**Resource Inventory and Assessment**	**3 – 1**
	Current Trends and Conditions Assessment	3 – 1
	Forest Resource Management in Northern Minnesota, A Landscape Perspective	3 – 1
	Koochiching County Comprehensive Land Use Plan	3 – 1
	Beltrami County Comprehensive Plan	3 – 2
	Cultural Values of Red Lake Band	3 – 2
	Additional Information	3 – 2
4	**Ecological Context**	**4 – 1**
	Minnesota Ecological Classification System (ECS)	4 – 1
	Native Plant Communities (NPC)	4 – 2
	Overview: NPC Systems in the Northern Minnesota & Ontario Peatlands Section	4 – 5
	System Descriptions in the Northern Minnesota & Ontario Peatlands Section	4 – 6
5	**Public Input and Decision-Making Process**	**5 – 1**
	Focus Meetings	5 – 1
	Decision-Making Process	5 – 1
	Input on the 2010 Plan Amendment	5 – 1

Section	Title	Page
	Part 2: Where do we want to go?	
6	**Forest Management Policy Framework: Desired Future Conditions, Goals and Strategies**	**6 – 1**
	Economic Resources	6 – 1
	Social Resources	6 – 3
	Ecological Resources	6 – 5
	NPC System Based Forest Management Goals and Strategies	
	Part 3: How will we get there?	
7	**Coordination Framework**	**7 – 1**
8	**Monitoring Framework**	**8 – 1**
	Economic Goals	8 – 1
	Social Goals	8 – 3
	Ecological Goals	8 – 4
	Appendix	
A	2010 Northern Regional Landscape Committee Members	A – 1
B	An Ecological Classification and Assessment of Minnesota's Northern Landscape – NRRI.	B – 1
C	Crosswalk Diagram	C – 1

Section 1
Introduction

A. Sustainable Forest Resources Act

The Minnesota State Legislature enacted the Sustainable Forest Resources Act (Minn. Statues, Chapter 89A) in 1995, which established the MN Forest Resource Council (MFRC) and formalized the state's policy to:

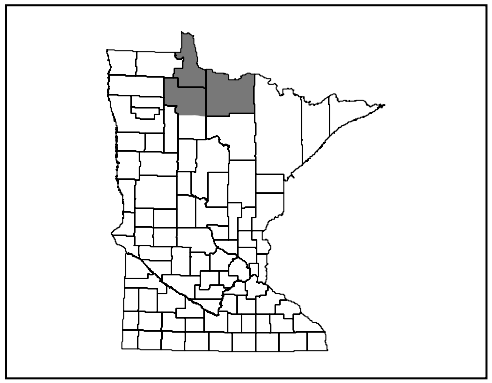
- pursue the sustainable management, use, and protection of the state's forest resources to achieve the state's economic, environmental, and social goals;
- encourage cooperation and collaboration between public and private sectors in the management of the state's forest resources;
- recognize and consider forest resource issues, concerns, and impacts at the site and landscape levels;
- recognize the broad array of perspectives regarding the management, use, and protection of the state's forest resources and establish processes and mechanisms that seek and incorporate these perspectives in the planning and management of the state's forest resources.

The purpose of the MFRC is to develop recommendations to the Governor and to federal, state, county and local governments with respect to policies that result in sustainable management of forests in the state. The policies must:

- acknowledge the interactions of complex sustainable forest resources, multiple ownership patterns, and local to international economic forces;
- give equal consideration to the long-term economic ecological, and social needs and limits of the state's resources;
- foster productivity of the state's forests to provide a diversity of sustainable benefits as site and landscape levels;
- enhance the ability of the state's forest resources to provide future benefits and services;
- foster no net loss of forest land;

- encourage appropriate mixes of forest cover types and age classes within landscapes to promote biological diversity and viable forest-dependent fish and wildlife habitats;
- encourage collaboration and coordination with multiple constituencies in planning and managing the state's forest resources; and
- address the environmental impacts and implement mitigations as recommended in the *Generic Environmental Impact Statement on Timber Harvesting and Forest Management.*

B. Regional Forest Resources Committees



The MFRC Landscape Program established landscape committees on a regional basis to implement these state policies at the landscape level throughout the state.

The Northern Landscape Region includes Koochiching, Lake of the Woods and the northern half of Beltrami counties (approximately 4.4 million acres). In 2002 the Northern Regional Landscape Committee was organized to begin their work of determining how to achieve long-term forest sustainability considering the economic, ecological, and social characteristics of the landscape.

The 2004 plan document summarized the work of the Northern Regional Landscape Committee (the Committee) from 2002 through 2003.

2010 Plan Amendment

This document integrates the 2010 plan amendment into the approved 2004 Northern Landscape Plan.

Section 2
Process Summary

A. Formation of the Northern Regional Landscape Committee

The Committee was organized in October of 2002 with 25 people expressing interest in participating. There were 23 people on the mailing list with an active group of 12-15 attending regularly scheduled meetings (see table to the right for mailing list). The Committee chose to work as a single group, scheduling monthly meetings to complete their work by November 2003.

Northern Regional Landscape Committee Members:

Bruce Anderson
Rod Bergstrom*, Bergstrom Forest Products
Kara Dunning*, Boise
Steve Early, Boise
Robert Ecklund*
Perry Eide*, Tree Farmer
Jim Glaser, Sierra Club
Jan Hacker*, MN Forest Resources Partnership
Clyde Hanson*, Sierra Club
Mike Hanson*, Koochiching County Commissioner
Jim Hebner, Boise
Dennis Hummitzsch*, Koochiching County Land Commissioner
Wanda LaDuke, Red Lake Band
Gene Larson*, Koochiching County SWCD Board
Paul Nevanen*, Koochiching Economic Development Agency
Matt Norton, MN Center for Environmental Advocacy
Peggy O'Laughlin-Julson*, DNR Forestry
Greg Snyder*, Beltrami County Land Department
Dave Thomas*, DNR Forestry
Tom Toratti*, Koochiching County SWCD Board
Eldon Voigt*, Tree Farmer
Gloria Whitefeather-Spears*, Red Lake Band
Jim Yount*
* Active Members (attended half or more meetings)

B. Planning Process Overview

General Steps in the Planning Process

The Committee agreed to the following process:

- The Committee will have three focused meetings (economic, social, ecological)
- At each of the above meetings the Committee will develop the most important goals and strategies for the economic, social, and ecological areas.
- An additional meeting or two will be held to review the goals and strategies of the focus meetings, look at conflicts or tradeoffs, and integrate their results to develop the final desired outcomes, goals, and strategies.
- The Committee will establish measurement systems for all goals, objectives, strategies, and outcomes.

- If agreement on a particular point cannot be reached the discussion will shift up to a more general level until agreement can be reached.
- The Committee will produce a final report for presentation to the Minnesota Forest Resources Council.
- The Committee will assess its progress approximately every five years or when significant new data becomes available and, if needed, modify the report.

C. 2010 Plan Amendment

As a part of their approval of the first generation Northern Landscape Plan in 2004, the Minnesota Forest Resources Council requested that the Northern Committee "give high priority to Ecological Goal 4", which called for the improving of information sources for forest management decision making through the development of a potential native plant community (NPC) study.

Funding for the study was secured in 2006. The Northern Committee, through the MFRC, contracted with the Natural Resources Research Institute (NRRI) to prepare the study. After the study was completed in 2007, the Committee began working with the NPC data as a foundation to revising the ecological policy framework (desired future conditions, goals and strategies). The Northern Committee thoroughly reviewed and discussed the NPC data and maps from the study over a series of their quarterly meetings.

As a part of the plan amendment process, the Committee also organized and hosted locally based training sessions on ecological classification systems, native plant communities (NPC), and applications of the Minnesota Department of Natural Resources NPC field guide in forest management.

Together, the NPC study coupled with the workshops supported an increased understanding of these emerging concepts which have been incorporated into the 2010 plan amendment. The amended text is found primarily in Sections 4 and 6 as well as Appendices B and C.

Section 3
Resource Inventory and Assessment

A. Current Trends and Conditions Assessment Report

Existing information on the economic, ecological, and social aspects of the landscape was identified and compiled by staff prior to organization of the Committee. This document served as a starting point for discussion, definition of new information, and initial issue identification (refer to MFRC web site at www.frc.state.mn.us for the assessment).

B. Forest Resource Management in Northern Minnesota, A Landscape Perspective

This document summarized 10 existing plans in the landscape. The main objective of the report was to highlight landscape issues, visions, goals, and strategies presented in the 10 forest management and planning documents reviewed. Common themes were identified and common goals and strategies were listed under each theme and referenced back to the individual management plan. The purpose of this document was to give the Committee knowledge of what existing plans were being used in the landscape and common themes for future use (refer to MFRC web site at www.frc.state.mn.us for this report).

C. Koochiching County Comprehensive Land Use Plan

Comprehensive plan for the county including land use, natural resources, transportation, community facilities and services, economic development and housing. Plan developed a scenario for what county would look like 25 years from 2001 and then developed goals and strategies for how to achieve the desired condition.

D. Beltrami County Comprehensive Plan

The Beltrami County Comprehensive Plan includes four sections: Land Use, Transportation, Economic Development, and Housing. Within each of the four sections is an inventory of the existing situation, an analysis of available information, and the plan for that specific area. Each plan component outlines the goals, objectives, and policies for that functional area, and concludes with specific implementation strategies.

E. Cultural Values of Red Lake Band

Jody Beaulieu gave a historical perspective of the treaties that shaped the Red Lake Band and spoke to the cultural values toward natural resources of the Ojibwe people. The Ojibwe look at natural resources as having a spiritual value as well as a utilization value. Spiritual values are important considerations in determining how natural resources are managed on Red Lake Tribal lands.

F. Additional Information

Council staff working with Jan Hacker, Executive Director, Forest Resources Partnership, prepared a list of information that was derived from discussions of the Northern Regional Committee as well as information that has been helpful in other natural resource plans. The Committee reviewed each item in the list and decided if they wanted to spend additional staff time and money obtaining it. Staff compiled the data requested by topic areas and had an information package ready for each of the three focused meetings (refer to MFRC web site at www.frc.state.mn.us for this information).

Section 4
Ecological Context

A. Minnesota Ecological Classification System (ECS)

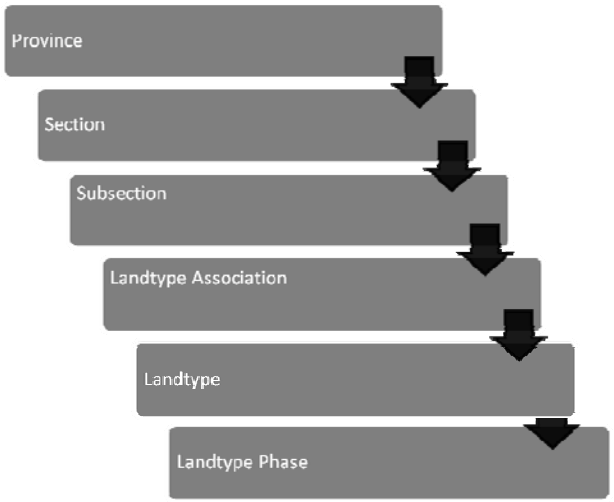
The Minnesota Department of Natural Resources and the U.S. Forest Service have developed an Ecological Classification System (ECS) for ecological mapping and landscape classification in Minnesota following the National Hierarchical Framework of Ecological Units (ECOMAP 1993).

Ecological land classifications are used to identify, describe, and map progressively smaller areas of land with increasingly uniform ecological features. The system uses associations of biotic and environmental factors including: 1) climate, 2) geology, 3) topography, 4) soils, 5) hydrology, and 6) vegetation. There are eight levels of ECS units in the United States. Map units for six of these levels occur in Minnesota: Provinces, Sections, Subsections, Land Type Associations, Land Types, and Land Type Phases. The first three levels are described below:

- **Provinces** are units of land defined using major climate zones, native vegetation, and biomes such as prairies, deciduous forests, or boreal forests. There are four Provinces in Minnesota.

- **Sections** are units within Provinces that are defined by origin of glacial deposits, regional elevation, distribution of plants, and regional climate. Minnesota has 10 sections.

- **Subsections** are units within Sections that are defined using glacial deposition processes, surface bedrock formations, local climate, topographic relief, and the distribution of plants, especially trees. Minnesota has 26 subsections.



Ecological Classification System Geography

Provinces in Minnesota

Sections in Minnesota

Subsections within the MFRC Northern Regional Landscape

The Northern Minnesota and Ontario Peatlands Section covers the majority of the administrative boundaries of the Northern landscape region. Small portions of three other sections including the Lake Agassiz Aspen Parklands, Northern Minnesota Drift & Lake Plains, and the Northern Superior Uplands cross into the Northern landscape administrative region.

B. Native Plant Communities (NPC)

What is a native plant community?

A **native plant community** is a group of native plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plant species form recognizable units, such as oak savannas, pine forests, or marshes, that tend to repeat over space and time. Native plant communities are classified and described by considering 1) vegetation, 2) hydrology, 3) landforms, 4) soils, and 5) natural disturbance regimes. Examples of natural disturbances include: wildfires, severe droughts, windstorms, and floods.

Sometimes referred to as native habitats or natural communities, native plant communities are named for the characteristic plant species within them or for characteristic environmental features. Examples of native plant communities in Minnesota include Dry Barrens Oak Savanna, Red Pine-White Pine Forest, Bulrush Marsh, Sedge Meadow, and Mesic Sandstone Cliff.

There are many kinds of vegetated areas that are not native plant communities. These include places where native species have largely been replaced by exotic or invasive species such as smooth brome grass, buckthorn, and purple loosestrife, and planted areas such as orchards, pine plantations, golf courses, and lawns. Other areas not considered to be native plant communities include areas where modern human activities such as farming, overgrazing, non-sustainable logging, and development have destroyed or greatly altered the vegetation.

Native Plant Community Classification

In 2003, researchers in the Minnesota Department of Natural Resources (DNR) completed a new classification of the native vegetation of Minnesota, Minnesota's Native Plant Community Classification (Version 2.0). The DNR's new classification is intended to provide a framework and common language for improving our ability to manage vegetation, to survey natural areas for biodiversity conservation, to identify research needs, and to promote study and appreciation of native vegetation in Minnesota.

Version 2.0 of the DNR's native plant community classification is based strongly on plant species composition and was developed through analysis of extensive field data collected from sample plots in forests, prairies, wetlands, and other habitats. The classification is hierarchical, with vegetation units described at levels ranging from broad landscape-level ecological systems to local communities. One of the most important features of the new classification is the inclusion of ecological processes as an organizing principle.

The NPC classification has six levels. **System Groups**, the highest level, were created to allow development of manageable field keys for lower levels of the classification. System Groups were formed by combining lower levels of the classification along major physiognomic and hydrologic splits in vegetation. **Ecological Systems** are groups of native plant communities that are unified by strong influence from a major ecological process or set of processes, especially nutrient cycling and natural disturbances. **Floristic Regions** are divisions within Ecological Systems that reflect the distribution of Minnesota's plant species into characteristically northern, northwestern, central, and southern groups, or floras. The important influences on these species distributions appear to be climate and paleohistory.

Native Plant Community Classes are units of vegetation that generally have uniform soil texture, soil moisture, soil nutrients, topography, and disturbance regimes. For wooded vegetation, Native Plant Community Classes were developed by emphasizing understory vegetation more than canopy trees, under the hypothesis that in much of Minnesota understory plants are often more strongly tied to specific habitat conditions (such as levels of nutrients and moisture) than are canopy trees.

Native Plant Community Types are defined by dominant canopy trees, variation in substrate, or fine-scale differences in environmental factors such as moisture or nutrients. Type distinctions were also made to describe geographic patterns within a Class.

Native Plant Community Subtypes are based on finer distinctions in canopy composition, substrates, or other environmental factors. In some instances, Subtypes represent apparent trends within a Type for which more study and collection of data are needed. In other instances Subtypes are well-documented, fine-scale units of vegetation that are useful for work such as rare plant habitat surveys.

NPC Classification Hierarchy

Classification Level	Dominant Factors	Example
System Group	Vegetation structure & geology	Upland Forest & Woodland Systems
Ecological System	Ecological processes	Fire-Dependent Forest/Woodland
Floristic Region	Climate & paleohistory	Central
NPC Class	Local environmental conditions	Central Dry Pine Woodland
NPC Type	Canopy dominants, substrate, or finer environmental conditions	Jack Pine-(Yarrow) Woodland
NPC Subtype	Finer distinctions in canopy dominants, substrate, or environmental conditions	Ericaceous Shrub

Source: http://www.dnr.state.mn.us/npc/classification.html

C. Overview: NPC Systems in the Northern Minnesota & Ontario Peatlands Section

Upland/Lowland Characteristics

The Northern Minnesota & Ontario Peatlands (NMOP) Section covers over 4.45 million acres. Within this section there are six (6) NPC systems; four (4) of which are generally represented in lowland areas and two (2) systems that are generally considered in upland terrain areas. Lowland systems cover almost two-thirds of the NMOP Section (2.9 million acres) while upland systems cover approximately 20 percent or about 880,000 acres. The six systems are listed below and areas covered summarized in Tables 1 and 2.

Lowland Systems
- Acid Rich Peatland.
- Forest Rich Peatland.
- Floodplain Forest.
- Wet Forest.

Upland Systems
- Fire Dependent.
- Mesic Hardwood.

Table 1
NMOP Land Areas by Lowland/Upland

	Acres	**Percent**
Lowland NPC Systems	2,927,185	65.8
Upland NPC Systems	879,546	19.8
Non-Forested Areas	644,238	14.4
Total	**4,450,969**	**100.0**

Table 2
NMOP Land Areas by NPC Systems

Code	**NPC System**	**Acres**	**Percent**
Lowland Systems			
AP	Acid Peatlands	80,275	2.7
FP	Forest Rich Peatland	2,441,837	83.4
FF	Floodplain Forest	4,119	0.2
WF	Wet Forest	400,954	13.7
Totals		**2,927,185**	**100.0**
Upland Systems			
FD	Fire Dependent	715,557	81.4
MH	Mesic Hardwood	163,989	18.6
Total		**879,546**	**100.0**

Landownership and NPC Systems

The State of Minnesota is by far the largest landowner in the NMOP Section owning almost 2.5 million acres of land or 56.1 percent. Tribes in the region own the second largest amount of land followed by counties, the federal government and industry. Table 3 provides an inventory of landownership in the NMOP Section at the NPC system level.

