**MINNESOTA
FOREST
RESOURCES
COUNCIL**

Northern
Landscape Plan

*A Regional Plan to Guide Sustainable
Forest Management*

Table of Contents

List of Figures

List of Tables

Minnesota and Ontario Paper Company Mill in International Falls, circa 1930. Photo credit: Source unknown, via James Aasen

EXECUTIVE SUMMARY

The Northern Landscape Plan has been prepared by the Minnesota Forest Resources Council (MFRC) and the Northern Regional Landscape Committee (Committee). The MFRC promotes long-term sustainable management of Minnesota's forests as directed by the Minnesota State Legislature in the Sustainable Forest Resources Act of 1995 (SFRA). Through its Regional Landscape Program and regional forest resource committees, the MFRC develops and supports the implementation of regional forest resource plans for Minnesota's six major forested regions. The SFRA directs the MFRC to establish regional forest resource committees to foster landscape-based forest resource planning and coordination activities. This legislation defined landscape-level planning as "long-term or broad-based efforts that may require extensive analysis or planning over large areas that may involve or require extensive coordination across all ownerships." The six regional committees provide an opportunity to involve private citizens, natural resource professionals, Tribal representation, and members of various interest groups in developing and implementing landscape-level plans that promote forest sustainability across all ownerships. Regional landscape plans are designed to be utilized by a broad scope of stakeholders including natural resource professionals of various disciplines that intersect with forestry (e.g. wildlife and fisheries specialists), and also forest industry and community leaders that support and are supported by forest resource management.

The Northern Landscape Region (Northern Landscape) includes Koochiching County, Lake of the Woods County, and the northern half of Beltrami County and lies within the Laurentian Boreal Forest ecological province This area encompasses approximately 4.4 million acres. The Committee committed to revising the existing regional landscape plan prepared in 2010. Through a series of meetings in 2023 and 2024 and an information gathering and review process, the plan was revised to reflect the discussion, decisions, and ideas of the Committee and the input of meeting participants. MFRC staff and project partners compiled available information on the social, economic, and ecological aspects of the landscape and presented it to the Committee during the planning process. The Minnesota Department of Natural Resources (MN DNR), U.S. Forest Service, Minnesota State Demographic Center, Explore Minnesota, and others aided in gathering and analyzing information to inform the Committee's planning process.

The major trends and conditions in the Northern Landscape that are discussed in the plan and that informed the development of regional goals and strategies include:
- Stable forest acreage and volume in recent decades
- Changes in forest cover types and age class distributions
- Regional sustainability of timber harvest activities in relation to forest growth and mortality
- Declining trends in human populations and an aging demographic
- Recognition of tourism and recreation activities within the economy
- Importance of road infrastructure and workforce retention
- Dominance of public land ownership, including significant state and county lands, along with private and Tribal lands.

Large portions of the Northern Landscape are under public land management. Most of these lands are administered by MN DNR and county forestry departments. The other forest lands in this region include Tribal, timber industry, and non-industrial private forest ownership. There are two sovereign Tribal nations with reservations in the region: the Red Lake Band (Red Lake Reservation) and Bois Forte Band (Nett Lake Reservation).

Photo credit: James Aasen

Treaties with multiple Bands of Chippewa (Ojibwe) ceded lands and formulate current reservation boundaries and also maintain off-reservation hunting, fishing, and gathering rights for Tribal members. For residents and visitors to the Northern Landscape, outdoor recreation is an important cultural value and economic driver that relies on the well-managed natural resources across the landscape. The region's multi-generational social and cultural fabric is directly tied to the land and diverse individual and community experiences within the forested landscape.

The Northern Landscape's varied topography, soils, and hydrology support a range of upland and lowland habitats including significant areas of open peatlands and woody wetlands (including forested wetlands) and upland forests. The region contains nearly 2.7 million acres of forest land, of which about 2.5 million acres (93%) are classified as timberland. Forestland and timberland acreage has been stable to slightly increasing in recent decades.

Approximately fifteen forest cover types can be found throughout the region with aspen, black spruce, tamarack, northern white-cedar, and lowland hardwood being the five most dominant. Together they represent about 70% of the total timberland. Private (including Tribal), federal, state, and local county lands all contribute to the timber harvest with aspen and black spruce being the major market species.

All water within the region eventually makes its way to the Hudson Bay in Canada through either the Rainy River or Red River basins. Important waterbodies are the Rainy River, Lake of the Woods, and Upper and Lower Red Lake. Supporting these waters are the vast peatlands of Northern Minnesota that form one of the region's most extensive ecosystems and cover more than 10% of the state. The peatlands in Northern Minnesota are studied for their hydrology and water chemistry as well as flow patterns and ecological processes. Information gained from this research contributes to understanding the impacts of and potential mitigations for climate change. Due to their location at the southerly point within the boreal ecosystem, peatlands in the Northern Landscape are considered especially vulnerable to fluctuations in climate and may provide scientists with early indications of the effects of climate change on peatlands across North America.

Climate change is also impacting Minnesota's forests in the form of warmer average annual temperatures, longer growing seasons, intermittent drought, changes in freeze/thaw cycles, and more frequent and extreme storm events. Winters are becoming shorter and warmer, which creates operational difficulties for forest management. These changes are evident statewide and within the Northern Landscape. The Committee's planning process included two meetings focused on understanding the available scientific information on potential future climate change impacts on forests, communities, and the economy for the region. During these meetings the Committee identified adaptation strategies, including through silviculture techniques, that are most applicable to the Northern Landscape. The Committee also incorporated climate change considerations in the identification and prioritization of goals and strategies.

After drafting this revised plan, the Committee prioritized the following near-term strategies from a subset of goals and strategies listed in Sections 4a, 4b, and 4c. Prioritized goals and strategies are of near-term importance or urgency (i.e., next 10 years and before the next plan review) and are listed again in Section 7.

Priority Social Strategies for the Northern Landscape

1. Manage for diverse forest recreation and outdoor activities for residents and visitors (i.e., motorized and non-motorized recreational uses, trail and/or water-based activities, and consumptive and non-consumptive uses).
2. Support regional and state-level recognition of the importance of the forest road system that facilitates diverse and high-quality multiple use, recreation experiences, and private landowner access.
3. Support regional programs that offer education and training, especially for natural resources, trades, health care, and needed social services.

Priority Economic Strategies for the Northern Landscape

1. Encourage business development in the outdoor recreation and tourism sector, including underutilized opportunities.
2. Encourage landowners to develop and implement science-based management plans and utilize private landowner incentives and cost-share programs.
3. Support funding for tree improvement programs, capacity for containerized seedling, and quality seedling production.

Priority Ecological Strategies for the Northern Landscape

1. Implement management strategies that adapt to impacts associated with weather events, forest health and disease issues, wildfire, and consider information about species climate migration.
2. Implement and promote the MFRC's *Voluntary Site-Level Forest Management Guidelines*.
3. Educate decision-makers on sustainable forest management and related policy actions.

Coordination and implementation of the goals and strategies identified will occur following finalization of this plan. The Northern Regional Landscape Committee will meet on a quarterly basis to discuss priority goals and strategies outlined in the plan. Quarterly meetings also provide a venue to exchange information on current committee member activities and discuss resource issues. Often these exchanges generate synergy of learning from each other. Meeting discussions help identify opportunities for collaboration or spur ideas for projects that solve problems experienced at the regional level. The Committee also utilizes committee meetings as a forum to gather valuable feedback to the MFRC on issues experienced at the regional level.

Some goals and strategies may be implemented through collective efforts by committee members and associated organizations with support from MFRC staff. In addition, regional landscape plan goals and strategies are often implemented by non-MFRC member organizations as a means to support local efforts and priorities.

Photo credit: Jolén Simon

SECTION 1: INTRODUCTION

The Minnesota Forest Resources Council (MFRC) is a 17-member organization working to promote long-term sustainable management of Minnesota's forests as directed by the Minnesota State Legislature in the Sustainable Forest Resources Act of 1995. Through its Regional Landscape Program and the six regional forest resource committees, the MFRC develops and supports the implementation of regional forest resource plans (landscape plans) for Minnesota's six major forested regions. This section summarizes the statutory foundations for landscape management in Minnesota.

SUSTAINABLE FOREST RESOURCES ACT

The Sustainable Forest Resources Act (SFRA) in Minnesota was conceived by the Generic Environmental Impact Statement (GEIS) on Timber Harvest and Forest Management (1988-1994). Resulting from the findings of fact and recommendations of the GEIS, the Minnesota State Legislature enacted the SFRA (Minn. Statutes, Chapter 89A) in 1995. The SFRA established the Minnesota Forest Resources 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; and
- 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*. This includes development and implementation of MFRC *Voluntary Site Level Forest Management Guidelines* that help sustain forest resources.

MFRC LANDSCAPE PROGRAM

The Sustainable Forest Resources Act (SFRA) directs the Minnesota Forest Resources Council (MFRC) to establish regional forest resource committees to foster landscape-based forest resource planning and coordination activities. This legislation defines landscape-level planning as "long-term or broad-based efforts that may require extensive analysis or planning over large areas that may involve or require extensive coordination across all ownerships."

The SFRA directs the MFRC to maintain regional forest resource committees that:
- include representative interests in a particular region that are committed to and involved in landscape planning and coordination activities;
- serve as a forum for landowners, managers, and representative interests to discuss landscape forest resources issues;
- identify and implement an open and public process whereby landscape-based strategic planning of forest resources can occur;
- integrate its planning with existing public and private landscape planning efforts in the region;
- facilitate landscape coordination between land managers in the region, both public and private;
- identify and facilitate opportunities for public participation in existing landscape planning efforts in the region;
- identify sustainable forest resource goals for the landscape and strategies to achieve those goals;
- periodically recommend that the MFRC undertake revisions of the region's landscape plan; and
- provide a regional perspective to the MFRC with respect to MFRC activities.

The MFRC established the Regional Landscape Program in June 1997 to organize and support the regional forest resource committees.

Following direction from the SFRA, the MFRC established regional forest resource committees within the six forested landscapes to solicit the input of diverse forest resource interests. These landscapes are based on broadly defined ecological units yet recognize existing political and administrative boundaries for delineation (e.g., county boundaries). The six regional forest resource committees provide an opportunity to involve private citizens, natural resource professionals, Tribal representation, and members of various interest groups in developing and implementing landscape-level plans that promote forest sustainability across all ownerships. The Northern Landscape (Figure 1) includes Koochiching County, Lake of the Woods County, and the northern half of Beltrami County and lies within the Laurentian Boreal Forest ecological province. The Northern Landscape encompasses approximately 4.4 million acres.

Figure 1: Northern Landscape Regional Boundary and Location within Minnesota's Ecological Provinces

*The Northern Landscape includes Koochiching County, Lake of the Woods County, and the northern half of Beltrami County and lies within the Laurentian Boreal Forest ecological province. The Northern Landscape encompasses approximately **4.4 million acres**.*

Legend

	Northern Landscape
	Eastern Broadleaf Forest Province
	Laurentian Mixed Forest Province
	Prairie Parkland Province
	Tallgrass Aspen Parklands

Source: MN DNR and MFRC

The MFRC Landscape Program provides an ongoing means of addressing regional issues through local partnerships that help to develop and accomplish citizen-identified short-term and long-term sustainable forest management goals and projects for the broader landscape region by bridging land ownership and forest types. More information about Minnesota's forested landscapes, the process of landscape-level forest management, and the regional volunteer committees can be found on the MFRC website (mn.gov/frc).

MFRC Forest Landscape Plans

MFRC Regional Landscape Plans are designed to be strategic in purpose and transcend all ownerships in a region. Forest resource planning takes place on many scales based on administrative (e.g., township or county) or ecological boundaries (e.g., watershed or ecological subsections). As planning scales decrease to the sub-landscape and eventually to the site-level, forest resource plans typically become more project-specific in nature and cover fewer ownerships. Yet all scales are connected, and landscape-level plans can broadly help to guide plans that occur at a smaller scale, whose collective accomplishments help to achieve landscape level goals and objectives.

MFRC landscape plans also provide perspective on environmental, social, and economic aspects of forests and forest resource management within the region. This plan is intended to be utilized by a broad scope of stakeholders, including natural resource professionals of various disciplines that intersect with forestry (wildlife and fisheries specialists), and also forest industry and community leaders that support forest resource management.

The MFRC Regional Landscape Plans are often incorporated into more specific and actionable planning efforts including: 1) forest management plans for specific land managing entities, 2) agency programmatic plans for other disciplines such as watershed plans, and 3) funding development plans.

This plan is intended to be utilized by a broad scope of stakeholders including natural resource professionals of various disciplines that intersect with forestry (wildlife and fisheries specialists), and also forest industry and community leaders that support forest resource management.

Photo credit: Jim Hansen

Photo credit: James Aasen

SECTION 2: PROCESS SUMMARY
FORMATION OF THE NORTHERN REGIONAL LANDSCAPE COMMITTEE AND PRIOR PLANNING EFFORTS

Landscape planning is a voluntary, open, and consensus-based process that brings together people who have an interest in the long-term health and vitality of a particular region. The landscape planning process helps landowners and resource managers understand how the lands they manage, which may range from an individual site to a portfolio of agency lands, fit into the larger region or 'landscape.' Landscape planning provides a collaborative process for participants to share information and insights and a way to identify landscape-level concerns and opportunities while developing shared actionable strategies to achieve regionally defined goals. This section describes the overall context for forest resource planning in Minnesota and provides an overview of the process used to develop this updated Northern Regional Landscape Plan.

Photo credit: Jaimé Thibodeaux

MFRC first convened a diverse set of stakeholders to comprise the Northern Regional Committee (Committee) in October of 2002. The Committee was responsible for preparing the first Northern Regional Landscape Plan. The plan was developed through an extensive series of meetings occurring in 2002 and 2003, and finalized in 2004. In 2010 the Committee revised the plan to include a vegetation management framework utilizing the Minnesota Department of Natural Resources (MN DNR) Native Plant Community (NPC) classification. 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, and applications of NPC field guides in forest management. These historic documents can be requested from the MFRC.

This 2024 Northern Landscape Plan reflects updates, revisions, and additions from the 2010 amended plan, including updated silvicultural strategies for NPCs. Members of the Planning Committee and the organizations and interests they represent are provided in Appendix A.

2024 PLANNING PROCESS OVERVIEW

The Committee agreed to the following process for developing this 2024 plan:

- The Committee chair and MFRC staff compiled a list of representative stakeholders to invite to the planning process. An open house for these partners and any interested members of the public was held to kick-off the planning process. Attendees who actively participated are referred to as the Planning Committee.
- A smaller steering team, composed of active Committee members, guided the planning process.
- The Committee held three focused meetings (addressing economic, social, and ecological subjects) and invited participation from all representative stakeholders.
- At each meeting, the Committee reviewed trends and conditions of the economic, social, and ecological issues of the region. They used this information to develop goals and strategies for each subject. Two additional meetings were held with the steering team to discuss climate change and a vegetation management framework.
- When agreement on a particular point could not be reached the discussion was elevated to be more general in nature until consensus was reached.
- Additional meetings were held by the steering team and input sought by the Committee to review the goals and strategies developed in the focused meetings, look at conflicts or tradeoffs, and integrate results to develop the final desired outcomes, goals, and strategies included in the plan.
- The steering team and Committee prioritized the plan's goals, objectives, strategies, and outcomes.
- The Committee was tasked with producing a final regional landscape plan for presentation to the MFRC.
- The Committee commits to assessing its progress on plan goals and strategies approximately every five years or when significant new data becomes available and, if needed, modify the plan.

A draft plan was developed to reflect the discussion, decisions, and ideas of the Committee and the input of meeting participants. The steering team reviewed and edited the draft plan, and provided a version to the full Committee with opportunity to provide comments and revisions. A committee representative and MFRC staff presented the draft document to the Landscape Advisory Committee (LAC) on June 12, 2024, and to the MFRC on July 17, 2024, to gain approval to advance the document for Tribal coordination and a public comment period.

Tribal coordination as directed by Minnesota Statute 10.65 was conducted through ongoing invitations and updates to Tribal staff of Red Lake and Bois Forte Tribal nations throughout the planning process, followed by a formal invitation for a coordination meeting prior to the public comment period.

The following public review process was used:
- An email notice announcing the 30-day public review process and comment period was sent to interested persons and entities in the region and posted in the Environmental Quality Board Monitor.
- A press release was sent to newspapers in the region.
- The public review draft plan and supporting materials were posted on the MFRC website and promoted in the MFRC newsletter.
- Comments were reviewed by the Committee Chair and MFRC.
- Review / approval of the plan by the MFRC.

The Minnesota Forest Resources Council review and approval of this plan was completed on March 18, 2025.

SECTION 3: RESOURCE INVENTORY AND ASSESSMENT

The steering team conducted a resource inventory and assessment to inform the Committee's discussions and the development of goals and strategies. The MN DNR, U.S. Forest Service, Minnesota State Demographic Center, Explore Minnesota, and others aided in gathering and analyzing information. Findings were presented to the Committee during the planning process. Main highlights from the data review are found below, with further details and background in subsections 4a, 4b, and 4c to provide context for the social, economic, and ecological goals and strategies. A full review of the region's trends and conditions is provided in a separate Trends and Conditions Report.

OVERVIEW OF CURRENT TRENDS AND CONDITIONS

The major trends and conditions in the region that informed the development of plan goals and strategies include:

- Stable forest acreage and increasing volume in recent decades
- Changes in forest cover types and age class distributions
- Regional sustainability of timber harvest activities in relation to forest growth and mortality
- Declining trends in human populations and an aging demographic
- Recognition of tourism and recreation activities within the economy
- Importance of road infrastructure and workforce retention
- Public land ownership is dominant, including significant state and county lands, along with private, and Tribal lands

Additional forest trends and conditions are included in subsections 4a, 4b, and 4c to provide context for the social, economic, and ecological goals and strategies. A full review is provided in a separate Trends and Conditions Report.

Photo credit: James Aasen

Photo credit: Nick Jensen

SECTION 4: FOREST MANAGEMENT POLICY FRAMEWORK

One of the key tasks during the planning process was the development of a long-range vision for guiding the sustainable management of the forests across the landscape. The vision for forest management is first described through desired future conditions (DFCs). The region's DFCs are statements that are long-range in nature and provide a vision for the future of the landscape in approximately 100 years—a roadmap for "where we want to go." Next, the Committee developed a series of goals and more detailed strategies to further describe how the DFCs can be achieved. Goals and strategies are short-term (10-20 years) actionable steps to move the landscape toward the DFCs. Together, the long-range DFCs and the short-term goals and strategies form the forest management policy framework.

The resulting forest management policy framework is an updated outline of the Committee's vision based on economic, social, and ecological perspectives of the Northern Committee reflective of current conditions. Readers are encouraged to review the entire plan to fully understand how to apply and implement the strategies outlined for the forests, forest resources, and forest-dependent communities they manage or influence across the landscape region.

<u>Desired Future Conditions (DFCs):</u>

In 100 years, the Northern Landscape will have the following characteristics:

- *A vibrant economy capable of sustaining the Northern Landscape's population and communities.*
- *A landscape with a distinctive identity where residents and visitors have a strong sense of place and that fulfills social needs.*
- *A landscape where collaborative natural resource planning, management, and use provide outcomes that support societal needs in the region.*
- *Resilient ecosystems, diverse habitats, and a functioning forested landscape.*

IDENTIFICATION OF REGION'S STRENGTHS, CHALLENGES, GOALS AND STRATEGIES

Through a series of focused meetings, the Committee refined its planning for how to achieve the agreed upon desired future conditions. Each meeting focused on the social, economic, or ecological aspects of the landscape. Meeting discussion was supported by a presentation of data and information about the economic, social, or ecological trends and conditions of the region.

Prior to each meeting Committee members submitted their perspectives on the strengths and challenges pertaining to the meeting focus. The Committee collectively reviewed submissions, and the outcome was the identification of the region's strengths and challenges (i.e., a snapshot in time of individual perspectives and local conditions and needs).

The Committee also reviewed resource trends and conditions, resulting in updated and revised goals and strategies to best align with current strengths, challenges, regional opportunities and priorities. The strengths and challenges along with the 10-year near-term goals and strategies are summarized in the following sections that address the social, economic, and ecological aspects (4a, 4b, 4c) of the plan. A consolidated list of the Forest Policy Framework including DFC's, goals, and strategies is provided in Appendix C.

Photo credit: Danae Schafer

SECTION 4A. SOCIAL ASPECTS OF THE NORTHERN LANDSCAPE

SOCIAL TRENDS AND CONDITIONS

The sparse population, abundance of public land, and presence of the two Tribal nations make the Northern regional landscape a unique place to live and work. The Committee examined demographics and other social trends and conditions for the region to inform development of the plan.

Regional Population

The available U.S. Census data indicate the region has experienced a population decline, although there are some exceptions. As shown in Figure 2, most towns and communities have experienced a loss of 2-10% or more of their population since 2000 while a few areas have seen gains of 2-10%.

