DEPARTMENT OF NATURAL RESOURCES

Minnesota 2020 State Forest Action Plan

Part 1 of 2: Assessment and Trends

07/09/2020

Figure 1 – Bear Island State Forest. Source: DNR.

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The US Department of Agriculture Forest Service (USFS) is a partner with the Minnesota DNR in this effort.

DEPARTMENT OF NATURAL RESOURCES

Letter from the Minnesota State Forester

July 9, 2020

Dear Minnesota forest stakeholder:

It is with great pleasure that I present to you the Minnesota 2020 State Forest Action Plan (SFAP). Minnesota has always had a strong and active forestry community working together to manage our forests sustainably. Developing this plan has been a collaborative effort between the Minnesota Department of Natural Resources (DNR), and the US Department of Agriculture Forest Service, with input from stakeholders and partners including Minnesota's National Forests, tribal forest land managers, county land departments, Minnesota Forest Resources Council, Board of Water and Soil Resources (BWSR), State and Private Forestry advisory committees, forest industry representatives, university forestry advisors, conservation organizations, and private forest landowners. The 2020 SFAP builds upon both the Minnesota 2010 SFAP, and updates identified in a 2015 SFAP review.

Federal approval of this plan and alignment of program goals with the final plan, is a requirement for eligibility to receive funds from the US Forest Service State and Private Forestry program, under the authority of the federal Cooperative Forestry Assistance Act.

Examples of these federal funds include grants to support the following: Landscape Scale Restoration (LSR), Great Lakes Restoration Initiative (GLRI) and Wildfire Risk Reduction (WRR). Although the US Forest Service State and Private Forestry program itself is not the primary driver for forestry activity or economic development in the state, Minnesota DNR regards these funding sources as critical seed funding for many aspects of sustainable forestry. Considerable State and Private Forestry work and initiatives would be lost or incomplete without this foundation and partnership between Minnesota DNR Forestry and the US Forest Service.

The Minnesota 2020 SFAP is comprised of two documents: **Part 1: Assessment and Trends**; and **Part 2: Strategies, Stakeholders, Successes and National Priorities**. It is important to note that these documents are a broad overview of Minnesota's forest conditions and trends, with general strategies to guide sustainable forest management across all ownerships within Minnesota. Existing data sources include US Forest Service Forest Inventory Analysis, Northern Institute for Applied Climate Science, DNR Resource Assessment, DNR Climatology, BWSR, National Woodland Owners Survey, among many others. Data gaps are also identified within the documents to assist both Minnesota DNR and the US Forest Service to guide investments in new forestry related data products, and to continually improve the accuracy of information.

As Minnesota State Forester, I am proud to share all of our collective forestry accomplishments, future challenges, and opportunities described in the 2020 SFAP with you, our forestry partners, stakeholders and all Minnesotans. We, at DNR, are committed to work together with all our forestry community, to address these future challenges and opportunities in the coming months and years, in order to protect and ensure the health and sustainability of our precious and abundant forest resources.

Forrest Boe – State Forester 

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Chapter 1: Introduction

Background on the Forest Action Plan

The 2008 Federal Farm Bill required that each state in the nation complete a State Forest Action Plan (SFAP) to continue receiving federal funds under the Cooperative Forestry Assistance Act (CFAA). The United States Department of Agriculture (USDA) Forest Service requires that statewide forest assessments and strategies be completed every 10 years and incorporate the national priorities for State and Private Forestry (S&PF) programs. The guidance from the US Forest Service is for states to work collaboratively with key partners and stakeholders to develop a statewide forest resource assessment based on comprehensive analysis of forest-related conditions, trends, threats, and shared management opportunities in the state.

In 2010, Minnesota produced its first State Forest Action Plan (SFAP). That plan is comprised of two documents, the "Minnesota Forest Resource Assessment" and "Minnesota Forest Resource Strategies."

In 2015, Minnesota submitted a 5-year review of the 2010 MN SFAP. That document reviewed and updated strategies and provided the US Forest Service with a host of "success stories" related to 2010 SFAP accomplishments. The 2010 SFAP and 2015 review provided the basis for several federal competitive landscape-level grants that the state has requested and received.

This Minnesota 2020 SFAP revision continues to follow the Montreal Process Criteria and Indicators framework as set forth by the US Forest Service S&PF programs. The Montreal Process was created in 1994 as an international and intergovernmental response to sustainably manage the earth's temperate and boreal forests for the purposes of ecological, economic, and social conditions. One of the overarching tasks was to develop and implement internationally agreed-upon criteria and indicators for the purpose of conserving and sustainably managing forests and preserving these for future generations. The criteria and indicators are designed to capture the essential components of forests as ecosystems that provide a complex and dynamic array of environmental and socio-economic benefits and services. These criteria and indicators are used by countries and states to monitor and assess national trends in forest conditions and forest management; and to provide forest-related information essential to the formulation of policies that promote sustainable forest management.

Minnesota Forests Overview

Minnesota is located at the confluence of four biomes including coniferous forest, deciduous forest, prairie grassland, and tallgrass aspen parkland (Figure 2). Overall, nearly one-third of the state is forested (16.7 million acres); Minnesota ranks in the top 20 forested states in the nation by acreage. Forests, forest-related industries, and use of forests for a variety of purposes have been part of the state's history since even before Minnesota became a state in 1858.

Figure 2 – Biomes of Minnesota.

Forest Management History in Minnesota

The 1800s saw large portions of Minnesota transformed by logging and subsequent land clearing for settlement and agriculture. This prompted several efforts to preserve outstanding forest landscapes while encouraging sustainable methods of timber harvesting. In 1872, surveyors discovered and recorded the Mississippi River headwaters. In 1891, Itasca State Park was established to permanently protect the headwaters of the Mississippi River and some of the last remaining virgin pine forests in Minnesota. This state park encompasses over 32,000 acres and is the second oldest in the nation, after New York's Adirondacks State Park.

In 1902, the first national forest reserve east of the Mississippi River was established in Minnesota. This became the Chippewa National Forest (CNF) in 1908. The boundaries of the forest contain 672,079 acres of federal-owned acreage along with state, tribal, county and private lands for an approximate total of 1.6 million acres. In 1909, the US Forest Service established the Superior National Forest (SNF) along the northern and eastern borders of the state. Superior National Forest boundaries contains 2,092,796 acres of federal acres, interspersed with other land ownerships for an approximate total of 3.9 million acres. This includes the more than 1 million acres of the Boundary Waters Canoe Area Wilderness (BWCA). Federal acreages are based upon USFS 2017 land data. Since 1909, the State of Minnesota has designated 4.9 million acres as state forest lands, now contained primarily within the statutory boundaries of 59 state forests.

The profession of forestry began in Minnesota under the federal guidance of the USDA Forest Service (established 1905), followed by the state's establishment of the Minnesota Forest Service in 1911. This was later renamed the Forestry Division under the Minnesota Department of Natural Resources (DNR). Forestry practices and forestry professionals are now employed at all levels of federal, tribal, state, county, and city governments and are committed to practicing sustainable forestry within Minnesota.

Sustaining forests is a major goal of many forestry organizations across the United States and throughout the world. Minnesota forests are managed across multiple ownerships (Figure 3) with primary consideration for sustaining long-term ecosystem integrity, healthy forest economics, and the communities that depend on these resources. The state's forest resource policy and management decisions are based on the latest science, economic needs, community values, and public involvement.

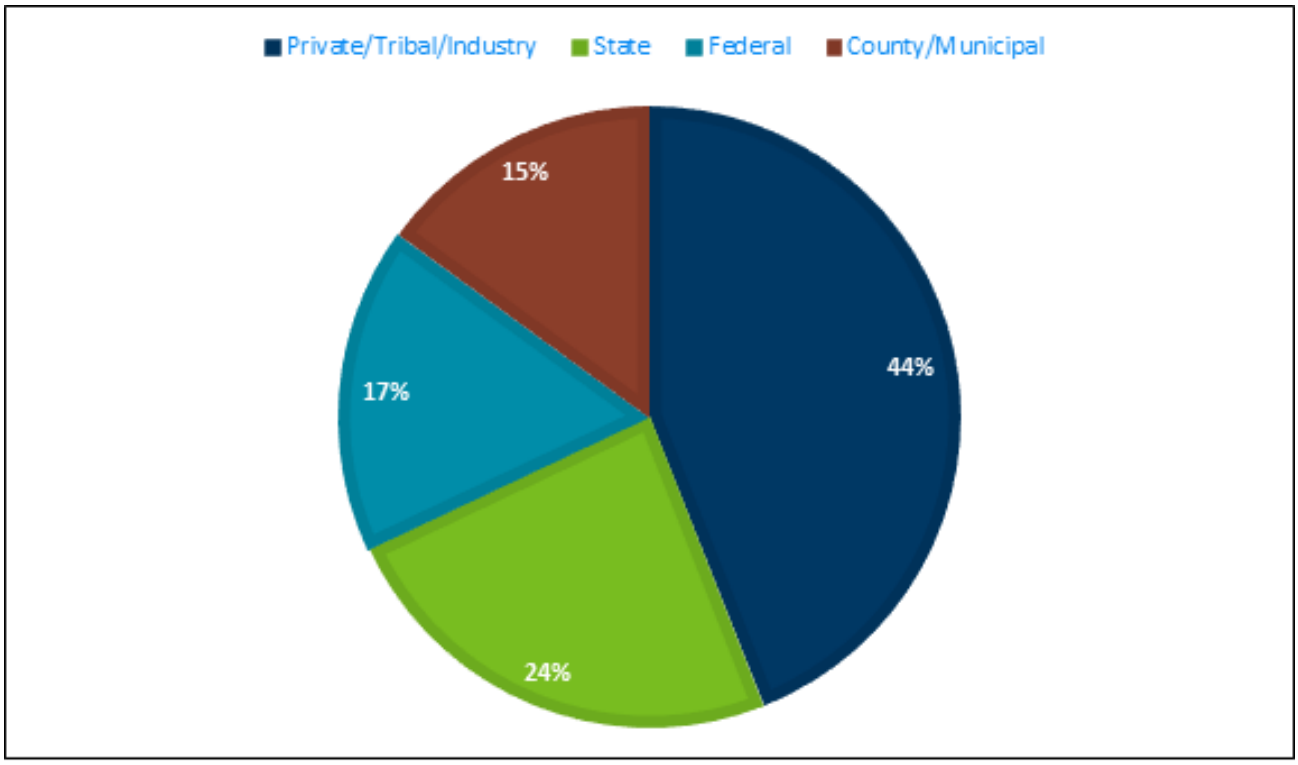

Figure 3 – Minnesota Forest Ownership by Percentage. Source: DNR.

Chapter 2: Forest Conditions and Trends

The Forest Conditions and Trends section of this document uses the Montreal Process Criteria to describe, assess, and monitor the sustainability of Minnesota's forests. Regional-level forest sustainability indicators were developed in the early 2000s for the eastern and mid-west forest regions by the Northeast-Midwest State Foresters Alliance (NMSFA), and US Forest Service Eastern Region State-R9 State and Private Forestry. These indicators and metrics measure the seven criteria laid out in the Montreal Process and are described in the table below. Each criterion is tied to the national priorities identified by the US Forest Service for S&PF Cooperative Forest Management (CFM) programs. The national priorities set by the US Forest Service are:

1. Conserve and Manage Working Forest Landscapes for Multiple Values and Uses
2. Protect Forests from Threats
3. Enhance Public Benefits from Trees and Forests

Table 1 shows the seven criteria and their corresponding national priorities.

#	Criterion	Corresponding National Priority
1	Conservation of Biological Diversity	Conserve and Manage Working Forest Landscapes for Multiple Values and Uses
2	Maintenance of Productive Capacity of Forest Ecosystems	Conserve and Manage Working Forest Landscapes for Multiple Values and Uses
3	Maintenance of Forest Ecosystem Health and Vitality	Protect Forests from Threats
4	Conservation and Maintenance of Soil and Water Resources	Enhancing Public Benefits from Trees and Forests
5	Maintenance of Forest Contribution to Global Carbon Cycles	Enhancing Public Benefits from Trees and Forests
6	Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies	Enhancing Public Benefits from Trees and Forests
7	Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management	Conserving and Managing Working Forest Landscapes for Multiple Values and Uses; Protecting Forests from Threats; Enhancing Public Benefits from Trees and Forests

Table 1 – The seven criteria used for describing, assessing and monitoring forest sustainability in Minnesota and their corresponding national priorities as approved by the S&PF Redesign Implementation Council and NASF, Sept. 2008.

The seven criteria of forest sustainability do the following:

- Provide broad goals for sustainable forest management. Ecological, social, and economic aspects of forests are tied to the three national priorities set forth by the US Forest Service.
- Support monitoring of forest trends at multiple levels of agencies and organizations associated with the US Forest Service S&PF programs.
- Allow for state-level data compilations and comparisons that include broad performance measures.

Much of the forest data presented in this 2020 SFAP are from the US Forest Service, Forest Inventory and Analyses Program (FIA). FIA is the nation's continuous forest census, employing plot-based fixed-area measurements in a nationally consistent manner, across all ownerships. In Minnesota, periodic inventories were conducted in various years; the inventories conducted in 1977 and 1990 are available in the FIA database (it should be noted that older inventories have occurred but are not included in the database). Annual inventories began in 1999 with a portion of the state completed each year-on a 5-year cycle. In 2003, the first complete inventory cycle under the annualized inventory plan was completed in Minnesota.

While many states east of the Mississippi have more recently gone to a 7-year cycle, which is now the base FIA program sponsored by the US Forest Service, the State of Minnesota augments this funding with state funds to maintain a 5-year inventory cycle. In addition, Minnesota measures twice as many forested FIA plots as compared to other inventories; this increased intensity is also paid for with state funds. The FIA program annually measures between 1,200-1,300 forested plots for a given metric, such as volume. This equates to approximately 6,300 forested plots and 11,300 plots classified with not having forest land condition. Estimates of metrics (volume, height, diameter, age, etc.) typically have increasing errors as the area being evaluated is reduced. This is caused by the presence of having fewer plots present in an area. Analyses using FIA data should take into account this increasing error when evaluating small areas, as the estimated error could be much larger than the estimate itself. In Minnesota, most estimates down to a county are typically reliable, in that the error of an estimate is not larger than the estimate itself. However, this may not apply to rare features, which could have large errors associated with their estimates, such as a non-common forest type.

In addition to US Forest Service sponsored annual FIA and 5-year reports, the State of Minnesota also produces the Minnesota Forest Resources Report annually. This report explores FIA data estimates of forest resources, as well as utilization data in the state, and is currently available for the years 2006-2017.

The following sections explore Minnesota forest conditions and trends in the context of the Montreal Process criteria and indicators.

Criterion 1. Conservation of Biological Diversity

Criterion 1 ties to the national priority *Conserve and Manage Working Forest Landscapes for Multiple Values and Uses.*

Biological diversity refers to variety in the natural environment, such as, the number and kinds of life forms, their genetic makeup, and the habitats in which they live. Generally, greater diversity means a greater resiliency and potential to adapt to changes. To preserve biological diversity, animal and plant species must be able to interact freely with one another and with their environment. Foods for each species, clean water, and adequate shelter in sufficient amounts to sustain the species across the landscape is needed. Biological diversity is measured at the ecosystem, species, and genetic scales.

Indicator 1. Area of Total Land, Forest Land, Protected Forest Land, and Forest Ownership

1.1 Total Land Area and Area and Percent of Forest, Other Natural Cover, Agricultural, and Urban Land

Minnesota is among the top 20 forested states in the nation by acreage. Forests occupy one-third of the state's land base (Figure 4). There are over 54 million acres in Minnesota, of which over 17 million acres are forested according to the National Land Cover (NLCD) dataset.

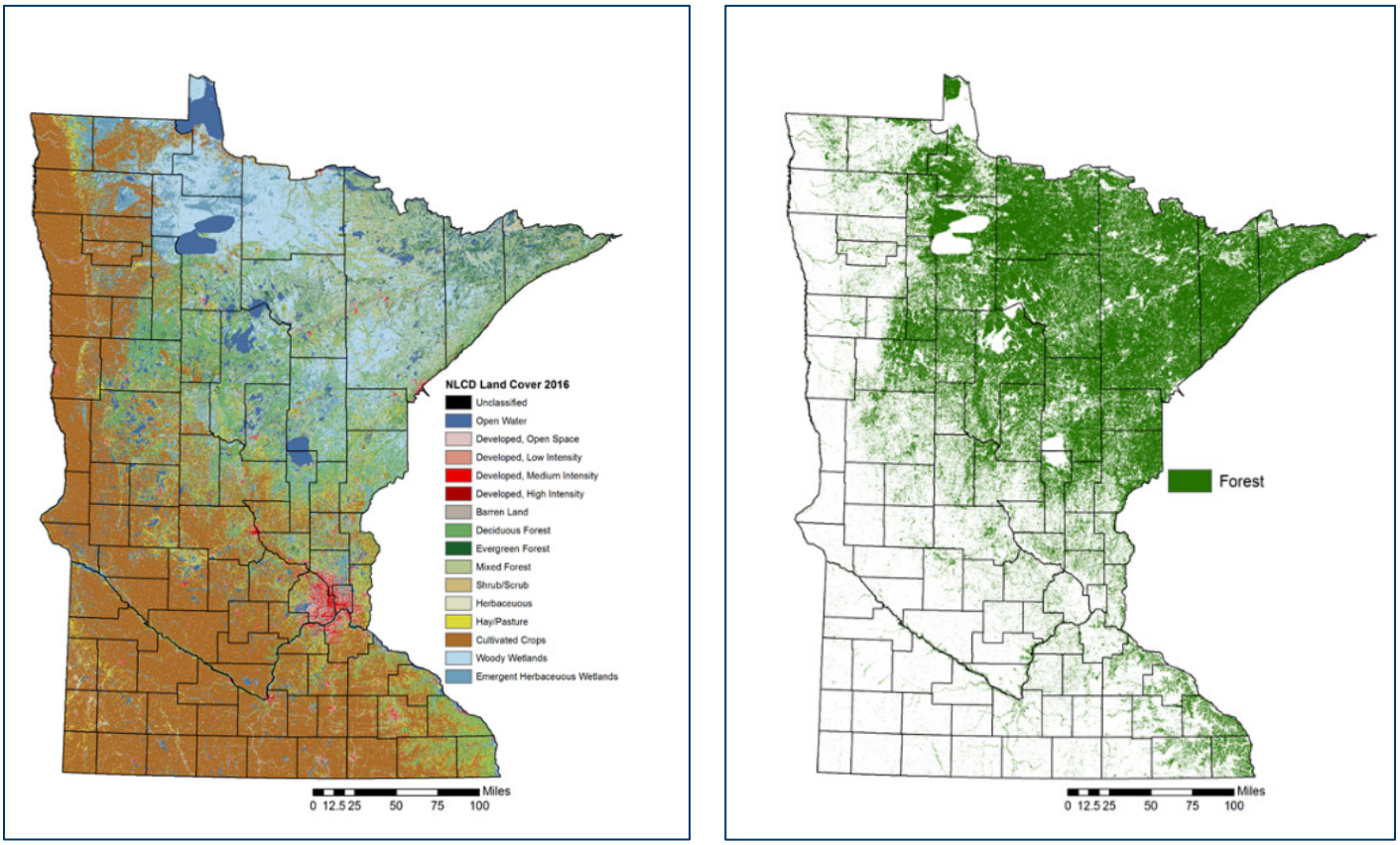

Figure 4 – Land Cover Classes in Minnesota, and 2016 Map of Forested Lands. Source: NLCD Land Cover 2016.

Prior to 1850, approximately 31.6 million acres (46 percent) of land in Minnesota was forested. Since the late 1800s, land clearing resulted in the loss of about half of the state's forests. Forest lands recovered somewhat during the 1920s and 30s, dipped again in the 50s and 60s (Figure 5), and now occupy over 17 million acres. Over time, timberlands (which are defined by the US Forest Service as forest land capable of producing in excess of 20 cubic feet of timber per year and not legally withdrawn from timber production, with a minimum area classification of 1 acre), have seen the steepest decline, and currently occupy approximately 15.5 million acres. Most of the historical loss in forest lands occurred in the Eastern Broadleaf Forest and the Prairie through the conversion to agricultural uses and urban development (approximately 14.6 million acres).

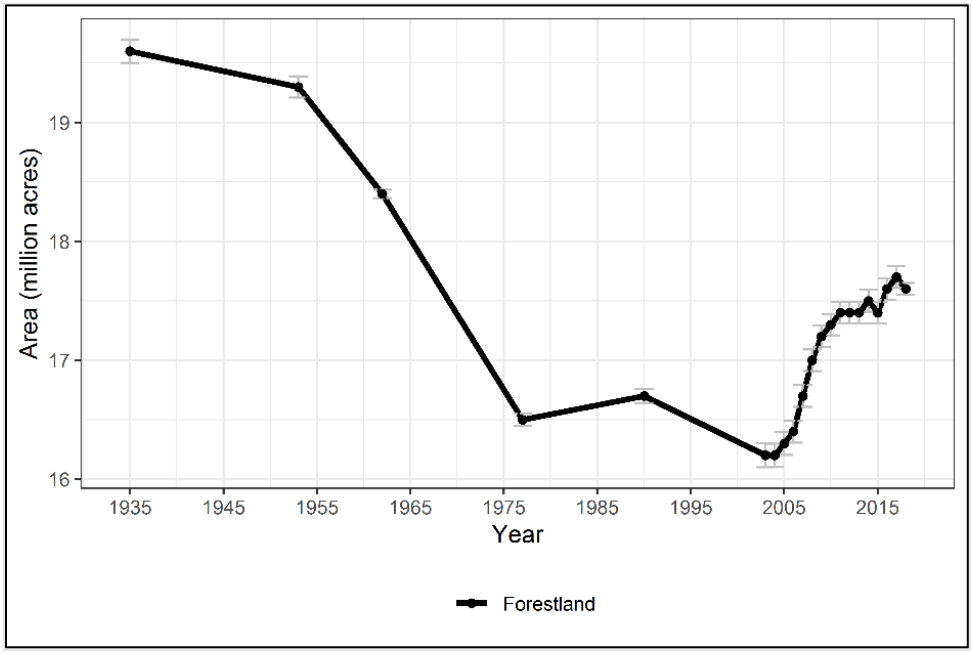

Figure 5 – Trend of Forested Lands Since 1935 in Minnesota. Source FIA program; USFS Northern Research Station. Forest land is land that has 10 percent or greater canopy cover (or equivalent stocking) and is at least 1 acre in size and 120 feet wide.

Minnesota has a large amount of land that is not forested (Figure 6). *Accessible forest* refers to the main population of interest for FIA purposes and lands that meet the definition of forest land (i.e., 10 percent canopy cover and is at least 1 acre in size and 120 feet wide). *Census water* refers to bodies of water that are 4.5 acres in size or larger. *Noncensus water* refers to bodies of water 1-4.5 acres in size, and can include rivers and canals. *Nonforest* refers to land that does not meet the definition of accessible forest or other land classes. According to FIA estimates, in 2018 Minnesota had greater than 30 million acres of non-forest land, less than 5 million acres of water bodies greater than 4.5 acres, and a small amount of water that does not meet the 4.5 acres threshold. Since 2010, forest land has increased by 330,443 acres, resulting in approximately 17 million acres of forest land in Minnesota.

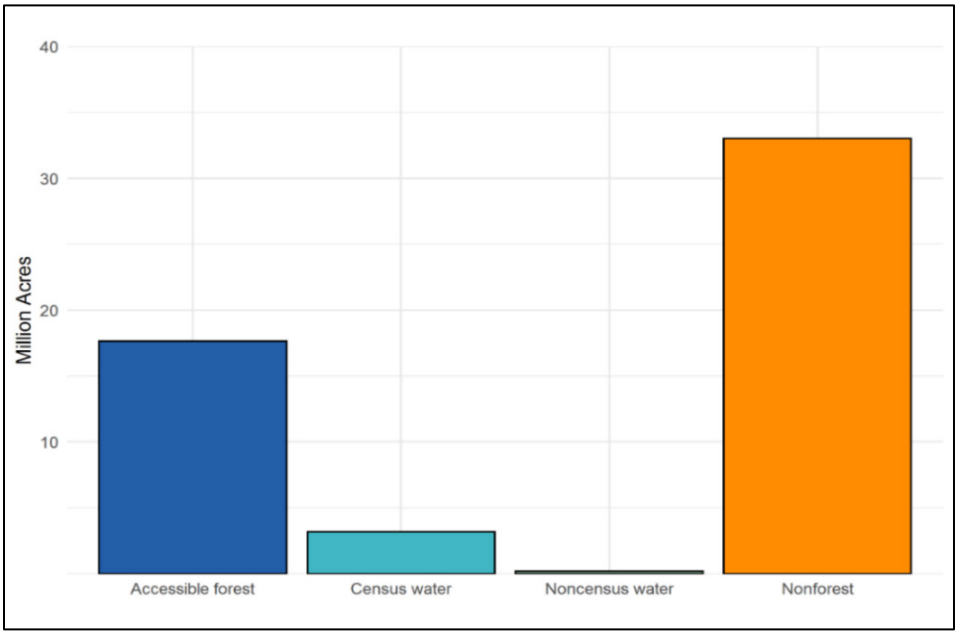

Figure 6 – Area (acres) by Land Class According to Forest Inventory and Analysis (FIA); source FIA 2018, USFS Northern Research Station.

1.2 Forest Ownership

County, state, and federal administrators control the majority of forest land acres in Minnesota (Figure 7). Acreages have fluctuated over time as some county, state, and federal land assets are acquired or sold. For example, the 1936 USDA-FIA inventory reported 12,542,000 acres of private and 5,230,200 acres of public forest land (Flanary et al 2016), although 4,320,400 of these total acres were non-productive, or brush/grassland.

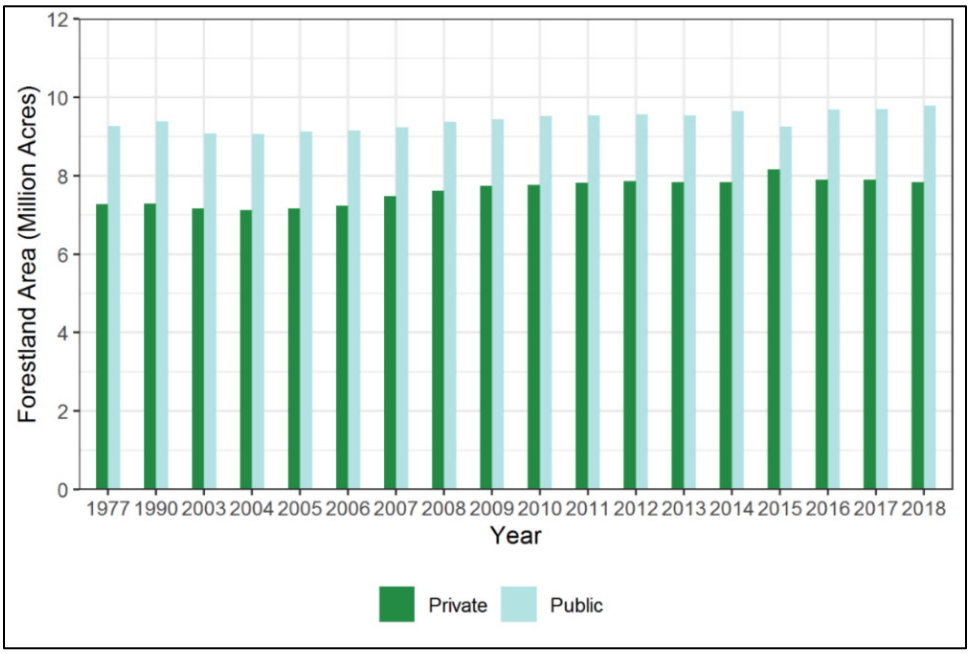

Figure 7 – Public and Private Administered Forest Land Acres in Minnesota from 1977-2018.

State and private administrators make up the majority of forest land managers in Minnesota, followed by aggregated county and aggregated federal ownerships which is mostly US Forest Service (Figure 8). Again, the increase in state administered lands between 2015 and 2016 is likely a data anomaly.