Table 3
NMOP Section Landownership by NPC Systems

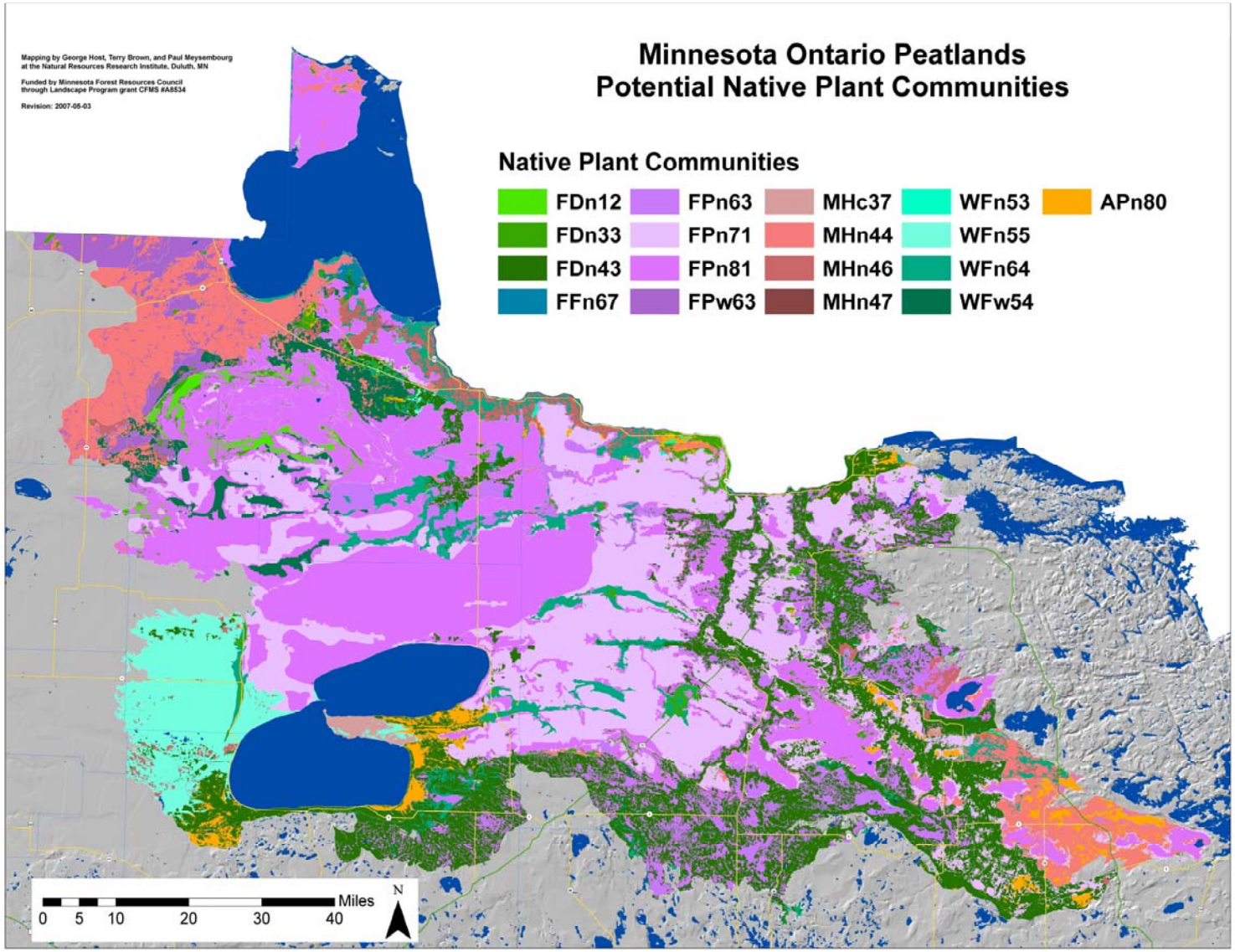
	Acid Peatland	Forested Rich Peatland	Floodplain Forest	Wet Forest	Fire Dependent Forest	Mesic Hardwood Forest	Non-Forested Systems	Total
Private	1,108	15,929	800	4,124	15,084	12,544	11,366	**60,960**
Industrial	1,940	70,358	0	5,465	91,348	12,720	53,580	**235,416**
Tribal	17,524	196,181	0	189,759	73,444	31,285	53,810	**562,013**
County	16,894	138,610	0	14,754	197,538	13,738	41,493	**423,036**
State	32,803	1,862,880	3,311	145,189	208,861	76,630	165,361	**2,495,043**
Federal	7,746	46,002	8	13,422	31,179	2,918	204,347	**305,656**
Undiff. Ownership	2,257	111,866	0	28,229	98,097	14,144	114,251	**368,851**
Total	**80,272**	**2,441,826**	**4,119**	**400,942**	**715,551**	**163,979**	**644,235**	**4,450,924**

D. System Descriptions in the Northern Minnesota & Ontario Peatlands Section

The following narrative provides a summary of the six NPC systems in the NMOP Section. A general overview is provided first along with a listing of the NPC classes and then followed by a silvicultural description. A map of the potential NPC classes is provided on the following page.

For more information on NPC classes and the NPC classification methodologies, please refer to "*Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province*".

Figure 1
Potential NPC Map



Acid Peatland System (AP)

The Acid Peatland (AP) System is characterized by conifer-, low-shrub, or graminoid-dominated communities that develop in association with peat-forming Sphagnum. AP communities are acidic (pH < 5.5), extremely low in nutrients, and have hydrological inputs dominated by precipitation rather than groundwater. These communities are floristically depauperate, with the flora composed primarily of a small subset of species characteristic of rich peatland systems that are able to survive in the harsh, low-nutrient environments typical in AP communities. The floristic differences between forested and open AP communities are subtle because of low species diversity in the AP System as a whole and because trees, when present, are usually sparse, making the boundary between forested and open AP communities diffuse. Therefore, this classification places all acid peatland communities into one System, unlike the rich peatland communities, which are divided into forested and open systems.

AP communities are widespread in the Laurentian Mixed Forest (LMF) Province because of cool climate, abundant precipitation, numerous poorly drained basins, and extensive poorly drained glacial lake plains, which produce favorable conditions for peat development across much of the Province. AP communities tend to be prevalent in basins in areas with non-calcareous soils and on lake plains underlain by impermeable clayey and loamy soils, which minimize movement of groundwater through the overlying peat.

NPC Classes in the AP System

- Northern Spruce Bog (APn80)

APn90 foreground/APn80 background
Courtesy of MN-DNR Ecological Resources

Northern Spruce Bog
Courtesy of Eli Sagor

Northern Spruce Bog
Courtesy of Eli Sagor

Silvicultural Description

The canopies of forests in the AP System are typically dominated by black spruce. Trees are usually stunted (<30 ft or 10m tall) with 25-75% cover. Some sites have scattered tamarack in addition to black spruce. The vegetation in the area is composed only of bog species, with very low species diversity. This environment occurs where a buildup of peat causes the peat surface to become isolated from mineral-rich runoff or subsurface flow so that all mineral inputs come from precipitation.

Although fires can occur in spruce bogs, they are not very common. Records indicate that the historic rotation of catastrophic fires in these areas was in excess of 1,000 years. Superficial fires appear to have been more common, occurring about every 120 years. Such fires can kill black spruce trees and favor nearly continuous cover of leatherleaf. Following lighter fires, some of the characteristic shade-tolerant understory species usually remain at the site. Severe, catastrophic fires can result in conversion of the peatland to an open bog community dominated by bog wire grass. If sufficient nutrients are released into surface waters by burning of peat and vegetation, the bog may be converted to a poor fen. Recovery to forested conditions may take decades in these peatlands. The ability of black spruce to send up new stems, or layer, from branches buried by peat has been interpreted as an adaptive trait for surviving windthrow. There is, however, little direct evidence that windthrow has a significant impact on spruce bogs. Records suggest the historic rotation of catastrophic windthrow in these areas was about 700 years. These trees are somewhat susceptible to windthrow because of structurally weak peat soils and shallow root systems, but this seems to be offset by short height (<30ft or 10m), sparse crowns, rootgrafting, and branch-layering.

There are several management options that are suggested to help support the conservation of particular species, and general diversity, in the area. The first is to use natural disturbance patterns to help guide rotation periods. Landscape disturbance patterns can also be mimicked by timber harvesting practices to help maintain the natural succession of these lowland species and environments. If timber is harvested in this area, regulation and monitoring of damage to the area, such as rutting and other negative impacts on the soils, vegetation and hydrology of the area need to be addressed. One advisable action is to harvest only in frozen-soil conditions to keep the impact on the environment at a minimum. Options such as harvesting spruce tops and boughs may produce extra revenue from the area.

Methods to mimic the natural disturbance of the area could be provided by several management options. The first is to leave reserve trees in the area after harvesting. While these trees leave some potential for seed dispersal they also act as future snag trees, and attempts to mimic the stratified vertical pattern natural to the landscape. Leaving downed logs in the area may also mimic the disturbance of windthrow. Regenerating the area may cause a problem due to a lack of knowledge on how to regenerate species in lowland bog areas. Some options include aerial seeding, which may only be possible if pathogens such as dwarf mistletoe aren't present in the area.

Forested Rich Peatland System (FP)

Forested Rich Peatland (FP) communities are conifer- or tall shrub-dominated wetlands on deep (>15in [40 cm]), actively forming peat. They are characterized by mossy ground layers, often with abundant shrubs and forbs. FP communities are widespread in the Laurentian Mixed Forest (LMF) Province. The cool climate of the region, abundant precipitation, and presence of poorly drained basins and glacial lake plains result in extensive peat development relative to other parts of Minnesota. These communities are particularly prominent in the Northern Minnesota and Ontario Peatlands and the Minnesota Drift and Lake Plains sections within Minnesota.

FPn63 – Northern Cedar Swamp
Courtesy MN-DNR Ecological Resources

NPC Classes in the FP System

- Northern Cedar Swamp (FPn63)
- Northern Rich Spruce Swamp (FPn71)
- Northern Rich Tamarack Swamp (FPn81)
- Northwestern Rich Conifer Swamp (FPw63)

FPn71 – Northern Rich Spruce Swamp
Courtesy MN-DNR Ecological Resources

FPn82 – Northern Rich Tamarack Swamp
Courtesy MN-DNR Ecological Resources

Silvicultural Description

This area's understory is comprised mostly of white cedar, balsam fir, black spruce, tamarack and paper birch, with a few elm and black ash. The canopy is made up by the same species composition with a variable 25-100% canopy cover.

This area very rarely experiences catastrophic fire disturbance, with an estimated rotation of about 400 years in some areas and up to almost 1,000 years in other areas. The areas that are more susceptible to fire disturbance are those with more poorly drained landscapes paralleled with extreme draught.

Because of structurally weak peaty soils and shallow root systems, trees in this area are susceptible to windthrow, resulting in somewhat shorter rotations for both stand-regenerating catastrophic windthrow (about 600 years) and windthrow of small patches of canopy trees (about 380 years). Smaller disturbances resulting in partial mortality of the canopy were somewhat common, with a rotation of about 80 year**s**, and are presumed to have involved both patchy windthrow and surface fires. Hummocks of soil and peat are also somewhat common due to the presence of tip-up-mounds found from fallen and wind-thrown trees. Recommended silvicultural methods in this area are similar to the Acid Peatland system, with a high presence of downed woody debris as well as snags.

Floodplain Forest System (FF)

Floodplain Forest (FF) communities are present on occasionally or annually flooded sites on terraces and floodplains of streams and rivers. FF communities are dominated by deciduous trees tolerant of saturated soils, prolonged inundation, and frequent erosion or deposition of sediment. Common species include characteristic floodplain trees such as silver maple, American elm, cottonwood, and black willow, and wet and mesic forest trees such as black ash, green ash, basswood, and white spruce. The understory often is open, with few shrubs or saplings. Ground-layer cover is highly variable, ranging from areas of bare silt or sand to dense patches of wood nettle or ostrich fern. Pools or mucky depressions in old channels are characteristic of more actively flooded sites. FF communities are associated with streams and rivers throughout the Laurentian Mixed Forest (LMF) Province but are generally not as extensive as those associated with rivers in the Eastern Broadleaf Forest or Prairie Parkland Provinces, which have larger rivers with broader floodplains.

FFn67 – Northern Floodplain Forest
Courtesy of MN-DNR Ecological Resources

Floodplain Forest
Courtesy of MN-DNR Resources

Flooding along streams and rivers is fed by surface flow as well as base flow that enters streams and river beds as groundwater. Most of the surface flow reaches streams or rivers over frozen or saturated ground in the spring, initiating flooding in the lower reaches of the watershed. After spring flooding, base flow maintains river levels. Floodplain challenges for plants include inundation, erosion, sedimentation, and severe scarring of tree trunks by flood-transported ice and debris. Flooding also results in chemical or physiological stresses, especially lack of the oxygen necessary for plant metabolism and decomposition of litter. Although the annual pattern of flooding is predictable, the timing, duration, and energy vary from year to year. Flooding causes a rather constant shifting of sediment and features such as point-bars, meander scrolls, levees, and backwaters that control where understory plants occur in the community.

NPC Classes in the FF System

- Northern Floodplain Forest (FFn67)

Silvicultural Description

The canopy is interrupted to continuous (50–100% cover) and strongly dominated by silver maple, with occasional green ash, black ash, or American elm. The understory shrub and sub-canopy layer is sparse to patchy (5-50% cover) and is comprised of silver maple, green ash and American elm.

Due to the limited extent of this community, Public Land Survey data are insufficient to reliably calculate natural disturbance regimes. Windthrow and fire were not explicitly referenced at any survey corners along northern rivers, and their influence on the community is believed to have been much less than that of flooding. The data are also too sparse to determine historic tree composition or define growth stages. The most frequent trees in modern floodplain forests—silver maple, green ash, black ash, American elm, and bur oak—were also the most common bearing trees along rivers. The historic notes indicate that ash and American elm occurred more frequently than silver maple, in contrast to modern forests, where silver maple is dominant, with ash and American elm occurring less frequently and mainly in the understory.

With the forest lowland-deciduous systems, there are several management options to help support species conservation. One is promoting the management of uneven aged stands of mature trees. Managing stands to help retain biological legacies at the site level, such as promoting large trees with cavities, is beneficial. Therefore, harvesting with reserves is one option for the area. Due the lowland, and often-saturated soils, harvests should be scheduled when the soils are frozen, leaving a smaller chance for sited to be damaged during harvesting operations.

Wet Forest Systems (WF)

Wet Forest (WF) communities occur commonly in narrow zones along the margins of lakes, rivers, and peatlands; they also occur in shallow depressions or other settings where the groundwater table is almost always within reach of plant roots but does not remain above the mineral soil surface for long periods during the growing season. Because of a cool climate characterized by regular precipitation and slow rates of evaporation, WF communities are common across the Laurentian Mixed Forest (LMF) Province. They are dominated most often by black ash or white cedar, with understories characterized by patches of shrubs such as speckled alder or mountain maple, mosses and upland forest herbs on raised hummocks, and sedges and wetland forbs in wet or mucky hollows.

WFn55 – Northern Wet Ash Swamp
Courtesy of MN-DNR Ecological Resources

WF communities are strongly shaped by steady fluxes of water and nutrients supplied to deep soil layers by moving groundwater. In basins or depressions connected to annually recharged shallow aquifers, the supply of groundwater peaks early in the growing season but persists at some level through much of the summer. In settings connected to deeper aquifers that discharge groundwater throughout the year, the supply of water and nutrients is steady through the growing season. The groundwater moves laterally below the surface but often upwells to create springs, seeps, or spring runs within and adjacent to WF communities. Varied microtopography and variation in groundwater supply on sites fed by shallow aquifers result in the alternating presence of water-logged and dry conditions in upper soil layers. This variability in soil moisture in both space and time is a hallmark of the WF System and controls the availability of the oxygen needed for roots to respire, for decomposition of organic litter, and for release of nutrients in forms usable by plants.

WFn64 – Northern Very Wet Ash Swamp
Courtesy of MN-DNR Ecological Resources

NPC Classes in the WF System

- Northern Wet Cedar (WFn53)
- Northern Wet Ash Swamp (WFn55)
- Northern Very Wet Ash Swamp (WFn64)
- Northwestern Wet Aspen Forest (WFw54)

WFw54 – Northwestern Wet Aspen Forest
Courtesy of MN-DNR Ecological Resources

Silvicultural Description

Species present in the sub-canopy of this area include white cedar, balsam fir, black ash, basswood, red maple, yellow birch quaking aspen, paper birch sugar maple and green ash. The canopy is composed mostly of the same species with a small component of black spruce, white spruce and tamarack.

In the past, catastrophic disturbances were infrequent in WFn53. An analysis of Public Land Survey records indicates that the rotation of catastrophic fires was more than 800 years, and the rotation of catastrophic windthrow was more than 300 years. Events that result in partial loss of trees, such as patchy windthrow or light surface fires, were also rare, with a rotation of about 340 years.

Succession is evident in this system, with various species growing at varying times under the canopy. Different sites differ by species located within the canopy and sub-canopy at any point in time. In order to preserve the species diversity in the area and mimic natural selection, harvesting while leaving reserves and underplanting other species at certain time intervals would best replicate the natural growth and establishment in the area.

Fire-Dependent Forest/Woodland System (FD)

FDn43 – Northern Mesic Mixed Forest
Courtesy of Tom Duffus (asking permission)

Fire-Dependent Forest/Woodland (FD) communities are common across the Laurentian Mixed Forest (LMF) Province, even after nearly 100 years of wildfire suppression. As the name implies, Fire-Dependent Forest/Woodland communities are strongly influenced by wildfires. Fires are the major source of species mortality and exert strong influence on patterns of plant reproduction by exposing mineral soil seedbeds, triggering dispersal of propagules, and increasing the amount of light reaching the ground or understory. Fires periodically remove much of the litter, duff, and other organic material from the community and can have a significant effect on nutrient cycling and nutrient availability. In the LMF Province, FD communities are characterized by prevalence of evergreen species, most visibly pines and other conifers. These species, like most of the species are adapted to survive repeated fires or to regenerate successfully following fire.

FD communities occur in the LMF Province on sites with coarse sandy or gravelly soils or with thin soils over bedrock. These sites are often drought prone, a condition enhanced by removal by fire of organic material, such as litter and humus that retains soil moisture. Fires also can contribute to low nutrient availability in FD communities by releasing nutrients from plant material and making them susceptible to being leached below the plant rooting zone or carried away by runoff. In comparison with other communities, such as Mesic Hardwood Forests, in which nutrient availability changes predictably over each year and remains relatively stable from year-to-year, the random behavior of wildfires causes nutrient availability in FD communities to be episodic and unpredictable.

NPC Classes in the FD System

- Northern Dry-Sand Pine Woodland (FDn12)
- Northern Dry-Mesic Mixed Woodland (FDn33)
- Northern Mesic Mixed Forest (FDn43)

Silvicultural Description

Jack pine, red pine and white spruce are the dominant species in these areas. These species are often successful due to their ability to adapt their physical conditions to these sites. Quaking aspen was also native to some of these sites but occurred naturally at lower abundance. In some areas catastrophic fires killed most canopy trees and created young forests with clear dates of origin. Other sites were abundant with young seedlings recovering from stand-regenerating fire. Often crown fires and severe surface fires left a rather clean, mineral-soil slate for tree establishment.