Figure 2: Population Density Change in the Northern Landscape, 2000-2020
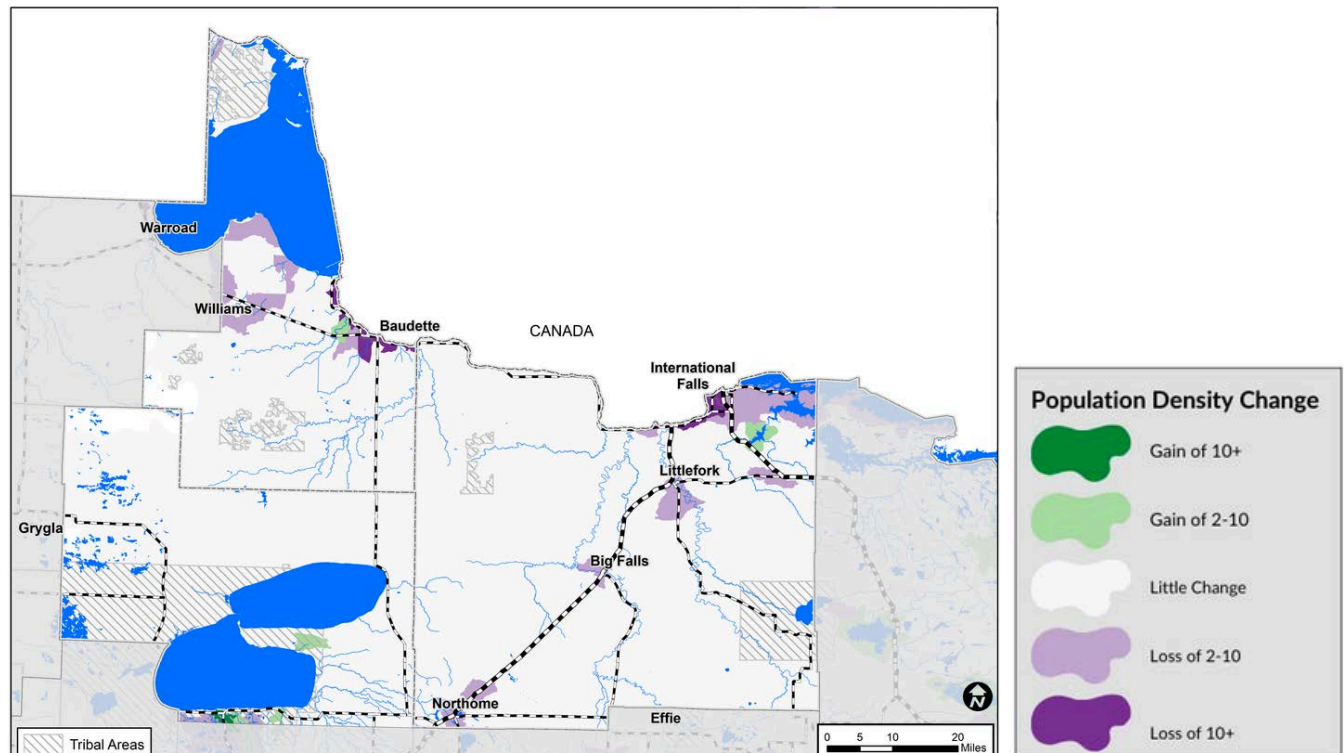
Source: US Census Bureau (2000-2020) and Maps by Mitch

In addition to a declining population (particularly in Koochiching and Lake of the Woods counties), the population is aging. These two trends present an important issue impacting available labor force and economics of the region. As shown in Figure 3, the demographic changes in Koochiching, Lake of the Woods, and Beltrami counties in relation to the labor force (ages 16 and over) show declines from 2015 and 2020 with projected additional declines through 2030. There are also concerns that young people are not being retained in the region after high school.

Figure 3: Population Age Distribution in Beltrami, Koochiching, and Lake of the Woods County, 2020
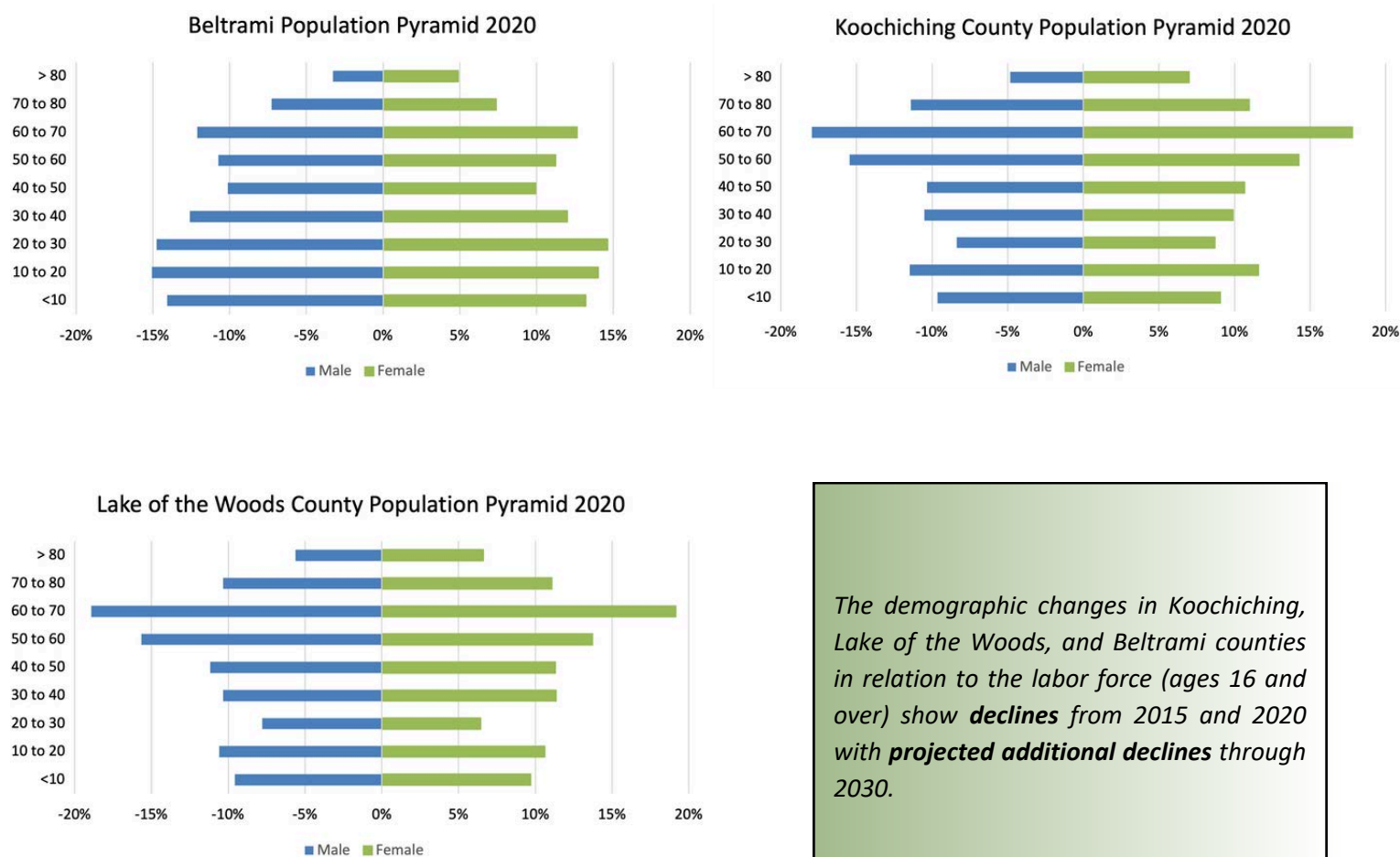
Note: The Beltrami graphic includes the entire county.
Source: US Census Bureau, 2020.

*The demographic changes in Koochiching, Lake of the Woods, and Beltrami counties in relation to the labor force (ages 16 and over) show **declines** from 2015 and 2020 with **projected additional declines** through 2030.*

Social Aspects

21

Declining populations and aging demographic trends result in a limited workforce. There are limited workers to provide forestry services on private lands, public lands, and within local industries. Shortages occur both at the professional (e.g., forest and natural resource managers) and technical levels (e.g., loggers, mill workers, and truck drivers).

Population challenges also influence availability of workers for community services such as medical care, education, and retail for basic commodities such as groceries and business services such as auto and home repair. In turn, this can limit the ability of employers to attract quality workers for all economic sectors, including forestry and the forest products industry. Conversely, the sparse population of the region also results in lower development pressure and avoids or mitigates other social and environmental issues normally associated with growing populations.

Outdoor Recreation

The landscape's rich social and cultural heritage is deeply rooted in connections to the land and shaped by diverse individual and community experiences. For both residents and visitors to the Northern Landscape, outdoor recreation holds significant cultural value, relying on the careful management of natural resources. It also plays an important role in supporting the local economy.

The widespread abundance and accessibility of forests, lakes, rivers, and other ecosystems within the Northern Landscape provide unique opportunities for outdoor recreation. Most of the land remains publicly owned, allowing for plentiful places for a wide variety of recreational opportunities for the region's year-round residents. These opportunities also attract tourists and seasonal cabin owners. The vast expanse of contiguous forestland under public ownership also contributes to forests protected from land conversion leading to high water quality and a stable natural resource base across the landscape (see Section 4c).

Figure 4: Forest Ownership Northern Landscape
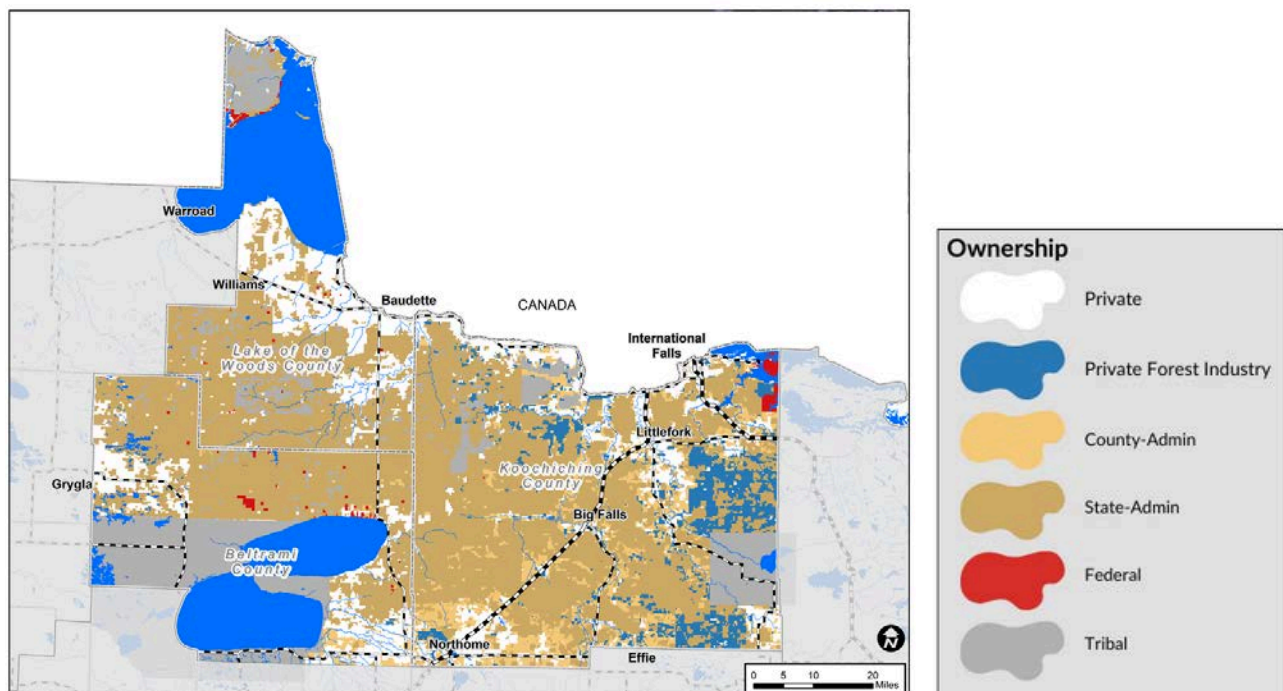
Source: Maps by Mitch, 2024.

The region contains several world-class waterbodies for open water and ice fishing including Upper Red Lake (and Lower Red Lake within the Red Lake Nation) for walleye, Rainy River, and Lake of the Woods for walleye and lake sturgeon. In recent years, the number of public water access facilities has increased, with the addition of 20 more access points since 1998.

Upland game hunting of bear, deer, and grouse, cross-country skiing, snowshoeing, gathering of mushrooms and berries, off-road vehicle use, and bird watching are also significant recreational activities for residents and visitors. Due to vast expanses of wetlands, access can be difficult and only found using the extensive network of forest roads that are maintained primarily by county land departments and the MN DNR. The remote road infrastructure of the region is vital for the forest economy, access for residents, tourism, and wildfire management and mitigation. As shown in Figure 5, the road infrastructure includes state, county, federal, and township systems. These systems are socially and economically important to the region.

Figure 5: Forest Roads and Infrastructure
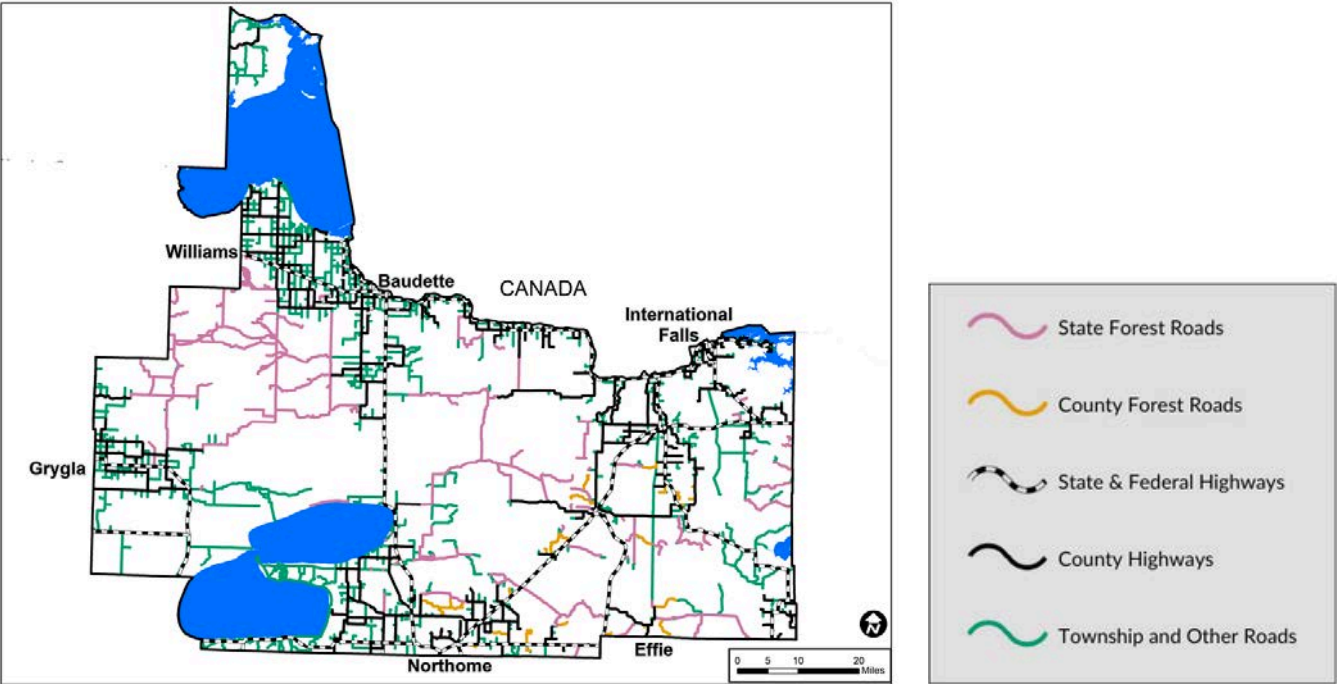
Source: Maps by Mitch, 2024.

Table 1: Miles of Trail

Type of Use	Miles of Trail
Water Trails	314
ATV	455.6
Hunter Walking Trails	146.5
Snowmobile	1,973.4
Hiking	14.2
Biking (Paved)	8
Ski Trails (Koochiching)	20.8

Source: MN DNR, 2023.

Tribal Nations within the Landscape

The Northern Landscape encompasses lands of Anishinaabe (Ojibwe) peoples who have inhabited the area prior and during European settlement and continue to live in the region today. The Anishinaabe have strong relationships with forest resources and traditional and cultural uses for forests and forest-dependent fish, plant, and wildlife species.

Land cession treaties of the 1800s and early 1900s crafted the geo-political boundaries seen today. These treaties with multiple Bands of Chippewa (Ojibwe) ceded lands and formulate current reservation boundaries, and also maintain off-reservation hunting, fishing, and gathering rights for Tribal members. Treaties of Old Crossing 1863 and 1864 followed by treaties in 1889 and 1904 ceded much of the western portion of the landscape region, while retaining lands now forming the Red Lake Nation Reservation. The Northern Landscape also encompasses land ceded through treaties in 1854 and 1866 (and an executive order in 1881) but retains lands that now form the Bois Forte Reservation. Additional lands were ceded through treaty in 1855 forming the Leech Lake and Mille Lacs Bands of Chippewa reservations, which are located outside of the landscape region.

Today there are two sovereign Tribal nations with reservations in the region: the Red Lake Band (Red Lake Reservation) and Bois Forte Band (Nett Lake Reservation). The Red Lake Reservation is located adjacent to most of Upper Red Lake and all Lower Red Lake in the southwest part of the Northern Landscape, encompassing approximately 348,000 acres of managed timber as well as a tree nursery. The band has approximately 5,500 members. Red Lake Reservation is unallotted, which means the land is completely owned by the tribe and is occupied entirely by members of the Red Lake Band of Chippewa Indians, which is unique among reservations in Minnesota. The Tribe maintains a school to provide primary and secondary education on the reservation, and a Tribal college for post-secondary opportunities. The current boundary of the Red Lake Reservation dates to the 1904 Land Act.

The Bois Forte Reservation is divided into three sectors, Nett Lake, Vermilion, and Deer Creek. Nett Lake Reservation falls within the Northern Landscape and is home to the largest number of band members and government offices. The reservation is also home to the 7,400-acre Nett Lake and is widely considered the world's largest and most prolific wild rice lake (Bois Forte Band of Chippewa, n.d.). The Bois Forte Department of Natural Resources continuously monitors water quality, regulates access, and controls the wild rice harvest. Bois Forte reservations are "allotted", resulting in a land ownership pattern of Tribal and non-Tribal ownership within their boundaries today. They maintain a robust natural resources department with a forest management program. Foresters manage both Tribal and allotted lands within the boundary of the reservations.

Bois Forte, Red Lake, and other Bands own lands outside of reservation boundaries and their members reside throughout the landscape. Tribal resources in these territories are maintained by the Bands and regional treaty organizations.

SOCIAL STRENGTHS AND CHALLENGES

The following are committee member perspectives of strengths and challenges related to social aspects of the region. These were solicited as an exercise to document local conditions and begin brainstorming potential goals based on needs.

Strengths

- Education system, including active schools and junior college.
- Active state and county forestry department, Soil and Water Conservation Districts (SWCDs), and other public agencies and entities.
- Good road transportation systems, including the state highway system.
- Broadband access is improving.
- A conscious policy of making access to public lands available for a variety of user groups, abundant recreation opportunities, and investments in access.
- Metrics for quality of life: education, healthcare, housing, public safety, a clean environment, and sense of community are strong; and there is a strong social services network to provide access to social programs.
- Recreation is supported by good water quality, water access infrastructure, healthy fishery, and lease cabins/shacks that provide increased opportunity to use public land for public use.
- Diverse businesses and robust recreation opportunities from natural resources, including logging and harvesting for timber and non-timber products, snowmobiling, ATV use, and hunting and foraging as great ways to harness the economic potential of our region.
- Lower population density means less competition for recreational activities, and fewer conflicts with user groups during resource management efforts.
- Residents tend to be engaged with and aware of the natural resources of their landscape and committed to living in America's Icebox.
- Voyageurs National Park is in the region, the only national park in Minnesota.
- Workforce committed to maintaining the current industry with a strong social connection to outdoors and forests.
- Some parts of the region have increasing population trends and a more even workforce age structure.
- Residents in favor and understand the benefits of forest management.

Photo credit: Kristi Coughlon

Challenges

- Increased social pressure to limit some activities and access for recreation (i.e., restrictions on ATV use).
- Decreased participation in some types of outdoor recreation (i.e., hunting, fishing, snowmobiling) because of changing interests and conditions.
- Shrinking tax base with potential to impact the social safety-net.
- Reliance on volunteers and community organizations with aging members who are facing burnout. The population of small business owners is also aging.
- Remote and long distances from consumer retail services, and the location can also make it difficult to attract some tourists/visitors and new residents.
- Imbalances in population demographics (i.e., age and gender) and limited livable-wage job opportunities hinder the formation of stable households and multi-generational family structures. This impacts enrollment in local schools and increases support needs for retirement aged community members.
- Low population density, declining population, high poverty levels, and lack of diversity (age, race, etc) impacts workforce, tax base, and the business community.
- Educational opportunities to support natural resource related careers are not available locally within the region.
- The uniqueness of the region and its needs and opportunities are not always well understood by state-level decision-makers.
- Communities in the region may be isolated and face challenges in adapting to changes.
- Instances of inadequate maintenance of public accesses for forests, lakes, and rivers (especially the Rainy, Big Fork and Little Fork Rivers).
- Conflict between users over public lands and meeting expectations for diverse recreation uses.
- Some areas of the region face development pressure into forest land, creating potential conflict with forest management.
- Third party forest certification requirements and cost may be a barrier to entry into the business for new loggers.

SOCIAL GOALS AND STRATEGIES

Desired Future Outcomes:

- A landscape with a distinctive identity where residents and visitors have a strong sense of place and that fulfills social needs.
- A landscape where collaborative natural resource planning, management, and use provide outcomes that support societal needs in the region.

Goal 1: Increase and maintain sustainable multiple use of public lands, public waters, and private industrial lands open to the public.

Strategies:

- Manage for diverse forest recreation and outdoor activities for residents and visitors (i.e., motorized and non-motorized recreational uses, trail and/or water-based activities, and consumptive and non-consumptive uses).
- Enhance public access while maintaining natural resource integrity.
- Maintain boat launches, campgrounds, trailheads, facilities, roads, and other recreation infrastructure to ensure quality experiences for residents and visitors.
- Encourage additional funding for maintenance and strategic enhancement of recreational systems and infrastructure.

Photo credit: Kirby Readman

- Support regional and state-level recognition of the importance of the forest road system in providing high-quality multiple use, recreation experiences, and access for private landowners.
- Provide access to recreation maps and information to support sustainable multiple use and avoid conflict.
- Maintain a stable public land base while supporting adequate state and federal programs that ensure local taxing districts receive revenues to offset non-taxable public lands.