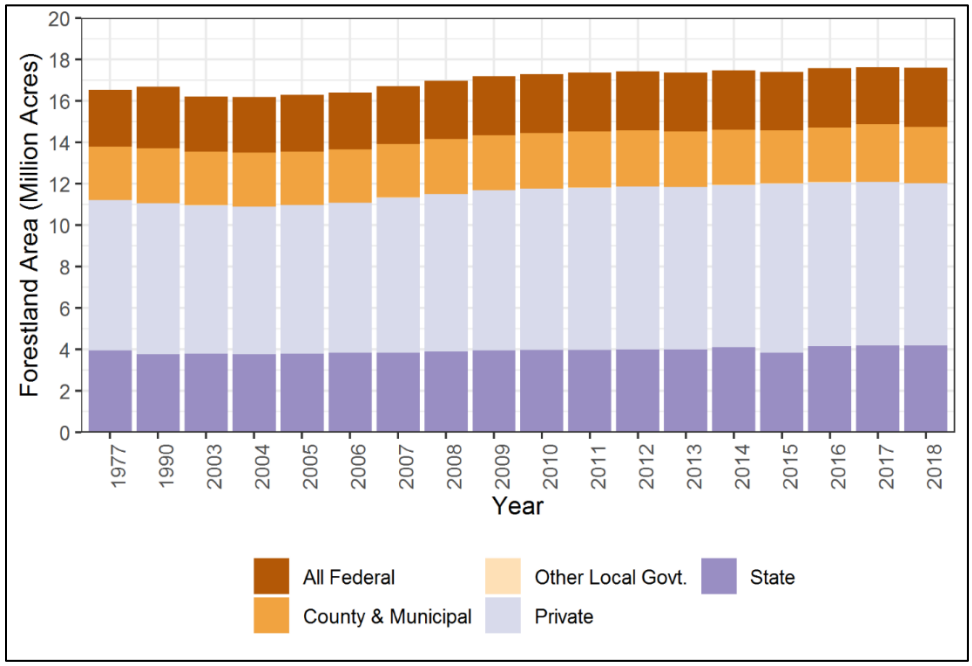

Figure 8 – Minnesota Forest Land Acres by Ownership in Minnesota. Source: FIA 2018, USFS Northern Research Station.

While the publicly available FIA data do not differentiate types of private landowners, the 2013 National Woodland Ownership Survey (NWOS) estimates that approximately 5.8 million acres of private forest land was held by individual private land owners. The 2018 FIA estimates of total private forest were approximately 7.9 million acres, thus allowing estimates that there are approximately 2 million acres of other private ownerships including corporate forest ownership, such as timber investment management organizations (TIMOs) and real estate investment trusts (REITs), in Minnesota.

In 1982, an estimated 131,000 owners held 5.1 million acres of private forest land (Carpenter 1986). By 2013, the estimated number of all private landowners owning forest land had increased to 213,000. These private land owners held approximately 7.9 million acres (44 percent) of Minnesota's forest land (Butler 2016). Private ownership of forest land has been increasing due to the reforestation of lands primarily in the southern and western portions of the state. These lands, distributed among both individuals and organizations, face increasing development pressures at the same time as they are being transferred from one generation to the next. According to NWOS, new forest landowners often display differing management goals from their predecessors, which may or may not conform to traditional forest management. Fragmentation of forest lands for development purposes can impede timber and wildlife management options, increase the risk of wildfires (called the wildland urban interface or WUI), restrict public recreational access, and reduce the habitat value of forest lands.

2008 trend data indicated that as more landowners were buying up forest lands, parcel sizes were decreasing, but there is no updated data available in 2020 to verify this assertion. However, observational information suggests that current management objectives are changing to reflect less timber harvest on these lands. Private forest management objectives such as wildlife habitat retention or recreation may be increasing, but further long-term data are needed to confirm these observations for private forest management (PFM).

1.3 Population and Acres of Forest per Person

Minnesota's population is on track to increase by 1 million people by 2070 (Minnesota State Demographic Center 2019). With population growth and associated development pressures on forest lands, there is increasing potential for forest loss and fragmentation. Altered land uses can affect timber production, ecosystem and habitat integrity, as well as recreational opportunities. A major projected trend in Minnesota is the conversion of forest lands around urban centers to other uses as a result of projected population growth, impacting the acres of forest available per person (Figure 9). From 1982 to 1997, urban land expanded by 27 percent. Until the 2007-08 downturn in the national economy, the average acres lost to urban development was approximately 1500 acres annually, mostly around the growing metropolitan areas of Minneapolis-St. Paul. Information statistics on acreage loss to urban development since 2008, are not readily available, and are considered a data gap that needs further exploration.

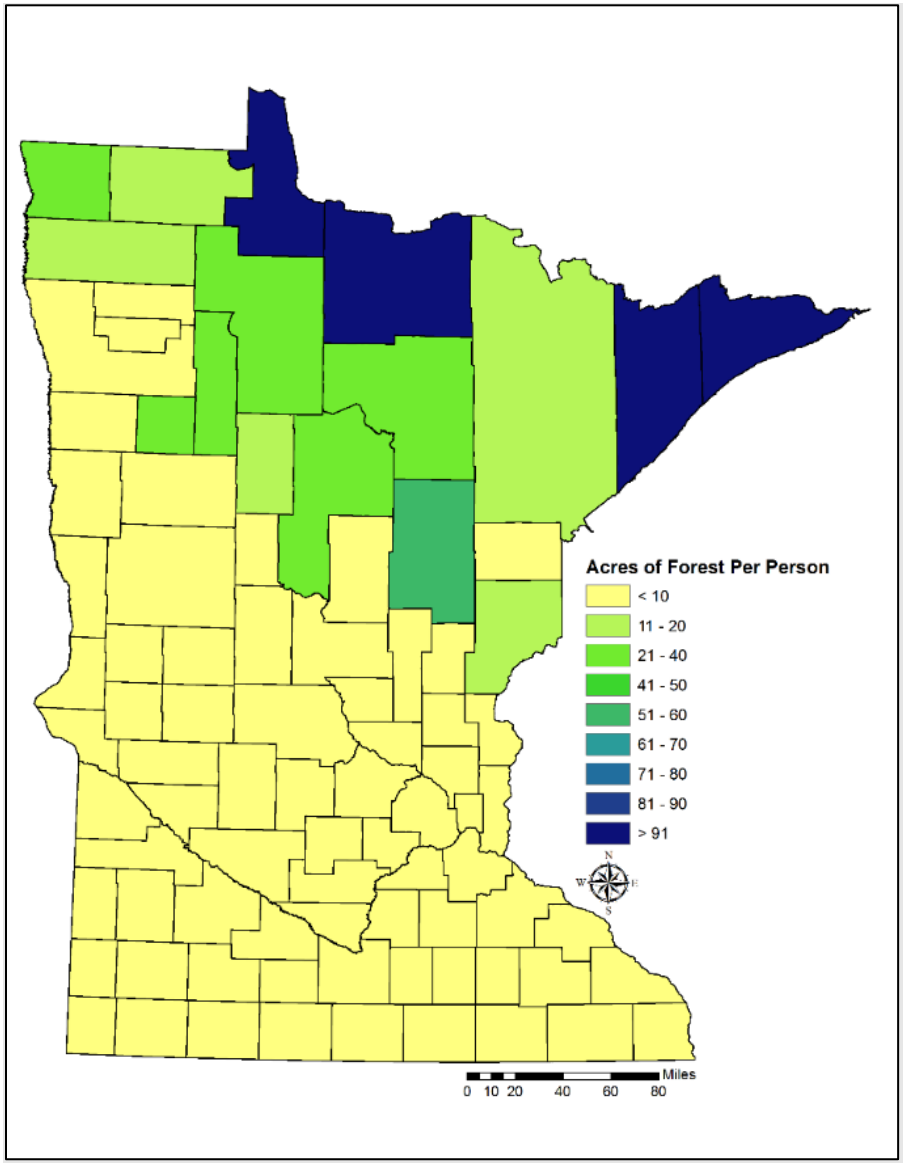

Figure 9 – Acres of Forest Per Person in Minnesota. Source: DNR.

1.4 Protected Forest Land

As of 2018, timberlands make up the majority of Minnesota's forest land (Figure 10). Of the total forest land, FIA distinguishes it into four classes. "Other forest land" refers to forest that is unreserved but also unproductive; e.g., does not grow at 20 cubic feet per acre per year and is not in a designated park or under formal protection. "Reserved other forest land" refers to lands that are reserved but are unproductive. "Reserved productive forest land" refers to lands that meet the definition of productive but are reserved. "Timberland" refers to lands that are unreserved and productive. In Minnesota, timber companies have owned and managed forest lands for over a century and have been committed to stewardship of those lands. However, shifting economies of the forest products industry over the past several years, coupled with escalating real estate prices, have forced unprecedented changes in forest land ownership and priorities for both forest management and protection. In recent years, large-and small-scale forest land sales have altered the protected forest land outlook for the state.

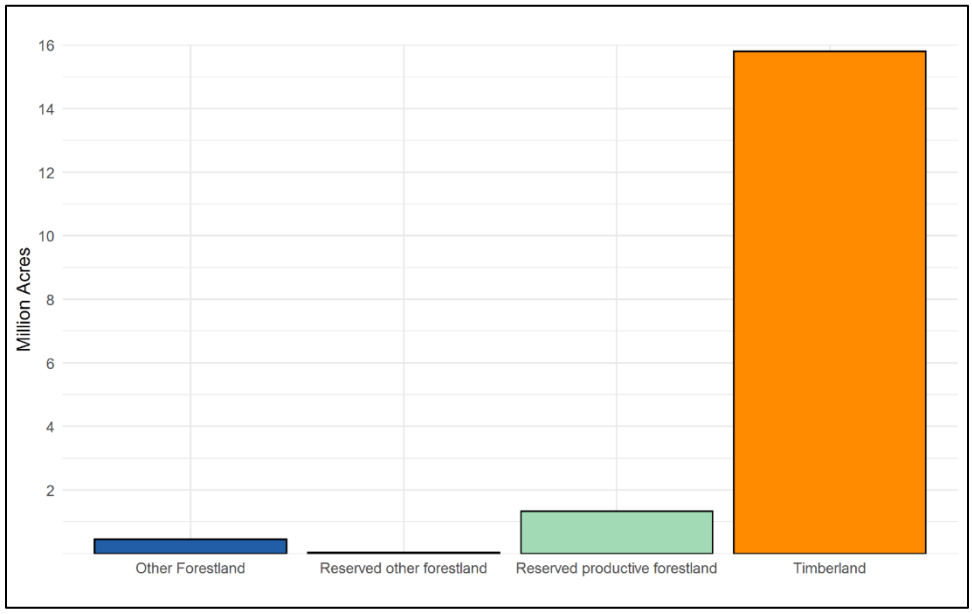

Figure 10 – FIA Forest Land Use Classes; source: 2018 FIA USFS Northern Research Station.

Forest Legacy and Minnesota Forests for the Future Programs

The Forest Legacy and Minnesota Forests for the Future (MFF) Programs are conservation programs administered by the DNR Forestry Division. Their purpose is to keep forests forested throughout Minnesota. Methods include fee acquisition and permanent or long-term conservation easements on private lands. Working forest conservation easements play an important role in carbon sequestration by protecting forest land and preventing the conversion of forest land to other land uses. Placing working forest conservation easements on forest land guarantees that the land will continue to be managed in a productive and sustainable way. This will provide ecosystem services in perpetuity such as clean water, clean air, wildlife habitat, recreational opportunities, and carbon sequestration.

The state legislature established Minnesota Forests for the Future program in 2008 (*Minnesota Statutes,* chapter 84.66) to identify and protect private working forests for their timber, economic, recreational, and habitat values through conservation easements, fee title acquisition, and other tools.

The Forest Legacy Program Assessment of Need (AON) was completely revised in 2017 (Figure 11). The 2017 AON identified priority landscapes (i.e., Forest Legacy Boundaries) as a detailed roadmap for the program. The AON was submitted to the US Forest Service in 2017 and received federal approval in August 2019. The complete report and US Forest Service approval letter are included in Part 2 Strategies-Appendix A and B of this Minnesota 2020 SFAP.

In Minnesota, approximately 1 million acres of publically owned federal, state, and county forest lands are expected to be protected from conversion to non-forest via long-term or permanent conservation easements. Lands under conservation easements must remain as forests. Tribal lands in Minnesota are administered separately from other entities, as Tribes are sovereign nations.

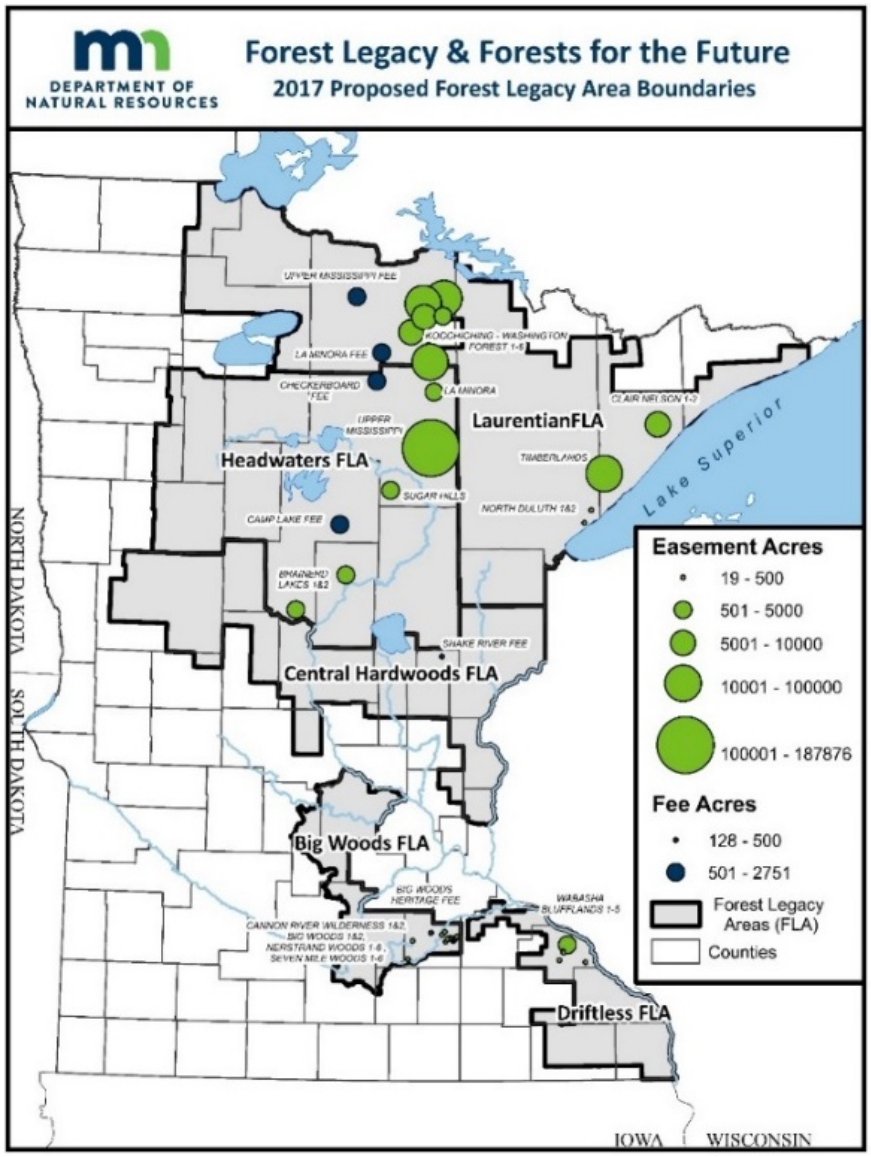

Figure 11 – USFS Approved Minnesota Forest Legacy Area Boundaries, 2019.

Public recreation opportunities are another important component of the Forest Legacy Program AON and have been identified through Minnesota Forests for the Future (MFF) Recreation Value GIS analysis. Priority sites should preserve

hunting and fishing access and have the potential to enhance or maintain existing recreational opportunities through linkages or additional trail development. Priority sites should also contain forests that help maintain habitat for fish on high-quality lakes.

As a component of the Forest Legacy AON, scenic resources were also identified through MFF Recreation Value GIS analysis for priority site selections. The criteria for scenic resources includes whether a site is located within a view-shed of a formally designated state or federal scenic feature or area, such as a trail, river or scenic byway. The Minnesota Department of Transportation (MN DOT) administers the Scenic Byways program and an interactive map of all scenic byways in the state is accessible through that state agency. The components identified in the AON analyses also include locally important and easily accessible scenic resources as identified in a local or regional plan where development would significantly alter that appearance of the landscape. Examples include Minnesota's Wild and Scenic Rivers and the North Country National Scenic Trail.

Reserved Lands

Reserved forest land is land reserved from harvest by policy or law, including designated forested wilderness areas like the US Forest Service Boundary Waters Canoe Area (BWCA), old growth reserves, conservation easements, and others. Reserved lands are a subset of the protected forest lands biome in Minnesota (Figure 12). The largest reserved land tract in the state is the federal Boundary Waters Canoe Area (BWCA) wilderness. These 960,000 acres of mostly coniferous forest and water resources are under the jurisdiction of the US Forest Service and Superior National Forest. Voyageurs National Park is the second largest tract of reserved land in Minnesota and is under the federal jurisdiction of the National Park Service (NPS), which manages a total of five parks or monuments in Minnesota. Voyageurs National Park contains 218,000 acres of reserved coniferous forest and water, which straddles the international border between Minnesota and Ontario, Canada.

Approximately seven percent of state-owned forest lands are reserved, and therefore not managed for industrial or commercial timber production, due to a variety of laws and land protection programs. State-owned reserved lands include those acres within the boundaries of state parks, state natural areas, and DNR-designated old growth forest stands. In Minnesota, there are 333,072 acres of forest land currently reserved on state lands. This includes 53,000 acres of reserved lands on the National Guard site of Camp Ripley. When acres within the BWCA and Camp Ripley are excluded, 283,000 acres of federal forest land are currently reserved. This number is derived from the state's forest inventory data.

Additional state-owned forest acres are set aside from intensive timber management for a variety of reasons, often related to forest certification, merchantability, maintenance of high conservation value forest, and new old-growth designation as the state's understanding of this resource evolves. It is important to note that such reserves balance forest health, biodiversity, and wildlife considerations with industry capacity and long-term age-structure management.

About 34 percent of the forest land owned by the federal government is reserved. In comparison, seven percent of state-owned forest lands is officially reserved, but a greater acreage (980,000 acres) is withheld from intensive management; two percent of county and municipal forest land is reserved. Overall, approximately seven percent of the state's total forest land of 17,621,098 acres is reserved from timber harvest, which equates to 1,372,047 acres. Refer to Table 2 below.

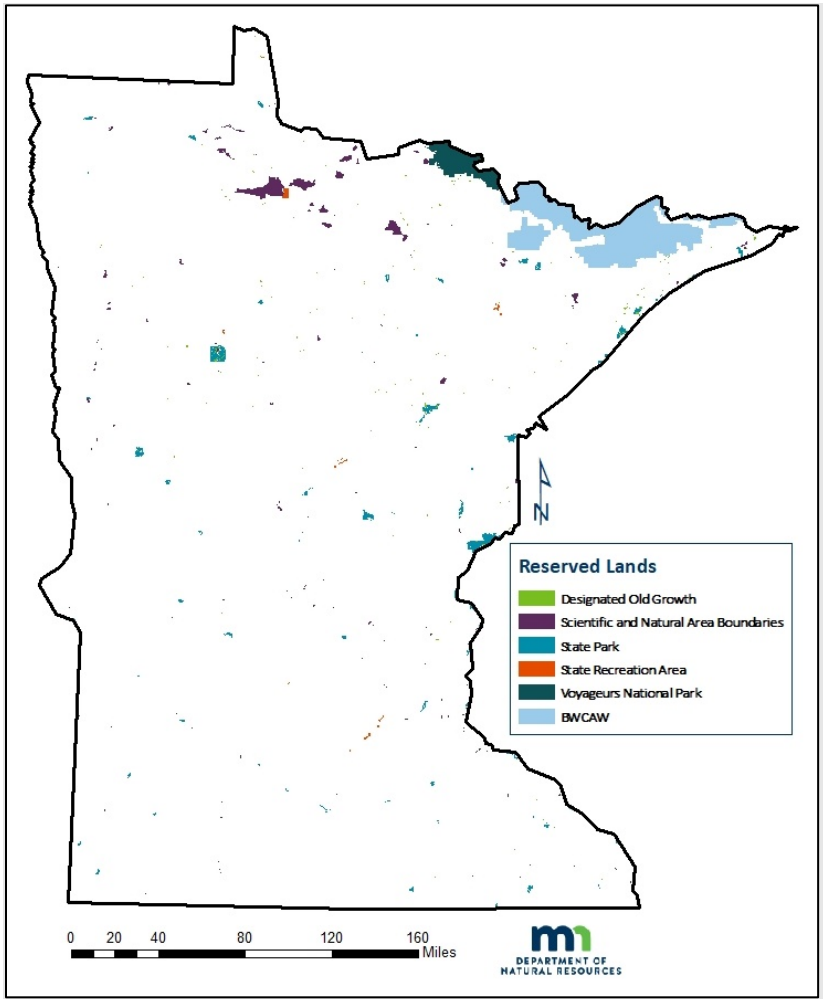

Figure 12 – Reserved Lands in Minnesota.

Owner	Total Reserved Acres by Statute or Policy	Percentage Forest Land by Ownership
Total	1,372,047	7
Federal	981,726	34
State	333,072	7
County and Municipal	68,637	2

Table 2 – Reserved Acres by Ownership in Minnesota - FIA 2018.

Old Growth Forests

Old growth forests are rare and unique ecological communities in Minnesota. They are defined by age, structural characteristics, and relative lack of human disturbance. These forests are essentially free from catastrophic disturbances and contain trees that are generally over 120 years of age. Historic records and photos indicate that the harvest of these forest ecosystems delivered immense wealth to individuals, industry, and government that accelerated the development of the state's early economy.

Today on lands administered by the DNR, old growth forests are protected from harvest and represent new values in modern sustainable forest management. Minnesota's remaining old growth forests are important for their ecological, scientific, educational, aesthetic, and spiritual values. Minnesota is home to several types of old growth forests that provide important habitats for native plants and animals and a glimpse into what is biologically possible for tree growth. The DNR protects the highest quality remaining old growth forests to preserve and perpetuate these ecosystems and their multiple values. Some old growth forests in Minnesota are easily accessible and located in state forests, state parks, and scientific and natural areas (SNAs). Other old growth forests are under private ownership or owned by non-governmental organizations (NGOs) such as The Nature Conservancy (TNC). To learn more about the ecological importance, characteristics, and management of Minnesota's old growth forests, visit the DNR's old growth webpage.

1.5 Urban and Community Forestry

Urban and community forestry is the establishment, conservation, protection, and maintenance of trees and forest ecosystems in areas of human development for economic, social, and ecological benefits. Community forests are unique ecosystems that provide vital environmental services such as mitigating stormwater and cleaning and filtering city air. Maintaining shade in communities reduces energy consumption and the impacts of heat island effects, mitigating the effects of climate change. Trees in community forests strengthen social cohesion and add economic value to homes and businesses. Climate change and the increasing threats of invasive species require continued research and education for both public and private practitioners to safely continue best management practices and maintain trees for environmental services.

Local Urban and Community Forestry Programs

Minnesota DNR's Urban and Community Forestry (U&CF) program works cooperatively with communities to encourage active forest management. In compliance with US Forest Service, the DNR actively tracks community forest program development in over 450 Minnesota communities. From 2010 to 2019 there has been a net increase in the number of communities achieving each of the four components tracked by the US Forest Service. These four components include: community forest management plans; professional staff; tree ordinances; and tree advocacy and advisory groups. The US Forest Service considers a community with one to three of these components to be a forest program 'Developing Community', and a community with all four components is a 'Managing Community' (Figure 13). In 2018, over 4 million Minnesotans lived in communities with developing or managed community forest programs.

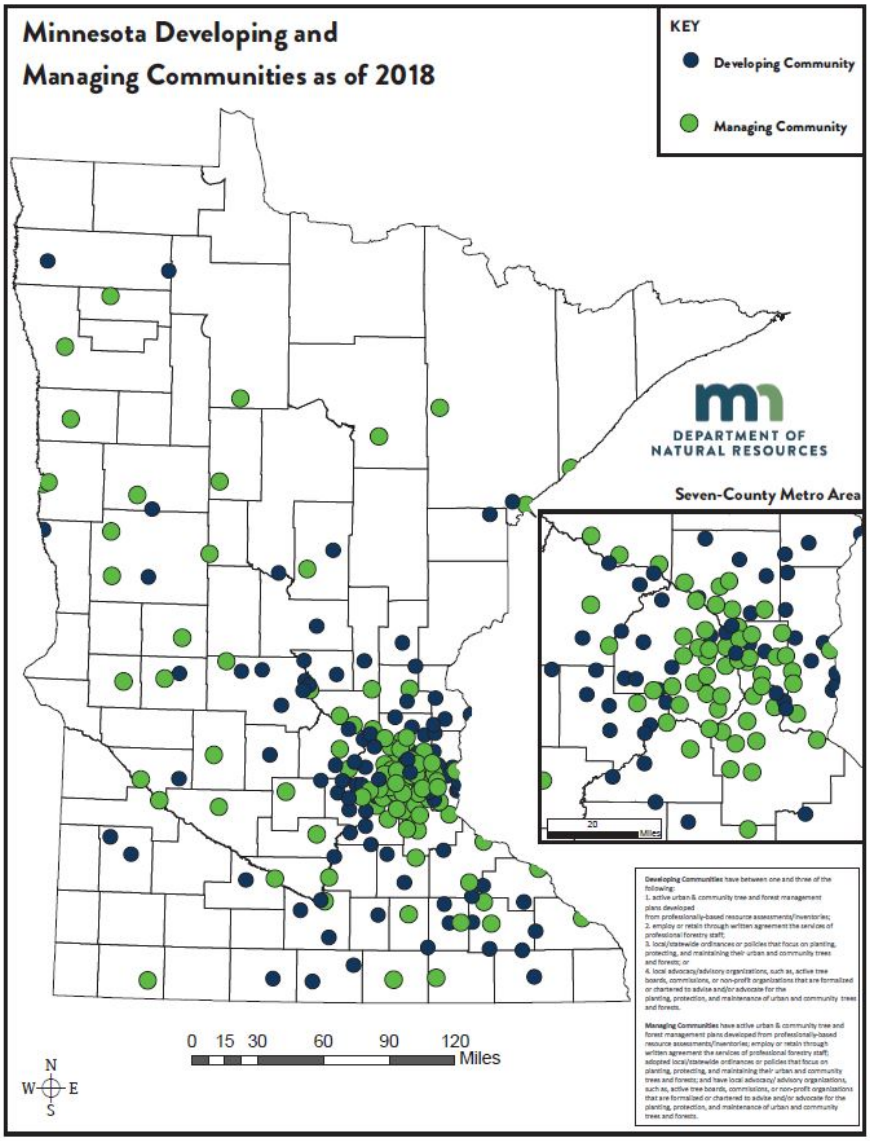

Figure 13 – Minnesota Community Forest Management "Developing" and "Managing" Communities as of 2018.

Minnesota community forest management plans have tripled from 2010 to 2019 (Figure 14). The increased awareness by the public, aided by Minnesota Tree Inspectors, to the need for urban tree management came after the invasive emerald ash borer (EAB) was discovered in the state in 2009. Minnesota Tree Inspectors, who make up a significant portion of community-based professional forestry staff, are trained on all aspects of tree health from planting, maintenance (water, nutrients, pruning etc.), and identification/diagnostics of tree insects and diseases. In partnership with the University of Minnesota, the state trains and certifies more than 850 Tree Inspectors each year, who serve nearly 200 Minnesota communities (Figure 15).