Silvicultural systems such as clear-cutting or clear-cutting with reserves best matches our impression of natural fires and skips. Quaking aspen, big-toothed aspen, and jack pine are the species with open regeneration strategies able to succeed following clear-cutting and variable seedbeds ranging from mineral (jack pine, big-toothed aspen) to rather undisturbed duff (quaking aspen).

Although fires are historically present in these areas, these silvicultural practices are often our only choice in mimicking this natural disturbance on a large-scale. When possible, however, controlled burns are a preferred option. While clear-cutting and clear-cutting with reserves mimics the light distribution in an area fairly well, components left by fires such as burned snags, tree scars and accelerated nutrient cycling are missing.

Mesic Hardwood Forest System (MH)

Mesic Hardwood Forest (MH) communities are present in the Laurentian Mixed Forest (LMF) Province on upland sites with moist soils, usually in settings protected from fire. They are characterized by continuous, often dense, canopies of deciduous trees, including sugar maple, basswood, paper birch, and northern red oak, and understories with shade-adapted shrubs and herbs.

MHn37 – Central Mesic Hardwood
Courtesy of MN-DNR Ecological Resources

Plants in MH communities have access to predictable supplies of water and nutrients, but they are often limited by light because of the dense forest canopy. Typical sites are buffered from seasonal drought by fine-textured, moisture-retaining soils or dense subsoil layers that perch snowmelt and rainfall. At the same time, soils are well drained and do not experience water logging or saturation except after spring snowmelt or heavy rains. Consequently, plants in MH communities rarely experience diminished respiration due to soil anoxia. Essential nutrients, especially nitrogen, are mineralized from decaying organic matter at twice the rate of that in either Fire-Dependent Forest/Woodland (FD) or Wet Forest (WF) communities. As a result, nutrients in dead plant material quickly become available again for uptake by plants.

Possible MHn44 –
Northern Wet-Mesic Boreal Hardwood-Conifer Forest
Courtesy of MN-DNR Ecological Resources

Nutrient availability in MH communities follows an annual or seasonal pattern that is more predictable than in FD forests, where nutrients are released mainly following episodic fires. Tree mortality in MH communities is also rather constant, with stand-regenerating disturbances such as wildfires and windthrow uncommon. The death of established trees most often involves individual canopy trees or small patches that are affected by minor windthrow, disease, or other fine-scale disturbances.

NPC Classes in the MH System

- Central Mesic Hardwood Forest (MHc37)
- Northern Wet-Mesic Boreal Hardwood-Conifer Forest (MHn44)
- Northern Wet-Mesic Hardwood Forest (MHn46)
- Northern Rich Mesic Hardwood Forest (MHn47)

Silvicultural Description

Quaking aspen, paper birch, balsam fir, and white spruce were the dominant native trees that occupied this area historically. White pine, red maple, black ash, balsam poplar, white cedar, bur oak, and red oak are likewise native to some sites but occurred naturally at lower abundance. The consequence of fire suppression, commercial logging, and settlement in the past century has been to promote more balsam fir than usual at the expense of white spruce. Otherwise, most stands are similar to their historic counterparts, and management interpretations are not complicated by the ingress of atypical species.

Historically, senescence of the initial-cohort trees created regeneration opportunities for trees, ranging from single-tree gaps to large gaps up to an acre in size. Several silvicultural systems could be used to approximate the natural loss of initial-cohort trees and regeneration typical of transitioning forests. Selective harvesting matches best the small-gap mortality pattern, and would favor white spruce and balsam fir. Shelterwood variants or group selection would create the large-to-small openings that favor recruitment of white spruce, balsam fir, red maple, and black ash. Paper birch, red oak, bur oak, white cedar, white pine, and basswood should all do well in the larger gaps created by patch cutting or variants of seed-tree harvests.

Given that only minimal stands in the area were described as having been burned or windthrown, it is clear that destructive agents other than these obvious catastrophes were involved to create so much young, small diameter forests. We suspect chronic disease and possibly surface fire. What seems clear from the historic records is that young, re-initiated stands were patchy and offered a mixture of situations where seeding, sprouting, and release of advance regeneration worked together to initiate the next forest. It is highly unlikely that re-initiated forests resembled something as uniform as a clear-cut. Clear-cutting with reserves, patch cutting, and variants of seed-tree cutting could all approximate the natural pattern of disturbances that created young forests. Clear-cutting with reserves would favor quaking aspen and balsam poplar, which are primarily open regeneration strategists on sites. Patch cutting or variants of seed-tree harvests are silvicultural strategies that should work to re-initiate stands and favor trees that do well in the open or in large gaps such as paper birch, white cedar, and white pine.

E. Suggested Silvicultural Prescriptions

Detailed silvicultural prescriptions for many of the NPC classes in the NMOP Section are available on the MN DNR website. Please refer to:

http://www.dnr.state.mn.us/forestry/ecs_silv/interpretations.html

Lowland NPC Classes

- Northern Spruce Bog (APn80)
- Northern Cedar Swamp (FPn63)
- Northern Rich Spruce Swamp (FPn71)
- Northern Rich Tamarack Swamp (FPn81)
- Northwestern Rich Conifer Swamp (FPw63)
- Northern Floodplain Forest (FFn67)
- Northern Wet Cedar (WFn53) *
- Northern Wet Ash Swamp (WFn55)
- Northern Very Wet Ash Swamp (WFn64) *
- Northwestern Wet Aspen Forest (WFw54)

Upland NPC Classes

- Northern Dry-Sand Pine Woodland (FDn12) *
- Northern Dry-Mesic Mixed Woodland (FDn33) *
- Northern Mesic Mixed Forest (FDn43) *
- Central Mesic Hardwood Forest (MHc37)
- Northern Wet-Mesic Boreal Hardwood-Conifer Forest (MHn44) *
- Northern Wet-Mesic Hardwood Forest (MHn46)
- Northern Rich Mesic Hardwood Forest (MHn47) *

** NPC classes currently on the DNR silvicultural interpretations website.*

Section 5
Public Input and Decision-Making Process

A. Focus Meetings

The Committee held three focus meetings dealing with the topics of economics (May 15, 2003), social (June 19, 2003), and ecology (July 17, 2003). At each meeting the Committee discussed information they had requested of staff for the topic and then developed desired outcomes, goals, and strategies for the topic. Once the meeting was over the Committee did not want to re-visit the topic at future meetings.

B. Decision-Making Process

An additional meeting was held on August 28, 2003, to integrate the results of the three focus meetings into a final set of recommended desired conditions, goals, and strategies to recommend to the Council. The majority of the Northern Regional Committee supported the recommended goals and strategies, however, not all Northern Regional Landscape Planning Committee members were in agreement with the contents of this plan. The Sierra Club did not support the final plan due to the lack of data and specificity of the ecological goals and lack of analysis of the interaction between economic and ecological goals.

The recommendations were submitted to the Landscape Committee for review. The Landscape Committee requested additional work on some of the goals and strategies. The Northern Regional Landscape Committee re-convened on December 11, 2003, to discuss the Landscape Committee's requests and modify their original recommendations to meet those requests. There was still no consensus on the modified recommendations although a majority of Northern Regional Committee members did support them with the Sierra Club not in agreement with the plan for the reasons stated above.

C. Input on the 2010 Plan Amendment

Members of the Northern Committee provided input for the formation of the amended ecological policy framework through a series of worksheets, committee meeting discussions, and detailed review of draft text developed by staff.

One of the worksheets asked members to individually rank forests in each of the given NPC systems with a scale of high (H), medium (M) or low (L) as for three broad management areas including forest productivity, recreational opportunities and ecological vulnerability. The collective results from the worksheets were then tabulated and presented back to the Committee for their further consideration.

Table 4 summarizes the results for the NPC system values exercise.

Table 4
Ranking NPC Systems

Code	NPC System	Description	Acres	Forest Productivity (H,M,L)	Recreation Opportunities (H,M,L)	Ecological Vulnerability (H,M,L)
Lowland						
AP	Acid Peatlands	Conifer, low shrub peat communities, acidic soils, extremely low nutrients, hydro precip based	80,275	**M **** 2.08 (12.5)	**L ***** 1.00 (6.0)	**H/M *** 2.58 (15.5)
FP	Forest Rich Peatland	Conifer tall shrub wetlands on deep actively forming peat, poorly drained level basins	2,441,837	**H/M** 2.25 (13.5)	**L** 1.08 (6.5)	**H/M *** 2.58 (15.0)
FF	Floodplain Forest	Located on occasionally or annually flooded sites on terraces and floodplains of streams and rivers	4,119	**M** 2.00 (12.0)	**L** 1.25 (10.5)	**H/M** 2.66 (16.0)
WF	Wet Forest	Located in narrow zones along lakes, rivers and peatlands	400,954	**M** 1.83 (11.0)	**M/L** 1.75 (10.5)	**H/M *** 2.66 (16.0)
Upland						
FD	Fire Dependent	Strongly influenced by wildfires, course or gravelly soils or thin souls over bedrock	715,557	**H** 2.83 (17.0)	**H/M** 2.75 (16.5)	**M/L** 1.58 (9.5)
MH	Mesic Hardwood	Upland sites with moist soils, usually protected from fire.	163,989	**H** 3.00 (18.0)	**H/M** 2.66 (16.0)	**M/L** 1.5 (9.0)

Notes: Six worksheets were returned for tabulation. The results for each NPC system in the table above includes a high to low ranking, the average score and total score assigned by the 6 respondents collectively. Scoring weights assigned in this exercise include the following: High (H) = 3.0; High/Medium (H/M) = 2.5; Medium (M) = 2.0; Medium/Low (M/L) = 1.5; and Low (L) = 1.0

Comments:

* = Not vulnerable if operated on frozen ground; no shortage of acres of this NPC system around here! Easily damaged if used improperly.

** = Both ends of the scale – some of this is unproductive bog, some productive spruce. Probably far more, or fewer, acres are unproductive.

*** = Fewer users; opportunities tend towards bird watching, plant ID (if you can get there).

(*Page left blank intentionally*.)

Section 6
Forest Management Policy Framework

One of the key tasks charged to the Northern Committee in the planning process was the development of a long range vision for guiding the sustainable management of the forests across the 4.5 million acre landscape.

The vision for forest management is first described through desired future conditions (DFCs), statements which are long-range in nature, providing a vision for the future of the landscape in approximately one hundred years—a roadmap for "where we want to go." Next a series of goals and more detailed strategies have been developed to further describe how the desired future conditions can be achieved. Goals and strategies are short-term (10-20 years) steps that can be accomplished to move the landscape toward the desired future conditions.

Together, these statements form the forest management policy framework. This section in an outline format, describes the Committee's vision based on economic, social and ecological perspectives. The following policy framework includes the amended revisions from the 2010 Plan Amendment as developed by the Northern Committee.

Readers are encouraged to review the entire framework of statements (DFCs, goals and strategies) to better understand how to apply the concepts to the forests they manage across the landscape region.

In 100 years, the Northern landscape region will have the following characteristics:

A. Economic

Desired Future Conditions:

- A vibrant economy capable of sustaining the Northern Landscape's population and communities.

Goals and Strategies:

Goal 1: Stabilize and improve employment and incomes by sustainable use of landscape assets.

Strategies:
- Encourage utilization of biomass as a renewable fuel source.
- Promote interagency cooperation leading to more timely permitting processes.
- Promote and protect responsible and sustainable use of ATV's through locally developed plans.
- Encourage landowners to develop science-based management plans.
- Evaluate changes in local and state policies that could assist existing industries.
- Provide increased loan funds for business startups and expansions.

Goal 2: Increase the Northern Landscape's average mean annual increment (MAI) for timber growth as measured by the USDA FIA program.

Strategies:
- Support silvicultural productivity research.
- Increase capture of mortality.
- Encourage land managers to harvest at rotation on all timber types.
- Ensure prompt, adequate regeneration on all harvested sites.
- Increase utilization within harvest areas, consistent with the site-level guidelines.
- Promote use of existing silvicultural science in management practices (thinning, insect control, etc.).

Goal 3: A stable or rising population as measured by census data.

Strategies:
- Create jobs that would attract young adults.

Goal 4: Stable employment figures within job sectors that pay at or above the living wage.

Strategies:
- Accomplish this through action on the other strategies listed in economic goals 1-8.
- Encourage economic development through existing organizations (i.e. KEDA).

Goal 5: Increase farm income.

Strategies:
- Promote local consumption of local livestock.
- Identify and promote alternative agricultural products.

Goal 6: Maintain or increase timber harvest in the Northern Landscape in a sustainable manner consistent with site-level guidelines.

Strategies:
- Encourage landowners to actively and sustainably manage forest lands.
- Identify forest types for increased harvest.

Goal 7: Diversify the local economy.

Strategies:
- Promote the marketing of locally crafted forest products.
- Increase job opportunities in the 60+ age group.
- Promote deer archery hunting.
- Encourage creation of value added forest products.
- Promote businesses that complement existing industries.
- Promote tourism and recreational economies.
- Consider pursuing designation as a JOB zone.

- Identify economic opportunities as a result of increased international trade.
- Increase entrepreneurial capacity by targeting entrepreneurial business opportunities and startups.
- Create an enterprise center network.
- Manage wildlife to increase recreational opportunities.

Goal 8: Ensure educational opportunities to promote economic stability.

Strategies:

- Include retirees as knowledgeable economic/entrepreneurial resources.
- Collaborate with college and high school students to develop detailed plans and studies concerning the goals and strategies in this landscape plan.
- Promote use of county extension services.

B. Social

Desired Future Conditions:

- A landscape with a distinctive identity where residents and visitors have a strong sense of place and that fulfills social needs.
- A region that balances social needs and landscape planning.

Goals and Strategies:

Goal 1: Maintain and/or increase access to public lands and waters, and private lands open to the public, for sustainable multiple use.

Strategies:
- Provide for a diversity of both motorized and non-motorized recreational uses for residents and visitors.
- Enhance facilities at public access points.
- Maintain a stable public land base

Goal 2: Increase the well being of the landscape's population.

Strategies:
- Enhance housing programs to upgrade housing stock within the landscape.
- Strive for continuous improvement of air and water quality.
- Ensure adequate youth programs exist.
- Recognize that the landscape's multi-generational social and cultural fabric is closely and directly tied to the land.
- Ensure that land use and building codes reflect "FIREWISE".
- Recognize the importance to the communities of good social services such as schools, health care, and roads.

Goal 3: Promote future development within existing transportation corridors.

Strategies:
- Continue to implement local comprehensive land use plans.

C. Ecological

Desired Future Conditions:

- To maintain a viable, healthy functioning ecosystem on the landscape, by managing forests towards the potential of what the land can produce and sustain (please refer to Ecological Goal 5).

Goals and Strategies:

Goal 1: Maintain viable populations of existing plant and animal species.

Strategies:
- Maintain sufficient diversity and extent of habitat to support existing species
- Implement the Council's *Voluntary Site-Level Forest Management Guidelines.*

Goal 2: Ensure the sustainability of natural resource uses.

Strategies:
- Ensure that appropriate tree species occupy the appropriate sites.
- Promote the ecological sustainability of public lands that have a fiduciary responsibility to produce a sustainable income stream (for example: county lands, school trust fund lands, con-con lands). Applies to Social Goal 2 as well.

Goal 3: Ensure the consideration of the role of natural processes and disturbances in planning and implementing management activities.

Strategies:
- Encourage land managers to use forest habitat type classification systems in forest planning and management (for example: Kotar and Almendinger/Hanson).
- Review and consider new research and science in forest land management decision-making on an on going basis.
- Gain a better understanding of how age-class distribution has varied over time.

Goal 4: Improve information sources for management decision making

Strategies:

- Publicize and encourage the implementation of the forest management goals and strategies for each native plant community in the Minnesota & Ontario Peatlands Section.
- Support ECS, NPC and habitat type training for field foresters and resource managers working in the Northern landscape region.

Goal 5: Ecological Classification Systems. Encourage resource managers and private landowners to manage their forests by using ecological classification system concepts (MN DNR ECS, Kotar, etc.) to determine site suitability and potential forest management opportunities.

Strategies:

- Develop NPC field guides (Tatum guides) for the native plant communities in the Minnesota & Ontario Peatlands Section and distribute to field foresters and resource managers working in the region.
- Develop crosswalks between cover types with ECS/NPC and habitat type systems and distribute to field foresters and resource mangers working in the region.

D. NPC System Based Forest Management Goals and Strategies

As a part of the process for the 2010 Plan Amendment, the Northern Committee developed a series of specific forest management goals and strategies based on the NPC systems in the Northern Minnesota & Ontario Peatlands Section. These goals and strategies are based on the upland and lowland forest systems delineated in the NPC study (please see Section 4 for more information). Goals and strategies were developed for the following NPC forest systems:

Upland Systems
- Mesic Hardwood Forest.
- Fire Dependent Forest/Woodland.

Lowland Systems
- Acid Rich Peatland.
- Forest Rich Peatland.
- Wet Forest.
- Floodplain Forest.

Readers will note that at the beginning of the goals and strategies for each NPC system, there is some background information included to assist the reader of the plan. The information includes: 1) basic geographic information, 2) an inventory of the NPC classes by landowner type, and 3) a value ranking (high, medium, low ranking) as determined by the Northern Committee for forest productivity, recreation opportunities and ecological vulnerability (please see Section 5 for more information).

Collectively, this information was used by the Committee to form the recommended NPC system based goals and strategies. Land managers and owners are encouraged to adopt and implement these more specific goals and strategies as well as support the recommended collaborative projects. They are also encouraged to view ECS and NPC as tools to provide relevant information to resource managers and decision makers, these concepts are not an end or a goal in and of themselves. The Committee further encourages that landowners use these concepts as ways to mimic natural systems and forests habitats in order to promote the sustainable management of forests across the landscape region.

Readers should also note that the Committee decided to develop a “crosswalk” diagram to support movement towards the more consistent use of ecological classification systems. Currently, major landowners in the region use different ecological classification schemes (Kotar, Almendinger/Hanson, and others), which has caused some confusion in cross boundary forest management efforts. The crosswalk diagram is intended to serve as a starting point for dialogue by land managers to increase coordinated forest management across the landscape region. The crosswalk diagram is provided in Appendix C.

Upland Systems

Mesic Hardwood Forest System

Area:
- 163,989 acres
- 18.6% of the uplands systems in the Northern Minnesota & Ontario Peatlands Section.