Goal 2: Contribute to the well-being of the landscape's population.

Strategies:

- Manage forests to maintain or improve air, water, and soil resources.
- Manage forests and communities to support viable populations and quality habitat for culturally significant organisms, plants, and animal species for hunting, gathering, and other non-consumptive recreation.
- Support regional programs that offer education and training, especially for natural resources, trades, health care, and essential social services.
- Encourage decision-makers to participate in regional events that demonstrate the needs of constituents.
- Encourage initiatives to mitigate and adapt to climate change.
- Support opportunities and access to outdoor and cultural experiences for residents and visitors.

Goal 3: Promote development and infrastructure investment that values and supports the natural resources of the region.

Strategies:

- Continue to implement local comprehensive land use plans and support opportunities to fund regional planning.
- Locate development within existing corridors to minimize fragmentation.
- Consider the vulnerabilities to human health and safety of the rural landscape in anticipation of increasing climate change risks, including wildfire, flooding, and other ecosystem impacts.
- Support housing programs that attract and retain residents, including the workforce.
- Recognize the importance of essential community infrastructure and services, including schools, health care, and roads.

SECTION 4B: ECONOMIC ASPECTS OF THE NORTHERN LANDSCAPE

Forestry, the forest products industry, and forest-based recreation is a significant part of the economy in the Northern Landscape. Forest harvest has been relatively stable over the last decade.

ECONOMIC TRENDS AND CONDITIONS

The Committee reviewed forest trends and conditions for insights on long-term economic sustainability for forestry and forest based recreation to guide decisions and management considerations.

Forest Inventory and Analysis (FIA)
Definitions of *Forest land* and *Timberland*

Forest land: *Land with at least 10% canopy cover of trees, or evidence of past canopy cover, that can be regenerated naturally or artificially. This includes land that is marginally productive or where timber production is prohibited.*

Timberland: *Unreserved forest land capable of producing 20 cubic feet per acre per year of wood from trees classified as timber species and designated as a timber forest type. Timberland excludes reserved forest land or forest land that is not managed for production of wood products through statute or administrative designation such as wilderness areas.*
Source: *FIA Glossary*

Timber Industry

Forest trends and conditions within the Northern Landscape are informed by data collected through the U.S. Forest Service Forest Inventory and Analysis (FIA) program. The FIA program provides nationwide data on forest resources, health, and related data. FIA data show the Northern Landscape includes nearly 2.7 million acres of forestland, of which about 2.5 million acres (93%) is classified as timberland (U.S. Forest Service, 2024). The definitions for these classifications are included below.

As shown in Table 2 and Figure 6, the forest land and timberland acreage in the Northern Landscape has been stable to slightly increasing in recent decades. The percentage of the forested area that qualifies as timberland has been steady.

Table 2. Change in Forest Land and Timberland, 2003, 2013, and 2021 (FIA)

Classification	2003 (acres)	2013 (acres)	2021 (acres)	Change 2003-2021 (%)
Forest land	2,618,378	2,746,243	2,650,600	1.2%
Timberland	2,401,561	2,571,872	2,465,521	2.7%
% Timberland	*92%*	*94%*	*93%*	

Source: U.S. Forest Service, 2024.

Table 3. Forest Land and Timberland Cover Types in the Northern Landscape (FIA, 2021)

Cover type (MN DNR Class)	Forest land (Acres)	Timberland (Acres)	Timberland in each Cover Type across the Northern Region (%)
Jack pine	24,435	24,435	0.99%
Red pine	63,213	60,523	2.45%
Eastern white pine	10,400	10,400	0.42%
Balsam fir	46,207	40,927	1.66%
White spruce	35,884	35,137	1.43%
Black spruce	**474,878**	**411,520**	**16.69%**
Tamarack	**372,967**	**327,101**	**13.27%**
Northern white-cedar	**223,816**	**222,948**	**9.04%**
Oak	120,702	108,864	4.42%
Northern hardwoods	113,934	105,121	4.26%
Lowland hardwoods	**221,884**	**198,722**	**8.06%**
Cottonwood / Willow	7,531	5,622	0.23%
Aspen	**689,711**	**674,967**	**27.38%**
Birch	84,958	83,330	3.38%
Balsam poplar	88,897	88,897	3.61%
Non stocked	23,671	22,842	0.93%
Other	47,512	44,164	1.79%
Grand Total	**2,650,600**	**2,465,521**	**100.00%**

Source: U.S. Forest Service, 2024.

*There are approximately **15** USFS defined forest cover types in the region (Table 3). The **top five forest** types by acreage and timberland percentage are shown in bold in Table 3 and illustrated in Figure 6.*

Figure 6: Percentage Distribution of Timberland Cover Types in the Northern Landscape (FIA, 2021)
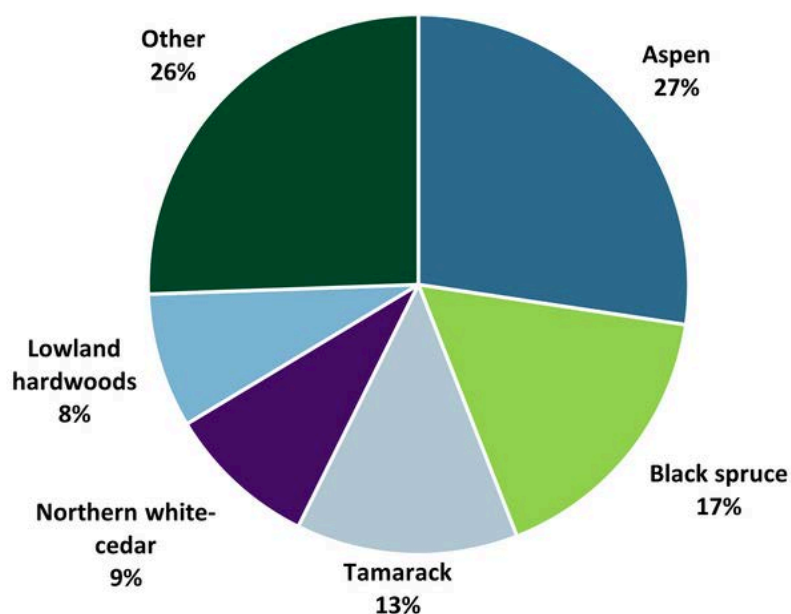
Source: U.S. Forest Service, 2024.

Timberland trends for aspen, black spruce, tamarack, northern white cedar, and lowland hardwoods from 2003, 2013, and 2021 indicate slight shifts but are generally stable over the last 20 years (Figure 7). The last decade shows reductions in tamarack, likely due to eastern larch beetle but is comparable with acreage from 2003.

The net growth, harvest removals, and mortality across the forest ownership categories in the Northern Landscape for a five-year moving average derived from FIA are shown in Figure 7 and Table 4. Net growth (gross growth minus mortality) to harvest ratios may be utilized to indicate sustainability of harvest throughout a landscape area. Ratios below include a balanced harvest to growth ratio throughout the landscape despite a large weather-related mortality event resulting in substantial salvage harvest during the five-year moving average. Resource experts also advise that increasing natural disturbances related to climate change may challenge the region's ability to manage for multiple objectives. Active harvest in the region is occurring across Tribal, private, state and locally administered county lands at well below the level recommended by the net growth to removals ratio.

Figure 7: Timberland Area for Top Five Cover Types, 2003-2021
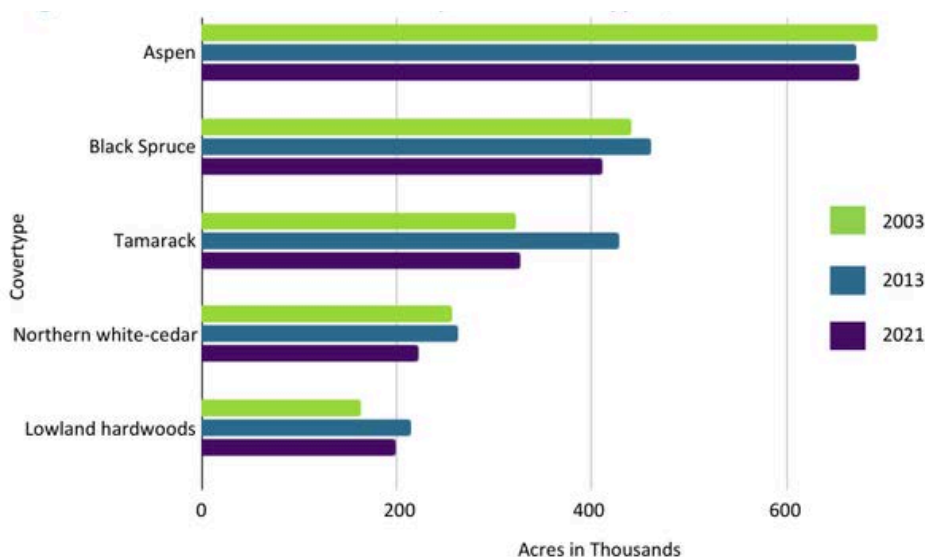
Source: U.S. Forest Service, 2024.

Table 4. Annual Growth, Harvest, and Mortality by Forest Ownership in the Northern Landscape (FIA, 2021)

Owner Class	Harvest Removals	Mortality	Gross Growth	Harvest Removals	Mortality	Ratio
Local	15,611,209	6,258,417	22,180,073	-15,611,209	-6,258,417	(1.02)
Federal	1,269,425	1,014,315	5,170,041	-1,269,425	-1,014,315	(3.27)
Private (includes Tribal)	18,210,916	18,876,532	54,433,867	-18,210,916	-18,876,532	(1.95)
State	10,808,330	15,754,324	42,005,379	-10,808,330	-15,754,324	(2.43)
Total	45,899,880	41,911,442	123,803,551	-45,899,880	-41,911,442	(1.78)

FIA summaries of gross growth, mortality, removals, and net growth for ownerships in the Northern Landscape in cubic feet of sound timber in growing stock trees greater than 5 inches d.b.h.: Annual five year moving average ending in 2021. Source: U.S. Forest Service, 2024.

Figure 8: Annual Growth, Harvest, and Mortality by Forest Ownership in the Northern Landscape (FIA, 2021)

FIA summaries of gross growth, mortality, removals, and net growth for ownerships in the Northern Landscape in cubic feet of sound timber in growing stock trees greater than 5 inches diameter at breast height: Annual five year moving average ending in 2021.

* Private forestland includes industrial, family, and Tribal ownerships.
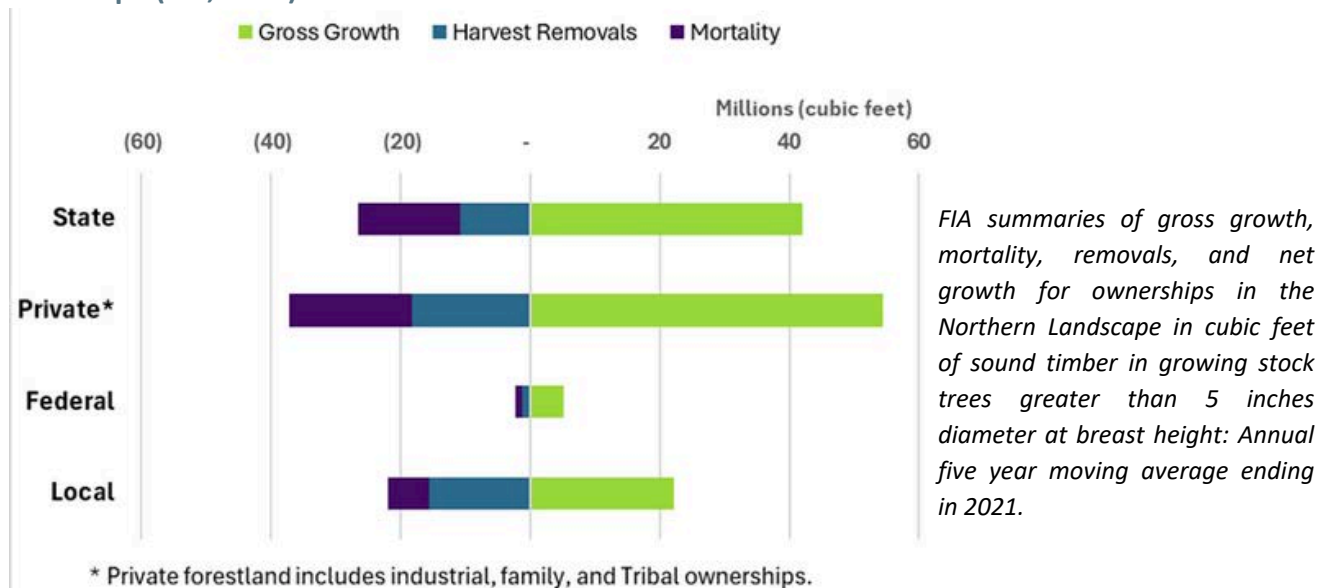
Source: U.S. Forest Service, 2024.

Aspen and black spruce are two of the major cover types in the region, representing about 44% of the total timberland area (Figure 8). The age class distributions of these cover types are illustrated below (Figures 9 and 10).

Figure 9: Aspen Age Class Change, 1990 - 2021
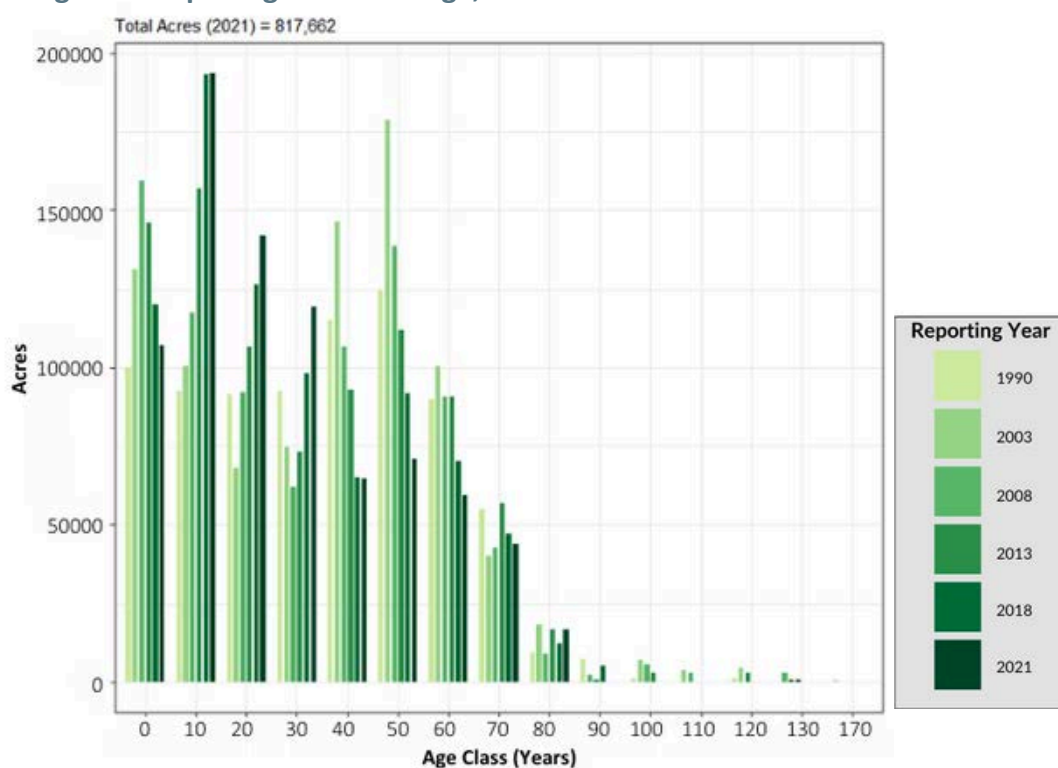
Age distribution of aspen in 10-year age class totals for inventories conducted 1990-2021.
Source: U.S. Forest Service, 2024.

Figure 9 shows 10-year age classes for aspen from 1990 to 2021. Management activities for aspen in the region have involved older stands being harvested, regenerated, and subsequently recording these acres within the younger age classes. As shown in Figure 10, in 2003 there were a large number of acres in the 40- and 50-year age classes, and as of 2021 there are more acres in the 10- and 20-year age classes. Often, aspen timberlands are managed on a short rotation to avoid fiber loss and to preempt natural succession to a black ash or balsam fir dominated, lower value and/or fuels heavy forest. From 1990 to 2021 there were decreases in the 40-, 50- and 60-year age classes for aspen as harvests (and mortality events). Therefore, the data also shows the corresponding gains in the 10-, 20- and 30-year age classes as the stands regenerated. To some degree, harvesting activities in recent decades focused on older stands presumably to avoid volume losses and capture mortality. Older stands may also experience mortality or natural disturbance events that result in a change in the age class. The amount of aspen in the 70- and 80-year-old age classes in the landscape remained similar or slightly higher in 2021 than in 1990. With active management, the total acreage of aspen and the age class distribution of aspen in the region remains stable and able to contribute to regional markets.

As shown in Figure 10, from 1990 to 2021 there were decreases in the younger age classes of black spruce and increases in the older age classes. These trends correspond to lower rates of harvest in these cover types and an overall aging trend for black spruce forests in the region. Additional graphical representation of cover types and age classes in the region is included in a separate Trends and Conditions Report.

Figure 10: Black Spruce Age Class Change, 1990-2021

Age class distribution of black spruce in 10-year age class totals for inventories conducted 1990-2021.
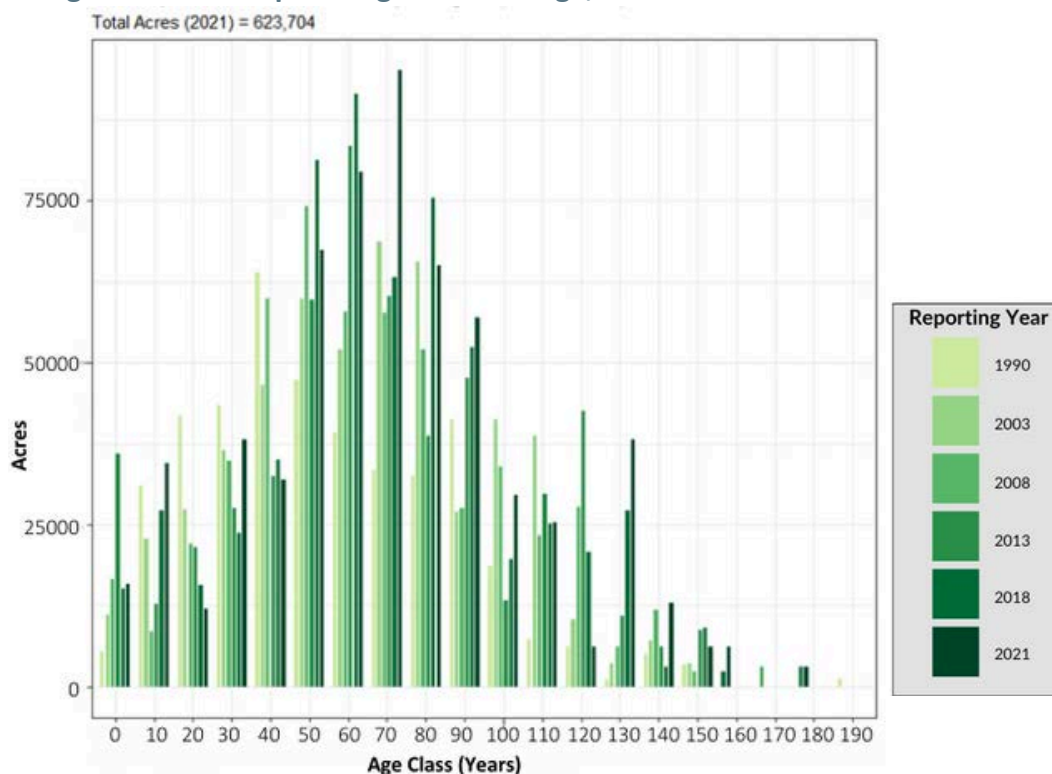Source: U.S. Forest Service, 2024.

Forest management is dependent upon the availability of logging firms to implement the activities and conduct harvesting operations that contribute to the economic, social, and ecological goals of the landscape. As shown in Table 5, the number of logging firms has remained stable. However, the reliance on large and medium sized firms may limit the ability to economically provide services to small landowners and meet diverse management needs (Figure 11). As noted in section 4a and Figure 3, the workforce is also aging. This presents potential future challenges for staffing logging firms, mills, and other forestry-related industries.

Table 5. Logging Firms in Beltrami, Koochiching, and Lake of the Woods Counties with Minnesota Logger Education Program Membership

	2015	2017	2019	2021	2023
Beltrami					
Small	24	21	23	26	24
Medium	12	9	10	10	9
Large	4	4	4	5	5
Total	40	34	37	41	38
Koochiching					
Small	10	12	13	13	9
Medium	5	5	5	5	4
Large	15	15	15	14	15
Total	30	32	33	32	28
Lake of the Woods					
Small	6	4	6	6	5
Medium	2	2	1	0	0
Large	0	0	2	2	2
Total	8	6	9	8	7
Total	78	72	79	81	73

Small (<5,000 cds/yr), Medium (5,000-10,000 cds/yr), Large (>10,000 cds/yr)
Source: Minnesota Logger Education Program, 2023.

*Continued **declines** in the overall regional population and **increasing** average age will continue to make workforce availability a challenge for regional industries including logging and forestry.*

Outdoor Recreation and Tourism

The rich abundance of natural resources within the Northern Landscape attracts significant tourism and contributes to the local economy. Extensive networks of ATV and snowmobile trails connect visitors to rural communities, resorts, and public campgrounds. The region is home to unique tourism opportunities not found elsewhere in Minnesota including world-class fishing lakes, vast expanses of forests to deer, bear, and grouse hunt, and a location to see boreal bird species within the lower 48 of the United States. Tourism generates at least 20% of the local economy in Beltrami County (includes the entire county) to almost 50% tax revenue in Lake of the Woods County (Figure 11).