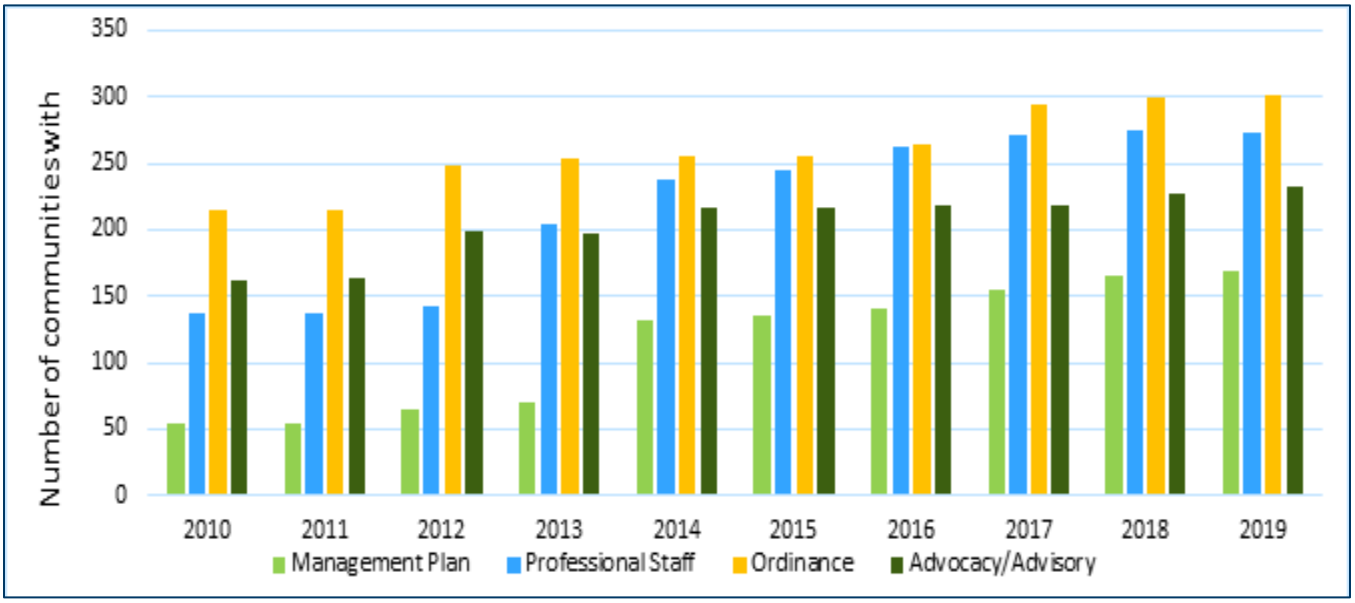

Figure 14 – Number of Minnesota Communities with Community Forestry Management Plans, Professional Staff, Tree Ordinances, and Advocacy/Advisory Groups from - 2010 to 2019. UCF data source: USDA Forest Service Community Accomplishment Reporting System (CARS).

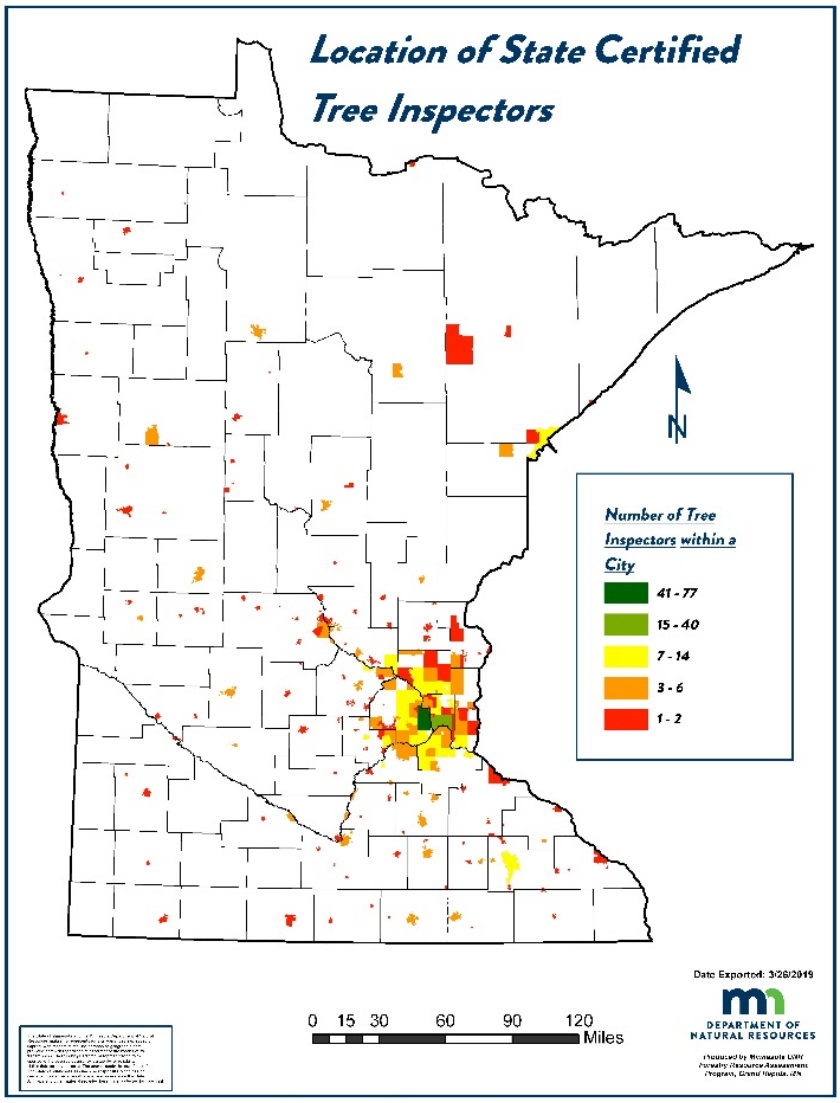

Figure 15 – Location and Number of 2018 Minnesota Certified Tree Inspectors.

Community Forest Characteristics, Forest Health Threats, and Community Characteristics

Millions of community trees in Minnesota are susceptible to insects and diseases including EAB, Dutch elm, and oak wilt. Minnesota anticipates additional threats, such as Asian long-horned beetle and climate change, to increase stress in Minnesota's community trees in the coming years.

Discovered in Minnesota in 2009, EAB instigated a statewide community forest tree survey in 2010. As of 2010, Minnesota communities had approximately 2.65 million ash in maintained areas, which is, approximately one in every five trees. (Figure 16). EAB kills 99.9 percent of all ash trees that have not been treated with an insecticide. Minnesota anticipates a number of environmental and human health impacts from the loss of ash. For example, Minnesota estimates losing 2.96 billion gallons for stormwater mitigation capacity with the loss of ash, thereby increasing salt and sediment into already struggling hydrologic systems *(data source: DNR 2010 Rapid Assessment Data and iTree)*.

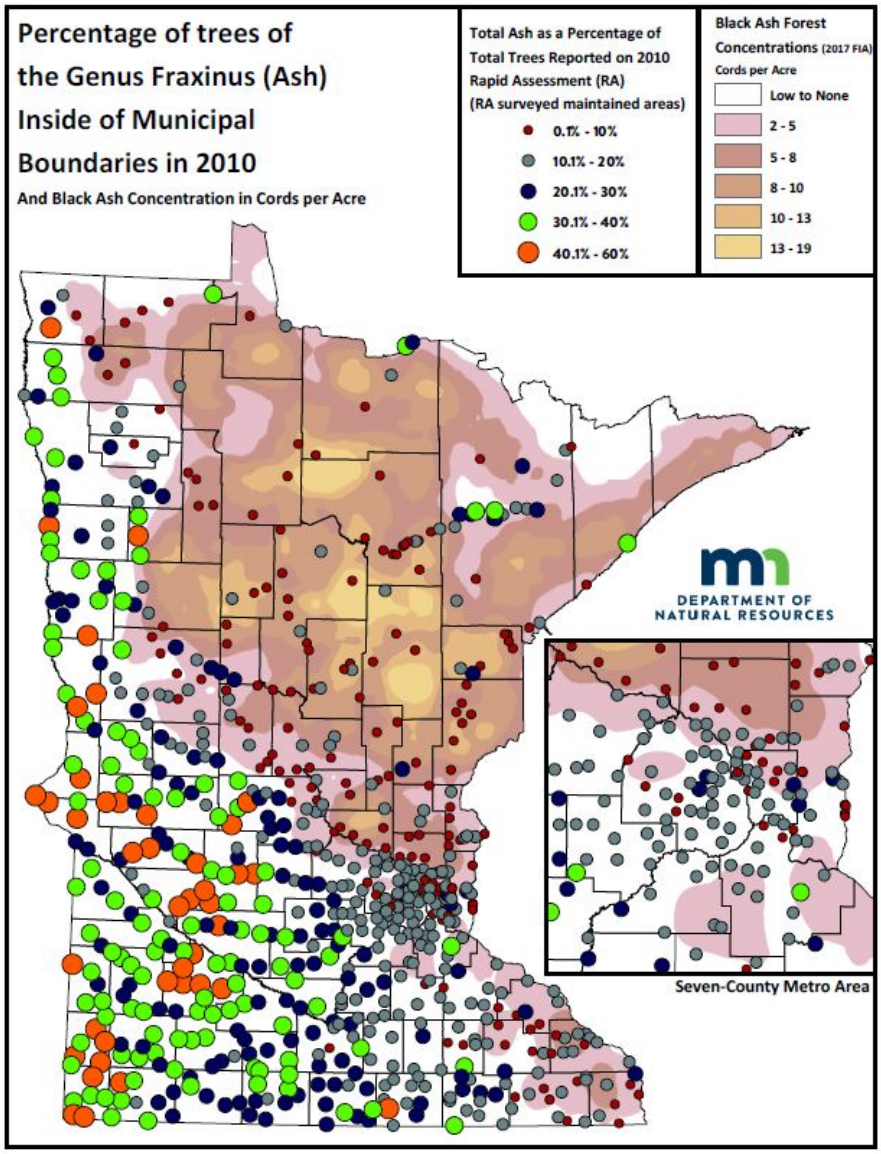

Figure 16 – Percentage of Trees of the Genus Fraxinus (ash) Inside of Municipal Boundaries in 2010 and Black Ash Concentrations in Cords Per Acre from 2017 Forest Inventory Analysis data (FIA).

Minnesota has seen an increase in tree inventories with the increase of submitted management plans; however, many communities do not have the capacity or means to update their community's tree survey or fully implement EAB management plans without additional technical or financial assistance. Utilizing US Forest Service funds, the DNR hosted a competitive grant in 2018 to assist communities in managing ash for EAB (Figure 17). More than 100 communities applied for this grant, with over 60 percent of applicants requesting the maximum dollar amount of $30,000. Ongoing financial and technical assistance is a critical need for communities in the management of EAB.

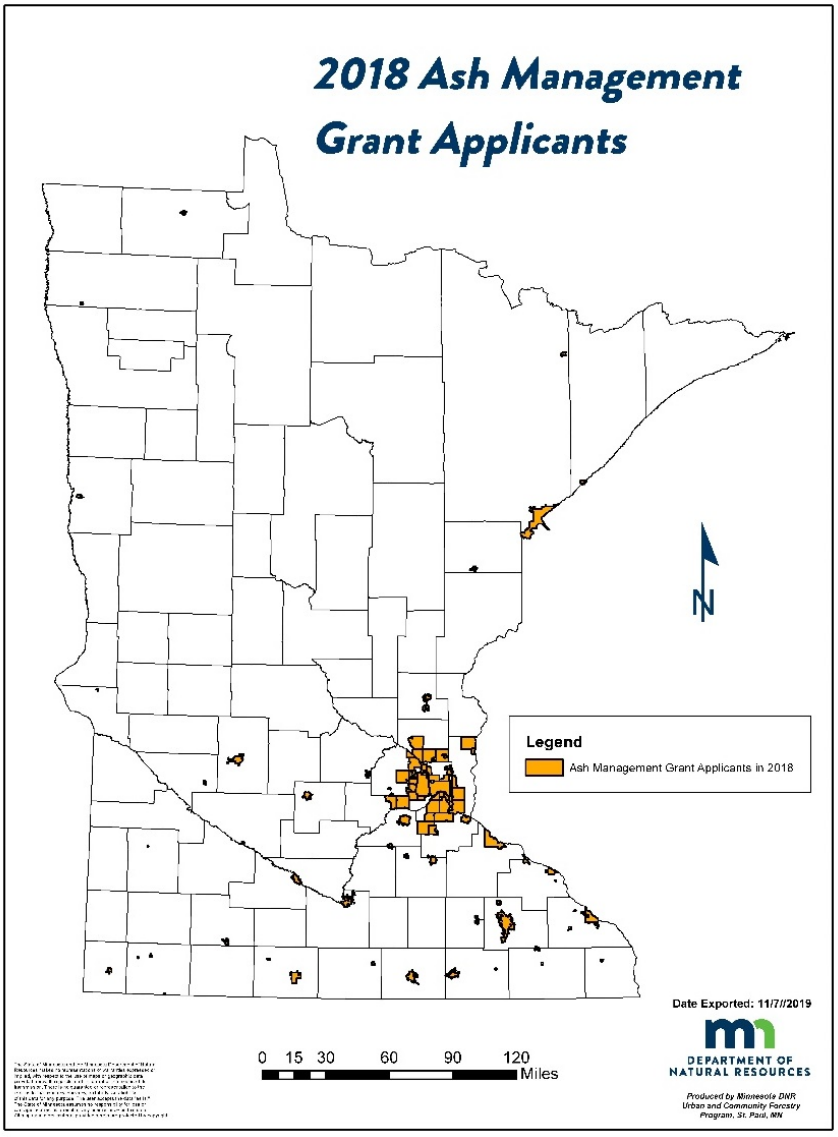

Figure 17 – Community Ash Management Grant Applicants in 2018.

According to the US Forest Service and the Minnesota Department of Health (MDH), minorities and people with lower income often live in places that have less tree canopy cover than white and affluent communities. In Minnesota, people of Color (those who identify as a race other than White alone, and/or those who are Hispanic or Latina) make up 20 percent of the total population. Non-Hispanic White Minnesotans represent the remaining 80 percent of the statewide population *(source: 2018 Population Estimates, U.S. Census Bureau)*. Minnesota's overall poverty rate in 2017 was 10 percent. Poverty rates were highest for those who are Black (32 percent), American Indian (31 percent) and Hispanic (21 percent), three to four times higher than the rates of Non-Hispanic White Minnesotans (7.5 percent) *(source: 2017 American Community Survey, U.S. Census Bureau)*. Populations of Color are distributed unevenly across the state, and are more likely to live in metro areas than rural areas. Providing services and tree canopy equitably to Minnesotans is a priority for the DNR Urban and Community Forestry program.

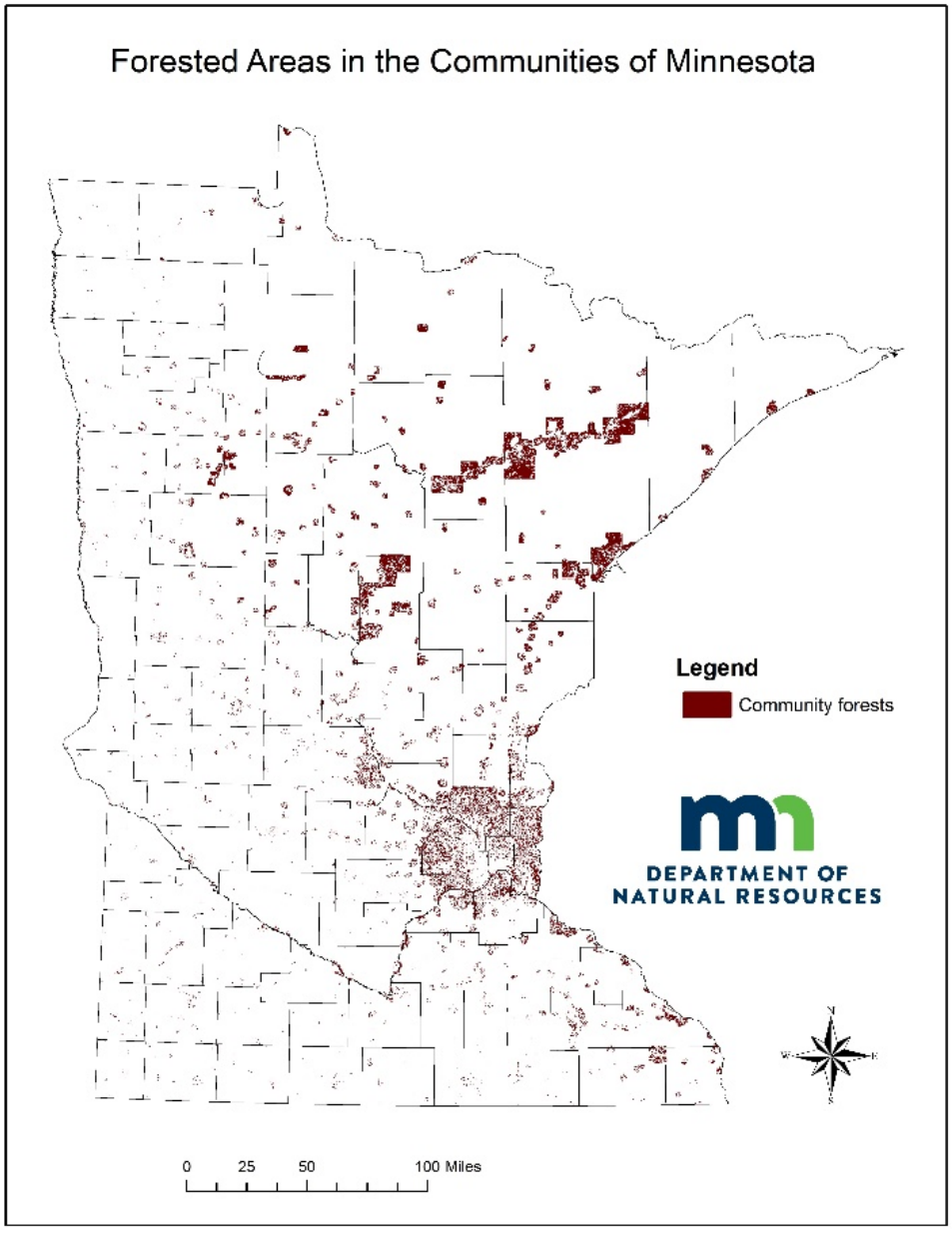

Figure 18 – Communities with Forest Land Cover, According to the 2013 Map Produced by the University of Minnesota Remote Sensing and Geospatial Analyses Lab.

In Minnesota, many communities rely on the preservation and maintenance of public and private forest lands to protect community drinking water supplies (Figure 18). Protection of forest land cover helps communities maintain a safe, clean drinking water supply. Forest land planning and protection is also needed at the watershed scale to help protect community drinking water supplies. Many communities rely on surface water sources of drinking water where forest land is the dominant cover type. For example, the Twin Cities metropolitan area relies on the protection and preservation of forest land in the Upper Mississippi watershed to help protect and provide a clean and safe source of drinking water to a large network of communities (See also Figure 56 and Figure 57). Robust research and analyses on the connection between forest land cover and land use management at the parcel-to-landscape scale, and the effectiveness of stewardship programs on water quality and quantity, are a data gap.

Indicator 2. Forest Type, Size Class, Age Class, and Successional Stage

2.1 Forest Type Groups and Size Classes

The FIA program classifies the forest by types detailed in Eyre (1980), and uses an algorithm to determine the type. The type algorithm is detailed on the FIA website. "Size class" refers to diameter condition. The thresholds for each category are: small, less than 5 inches in diameter; medium, 5 to 9 inches for softwoods, and 5 to 11 inches for hardwood trees. Eleven inches and up is considered large-diameter for hardwoods and 9 inches and up is considered large-diameter for softwood species (Figure 19).

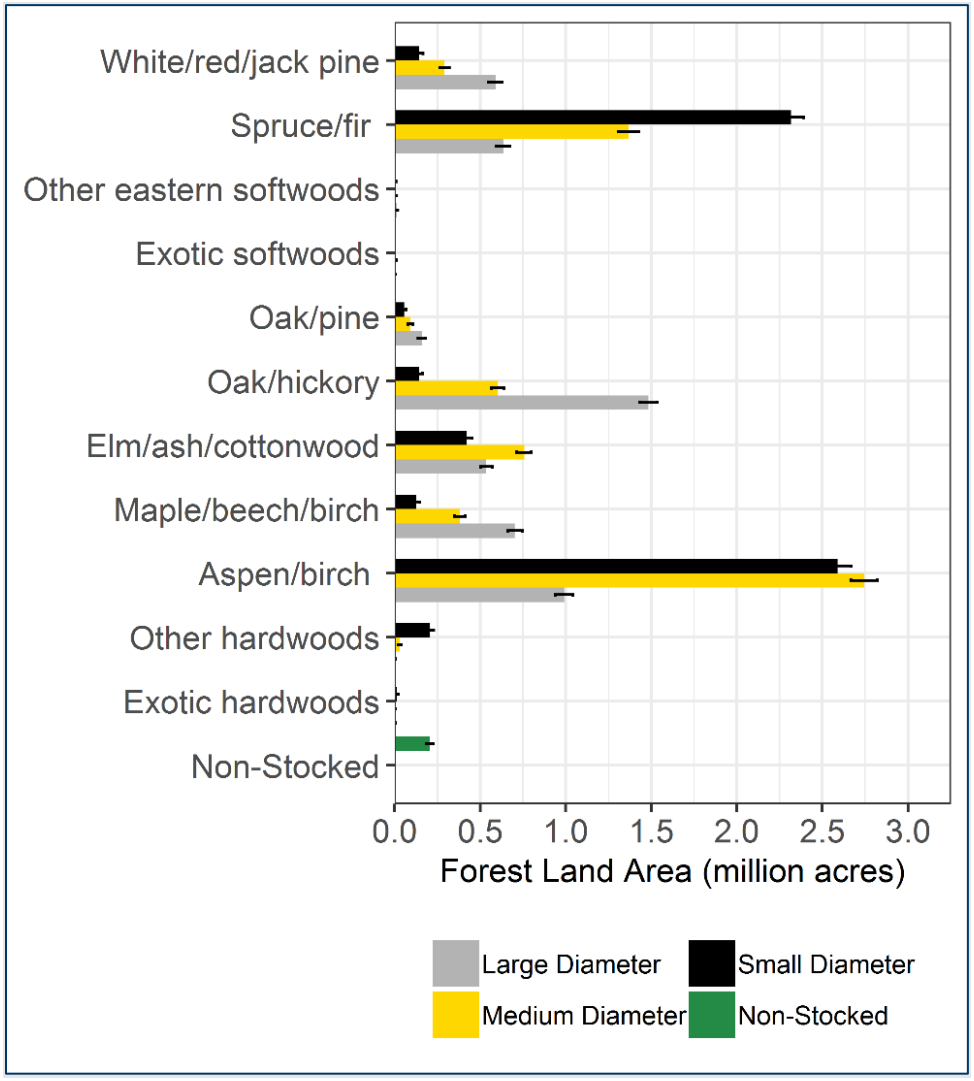

Figure 19 – Forest Land Area by Forest Type Group and Stand Size Class in Minnesota. Source: DNR.

2.2 Age Group

As detailed previously, forests are classified by types described in Eyre 1980, and determined using an algorithm. FIA breaks the forest into a number of age classes, which can be aggregated to larger age-class groups. Figure 20 shows forest types and associated acres by 50-year age classes. Examples showing age distributions for aspen-birch and spruce-fir are shown in Figure 21 and Figure 22. These detailed age-class distributions are helpful in planning for future supplies of each forest type in conditions appropriate for wildlife habitat, timber, recreational opportunities, ecological function, hydrologic regulation, and resiliency and response to climate change.

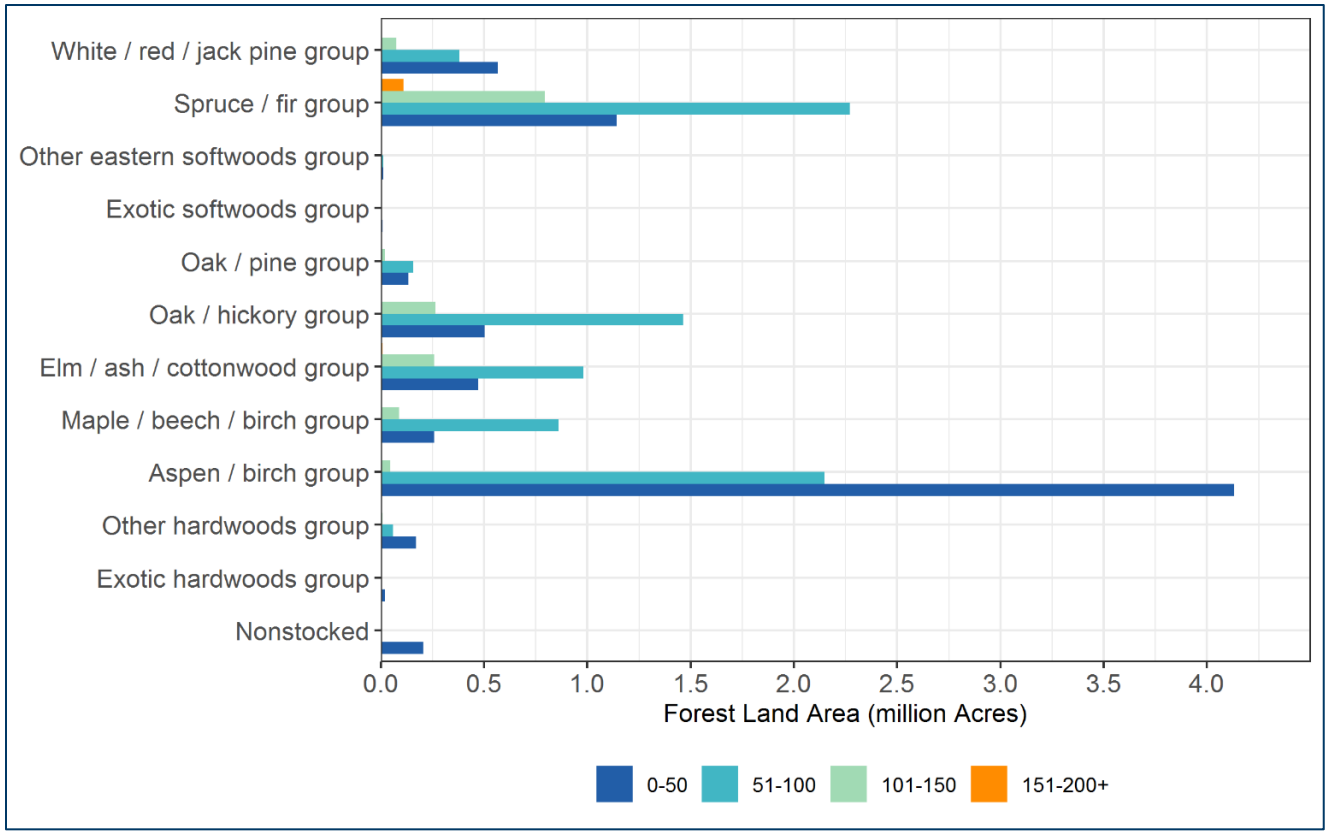

Figure 20 – 50-year Age Group by Forest Type in Minnesota. Source: DNR.

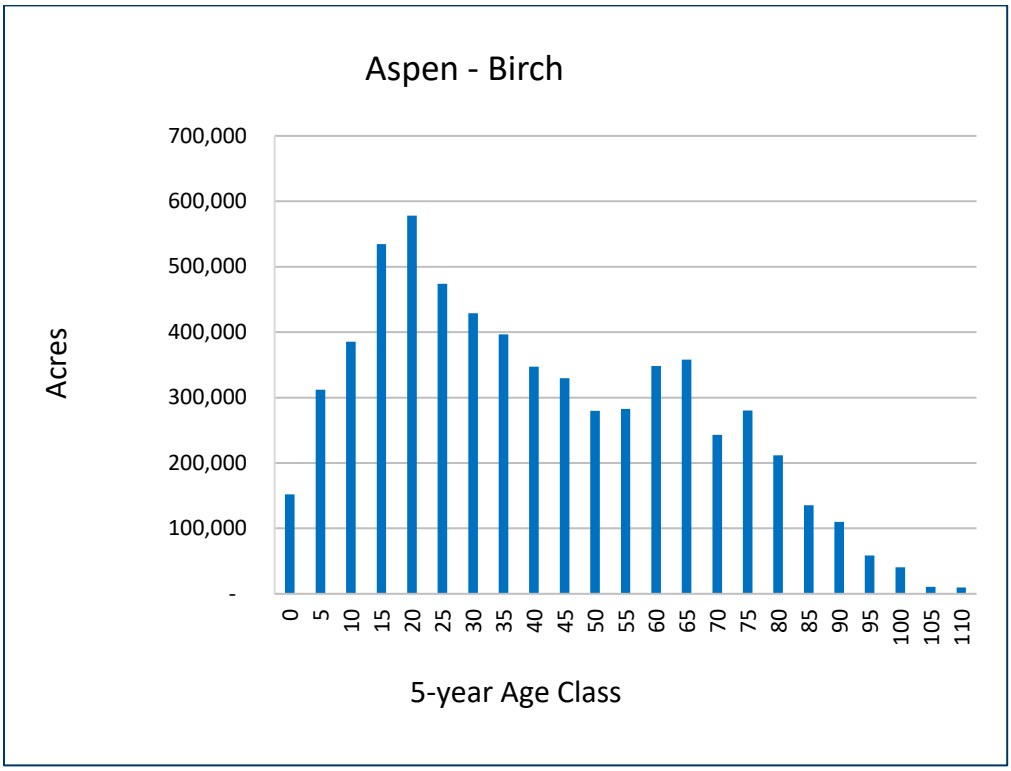

Figure 21 – 5-year Age-class Distribution for Aspen-Birch. Source: DNR.