Current Land Ownership:

NPC Classes	Private	Industry	County	State	Tribal	Federal	Und Own	Total
MHc37	0	0	14,015	0	33	1,521	0	15,571
MHn44	8,352	8,968	5,741	12,525	67,759	604	10,383	114,336
MHn46	4,189	3,752	11,529	1,213	8,791	793	3,761	34,032
MHn47	3	0	0	0	47	0	0	50

Forest Management Values:

Code	NPC System	Description	Forest Productivity (H,M,L)	Recreation Opportunities (H,M,L)	Ecological Vulnerability (H,M,L)
MH	Mesic Hardwood	Upland sites with moist soils, usually protected from fire.	**H**	**H/M**	**M/L**

Long Term Goals
- Encourage the use of even aged silviculture systems to perpetuate a diverse age class distribution with an emphasis on younger aged, aspen-dominated forests or aspen trending to conifer or hardwoods.
- Provide for critical forest habitats such as upland cedar inclusions.

Recommended Forest Management Strategies:
- Manage predominantly for younger aged forests, primarily aspen species using even age management and clear cutting with leave patches as guided by MFRC site-level guidelines.
- Manage some older age class aspen forests for late succession, conifer dominated forests; allowing conversion to conifer or mixed hardwoods where site conditions permit.
- Manage critical habitats such as upland cedar within aspen-dominated forests; consider using residual cedar and remnants as reserve patches.
- Coordinate salvage operations to promote forest health following insect and disease outbreaks.

Recommended Collaboration Strategies:

- Support the development of targeted training efforts for upland forest systems.
- Support the convening of work groups to work on priority projects in areas with upland forest systems.
- Joint road system layout and harvest block designs to promote minimal road construction and impacts on wildlife.
- Support joint salvage operations to promote forest health such as spruce budworm outbreaks, etc.

Potential Collaborative Projects:

Outreach & Education Projects

- Promote and support education programs and outreach products specific to the Mesic Hardwood Forest system. Address topics such as the economic importance of forest products from this system to diverse outdoor recreation opportunities.
- Public access/wildlife habitat information management project.

Research and Development Projects

- Research and test various forest management practices that maximize the sustainable harvests of younger age forests which support wildlife populations.

Opportunity Area Projects – Pilots or Demonstration Projects

- Develop an opportunity area project focusing on aspen production balanced with early successional wildlife habitat in each of the four NPC classes in the Mesic Hardwood System. Tie in with research project noted above.
- Cooperative on road system layout and harvest block design to promote minimal road construction while enhancing wildlife habitat.

Fire-Dependent Forest/Woodland System (FD)

Area:
- 715,557 acres
- 81.4% of the uplands systems in the Northern Minnesota & Ontario Peatlands Section

Current Land Ownership:

NPC Classes	Private	Industry	County	State	Tribal	Federal	Und Own	Total
FDn12	14	0	2,292	0	18,503	0	5,957	26,767
FDn33	937	4,042	4,629	11,590	28,653	807	10,398	61,058
FDn43	14,133	87,306	66,523	185,948	161,705	30,372	81,742	627,732

Forest Management Values

Code	NPC System	Description	Forest Productivity (H,M,L)	Recreation Opportunities (H,M,L)	Ecological Vulnerability (H,M,L)
FD	Fire Dependent	Strongly influenced by wildfires, course or gravelly soils or thin soils over bedrock	**H**	**H/M**	**M/L**

Long Term Goals:
- Encourage the use of even aged silviculture systems to mimic natural disturbance and perpetuate a diverse age class distribution of pine, spruce/fir, and aspen/birch communities.

Recommended Forest Management Strategies:
- Use even age management and clear cutting with leave patches as guided by MFRC site-level guidelines to mimic natural disturbance on larger scales.
- Reduce and/or manage fuel loading.
- Establish techniques that recognize deer predation issues (planting through slash, increased harvest sizes in appropriate areas, increased coordination by forest and wildlife managers, etc.).
- Encourage and support jack pine re-establishment.
- Encourage prescribed burning when and where possible and appropriate.

Recommended Collaboration Strategies:

- Identify and focus on key sub-landscape areas and partners that can work together to promote jack pine and red pine restoration and management.
- Support the convening of work groups to work on priority projects.
- Support coordinated funding development.
- Support the development of targeted training efforts.

Potential Collaborative Projects:

Outreach & Education Projects

- Foresters and Resource Managers. Integrate specific jack pine and red pine forest management techniques in the SFEC curriculum.
- Loggers. Integrate specific jack pine and red pine forest management techniques in the MLEP curriculum.
- NIPF. Explain sustainable forest harvest and the benefits of harvesting timber using accepted rotation timeframes.
- Deer Management. Project support, funding development, education.

Research and Development Projects

- Deer browse research.
- Jack pine planting or regeneration strategies to reduce browsing mortality.
- Literature search – prescribed burning effects and benefits.

Opportunity Area Projects – Pilots or Demos

- Red Lake Ceded Lands/MN Red Lake WMA – prescribed burns and site preparation. Work with private landowners and agencies.
- Jack pine budworm areas – collaborative harvest efforts.
- Deer predation projects.
- Boreal forest demonstration projects.

Lowland Systems

Acid Peatland System (AP)

Area:
- 80,275 acres
- 2.7% of the lowlands systems in the Northern Minnesota & Ontario Peatlands Section

Current Land Ownership:

NPC Classes	Private	Industry	County	State	Tribal	Federal	Und Own	Total
APn80	1,108	1,940	17,524	16,894	32,803	7,746	2,257	80,275

Forest Management Values

Code	NPC System	Description	Forest Productivity (H,M,L)	Recreation Opportunities (H,M,L)	Ecological Vulnerability (H,M,L)
AP	Acid Peatlands	Conifer, low shrub peat communities, acidic soils, extremely low nutrients, hydro precip based	**M ****	**L *****	**H/M ***

* = Not vulnerable if operated on frozen ground; no shortage of acres of this NPC system around here! Easily damaged if used improperly.
** = Both ends of the scale – some of this is unproductive bog, some productive spruce. Probably far acres are unproductive.
*** = Fewer users; opportunities tend towards bird watching, plant ID (if you can get there).

Long Term Goals
- Encourage the use of even aged silviculture systems to mimic natural disturbance and perpetuate a diverse age class distribution of black spruce /tamarack communities.
- Provide for critical forest habitats and peatland ecosystems.

Recommended Forest Management Strategies:
- Follow MFRC site-level guidelines for harvest on frozen soils.
- Use even aged management of black spruce and tamarack for timber production and forest health, including harvests designs to address eastern larch beetle and mistletoe management, where appropriate.
- Support sustainable harvest of special forest products.

Recommended Collaboration Strategies:

- Support the development of targeted training efforts.
- Support the convening of work groups to work on priority projects.
- Coordinate winter road and harvest block designs to accomplish insect and disease salvage and special products harvest.

Potential Collaborative Projects:

Outreach & Education Projects

- Loggers. Integrate specific peatland forest management techniques in the MLEP curriculum.
- NIPF. Develop targeted training for NIPF landowners on how to sustainably manage peatland forests.

Research and Development Projects

- Support current SNA system and peatland research. Coordinate distribution of research results to foresters, loggers and landowners through education programs.
- Literature search for black spruce reforestation.
- Mechanisms for controlling insect outbreaks such as spruce budworm and eastern larch beetle.
- Climate change impacts on boreal forests.

Opportunity Area Projects – Pilots or Demos

- Set up technique trials with U of MN (CFC and Tree Imp Coop) and USFS.
- NIPF. Work with NIPF landowners to integrate private forest management with work by public agencies.

Forested Rich Peatland System (FP)

Area:
- 2,441,837 acres
- 83.4% of the lowlands systems in the Northern Minnesota & Ontario Peatlands Section

Current Land Ownership by NPC Class:

NPC Classes	Private	Industry	County	State	Tribal	Federal	Und Own	Total
FPn63	4,710	34,765	13,666	60,394	152,667	8,243	34,123	308,570
FPn71	4,453	24,896	48,757	52,528	751,062	24,007	25,739	931,446
FPn81	3,827	10,697	132,680	25,603	883,751	13,752	49,070	1,119,383
FPw63	2,939	0	1,078	85	75,400	0	2,934	82,438

Forest Management Values

Code	NPC System	Description	Forest Productivity (H,M,L)	Recreation Opportunities (H,M,L)	Ecological Vulnerability (H,M,L)
FP	Forest Rich Peatland	Conifer tall shrub wetlands on deep actively forming peat, poorly drained level basins	**H/M**	**L**	**H/M ***

Long Term Goals:
- Encourage the use of even aged silviculture systems to mimic natural disturbance and perpetuate a diverse age class distribution of black spruce /tamarack and cedar communities.
- Provide for critical forest habitats and peatland ecosystems.

Recommended Forest Management Strategies:
- Follow MFRC site-level guidelines for harvest on frozen soils
- Use even aged management of black spruce and tamarack for timber production and forest health, including harvests designs to address eastern larch beetle and mistletoe management, where appropriate.
- Encourage natural regeneration of white cedar cover types, on appropriate sites.
- Support sustainable harvest of special forest products.

Recommended Collaboration Strategies:

- Proactively support targeted training efforts on forest harvest activities in peatland systems.
- Support the convening of work groups to work on priority projects.
- Coordinate winter road and harvest block designs.

Potential Collaborative Projects:

Outreach & Education Projects

- Develop training sessions on forest management in peatland areas. Contact scientists working at the SNAs in peatland areas to find out what they are working on. Integrate into training.
- Emerald ash borer training.

Research and Development Projects

- Support current SNA system and peatland research. Coordinate distribution of research results to foresters, loggers and landowners through education programs.
- Literature search – peatland forest systems and significant hydrology changes on a watershed basis. Document critical water movement patterns and water levels on a watershed basis.
- Research effects of hydrology changes on a watershed basis.
- Coordinate hydrology research studies with county water plans.
- Support research of white cedar natural regeneration methods and systems.

Opportunity Area Projects – Pilots or Demos

- Coordinate special forest products markets with MN DNR Utilization and Marketing and other partners.
- Support the coordination and implementation of a watershed management project.

Wet Forest System (WF)

Area:
- 400,954 acres
- 13.7% of the lowlands systems in the Northern Minnesota & Ontario Peatlands Section

Current Land Ownership:

NPC Classes	Private	Industry	County	State	Tribal	Federal	Und Own	Total
WFn53	22	342	113	467	305	138	32	1,421
WFn55	935	70	176,492	179	24,998	12,044	5,906	220,628
WFn64	2,085	5,053	9,510	14,003	71,847	1,237	17,109	120,846
WFw54	1,082	0	3,644	105	48,039	3	5,182	58,059

Forest Management Values

Code	NPC System	Description	Forest Productivity (H,M,L)	Recreation Opportunities (H,M,L)	Ecological Vulnerability (H,M,L)
WF	Wet Forest	Located in narrow zones along lakes, rivers and peatlands.	**M**	**M/L**	**H/M ***

Long Term Goals:
- Support the use of uneven and even-aged silviculture systems with reserves to mimic natural disturbance and promote mixed species forests.
- Provide for critical forest habitat including white cedar cover types.
- Manage black ash within emerald ash borer context.
- Maintain forests in order to protect and maintain water table levels.

Recommended Forest Management Strategies:
- Plan harvests so as to maintain diversity of canopy and sub-canopy species.
- Use a mix of even and uneven aged management strategies across the NPC system provided site guidelines (RMZ) can be met.
- Manage ash through EAB guidelines.
- Encourage natural regeneration of white cedar cover types, on appropriate sites.
- Follow MFRC site-level guidelines for harvest on frozen soils.
- Manage and control beaver populations in key forest habitat areas.

Recommended Collaboration Strategies:

- Black Ash Management. Identify large areas of black ash stands and relevant land ownership patterns. Convene work groups based on project areas to address needed management activities. Develop cross boundary black ash management projects in priority fashion.
- Training. Develop targeted training for forest harvesting and regeneration of stands in Wet Forest Systems.

Potential Collaborative Projects:

Outreach & Education Projects

- Emerald Ash Borer/Ash Dieback. Support training on silvicultural ramifications – DNR, US FS State & Private Forestry, County, tribal, industry and others.
- EAB Guidelines. Support training on EAB guidelines by stakeholder groups in the region.
- Public Education. Support efforts to inform the general public about EAB and various activities that contribute to its spread such as the transport of firewood.
- Ash Market Development. Support efforts that promote and increase awareness about the development of markets for ash species.

Research and Development Projects

- Emerald Ash Borer. Support and encourage research on EAB and its potential impacts in the Northern landscape.
- Ash Forest/Hydrology Linkages. Support efforts to study the impacts of ash declines on hydrology.
- Alternatives to Ash. Support research and trials on species replacement.
- Ash Market Development. Support the development of markets for ash species.

Opportunity Area Projects – Pilots or Demos

- Emerald Ash Borer control priority projects.
- Ash habitat replacement demonstrations.
- Ash forest/hydrology demonstrations.

Floodplain Forest System (FF)

Area:
- 4,119 acres
- 0.2 % of the lowlands systems in the Northern Minnesota & Ontario Peatlands Section

Current Land Ownership:

NPC Classes	Private	Industry	County	State	Tribal	Federal	Und Own	Total
FFn67	800	0	0	0	3,311	8	0	4,119

Forest Management Values

Code	NPC System	Description	Forest Productivity (H,M,L)	Recreation Opportunities (H,M,L)	Ecological Vulnerability (H,M,L)
FF	Floodplain Forest	Located on occasionally or annually flooded sites on terraces and floodplains of streams and rivers	**M**	**L**	**H/M**

Long Term Goals:
- Protect floodplain forests and retain riparian resources.
- Provide for critical forest habitat.
- Manage black ash within emerald ash borer context.

Recommended Forest Management Strategies:
- Plan harvests so as to maintain diversity of canopy and sub-canopy species.
- Encourage the use of uneven aged management that perpetuates native cover types.
- Use a mix of even and uneven aged management strategies across the NPC system provided site level guidelines (RMZ) can be met.

Recommended Collaboration Strategies:

- Black Ash Management. Identify large areas of black ash stands and relevant land ownership patterns. Convene work groups based on project areas to address needed management activities. Develop cross boundary black ash management projects in priority fashion.
- Training. Develop targeted training for forest harvesting and regeneration of stands in Floodplain Forest Systems.

Potential Collaborative Projects:

Outreach & Education Projects

- Emerald Ash Borer/Ash Dieback. Support training on silvicultural ramifications – DNR, US FS State & Private Forestry, County, tribal, industry and others.
- EAB Guidelines. Support training on EAB guidelines by stakeholder groups in the region.
- Public Education. Support efforts to inform the general public about EAB and various activities that contribute to its spread such as the transport of firewood.
- Ash Market Development. Support efforts that promote and increase awareness about the development of markets for ash species.

Research and Development Projects

- Emerald Ash Borer. Support and encourage research on EAB and its potential impacts in the Northern landscape.
- Ash Forest/Hydrology Linkages. Support efforts to study the impacts of ash declines on hydrology.
- Alternatives to Ash. Support research and trials on species replacement.
- Ash Market Development. Support the development of markets for ash species.

Opportunity Area Projects – Pilots or Demos

- Emerald Ash Borer control priority projects.
- Ash habitat replacement demonstrations.
- Ash forest/hydrology demonstrations.

Section 7
Coordination Framework

Coordination and implementation will occur by landowners in the landscape on an ongoing basis with support from Council staff. The Northern Regional Landscape Committee will meet after this plan is approved to determine how coordination and implementation will begin. The Committee will then meet every 5 years (next meeting April, 2009), or when significant new data becomes available, to assess the impact of any new data and develop an assessment report with recommendations to the MFRC.

(*Page left blank intentionally*.)

Section 8
Monitoring Framework

Monitoring information for economic and social goals will be based on standard, accepted measures as compiled by Census and Labor except as noted below. Ecological measurements will have to be revisited once the habitat and land potential maps and analysis are completed. Until that happens data listed here will be used as in-term measures. The year 2003 will serve as the baseline year from which to measure change in the future.

A. Economic Goals

Goal 2: Increase the Northern Landscape's average mean annual increment (MAI) for timber growth as measured by the USDA FIA program.

Net growth of growing stock on timberland(cuft)[i]

1990	Total	Large diameter	Medium diameter	Small diameter	Nonstocked
Beltrami	22,911,799	7,867,692	11,101,648	3,919,025	23,435
Koochiching	32,802,526	6,149,986	17,499,128	9,130,357	23,055
Lake of the Woods	8,935,310	1,951,743	4,406,090	2,652,741	-75,264
Total	64,649,636	15,969,422	33,006,866	15,702,122	-28,774

2002	Total	Large diameter	Medium diameter	Small diameter	Nonstocked	Not collected
Beltrami	25,768,480	6,742,074	15,368,137	3,689,017	137,010	-167,758
Koochiching	20,924,772	1,570,788	14,344,410	4,950,031	59,542	0
Lake of the Woods	8,818,034	1,171,944	6,032,788	1,884,536	206,348	-477,582
Total	55,511,286	9,484,807	35,745,335	10,523,584	402,900	-645,340

Goal 6: Maintain or increase timber harvest in the Northern Landscape in a sustainable manner consistent with site level guidelines.

Volume of Wood Sold, and Average Price[ii]

	Beltrami Land Department		**Koochiching Land Department**		**B.I.A. (statewide)**		**DNR (statewide)**		**DNR (Beltrami, Koochiching, and Lake of the Woods**	
	Cords Sold	Ave. Price	Cords Sold	Ave. Price	Cords Sold	Ave. Price	Cords Sold	Ave. Price	Cords Sold	Ave. Price
Aspen	16,978	$36.02	38,343	$32.53	48,062	$15.54	475,053	$29.12	140,840	$27.84
Balm	995	$27.79	9,715	$32.02	873	$6.31	1,814	$14.77	425	$7.39
Birch	1,007	$12.69	2,658	$10.89	2,475	$6.12	46,692	$8.93	4,904	$8.65
Ash			2,285	$12.06	7	$13.82	4,472	$9.63		
Elm							22	$33.01		
Oak	21	$7.00	55	$21.75	675	$12.60	10,472	$42.62	2	$5.00
Basswood	624	$18.20	239	$10.15	371	$9.19	5,080	$18.84	26	$6.04
Other Hardwoods	2,093	$12.55			724	$4.13	25,949	$5.60	235	$5.70
Balsam Fir	2,175	$28.73	9,095	$19.91	776	$11.84	38,916	$15.91	14,142	$16.73
White Spruce	152	$22.57			190	$14.59	5,702	$39.86	1,833	$26.93
Black Spruce			9,463	$28.38	392	$13.45	113,679	$26.76	54,984	$26.49
Tamarack			759	$9.17			57,935	$4.45	27,306	$5.52
White Cedar	1	$4.50	2,494	$10.70			3,190	$5.66	1,378	$3.08
Jack Pine	3,935	$46.25	2,230	$43.01	404	$13.45	52,318	$36.25	16,456	$36.10
Red/White Pine	2,145	$57.33	339	$45.07	1,180	$36.61	44,972	$38.66	5,687	$34.62
Total	30,126	$35.21	77,675	$28.49	56,129	$15.11	886,267	$25.74	268,218	$24.82

Removals of growing stock on timberland (cuft)[iii]

2002	**Beltrami**	**Koochiching**	**Lake of the Woods**	**Total**
Eastern white and red pine	0	91,695	0	91,695
Jack pine	256,082	457,516	1,380,260	2,093,859
Spruce and balsam fir	1,194,463	8,077,836	337,088	9,609,387
Other eastern softwoods	92,750	1,429,140	73,124	1,595,015
Select white oaks	211,678	0	0	211,678
Ash	499,488	531,281	0	1,030,769
Cottonwood and aspen	11,831,180	10,465,206	1,738,262	24,034,647
Basswood	305,480	0	0	305,480
Other eastern soft hardwoods	545,084	779,530	0	1,324,614
Total	14,936,205	21,832,205	3,528,734	40,297,144

B. Social Goals

Goal 1: Maintain and/or increase access to public lands and waters, and private lands open to the public, for sustainable multiple use.