Figure 11: Koochiching, Lake of the Woods, and Beltrami Tourism Sales Tax as Percent of Total
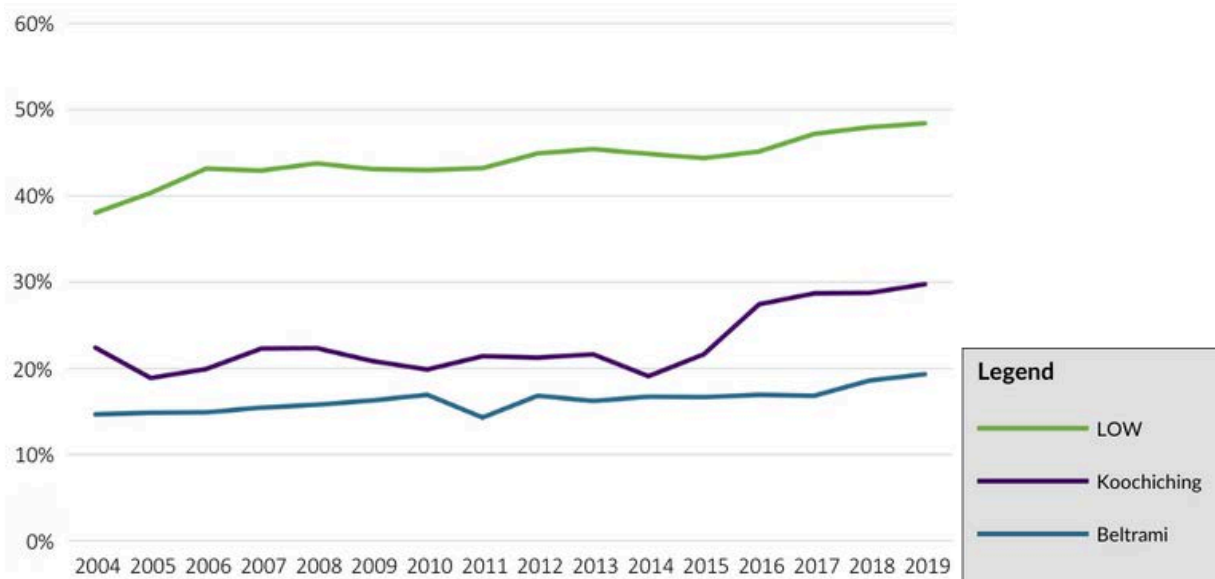
Source: Minnesota Department of Revenue, 2024

Photo credit: James Aasen

Economic Aspects

Fishing opportunities in the Northern Landscape have become an increasingly important aspect of the economy. Vast numbers of visitors travel to Lake of the Woods and Upper Red Lake to ice fish in the otherwise challenging winter tourism season. Increasing use of wheeled fish houses has resulted in substantial growth of winter angling hours over the last few decades (Figure 12). Rainy River has become known for its world-class spring walleye fishing and healthy and growing population of lake sturgeon, a species struggling in other portions of its range.

Figure 12: Angler Hours by Season on Popular Waterbodies
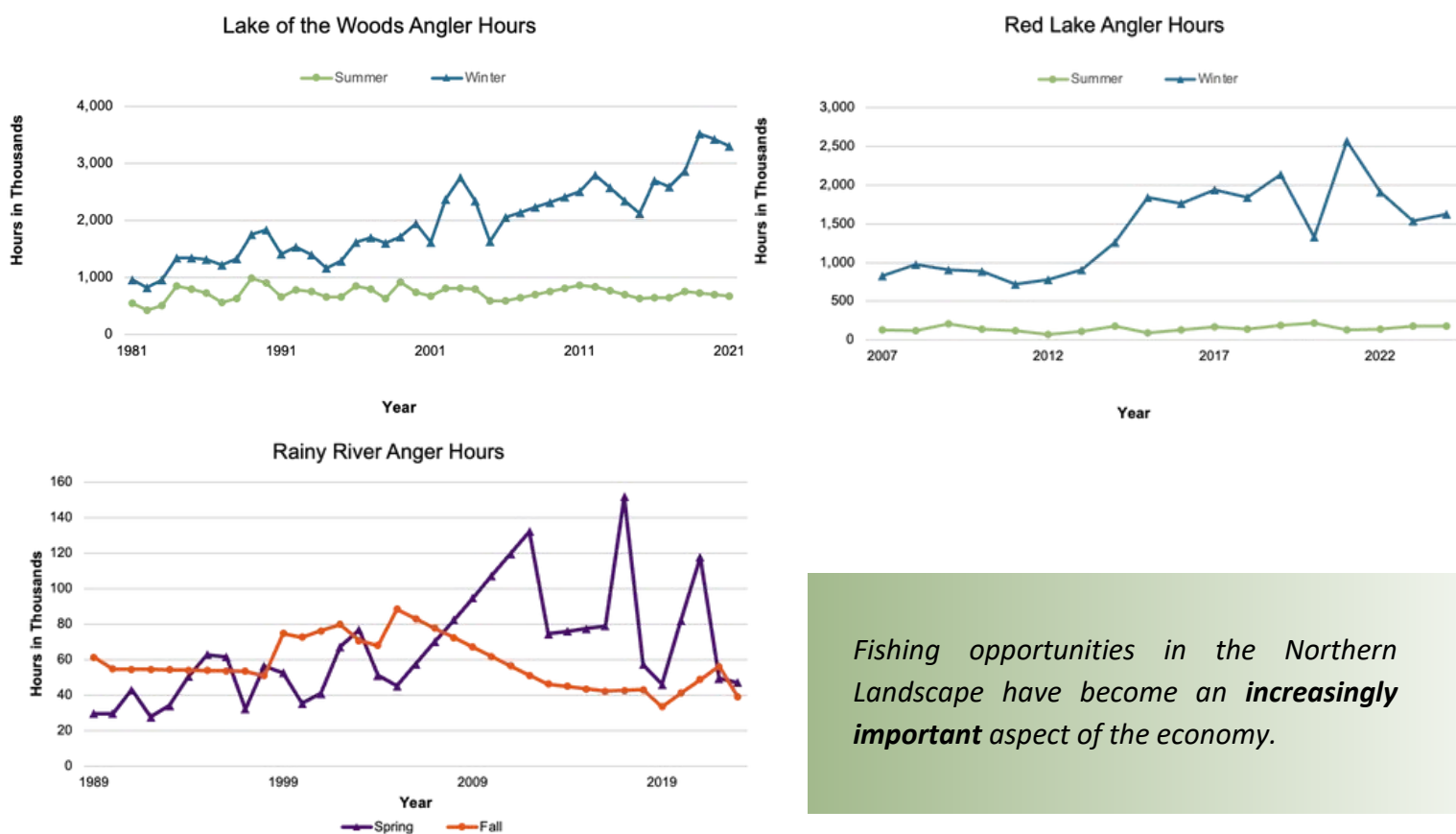
*Fishing opportunities in the Northern Landscape have become an **increasingly important** aspect of the economy.*

Source: MN DNR Fisheries (T. Kennedy & B. Nelson, personal communication, 2023)
Angler hours are observed for most years by MN DNR. Unobserved years were interpolated using a linear trend algorithm.

ECONOMIC STRENGTHS AND CHALLENGES

The following are committee member perspectives of strengths and challenges related to economic aspects of the region. These were solicited as an exercise to document local conditions and begin brainstorming potential goals based on needs.

Strengths

- Existing wood markets and mill capacity to support active forest management and knowledgeable loggers with state-of-the-art equipment to meet harvest needs.
- Available markets for less valuable timber species through Amish and other small lumber mills as well as non-timber forest products (foraging, maple syrup, birch poles, spruce tops, and balsam boughs, etc.).
- The Sustainable Forestry Incentives Act (SFIA) has been effective for engaging private forestlands in management.
- Local agencies provide forest planning services to family forest owners and the region has abundant public land with forest management plans.
- Abundant natural resources, including productive forests well-suited to recreation and tourism. They may be a draw for workers, including remote workers.
- Adjacency to an international border provides unique economic opportunities.
- Forests are well-managed (i.e., age class regulated) and productive (i.e., fully stocked).
- Well established road system and wood storage infrastructure with continued investment in water, sewer, broadband, and transportation corridors.
- Strong local cultural support for multiple-use, forest products industry, and tourism associated with forests and forest management.
- Lower cost of living than other regions and a growing population of experienced people that have retired from full-time work.
- Land available for industrial development.
- Strong opportunities for logging businesses, creating good jobs throughout the region.
- Recent partnerships between land managers and wildlife-focused non-profits have increased sustainable land management while also benefiting the local economy.
- Commercial fishing on Lower Red Lake is important for the local economy for Red Lake members.

Photo credit: James Aasen

Challenges

- Markets are not robust enough to attract private landowners to harvest timber (too far from markets for engineered wood products) and permitting requirements in Minnesota create cost and technical barriers to mill expansion and economic development.
- Increasing weather related mortality and large scale insect and disease threats to forest health, including blow-downs, drought, hail, Eastern larch beetle, Dutch elm disease, Emerald Ash Borer (EAB), and Dwarf mistletoe. These events decrease timber value and increase regeneration costs.
- Remote area far from essential services (i.e., health care, senior care, education alternatives, etc.) and insufficient local housing stock.
- Developable land is limited by hydrology and soil conditions.
- Few high-paying jobs, labor shortages in the logging and trucking industry, declining population, and a limited and aging workforce.
- Limited number of young people trained to operate logging equipment and manage forests. Challenges with recruitment and retention of a local labor force.
- Large start-up cost barrier for entry into profession for new loggers.
- Lack of economic diversity, inflation, limited forest products companies, lack of investor interest, and existing risks in opening a new business.
- A changing forest products sector (i.e., product and market changes) and potential impacts from technology changes.

Early Logging Camp in Northern Minnesota. Early 1900's.
Photo credit: Source unknown via James Aasen

ECONOMIC GOALS AND STRATEGIES

Desired Future Outcomes:

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

Goal 1: Stabilize, diversify, and improve local economies, population, job sectors, and incomes at or above the living wage that rely on the sustainable use of landscape assets.

Strategies:

- Encourage economic development through existing organizations (e.g., the Koochiching Economic Development Authority).
- Encourage utilization of biomass as a renewable fuel source.
- Promote and market outdoor recreation opportunities.
- Encourage business development in the outdoor recreation and tourism sector, including underutilized opportunities.
- Promote and protect responsible and sustainable recreation and tourism use of ATVs through locally developed plans.
- Explore opportunities for non-traditional forest products and encourage value-added and secondary forest product industries.
- Explore carbon and other ecosystem service market opportunities that are complementary to timber harvesting and provide local and in-state benefits.

Early Logging in Northern Minnesota. Early 1900's.
Photo credit: Source unknown, via James Aasen

- Promote interagency cooperation leading to more timely permitting processes.
- Evaluate changes in local and state policies that could assist existing industries.
- Encourage landowners to develop and implement science-based management plans and utilize private landowner incentives and cost-share programs.
- Support funding for business expansion and start-ups that complement existing industries.
- Explore opportunities available with a foreign trade zone designation and being located on an international border.
- Increase development and investment in broadband infrastructure and opportunities for remote work and careers, including jobs that attract young adults.
- Increase entrepreneurial capacity by targeting innovative and enterprising business opportunities and startup companies.

Goal 2: Increase the Northern Landscape's forest productivity and resilience in a sustainable manner consistent with MFRC's *Voluntary Site-Level Forest Management Guidelines.*

Strategies:
- Support silviculture productivity, climate resilience, and tree improvement research.
- Increase capture of mortality, including sites affected by forest health issues (ash, tamarack, black spruce).
- Look for opportunities to increase forest harvest treatments to support forest-based industries in the region while achieving multiple resource objectives (e.g., enhanced forest productivity, health, and resilience).
- Look for opportunities to increase the region's climate resiliency (climate smart forestry).
- Encourage land managers to harvest at rotation consistent with management objectives.
- Ensure prompt, adequate regeneration on all harvested sites consistent with management objectives.
- Increase utilization within harvest areas, consistent with the MFRC's *Voluntary Site-Level Forest Management Guidelines.*
- Promote use of existing silvicultural science in management practices (thinning, insect control, etc.).
- Monitor forest productivity and resilience through the data provided by the U.S. Forest Inventory and Analysis program and other state-level efforts.
- Support funding for tree improvement programs, capacity for containerized seedlings, and quality seedling production.
- Encourage landowners to actively and sustainably manage forests.
- Promote adequate and continued funding for maintaining and building reliable forest roads.

Goal 3: Increase and diversify income opportunities that complement logging and existing jobs, including seasonal, farming, and road or infrastructure work.

Photo credit: James Aasen

Strategies:
- Promote capital investments for equipment purchase.
- Provide technical support for loggers, farmers, and other small businesses wishing to access complex contracting opportunities and state bidding.
- Recognize the economic dependencies between farming and forestry operations.
- Increase opportunities and support for seasonal operations, such as summer harvest access or secondary wood products like biochar.
- Identify and promote consumption of local farm and forest products.
- Promote the marketing of locally crafted forest products, including possibilities for biochar.

Goal 4: Encourage educational opportunities to promote economic stability.

Strategies:
- Facilitate mentorships, apprenticeships, field-days, and job-shadowing to support workforce recruitment and retention.
- Promote local/regional opportunities for higher education, especially in careers that support retention of local workforce and that limit the need to travel or relocate outside the region.
- Promote the plan's goals and strategies locally, within regional communities, and with educators and educational organizations.
- Improve outreach and promote regional recruitment programs focusing on workforce stability.
- Promote use of statewide natural resource initiatives, services, and programs including University of Minnesota Extension, Minnesota Logger Education Program (MLEP), Sustainable Forests Education Cooperative (SFEC), and Natural Resources Research Institute (NRRI).

Photo credit: Andy Tri

SECTION 4C: ECOLOGICAL ASPECTS OF THE NORTHERN LANDSCAPE

ECOLOGICAL TRENDS AND CONDITIONS

The Northern Landscape's suite of ecosystems oscillates from well-drained mesic and fire-dependent uplands near the border lakes ecoregion on the eastern boundary to the saturated bogs of the Agassiz Peatlands subsection on the west. The predominant habitats are woody wetlands (including forested peatlands) and open peatlands (emergent wetlands) followed by upland forest areas (Figure 13 and Table 6). As described in the Vegetation Management Framework section of this document (Section 5), the National Land Cover Database provides the most accurate representation of the region's vegetation.

Figure 13: Land Cover and Land Use Mapping for the Northern Landscape
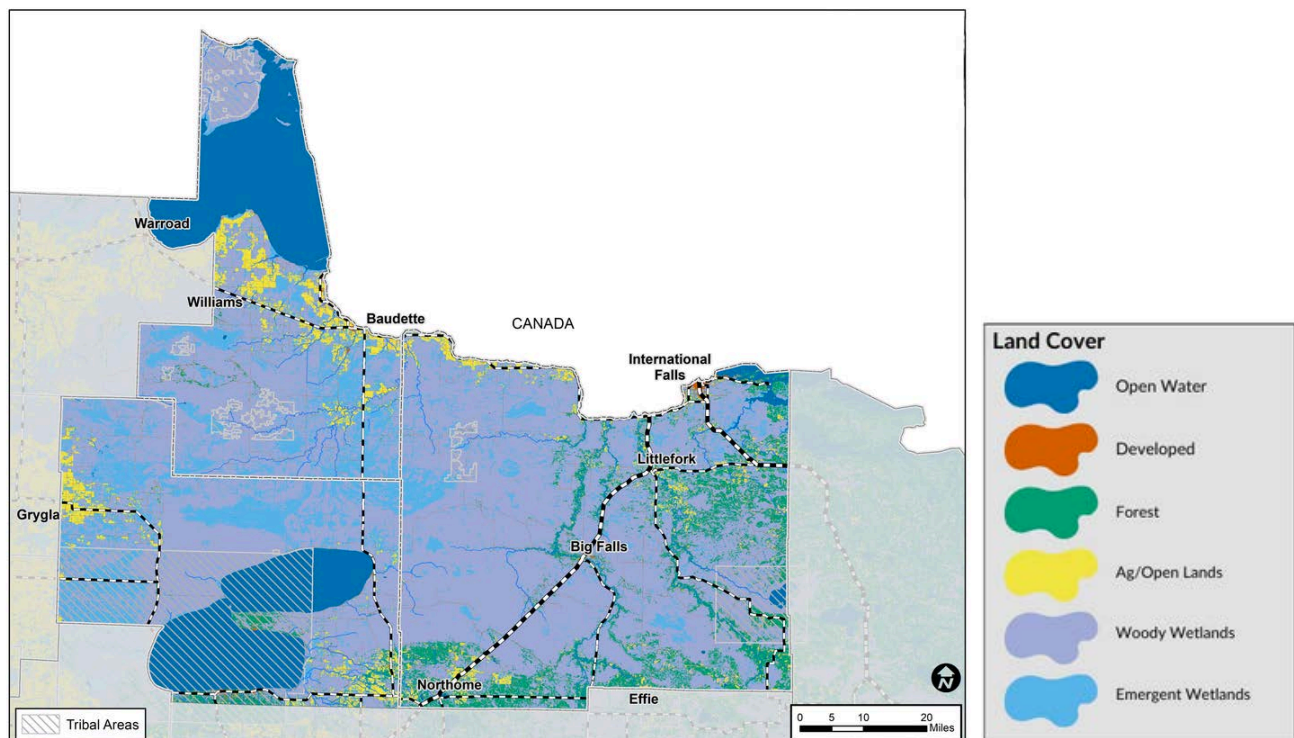
Source: National Land Cover Database, 2019 (Dewitz, J., 2021)

Table 6. Land Cover for the Northern Landscape (2019)

Land Cover Class	Acres
Woody Wetlands	2,517,383.6
Emergent Wetland	702,447.5
Evergreen Forest	23,327.4
Deciduous Forest	176,486.9
Mixed Forest	117,692.1
Grass-Herb	25,771.7
Hay-Pasture	48,981.5
Cultivated	102,641.5
Shrub-Scrub	19,810.5
Barren	640.1
Developed	51,950.0
Open Water	630,639.6
Total	4,417,772.4

Source: National Land Cover Database, 2019.

WATERSHED HEALTH AND QUALITY

Vast expanses of undisturbed forests and wetlands play a pivotal role in protecting the region's water quality (Figure 14). Overall, the Northern Landscape is at just over 91% 'protected'. Protected lands include public and Tribal lands, public waters, wetlands on private lands, conservation easements, and lands enrolled in the Sustainable Forests Incentive Act (SFIA). The extent of protected lands in each major watershed contributes to the region's excellent water quality and abundant forest resources.

The Northern Landscape does contain a few problem areas due to historical ditching in the Lake of the Woods watershed that contribute to impairments seen today (Hernandez et al., 2020). In addition, the geology and soils of the central and eastern portions of the landscape make rivers more susceptible to erosion and create highly mobile, young river systems (Funke et al., 2017). Most of the historical water quality impairments have recovered and current lingering impairments continue to recover.

Figure 14: Protected Lands by Minor Watershed in the Northern Landscape
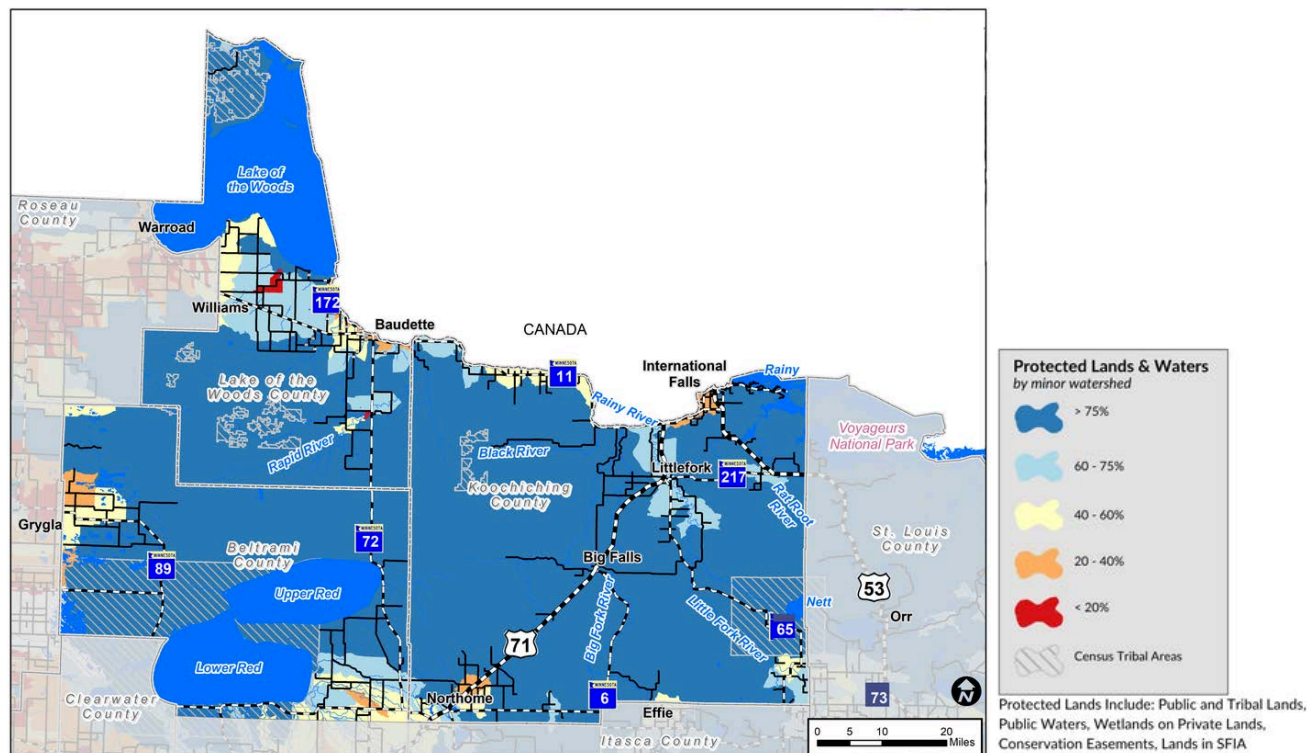
Source: Maps by Mitch, 2024. Utilizing the DNR Fish habitat plan.