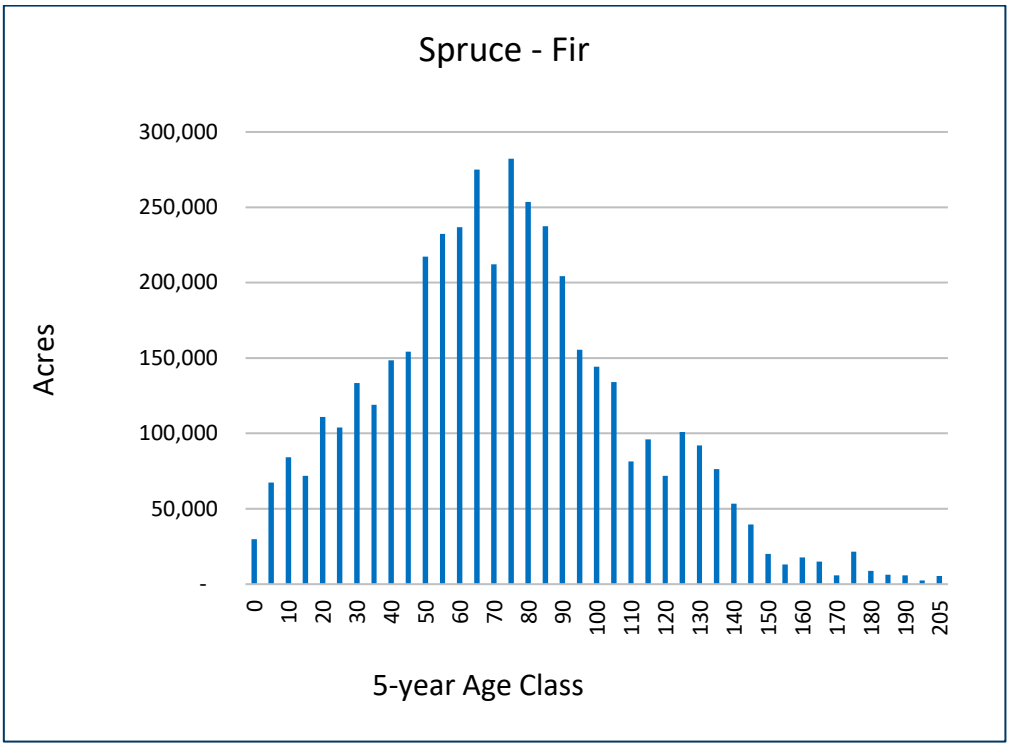

Figure 22 – 5-year Age-class Distribution for Spruce-Fir. Source: DNR.

Indicator 3. Extent of Forest Land Conversion, Fragmentation, and Parcelization

3.1 Fragmentation

Forest fragmentation occurs when a large, contiguous forest land mass is divided into smaller tracts through sale and subdivision; road construction; or clearing of forests for agriculture, housing, or other commercial developments. This often creates small, compromised forest pockets, which are inter-dispersed with non-forest land activities. Fragmentation can also occur as a result of timber harvesting or natural processes such as fire, floods or wind blowdowns.

Fragmentation of forest lands is a major concern for the state and the management of natural resources. Over the past several years, large contiguous industrial forest land tracts have been sold, sub-divided, reduced in size, or isolated from each other. Although the state maintains a robust amount of forest lands, many are private tracts, now under pressure for subdivision or sale, due to the last 10 years of changing industry priorities and market conditions.

One driver of fragmentation is catastrophic natural disturbances and events, which can change the composition and cover canopy of an intact forest system. An example would be the 1999 BWCA blowdown that caused major loss of interior forest in a large part of the border lakes area of the state.

Fragmentation can inhibit the natural migration of many plant and animal species, which is a major concern for climate change adaptation, as there may be a decrease in both biodiversity and genetic diversity of species. Conversely, fragmentation contributes to the spread of invasive species. The state is monitoring the effect of invasive species and climate change on the potential for forest fragmentation, specifically in species such as ash and tamarack.

The following map (Figure 23) describes one method of measuring recent landscape patterns by tracking changes in the state's interior forests (Riemann, 2019). As shown, the only remaining large tracts of intact forest in Minnesota are concentrated in the northern portions of the state, where population is small and forest tracts have been traditionally held by a few large industrial landowners.

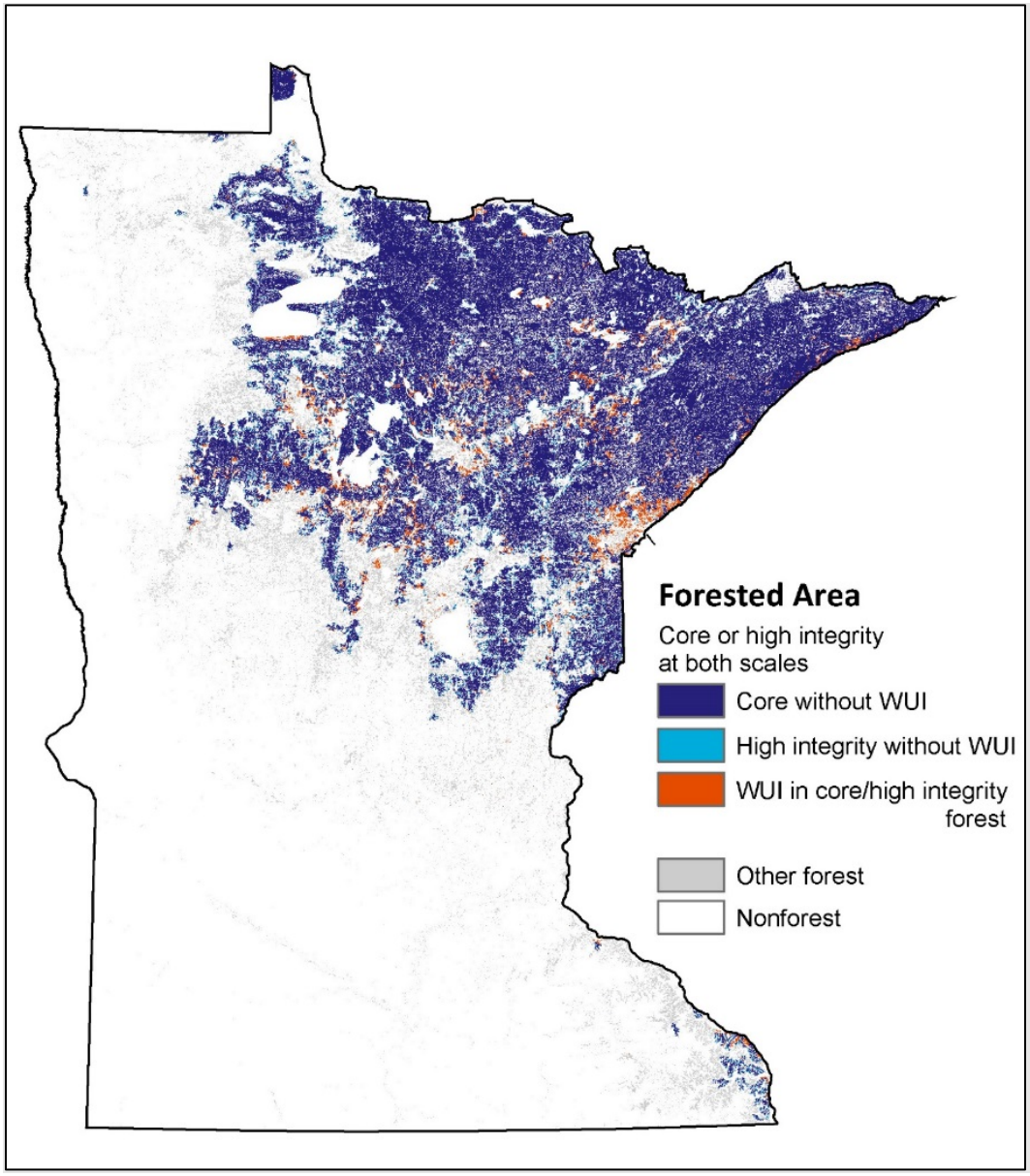

Figure 23 – Wildland Urban Interface (WUI) map as of 2010. Source: FIA.

3.2 Net Change in Forest Land and Additions to and Conversions from Forest Land

Minnesota had approximately 31.6 million acres of forest land prior to European settlement (Marschner 1930). Formal forest inventories began in the 1930s and estimated forest land at 19.6 million acres. Forest land area continued to decline up until the 2000s. Minnesota has gained forest in recent decades. From approximately 2003 to the present, forest land has increased by 1.5 million acres, with 333,443 of those acres being added since 2010. On net, Minnesota has lost forest land compared to historic levels, but has gained forest in recent decades (Figure 24). Some of this increase is attributable to improvements in remote sensing technologies rather than forest land restoration; some is also attributable to land use changes (Miles and Vanderschaaf, 2012).

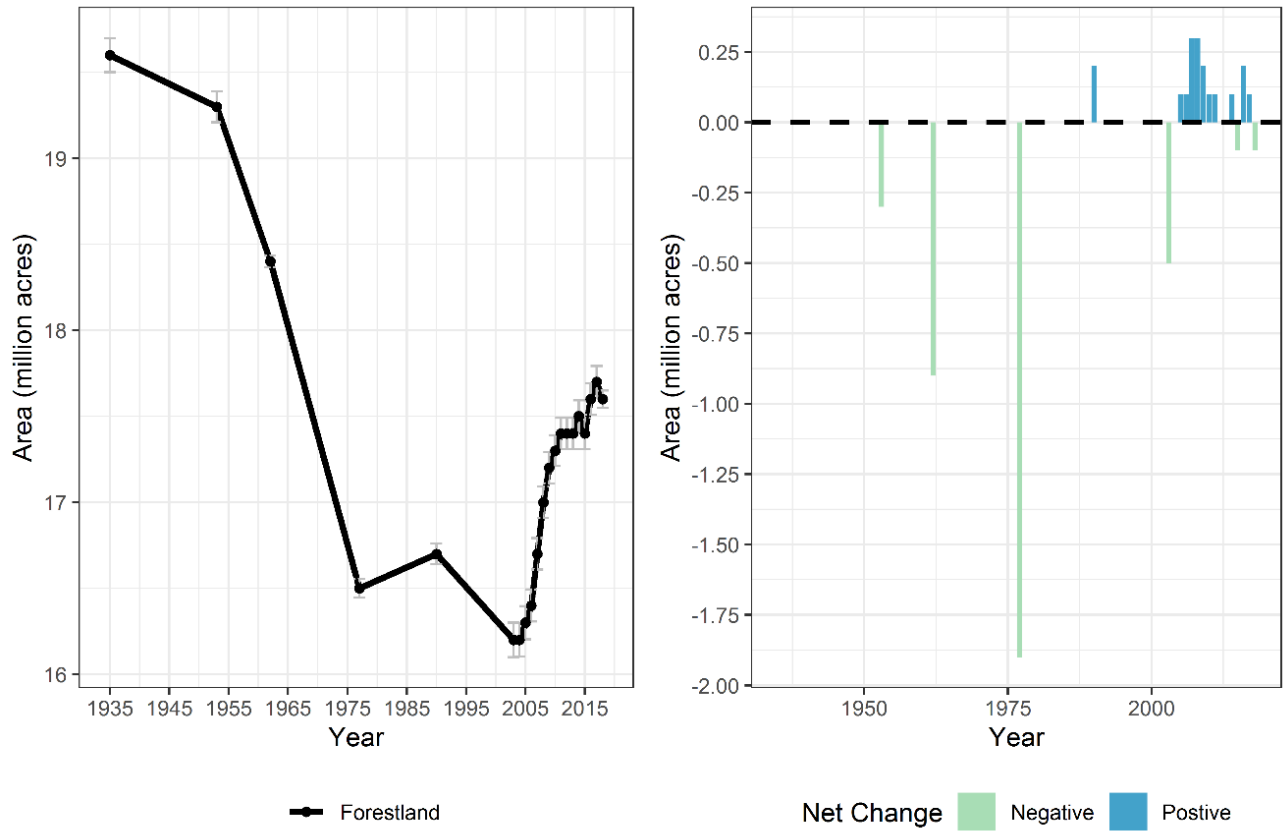

Figure 24 – Trend of Forest Land Since 1935 in Minnesota (left) and Net Change in Forest Land from 1935 to Present. Source FIA program; USFS Northern Research Station 2018.

3.3 Additions to and Conversions from Forest Land

The sale of large timber company holdings in Minnesota continues to mirror the national trend. Forest land ownership in Minnesota has changed significantly in recent years, especially around the 2008 recession. In northern Minnesota, both timber and mining companies have divested themselves of thousands of acres of forest lands to investors, who value these lands not for natural resources alone, but for their potential to provide a return on investments through real estate development. These lands now intermingle with state and county forest lands.

According to the 2011 report Maintaining the Forest land Base in Minnesota: Forest land Parcelization and Policy Tools:

> "From 1982 to 1992, 49,100 acres of land were converted from forest land to urban use in Minnesota. USDA Forest Service's Forest Inventory and Analysis [FIA] unit estimates that 314,944 acres of forest land were converted to a non-forest condition in Minnesota from 2003 to 2008, with 110,230 acres being converted to urban and right-of-way uses. Although this is a significant loss of forest land, over the same period, 1.2 million acres were converted from a non-forest to forested condition, of which nearly half was from marsh to forest and about one-quarter was a reversion from agriculture."

Data on more recent additions to and conversions from forest land are not readily available and is a data gap that needs further exploration.

3.4 Forest Parcel Sizes and Number of Private Forest Owners

According to the 2011 report referenced in Indicator 3.3, forest land parcel sizes have been decreasing nationally and in Minnesota. This trend is expected to continue as the development of housing units and associated land use changes continue to occur. In Minnesota, it is estimated that there will be a 54 percent increase in developed area by 2030, which is a much larger increase than in Minnesota's neighboring states.

The following tables (Table 3, Table 4, and Table 5), is based on the National Woodland Ownership Survey (NWOS) and depicts the amount of private forest land and number of owners in Minnesota compared to the USFS Northeastern region and, more broadly, the United States. A few observations can be made of these data including; that a relatively small number of mills and corporations own a large amount of forest land in Minnesota, (compared to both Northeastern region and United States as a whole); and the number of corporate owners that operate a primary wood processing facility (wood mills) is the same, while the total acreage of that land is lower. **Note:** standard of error is quite large for NWOS.

State, Region, Nation	Area (acres)	SE[a]	Ownerships	SE[a]
Minnesota	7,798,000	112,000	213,000	21,000
Northeastern region	129,458,000	574,000	5,147,000	206,000
United States	474,810,000	1,429,000	11,462,000	418,000

Table 3 – Estimated Area and Estimated Number of Private Forest and Woodland Ownerships (1+ acres) by State, Region, Nation, 2011-2013; SE[a] = Standard Error; Source: National Woodland Ownership Survey, 2011-2013.

State, Region, Nation	Area (acres)	SE[a]	Ownerships	SE[a]
Minnesota	7,263,000	120,000	213,000	21,000
Northeastern region	124,482,000	666,000	5,112,000	198,000
United States	442,726,000	1,456,000	11,390,000	409,000

Table 4 – Estimated Area and Estimated Number of Non-industrial Private Forest and Woodland Ownerships (1+ acres) by State, Region, Nation, 2011-2013; SE[a] = Standard Error; Source: National Woodland Ownership Survey, 2011-2013.

State, Region, Nation	Area (acres)	SE[a]	Ownerships	SE[a]
Minnesota	5,985,000	90,000	212,000	20,000
Northeastern region	93,469,000	434,000	4,767,000	173,000
United States	290,178,000	989,000	10,693,000	375,000

Table 5 – Estimated Area and Estimated Number of Family Forest and Woodland Ownerships (1+ acres) by State, Region, Nation, 2011-2013; SE[a] = Standard Error; Source: National Woodland Ownership Survey, 2011-2013.

Indicator 4. Status of Forest and Woodland Communities and Associated Species of Concern

4.1 Area of Forest and Woodland Communities of Concern

The 2015-25 Minnesota State Wildlife Action Plan (SWAP) built upon the 2005-15 SWAP. Approval of the plan by the US Fish and Wildlife Service (USFWS) allowed the state to continue administering the state Wildlife Grant Program, which has supported over 60 projects throughout the state with investments of $18 million. These federal funds are also leveraged with conservation funds, including the state Legacy Amendment and the Environmental and Natural Resources Trust Fund to help individuals and conservation organizations pursue their goals of addressing wildlife, habitat, and conservation needs across the state. The 2015 SWAP updates the previous plan by addressing vulnerability assessments for habitat and species in relation to population changes and climate change predictions for the state.

The following map (Figure 25) shows areas within Minnesota that the SWAP identified as important habitat and assigned scores to the areas. Scores are based on five scalable metrics: species in greatest conservation need (SGCN) population viability scores; SGCN richness; spatially prioritized 'Sites of Biodiversity Significance'; ranks of 'Lakes of Biological Significance'; and 'Stream Indices of Biological Integrity' (IBI). Lower scores (green) in a given area indicate the metric scores for any of these five components were either relatively low or zero, while high scores (red) indicate that multiple metrics of high scores overlap. For example, a red area could indicate several good or outstanding SGCN populations and/or high SGCN richness (including species that did not have population maps available) along with a high score from another prioritization layer. The area in northeastern Minnesota delineating a portion of Lake Superior represents the state's managed area of the lake.

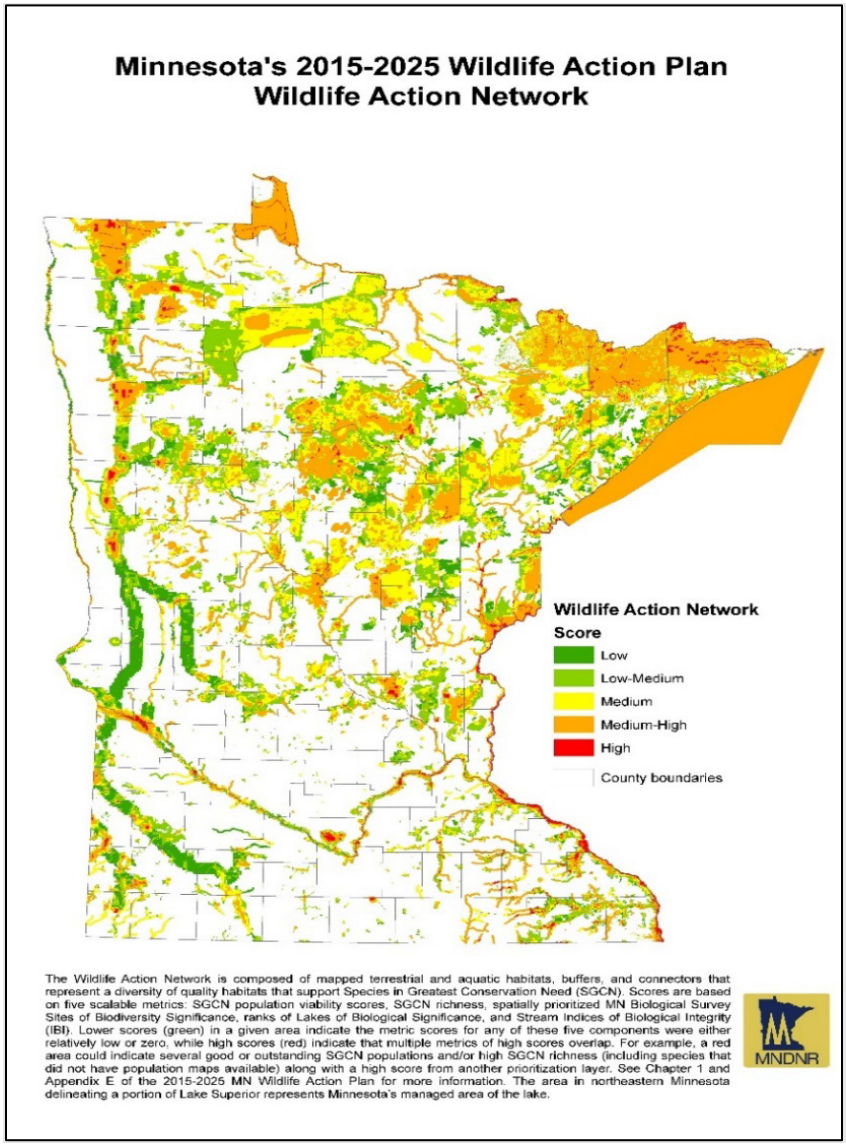

Figure 25 – Wildlife Action Network Scores in Minnesota. Source: DNR.

4.2 Status of Forest-associated and All Species of Concern

Minnesota is home to over 2000 known native wildlife species. Of these, roughly 16 percent are identified as species in greatest conservation need (SGCN) in the SWAP. This 10-year plan (2015-2025) took a three-pronged approach to ensuring the long-term health and viability of the state's wildlife, including (1) Habitat Threats and Protection, (2) Species Approach, and (3) Opportunities to Enjoy Wildlife. Nine species technical advisory teams (including federal, state, and external experts) reviewed and updated the SGCN lists from 292 species at risk in 2005 to 346 at risk in 2015. These at-risk species are not confined to in-state habitats but also include migrating populations, including the monarch butterfly and five native species of bees. Forest habitats play a key role in preserving these fragile species. An example includes the golden-winged warbler, which requires a forested landscape consisting of mature and young forests complemented by shrubby wetland edges. Even though Minnesota has less than 10 percent of this warbler's breeding range, it hosts close to 47 percent of the breeding population nests in the state.

State Listed Species

In early 2019, Minnesota released an up-to-date Rare Species Guide, which includes the state list of endangered, threatened, and species of special concern (Table 6). Profiles of species are updated continually. Currently there are 518 species listed, of which 32 are either bird or mammal species that occupy or depend on forests for their life cycle. The Rare Species Guide also includes delisted species. A collection of searchable species profiles includes, but is not limited to:

- Taxonomic information
- State and federal status designations
- Summaries of why the species is listed in Minnesota a
- Minnesota and contiguous US and Canada range maps
- Descriptive, habitat, and life history information
- Conservation and management information
- Photographs, illustrations, or both
- References and sources of additional information
- Authorship

Group	Endangered	Threatened	Special Concern	Total
Mammals	0	2	19	21
Birds	9	2	21	32
Amphibians and Reptiles	2	4	10	16
Fish	4	5	25	34
Mollusks	13	11	9	33
Arthropods	16	16	41	73
Vascular Plants	86	93	130	309
Total	**130**	**133**	**255**	**518**

Table 6 – 2019 State List of Endangered, Threatened, and Species of Special Concern by Group Type. Source: DNR.

In 2019, causes of species decline in Minnesota include low reproduction rates, poor dispersal of species, increasing disease presence such as Chronic Wasting Disease (CWD) in deer, and over exploitation of some species. The overarching issue looming over all SCGNs, however, is climate change and the associated implications for species and habitats in the future. This is an emerging issue and will require increased management and monitoring by forest and wildlife managers.

Northern Long-Eared Bat

The northern long-eared bat is a threatened species under the federal Endangered Species Act. While widely distributed throughout the eastern United States and Canada, the species was designated a species of special concern in Minnesota in 1984. White-nosed syndrome fungus, which negatively affects the northern long-eared bat, thrives in cave environments and was first documented in the state during the winter of 2015-16. On April 2, 2015, the USFWS federally listed the species as threatened. On February 16, 2016, a special federal regulation called the Northern Long-eared Bat Final 4(d) Rule for the conservation of the northern long-eared bat became effective. The Rule restricts tree removal near and around hibernacula (caves, mines, etc.), and maternity roost trees of the species (Figure 26).

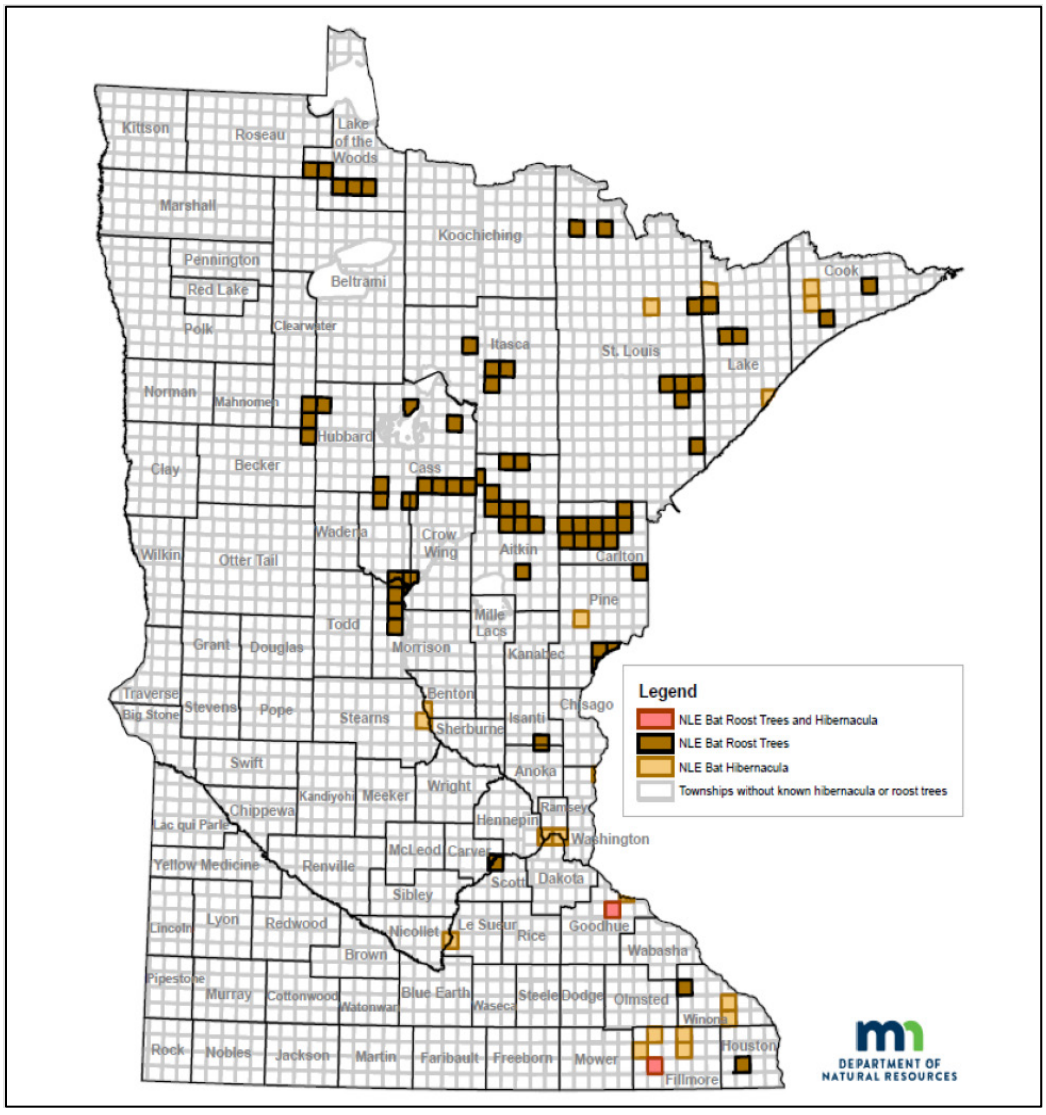

Figure 26 – Townships Containing Documented Northern Long-eared Bat Maternity Roost Trees and or Hibernacula Entrances.

Further information on all state SGCN is available through Minnesota's endangered, threatened, and special concern species website.

4.3 Status of Forest-dependent Bird Populations

Breeding bird communities of the western Great Lakes region are known to display among the richest diversity of bird species in North America (Green 1995; Howe et al. 1997; Rich et al. 2004; Niemi et al. 2016). Maintaining avian diversity in forest ecosystems affords many benefits for forest health and productivity; diverse bird communities play a vital role in maintaining both the structure and function of ecosystems by providing several ecological services such as seed dispersal and pest control (Krieger 2001; Whelan et al. 2008; Philpott et al. 2009; Sekercioglu 2012; Sekercioglu et al. 2017). Further, because birds integrate environmental variables over space and time, changes in forest bird communities provide meaningful signals of local forest health or degradation (Niemi and McDonald 2004; Gnass, Giese et al. 2015).