Public Water Access Points [iv]

	1998
MN	2,552
Beltrami	54
Koochiching	35
Lake of the Woods	11

C. Ecological Goals

Goal 1: Maintain viable populations of existing plant and animal species.

Cover Type

Species	1977	1990	2001	2001 Beltrami	2001 Koochiching	2001 Lake of the Woods
Jack pine	3.3%	2.7%	3.5%	4.5%	1.4%	8.3%
Red pine	1.1%	2.0%	1.1%	1.9%	0.9%	0.0%
Eastern white pine	0.2%	0.1%	0.2%	0.8%	0.0%	0.0%
Balsam fir	6.0%	4.6%	3.8%	0.6%	4.8%	6.5%
White spruce	0.6%	0.6%	0.9%	1.6%	0.8%	0.0%
Black spruce	16.1%	17.0%	16.9%	4.6%	23.2%	19.8%
Tamarack	6.9%	8.9%	7.9%	8.4%	4.6%	17.5%
Northern white-cedar	10.1%	12.0%	11.6%	7.3%	15.6%	6.5%
Oak / Hickory Group	0.3%	0.7%	1.2%	3.3%	0.3%	0.0%
Elm / Ash / Cottonwood Group	6.7%	8.0%	6.7%	8.5%	6.8%	3.0%
Maple / Beech / Birch Group	2.8%	2.9%	3.1%	8.2%	1.0%	0.0%
Aspen	32.7%	30.4%	31.4%	33.2%	32.1%	25.3%
Paper birch	3.6%	2.6%	4.6%	7.3%	3.5%	3.2%
Balsam poplar	8.4%	6.3%	6.0%	7.0%	4.6%	8.4%
Non stocked	0.9%	1.1%	1.3%	2.9%	0.5%	1.3%
Total (Acres)	2,419,500	2,651,000	2,803,981	868,269	1,485,271	450,441

Timberland Size Class

	1977	1990	2001	2001 Beltrami	2001 Koochiching	2001 Lake of the Wood
Large diameter	434,700	617,500	457,276	206,111	200,228	50,936
Medium diameter	1,217,000	993,700	1,138,352	355,683	564,468	218,201
Small diameter	745,400	1,011,500	1,170,760	281,566	713,744	175,450
Nonstocked	22,400	28,300	37,593	24,908	6,831	5,854
Total	2,419,500	2,651,000	2,803,981	868,269	1,485,271	450,441

Net Growth of Growing Stock on Timberland (cords)[v]

	Beltrami	Koochiching	Lake of the Wood	Total
Eastern white and red pine	24,335	16,295	2,363	42,993
Jack pine	14,751	6,950	6,194	27,894
Spruce and balsam fir	18,077	92,792	19,590	130,459
Other eastern softwoods	32,527	92,937	27,705	153,169
Select white oaks	9,834	1,404	848	12,086
Select red oaks	3,271	0	0	3,271
Other red oaks	61	0	0	61
Yellow birch	-218	18	0	-199
Hard maple	8,395	2,314	0	10,709
Soft maple	4,336	3,383	0	7,719
Ash	18,722	29,549	4,858	53,130
Cottonwood and aspen	141,388	189,223	50,228	380,839
Basswood	15,303	3,569	-98	18,774
Other eastern soft hardwoods	14,926	-1,069	7,449	21,305
Other eastern hard hardwoods	-218	3	0	-214
Total	305,491	437,367	119,137	861,995

Goal 2: Insure the sustainability of natural resource uses.

Bearing Trees and FIA Trends [vi]

Species	1908 Bearing Trees	1977 FIA Forestland	1990 FIA Forestland	2001 FIA Forestland
Tamarack	38.5%	8.5%	11.5%	9.0%
Spruce	20.1%	30.5%	24.1%	19.5%
Aspen	9.6%	23.6%	26.1%	29.8%
Cedar	7.6%	9.8%	11.0%	11.7%
Birch	4.8%	2.7%	2.2%	4.3%
Fir	4.7%	4.6%	4.0%	3.6%
Jack Pine	4.2%*	2.3%	2.2%	3.2%
Ash / Elm	2.6%	7.8%	7.2%	6.7%
Red Pine	2.4%*	0.8%	1.7%	1.0%
Other	2.2%	2.6%	4.0%	4.1%
White Pine	1.9%*	0.2%	0.1%	0.2%
Balm-of-Gilead	1.0%	6.1%	5.3%	5.8%
Oak	0.4%	0.2%	0.6%	1.1%

[i] Source - USDA – Forest Inventory and Analysis, 1990,2002; note numbers are partially different because of different inventory collection methods and also 2002 is only 60% complete.
[ii] Source – DNR 2002 Public Stumpage Price Review and Price Index
[iii] Source – USDA – Forest Inventory and Analysis, 2002
[iv] Source – DNR Waters, Water Access Sites Database
[v] Source – 1990 forest inventory and analysis; Note used a conversion factor of 75 cuft per cord
[vi] Source – Bearing Tree dataset, DNR Data Deli, FIA from http://www.ncrs.fs.fed.us/4801/FIADB/ .

Appendix A
2010 Members of the Northern Committee

Chair: Tom Castonguay

Vice Chair: Perry Eide

Committee Members:

Justin	Berg	District Technician	Koochiching County SWCD
Rod	Bergstrom	Owner	Bergstrom Wood Products, Inc.
Dick	Bing	Forester	Beltrami County NRM
Tom	Castonguay	BIA Forester	Red Lake BIA
Perry	Eide	Landowner	Tree Farmer
Dennis	Hummitzsch	Land Commissioner	Koochiching Cty. Land Dept.
Pat	Matuseski	SFRMP Planner	MN DNR - Forestry
Marty	Schoewe	Forester	Forest Capital Partners
Patty	Thielen	Area Supervisor	MN DNR - Forestry
Vacant		Forester	Potlatch Corp.

(*Page left blank intentionally*.)

Appendix B
NOMP NPC Study

A. Title

An Ecological Classification and Assessment of Minnesota's Northern Landscape
George Host, Terry Brown, and Paul Meysembourg

Natural Resources Research Institute
University of Minnesota, Duluth
5013 Miller Trunk Highway
Duluth, MN 55811

November 2006
Final report submitted to:
Mr. Lindberg Ekola, Project Officer
Minnesota Forest Resources Council

In fulfillment of: Minnesota Department of Natural Resources
CFMS Contract # A85234
NRRI Technical Report
NRRI/TR-2006/30

B. Background and Objectives

The MFRC Landscape Program recognizes several distinct regional landscapes, formed by integrating the natural physiographic and climatic regions of the state with social and economic objectives. These landscapes have served as focal points for regional planning efforts involving multiple groups of stakeholders. While the landscape regions have unique issues and potentials, they all have common data needs. Foremost among these is an assessment of landscape potential, which is required to formulate desired future conditions (DFCs).

The potential of the forest landscape is best understood in the context of landscape ecosystems, which are mappable, repeating combinations of soils, landform, climate and microclimate that support characteristic native plant communities. The science of identifying and classifying landscape ecosystems is called Ecological Land Classification (ELC) or Habitat Typing. Biophysically-based land classifications have a long history in European forestry (Cajander 1906, Barnes 1984), and a more recent history in the US (Barnes et al. 1982), but ecological classifications have been widely adopted for strategic and tactical forest planning by federal, state, county and private forest management agencies. Research has shown that ELCs can account for variation not only in forest composition, but also ecosystem functional processes, such as tree productivity (Host et al. 1988), forest succession (Host et al 1989) and nutrient cycling (Zak et al 1986). For this study, Landscape Ecosystems are defined in terms of the dominant late successional native plant community, e.g. Mesic Northern Hardwood Forest.

The fact that different forest successional pathways occur in different landscape positions has a direct bearing on forest management. Specifically, it is possible through field work and predictive modeling to identify the Native Plant Communities (NPC) that comprise the plant assemblages characteristic of a particular landscape position. The MN Dept of Natural Resources, in fact, has recently published a detailed NPC classification for the Laurentian Forest region of Minnesota (MNDNR 2003). An NPC consists of a series of Vegetation Growth Stages (VGS), which are combinations of age classes and tree species that form characteristic successional stages within a landscape ecosystem. These stages include the dominant late successional community, as well as the early and mid-successional forest types that precede the late successional type under various disturbance regimes.

Previous Ecological Mapping Efforts

To date, numerous efforts studies have been conducted to map landscape potential – these efforts typically integrate spatial data in a Geographic Information System (GIS) with forest compositional and structural information from remote sensing (e.g. Landsat; Wolter et al 1995, airphoto interpretations) or field inventories. White and Host (2000) created a native plant community map for the Northern Superior Uplands based on a spatial analysis of GIS data layers known to be important determinants or correlates of forest type distribution, including soils, elevation, landtype associations, climate, and numerous other factors. A similar effort, albeit with a different spatial resolution, was conducted for the Drift and Lake Plains by David Shadis, soil scientist and ECS coordinator for the Chippewa National Forest.

Information for the Northern Landscape, however, is relatively sparse. Boise-Cascade created an NPC classification for the eastern portion of the Minnesota-Ontario Peatlands Section of Minnesota; but little work has been done in the western portion of the landscape region. Moreover, since the initial NPC maps were created in northern MN, the MN DNR has published a field guide to native plant communities of the Laurentian Mixed Forest Province (MN DNR 2003). The goals of this project were to create a potential NPC map of the Northern Landscape Region and to assess current forest conditions within those landscape units.

A variety of methods have been used to map habitat or native ecosystem types. Allen and Wilson (1991), and Palik et al. (2000) used Discriminant Function analysis with vegetation data and environmental variables to map potential vegetation with overall accuracies of approximately 60%. Decision tree models have also proven to be useful for landscape scale ecosystem classification (Moore et al. 1991, Lynn et al. 1995). Host et al. (1996) integrated soil, landform and climate data in GIS to create an LTA level ecosystem classification for northwestern Wisconsin.

On the Chippewa National Forest relatively fine scale mapping was accomplished using digital soil series data, bearing tree data, surveyor line notes, and an existing phase level classification integrated within a GIS (D. Shadis, pers. comm.). The Boise Cascade Corporation mapped habitat type classes for a portion of the Northern Minnesota and Ontario Peatlands (MOP) using a decision tree modeling approach utilizing the relationships between habitat type samples and soil characteristics, surficial geology, topographic variables, climate, presettlement vegetation, and other predictive variables (Kernohan and Dunning 1998). They reported user's accuracies ranging from 13 to 76%, with an overall accuracy of 60%.

C. Methods

For the Northern Landscape, we adapted methods from White and Host's (2000) classification of the Northern Superior Uplands. That classification was based on several factors important to tree species distribution and growth rates; predominately soil texture and soil drainage classes. These were derived from various spatial databases, with minimum mapping units ranging from 16 to 100 ha. (Table 1). In this analysis we added a new data source, a topographic moisture index derived from slope, aspect, and slope curvature. Iverson et al (1997) successfully used this technique to quantify forest composition productivity in Ohio forests.

Table 1. Environmental variables for generating landscape polygons

Data Source	Attributes	Resolution	Minimum mapping unit
Minnesota Soil Atlas	Drainage, Texture, Depth of rooting zone	1 ha	16 ha
Cummings-Grigal Soil Associations	Texture + material	1 ha	5 km2
Geomorphology of MN	Geomorphic and sedimentary Associations	1 ha	16 ha
Land Type Associations Topographic Moisture Index	Soil-landform units Aspect, slope, curvature	1 ha 0.1 ha	5 km2 0.1 ha

Stratification

We used National Wetlands Inventory data to stratify upland and lowland areas prior to analysis; these areas were classified separately and then merged. Uplands were identified at the NWI system level (U), with areas identified as open water or wetland masked out. The upland mask included some unclassified wetlands that were not interpretable from aerial photography.

Areas classified under lowland category include palustrine systems, defined as forested and scrub/shrub that are not defined as permanently flooded. Areas defined as upland, open water, emergent, or otherwise not dominated by woody plants were masked out. The following NWI codes define forested wetland/semi-terrestrial forest: System = Palustrine (P), class1 = forested (FO), scrub shrub (SS), wreg (water regime modifier) = A (temporarily flooded), B (saturated), C (seasonally flooded), J (intermittently flooded).

ISODATA Cluster Analysis

Texture, drainage and landform polygons were gridded to 100 m cells and variables were converted from categorical to ordinal values to allow for cluster analysis. In the process of analyzing data from the MN Soil Atlas, we discovered a registration error in the drainage layer, in the form of an offset that is multidirectional and non-uniform across the map. Because of this error in the source data, we replaced the drainage layer with a topographic moisture index (TMI), which implicitly quantifies soil drainage as a function of watershed position and local slope conditions.

A five-layer ISODATA cluster analysis was performed on the gridded data. The Landtype Association ECS layer was then superimposed on the resulting clusters to add additional information and spatial resolution to the original map units.

Table 2. Variables used in 6-band ISODATA classification.

Variable	Description
TEXROOT	Soil texture in the rooting zone
THIROOT	Thickness of soil texture in the rooting zone
QuatGeol	Quaternary Geology Map Unit Description
CumGrig	Cummings-Grigal Soil Associations
TMI	Topographic Moisture Index

The ArcGIS zonal summary tool was used to calculate the distribution and frequency of bearing trees from the Government Land Office survey records; summaries were computed for each of the landscape polygons.

Defining "clusters"

Meysembourg created a 17 class physiographic classification, consisting of eight upland, eight lowland and one off-site class.

These were stratified by the MOP's 26 Land Type Associations (LTAs) to create a new set of 320 classes, hereafter referred to as clusters.

Physiographic classes

GRIDCODE	Description
0	Off-site (rivers, lakes, etc.)
1-8	Lowland classes
11-18	Upland classes

Cluster summaries of GLO bearing trees

Bearing tree occurrence was tabulated for each of the 320 clusters. Bearing tree data used was D. Shadis's refined bearing tree data in which generic tree identifications (pine, maple, etc.) are improved to the most probable or only possible species. For example in cases where four "pines" were listed Shadis may have suggested two white and two red, or two red and two jack, depending on the site.

Shadis's refined species occurred across the MOP as follows:

Bearing tree species (Shadis) in the MOP

Name	sp	count
Tamarack	TA	21240
Black Spruce	BS	9785
Aspen	AS	6123
White Cedar	WC	3828
Fir	FI	2481
White Birch	WB	2316
Jack Pine	JP	1909

Bearing tree species (Shadis) in the MOP

Name	sp	count
White Spruce	WS	1514
Ash	AH	778
Balm-of-Gilead	BG	554
Elm	EL	549
White Pine	WP	522
Red, Norway, or Yellow Pine	RP	464
Willow	WI	196
Oak	OA	123
Linden or Basswood	LI	89
Maple	MA	72
Black Ash	BA	41
Alder	AL	17
Box-Elder	BX	16
Ironwood	IR	11
White Oak	WO	9
Bur Oak	BO	6
Illegible or Not Recorded	XX	5
Buttonwood	BT	4
Red Oak	RO	4
Red Maple	RM	3
Spruce	SP	3
Cherry	CH	2
Hackberry	HA	2
Spanish Oak	SO	2
Sugar Maple	SU	2
Beech	BE	1
Hickory	HI	1

Species were ranked by number of observations within each of the 320 clusters. For example:

Species ranking for clusters 4-212Mb16

ecs_lta	gridcode	corners	density	sp	spdens	spcount	diam	dist	rank
212Mb16	4	159	0.621	TA	1.257	200	5.44	65.38	1
212Mb16	4	159	0.621	BS	0.496	79	5.253	30.03	2
212Mb16	4	159	0.621	JP	0.396	63	5.682	55.06	3
212Mb16	4	159	0.621	AS	0.100	16	5.562	83.43	4
212Mb16	4	159	0.621	WC	0.094	15	7.333	29.4	5
212Mb16	4	159	0.621	FI	0.050	8	6	24.37	6
212Mb16	4	159	0.621	RP	0.025	4	10.25	79	7
212Mb16	4	159	0.621	WB	0.025	4	4.75	26.5	7

Species ranking for clusters 4-212Mb16

ecs_lta	gridcode	corners	density	sp	spdens	spcount	diam	dist	rank
212Mb16	4	159	0.621	WS	0.025	4	4.25	137.2	7
212Mb16	4	159	0.621	BG	0.006	1	8	56	10
212Mb16	4	159	0.621	WI	0.006	1	4	36	10

Bearing Trees as NPC indicators

Tree species were given indicator scores for NPCs. Indicator scores were as follows:

Score	Indication
-3	Very strong counter indication.
-2	Moderate counter indication.
-1	Weak counter indication.
0	Neutral.
1	Weak indication.
2	Moderate indication.
3	Very strong indication.

Species that occurred very infrequently in the dataset (e.g.beech), were assigned a score of 0 for all NPCs, effectively removing them from the analysis. Appendix E provides a table of the indicator scores used to determine NPCs based on bearing tree data.