Figure 15: Water Resources of the Northern Landscape
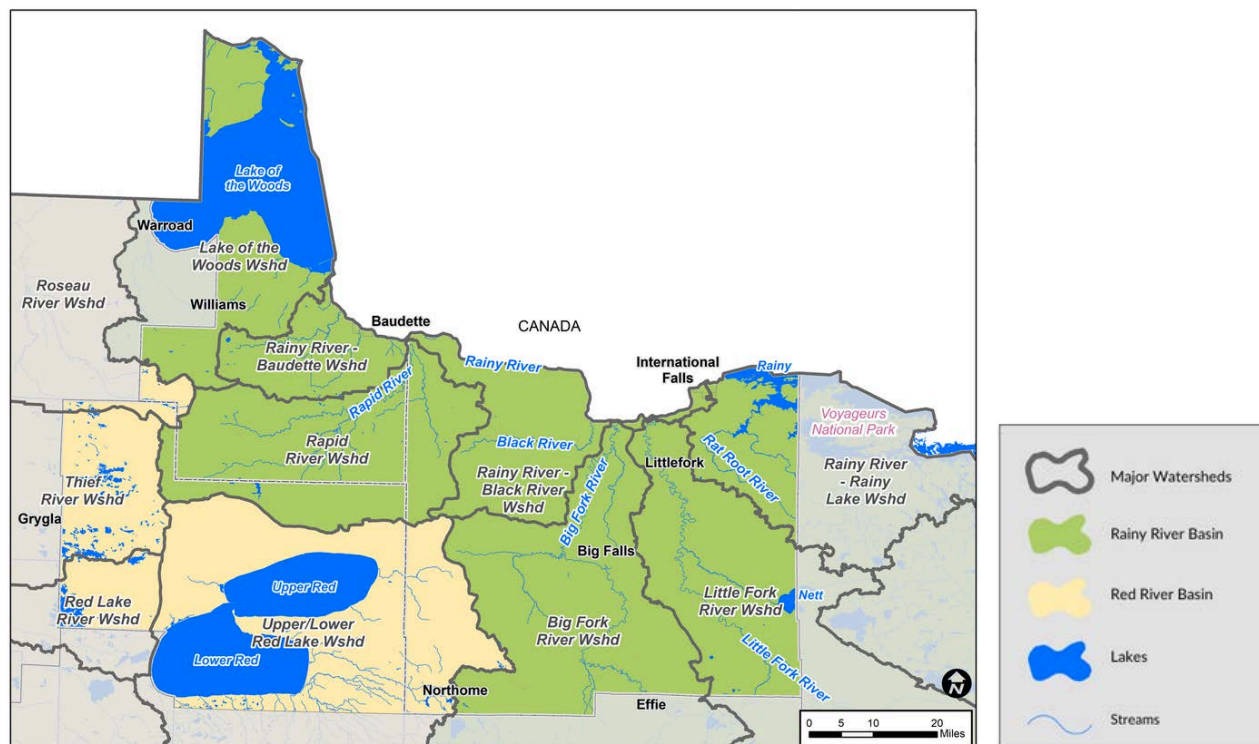
Source: Maps by Mitch, 2024.

Rainy River Basin Watershed (including Lake of the Woods)

The Lake of the Woods and Rainy River Watershed form the international boundary between Minnesota and Ontario, Canada. In this watershed, waters flow 372 miles from the Great Lakes basin divide to the east, proceed west through Namakan Lake, Rainy Lake, and the Rainy River to reach Lake of the Woods, and then enter the Lake Winnipeg basin, which continues the flow to Hudson Bay. An International Joint Commission called the International Rainy-Lake of the Woods Watershed Board assists with binational coordination of water quality efforts and coordinates the management of the water levels and flows on Rainy and Namakan lakes and the Rainy River. The board ensures outflows through dams at International Falls and Kettle Falls are regulated and reports on the ecological health of boundary waters in the watershed (International Joint Commission, n.d.).

The Rainy River – Rainy Lake Watershed is widely known for recreational opportunities the waters and the surrounding wilderness provide including Voyageurs National Park. The watershed includes 296,624 acres within Minnesota and is located in the Laurentian Mixed Forest Ecological Province. Lakes and wetland areas make up 54% of the Minnesota portion of the watershed. The Minnesota portion of the watershed is 67% in Koochiching County (within the Northern Landscape) and 33% in St. Louis County (outside the Northern Landscape) (Minnesota Pollution Control Agency, n.d.).

Red River Basin Watershed

The watershed includes five major subwatersheds: Upper/Lower Red Lakes, Thief River, Clearwater River, Red Lake River, and Grand Marais Creek. The Red Lake River watershed and Thief River watersheds cover a small portion of the southwestern part of the Northern Landscape (Red Lake Watershed District, n.d.).

The Upper/Lower Red Lake watershed is 1,263,678 acres and covers a substantial portion of the Northern Landscape's southern border. This watershed is home to Upper and Lower Red lakes, the two largest bodies of water within Minnesota. The Upper and Lower Red lakes comprise the largest drainage basin of the Red River measured by flow volume and surface area. Shotley Brook and the Tamarac River are the most prominent tributaries that flow directly into Upper Red Lake. Significant tributaries that flow directly into Lower Red Lake (from west to east) include the Sandy River, Pike Creek, Mud River, Hay Creek, Blackduck River, and Battle River (Koochiching Soil & Water Conservation District, n.d.).

Koochiching Falls Prior to Dam Construction in 1905
Photo credit: Source unknown, via James Aasen

PEATLANDS AND HISTORIC DITCHING

Peatlands cover more than 10% of Minnesota and are a dominant feature of the MFRC Northern Landscape. Minnesota's large peatlands are among the few patterned peatlands in the world not underlain by permafrost and are recognized regionally and internationally for their expansiveness and uniquely patterned landscape of bogs, fens, and water tracks. Peatlands are known for their carbon storage, covering only 3% of the earth's surface yet globally storing 30% of all land carbon and can be a significant carbon emission if drained (The Nature Conservancy, n.d.). By accumulating dead organic matter as peat, peatlands play a significant role in carbon sequestration and the global carbon cycle. However, these ecosystems are at risk due to climate change.

Peatlands in the Northern Landscape are unique in their hydrology compared to other similar peatland ecosystems. The Red Lake Peatland located in the southwest portion of the region is within 50 miles of the prairie border. In prairie environments evapotranspiration begins to exceed precipitation and conditions become unfavorable for peatland development. As a result, peatlands in the Northern Landscape are considered especially vulnerable to fluctuations in climate and may provide scientists with an early indication of the effects of climate change on North America's peatlands.

In the early 1900s, there were systematic attempts to drain the peatlands of Minnesota to convert them to productive farmland. These attempts were largely unsuccessful, but the hydrologic impacts of ditching remain today (Figure 16). While the existing ditches were not effective enough to drain the peatlands sufficiently to support farming, the ditches have changed and diverted regional waterflow and impacted the conditions of the peat within nearest proximity to the ditching. Resource experts have documented that peatland ditches continue to drain peatlands through changes to subsurface water flow and lowering of the water table within considerable distances from ditches. Ditches may also intercept groundwater flow when oriented perpendicular to regional groundwater flow patterns. Ditched peatlands emit greater amounts of methane and other greenhouse gasses as organic material becomes oxidized (Krause et al, 2021; Glaser et al., 2021).

Attempts to drain peatlands also degrade water quality through altered regional hydrology and modification of fish habitat where the ditches intersect with natural streams. Ditches increase sediment loads, water temperatures, and change stream geomorphic processes.

Despite these negative impacts, many of the region's forest road network and recreational snowmobile trails travel along the spoils cast aside during this historic ditching. These roads and trails are important to the social and economic aspects of the region including logging, property access, emergency response, wildfire management, and recreational use.

Ecological Aspects

Today peatlands in Minnesota provide an opportunity for landscape-scale conservation and innovative research on peatland hydrology, water chemistry, and ecological processes. The MN DNR and other organizations such as The Nature Conservancy are currently investigating means to restore peatland hydrology in ditched areas. Information gained from this research can contribute to understanding the impacts and potential mitigations for climate change. Peatlands also offer opportunities to research the complex adaptations of living organisms to their environment, as the environmental conditions in peatlands present challenges to plant and animal species. As these projects move forward, the Committee will be a good resource for project proposers to ensure projects avoid potential social and economic impacts.

Figure 16: Peatlands and Historic Ditching
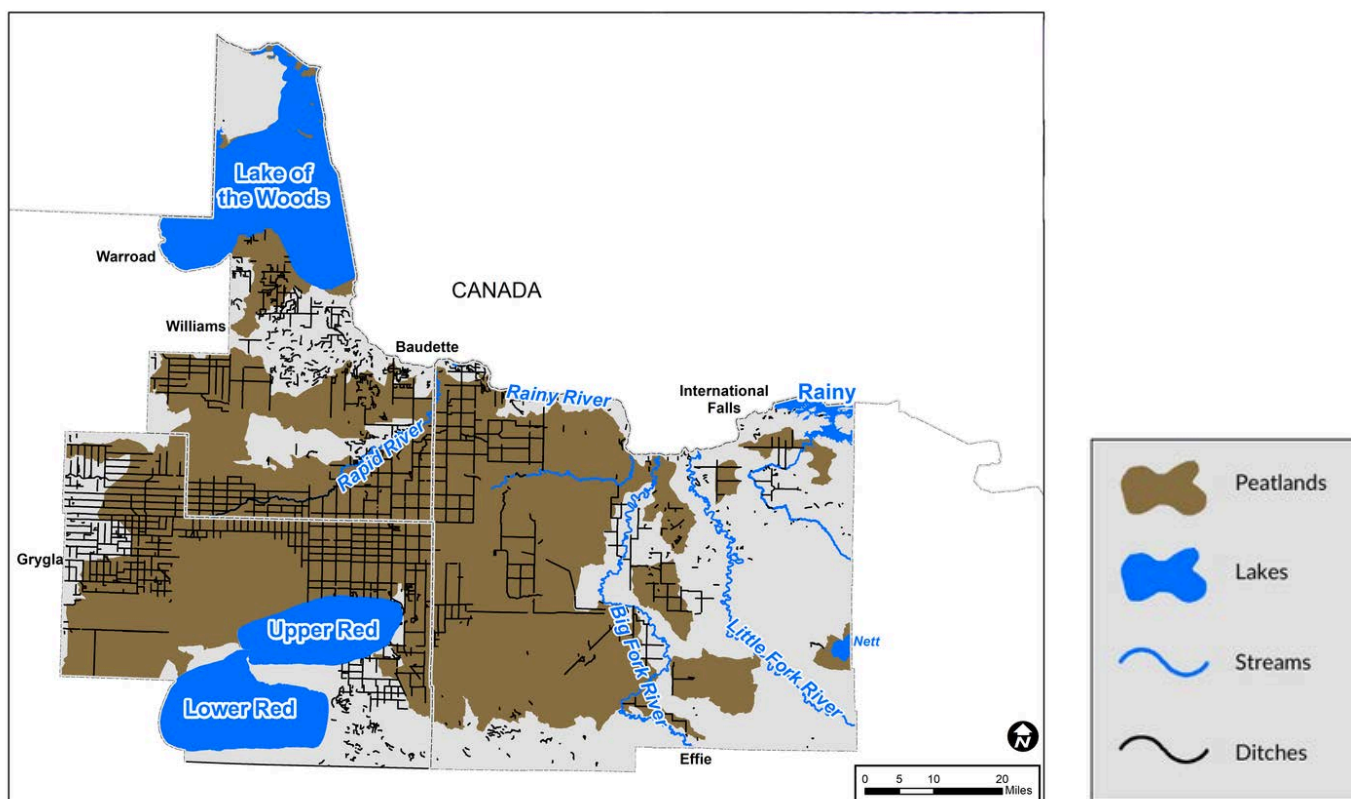
Source: Maps by Mitch, 2024

In 2025 the DNR public water inventory contained 2,754 miles of altered watercourses (centerlines) that intersect 2,287,458 acres of presumed peatlands.

Source: MN DNR, 2016 and MN DNR, 2024.

CLIMATE CHANGE

Climate change is impacting Minnesota's forests in the form of warmer average annual temperatures, longer growing seasons, intermittent drought, more frequent freeze/thaw cycles, and more frequent and extreme storm events. Winters are becoming shorter and warmer, which creates operational difficulties for forest management. These changes are evident statewide (Figure 17) and are more pronounced within the Northern Landscape (Figure 18).

Figure 17: Total Temperature Change Statewide Since 1895

| Annual Average (through 2023) | December - February Lows (through 2023) | June - August Highs (through 2023) |
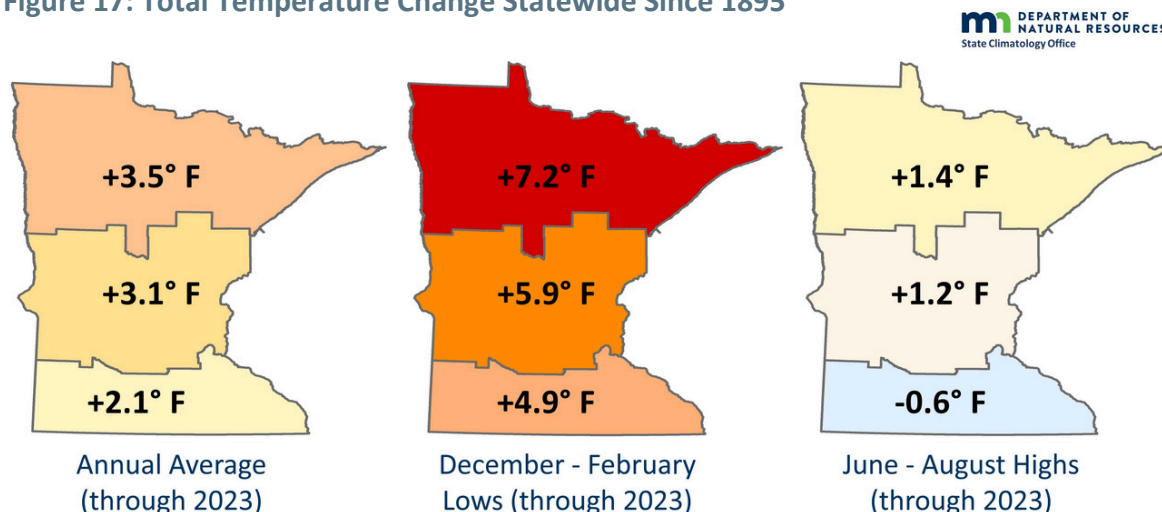
Source: MN DNR, 2023.

Temperature changes are shown for the average of the entire year (left), the average winter low (center), and the average summer high (right). The winters have warmed the most in the northernmost third of the state (MN DNR, 2023). Climate change temperature shifts are most pronounced through increasing minimum temperatures.

Figure 18: Average January Daily Minimum Temperatures for International Falls, 1948-2024
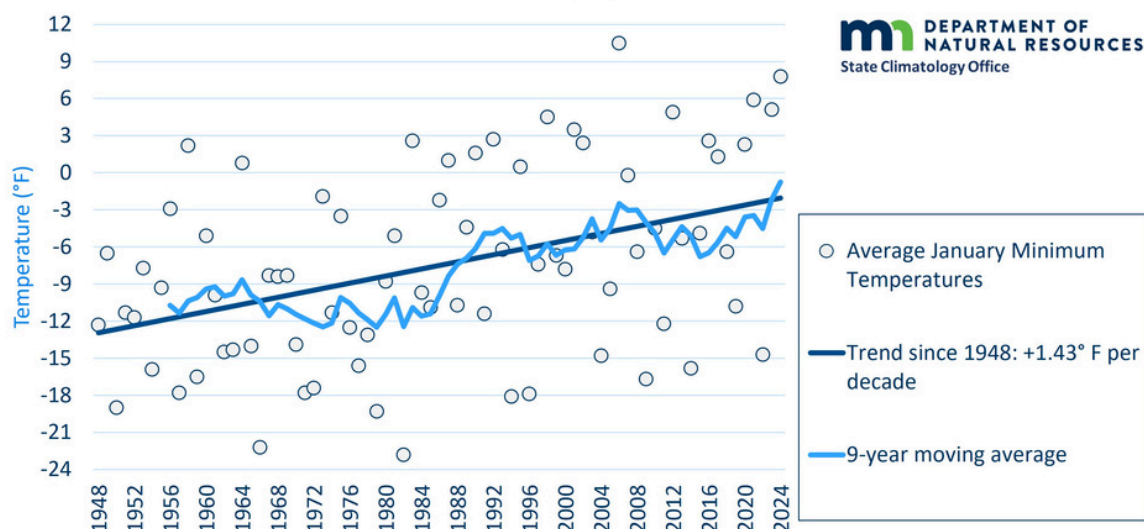
Source: Minnesota Department of Natural Resources, 2023.

A vulnerability assessment of the forest ecosystems in the Laurentian Mixed Forest Province determined that wet forest, forested rich peatlands, and acid peatland systems are among the most vulnerable forested native plant community systems to climate change (Handler et al., 2014).

Photo credit: James Aasen

The MFRC prepared a report on climate change and Minnesota's forests that concluded, "The effects of [climate change] will create numerous challenges for our forests and their management, including altered species composition, decreased access for management and recreation, and increased disturbance from extreme weather events, wildfire, and pests and pathogens. Importantly, these changes may also negatively affect the forest products industry, which in turn would reduce our capacity to effectively manage forest resources to increase their adaptability to changing conditions" (Friesen, 2020; Minnesota Department of Natural Resources, 2023).

Warming winters present a pronounced challenge for the wetland dominated Northern Landscape through declining winter harvest conditions. Decreasing frozen conditions will limit access for timber harvest in forested wetlands and other forests vulnerable to soil compaction. In addition, changing hydrology with larger storm events may present challenges to forest road infrastructure such as culverts and bridges.

The Committee's planning process included two meetings specifically focused on understanding the available scientific information and assessment results associated with climate change. During these meetings the Committee identified adaptation strategies, including adaptation through silviculture techniques, that are most applicable to the Northern Landscape. The Committee also incorporated climate change considerations in the social, economic, and ecological goals and strategies for the region.

ECOLOGICAL STRENGTHS AND CHALLENGES

The following are committee member perspectives of strengths and challenges related to ecological aspects of the region. These were solicited as an exercise to document local conditions and begin brainstorming potential goals based on needs.

Strengths

- Vast, diverse, and valued natural resources that are locally marketable.
- Limited pressure for development and land use change (more trees than people) coupled with wise and balanced use of renewable resources.

- Clean water and air, abundant wildlife, carbon sequestration, and diverse habitats derived from a mostly forested landscape and extensive wetlands.
- Vast peatland habitats (including internationally recognized patterned peatland formations) that support opportunities for carbon sequestration. Peatlands also support species that are rare in other parts of the state (e.g., bog lemmings, short-eared owls, and boreal owls).
- Large blocks of public, Tribal, and private industrial lands that make management coordination easier and provide a relatively stable and protected forest and ecological condition.
- Strong collaborative science-based management of walleye fishery on Upper and Lower Red lakes.

Challenges

- Impacts from climate change, including variable conditions with shorter and warmer winters. More frequent storm events that damage timber and habitats, and changes that have ecological, social, and economic impacts.
- Invasives species and increasing native insect and disease issues affecting forest and aquatic health.
- Weather events related to climate change are impacting seasonal wildlife behavioral and movement patterns.
- Abundant damage from beaver activity (also an economic challenge).
- Vast peatlands that may be vulnerable in extreme droughts (i.e., wildfire risks), and wet forest types (ash and tamarack) that are vulnerable to changes due to mortality events and climate change.
- Region is at the southern range for many boreal forest species, and therefore extremely vulnerable to climate change through changing temperatures and hydrological regimes.
- Limited upland/fire dependent habitat availability and limited connectivity between patches of uplands for species who need this type of habitat to move across the landscape.
- Lack of robust knowledge of natural processes (disturbances) and human land uses that occurred in the past. Managing for stability is increasingly difficult with climate change impacts.
- Resource pressures associated with increased public use and diversifying recreational and tourism interests (risk of conflict,competing land use goals, damages, and disturbance of wildlife).
- Potential decline in the public's understanding of natural resources and natural resource management, and difficulty to recruit/retain natural resource professionals. Yet there is an increase in public concerns about the environment that can lead to poor decision making.
- Majority of public natural resources are subject to political-driven changes in resource management.

ECOLOGICAL GOALS AND STRATEGIES

Desired Future Outcomes:

Resilient ecosystems, diverse habitats, and a functioning forested landscape.

Goal 1: Sustainably manage natural resources to support a full range of plant, animal, and fish species, by utilizing strategies that reflect and adapt to consideration of natural processes and disturbance.

Strategies:

- Maintain and/or increase sufficient diversity, extent of habitat, and water quality to support a full range of plant, animal, and fish species.
- Implement management strategies that adapt to impacts associated with weather events, forest health and disease issues, wildfire, and consider information about species climate migration.
- Maintain and/or enhance continuous migration corridors for fish and wildlife species.
- Utilize ecological classification systems and information about native plant communities in forest planning and management.
- Implement and promote the MFRC's *Voluntary Site-Level Forest Management Guidelines.*
- Consider the ecological goals and objectives of related planning efforts, including the Statewide Wildlife Action Plan, One Watershed One Plan (1W1P), or similar.
- Promote forest stewardship programs, projects, and third-party certification.

Goal 2: Manage for water quality, associated wildlife needs, and hydrologic functions.