In 2008, Audubon Minnesota, in partnership with several organizations, secured a major state appropriation from the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources to launch the Minnesota Breeding Bird Atlas (MNBBA), a comprehensive and systematic field survey of breeding birds in Minnesota. The MNBBA uses data collected by scientists to map which species breed in the state and where this breeding occurs. A coalition of agencies and organizations interested in bird conservation collectively planned, promoted, and supported the creation of the state MNBBA. This coalition includes:

- Minnesota Environment and Natural Resources Trust Fund
- Audubon Minnesota
- Natural Resources Research Institute
- U.S. Fish and Wildlife Service
- Minnesota Ornithologists' Union
- Minnesota Department of Natural Resources
- Bird Conservation Minnesota
- Bell Museum of Natural History

From 2009-2013, nearly 700 scientists, paid survey staff, and many resource organizations collected data on breeding bird activity in the state. These data were then compiled, analyzed, and summarized through 2017, and are now available through an interactive mapping tool. Though the data collection for this project happened over several years, the project is still considered a snapshot in time, as it was conducted over a limited number of breeding seasons, and is not based on historical information. An example of data collection for the bird species Pine Warbler is shown in Figure 27.

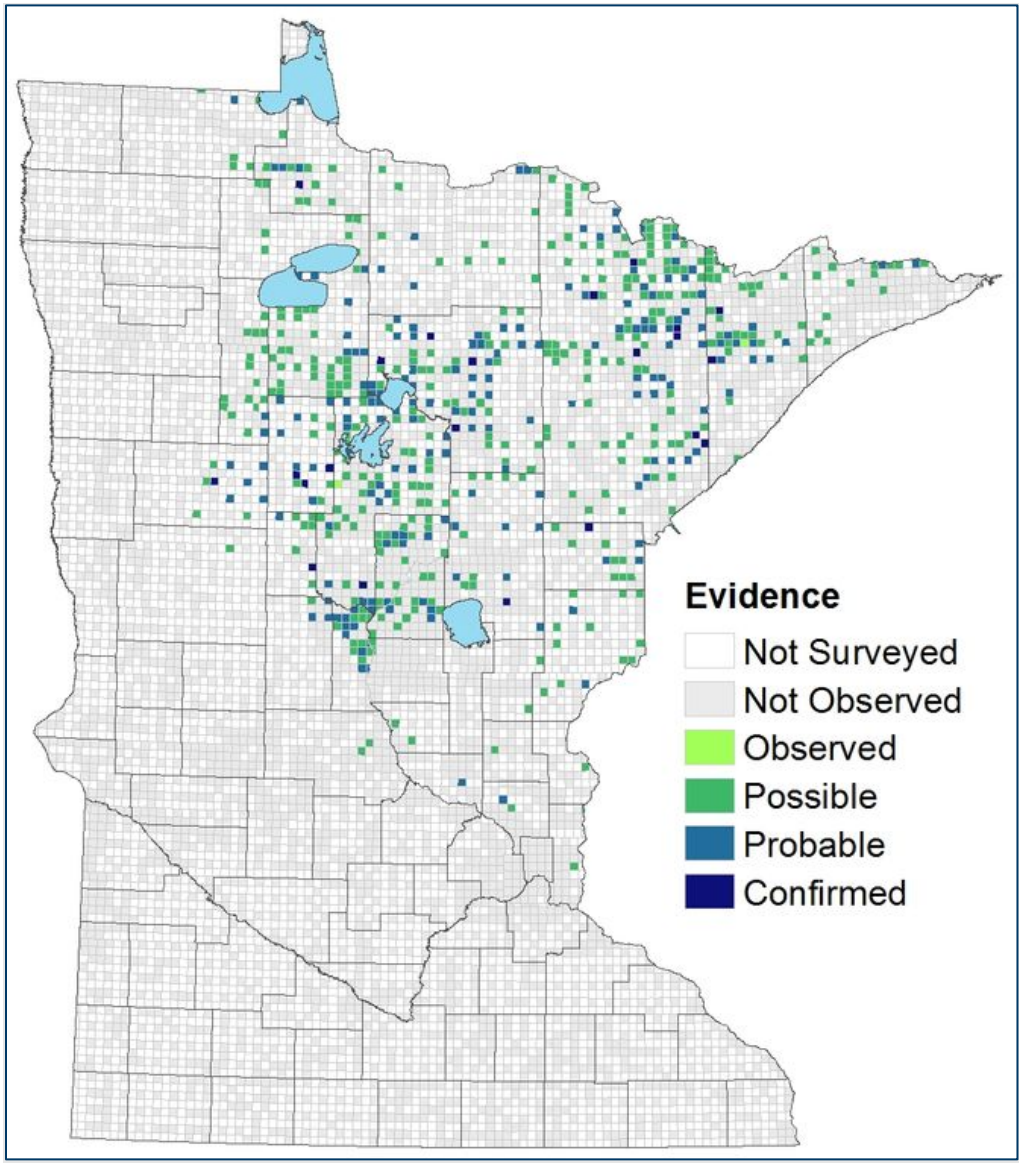

Figure 27 – Map of Pine Warbler Sightings in Minnesota. Source: NRRI.

Additionally, Minnesota's National Forest Breeding Bird Monitoring Program has documented trends in forest bird abundances for 25 years, and tracks information in both the Superior and Chippewa National Forests. The data collected have provided much insight into the impacts of forest management on breeding birds and helped to inform the development of management policies and conservation initiatives. Adaptive forest management has the potential to mitigate impacts of climate change and land use changes on bird communities by conserving forested habitats.

Regional trends for forest bird species have been mixed over the data collection period from 1995-2018. Bird species associated with upland conifer, lowland conifer, mixed forest, canopy nesters, cavity nesters, and permanent resident species all significantly increased. Early successional, shrub nesting, and short-distance migrant species significantly decreased, while deciduous forest, ground nesting, and long-migrant species showed no significant change.

The overall trend indicates that most breeding bird species within Minnesota's national forests are either increasing or stable in population. However, several species such as the Connecticut warbler, olive-sided flycatcher, and winter wren continue on a downward trend and remain a concern.

Detailed information can be found through the Natural Resources Research Institute (NRRI) Technical Report entitled Minnesota National Forest Breeding Bird Monitoring Program Annual Report 1995-2018 and US Forest Service General Technical Report NRS-159 Analysis of Long-term Forest Bird Monitoring Data from National Forests of the Western Great Lakes Region.

Criterion 2. Maintenance of Productive Capacity of Forest Ecosystems

Criterion 2 ties to the national priority *Conserve and Manage Working Forest Landscapes for Multiple Values and Uses.*

The importance of this criterion is that productive forests supply important goods and services to society. They protect and enhance water quality and ecosystem species habitat, help prevent soil erosion, produce oxygen, filter pollutants, and offer a haven for recreation and spiritual renewal. Forests supply wood fiber and lumber for homes, furniture, papermaking, and fuel. Other forest products include cellulose for clothing, boughs for wreaths, cones, herbs, medicines, and foods such as mushrooms and berries.

Forest productivity varies based on soil fertility, incidence of forest pathogens and insects, amount of environmental pollutants in the landscape, the forest's location along the urban-to-rural continuum, and past and present management. Managing forests sustainably means balancing resource production with the ecosystem's capability to renew and sustain itself. Measuring and tracking the amount of forest land available for producing goods and services, is critical to determining how the state balances resource production, long-term ecological health, and the capacity of forest products markets, to utilize timber and other forest products.

Indicator 5. Area of Timberland

5.1 Amount of Timberland (and Percent of Total Forest Land)

Minnesota has about 15.8 million acres of forest land that is classified as timberland. Timberland is forest land that is productive enough to produce a commercial crop of trees and is not reserved from harvest. Reserved forest land is land reserved from harvest by policy or law, including designated wilderness areas like the BWCA, old growth reserves, conservation easements, and others. Other forest land is mostly of very low productivity for tree growth, such that it is incapable of producing a commercial crop of trees.

Although FIA inventory figures indicate increasing acreages of productive timberland in Minnesota, this appears to be largely due to FIA inventory definition adjustments and not actual trends in the forest resource. Timberland acreage actually appears to be largely stable with the possibility of a very small increase on private lands due to reversion of agriculture lands to forest lands in the southern and western portions of the state (Figure 28). Indicators 1.1, 1.2, and 3.2 also include detail on the current status and trends of forest lands.

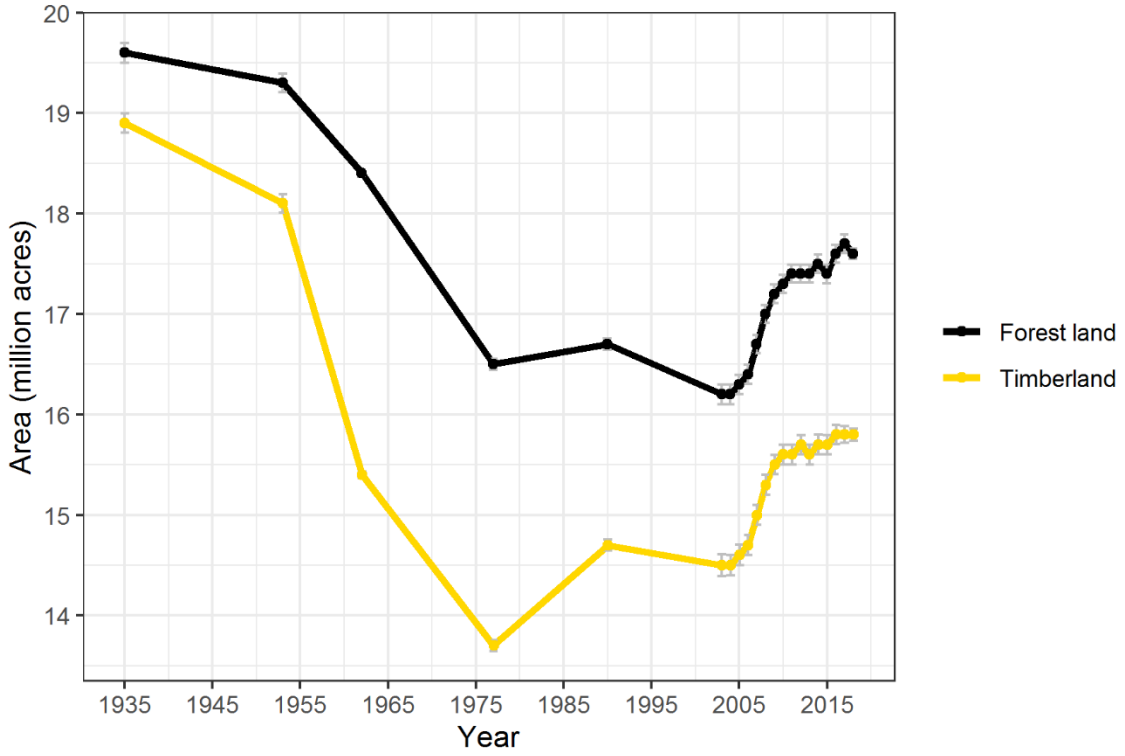

Figure 28 – Trend of Forest Land and Timberland since 1935 in Minnesota; Source: FIA program; USFS Northern Research Station.

Indicator 6. Annual Removal of Merchantable Wood Volume Compared With Net Growth

6.1 Net Growth and Removals (Volume and Percent of Mortality, Net Growth, and Removals)

Figure 29 illustrates that since 2008, overall harvest of all species in Minnesota is not capturing total forest net growth (growth after mortality). This trend is not surprising since the total timber harvest across all ownerships began declining in 2005, from approximately 3.73 million cords to an average of 2.9 million cords in 2016. Harvest has not returned to historic levels seen in the 1900s and early 2000s, as referenced in the 2017 MN Forest Resources Report. The decline in harvest was most dramatic on private lands, going from approximately 1.7 million cords annually to 1 million cords annually today. According to a 50-year projection Generic Environmental Impact Statement (GEIS) on timber harvest completed in 1994, Minnesota's forests could sustain a total harvest of approximately 5.5 million cords annually. The information used in the GEIS came from the FIA program, and is reliable at state and county scales. To get a detailed look at the field scale, or sub-stand, derivative models of forest inventory metrics using remotely sensed information are needed. Spatial data, such as light detection and ranging (lidar) and stereo aerial photography, could be leveraged to correlate 3D remotely sensed information with field inventory data to create empirical relationships to model the volume of the forest.

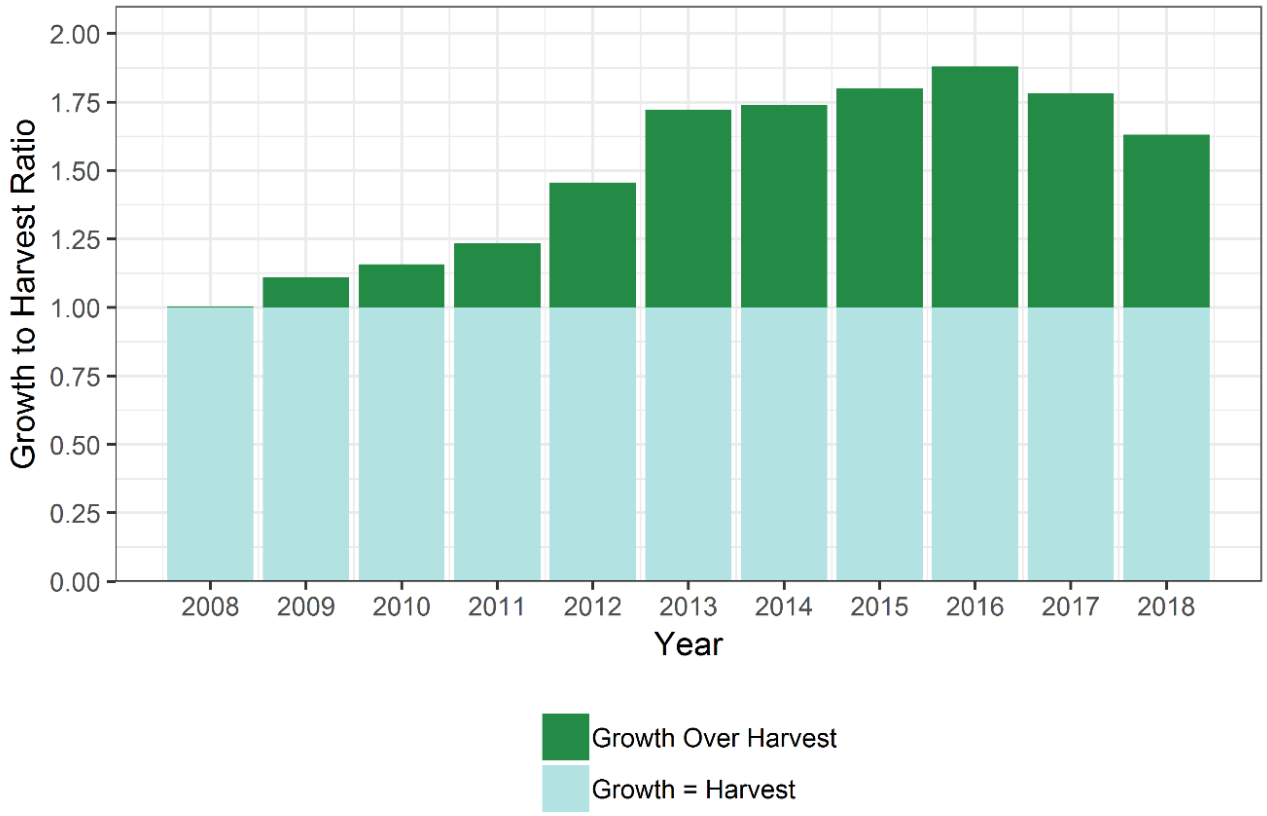

Figure 29 – The Net Growth to Harvest Ratio; 1.00 indicates net growth is equal to harvest, numbers above 1.00 indicate there is more growth than harvest. Having a number below 1.00 does not mean poor forest management, and maybe the result of harvesting in older stands. Source: DNR.

6.2 Type of Removals (Total Removals and Harvest Removals by Major Species Group)

Since 2009, total removals on timberland decreased through 2013 and then started to gradually increase annually through 2018. As removals decreased statewide (Figure 30) forest growth exceeded harvest; growth to harvest ratio values greater than one indicate net growth (Figure 29). Current removals are still below total removals from a decade ago but are showing some slight increases (Figure 30).

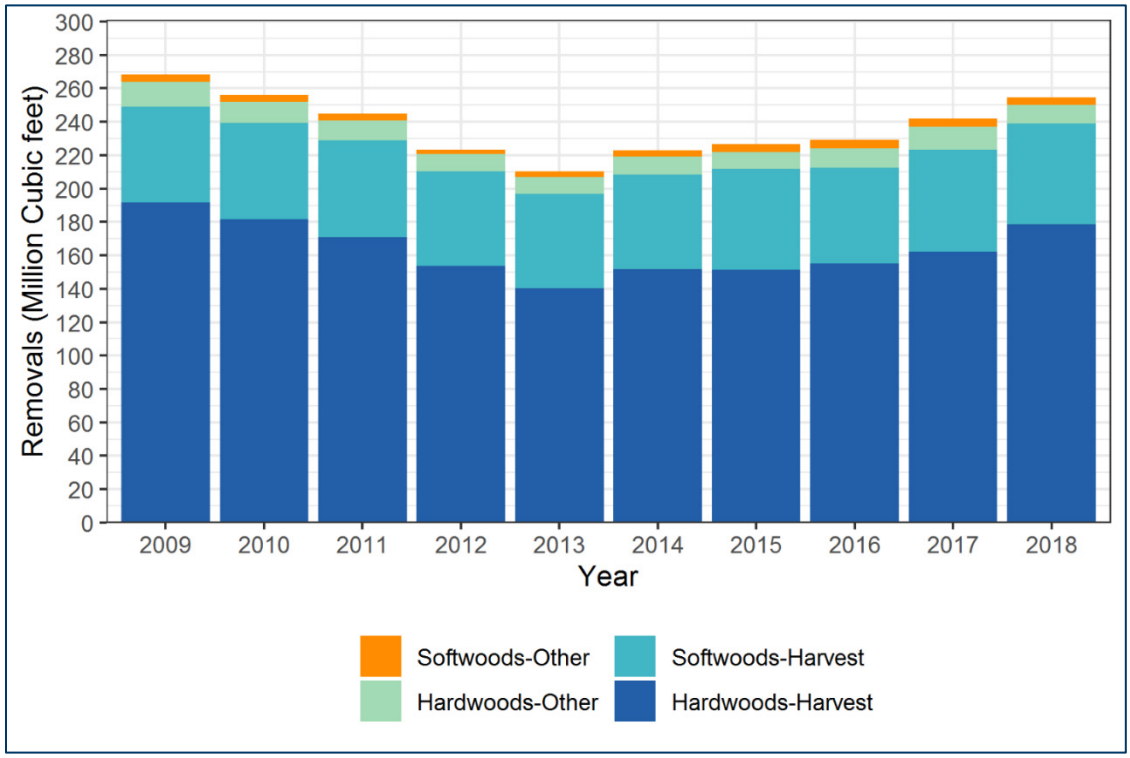

Figure 30 – Harvest and Other Removals by Species Group. Source: FIA 2018, USFS Northern Research Station. Other (removals) includes cultural operations, such as timber improvement operations, land clearing, and net growing stock on land that is reclassified from timberlands to non-commercial forest lands or non-forest land.

Criterion 3. Maintenance of Forest Ecosystem Health and Vitality

Criterion 3 ties to the national priority *Protect Forests from Threats.*

Forest health describes the overall condition of forests and trees and how well they recover from stress. Many factors affect forest health; some are natural, including insects and diseases, severe weather or catastrophic events such as ice storms, tornadoes, straight-line winds, floods and droughts. Some are human-induced, such as development, which causes changes in soil hydrology and reduces the size of forest patches and can lead to habitat degradation or destruction. External stressors that affect tree physiology and reduce tree vigor cause the greatest problems. Stressors come and go, and the likelihood of their occurrence cannot be accurately predicted, making forest health difficult to assess at a single point in time.

Indicator 7. Area and Percent of Forest Land Affected by Biotic and Abiotic Processes and Agents

7.1 Area and Percent of Forests Affected by Biotic Processes and Agents, e.g., Insects, Disease, Invasive Plants, and Animals

Tree mortality occurs as a result of adverse weather, disease, insects (native and non-native), senescence, competition, succession, fire, animal activity, human activities, and increasingly, climate change. Insects are responsible for only a small percentage of the primary cause of mortality in most tree species. However, there are two exceptions in Minnesota. In the ash and tamarack cover types, insects are the primary cause of mortality. The agents of change work in combination to weaken trees and make them vulnerable to decline or death. Data are often gathered on single causes or types of damage, not complex combinations of factors, thereby complicating assessment of trends in disturbance.

Nonetheless, US Forest Service – FIA provides a helpful record of both biotic and abiotic factors causing mortality to Minnesota's trees. Figure 31 shows the distribution of major disturbance factors affecting forests in Minnesota between 2014 and 2018 (O'Connell et al., 2017).

The FIA data provide a nearly 20-year record (1999 - 2018) of the many factors causing mortality to trees in Minnesota, with reporting on complete cycles of observation every 5-years. Minnesota also benefits from many satellite and aerial remote sensing data sources for forest cover analyses, going back to the late 1970's. The relatively long field data record allows for scalable assessment of trends over that time-period. Wilson et al. (2019) provide an analysis of these trends across forest types and disturbance groups. The trend across all forest types and disturbance groups shows an increasing frequency of disturbance. This trend drives the decreasing rotation interval reported for disturbance across Minnesota's forests (Figure 32). These changes mean that currently, Minnesota can expect a disturbance causing mortality or damage to at least 25 percent of the trees across any given acre of forest every eight years. This represents a dramatic shift from 2005, when the rotation interval was closer to 23-years for such an event.

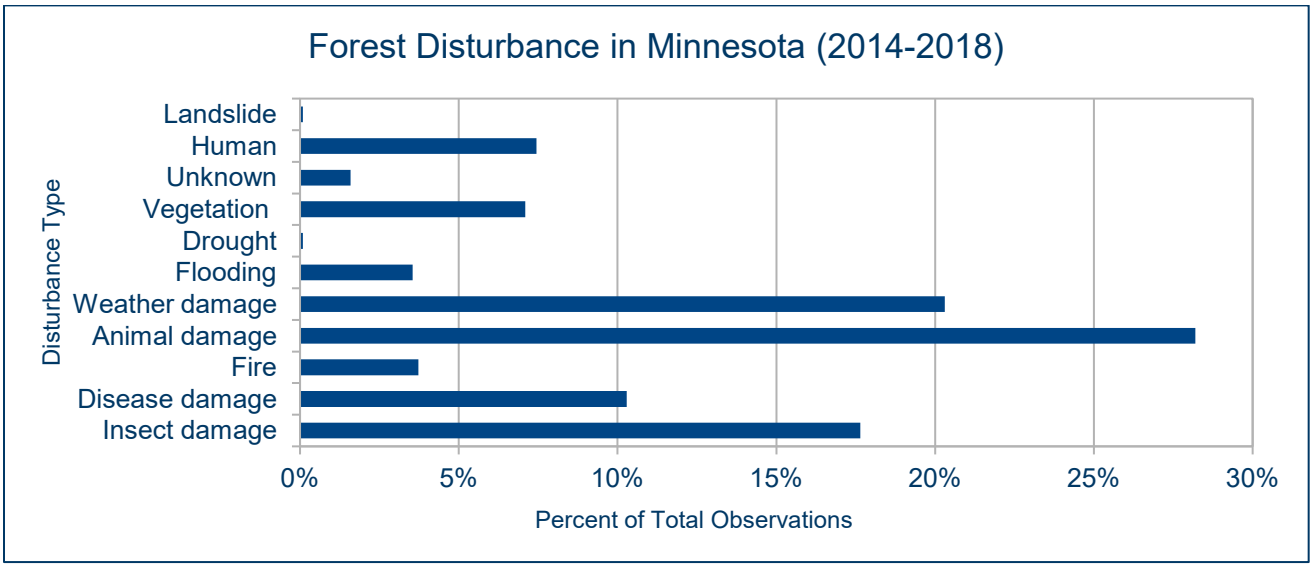

Figure 31 – Disturbance Factors Causing Tree Mortality in Minnesota (FIA: 2014-2018).

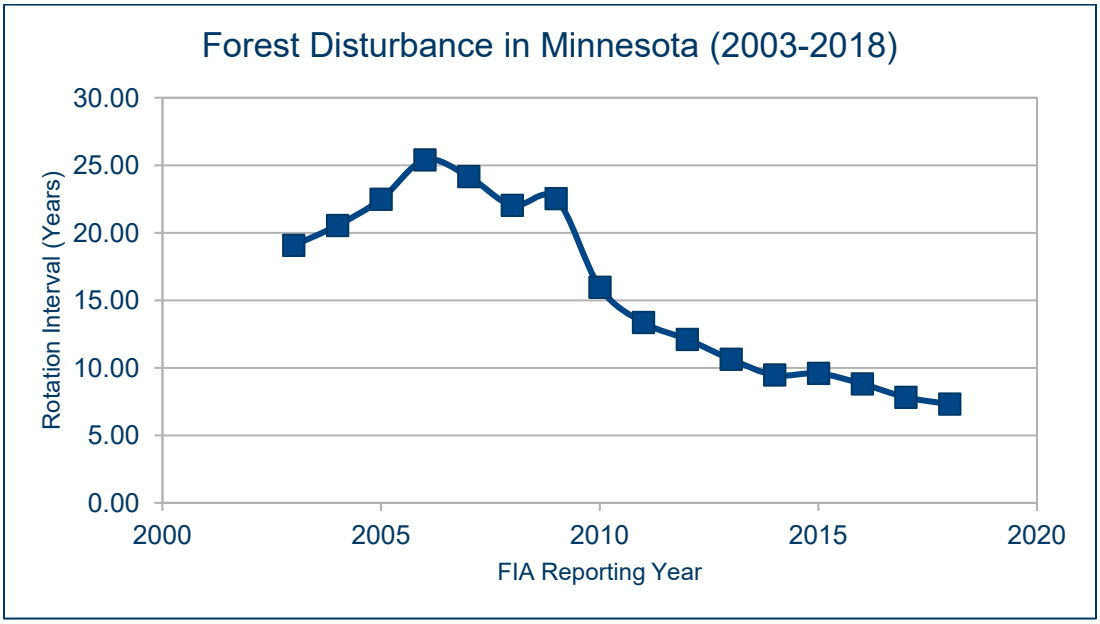

Figure 32 – Disturbance Trend in Minnesota's Forests (FIA: 2003-2018).

While warmer winters and longer summers have likely driven recent increases in insect outbreaks and other forest pathogens, these agents of change are far from unnatural. Native forest insects and disease organisms influence forest ecosystem dynamics as pests and biotic stressors, but they also serve a beneficial role in natural processes. Many native insects and diseases are essential natural components of healthy forests and contribute to compositional, structural, and functional diversity. They selectively affect tree growth, and mortality rates, and alter forest composition, structure, and succession. They thin and prune host populations, thereby reducing density and competition. Through the action of insects and disease, decay, and biomass decomposition, forests contribute significantly to carbon cycling, nutrient cycling, and energy flows in forest ecosystems.

A complete analysis of susceptibility of different forest types and developmental stages to the array of disturbance factors influencing Minnesota's forests is beyond the scope of this document. However, older stands are typically more prone to insect and disease, decay, and windstorm damage than younger stands and that is an important risk factor in determination of harvest or rotation age. Climate change is amplifying these issues, and increasing stress on Minnesota's forests. These factors can influence both the ecological health of the forest and the economic viability of the timber resource (Figure 33). This is an active research topic and will need further exploration and analysis both on the state and federal level. See Chapter 4 Geospatial Priorities for more information about risk of insect and disease and threats and risks modeling.