Tree density by NPC

For many of the NPCs occurring in the MOP cover density is a distinguishing characteristic. MNDNR (2003) provides descriptions of cover density in 25% increments for most NPCs. For example, NPC APn80 is described as having 25-75% cover. The minimum and maximum cover densities used for the MOP NPCs were:

NPC densities

npc	denslow	denshi	Name
FDn12	25	100	Northern Dry-Sand Pine Woodland
FDn32	25	100	Northern Poor Dry-Mesic Mixed Woodland
FDn33	50	75	Northern Dry-mesic Woodland
FDn43	25	100	Northern Mesic Mixed Forest

NPC densities

npc	denslow	denshi	Name
MHn44	25	100	Northern Wet-Mesic Boreal Hardwood-Conifer Forest
MHn46	25	50	Northern Wet-Mesic Hardwood Forest
MHn47	50	100	Northern Rich Mesic Hardwood Forest
MHc37	50	100	Central Mesic Hardwood Forest
FFn57	50	100	Northern Terrace Forest
FFn67	50	100	Northern Floodplain Forest
WFn53	25	50	Northern Wet Cedar Forest
WFn55	50	100	Northern Wet Ash Swamp
WFn64	25	75	Northern Very Wet Ash Swamp
WFw54	25	100	Northwestern Wet Aspen Forest
FPn63	50	100	Northern Cedar Swamp
FPn71	50	75	Northern Rich Spruce Swamp (Water Track)
FPn81	25	75	Northern Rich Tamarack Swamp (Water Track)
FPw63	25	75	Northwestern Rich Conifer Swamp
APn81	25	50	Northern Poor Conifer Swamp
APn80	25	75	Northern Spruce Bog
APn90	0	25	Northern Open Bog
APn91	0	25	Northern Poor Fen

Within each cluster the number of trees observed was divided by the number of bearing tree corners to get a tree density estimate. On 'full corners' up to four trees could be recorded, whereas on 'quarter corners' a maximum of two trees could be recorded. However as full and quarter corners were distributed without bias amongst clusters no adjustment was deemed necessary. The resulting tree density distribution was inspected and matched against the NPC density classes with the following break points:

Trees per corner density vs. NPC cover density (%)

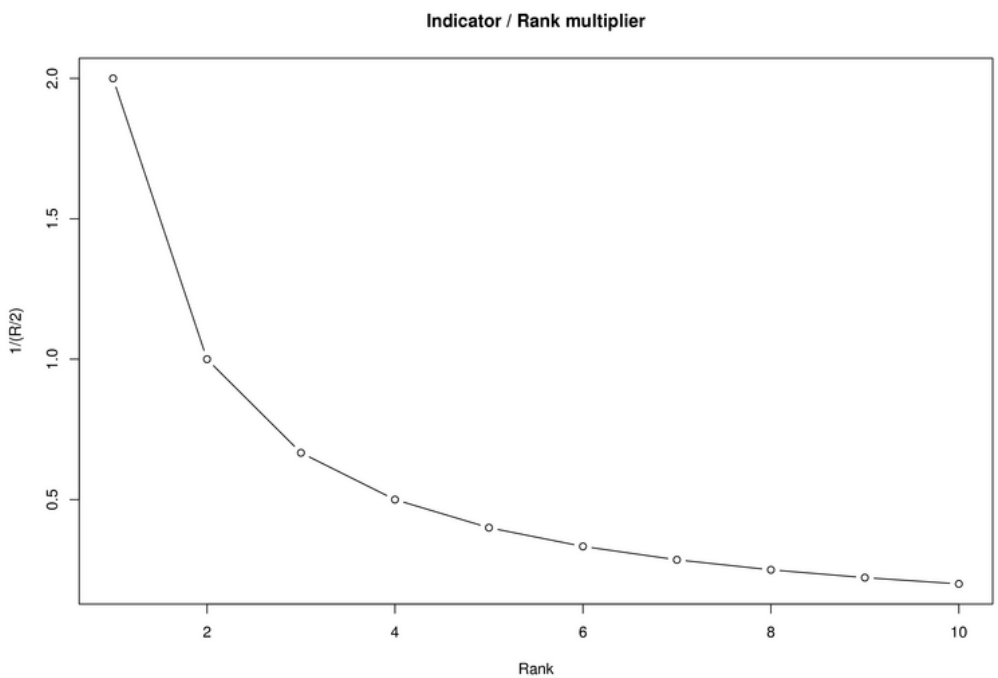
cover class	mindens	maxdens	mincov	maxcov
1	0	2.12474	0	25
2	2.12474	2.5	25	50
3	2.5	2.66934	50	75
4	2.66934	4	75	100

For example a cluster with a mean of 2.2 trees per corner would correspond to a cover density of 25-50%.

Assigning NPCs to LTA / physiographic classes

For each cluster a score was calculated for each NPC based on the tree species present, and their density. The landscape was split into upland and lowland clusters based on NWI data, and only lowland NPCs were considered for lowland clusters, and upland NPCs for upland clusters.

The NPC indicator score for each tree seen in a cluster was modified by the tree's rank in the cluster using the multiplier 1/(R/2) where R is the rank of the tree in the cluster.



The most common (low rank) species have a greater impact on the score than those that occur infrequently (high rank).

The most common tree (rank 1) has its indicator score doubled, the next most common tree (rank 2) has a modifier of 1.0, and trees that are only a minor component of the cluster have multipliers less than 0.5. The rank modified scores were summed for all trees seen in a cluster.

Density weightings

The density class table was used to calculate a penalty score for clusters NPC matching when the density of the cluster and NPC in question did not correspond. An cluster has a single density class calculated from the number of trees divided by the number of corners, a value between 1 and 4 as given in the density class table. An NPC can cover a range of density classes. When the cluster density was outside the range of the NPC, the number of classes by which it was outside (1-3) was multiplied by a weighting factor of 3, and subtracted from the cluster / NPC match score already calculated based on tree species present. For example:

cluster	Density from density class table	NPC	NPC minimum cover class	NPC maximum cover class	Score based on trees present	Density adjustment score	Final score
6-212Ma01	1	FFn57	1	3	7	0 [(1-1)x3]	7
6-212Ma01	1	FPn63	2	4	7	-3 [(2-1)x3]	4

NPC distribution screening

The tree score and density adjustment combine to give a score for each NPC for each cluster. MNDNR (2003) provide maps of possible occurrence for each NPC. For each polygon in a cluster, the highest scoring NPC allowed by these maps was assigned. An exception occurred when the NWI based upland / lowland division lead to a set of NPCs of which none were possible according to MNDNR maps. This would occur when the LTA was predominantly upland or lowland, but the more finely resolved NWI indicated isolated occurrence of the opposite type. In these cases the highest scoring NPC was assigned to the polygon.

Patching and filtering

In a small number of cases a cluster had no bearing trees in it. These small polygons, and all polygons less than one hectare where dissolved into their neighboring polygons.

D. Results and Discussion

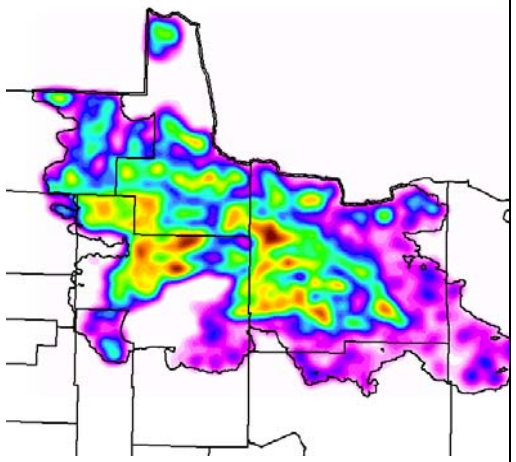
Native Plant Communities of the Minnesota Ontario Peatlands (Map)

A large-format map of Potential Native Plant Communities is included with this report, and the associate GIS coverage included as a shapefile on the enclosed CD-ROM. The MN DNR recognizes 42 NPCs in the Minnesota Ontario Peatlands. Eight of these are upland forest systems, four of which are fire dependent (northern dry-mesic woodland) and four mesic hardwood systems (northern wet-mesic hardwood). They also recognize 12 wetland forest systems, distributed among floodplain forests, wet

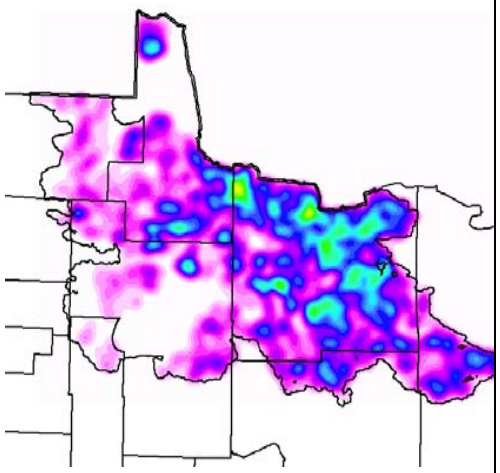
forests, forested rich peatlands, and acid peatlands. There are also 22 non-forest types (cliff/talus, lakeshore, carr, etc). We have mapped the cluster described above to the 16 upland and lowland NPC classes (Appendix D).

GLO Bearing Tree Analysis

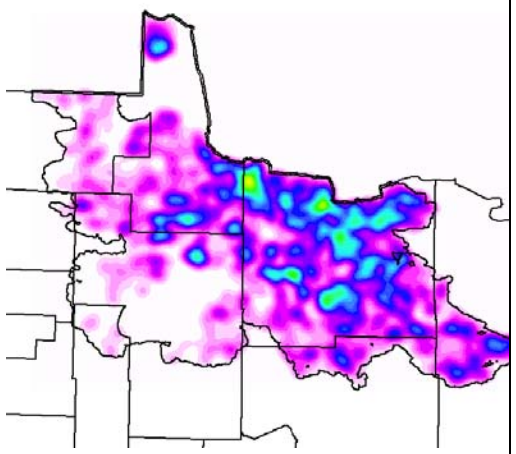
We used GLO bearing tree data to model presettlement species distributions over the study area. This was accomplished by interpolating species occurrence data based on section corner and line tree data. The following set of figures shows the interpolated distributions of several important species or combinations of species. Species are on a common relative abundance scale, with yellow to reds as high abundance and purple as low.



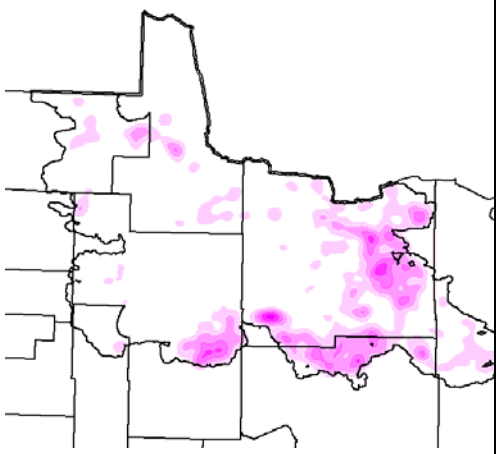
Tamarack



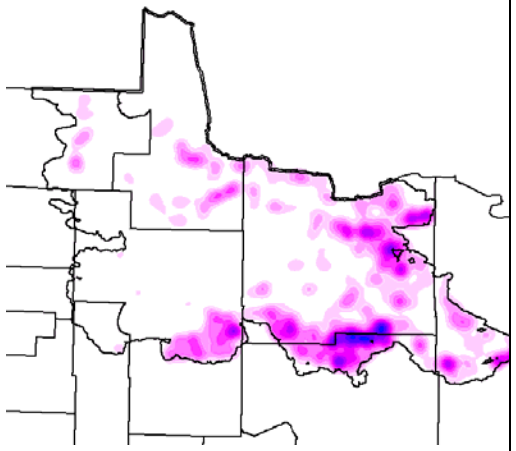
Combined spruce



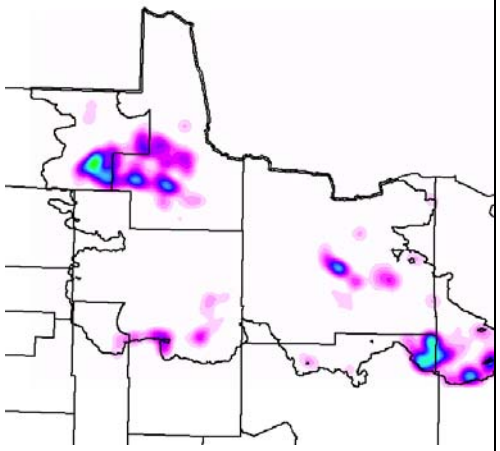
Black Spruce



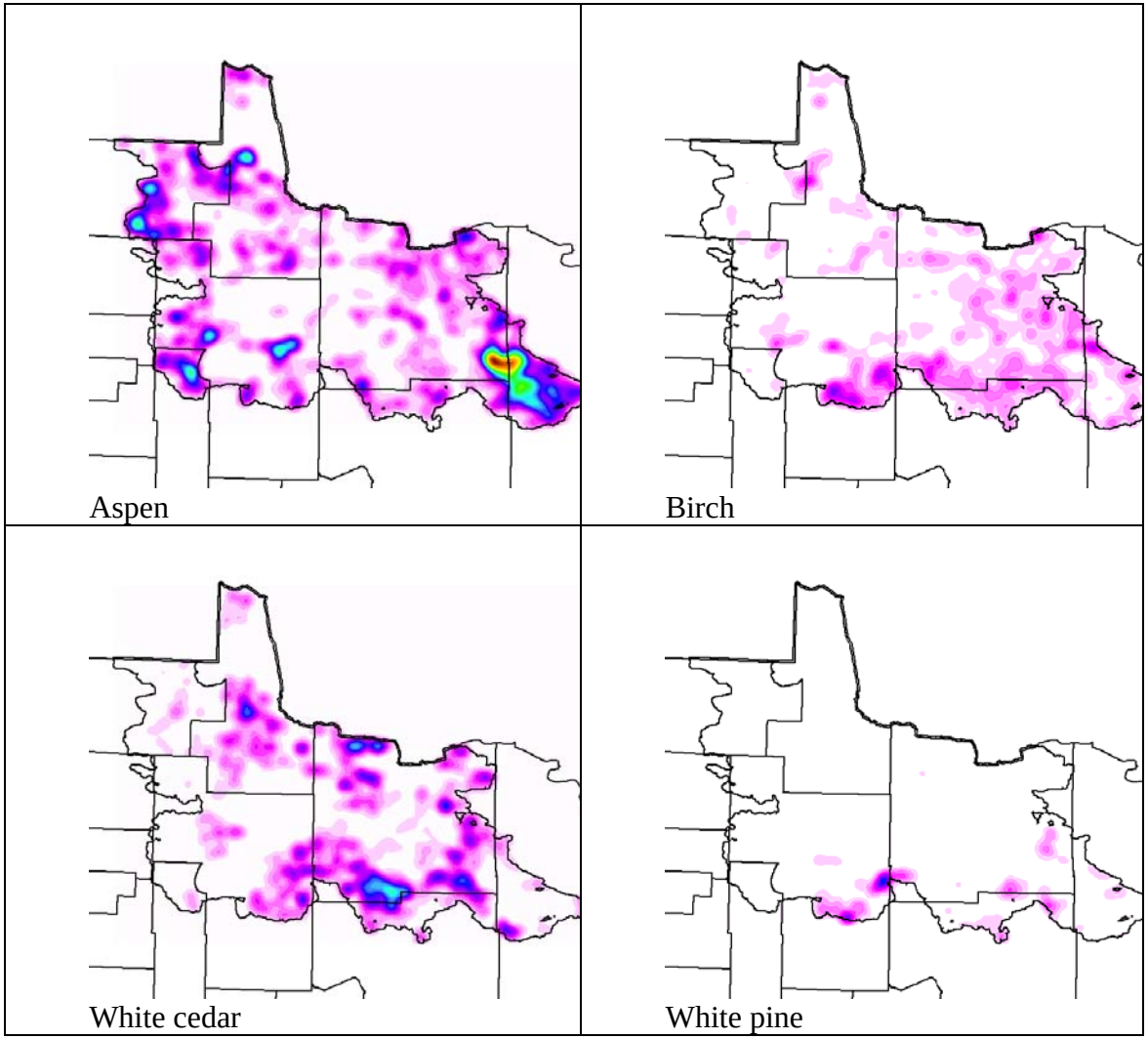
White Spruce



Balsam Fir



Jack pine



Landscape structure of MOP Native Plant Communities: patch sizes and area

There was broad variation in the number and areas of native plant community polygons. The spatial structure of these NPCs reflects the underlying landscape. Forested Peatlands are by far the dominant system in the Minnesota Ontario Peatlands,

occurring in large complexes on glacial lake plains and large peat-filled basins, primarily in the Glacial Lake Agassiz plain; in area they account for 56% of the MOP. Mean patch sizes are large, with the average size of FPn81 approaching 1000 ac.

The upland types occur on morainal or till-plain landforms, and were characterized by smaller patch sizes. The northern mesic mixed forest (FDn43) is the largest upland type by area, accounting for about 20% of the MOP. Mean patch sizes for this type are also large, approaching 250 ac. Of the mesic hardwood types, MHn44 had the largest area (8% total area) and a mean patch size of 240 ac.

Acreage and patch size attributes

NPC	Count (# of patches)	Total area (ac)	Minimum area (ac)	Maximum area (ac)	Mean patch size (ac)	Standard deviation patch size (ac)	Coefficient of Variation patch size
APn80	1478	108506.58	2.48	16170.19	73.41	579.44	7.89
FDn12	327	31595.20	2.51	7052.21	96.62	546.63	5.66
FDn33	1821	84807.15	2.47	6587.54	46.57	219.26	4.71
FDn43	3590	886214.69	2.47	417095.30	246.86	7337.92	29.73
FFn67	37	8860.97	2.53	3379.35	239.49	656.37	2.74
FPn63	4927	346143.03	2.47	24173.65	70.25	546.19	7.77
FPn71	1811	959200.97	2.48	350405.70	529.65	9072.09	17.13
FPn81	1197	1177013.81	2.48	349785.07	983.30	12492.61	12.70
FPw63	1138	118800.98	2.47	33414.88	104.39	1146.72	10.98
MHc37	22	15599.63	2.55	15324.04	709.07	3264.38	4.60
MHn44	1467	352532.05	2.47	111279.32	240.31	3706.95	15.43
MHn46	844	94192.87	2.49	12966.61	111.60	775.38	6.95
MHn47	10	341.82	2.48	164.77	34.18	47.46	1.39
WFn53	63	2760.47	2.48	489.25	43.82	90.16	2.06
WFn55	281	224472.75	2.56	181353.85	798.84	10997.33	13.77
WFn64	1678	157964.67	2.47	9612.59	94.14	473.35	5.03
WFw54	393	89692.78	2.47	14968.30	228.23	1069.60	4.69

Ownership patterns among NPCs

Most land in the MOP is under state management, and most of this land is in the Forested Peatland category. Tribal lands are the next largest category (562,000 ac), followed by county (423,000 ac) and federal (305,000 ac). In terms of NPCs, tribal lands are predominately in the lowland types, while the counties have the largest amount of northern mesic mixed forest (FDn43). Industrial+private owners hold approximately 300,000 acres of forest land, primarily in upland forest communities.