Strategies:

- Restore landscape hydrology including ditch restoration, improvement of fish passage, addressing problem beaver dams, and mitigating poorly designed and constructed road culverts or crossings.
- Gain a better understanding of changing hydrology due to beaver dams, emerald ash borer, Eastern larch beetle, and historic impacts from ditching.

Ecological Aspects

Goal 3: Improve and promote information and educational opportunities relating to forest resource management.

Strategies:
- Encourage completion and continuous refinement of Ecological Classification System (ECS) native plant community mapping for the Northern Landscape.
- Publicize and encourage implementation of the forest management goals and silviculture strategies for each native plant community in the Northern Landscape.
- Support ECS training for land managers, landowners, and interested parties in the Northern Landscape.
- Improve data availability and current information about peatland habitats, including impacts to spruce from Eastern dwarf mistletoe.
- Review and consider current science in forest land management and decision-making on an on-going basis.
- Educate decision-makers on sustainable forest management and related policy actions.
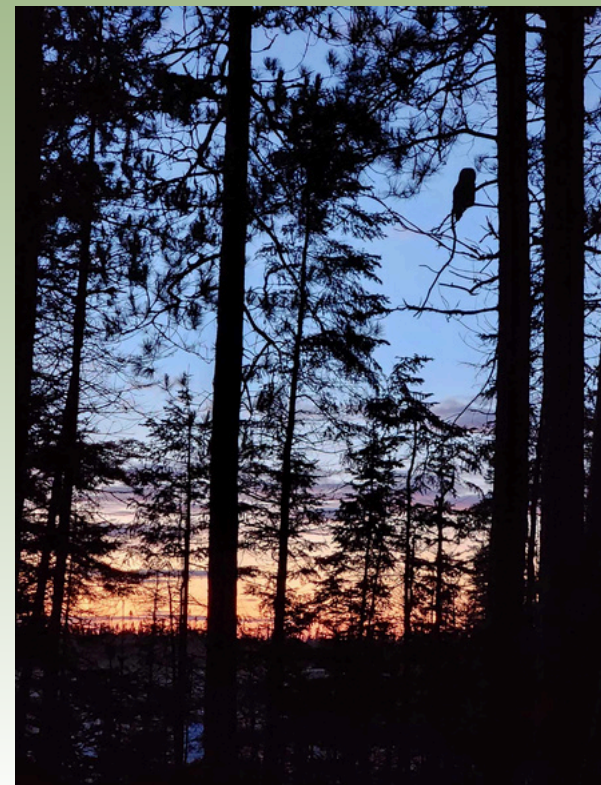
Photo credit: Mac Schafer

Photo credit: James Aasen

SECTION 5: VEGETATION MANAGEMENT FRAMEWORK
MINNESOTA ECOLOGICAL CLASSIFICATION SYSTEM

The MN DNR and the U.S. Forest Service have developed an ECS for ecological mapping and landscape classification in Minnesota following the National Hierarchical Framework of Ecological Units. This classification system is the backbone of the Northern Landscape's vegetation management framework, which includes recommendations from the Committee on forest management.

Ecological land classifications are used to identify, describe, and map progressively smaller areas of land using biotic and environmental factors. Classification factors include 1) climate, 2) geology, 3) topography, 4) soils, 5) hydrology, and 6) vegetation. There are six levels of ECS units in Minnesota: Provinces, Sections, Subsections, Land Type Associations, Land Types, and Land Type Phases.

The first three levels are described below and shown in Figure 19 and outlined in Table 7:
- **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.

Table 7. Ecological Province, Sections, and Subsections within the Northern Landscape

Province	Section	Sub-section
Laurentian Mixed Forest	**Northern Minnesota and Ontario Peatlands**	**Agassiz Lowlands**
		Littlefork-Vermillion Uplands
	Northern Superior Uplands	Border Lakes
	Northern Minnesota Drift & Lake Plains	Chippewa Plains
Tallgrass Aspen Parklands	Lake Agassiz Aspen Parklands	Aspen Parklands

Figure 19: ECS Provinces and Sections in Minnesota and Subsections within the Northern Landscape

Provinces   *Sections*   *SubSections*
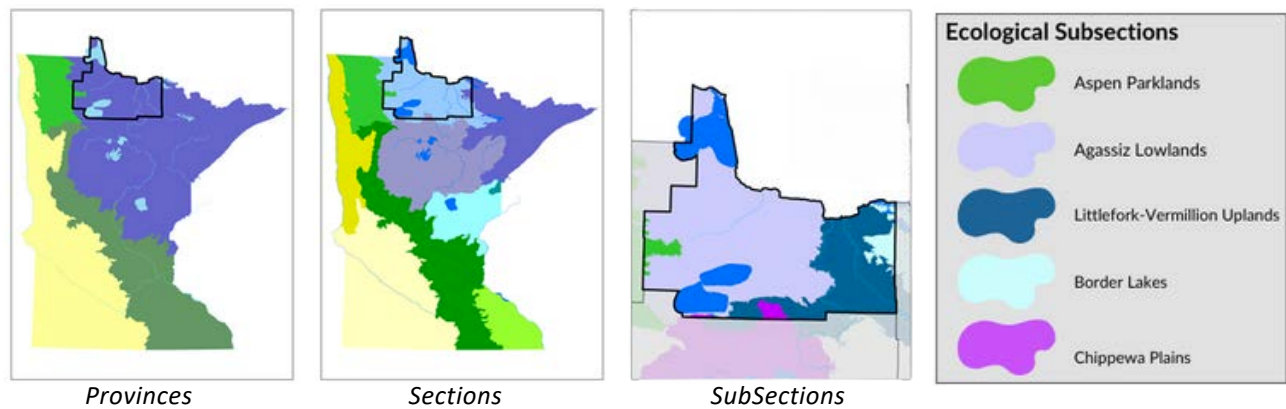
Source: MN DNR, 2012.

The Northern Minnesota and Ontario Peatlands Section cover most of the administrative boundaries of the Northern Landscape. 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.

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 introduced organisms. These groups of native plant species form recognizable 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 local habitat conditions (such as levels of nutrients and moisture) than are canopy trees.

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. Areas where native species have been largely replaced by exotic invasive species, planted areas such as plantations, lawns, and farm or non-native pastures or other areas where vegetation has been substantially altered are not considered native plant communities.

Native Plant Community Classification

MN DNR's Native Plant Community Classification system provides a framework and common language for natural resource professionals managing vegetation, surveying natural areas for biodiversity conservation, identifying research needs, and promoting the study and appreciation of native vegetation in Minnesota.

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 the dominant factors of vegetation structure and hydrology. **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** reflect the distribution of Minnesota's plant species by climate and paleohistory into characteristically northern, northwestern, central, and southern groups, or floras. All NPCs in the Northern Landscape are in the Northern floristic region.

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 communities are further broken down into NPC types (dominant canopy species) and sub-types (dominant canopy and diagnostic understory species). Although these classifications are utilized every day by resource managers within the region, the Committee has made vegetation management recommendations and considerations at the class-level.

NPC SYSTEMS IN THE NORTHERN MINNESOTA & ONTARIO PEATLANDS SECTION

The Northern Minnesota and Ontario Peatlands Section (NMOP) is generally flat and poorly drained. About half of the section consists of clayey deposits from prehistoric Glacial Lake Agassiz (Minnesota Department of Natural Resources, n.d.a).

These lake deposits are now covered primarily by bogs, swamps, fens, and other peatland vegetation. At the eastern edge of the NMOP, the peatlands are acidic, deep, and old (>4,000 years). They support extensive areas of acid peatland communities such as black spruce bogs and poor swamp forests.

At the western edge of the section, the peatlands are richer in minerals, shallower, and younger (~1,000 years). Tamarack swamps, rich fens, and other rich peatland communities tend to be common. Some areas, especially along the eastern and southern borders of the NMOP in the Littlefork Vermilion Uplands Subsection, have uplands formed of glacial till that was eroded and flattened by wave action from Glacial Lake Agassiz. Mesic and wet forests of aspen, paper birch, spruce, balsam fir, white cedar, and black ash are typical in these areas.

Uplands formed of sandy shoreline deposits that mark recessional stages of Glacial Lake Agassiz are present across the NMOP. These low, sandy uplands are less extensive than either the peatlands or glacial till uplands. They are characterized by fire-dependent forests of jack pine or red pine.

The Northern Landscape includes six NPC Systems, as listed in Table 8.

Table 8. Potential Native Plant Communities in the Northern Landscape

System Name	Acres	%
Forested Rich Peatlands	2,101,896.9	47.59%
Fire Dependent	760,892.1	17.23%
Wet Forest	469,823.7	10.64%
Mesic Hardwood	243,111.0	5.50%
Acid Peatland	109,424.3	2.48%
Floodplain	15,652.8	0.35%
Other	716,043.8	16.21%
	4,416,844.6	100.00%

"Other" includes non-forested systems: Open Rich Peatland, Open Water, Wet Meadow, and Marsh.
Source: Natural Resources Research Institute (Nixon, 2019)

The data shown in Table 8 is derived from modeling of potential native plant community systems from the Natural Resource Research Institute (NRRI). The Committee has observed this modeled extent of certain NPCs and total acreages within the Northern Landscape is likely inaccurate. For example the modeled NPC mapping over-represents fire-dependent vegetation on the eastern portions of the region, where the modeled NPCs show fire-dependent forests while NLCD shows woody wetlands. Figure 13 shows the NLCD map and is currently the most accurate geographical reflection of the region's vegetation.

The 3 Major NPC Systems in the Northern Landscape:

Mesic Hardwood Forest

Mesic Hardwood Forest (MH) communities are present across the Northern Landscape on upland sites with moist soils, usually in settings protected from fire. They are characterized by continuous, often dense, canopies of deciduous trees. Dominant tree species include quaking aspen, paper birch, red maple, black ash and basswood, and additional conifer components of balsam fir, white spruce, and less frequently white pine. 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. Hardwood forests differ from coniferous forests both in nutrient cycling and also seasonal canopy coverage. Unlike coniferous forests, deciduous tree canopy is lost in winter, resulting in increased exposure of soils to precipitation during leaf-off. Tree mortality in MH communities is rather constant, and stand regenerating natural disturbances such as wildfires and windthrow are 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.

Forested Rich Peatlands (FP)

Forested Rich Peatland (FP) communities are conifer or tall shrub-dominated wetlands on deep (>15in), actively forming peat. They are characterized by mossy ground layers, often with abundant shrubs and forbs. FP communities are widespread in the Northern Landscape. 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.

Accumulation and buildup of peat isolates the plant rooting zone from nutrient sources in the underlying mineral soil. Although peat accumulation can lead to the development of acidic, nutrient-poor growing conditions, some FP communities are also influenced by lateral flow of mineral-rich groundwater that can maintain more neutral pH and moderately rich soil conditions. Additionally, hummocks that rise above the water table can provide habitats that are sufficiently aerated for growth of woody plants. In the past, catastrophic disturbances were uncommon in FP communities. Although present in large, poorly drained landscapes, on rare occasions these peatlands did experience fires during periods of extreme drought. Because of structurally weak peaty soils and shallow root systems, trees in these communities are somewhat susceptible to windthrow. Smaller disturbances resulting in partial mortality of the canopy were somewhat common and are presumed to have involved both patchy windthrow and surface fires.

Wet Forest (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 Northern Landscape. 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. WF communities are strongly shaped by steady fluxes of water and nutrients supplied to deep soil layers by moving groundwater. Local groundwater aquifer depth and landscape settings largely shape the timing and supply of groundwater, and often creates springs, seeps, or spring runs within and adjacent to WF communities. 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. The most frequent natural disturbance in WF communities is flooding, typically resulting from periodic increases in precipitation or from beaver activity. If flooding is severe enough, it can kill the canopy trees and bring about conversion to Wet Meadow/Carr or Marsh ecological communities. Other potential disturbances include fire and windthrow, but historically WF communities were affected by these events very infrequently.

The 3 Minor NPC Systems in the Northern Landscape:

Fire Dependent (FD)

Although Fire-Dependent Forest/Woodland (FD) communities are widespread across the Laurentian Mixed Forest (LMF) Province, their distribution is more limited in the Northern Landscape. Within the Northern Landscape and NMOP they are restricted to sandy beach ridges and lake plains of Glacial Lake Agassiz. FD communities are characterized by a prevalence of pines and other conifers, but can also include quaking aspen and paper birch components. These tree species, like most of the species characteristic of FD communities, are adapted to survive repeated fires or to regenerate successfully following fire. FD communities occur on sites with coarse sandy or gravelly soils or with thin soils over bedrock. These sites are often drought prone, a condition enhanced by fire through removal of the organic material that retains soil moisture, such as litter and humus. 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. Historically, fires were the major source of species mortality and exerted strong influence on patterns of plant reproduction. Fire exposes mineral soil seedbeds, triggering dispersal of propagules, and increasing the amount of light reaching the ground or understory. In the past, fires were common throughout the range of FD communities, with both catastrophic and surface fires maintaining community characteristics and ecological processes. Windthrow was not common in FD communities.

Acid Peatland (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. The ground layer vegetation in these communities is composed primarily of a small subset of species characteristic of richer FP systems that can survive in the harsh, low-nutrient environments. Trees are usually sparse when present and often dominated by stunted (<33 ft tall) black spruce or tamarack. AP communities are widespread in the Northern Landscape because of cool climate, abundant precipitation, numerous poorly drained basins, and extensive poorly drained glacial lake plains. These factors produce favorable conditions for peat development across much of the landscape. Although fires can occur in spruce bogs, they are not very common, perhaps because of the tendency of the community to occupy the centers of peatland basins and other wet landscapes. Like the FP system, light windthrow is a somewhat more common natural disturbance agent, and the ability of black spruce and tamarack to send up new stems, or layer, from branches buried by peat has been interpreted as an adaptive trait for surviving windthrow.

Floodplain Forest (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. In the Northern Landscape, common species include characteristic floodplain trees such as silver maple and American elm, and wet and mesic forest trees such as black ash, green ash, basswood, bur oak, 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. FF communities are associated with streams and rivers throughout the NMOP section but are generally not as extensive as those associated with rivers farther south and west, which have larger rivers with broader floodplains. Flooding along streams and rivers is fed by surface flow as well as base flow that enters streams and riverbeds 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 and stable, high water tables on terraces and floodplains. Flooding imposes several physical challenges on plants in FF communities, including inundation, erosion, sedimentation, and severe scarring of tree trunks by flood-transported ice and debris. Catastrophic disturbances are rare in FF communities, and events that result in partial loss of tree canopies from flooding, light surface fires, or blowdowns are more common.

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

NPC SYSTEM BASED SILVICULTURE STRATEGIES AND CLIMATE ADAPTATION APPROACHES

The Committee considered the NPC silvicultural strategies for the Northern Minnesota & Ontario Peatlands Section as developed by the MN DNR (Minnesota Department of Natural Resources, (n.d.b). The Committee identified NPC silvicultural strategies most appropriate within the ecological, social, and economic goals of the Northern Landscape. The Committee also considered the adaptation strategies and carbon management approaches from the Northern Institute for Applied Climate Science (NIACS) Climate Adaptation Workbook in relation to the potential impacts of climate change (NIACS, 2014). Special management considerations for each system relating to climate change, wildlife habitat, and economic impacts were also highlighted through anecdotal committee member input.

The Northern Landscape is approximately congruent with the NMOP section but does include small portions of other sections and NPCs from the western floristic region/aspen parkland section and province. The NPC classes shown in **bold** below are the most represented forested plant communities found in the Northern Landscape.

3 Major Systems:
Mesic Hardwood Forest (MH): MHc37, **MHn44**, MHn46, MHn47
Forested Rich Peatlands (FP): **FPn63, FPn71, FPn81, FPn82**, FPw63
Wet Forest (WF): **WFn53**, WFn55, WFn64, **WFw54**

3 Minor Systems:
Fire Dependent (FD): FDn12, **FDn33**, FDn43, FDw44
Acid Peatland (AP): **APn80**, **APn81**, APn90, APn91
Floodplain Forest (FF): **FFn57**, FFn67

Figure 20: Potential Native Plant Communities
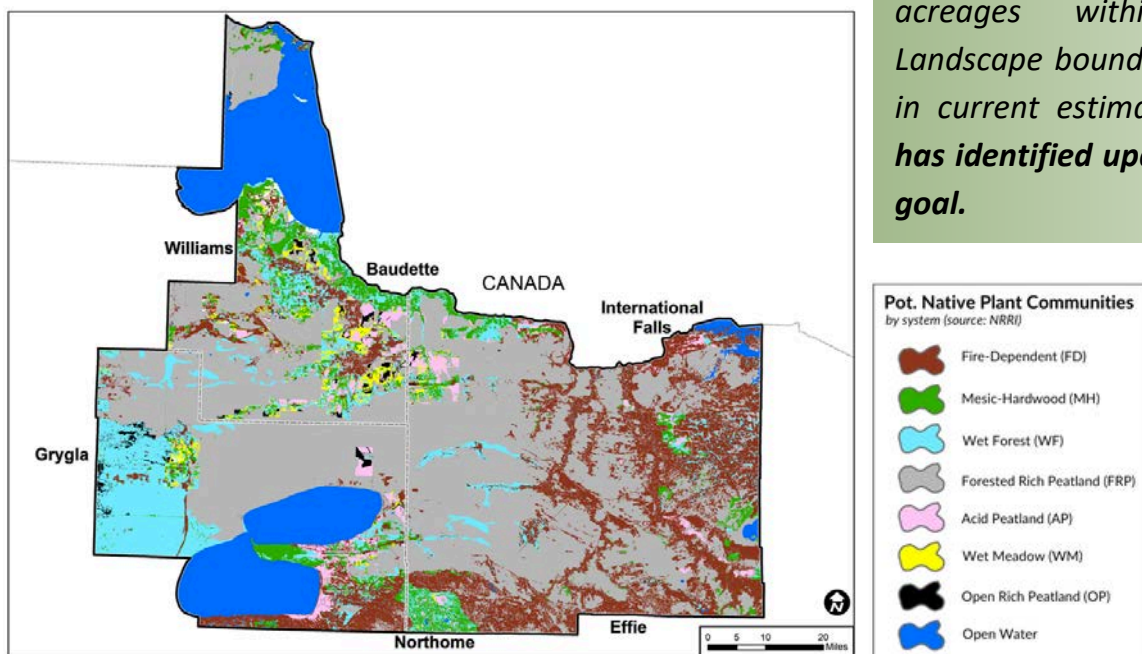
*The data shown in Figure 20 is derived from modeling of potential native plant community systems from the Natural Resources Research Institute. The Committee has observed the extent of certain NPCs and total acreages within the Northern Landscape boundary may be incorrect in current estimates. **The committee has identified updating this data as a goal.***

Source: Maps by Mitch, 2024

SILVICULTURAL STRATEGIES, CONSIDERATIONS, AND ADAPTATION APPROACHES FOR THE 3 MAJOR SYSTEMS IN THE NORTHERN LANDSCAPE

1. Mesic Hardwood Forest (MH)
- 243,111 acres
- 5.5% of the Northern Landscape forests

MN DNR Silvicultural Strategies for Management

1. Re-initiate a stand as would severe windthrow to create open to very large gap habitat. Emulate windthrow to favor quaking aspen, paper birch, white spruce or balsam poplar.
2. Accelerate natural succession as would selective windthrow by removal of initial-cohort trees. Emulate initial-cohort mortality to favor paper birch, balsam fir, red maple, black ash, white spruce, sugar maple, or basswood.
3. Maintain a stand as would natural senescence, disease or selective windthrow to create small-gap habitat. Emulate fine-scale disturbance to favor black ash, balsam fir, red maple, sugar maple, or basswood.
4. Re-initiate a stand as would severe surface fire to create open to very large gaps lacking fire-sensitive trees. Emulate severe surface fire to favor quaking aspen, paper birch, or balsam poplar.

The Mesic Hardwood Forest System in the Northern Landscape is characterized by upland aspen cover types that may also have a component of spruce, fir, birch, and other hardwoods. These stands are generally managed to re-initiate through windthrow or fire (i.e., silvicultural strategies #1 and #4). If there is advanced spruce regeneration in the stand, spruce will be supported through management (i.e., silviculture strategy #2). This strategy may also be applied in riparian areas and corridors to favor a more mixed stand with longer-lived species. Spruce planting may be appropriate on some sites, depending on the NPC classification. Small gap management is generally not practiced in aspen cover types (i.e., silviculture strategy #3). A selection cut may be done in hardwoods but is not common in much of the Northern Landscape where the dominant hardwood being managed is aspen (exceptions to this may occur in the southern part of the region). The abundance and diversity of mesic hardwood forest sites in the Northern Landscape allows for the benefits of older forests associated with longer rotations and wildlife habitat as well as early-successional, young, and highly productive forests important to the local economy.

Photo credit: James Aasen

Habitat, Economic, and Climate Change Considerations for Mesic Hardwood (MH) Forest Systems in the Northern Landscape:

Habitat:
- The structural diversity of mature stands of aspen mixed forest types are important habitat characteristics for many species of wildlife. Obtaining this structural diversity is not likely achievable through even-aged silviculture management. Considerations for the needs of wildlife that require more developed mesic hardwood forest may be achieved with larger pockets of reserves or longer rotation ages where appropriate and economically feasible.
- Manage forest age and species diversity to create and maintain healthy systems that provide well-distributed forest habitats across the landscape. Example management includes under plantings with white spruce and balsam fir.
- MH is one of our most prevalent and diverse habitat types. The acreage information provided by the potential NPC mapping from NRRI under-reports the abundance. Managing forests to create a significant representation of healthy early successional habitat is important and offers diverse management options in the face of disease, pest threats, or climate change. Continued active management supports the extensive plant and animal species that inhabit this forest type.

Economic:
- MH forest has significant economic impact for the timber industry and for the region's overall economy including tourism, recreation, and cultural values.
- Maximize fiber production while considering habitat and climate adaptation goals. Recognize how markets create or limit management opportunities.
- MH forests are the current economic driver for the region. These stands can be managed to maximize aspen production. In upland sites where prior forests have been cleared establish white spruce plantations and market softwoods.