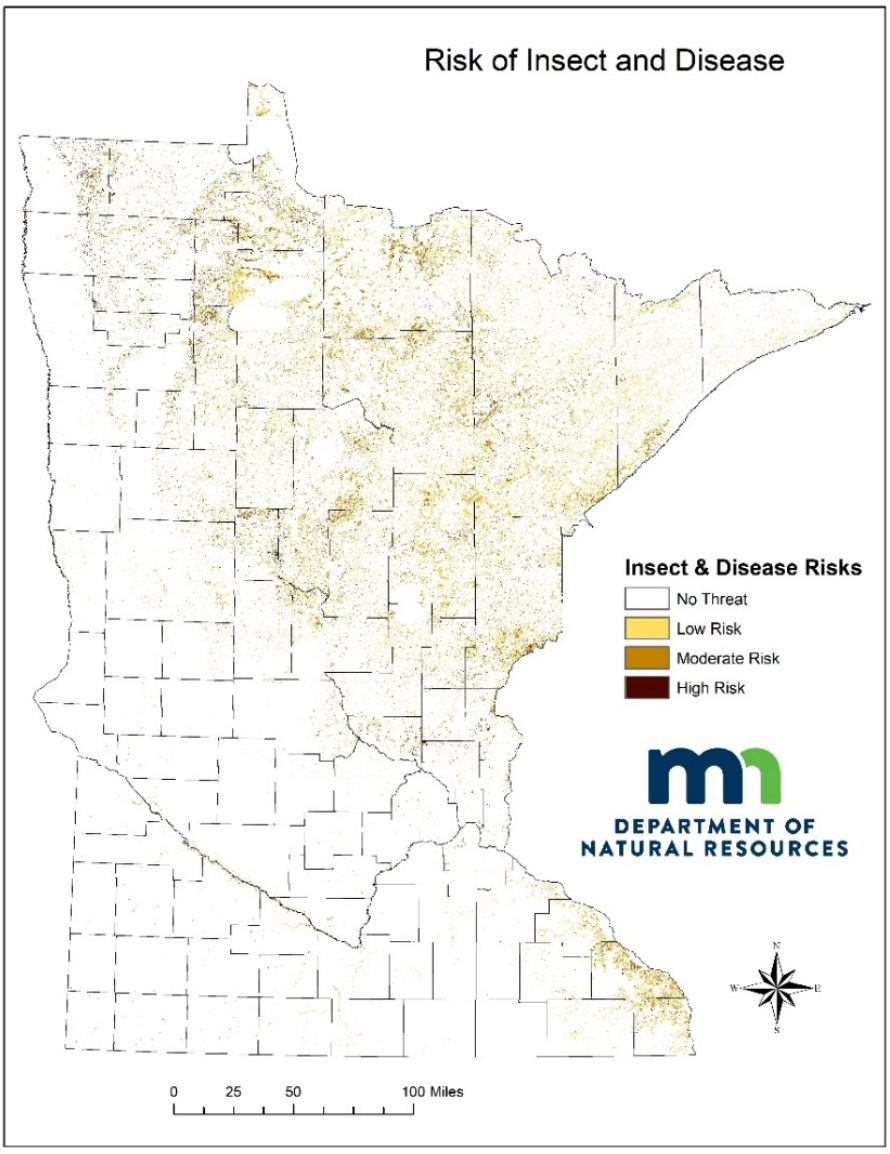

Figure 33 – Map of Risk of Insect and Disease in Minnesota. This data was created by the national "risk mapping" effort performed by the US Forest Service, Forest Health Assessment & Applied Sciences Team (FHAAST) to identify forest areas at risk of mortality from insect and disease infestation.

Below is a description of some of the forest pests, some native and some non-native, affecting Minnesota's trees and forests. More details on forest pest concerns in Minnesota can be found in the DNR's Forest Health Annual Report.

Insects

Emerald ash borer (EAB) is a non-native species that continues to be a threat to Minnesota's ash tree population. EAB was discovered in St. Paul in 2009. As of November 2019, it has spread to 21 counties. Through aerial surveys, the DNR has documented 5,630 acres impacted by EAB (Figure 34). Impact in the metropolitan area of Minneapolis and St. Paul is largely undetermined since the DNR cannot fly in the Minneapolis-St. Paul airport airspace and because symptoms of EAB do not appear widespread in the landscape until at least six years after infestation. The Minnesota Department of Agriculture (MDA) continues to be the lead agency for the Minnesota EAB program. By combining the DNR's aerial survey data with MDA's infested tree data and by buffering individual infestations by a half-mile, it is estimated that at least 208,000 acres are infested with EAB. Almost all of this acreage is urban forest or a mix of rural farmland and hardwood-dominated forest.

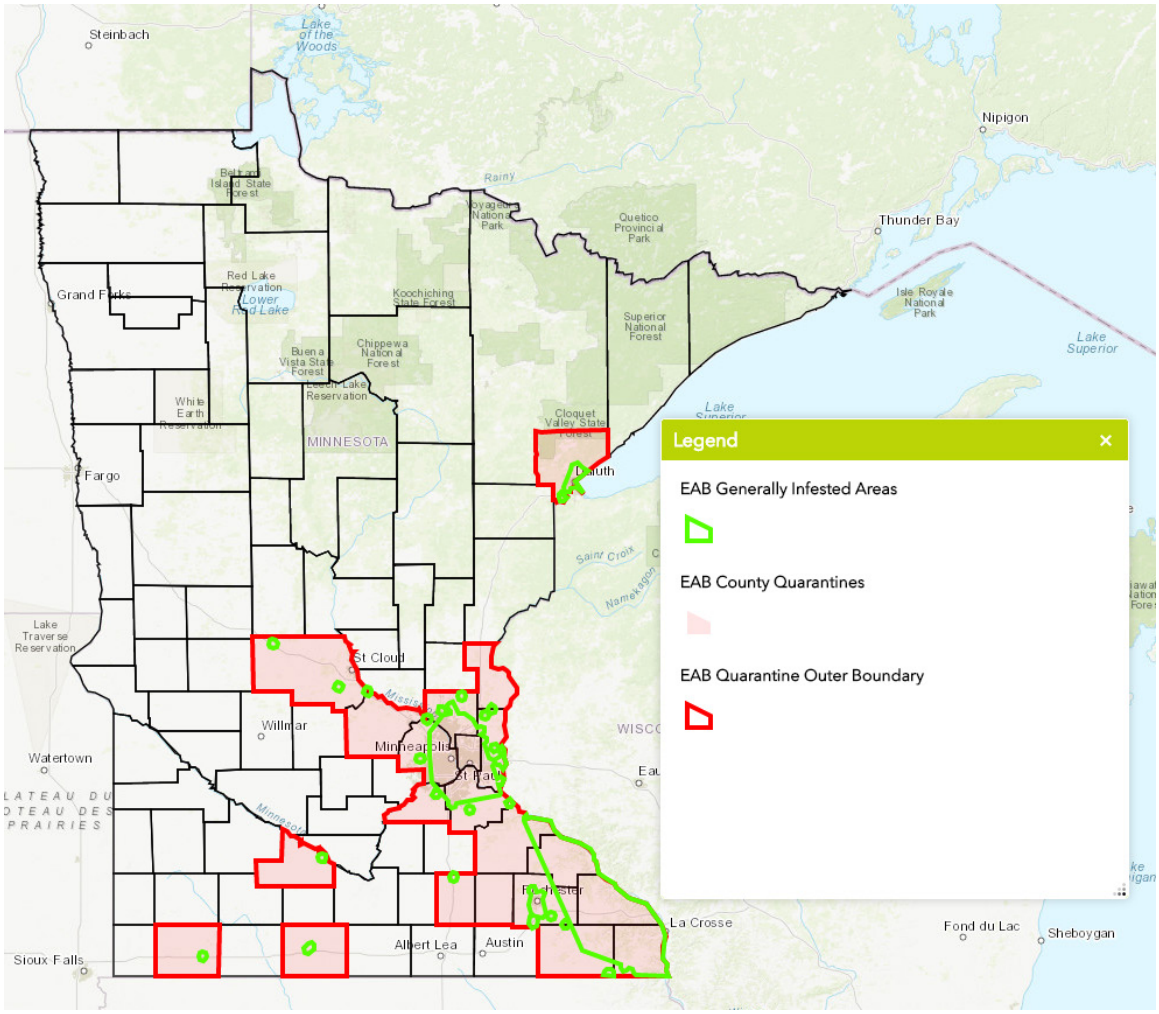

Figure 34 – EAB Quarantines and Confirmed Infestations in Minnesota as of November 2019. Source: MDA.

Eastern larch beetle is a native bark beetle that attacks tamarack species. In 2019, forest health staff recorded the eighteenth consecutive year of damaging larch beetle populations. Aerial surveys identified over 244,000 acres affected by eastern larch beetle in 2019, and since the beginning of the larch beetle outbreak in 2001, about 666,500 acres have been impacted; this represents 48 percent of the tamarack cover-type in the state (Figure 35).

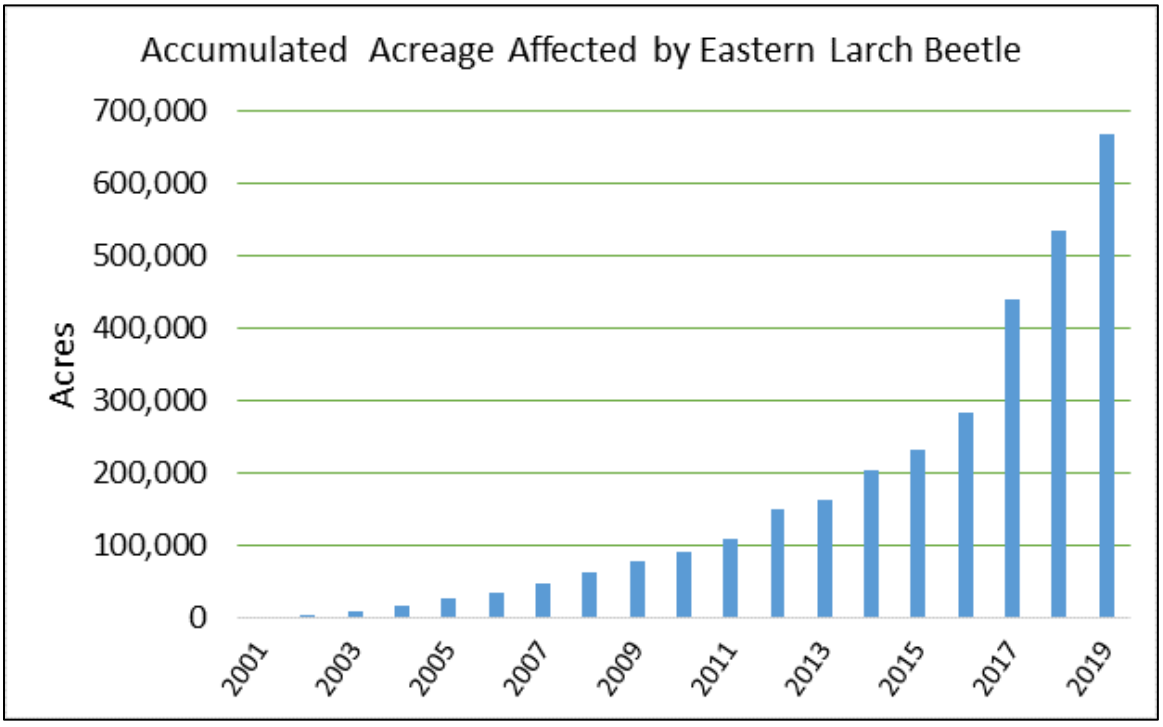

Figure 35 – Accumulated Acreage Affected by Eastern Larch Beetle in Minnesota, 2001-2017. Source: DNR.

Diseases

Bur oak blight is a native leaf disease of bur oak that causes the leaves to brown in late summer. However, vigorous trees affected by bur oak blight can recover and look normal the following spring. In the 2006 Forest Health Report, DNR forest health staff noted an increase of bur oak blight in southern Minnesota. That upward trend has generally continued since then, likely promoted by consecutive years of wetter-than-average springs. Minnesota had normal or slightly less-than-normal rainfall in May 2018 except for Houston County, which had significant bur oak blight in 2018. The low level of bur oak blight for most of the state in 2018 demonstrates that the disease can essentially disappear from susceptible bur oaks if the weather is dry during leaf expansion.

Diplodia is a fungal pathogen that frequently kills red pine seedlings and can cause crown loss and top-kill on mature pines after stressful conditions. Unfortunately, *Diplodia* can also cause latent infections that show no signs of disease until trees become stressed. In 2017, the DNR destroyed 400,000-500,000 red pine seedlings with possible latent infections to avoid distributing unhealthy seedlings. Traditionally, when latent *Diplodia* infections are more than 10 percent, the DNR advises destroying the nursery crop.

Oak wilt is a non-native, fatal oak disease that has been slowly spreading northward in Minnesota since about 1950. The disease is common in east-central and southeast Minnesota but has been confirmed only recently farther north and west. It currently can be found in pockets in 30 percent of the state's red oak range. The DNR's forest health unit estimates that at least 655,400 acres of rural and urban forests are threatened by oak wilt (Figure 36). Controlling oak wilt in the early stages of infestation is possible, but coordinating landscape-level disease management across multiple ownerships is challenging. The DNR's forest health unit is currently working on two projects aimed at the northeastern and northwestern extremes of the known oak wilt range in Minnesota.

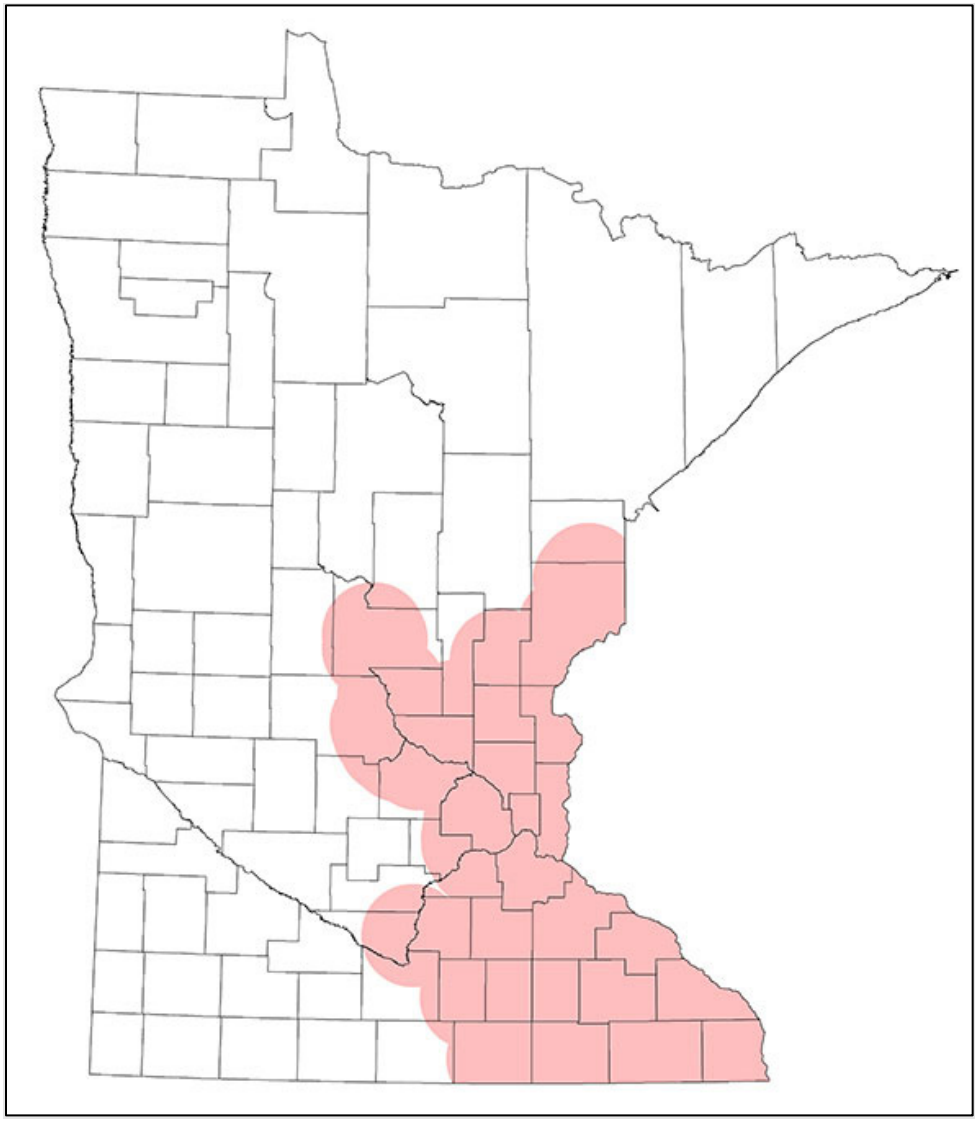

Figure 36 – The Pink Area Represents the High-risk Zone for Oak Wilt and Shows the Known Range of Oak Wilt in Minnesota as of May 2018. Source: DNR.

Terrestrial Invasive Species

Over 136,000 acres of land managed by DNR Forestry have been identified as infested by a terrestrial invasive species listed by the agency. Many of these invasive species are regulated by the state as noxious weeds and observations are recorded in EDDMapS. However, only about seven percent of DNR managed forest lands have actually been surveyed for invasive species, so there are likely many infested acres that have not yet been documented. Abundance and identity of invasive species vary across the state, with a higher prevalence of woody invasives (e.g., common buckthorn, oriental bittersweet, barberry) in the southeastern part of the state, and plentiful herbaceous species (e.g., common tansy, spotted knapweed) growing along forest roads and trails and in gravel pits across northern areas of the state. Newly-infested areas are reported to EDDMapS regularly by field staff as species continue to spread across the state. In addition, the University of Minnesota has generated distribution maps for 13 invasive plant species in the state that can be used to identify plant invasion fronts and isolated populations to limit their spread.

Many woody invasives can persist in the shaded understory of forests, competing with regenerating trees and making access difficult. While many of the herbaceous invaders thrive along sunny forest edges and along roadsides, they usually do not survive once the tree canopy closes and shade increases. However, these species can still negatively impact newly-planted seedlings and can be easily spread to uninvaded areas on equipment, wildlife, and people. The DNR is required to prevent reproduction and distribution of seeds and plant material, and in the case of certain species, to eradicate all individuals. Prompt action in response to new invasions may be crucial to preventing relatively localized invasions like oriental bittersweet from becoming widespread, and treating isolated populations can limit the expansion of problematic invaders like buckthorn into minimally-invaded areas in northern Minnesota (Figure 37).

With current funding and staffing levels, DNR is able to survey approximately 45,000 acres per year to monitor new and existing invasions, and treat 700-1,000 acres of invasive species, which is not enough to get ahead of the of invasive plants in Minnesota. This is considered a data gap and will need further monitoring.

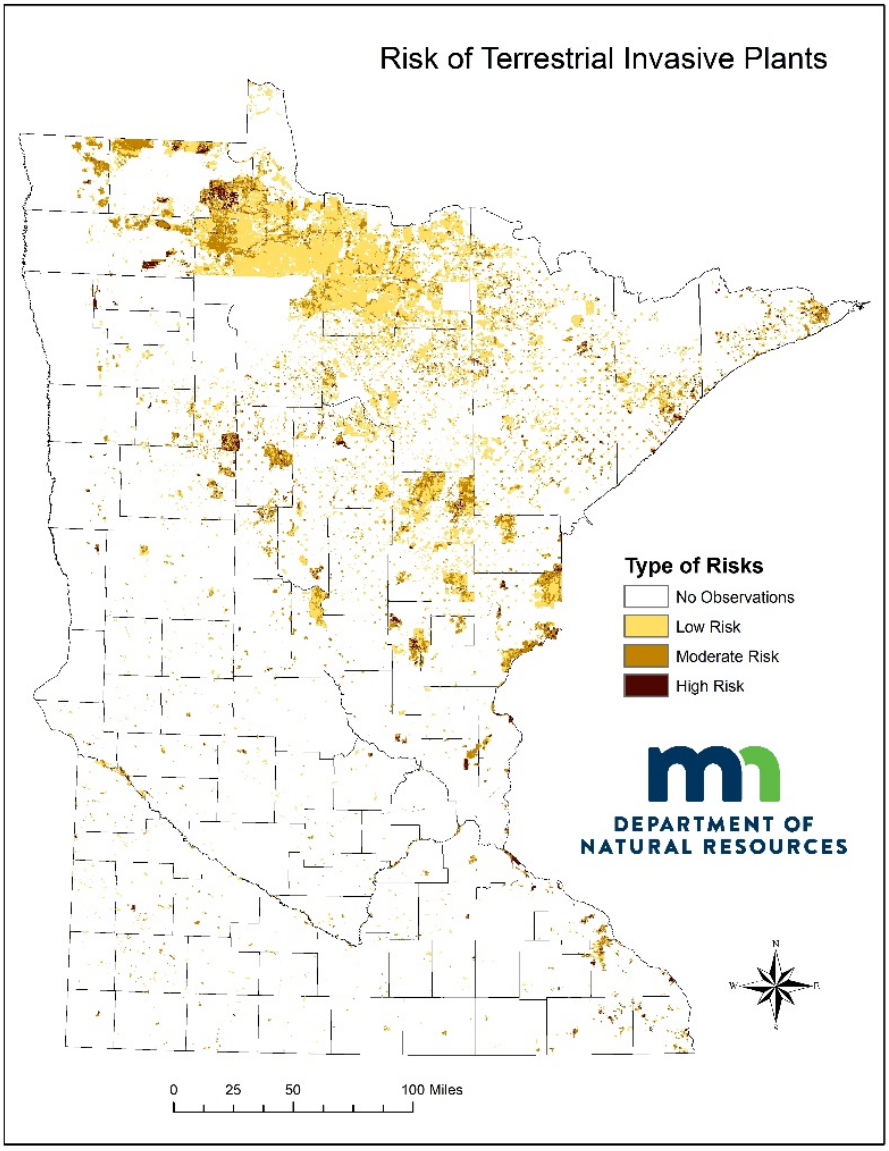

Figure 37 – Risk of Terrestrial Invasive Plants on FIM Stands in Minnesota.

PlayCleanGo

With funding from the US Forest Service, the DNR developed the PlayCleanGo outreach campaign in 2012 to stop the spread of invasive species by recreational users on public lands. The PlayCleanGo brand is now managed by the not-for-profit '*North American Invasive Species Management Association'.* The DNR is an active partnering organization and continues to use the branding and messaging on signage and outreach materials to users of state lands. PlayCleanGo is considered a state "success story" and is included in Part 2-Strategies of this 2020 SFAP.

7.2 Area and Percent of Forest Land Affected by Abiotic Agents, e.g., Fire, Storms, and Drought

Climate Changes in Minnesota

Minnesota's climate already is changing rapidly and will continue to do so for the foreseeable future. Temperatures have been increasing for decades, but especially during winter. Increases in annual precipitation during this time have been punctuated by larger and more frequent extreme precipitation events, and resulted in the 2010s finishing as the state's wettest decade on record.

Climatic changes have already affected Minnesota's forests directly and indirectly, and comprehensive climate assessments conducted nationally, along with individual and more localized studies, indicate that the observed increases will continue, along with additional changes that have not yet been observed. Table 7 summarizes which attributes of Minnesota's climate have changed already, along with future changes projected by climate models.

Climate Parameter	Observations (through 2010s)	Projections (2041-2070)	Cause/Explanation
Winter temperatures	**Increasing** rapidly, loss of cold extremes	**Continued increases expected** with narrowing of winter season	Greenhouse gasses absorb escaping heat, warming winters and nights most while shrinking hemispheric snow cover and "cold air reservoirs"
Rainfall	**Increasing** all seasons, more extreme events	**Increases likely** but timing and seasonality uncertain	More moisture available for precipitating weather systems
Snowfall	**Increasing**, more extreme events	**Decreases likely** but some extreme events	More moisture available for snow-producing weather systems, but warming of winter eventually decreases opportunities for snow
Heat waves & extreme heat	**No trend** through 2019	**Increases expected** by 2050, if not sooner	Warming to date concentrated in winters and nights, but heat waves more likely as seasonal and regional temperatures continue rising
Drought	**Decreasing** frequency, duration, coverage, and severity	**Increases possible** with longer dry spells and more "flash drought"	Wet trends have decreased drought regionally, but future precipitation increases projected to occur over fewer days, meaning longer dry spells

Climate Parameter	Observations (through 2010s)	Projections (2041-2070)	Cause/Explanation
Tornadoes, hail, t-storm winds	**Trends unclear** or none observed	**Projections unclear**	Higher global temperatures increase thunderstorm size and rainfall intensity but decrease wind shear required for tornadoes, hail, and thunderstorm winds

Table 7 – Climate changes and observed and projected in Minnesota, based on science summarized in the 2014, 2017, and 2018 National Climate Assessment reports, and from data analyzed by the Minnesota State Climatology Office.

Minnesota's two main ongoing climatic changes, (increased temperature and increased precipitation), can be co-visualized by graphing them against one another, and comparing recent years with the historical period (Figure 38). To understand Figure 38, note that the breakpoint selection (1986 vs 1987) was based on the initial requirement of having at least 30 years for climatological comparisons. Horizontal and vertical axes in the center of the graph, represent 20th century averages for precipitation and temperature, respectively. From 1987 to 2019, 32 out of 33 years were some combination of warmer and-or wetter than 20th century averages; only one year, was both cooler and drier. All of the combined warmest and wettest years on record have occurred during the recent period, and no year was both warmer and wetter than 2016. Minnesota recorded its wettest year in 2019, although that year was slightly cooler than 20th century averages.

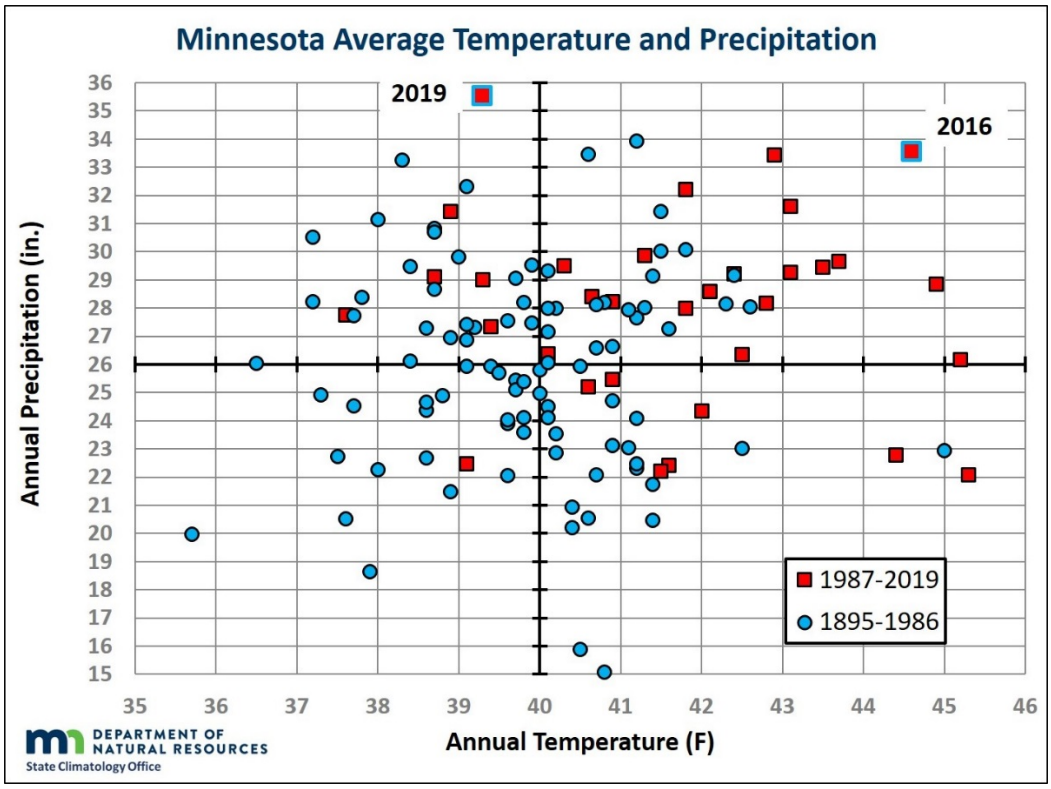

Figure 38 – Statewide average annual temperature and precipitation, comparing 1987-2019 (shown with red boxes) to the earlier period 1895-1986 (shown with blue circles). Data analyzed by Minnesota State Climatology Office, using data available from NOAA, available on the DNR Climate Trends tool.

Minnesota's northern forests feature some of the fastest-warming conditions in the state, along with pronounced increases in precipitation. Analysis of presently and historically forested ecological subsections using the Minnesota DNR Climate Trends tool (Figure 39) identified the following observed changes since 1895:

- Annual average temperatures increased by 3.4°F
- Average daily winter low temperatures (December – February) increased by 7.1°F
- Average daily summer high or maximum temperatures (June – August) increased by 1.1°F
- Annual precipitation increased by 2.75 inches.