Ownership patterns by native plant community (from MN DNR GAP database)

NPC	County	Federal	Industrial	Private	State	Tribal	Undifferentiated Ownership	Total
APn80	16894	7746	1940	1108	32803	17524	2257	80275
FDn12	0	0	0	14	18503	2292	5957	26767
FDn33	11590	807	4042	937	28653	4629	10398	61058
FDn43	185948	30372	87306	14133	161705	66523	81742	627732
FFn67	0	8	0	800	3311	0	0	4119
FPn63	60394	8243	34765	4710	152667	13666	34123	308570
FPn71	52528	24007	24896	4453	751062	48757	25739	931446
FPn81	25603	13752	10697	3827	883751	132680	49070	1119383
FPw63	85	0	0	2939	75400	1078	2934	82438
MHc37	0	1521	0	0	33	14015	0	15571
MHn44	12525	604	8968	8352	67759	5741	10383	114336
MHn46	1213	793	3752	4189	8791	11529	3761	34032
MHn47	0	0	0	3	47	0	0	50
WFn53	467	138	342	22	305	113	32	1421
WFn55	179	12044	70	935	24998	176492	5906	220628
WFn64	14003	1237	5053	2085	71847	9510	17109	120846
WFw54	105	3	0	1082	48039	3644	5182	58059
non-NPC	41493	204374	53580	11366	165361	53810	114251	644238
Total	423036	305656	235416	60960	2495043	562013	368851	4450978

E. Summary and Applications

Our primary goal was to create a map showing the potential native plant communities of the Minnesota-Ontario Peatlands that should be useful for landscape scale planning in this region. The map shows units which recur in characteristic landscape positions. While this map is relatively coarse compared to traditional stand maps, it provides insight into the scale at which forest communities respond to the landscape, and guidance as to the potential composition of disturbed sites. By classifying upland and lowland areas separately, and by integrating spatial databases on soils, landform, and topography, this map demonstrates the relative composition and distribution of potential native communities in this northern landscape.

A main application of this work is to guide forest management decisions. A particular issue is to place the right species on the right site – the maps provide evidence as to how species are distributed in particular landscape positions. This data set was also summarized by land ownership, showing the distribution of NPC areas among federal, state, county, tribal and private ownerships. The types of communities land held by the various land management agencies are not uniformly distributed, which has implications for landscape-scale strategic planning. Of particular importance is the distribution of types on industrial and private, as these ownerships are currently shifting the goals of their land holdings. Similarly, the potential NPC map is useful for

planning conservation easements to ensure that representative communities are maintained with an appropriate spatial distribution.

Another potential use of this map is the application of range of natural variation (RNV) concepts to this northern landscape. RNV is a system for predicting the acreages and age class distributions of successional stages within NPCs for a region. In the late 1990s, a group of ecologists from the university, the state and private industry assembled to explore and develop RNV models for forest lands of Minnesota. Model development involved identification of successional pathways for each of the native plant communities. This work focused on two ecological Sections that are extensive and important regions of forest production in the state: the Northern Superior Uplands and the Drift and Lake Plains; the Minnesota Ontario Peatlands were not part of these early analyses.

A critical component of the RNV modeling is the quantification of disturbance frequencies for the dominant disturbance types; this work was conducted by Dr. Lee Frelich of the University of Minnesota, and is documented in two reports (Frelich 1999, 2000). The key element of identifying disturbance regimes is determination of fire and wind rotations, defined as the number of years that elapse between stand-replacing disturbance events. This was done with a combination of dendrochronological work as well as analysis of historic studies and data sources (Frelich 2002). The RNV models used here have been employed to varying degrees in planning endeavors by the MN DNR Subsection Teams, the USFS, and MFRC's Northeastern Landscape Committees.

The disturbance rotations can be converted into return intervals – the frequency at which a particular point in the landscape is subjected to a stand-replacing disturbance, which in turn can be converted to an annual disturbance estimate. This latter calculation is the inverse of the rotation length. A 100 year fire rotation, for example, implies that 1/100 or 1% of that NPC will be subjected to fire each year. The combination of the successional models and disturbance frequencies allowed the development of RNV models, which ultimately define the proportions of an Ecological Section occurring in various VGSs under natural disturbance regimes. To construct the range of variation the model is run using the minimum and maximum estimates of disturbance rotations. This provides a pair of percentages that provide the range in the proportions of a VGS within a landscape ecosystem given the natural variation in disturbance frequencies.

The final step in RNV modeling is to translate the proportions into actual areas. This requires development of maps of native plant communities for the ecological sections. An NPC map for the Northern Superior Uplands was based on a spatial analysis of spatial data layers known to be important determinants or correlates of forest type distribution, including soils, elevation, landtype associations, climate, and numerous other factors (White and Host 2000). A similar effort for the Drift and Lake Plains was conducted by David Shadis, soil scientist and ECS coordinator for the Chippewa National Forest. These maps allow the proportions calculated in the RNV models to be translated to forest land areas. This latter step allows a comparison of current forest condition against the RNV, as well as an assessment of how different forest management strategies move the forest toward

or away from the RNV. This latter objective formed the basis of the Minnesota LCMR-funded SUSTAIN forest model, developed as a tool for RNV assessment.

Assessing the accuracy of potential vegetation classifications is confounded by several factors, including differences between potential versus current vegetation, inaccuracies difficulty in classifying sample data, and differences between the map unit resolution (coarse) and sample data (fine). Our current methods used a 'maximum likelihood" approach, meaning that the classification routines picked the best possible match, based on the strength of relationships between the input factors (soil, landform, etc) and potential communities as characterized by bearing tree distributions. The map is generally correct, but it is certainly possible that individual polygons may be misclassified. For this reason, areas of the map used for tactical planning and assessment should be verified in the field. The authors invite comments from end users that can be used to improve the accuracy and overall applications of this map product.

F. Acknowledgements

This work was funded by the Minnesota Forest Resource Council's Landscape Program through the MN Department of Natural Resources. We acknowledge the contributions of Mark White of The Nature Conservancy, who aided in adapting our work in the Northern Superior Uplands to the Minnesota-Ontario Peatlands.

Literature Cited

Allen, R.B., and J.B. Wilson. 1991. A method for determining indigenous vegetation from simple environmental factors, and its use for vegetation restoration. Biological Conservation. **56**:265-280.

Barnes, B.V., K.S. Pregitzer; T.A. Spies, and V.H. Spooner. 1982. Ecological forest site classification. *Journal of Forestry* 80:493-98.

Barnes, B.V. 1984. Forest ecosystem classification and mapping in Baden-Wurttemberg, West Germany. In: *Forest land classification: experience, problems, perspectives. Proceedings of the symposium; 1984 March 18-20*, pp. 49-65. Madison, WI.

Cajander, A.K. 1926. The theory of forest types. Society for the Finnish Literary. Acta For., Fenn,.29:1-108.

Frelich, L. 2000. Natural Range of Variability estimates for forest vegetation growth stages of Minnesota's Drift and Lake Plains. Minnesota Forest Resources Council http://www.frc.state.mn.us/Landscp/4/docs/rnvdlplee.htm

Frelich, L. 2002. Forest Dynamics and Disturbance Regimes - Studies from Temperate Evergreen-Deciduous Forests. Cambridge University Press. 276 p.

Host, G. E., K.S. Pregitzer, C.W. Ramm, D.P. Lusch, and D.T. Cleland. 1988. Variation in overstory biomass among glacial landforms and ecological land units in northwestern Lower Michigan. Canadian Journal of Forest Research 18:659-668.

Host, G. E. K. S. Pregitzer, C. W. Ramm, J. B. Hart, and D. T. Cleland. 1987. Landform-mediated differences in successional pathways among upland forest ecosystems in northwestern Lower Michigan. Forest Science 33:445-457.

Host, G.E., P.P. Polzer, D.J. Mladenoff, M.A. White, and T. R. Crow. 1995. A quantitative approach to developing regional ecosystem classifications. Ecological Applications, **6**: 608-618.

Iverson, L. R. M. E. Dale, C. T. Scott, and A. Prasad. 1997. A GIS-derived integrated moisture index to predict forest composition and productivity of Ohio forests. Landscape Ecology 12:331-348.

Kernohan, B., and K Dunning. 1998. Forest habitat type predictive model. Boise Cascade Corporation. w

Lynn, H., C.L. Mohler, S.D DeGloria, and C.E. McCulloch. 1995. Error assessment in decision tree models applied to vegetation analysis. Landscape Ecology. **10**:323-335.

G. Appendices

Appendix A: GIS Data characteristics

Horizontal Coordinate Scheme	UTM
Ellipsoid	GRS80
Horizontal Datum	NAD83
Horizontal Units	Meters
Cell Width	100
Cell Height	100
UTM Zone Number	15E

Appendix B: Ordinal coding system for map variables

Classification of soil textures

Class	Dom Texture
1	Sand to Loamy Sand
2	Loam Sand
3	Loamy Sand to Sandy Loam
4	Loam to Sand and Gravel
5	Sandy Loam
6	Sandy Loam to Loam
7	Loam
8	Loam to Silt Loam
9	Loam to Clay Loam
10	Clay Loam to Silty Clay Loam
11	Loam to Silty Clay
12	Silt Loam
13	Silty Clay Loam
14	Clay Loam
15	Silty Clay
16	Silty Clay to Clay
17	Peat
18	Water

Appendix C: Minnesota Soil Atlas Info (metadata)

The Soil Atlas project provides a consistent, statewide map series and GIS data set describing soil and landscape characteristics. The data is generalized. The scale of 1:250,000, or about 1/4 inch to 1 mile, makes it possible to show areas as small as 1 square mile. The data set and maps were created in the 1970's to provide information to support generalized planning over broad areas. The maps were not intended to replace the detailed soil surveys, but to provide a more general overview, and to provide make soil description information available until such a time as soil surveys were completed statewide. The Soil Atlas map series was developed by the Department of Soil, Water, and Climate of the University of Minnesota, in cooperation with the Natural Resources Conservation Service (previously Soil Conservation Service), U.S. Department of Agriculture, and the Minnesota Geological Survey.

Two main descriptors of soils are groupings of Soil Landscape Units based on a number of factors (soil texture of the rooting zone, soil texture below the rooting zone, drainage, and color), and delineations of Geomorphic Regions, which illustrate broad

physiographic features and provide some characterization of the parent materials of the soils. Further soils characterizations are derived from these primary categories.

Two main descriptors of soils in the Soil Atlas project are Soil Landscape Units (based on soil texture of the rooting zone, soil texture below the rooting zone, drainage, and color), and Geomorphic Regions, which illustrate broad physiographic features and provide some characterization of the parent materials of the soils. Soil Landscape Unit and Geomorphic Region delineations were developed using whatever detailed soil surveys were available in a given area, whether published or not.

SOIL LANDSCAPE UNITS: A Soil Landscape Unit is a group of soils generalized into a homogeneous unit based on sub-surface soil texture, surface soil texture, drainage characteristics, and surface color. Combinations of these four characteristics describe unique soil types identified by a four-letter soil code keyed to the four soil characteristics. Soils were grouped into Soil Landscape Units and coded with a four-letter designation based on the following factors:

1. Texture of the soil material below 5 feet of the surface, with S designating sandy; L for loamy or silty; C for clayey X for mixed sandy and loamy; Y for mixed silty and clayey; and R for bedrock.

2. Texture of the material in the first 5 feet below the surface, or a significant part of it, with S for sandy; L for loamy, and C for clayey.

3. Drainage of the unit, where W means well-drained (water table commonly below the rooting zone), and P means poorly-drained (water table within the rooting zone).

4. Color of the surface horizon with D for dark-colored and L for light colored (Darker colors associated with higher organic matter content).

Note: Some of the data sets include in the name a prefix of '4'. At one time the prefix was inserted to indicate that these data sets, although now presented in a 100-meter grid cell format, were derived from a 40-acre format (i.e., these were coarser data). This was done when these data files were included in data collections with other data files of higher resolution. All of the Soil Atlas data files are created from data originally coded as 40-acre cells; therefore the file names with or without a prefix of 4 represent the same data sets at the same resolution.

Appendix D: Summary of MN DNR NPC classes

System Group	System	NPC Class	NPC name
Upland Forest and Woodland Systems	Fire-dependent Forest/Woodland	FDn12	Northern Dry-Sand Pine Woodland
Upland Forest and Woodland Systems	Fire-dependent Forest/Woodland	FDn32	Northern Poor Dry-Mesic Mixed Woodland
Upland Forest and Woodland Systems	Fire-dependent Forest/Woodland	FDn33	Northern Dry-mesic Woodland
Upland Forest and Woodland Systems	Fire-dependent Forest/Woodland	FDn43	Northern Mesic Mixed Forest
Upland Forest and Woodland Systems	Mesic Hardwood Forest	MHn44	Northern Wet-Mesic Boreal Hardwood-Conifer Forest
Upland Forest and Woodland Systems	Mesic Hardwood Forest	MHn46	Northern Wet-Mesic Hardwood Forest
Upland Forest and Woodland Systems	Mesic Hardwood Forest	MHn47	Northern Rich Mesic Hardwood Forest
Upland Forest and Woodland Systems	Mesic Hardwood Forest	MHc37	Central Mesic Hardwood Forest
Wetland Forest Systems	Floodplain Forest	FFn57	Northern Terrace Forest
Wetland Forest Systems	Floodplain Forest	FFn67	Northern Floodplain Forest
Wetland Forest Systems	Wet Forest	WFn53	Northern Wet Cedar Forest
Wetland Forest Systems	Wet Forest	WFn55	Northern Wet Ash Swamp
Wetland Forest Systems	Wet Forest	WFn64	Northern Very Wet Ash Swamp
Wetland Forest Systems	Wet Forest	WFw54	Northwestern Wet Aspen Forest
Wetland Forest Systems	Forested Rich Peatland	FPn63	Northern Cedar Swamp
Wetland Forest Systems	Forested Rich Peatland	FPn71	Northern Rich Spruce Swamp (Water Track)
Wetland Forest Systems	Forested Rich Peatland	FPn81	Northern Rich Tamarack Swamp (Water Track)
Wetland Forest Systems	Forested Rich Peatland	FPw63	Northwestern Rich Conifer Swamp
Wetland Forest Systems	Acid Peatland	APn81	Northern Poor Conifer Swamp
Wetland Forest Systems	Acid Peatland	APn80	Northern Spruce Bog
Upland Grassland, Shrubland and Sparse Vegetation Sy	Cliff/Talus	CTn11	Northern Dry Cliff
Upland Grassland, Shrubland and Sparse Vegetation Sy	Cliff/Talus	CTn12	Northern Open Talus
Upland Grassland, Shrubland and Sparse Vegetation Sy	Cliff/Talus	CTn32	Northern Mesic Cliff
Upland Grassland, Shrubland and Sparse Vegetation Sy	Cliff/Talus	CTn42	Northern Wet Cliff
Upland Grassland, Shrubland and Sparse Vegetation Sy	Rock Outcrop	ROn12	Northern Bedrock Outcrop
Upland Grassland, Shrubland and Sparse Vegetation Sy	Rock Outcrop	ROn23	Northern Bedrock Shrubland
Upland Grassland, Shrubland and Sparse Vegetation Sy	Lakeshore	LKi32	Inland Lake Sand/Gravel/Cobble Shore
Upland Grassland, Shrubland and Sparse Vegetation Sy	Lakeshore	LKi43	Inland Lake Rocky Shore
Upland Grassland, Shrubland and Sparse Vegetation Sy	Lakeshore	LKi54	Inland Lake Clay/Mud Shore
Upland Grassland, Shrubland and Sparse Vegetation Sy	River Shore	RVx32	Sand/Gravel/Cobble River Shore
Upland Grassland, Shrubland and Sparse Vegetation Sy	River Shore	RVx43	Rocky River Shore
Upland Grassland, Shrubland and Sparse Vegetation Sy	River Shore	RVx54	Clay/Mud River Shore
Wetland Grassland, Shrubland and Marsh Systems	Acid Peatland	APn90	Northern Open Bog
Wetland Grassland, Shrubland and Marsh Systems	Acid Peatland	APn91	Northern Poor Fen
Wetland Grassland, Shrubland and Marsh Systems	Open Rich Peatland	OPn81	Northern Shrub Shore Fen
Wetland Grassland, Shrubland and Marsh Systems	Open Rich Peatland	OPn91	Northern Rich Fen (Water Track)
Wetland Grassland, Shrubland and Marsh Systems	Open Rich Peatland	OPn92	Northern Rich Fen (Basin)
Wetland Grassland, Shrubland and Marsh Systems	Open Rich Peatland	OPn93	Northern Extremely Rich Fen
Wetland Grassland, Shrubland and Marsh Systems	Forested Rich Peatland	FPn73	Northern Alder Swamp
Wetland Grassland, Shrubland and Marsh Systems	Wet Meadow.Carr	WMn82	Northern Wet Meadow/Carr
Wetland Grassland, Shrubland and Marsh Systems	Marsh	MRn83	Northern Mixed Cattail Marsh
Wetland Grassland, Shrubland and Marsh Systems	Marsh	MRn93	Northern Bulrush-Spikerush Marsh

Appendix E

Table: Tree species as NPC indicators

Tree species and NPC indicators, non-zero (neutral) scores only.