Climate Change:
- Aspen is projected to have fair to good adaptability to climate change depending on the species *(p. balsamifera, p. grandidentata, p.tremuloides)* throughout the state of Minnesota but may be less vulnerable in the Northern Landscape because of its healthy condition and abundance (NIACS, n.d.). Many of the region's aspen dominated forest types have high species diversity and therefore may be more resilient from an overall forest perspective. Other less diverse types, especially in the northwestern portion of the region, may be more vulnerable to extremes and require secondary adaptive strategies in the long term.
- Diversity of age and species, and spatial distribution across the landscape may improve climate change resilience for this cover type in the region.

Mesic Hardwood Forest – Adaptation– Strategies and Approaches

(See Appendix D for additional information)

Developed for forests

Resistance Strategies:

1.1 – Reduce impacts to soils and nutrient cycling

1.2 – Maintain or restore hydrology

4.1 – Prioritize and maintain unique sites

4.2 – Prioritize and maintain sensitive or at-risk species or communities

Resilience Strategies:

2.1 – Maintain or improve the ability of forests to resist pests and pathogens

2.2 – Prevent the introduction and establishment of invasive plant species and remove existing invasive species

Transition Strategies:

5.2 – Maintain and restore diversity of native species

Strategy 9: Facilitate community adjustments through species transitions

Consider these adaptation strategies and approaches within the existing forest management site-level guidelines (FMGs) and timber sale contract language in ways that support keeping high-quality aspen production in the Northern Landscape.

Developed for forest carbon management

Resistance Strategies:

1.1 – Avoid forest conversion to non-forest land uses

1.2 – Reforest lands that have been deforested and afforest suitable lands

2.1 – Reduce impacts on soils and nutrient cycling

2.2 – Maintain or restore hydrology

Resilience Strategies:

2.3 – Prevent the introduction and establishment of invasive plant species and remove existing invasives

2.4 – Maintain or improve the ability of forests to resist pests and pathogens

Transition Strategies:

6.1 – Increase structural complexity through retention of biological legacies in living and dead wood

7.4 – Introduce species or genotypes that are expected to be adapted to future conditions (may not be an immediate need in the region as aspen forests are likely to keep doing well in this landscape for the near term, no immediate need for artificial planting)
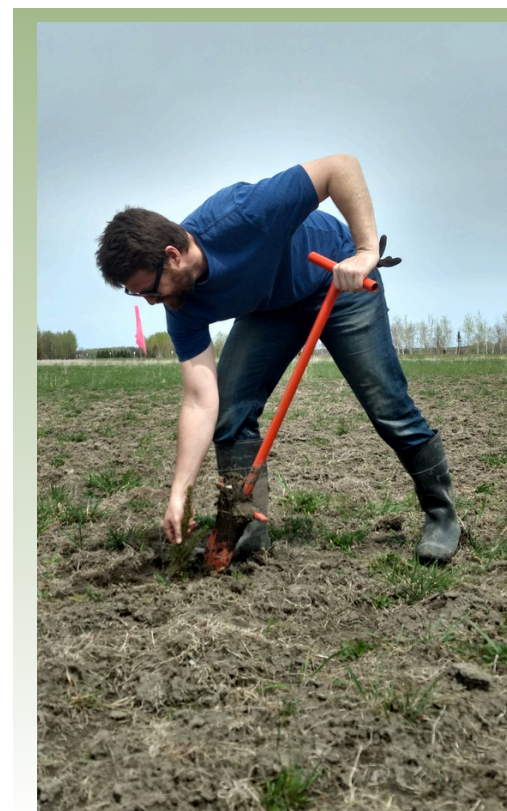

Photo credit: Jolén Simon

2. Forested Rich Peatlands (FP)
- 2,101,897 acres
- 47.59% of the Northern Landscape forests

MN DNR Silvicultural Strategies for Management
1. Re-initiate a stand as would stand-replacing disease/pest wave events to create open to very large-gap habitat. Emulate stand-replacing outbreaks of defoliating insects or disease to favor black spruce.
2. Maintain a stand as would natural senescence, selective windthrow, or disease/pest expanding gap events to create small-gap habitat. Emulate expanding gap events to favor tamarack and some black spruce.
3. Maintain a stand as would selective windthrow by removal of canopy trees in large gaps. Emulate selective windthrow to favor northern white cedar and some paper birch.
4. Re-initiate a stand as would light surface fire to create open to very large gap habitat primarily for sanitation reasons. Emulate surface fire to favor black spruce and tamarack (FPw63).

Forest Rich Peatlands are lowland systems commonly managed with silvicultural strategy #1 as well as #4 to re-initiate and create a very large gap. Currently, cedar management is uncommon in the region, but this could change as market demand develops. Cedar is abundant in the Northern Landscape but may not be in good condition or highly productive. Silvicultural strategies #2 and #3 are commonly applied in response to insects and disease. Current forest health issues affecting these peatlands include dwarf mistletoe and the eastern larch beetle, which are significantly changing the landscape through large scale tree mortality. Management in peatland forest types may require smaller and lighter logging equipment, which is not always readily available in the region as operations invest in bigger equipment. Bigger equipment may be unable to access lowland forest types and also may not be economical for loggers on small or lower-return harvests. Additionally, the window for fully frozen conditions necessary for operating in these wetlands is becoming shorter due to climate change.

Habitat, Economic, and Climate Change Considerations for Forested Rich Peatlands:

Habitat:
- Forest health issues can dictate management direction. Complex issues arise in management decisions related to forest reserve practices and control of dwarf mistletoe infestations.
- Important habitat for a multitude of species at the southernmost edge of their range. Gap or small patch management is likely more beneficial to specific wildlife species.
- Spatial, age, and species diversity create and maintain healthy systems that provide multiple benefits for all species.

Economic:
- Second most important NPC behind MH to the economics of the region. Significant economic impact not only for the timber industry, but also for the region's overall economy.
- Emerging non-traditional forest products industry with spruce tops for holiday and winter decorations is diversifying the forest products economy.
- Reinitiate stands infected with disease/mistletoe. Management is only currently economically feasible through large clearcut or volume significant enough to outweigh access constraints.
- Carbon sequestration programs and their requirements create questions about impacts to the regional economy.

Climate Change:
- One of the most vulnerable forest types to climate change and human disturbance.
- Protection and restoration of degraded peatlands will be an important climate carbon management strategy.
- Forest health issues are increasing due to the additional life cycles of eastern larch beetle facilitated by warmer winters and longer growing seasons.
- Most lowland systems across the region require frozen ground for harvest access. Shorter and inconsistent operation periods due to climate change will have significant negative impact on timber access and harvest season.

(Combined with Acid Peatland in adaptation strategies discussion, see the Acid Peatlands section for additional information.)

Photo credit: James Aasen

3. Wet Forest (WF)
- 469,824 acres
- 10.64% of forests in the Northern Landscape

MN DNR Silvicultural Strategies for Management
1. Re-initiate a stand as would severe windthrow to create open to very large gap habitat. Emulate stand-replacing windthrow to favor black ash, quaking aspen, paper birch, green ash, or balsam poplar.
2. Maintain a stand as would selective windthrow by removal of initial-cohort trees in large gaps. Emulate selective windthrow to favor black ash, yellow birch, paper birch, green ash, or American elm.
3. Maintain a stand as would natural senescence, disease, or selective windthrow to create small-gap habitat. Emulate fine-scale disturbance to favor black ash, American elm, red maple, yellow birch, balsam fir, green ash, basswood, or northern white cedar.
4. Re-initiate a stand as would severe surface fire to create open or very large gap lacking fire-sensitive trees. Emulate severe surface fire to favor quaking aspen, balsam poplar, or tamarack (relevant in WFw54).

The most implemented silviculture strategy for Wet Forest is to re-initiate utilizing a very large gap emulating a stand-replacing windthrow (#2), but the intensity of harvest is determined by site-specific hydrology. Lower intensity cutting is more appropriate on the wetter sites so that the water table level does not rise (i.e., reduce risk of swamping). The #2 silviculture strategy may be more common on drier sites while #3 and #4 may be more common on wetter sites. The drier sites have more species diversity while the wetter sites have higher abundance of ash and therefore are at greater risk with emerald ash borer (EAB). The drier sites have more species diversity. The impacts and risks of EAB and the capacity of markets influence opportunities and desire to manage these sites. The market for ash is limited, unless it is high enough quality timber. The cover type and NPC mapping for the Northern Landscape may under-represent wet forests because they occur in small pockets and inclusions within a larger stand. The NPCs WFn55 and WFn64 are most common. The WF and Floodplain Forest (FF) systems within the landscape have related considerations for habitat, economic limitations, and climate change.

Habitat, Economic, and Climate Change Considerations for Wet Forest:

Habitat:
- Preemptive diversification of black ash dominated forest types is needed to reduce the impact of EAB. Deer browse is a major impediment to these efforts, especially with regards to cedar regeneration.
- Cedar is an important cover type that has inconsistent regeneration in portions of the landscape. Management must be mindful of hydrologic pump function when planning clear cuts. Discriminate against ash and promote diversity of species over time.
- Manage age and species diversity spatially to create and maintain healthy systems that provide multiple benefits for all species.

Economic:

- EAB will have economic impacts to timber, infrastructure, and hydrology changes due to vast ash mortality.
- Cedar is a re-emerging market with renewed interest for roundwood, lumber, and mulch. Some demand for cedar homes is increasing, as well as cedar tongue and groove lumber.
- Maintain a healthy system with market opportunities. Look for market opportunities for ash due to the EAB threat.

Climate Change:

- Ash is less likely to be replaced by other species. Other species such as tamarack that could replace ash also face challenges associated with climate change. Assisted migration of species that could fill this niche may be unsuccessful due to warmer temperatures already being observed and are predicted to increase with climate change.
- Diversify age class and species on a spatial scale to increase resilience.

Wet Forest – Adaptation – Strategies and Approaches
(See Appendix D for additional information.)

<u>Developed for forests</u>
Resistance Strategies:

- Strategy 1: Sustain fundamental ecological functions
- 1.2 – Maintain or restore hydrology (current strategy)
- 2.1 – Maintain or improve the ability of forests to resist pests and pathogens (current strategy)

Resilience Strategies:

- Strategy 5: Maintain and enhance species and structural diversity (part of current strategy, as part of uneven aged management)

Transition Strategies:

- Strategy 9 is the focus for Wet Forests – Facilitate community adjustments through species transitions (but limited by economics)
- 9.2 Establish or encourage new mixes of species (shift away from ash; current strategy)
- 9.3 and 9.7 are future strategies – Guide changes in species composition at early stages of stand development; Introduce species that are expected to be adapted to future conditions

<u>Developed for forest carbon management</u>

- Strategy 2: Sustain fundamental ecological functions
- Strategy 4: Enhance forest recovery following disturbance
- 6.6 – Promote species and structure diversity to enhance carbon capture and storage efficiency

Prioritize active adaptive strategies on drier sites (where success may be more likely) and in riparian areas where there are multiple benefits (shore stabilization, etc.). Available seed sources in the landscape (silver maple, red maple) may limit naturally occurring species transitions.

SILVICULTURAL STRATEGIES, CONSIDERATIONS, AND ADAPTATION APPROACHES FOR 3 MINOR SYSTEMS IN THE NORTHERN LANDSCAPE

Fire Dependent (FD), Acid Peatland (AP), and Floodplain Forest (FF) are the three minor systems in the Northern Landscape. The overall goal of management in these systems is to maintain them for their wildlife and social benefits.

Currently there are limited markets and therefore no economic driver for harvests within floodplain forests. These minor systems represent a small percentage of the landscape but provide high diversity and wildlife habitat importance. Management includes maintenance and favoring regeneration of all tree species except for ash due to EAB risk. Future management and tree regeneration may not be possible in wet sites after the ash dies, removing the evapotranspiration effect, resulting in elevated water tables and possible flooding.

The fire-dependent sites are drier, upland areas that are associated with recreation such as hunting and foraging. Red pine is an economically important species and red pine stands are intensively managed at economic rotation lengths, including plantation management. The genetics of existing nursery supply and planting stocks of red pine are limited. Lack of genetic diversity presents greater risks including less resiliency and higher mortality with climate change.

Acid peatlands may have been productive in the past, but are no longer today, with harvests that occurred approximately 100 years ago during drier climatic conditions. Some of these stands have not regenerated as viable productive forests to manage. This is especially true on marginal sites and is likely due to a combination of ecological, economic, and social factors that have changed over time.

2. Fire-Dependent (FD)
- 760,892 acres
- 17.23% of the Northern Landscape forests

Species: quaking aspen, paper birch, jack pine, black spruce, big-toothed aspen, red pine, white pine, white spruce, balsam fir, northern white cedar, red maple

MN DNR Silvicultural Strategies for Management
1. Re-initiate a stand as would severe crown fire to create open, large gaps.
2. Maintain a stand as would surface fire to create large-gap habitat.

Photo credit: James Aasen

Habitat, Economic, and Climate Change Considerations for Fire Dependent (FD):

Habitat:
- Regeneration of pine species can be difficult due to deer browse. Occurs largely outside the pre-settlement areas of mixed pine forests. Some specific locations in the Northern Landscape may be appropriate for red and white pine restoration or incorporation for species diversity.
- Transition pine stands to multi-species condition for wildlife habitat improvement. Manage spatially forage (mast producing trees) and species diversity to create and maintain healthy systems that provide multiple benefits for all species.
- Often require heavy disturbance to maintain their important conifer component.

Economic:
- Low overall acreage of FD in the landscape makes it an important resource for sawmills who rely on timely thinnings and management towards maximum yield.
- Maximize fiber production while considering habitat goals. Market drives management opportunities.
- When properly managed these forest types out produce any other plant community on an acre-to-acre comparison. They require maintenance to keep them conifer dominated.

Climate Change:
- Pine and conifer species will likely be important for afforestation or increased carbon storage efforts in suitable areas.
- Forest health concerns continue for this NPC. Diplodia threatens regeneration attempts. Mountain pine beetles are a threat in the face of climate change. Managing some pine stands to multi species is likely a better strategy than monoculture, though some should be left for maximum yield management.
- Manage for diverse age classes and species at a spatial scale. Consider diversifying tree species used in reforestation and afforestation techniques.

Fire Dependent – Adaptation– Strategies and Approaches
Developed for forests
> 1.4 – Reduce competition for moisture, nutrients and light (site prep)
> 1.5 – Restore or maintain fire in fire-adapted ecosystems
> 3.4 & 10.1 – Promptly revegetate sites after disturbance

Developed for forest carbon management
> 3.4 – Reduce the risk of tree mortality from biological or climatic stressors in fire-prone systems (expanded use of fire as a management tool would be a new strategy for the landscape)
> 4.1 – Promptly revegetate sites after disturbance
> 7.3 – Promote species with enhanced carbon density in woody biomass (sequestration, products, longer-lived species, conifers)

2. Acid Peatland (AP)
- 109,424 acres
- 2.48% of the Northern Landscape forests

MN DNR Silvicultural Strategies for Management
1. Re-initiate a stand as would light surface fire to create open, large gaps.
2. Re-initiate a stand as would stand-replacing disease/pest wave events to create open, large gaps.
3. Maintain a stand as would natural senescence, windthrow or disease/pests to create small-gap habitat.

Habitat, Economic, and Climate Change Considerations for Acid Peatland:

Habitat:
- Dominant tree species are black spruce and tamarack.
- Provide important habitat for species at the edge of their range. Could be refugia for some species of wildlife and plants in the U.S. but not likely threatened on a continental scale (range constriction). Management is usually not conducted in these types.
- Forest health issues can dominate management direction.

Economic:
- Potential long-term economic benefits from Acid Peatlands is likely to occur through revenue generated from carbon banking programs. Some sites may have marketable black spruce and tamarack and these income opportunities may conflict.
- These stands are sometimes not economically feasible to manage.

Climate Change:
- Protection and restoration of degraded peatlands will be an important climate carbon management strategy.
- Most threatened forest type to both climate changes and human disturbances such as peat mining operations.
- Forest health issues are increasing due to the additional life cycles of eastern larch borer associated with shorter and warmer winters.
- Warming winters due to climate change will limit access and operability within this forest type.

(Acid Peatlands are combined with Forested Rich Peatlands in the following adaptation strategies discussion.)

Forested Rich Peatlands and Acid Peatlands – Adaptation– Strategies and Approaches
(See Appendix D for additional information)

Developed for forests

Resistance Strategies:

- 2.1 – Maintain or improve the ability of forests to resist pests and pathogens (dwarf mistletoe, Eastern larch beetle)

Resilience Strategies:

- 1.1 – Reduce impacts to soils and nutrient cycling
- 1.2 – Maintain or restore hydrology
- 4.1 – Prioritize and maintain unique sites
- 4.2 – Prioritize and maintain sensitive or at-risk species or communities

Transition Strategies:

- 5.1 – Promote diverse age classes
- 6.1 – Manage habitats over a range of sites and conditions
- 8.1 – Use seeds, germplasm, and other genetic material from across a greater geographic range (some collaboration is already occurring between Canadian and Minnesota seed sources).

Developed for forest carbon management

Strategy 5: Prioritize management of locations that provide high carbon value across the landscape (i.e., peatland carbon storage)

- 5.1 – Prioritize low-vulnerability sites for maintaining or enhancing carbon stocks
- 5.2 – Establish reserves on sites with high carbon density

Photo credit: Jaimé Thibodeaux

3. Floodplain Forest (FF)
- 15,653 acres
- 0.35% of the forest in the Northern Landscape

Species: silver maple, black ash, green ash, American elm, bur oak

MN DNR Silvicultural Strategies for Management
- Maintain a stand as would selective windthrow involving patches of similarly stressed trees by removal of canopy trees in large gaps.
- Maintain a stand as would natural senescence, disease, beaver cutting or physical battering to create small gap habitat.

Habitat, Economic, and Climate Change Considerations for Floodplain Forest:

Habitat:
- Important for both terrestrial and aquatic wildlife and plants including species not found in other parts of the landscape such as silver maple, bur oak, American basswood, and green ash.
- Should be managed for old forest characteristics.
- Limit erosion potential by increasing conifer component to slow rainfall.
- Manage spatially for age and species diversity to create and maintain healthy systems that provide multiple benefits for all species.

Economic:
- Very low economic value to the region. Habitat benefits outweigh economics in this type. Shifts in economics away from ash to other currently less desirable species (American basswood, maple, etc.).
- This type is sometimes not economically feasible to manage.

Climate Change:
- EAB threatens ash resource, though habitat niche will likely be filled by other species currently on the landscape.

Floodplain Forest – Adaptation– Strategies and Approaches
*(See Appendix D for additional information*)

Developed for forests

- 2.1 – Maintain or improve the ability of forests to resist pests and pathogens
- 2.3 – Manage herbivory to promote regeneration of desired species (if harvested, move away from ash);
- 7.1 – Reduce landscape fragmentation (promote private forest management along river corridors to maintain shoreline, etc.),
- 9.1 – Favor or restore native species that are expected to be adapted to future conditions
- 9.4 – Protect future-adapted seedlings and saplings (favor conifer species along riparian corridors)

Strategy 1: Sustain fundamental ecological functions
- 1.2 – Maintain or restore hydrology
- 1.3 – Maintain or restore riparian areas
- 1.4 – Reduce competition for moisture, nutrients, and light

Photo credit: James Aasen

Developed for forest carbon management

6.3 – Increase harvest frequency or intensity because of greater risk of tree mortality   (increase harvest to stimulate renewal in face of risk of mortality - within existing FMGs for these areas)
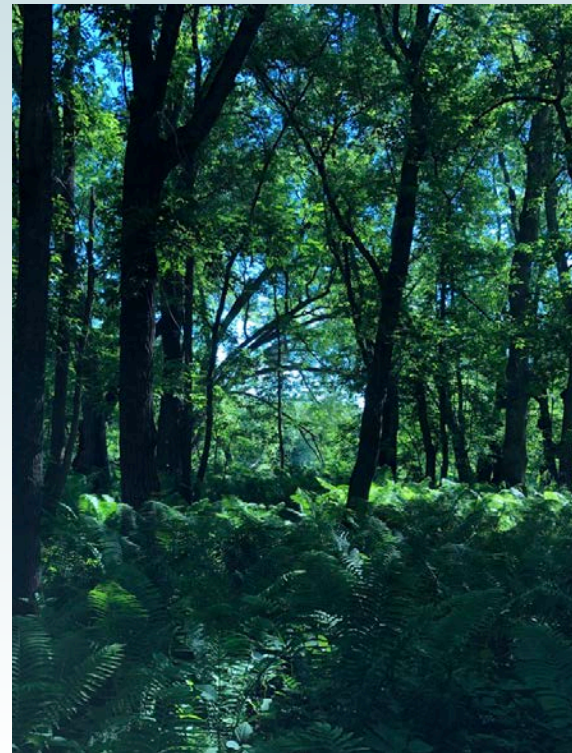
SECTION 6: COORDINATION FRAMEWORK

Coordination and implementation of the goals and strategies identified within this plan will occur through collaborative efforts. Some goals and strategies may be implemented by committee members and associated organizations via support from the Committee and MFRC staff. Often regional landscape plan goals and strategies are implemented by non-MFRC member organizations to support local efforts and priorities. The Northern Regional Landscape Committee determines how coordination and implementation of the approved plan will begin. The Committee will continue to meet quarterly to exchange information on member activities and discuss resource issues. Often these exchanges generate synergy through learning from each other or spur ideas for collaborative projects that solve problems experienced at the regional level. The Committee also discusses and comes to mutual understanding on resource issues experienced locally. Due to members' on-the-ground experience and interdisciplinary conversations at quarterly meetings, regional committees provide valuable recommendations and insight to the MFRC on regionally specific issues.