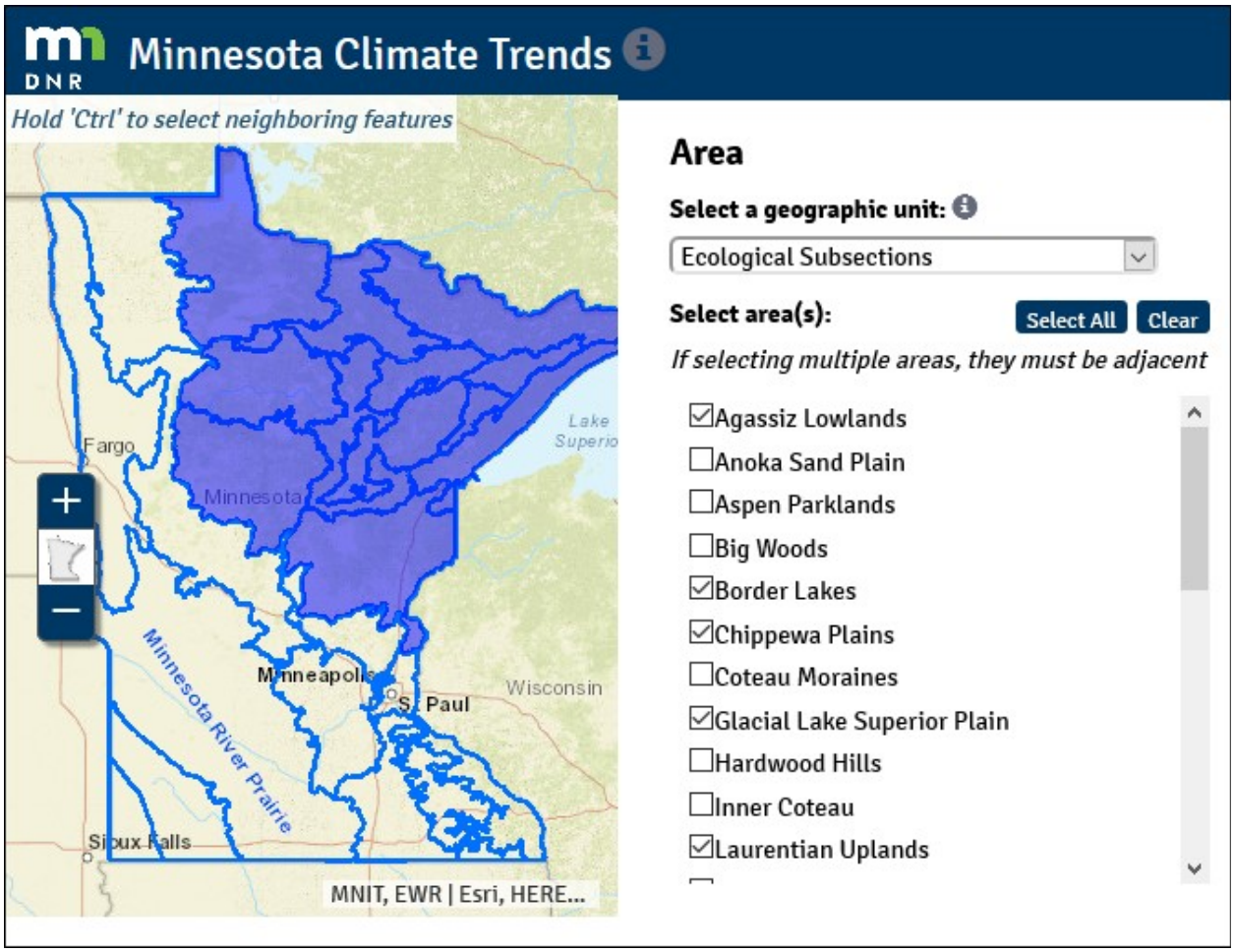

Figure 39 – DNR Climate Trend Tool, illustrating the use of the tool with Ecological subsections selected.

The pattern of warming trends observed in forested areas is consistent with observations that Minnesota's warming increases with northward extent, and is more prominent during winter than summer. This pattern is shown clearly in Figure 40, which shows northern Minnesota warming faster than the rest of the state throughout the year, with the sharpest changes seen for winter low temperatures. Summertime high temperatures do show modest increases in northern and to a lesser extent central Minnesota, but southern Minnesota's summer high temperatures have been in minor decline since 1895.

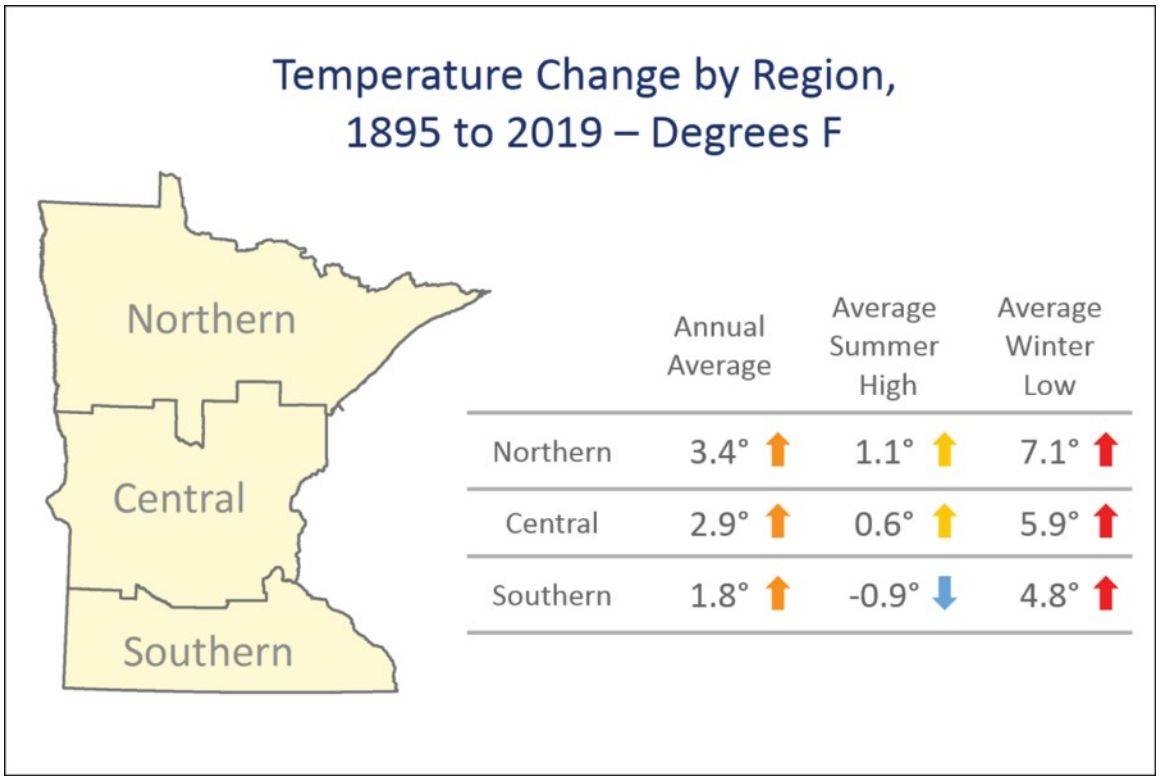

Figure 40 – Temperature change in Minnesota by region from 1895 to 2019, for annual averages, summer (June-August) highs, and winter lows (December-February). Analysis by Minnesota State Climatology Office using data from DNR Climate Trends Tool. Graphic courtesy of B. Gosack, DNR Watershed Health Assessment Framework Team.

Another way to visualize the changes in the climate is to track the observed "migration" of different average temperature contours over time. In particular, the average winter minimum temperatures show rapid northward movement over just the past few decades (Figure 41). Between 1989 and 2018, the average winter minimum temperature in Minnesota rose by roughly 5°F from the averages valid just 30 years earlier, from 1959 to 1988. Similar changes were also revealed in 2006, when the USDA revised its Plant Hardiness Zones, based on the annual daily minimum temperature. In Minnesota, Zones 3 and 4 shifted north by 75-150 miles, with Zone 5 establishing itself in far southern Minnesota for the first time. This has ramifications for forests and forest management, as suitable conditions for boreal forest species such as black and white spruce and balsam fir may contract, and those species migrate northeastward out of the state towards Canada. Conversely, opportunities for hardwood species to migrate north may be enhanced with increased plant hardiness zones being recorded in the state.

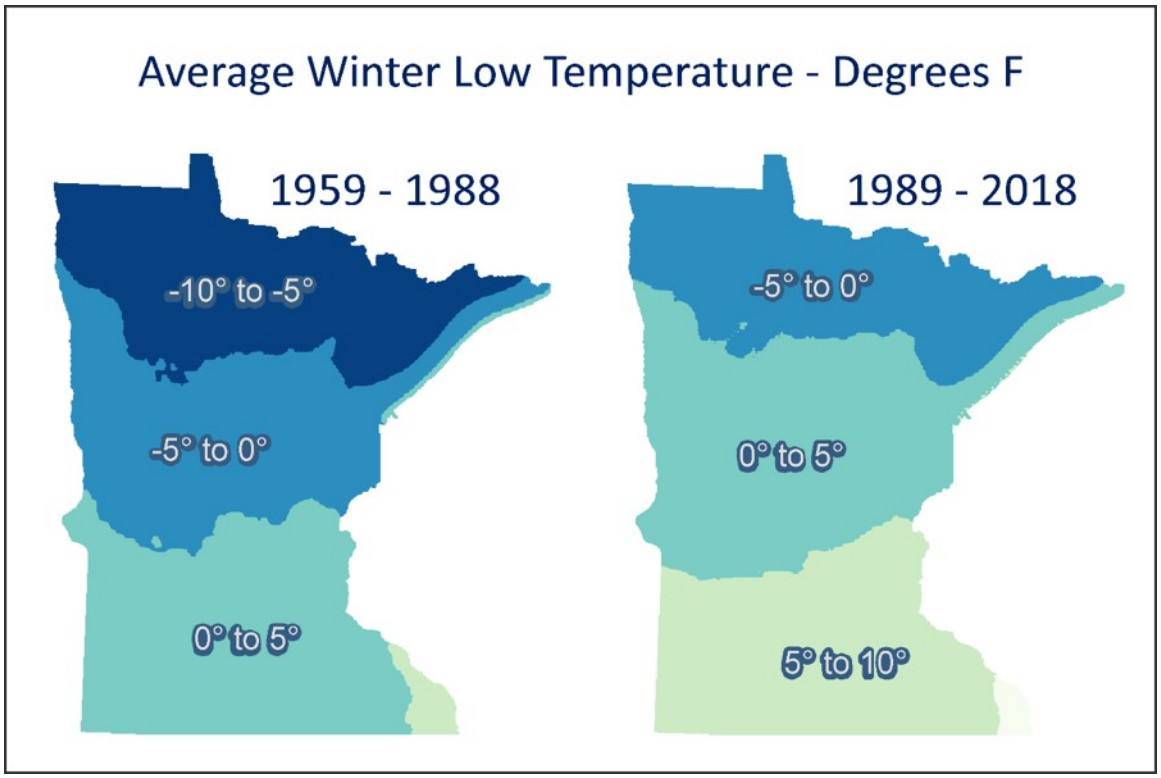

Figure 41 – Comparison of average winter minimum temperatures (December through February), 1959-1988, versus 1989-2019. The majority of the state saw winter temperatures increase by approximately 5 degrees Fahrenheit during the most recent 30-year period. Graphic courtesy of B. Gosack, DNR Watershed Health Assessment Framework Team. Data from NOAA.

Changes in climate are already affecting the state's forest resources and people's interactions with these resources, and these trends are projected to continue. Examples are as follows:

- **Forest health impacts**: Milder winters and longer growing seasons favor the survivability of certain native and invasive pests that damage forests. For example, nearly half a million acres of tamarack forest have been damaged by eastern larch beetle in recent years, as milder winters and longer summer seasons have led to an explosion in the native insect's population. Similarly, there are concerns that the invasive EAB will receive a boost in survivability as winters warm, accelerating their devastating march across the state's ash forests. However, this needs further research as there is some information suggesting that EAB is moving without any constraints due to climate but rather human-induced factors.
- **Water stress:** While overall precipitation is increasing in Minnesota, warmer temperatures and dry spells between heavy rainstorms are creating some evidence of hydrothermal deficit and stress in northern Minnesota forests. Water-stressed trees are more prone to secondary impacts from insects and disease.
- **Shifting forest composition and structure**: Warming temperatures and increased forest disturbances such as windstorms, flooding, drought, fire, and insect outbreaks are expected to favor the survival of more southerly tree species in the state, and diminish the survival of the state's boreal tree species, such as aspen, birch, and spruce. These impacts may lead to changes in the composition of Minnesota's forests over time as stated above in reference to plant hardiness zones. This is an area of concern for future climate-biome successions (R. Toot 2019) not only for Minnesota, but also for the entire Western Great Lakes Region of North America.

- Figure 42 below is an example of climate change projections for individual northern tree species in Minnesota. The state has three tree species zones that are all being affected by climate change. Information about all three is available through the Forest Adaptation report, which describes the vulnerability of tree species in the state over the next 100 years.

CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES

NORTHERN MINNESOTA

Northern forests will be affected by climate change during this century. A team of forest managers and researchers created a report that describes the vulnerability of forests in northern Minnesota (Handler et al. 2014). This report includes information on the current landscape, observed climate trends, and a range of projected future climates. It also describes many potential climate change impacts to forests and summarizes key vulnerabilities for major forest types. This handout is summarized from the full report.

TREE SPECIES INFORMATION:

This report uses two climate scenarios to "bracket" a range of possible futures. These future climate projections were used with two forest impact models (Tree Atlas and LANDIS) to provide information about how individual tree species may respond to a changing climate. More information on the climate and forest impact models can be found in the full report. This page shows the most common tree species in this local area, organized into general categories of future expectations. Results for all species can be compared side-by-side on page 2.

SPECIES	ADDITIONAL CONSIDERATIONS
LIKELY TO DECREASE	
Balsam fir	Requires cold climate and susceptible to drought, fire, and insects
Balsam poplar	Early-sucessional colonizer, but susceptible to drought
Black spruce	Requires cold climate, susceptible to insect pests and drought
Paper birch	Early-sucessional colonizer, but susceptible to insects and drought
Quaking aspen	Early-sucessional colonizer, but susceptible to heat and drought
Tamarack	Requires cold climate and susceptible to drought, fire, and insects
White spruce	Requires cold climate, susceptible to insect pests
MAY DECREASE	
Black ash	Emerald ash borer causes mortality
Northern white-cedar	Requires cold climate and susceptible to fire and herbivory
Pin cherry	Establishes well and regenerates after fire
MIXED MODEL RESULTS	
Bigtooth aspen	Early-sucessional colonizer, but susceptible to drought
Jack pine	Tolerates drought and fire, but susceptible to insect pests
Northern red oak	Susceptible to some insect pests and oak wilt
Red pine	Susceptible to insect pests and diseases, and limited dispersal.
Yellow birch	Good disperser, but susceptible to fire, insects, and disease

SPECIES	ADDITIONAL CONSIDERATIONS
NO CHANGE	
Bur oak	Tolerates drought and fire
MAY INCREASE	
American basswood	Tolerates shade but susceptible to fire
American elm	Affected by Dutch elm disease, grows across a variety of sites
American hornbeam	Shade-tolerant, but susceptible to fire and drought
Black cherry	Susceptible to insects and fire, tolerates some drought
Boxelder	Tolerates drought, also disperses and establishes well
Eastern red cedar	Tolerates drought, but susceptible to fire and insect pests
Eastern white pine	Good disperser, but susceptible to drought and insects
Green ash	Emerald ash borer causes mortality
Ironwood	Grows across a variety of sites and tolerates shade
Northern pin oak	Tolerates drought and fire
Red maple	Competitive colonizer tolerant of disturbance and diverse sites
Silver maple	Good disperser and tolerates wet soils, but vulnerable to drought
Sugar maple	Grows across a variety of sites and tolerates shade
White oak	Fire-adapted and grows on a variety of sites

Figure 42 – Climate Change Projections for Individual Tree Species – Northern Minnesota NIACS-Forest Adaptation 2014.

- **Timber access**: Sustainable forestry practices in Minnesota often rely on periods of frozen ground for accessing timber, to avoid damaging wet soils during harvest. The frozen soil season is growing shorter in Minnesota, decreasing the number of days each winter that harvest can occur. Harvest operations and trucking transportation will also be affected by decreased duration of frozen soils.
- **Outdoor recreation:** Minnesota's climate changes are affecting outdoor recreation and nature-based tourism as winters shorten and summers become longer and more humid. Outdoor changes such as snow depth and groomed trail conditions are tracked on the DNR website.

The state is concerned about these changes and impacts to forests, and is pursuing a variety of strategies to address the challenges associated with climate change. To learn more on the state's changing climate, the Minnesota Climate Trends mapping tool provides up-to-date data on climate trends dating back to 1895 across many different geographic units. Please refer to Part 2 Strategies document of this SFAP for details on climate adaptation and mitigation strategies in Minnesota.

For a further overview of 2020 climate and forestry initiatives within Minnesota refer to the recent *Washington Post* article entitled 'In Fast-Warming Minnesota, Scientists are Trying to Plant the Forests of the Future'.

Wildfire and Prescribed Burn Trends

Climate data observed over the past 10 years indicates that Minnesota is getting wetter and warmer. This wetter weather has likely contributed to unchanged trends in wildfire and prescribed burns. The maps below (Figure 43, Figure 44) were created from data submitted to the DNR Fire Reporting system and do not represent a comprehensive look at all fires across the state of Minnesota. Additional fires have occurred on other ownerships but are not recorded in the DNR system. This includes land managed by US Forest Service, US Fish & Wildlife Service, Native American Tribal Authorities, municipalities, and other agencies. The DNR does report observed fires on both public and private lands, including occurrences as small as a burn barrel to large wildfires covering extensive acreage. The symbology used in Figures 43 and 44 is not indicative of fire size. The maps below display the locations of fires occurring during the span of 2013-2018. Further data and information is available through the DNR Fire Reporting system.

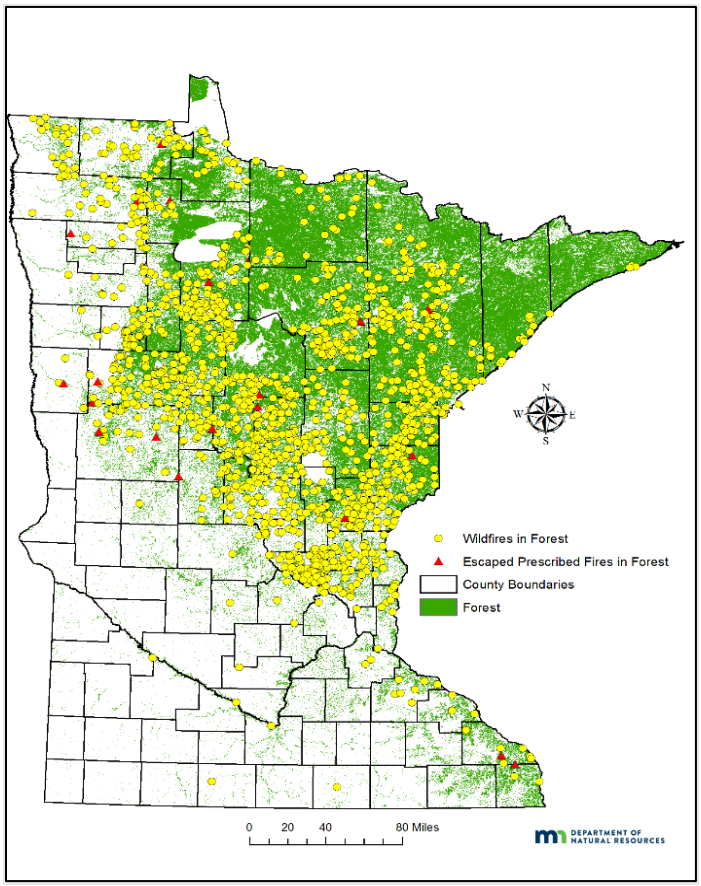

Figure 43 – Wildfires in Minnesota Across All Ownerships, 2013-2018.

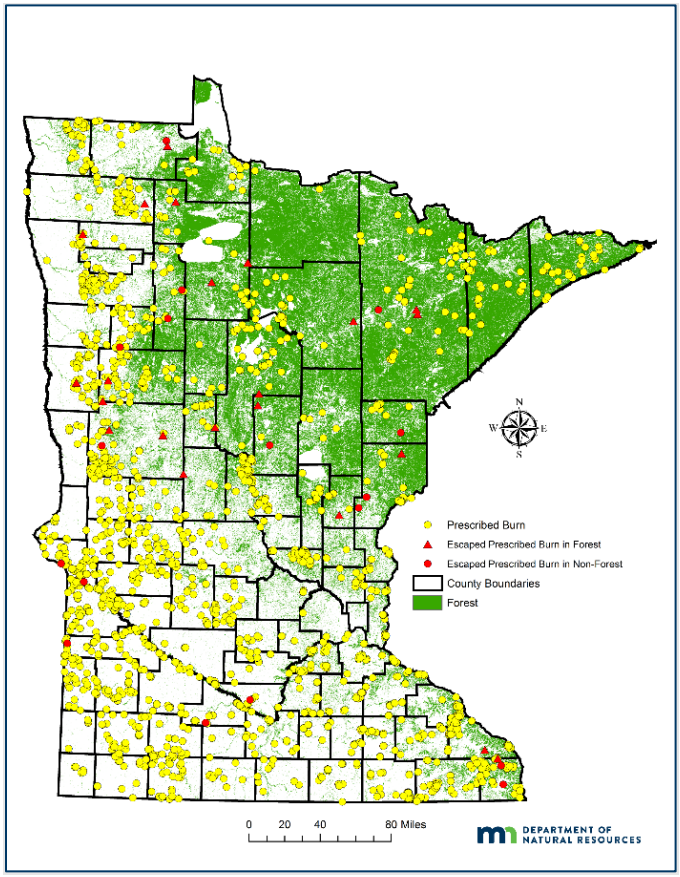

Figure 44 – Prescribed Burns in Minnesota Across All Ownerships, 2013-2018.

Community Wildfire Protection Plans (CWPP)

Minnesota encourages all communities or local units of government (LGUs) to develop CWPPs as defined by the federal Healthy Forests Restoration Act (HFRA) whenever possible. In some cases, an area may have an existing emergency management plan with a wildfire section addressing many of the points within a CWPP. In this instance, fire prevention staff work with local emergency management staff to modify the existing plan to meet the intent of a CWPP without requiring the development of a stand-alone document.

The plans enable communities to identify, coordinate, and track how they will reduce the risk of wildfires through identifying strategic sites and methods for fuel reduction projects across landscapes and jurisdictional boundaries. Benefits of having a CWPP include National Fire Plan funding priority for projects identified in the CWPP. The US Forest Service can help expedite the implementation of fuel treatments identified in the CWPP through alternative environmental compliance options offered under the HFRA.

The goal of the DNR Forestry is to develop CWPPs meeting federal requirements in all of Minnesota's 87 counties. The state also works with almost 50 communities currently recognized as a Firewise Community to assist with the risk assessment process and build their programs. DNR Forestry will continue to support current and new communities through the planning process. In 2019, seven Minnesota counties (Cook, Itasca, Lake, Pine, Mahnomen, St. Louis, and the Northwest Angle in Lake of the Woods County), two other LGUs (Karlstad Fire Department, and Kensington Fire Department), and the

Leech Lake Band have completed plans. Seven additional counties (Chisago, Isanti, Koochiching, Beltrami, Cass, Aitkin, and Carlton) have emergency management plans in place meeting the intent of a CWPP (Figure 45).

Further information is available through from the US Forest Service and the DNR.

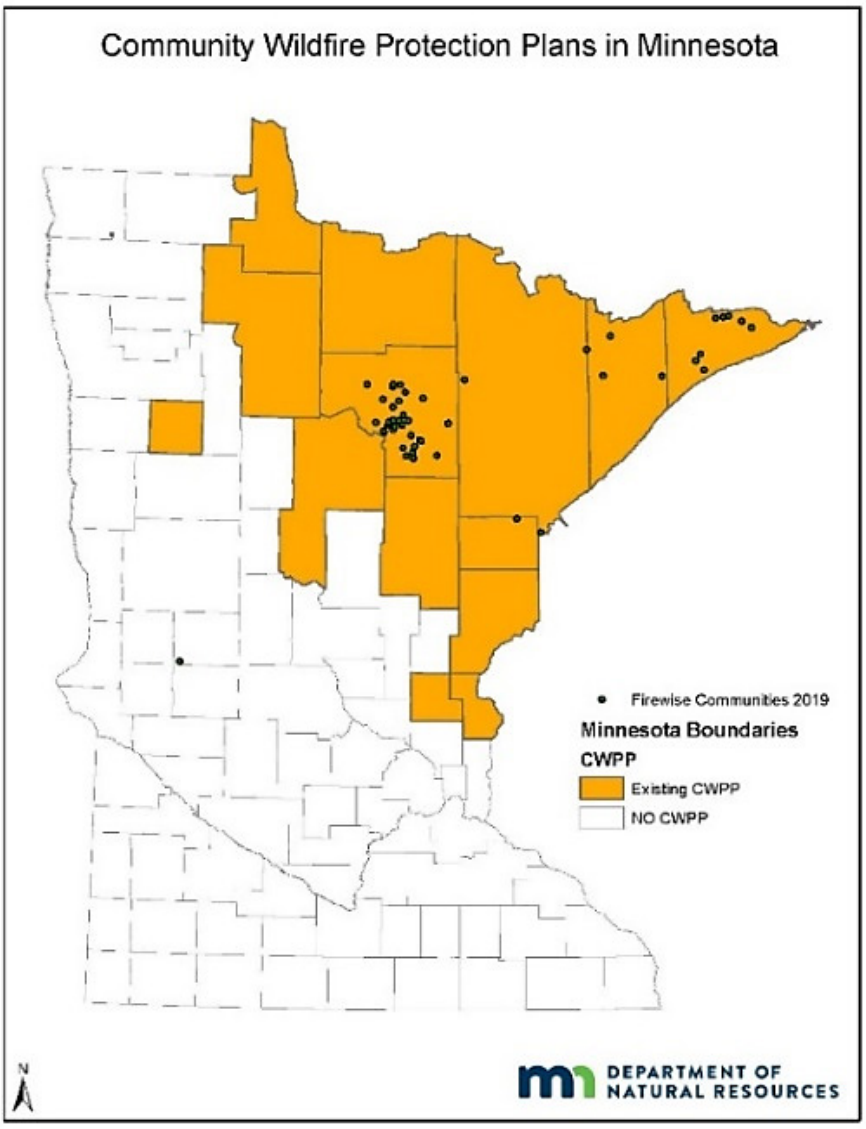

Figure 45 – 2019 Minnesota CWPP Plans and Firewise Communities.

Criterion 4. Conservation and Maintenance of Soil and Water Resources

Criterion 4 ties to the national priority *Enhancing Public Benefits from Trees and Forests*.

Indicator 8. Soil Quality on Forest Land

Geology is the foundation for soils in Minnesota that support both native land cover and the 81 HUC8 watersheds that traverse the state (Figure 46). The Minnesota Geological Survey maintains several geology databases and works cooperatively with the DNR and the Minnesota Pollution Control Agency (MPCA) to keep abreast of changes to the underlying composition of the state's deepest layers of natural resources.