name	npc	indic	sp	name2
Northern Spruce Bog	APn80	-3	BA	Black Ash
Northern Spruce Bog	APn80	-3	FI	Fir
Northern Spruce Bog	APn80	-3	JP	Jack Pine
Northern Spruce Bog	APn80	-3	LI	Linden or Basswood
Northern Spruce Bog	APn80	-3	MA	Maple
Northern Spruce Bog	APn80	1	TA	Tamarack
Northern Spruce Bog	APn80	3	BS	Black Spruce
Northern Poor Conifer Swamp	APn81	-3	BA	Black Ash
Northern Poor Conifer Swamp	APn81	-3	FI	Fir
Northern Poor Conifer Swamp	APn81	-3	JP	Jack Pine
Northern Poor Conifer Swamp	APn81	-3	LI	Linden or Basswood
Northern Poor Conifer Swamp	APn81	-3	MA	Maple
Northern Poor Conifer Swamp	APn81	1	TA	Tamarack
Northern Poor Conifer Swamp	APn81	3	BS	Black Spruce
Northern Dry-Sand Pine Woodland	FDn12	-3	AS	Aspen
Northern Dry-Sand Pine Woodland	FDn12	-3	BA	Black Ash
Northern Dry-Sand Pine Woodland	FDn12	-3	BS	Black Spruce
Northern Dry-Sand Pine Woodland	FDn12	-3	LI	Linden or Basswood
Northern Dry-Sand Pine Woodland	FDn12	-3	SM	Soft or White Maple
Northern Dry-Sand Pine Woodland	FDn12	-3	WC	White Cedar
Northern Dry-Sand Pine Woodland	FDn12	-2	EL	Elm
Northern Dry-Sand Pine Woodland	FDn12	-2	IR	Ironwood
Northern Dry-Sand Pine Woodland	FDn12	-1	BG	Balm-of-Gilead
Northern Dry-Sand Pine Woodland	FDn12	-1	WP	White Pine
Northern Dry-Sand Pine Woodland	FDn12	1	BI	Birch
Northern Dry-Sand Pine Woodland	FDn12	1	FI	Fir
Northern Dry-Sand Pine Woodland	FDn12	1	WB	White Birch
Northern Dry-Sand Pine Woodland	FDn12	2	RP	Red, Norway, or Yellow Pine
Northern Dry-Sand Pine Woodland	FDn12	3	JP	Jack Pine
Northern Poor Dry-Mesic Mixed Woodland	FDn32	-3	BA	Black Ash
Northern Poor Dry-Mesic Mixed Woodland	FDn32	-3	LI	Linden or Basswood
Northern Poor Dry-Mesic Mixed Woodland	FDn32	-3	SM	Soft or White Maple
Northern Poor Dry-Mesic Mixed Woodland	FDn32	-3	WC	White Cedar
Northern Poor Dry-Mesic Mixed Woodland	FDn32	-2	EL	Elm
Northern Poor Dry-Mesic Mixed Woodland	FDn32	-2	IR	Ironwood
Northern Poor Dry-Mesic Mixed Woodland	FDn32	-1	BG	Balm-of-Gilead
Northern Poor Dry-Mesic Mixed Woodland	FDn32	1	AS	Aspen
Northern Poor Dry-Mesic Mixed Woodland	FDn32	1	BI	Birch
Northern Poor Dry-Mesic Mixed Woodland	FDn32	1	WB	White Birch
Northern Poor Dry-Mesic Mixed Woodland	FDn32	1	WP	White Pine
Northern Poor Dry-Mesic Mixed Woodland	FDn32	1	WS	White Spruce
Northern Poor Dry-Mesic Mixed Woodland	FDn32	2	RP	Red, Norway, or Yellow Pine
Northern Poor Dry-Mesic Mixed Woodland	FDn32	3	BS	Black Spruce
Northern Poor Dry-Mesic Mixed Woodland	FDn32	3	JP	Jack Pine
Northern Poor Dry-Mesic Mixed Woodland	FDn32	3	OA	Oak
Northern Dry-mesic Woodland	FDn33	-3	LI	Linden or Basswood
Northern Dry-mesic Woodland	FDn33	-3	SM	Soft or White Maple
Northern Dry-mesic Woodland	FDn33	-2	BA	Black Ash

Northern Dry-mesic Woodland	FDn33	-2	EL	Elm
Northern Dry-mesic Woodland	FDn33	-2	IR	Ironwood
Northern Dry-mesic Woodland	FDn33	-1	BG	Balm-of-Gilead
Northern Dry-mesic Woodland	FDn33	-1	WC	White Cedar
Northern Dry-mesic Woodland	FDn33	1	FI	Fir
Northern Dry-mesic Woodland	FDn33	1	MA	Maple
Northern Dry-mesic Woodland	FDn33	1	WS	White Spruce
Northern Dry-mesic Woodland	FDn33	2	AS	Aspen
Northern Dry-mesic Woodland	FDn33	2	BI	Birch
Northern Dry-mesic Woodland	FDn33	2	BS	Black Spruce
Northern Dry-mesic Woodland	FDn33	2	JP	Jack Pine
Northern Dry-mesic Woodland	FDn33	2	OA	Oak
Northern Dry-mesic Woodland	FDn33	2	WB	White Birch
Northern Dry-mesic Woodland	FDn33	3	RP	Red, Norway, or Yellow Pine
Northern Dry-mesic Woodland	FDn33	3	WP	White Pine
Northern Mesic Mixed Forest	FDn43	-3	LI	Linden or Basswood
Northern Mesic Mixed Forest	FDn43	-3	SM	Soft or White Maple
Northern Mesic Mixed Forest	FDn43	-2	BA	Black Ash
Northern Mesic Mixed Forest	FDn43	-2	EL	Elm
Northern Mesic Mixed Forest	FDn43	-2	IR	Ironwood
Northern Mesic Mixed Forest	FDn43	-1	BG	Balm-of-Gilead
Northern Mesic Mixed Forest	FDn43	1	WS	White Spruce
Northern Mesic Mixed Forest	FDn43	2	AS	Aspen
Northern Mesic Mixed Forest	FDn43	2	JP	Jack Pine
Northern Mesic Mixed Forest	FDn43	2	MA	Maple
Northern Mesic Mixed Forest	FDn43	2	WC	White Cedar
Northern Mesic Mixed Forest	FDn43	3	BI	Birch
Northern Mesic Mixed Forest	FDn43	3	BS	Black Spruce
Northern Mesic Mixed Forest	FDn43	3	FI	Fir
Northern Mesic Mixed Forest	FDn43	3	RP	Red, Norway, or Yellow Pine
Northern Mesic Mixed Forest	FDn43	3	WB	White Birch
Northern Mesic Mixed Forest	FDn43	3	WP	White Pine
Northern Terrace Forest	FFn57	2	WS	White Spruce
Northern Cedar Swamp	FPn63	2	BS	Black Spruce
Northern Cedar Swamp	FPn63	2	FI	Fir
Northern Cedar Swamp	FPn63	3	WC	White Cedar
Northern Rich Spruce Swamp (Water Track)	FPn71	1	TA	Tamarack
Northern Rich Spruce Swamp (Water Track)	FPn71	1	WC	White Cedar
Northern Rich Spruce Swamp (Water Track)	FPn71	3	BS	Black Spruce
Northern Rich Tamarack Swamp (Water Track)	FPn81	-3	AS	Aspen
Northern Rich Tamarack Swamp (Water Track)	FPn81	-3	BI	Birch
Northern Rich Tamarack Swamp (Water Track)	FPn81	-2	BG	Balm-of-Gilead
Northern Rich Tamarack Swamp (Water Track)	FPn81	1	WC	White Cedar
Northern Rich Tamarack Swamp (Water Track)	FPn81	2	BA	Black Ash
Northern Rich Tamarack Swamp (Water Track)	FPn81	2	BS	Black Spruce
Northern Rich Tamarack Swamp (Water Track)	FPn81	3	TA	Tamarack
Northern Rich Tamarack Swamp (Water Track)	FPn81	3	WI	Willow
Northwestern Rich Conifer Swamp	FPw63	-3	AS	Aspen
Northwestern Rich Conifer Swamp	FPw63	-3	BI	Birch
Northwestern Rich Conifer Swamp	FPw63	-2	BG	Balm-of-Gilead
Northwestern Rich Conifer Swamp	FPw63	2	BA	Black Ash
Northwestern Rich Conifer Swamp	FPw63	2	BS	Black Spruce
Northwestern Rich Conifer Swamp	FPw63	2	EL	Elm

Northwestern Rich Conifer Swamp	FPw63	2	FI	Fir
Northwestern Rich Conifer Swamp	FPw63	3	TA	Tamarack
Northwestern Rich Conifer Swamp	FPw63	3	WC	White Cedar
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	-2	JP	Jack Pine
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	-2	RP	Red, Norway, or Yellow Pine
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	-1	BS	Black Spruce
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	-1	WC	White Cedar
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	1	BO	Bur Oak
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	1	LI	Linden or Basswood
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	2	BA	Black Ash
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	2	MA	Maple
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	2	SM	Soft or White Maple
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	2	WP	White Pine
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	3	AS	Aspen
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	3	BI	Birch
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	3	FI	Fir
Northern Wet-Mesic Boreal Hardwood-Conifer Forest	MHn44	3	WB	White Birch
Northern Wet-Mesic Hardwood Forest	MHn46	-3	JP	Jack Pine
Northern Wet-Mesic Hardwood Forest	MHn46	-2	BS	Black Spruce
Northern Wet-Mesic Hardwood Forest	MHn46	-2	RP	Red, Norway, or Yellow Pine
Northern Wet-Mesic Hardwood Forest	MHn46	1	EL	Elm
Northern Wet-Mesic Hardwood Forest	MHn46	1	IR	Ironwood
Northern Wet-Mesic Hardwood Forest	MHn46	1	WC	White Cedar
Northern Wet-Mesic Hardwood Forest	MHn46	2	BG	Balm-of-Gilead
Northern Wet-Mesic Hardwood Forest	MHn46	2	BI	Birch
Northern Wet-Mesic Hardwood Forest	MHn46	2	BO	Bur Oak
Northern Wet-Mesic Hardwood Forest	MHn46	2	FI	Fir
Northern Wet-Mesic Hardwood Forest	MHn46	2	LI	Linden or Basswood
Northern Wet-Mesic Hardwood Forest	MHn46	2	MA	Maple
Northern Wet-Mesic Hardwood Forest	MHn46	2	SM	Soft or White Maple
Northern Wet-Mesic Hardwood Forest	MHn46	2	WB	White Birch
Northern Wet-Mesic Hardwood Forest	MHn46	2	WP	White Pine
Northern Wet-Mesic Hardwood Forest	MHn46	2	WS	White Spruce
Northern Wet-Mesic Hardwood Forest	MHn46	3	AS	Aspen
Northern Wet-Mesic Hardwood Forest	MHn46	3	BA	Black Ash
Northern Rich Mesic Hardwood Forest	MHn47	-3	BS	Black Spruce
Northern Rich Mesic Hardwood Forest	MHn47	-3	JP	Jack Pine
Northern Rich Mesic Hardwood Forest	MHn47	-3	RP	Red, Norway, or Yellow Pine
Northern Rich Mesic Hardwood Forest	MHn47	1	AS	Aspen
Northern Rich Mesic Hardwood Forest	MHn47	1	BA	Black Ash
Northern Rich Mesic Hardwood Forest	MHn47	1	BG	Balm-of-Gilead
Northern Rich Mesic Hardwood Forest	MHn47	1	BO	Bur Oak
Northern Rich Mesic Hardwood Forest	MHn47	1	FI	Fir
Northern Rich Mesic Hardwood Forest	MHn47	1	WS	White Spruce
Northern Rich Mesic Hardwood Forest	MHn47	2	BI	Birch
Northern Rich Mesic Hardwood Forest	MHn47	2	IR	Ironwood
Northern Rich Mesic Hardwood Forest	MHn47	2	WB	White Birch
Northern Rich Mesic Hardwood Forest	MHn47	2	WC	White Cedar
Northern Rich Mesic Hardwood Forest	MHn47	2	WP	White Pine
Northern Rich Mesic Hardwood Forest	MHn47	3	LI	Linden or Basswood
Northern Rich Mesic Hardwood Forest	MHn47	3	MA	Maple
Northern Rich Mesic Hardwood Forest	MHn47	3	SM	Soft or White Maple
Northern Wet Cedar Forest	WFn53	-1	AS	Aspen

Northern Wet Cedar Forest	WFn53	1	FI	Fir
Northern Wet Cedar Forest	WFn53	1	WP	White Pine
Northern Wet Cedar Forest	WFn53	2	BA	Black Ash
Northern Wet Cedar Forest	WFn53	3	WC	White Cedar
Northern Wet Ash Swamp	WFn55	-1	FI	Fir
Northern Wet Ash Swamp	WFn55	1	AS	Aspen
Northern Wet Ash Swamp	WFn55	1	WC	White Cedar
Northern Wet Ash Swamp	WFn55	2	BG	Balm-of-Gilead
Northern Wet Ash Swamp	WFn55	2	MA	Maple
Northern Wet Ash Swamp	WFn55	3	BA	Black Ash
Northern Very Wet Ash Swamp	WFn64	-1	FI	Fir
Northern Very Wet Ash Swamp	WFn64	1	MA	Maple
Northern Very Wet Ash Swamp	WFn64	1	WP	White Pine
Northern Very Wet Ash Swamp	WFn64	2	TA	Tamarack
Northern Very Wet Ash Swamp	WFn64	2	WC	White Cedar
Northern Very Wet Ash Swamp	WFn64	2	WS	White Spruce
Northern Very Wet Ash Swamp	WFn64	3	BA	Black Ash
Northwestern Wet Aspen Forest	WFw54	1	BI	Birch
Northwestern Wet Aspen Forest	WFw54	1	EL	Elm
Northwestern Wet Aspen Forest	WFw54	1	TA	Tamarack
Northwestern Wet Aspen Forest	WFw54	1	WC	White Cedar
Northwestern Wet Aspen Forest	WFw54	1	WP	White Pine
Northwestern Wet Aspen Forest	WFw54	3	AS	Aspen
Northwestern Wet Aspen Forest	WFw54	3	BA	Black Ash
Northwestern Wet Aspen Forest	WFw54	3	BG	Balm-of-Gilead

Minnesota Department of Natural Resources. 2003. Field guide to the native plant communities of Minnesota: the Laurentian Mixed Forest Province, Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Programm MNDNR St. Paul, MN. 352 p.

Moore, D.M., B.G. Lees, S.M. Davey. Profile: a new method for predicting vegetation distributions using decision tree analysis in a Geographic Information System. Environmental Management. **15**:59-71.

Palik, B.J., P.C. Goebel, L.K. Kirkman, and L. West. 2000. Using landscape hierarchies to guide restoration of disturbed ecosystems. Ecological Applications. **10**:189-202.

White, M. A. and G. E. Host. 2000. Mapping range of natural variation ecosystems classes for the Northern Superior Uplands: Draft map and analytical methods. Natural Resources Research Institute Technical Report NRRI/TR-2000/39. 13 p.

Wolter, P. T., D. J. Mladenoff, G. E. Host, and T. R. Crow. 1995. Improved forest classification in the northern Lake States using multi-temporal Landsat imagery. Photogrammetric Engineering and Remote Sensing 61(9):1129-1143.

Zak, D. R., K. S. Pregitzer, and G. E. Host. 1986. Landscape variation in nitrogen mineralization and nitrification. Canadian Journal of Forest Research 16:1258-1263.

(*Page left blank intentionally*.)

Appendix C
Crosswalk Diagram

(Approximate) Relationship Between (Kotar) Habitat Types & (Almendinger) Native Plant Communities For Forests in Northern Minnesota*

By: Thomas Castonguay – Red Lake Trust Forester

Description	Native Plant Community	Habitat Type
	= Close Correlation - Rough Equivalent	
Sandy Upland	**Fire-Dependant Pine/Oak System**	
Deep Sand (Jack) Pine Barren	= Poor Pine Forest: FDn12	= AbPiPl, AbPiG
Excessively Drained	= Dry Pine/Oak Forest: FDn22c	= AbPiV & (Pl)(Pe)
	= Dry Pine Forest: FDn22, FDn32a,b	= AbArV, AbArV-Ly
Well Drained	= Dry Mesic Pine/Oak Forest: FDn32/33	- PArV (Asp&Ta)
	= Dry Mesic Pine Forest: FDn43	= AbArAo
Well Drained To Damp	**Mesic Hardwood System**	
Oak/Hardwood	= Mesic Oak Forest: MHn35	- ATiPo (ATiDr, TiAPt)
Sugar Maple/Balsam Fir	= Mesic Boreal Hardwood: MHn44	= AAbAa
Hardwood/Hazel	= Mesic Northern Hardwood: MHn45	- ATiDr, TiAPt (ATiPo)
Sugar Maple/Basswood	= Rich Hardwood Forest: MHn47	= ATiCa, FnTiAt
Wet Seasonally	= Lowland Hardwood – Conifer: MHn46	= AbFnAu, AbFnAu-Rh, AbThSp

Mineral Rich Wetland System

Poorly Drained, Basic	- Semi terrestrial Black Ash: WFn55	= FnLa
Poorly Drained, Acidic	- Semi terrestrial White Cedar: WFn53	= AbFnThAn
Moss	= Black Ash Swamp: WFn64	None
	= White Cedar Swamp: FPn63	= AbThLe
	= Tamarack Swamp: FPn81, FPn82	= AbThLe

Acid Peatland System

= Forested Poor Fen: APn91	= PmPl
= Forested Bog: APn80, Apn81	= PmCh

All sites are unique, any conversation between systems must use an appropriate field guide to confirm the identification.

Habitat Type Translations to Latin (Minnesotan)

AAbAa = Acer-Abies/Aralia nudicaulis (Sugar Maple – Balsam Fir/Wild Sarsaparilla)
AbArV = Abies – Acer rubrum/Vaccinium (Balsam Fir – Red Maple/Blueberry)
AbFnAu = Abies-Fraxinus nigra/Asarum canadense (Balsam – Black Ash/Wild Ginger)
AbFnThAn = Abies – Fraxinus nigra – Thuja occidentalis/Alnus rugosa (Balsam Fir – Black Ash – White Cedar/Tagalder)
AbPi = Abies balsamea – Picea glauca (Balsam Fir – White Spruce)
AbThLe = Abies balsamea -Thuja occidentalis/Ledum groenlandicum (Balsam Fir – White cedar / Labrador tea) = White Cedar Swamp, or Tamarack Swamp
AbThSp=Abies–Thuja occidentalis/Sphagnum (Balsam – Cedar/Sphagnum Moss)
Ao = Apocynum androsaemifolium (Dogbane)
Asp = Acer spicatum (Mountain Maple)
ATi = Acer saccharum – Tilia Americana (Sugar Maple – Basswood)
Ca = Caulophyllium thalictroides (Blue Cohosh)
Ch = Chameadaphne caliculata (Leatherleaf)
Dr = Dirca palustris (Leatherwood)
FnLa = Fraxinus nigra/Laportea Canadensis (Black Ash/Wood Nettle)
FnTiAt = Fraxinus – Tilia/Athyrium filix-femina (Black Ash – Basswood/Lady Fern)
G = Gaultheria procumbens (Wintergreen)
Ly = Lycopodium (Clubmoss, Ground Pine, Ground Cedar)
Moss = Sphagnum and Feather Mosses
PArV = Pinus – Acer rubrum/Vaccinium (White Pine – Red Maple/Blueberry)
Pe = Petasites palmatus (Sweet Coltsfoot)
Pl = Pleurozium (Feathermoss)
PmPl = Picea mariana / Pleurozinum (Black Spruce/Feather Moss)
Po = Polygonatum pubescens (Solomon’s Seal)
Rh = Rubus hispidus (Swamp Dewberry)
Ta = Thallictrum dioicum (Meadowrue)
TiAPt = Tilia – Acer/Pteridlum aquilinum (Basswood – Sugar Maple/Bracken Fern)
V = Vaccinium (Blueberry)

*Adapted from page 5-43 of the "Field Guide to Forest Habitat Type Classification for North Central Minnesota" (Kotar & Burger) 2000, and information from:

- "A Field Guide to the Forest Habitat Types of the Red Lake Indian Reservation Minnesota" (Kotar & Burger) 2004
- "Field Guide to the Native Plant Communities of Minnesota – the Laurentian Mixed Province" (Minnesota Department of Natural Resources) 2003