SECTION 7: PRIORITY GOALS AND STRATEGIES

This section identifies the top strategies prioritized by the Committee as actionable items for achieving social, economic, and ecological goals through near-term implementation and monitoring. The following prioritized strategies are a subset from the complete sets listed in Sections 4a, 4b, and 4c. This subset includes strategies that are of near-term importance or urgency (i.e., next 10 years and before the next plan review).

As capacity allows the committee may develop action-oriented work plans (2-5 years) for collaborative projects based on these priorities.

PRIORITY SOCIAL STRATEGIES

- Manage for diverse forest recreation and outdoor activities for residents and visitors (i.e., motorized and non-motorized recreational uses, trail and/or water-based activities, and consumptive and non-consumptive uses).
- Support regional and state-level recognition of the importance of the forest road system in providing high-quality multiple use, recreation experiences, and access for private landowners.
- Support regional programs that offer education and training, especially for natural resources, trades, health care, and essential social services.

PRIORITY ECONOMIC STRATEGIES

- Encourage business development in the outdoor recreation and tourism sector, including underutilized opportunities.
- Encourage landowners to develop and implement science-based management plans and to utilize private landowner incentives and cost-share programs.
- Support funding for tree improvement programs, capacity for containerized seedling, and quality seedling production.

PRIORITY ECOLOGICAL STRATEGIES

- Implement management strategies that adapt to impacts associated with weather events, forest health and disease issues, wildfire, and consider information about species climate migration.
- Implement and promote the MFRC's *Voluntary Site-Level Forest Management Guidelines.*
- Educate decision-makers on sustainable forest management and related policy actions.

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APPENDIX A: PARTICIPANTS IN THE DEVELOPMENT OF THE 2024 NORTHERN REGION LANDSCAPE PLAN

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Zach	Gutknecht	Beltrami SWCD
Stephan	Handler	USFS Climate Change Specialist
Jim	Hansen	DNR Wildlife
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Nick	Jensen	MN DNR Forest Ecologist
Keith	Karnes	Leech Lake DRM Director
Linda	Kingery	MN Citizens Climate Lobby
Scott	Laudenslager	DNR Wildlife
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Paul	Nevanen	Koochiching Economic Development
Marcie	Peeters	Koochiching SWCD Resource Conservationist
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Danae	Schafer	Koochiching County Assistant Land Commissioner
Mac	Schafer	Packaging Corporation of America Forester
Marty	Schoewe	Molpus Timberland Management LLC.
Jolen	Simon	Koochiching SWCD Program Coordinator
Phil	Talmage	DNR Fisheries
Jaime	Thibodeaux	MFRC Landscape Coordinator
Eldon	Voigt	Private Landowner/Koochiching SWCD Supervisor
Tim	Wegner	MFRC Labor Organizations Representative
Ben	West	DNR – Area Supervisor
David	Wilson	MFRC Applied Forest Science Coordinator

APPENDIX B: ADDITIONAL INFORMATION ABOUT REFERENCE PLANS

The MFRC landscape plans provide guidance to the following:

Forest Management Plans
- U.S. Forest Service land and resource management plans – ten to fifteen year plans developed for the Chippewa and Superior National Forests. They cover approximately 3 million acres of federal lands in northern Minnesota.
- Tribal land and resource management plans – there are eleven tribes in the state. Tribal forestry organizations have developed plans to cover over 600,000 thousand acres of tribal forest land in northern Minnesota.
- MN DNR Forestry Section Forest Resource Management Plans – plans that guide the management of vegetation including timber harvest on state owned lands within ecological units, for 3.8 million acres of state forest land managed by DNR Forestry and Wildlife Divisions.
- County tax forfeited land management plans – fifteen northern and central Minnesota counties manage approximately 2.8 million acres of forest land. These plans guide land management including timber harvest on most of these acres.
- Industry forest management plans – forest industry and timber investment companies have plans for about 1.0 million acres of forest land.
- Woodland stewardship plans – some of Minnesota's 150,000 family forest owners have woodland plans covering 10 to 15 percent of the 6.0 million acres of family-owned private forest land.
- Other private land plans – there are a number of other private plans related to forest management in Minnesota and related conservation activities undertaken by various environmental organizations, land trusts, and others.

Program Plans
- Forest for the Future Plan – the plan used to create and manage the MN DNR's forest conservation easement and acquisition program.
- Private Forest Management System Framework – the plan developed to guide the delivery of planning and implementation services to Minnesota's family forest landowners through the MN DNR Forestry Private Forest Management (PFM) Program.
- Urban and Community Forestry program plan – the plan developed to direct efforts by DNR Forestry to promote urban forestry projects and practices in communities throughout the state.
- Landscape stewardship plans – plans developed through the DNR PFM Program to increase collaborative efforts by all service providers to promote the implementation of landscape stewardship approaches at sub-landscape scales.
- Community wildfire protection plans – locally based program plans to promote collaborative efforts to help landowners be properly prepared for wildfire protection.

- [Watershed Restoration and Protection Strategies (WRAPs)](#) reports – reports developed by the Minnesota Pollution Control Agency (MPCA) and partner organizations which provides detail on water quality issues in major watersheds (8-digit HUC) and identifies ways to prioritize projects to protect or restore water quality in those watersheds.
- Minnesota Pollution Control Agency watershed information including Total Maximum Daily Load (TMDL) plans.

Funding Development Plans
- [State Forest Action Plan (FAP)](#) – federally required plans that all states must prepare to received federal funding for forestry projects through the US FS State & Private Forestry.
- Forest Legacy Assessment of Need (AON) – a federally mandated plan that provides direction for investing of federal funds for fee title acquisitions and conservation easements through the Forest Legacy Program.
- 25-Year Lessard-Sams Outdoor Heritage Council (LSOHC) Forest Habitat Implementation Vision – a framework for the LSOHC to use in advising the legislature about funding for forest projects that improve fish and wildlife habitat for game and nongame species.

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 website at https://mn.gov/frc/ for this report).

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 the county would look like 25 years from 2001 and then developed goals and strategies for how to achieve the desired condition.

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.

APPENDIX C: NORTHERN LANDSCAPE DESIRED FUTURE CONDITIONS, GOALS, AND STRATEGIES

Forest Policy Framework

2024 Northern Landscape, Desired Future Conditions (DFCs):
In 100 years, the Northern Landscape will have the following characteristics:
- *A vibrant economy capable of sustaining the Northern Landscape's population and communities.*
- *A landscape with a distinctive identity where residents and visitors have a strong sense of place and that fulfills social needs.*
- *A landscape where collaborative natural resource planning, management, and use provide outcomes that support societal needs in the region.*
- *Resilient ecosystems, diverse habitats, and a functioning forested landscape.*

SOCIAL GOALS AND STRATEGIES

Desired Future Outcomes:
- A landscape with a distinctive identity where residents and visitors have a strong sense of place and that fulfills social needs.
- A landscape where collaborative natural resource planning, management, and use provide outcomes that support societal needs in the region.

Goal 1: Increase and maintain sustainable multiple use of public lands, public waters, and private industrial lands open to the public.

Strategies:
- Manage for diverse forest recreation and outdoor activities for residents and visitors (i.e., motorized and non-motorized recreational uses, trail and/or water-based activities, and consumptive and non-consumptive uses).
- Enhance public access while maintaining natural resource integrity.
- Maintain boat launches, campgrounds, trailheads, facilities, roads, and other recreation infrastructure to ensure quality experiences for residents and visitors.
- Encourage additional funding for maintenance and strategic enhancement of recreational systems and infrastructure.
- Support regional and state-level recognition of the importance of the forest road system in providing high-quality multiple use, recreation experiences, and access for private landowners.
- Provide access to recreation maps and information to support sustainable multiple use and avoid conflict.
- Maintain a stable public land base while supporting adequate state and federal programs that ensure local taxing districts receive revenues to offset non-taxable public lands.

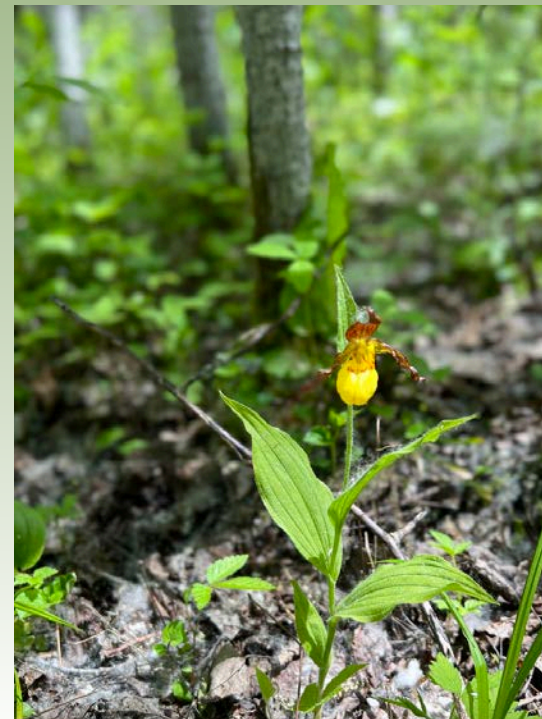**Goal 2:** Contribute to the well-being of the landscape's population.

Strategies:
- Manage forests to maintain or improve air, water, and soil resources.
- Manage forests and communities to support viable populations and quality habitat for culturally significant organisms, plants, and animal species for hunting, gathering, and other non-consumptive recreation.
- Support regional programs that offer education and training, especially for natural resources, trades, health care, and essential social services.
- Encourage decision-makers to participate in regional events that demonstrate the needs of constituents.
- Encourage initiatives to mitigate and adapt to climate change.
- Support opportunities and access to outdoor and cultural experiences for residents and visitors.

Goal 3: Promote development and infrastructure investment that values and supports the natural resources of the region.

Strategies:
- Continue to implement local comprehensive land use plans and support opportunities to fund regional planning.
- Locate development within existing corridors to minimize fragmentation.
- Consider the vulnerabilities to human health and safety of the rural landscape in anticipation of increasing climate change risks, including wildfire, flooding, and other ecosystem impacts.
- Support housing programs that attract and retain residents, including the workforce.
- Recognize the importance of essential community infrastructure and services, including schools, health care, and roads.

Photo credit: Kirby Readman

ECONOMIC GOALS AND STRATEGIES

Desired Future Outcomes:

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

Goal 1. Stabilize, diversify, and improve local economies, population, job sectors, and incomes at or above the living wage that rely on the sustainable use of landscape assets.

Strategies:

- Encourage economic development through existing organizations (e.g. the Koochiching Economic Development Authority).
- Encourage utilization of biomass as a renewable fuel source.
- Promote and market outdoor recreation opportunities.
- Encourage business development in the outdoor recreation and tourism sector, including underutilized opportunities.
- Promote and protect responsible and sustainable recreation and tourism use of ATVs through locally developed plans.
- Explore opportunities for non-traditional forest products and encourage value-added and secondary forest product industries.
- Explore carbon and other ecosystem service market opportunities that are complementary to timber harvesting and provide local and in-state benefits.
- Promote interagency cooperation leading to more timely permitting processes.
- Evaluate changes in local and state policies that could assist existing industries.
- Encourage landowners to develop and implement science-based management plans and utilize private landowner incentives and cost-share programs.
- Support funding for business expansion and start-ups that complement existing industries.
- Explore opportunities available with a foreign trade zone designation and being located on an international border.
- Increase development and investment in broadband infrastructure and opportunities for remote work and careers, including jobs that attract young adults.
- Increase entrepreneurial capacity by targeting innovative and enterprising business opportunities and startup companies.

Goal 2: Increase the Northern Landscape's forest productivity and resilience in a sustainable manner consistent with MFRC's *Voluntary Site-Level Forest Management Guidelines*.

Strategies:

- Support silviculture productivity, climate resilience, and tree improvement research.
- Increase capture of mortality, including sites affected by forest health issues (ash, tamarack, black spruce).
- Look for opportunities to increase forest harvest treatments to support forest-based industries in the region while achieving multiple resource objectives (e.g., enhanced forest productivity, health, and resilience).

- Look for opportunities to increase the region's climate resiliency (climate smart forestry).
- Encourage land managers to harvest at rotation consistent with management objectives.
- Ensure prompt, adequate regeneration on all harvested sites consistent with management objectives.
- Increase utilization within harvest areas, consistent with the site-level guidelines.
- Promote use of existing silvicultural science in management practices (thinning, insect control, etc.).
- Monitor forest productivity and resilience through the data provided by the U.S. Forest Inventory and Analysis program and other state-level efforts.
- Support funding for tree improvement programs, capacity for containerized seedling, and quality seedling production.
- Encourage landowners to actively and sustainably manage forests.
- Promote adequate and continued funding for maintaining and building reliable forest roads.

Goal 3: Increase and diversify income opportunities that compliment logging and existing jobs, including seasonal, farming, and road or infrastructure work.

Strategies:
- Promote capital investments for equipment purchase.
- Provide technical support for loggers, farmers, and other small businesses wishing to access complex contracting opportunities and state bidding.
- Recognize the economic dependencies between farming and forestry operations.
- Increase opportunities and support for seasonal operations, such as summer harvest access or secondary wood products like biochar.
- Identify and promote consumption of local farm and forest products.
- Promote the marketing of locally crafted forest products, including possibilities for biochar.

Goal 4: Encourage educational opportunities to promote economic stability.

Strategies:
- Facilitate mentorships, apprenticeships, field-days, and job-shadowing to support workforce recruitment and retention.
- Promote local/regional opportunities for higher education, especially in careers that support retention of local workforce and that limit the need to travel or relocate outside the region.
- Promote the plan's goals and strategies locally, within regional communities, and with educators and educational organizations.
- Improve outreach and promote regional recruitment programs focusing on workforce stability.
- Promote use of statewide natural resource initiatives, services, and programs including University of Minnesota Extension, Minnesota Logger Education Program (MLEP), Sustainable Forests Education Cooperative (SFEC), and Natural Resources Research Institute (NRRI).

ECOLOGICAL GOALS AND STRATEGIES

Desired Future Outcomes:
Resilient ecosystems, diverse habitats, and a functioning forested landscape.

Goal 1: Sustainably manage natural resources to support a full range of plant, animal, and fish species, by utilizing strategies that reflect and adapt to consideration of natural processes and disturbance.

Strategies:
- Maintain and/or increase sufficient diversity, extent of habitat, and water quality to support a full range of plant, animal, and fish species.
- Implement management strategies that adapt to impacts associated with weather events, forest health and disease issues, wildfire, and consider information about species climate migration.
- Maintain and/or enhance continuous migration corridors for fish and wildlife species.
- Utilize ecological classification systems and information about native plant communities in forest planning and management.
- Implement and promote the MFRC's *Voluntary Site-Level Forest Management Guidelines.*
- Consider the ecological goals and objectives of related planning efforts, including the Statewide Wildlife Action Plan, One Watershed One Plan (1W1P), or similar.
- Promote forest stewardship programs, projects, and third-party certification.

Goal 2: Manage for water quality, associated wildlife needs, and hydrologic functions.

Strategies:
- Restore landscape hydrology including ditch restoration, improvement of fish passage, addressing problem beaver dams, and mitigating poorly designed and constructed road culverts or crossings.
- Gain a better understanding of changing hydrology due to beaver dams, emerald ash borer, Eastern larch beetle, and historic impacts from ditching.

Goal 3: Improve and promote information and educational opportunities relating to forest resource management.

Strategies:
- Encourage completion and continuous refinement of Ecological Classification System (ECS) native plant community mapping for the Northern Landscape.
- Publicize and encourage implementation of the forest management goals and silviculture strategies for each native plant community in the Northern Landscape.
- Support ECS training for land managers, landowners, and interested parties in the Northern landscape region.

- Improve data availability and current information about peatland habitats, including impacts to spruce from Eastern dwarf mistletoe.
- Review and consider current science in forest land management and decision-making on an on-going basis.
- Educate decision-makers on sustainable forest management and related policy actions.

Menu of Adaptation Strategies and Approaches
Developed for forests

Strategy 1: Sustain Fundamental ecological functions.
1.1 Reduce impacts to soils and nutrient cycling.
1.2 Maintain or restore hydrology.
1.3 Maintain or restore riparian areas.
1.4 Reduce competition for moisture, nutrients, and light.
1.5 Restore or maintain fire in fire-adapted ecosystems.

Strategy 2: Reduce the impact of biological stressors.
2.1 Maintain or improve the ability of forests to resist pests and pathogens.
2.2 Prevent the introduction and establishment of invasive plant species and remove existing invasive species.
2.3 Manage herbivory to promote regeneration of desired species.

Strategy 3: Reduce the risk and long-term impacts of severe disturbances.
3.1 Alter forest structure or composition to reduce the risk or severity of wildfire.
3.2 Establish fuelbreaks to slow the spread of catastrophic fire.
3.3 Alter forest structure to reduce severity or extent of wind and ice damage.
3.4 Promptly revegetate sites after disturbance.

Strategy 4: Maintain or create refugia.
4.1 Prioritize and maintain unique sites.
4.2 Prioritize and maintain sensitive or at risk species or communities.
4.3 Establish artificial reserves for at-risk and displaced species.

Strategy 5: Maintain and enhance species and structural diversity.
5.1 Promote diverse age classes.
5.2 Maintain and restore diversity of native species.
5.3 Retain biological legacies.
5.4 Establish reserves to maintain ecosystem diversity.

Strategy 6: Increase ecosystem redundancy across the landscape.
6.1 Manage habitats over a range of sites and conditions.
6.2 Expand the boundaries of reserves to increase diversity.

Strategy 7: Promote landscape connectivity.
7.1 Reduce landscape fragmentation.
7.2 Maintain and create habitat corridors through reforestation or restoration.

Strategy 8: Maintain and enhance genetic diversity.
8.1 Use seeds, germplasm, and other genetic material from across a greater geographic range.
8.2 Favor existing genotypes that are better adapted to future conditions.

Strategy 9: Facilitate community adjustments through species transitions.
9.1 Favor or restore native species that are expected to be adapted to future conditions.
9.2 Establish or encourage new mixes of native species.
9.3 Guide changes in species composition at early stages of stand development.
9.4 Protect future-adapted seedlings and saplings.
9.5 Disfavor species that are distinctly maladapted.
9.6 Manage for species and genotypes with wide moisture and temperature tolerances.
9.7 Introduce species that are expected to be adapted to future conditions.
9.8 Move at-risk species to locations that are expected to provide habitat.

Strategy 10: Realign ecosystems after disturbance.
10.1 Promptly revegetate sites after disturbance.
10.2 Allow for areas of natural regeneration to test for future-adapted species.
10.3 Realign significantly disrupted ecosystems to meet expected future conditions.

NIACS
Northern Institute of
Applied Climate Science

Menu of Adaptation Strategies and Approaches
Developed for forest carbon management

Strategy 1: Maintain or increase extent of forest ecosystems.
Approach 1.1 Avoid forest conversion to nonforest land uses.
Approach 1.2 Reforest lands that have been deforested and afforest suitable lands.
Approach 1.3 Increase the extent of forest cover within urban areas.
Approach 1.4 Increase or implement agroforestry practices.

Strategy 2: Sustain fundamental ecological functions.
Approach: 2.1 Reduce impacts on soils and nutrient cycling.
Approach: 2.2 Maintain or restore hydrology.
Approach: 2.3 Prevent the introduction and establishment of invasive plant species and remove existing invasives.
Approach: 2.4 Maintain or improve the ability of forests to resist pests and pathogens.
Approach: 2.5 Reduce competition for moisture, nutrients, and light.

Strategy 3: Reduce carbon losses from natural disturbance, including wildfire.
Approach: 3.1 Restore or maintain fire in fire-adapted ecosystems.
Approach: 3.2 Establish natural or artificial fuelbreaks to slow the spread of catastrophic fire.
Approach: 3.3 Alter forest structure or composition to reduce the risk, severity, or extent of wildfire.
Approach: 3.4 Reduce the risk of tree mortality from biological or climatic stressors in fire-prone systems.
Approach: 3.5 Alter forest structure to reduce the risk, severity, or extent of wind and ice damage.

Strategy 4: Enhance forest recovery following disturbance.
Approach: 4.1 Promptly revegetate sites after disturbance.
Approach: 4.2 Restore disturbed sites with a diversity of species that are adapted to future conditions.
Approach: 4.3 Protect future-adapted seedlings and saplings.
Approach: 4.4 Guide species composition at early stages of development to meet expected future conditions.

Strategy 5: Prioritize management of locations that provide high carbon value across the landscape.
Approach: 5.1 Prioritize low-vulnerability sites for maintaining or enhancing carbon stocks.
Approach: 5.2 Establish reserves on sites with high carbon density.

Strategy 6: Maintain or enhance existing carbon stocks while retaining forest character.
Approach: 6.1 Increase structural complexity through retention of biological legacies in living and dead wood.
Approach: 6.2 Increase stocking on well-stocked or understocked forest lands.
Approach: 6.3 Increase harvest frequency or intensity because of greater risk of tree mortality.
Approach: 6.4 Disfavor species that are distinctly maladapted.
Approach: 6.5 Manage for existing species and genotypes with wide moisture and temperature tolerances.
Approach: 6.6 Promote species and structural diversity to enhance carbon capture and storage efficiency.
Approach: 6.7 Use seeds, germplasm, and other genetic material from across a greater geographic range.

Strategy 7: Enhance or maintain sequestration capacity through significant forest alterations.
Approach: 7.1 Favor existing species or genotypes that are better adapted to future conditions.
Approach: 7.2 Alter forest composition or structure to maximize carbon stocks.
Approach: 7.3 Promote species with enhanced carbon density in woody biomass.
Approach: 7.4 Introduce species or genotypes that are expected to be adapted to future conditions.

MINNESOTA FOREST RESOURCES COUNCIL

The mission of the Minnesota Forest Resources Council is to develop recommendations that result in the sustainable management of Minnesota's forest resources while protecting the balance of long-term economic, ecological, and social forest values in accordance with the Sustainable Forest Resources Act. Council members represent a wide range of forest resource interests and hold public meetings every other month to discuss key issues.