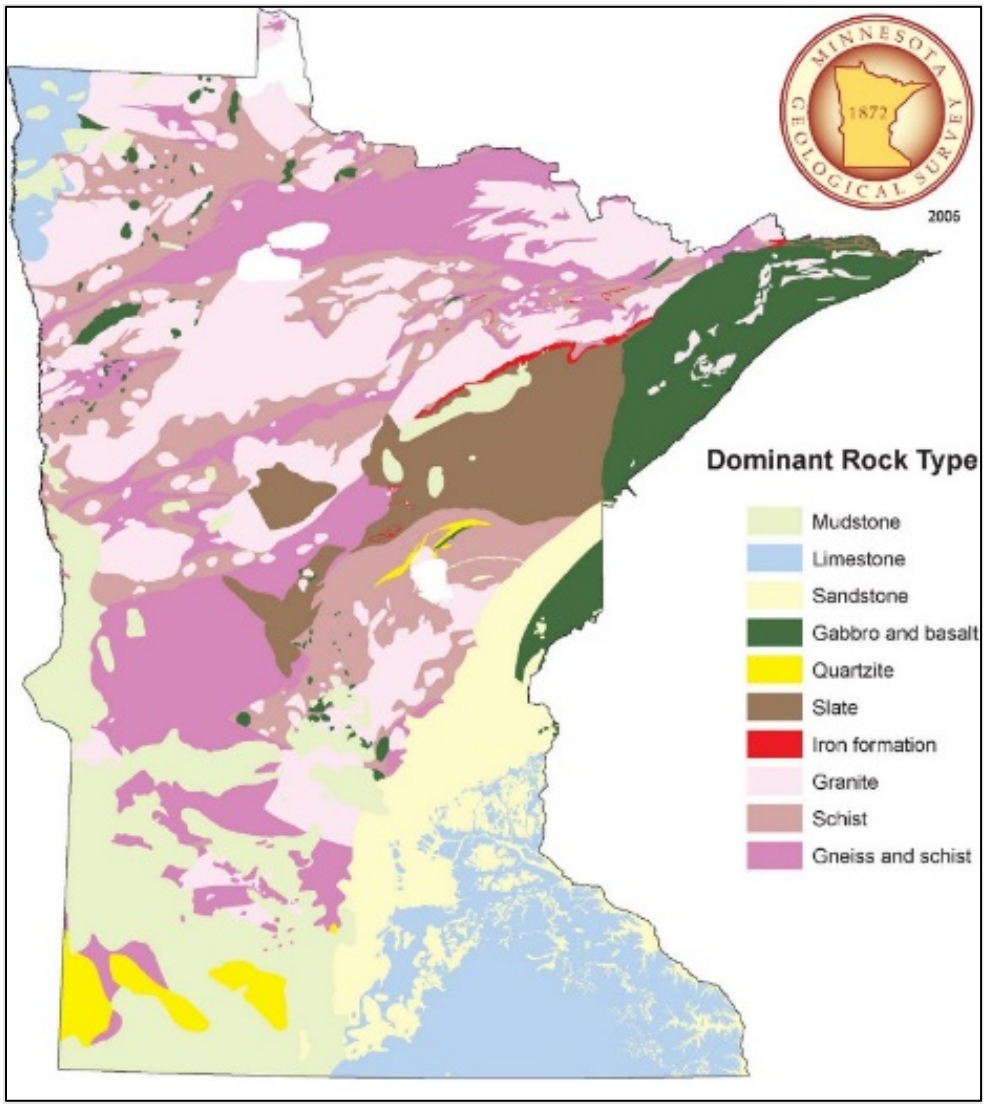

Figure 46 – Dominant Rock Types in Minnesota; Source: Minnesota Geological Survey.

8.1 Soil pH

Rich and varied soil layers are the principle foundation of productive forest land (Figure 47). Minnesota's forests soils are largely underlain by alfisols, inceptisols, entisols, and histosols. Alfisols are fertile soils that develop under deciduous forests. Inceptisols are diverse soils occurring across a wide range of climatic conditions and vegetative communities. They are considered weakly developed soils. Entisols are young soils and are common in river bottoms and outwash sand areas. Histosols are marsh and bog soils found in ancient glacial lakebeds across northern Minnesota.

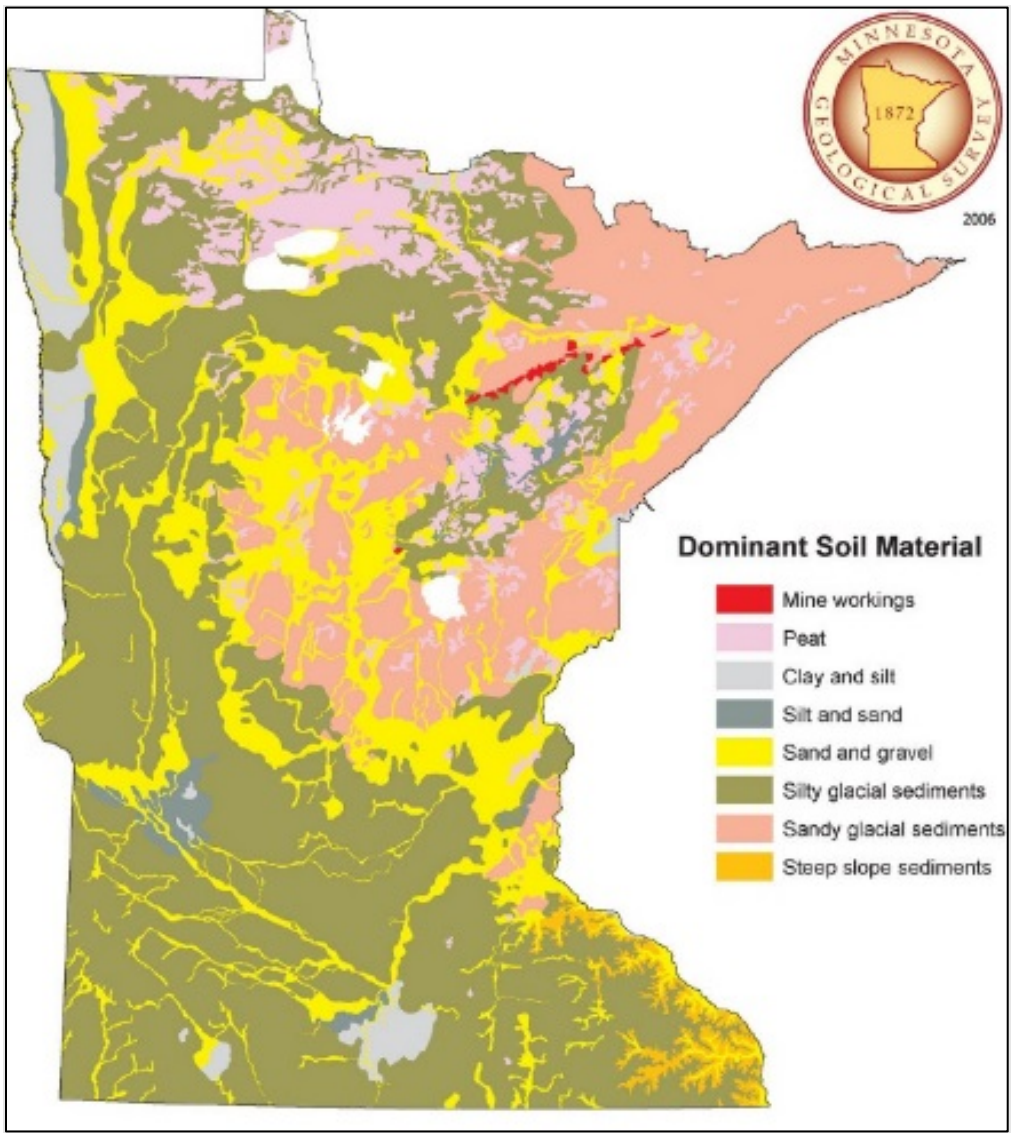

Figure 47 – Dominant Soil Materials in Minnesota; Source: Minnesota Geological Survey.

8.2 Total Soil Carbon

Forest floors of coniferous forests are deeper and thicker than those of deciduous forests. Spruce and fir forest-types have higher relative carbon content. Conversely, coniferous forest-types have lower soil pH than deciduous forest-types. Figure 48 shows soil carbon as measured on FIA phase 3 plots.

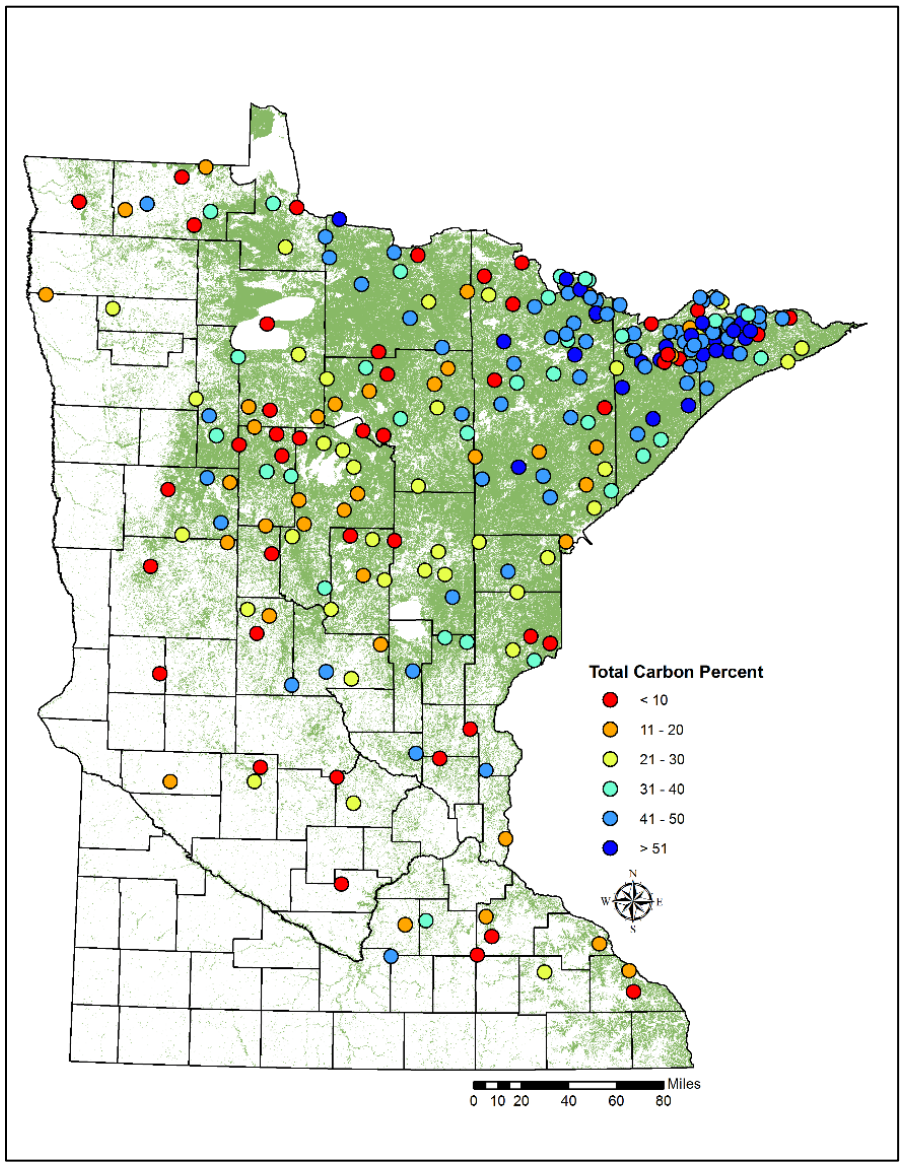

Figure 48 – Map of Total Forest Carbon in Minnesota by Percent Carbon. Source: DNR.

Higher-quality soils are found in the forest-prairie transition zone and higher amounts of soil carbon are observed in the ancient glacial lakebeds and peatlands of northwestern Minnesota. Minnesota has the most peatland (over 6 million acres) of any of the lower 48 states (Figure 49). Carbon storage in peatlands is exceptionally high. Although this soil-type covers only three percent of the world's surface, it stores more than 30 percent of the earth's soil carbon, which makes the state's peatlands a valuable commodity. However, peatlands are very sensitive to climate change. Predicted warming will aid the decomposition of organic material and thus release large amounts of stored carbon into the atmosphere. The US Forest

Service has reviewed several methods of measuring peatland carbon storage and determined that the depth of peat is the best predictor of total carbon storage (Chimner et al 2014).

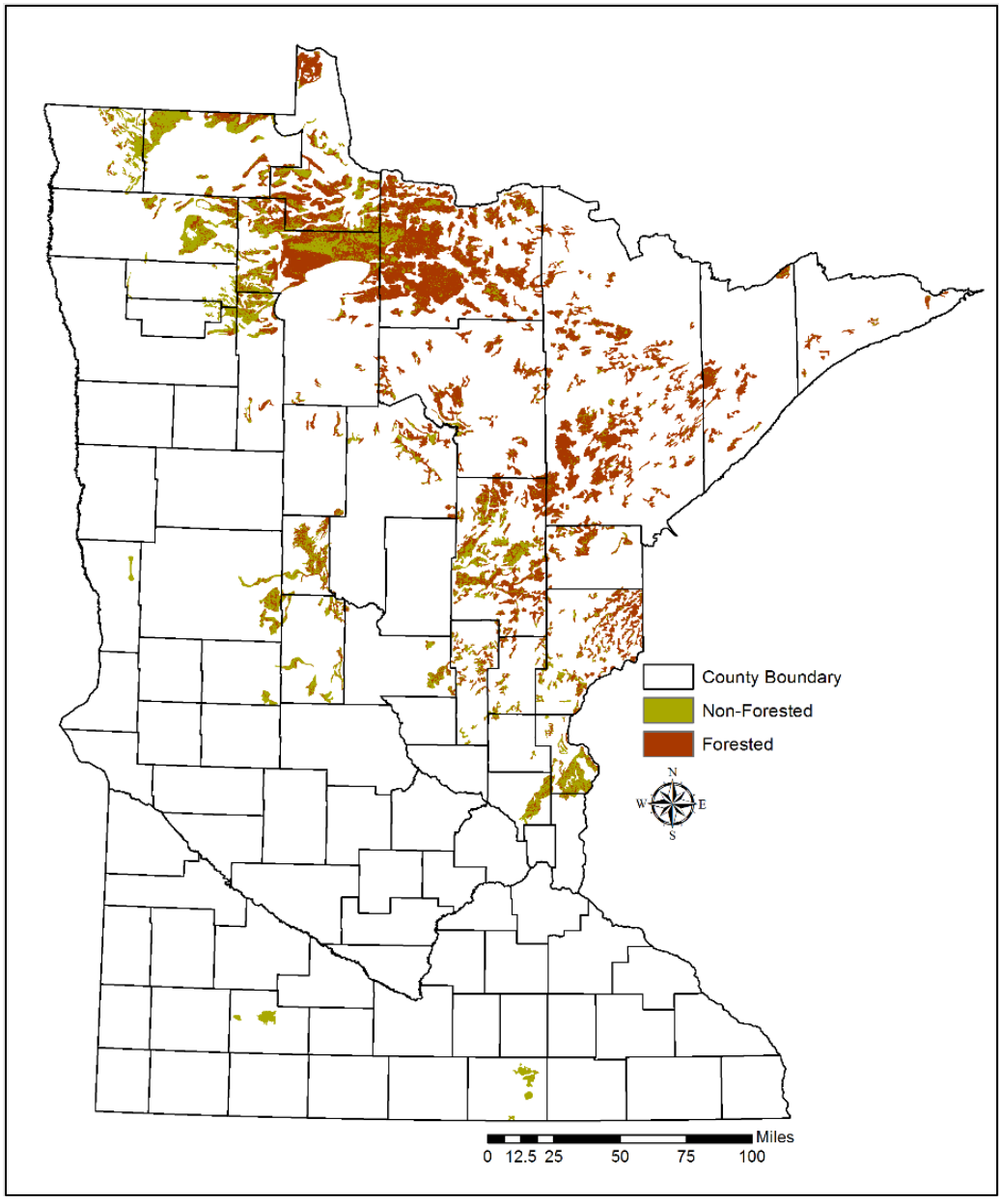

Figure 49 – Peatlands in Minnesota; Source: STATSGO Soil Survey, NRCS, 2018.

8.3 Estimated Bare Soil

Generally, bare soils are less than 10 percent as observed on phase three FIA plots around the state of Minnesota. The most common occurrence is bare soil greater than 10 percent across Minnesota (Figure 50).

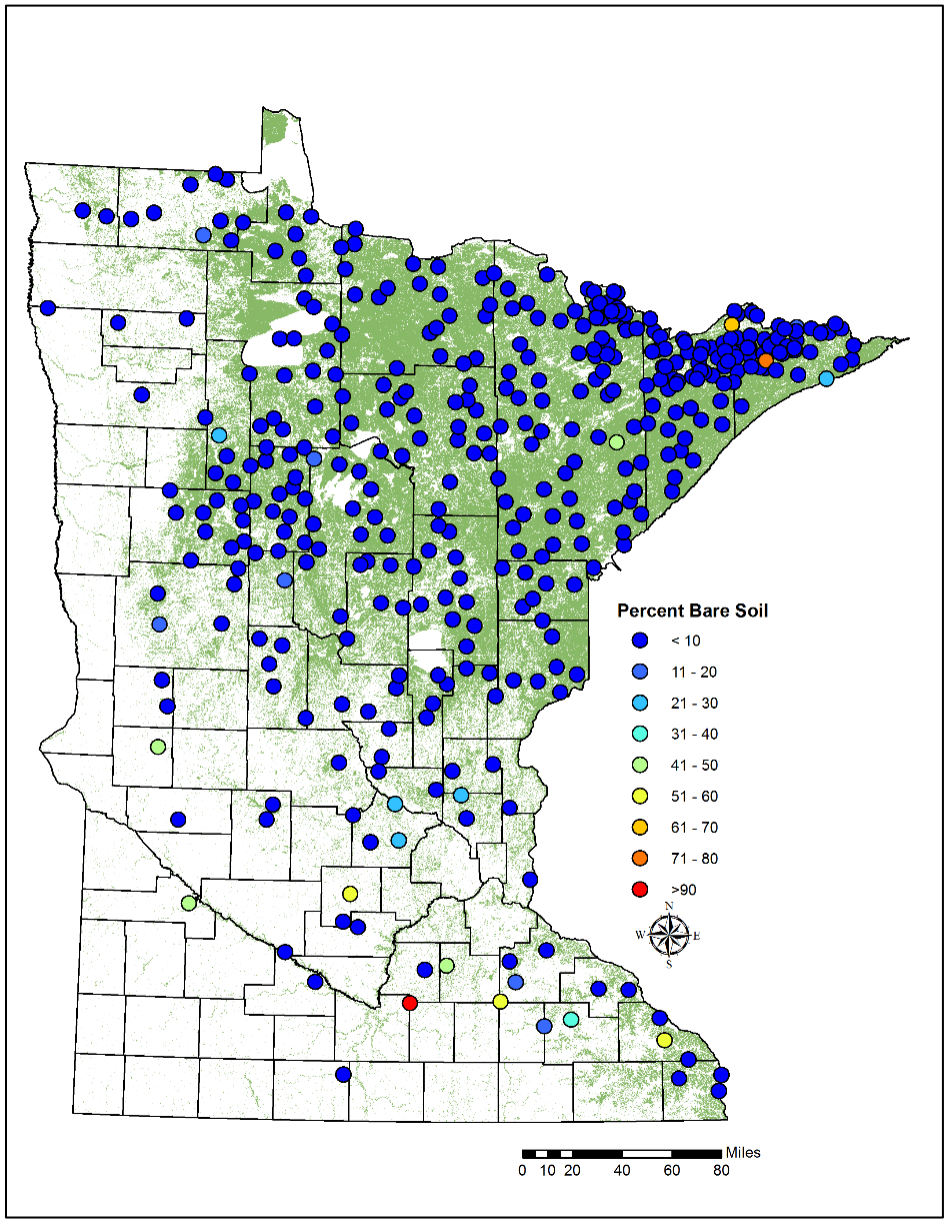

Figure 50 – Percent Bare Soil on Phase 3 FIA plots. Source: DNR.

8.4 Bulk Density

Bulk density is typically measured in grams per cm^3, and describes the amount of compaction (Figure 51). The type of soil will determine critical values of bulk density. In general, soil scientists point to values above 1.6 g per cm^3 as being detrimental to root production in plants.

There is concern about the status of soil bulk density in forest lands especially related to timber harvesting practices and urban development. During the 1980's some individual projects were undertaken by the University of Minnesota to collect bulk density data on biomass harvest research sites. However, no concerted monitoring programs or data currently exists regarding this indicator. The state would like to pursue data monitoring but is currently unable to do so, due to lack of funding. This remains a data gap in 2020.

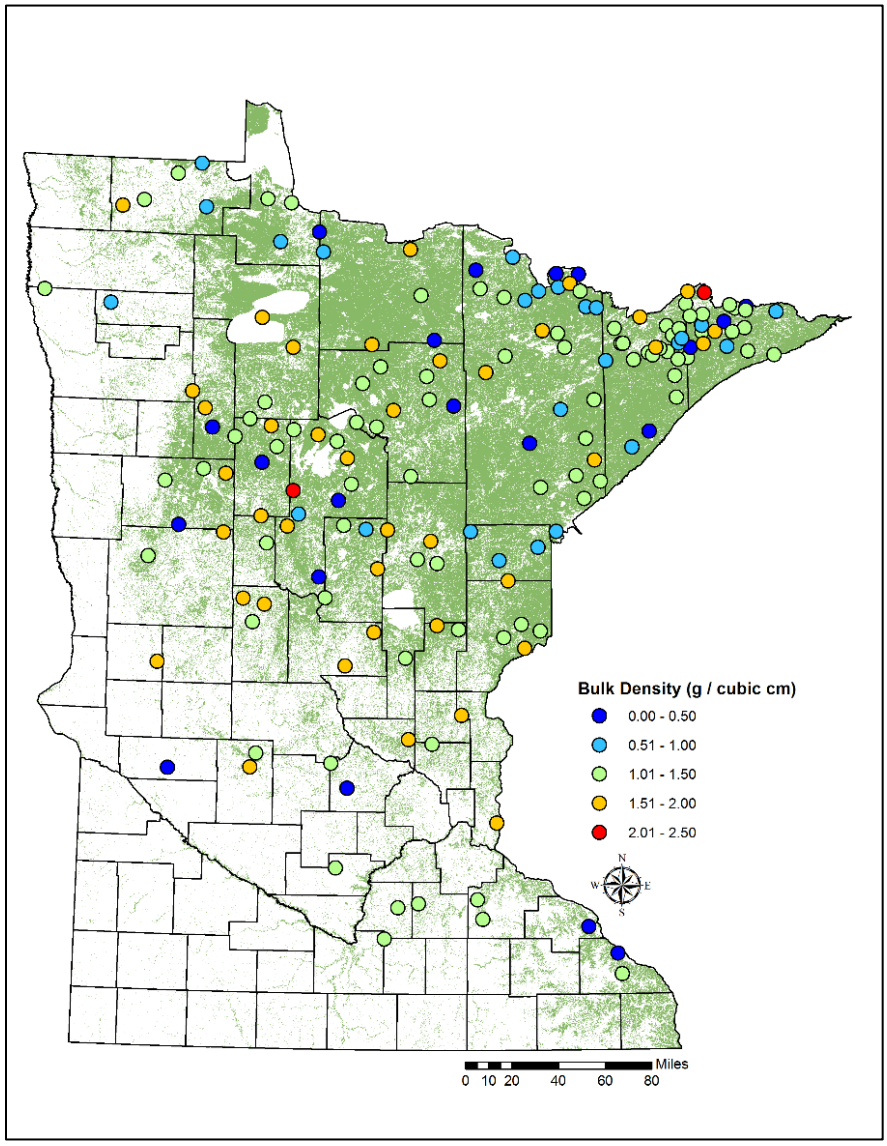

Figure 51 – Soil Bulk Density on Phase 3 FIA plots in Minnesota. Source: DNR.

8.5 Calcium-Aluminum Ratio

There is need to monitor calcium-aluminum ratios to see if any climate changes are contributing to more acidic soils in Minnesota (Figure 52). This would adversely affect current forest cover types and have wide-ranging consequences for the future of forest lands and management of forests in the state. Low values indicate areas that may be experiencing higher acidic deposition, which may impact forest health. No trend data is available at this time; this remains a data gap in 2020. The state would like to pursue additional monitoring.

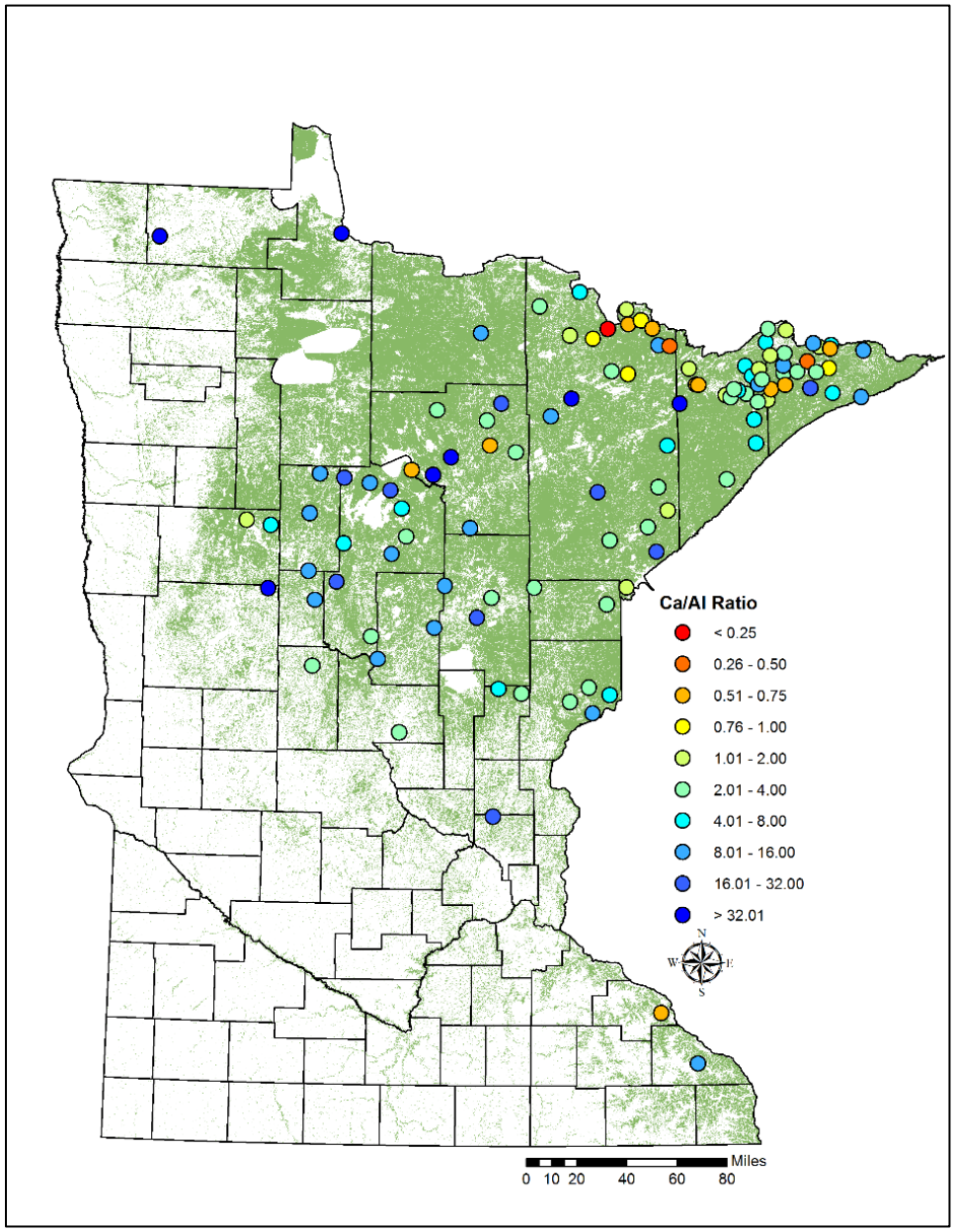

Figure 52 – CA to Al Molar Ratio as Measured on Phase 3 FIA plots. Source: DNR.

Indicator 9. Area of Forest Land Adjacent to Surface Water, and Forest Land by Watershed

9.1 Forested Riparian Areas

The extent of forested riparian areas varies greatly across Minnesota, given the diverse geomorphic and hydrologic contexts across the state, coupled with the corresponding land use patterns that have developed over the past 200 years. In the northern and eastern portions of the state, riparian areas as well as the surrounding watersheds are dominated by forest land cover. These landscapes host most of the high-quality lakes and streams that Minnesota is known for.

In contrast, the southern and western portions of the state are dominated by agricultural land uses, and fewer forested riparian areas. Surface water quality is substantially lower in these parts of the state due to a combination of geology, climate, and land-use impacts. Existing forest lands adjacent to the lakes, rivers, and streams in this part of the state provide tremendous benefits by reducing soil erosion and high levels of suspended sediments in stormwater runoff. This helps to improve water quality.

Passed in 2015 and amended in 2016 and 2017, Minnesota's Buffer Law *(Minnesota Statutes,* section 103F.48) requires perennial vegetative buffers of up to 50 feet along public lakes, rivers, and streams, and buffers of 16.5 feet along public ditches (Figure 53). These buffers help filter out phosphorus, nitrogen, and sediment. The law is meant to provide flexibility for landowners to install alternative practices with equivalent water quality benefits that are based on the Natural Resources Conservation Service Field Office Technical Guide (source: BWSR). As of July 2019, approximately 98 percent of parcels adjacent to Minnesota waters are compliant with the Buffer Law. Soil and Water Conservation Districts (SWCDs) are reporting encouraging progress in their work with landowners around the state to enhance water quality protection.

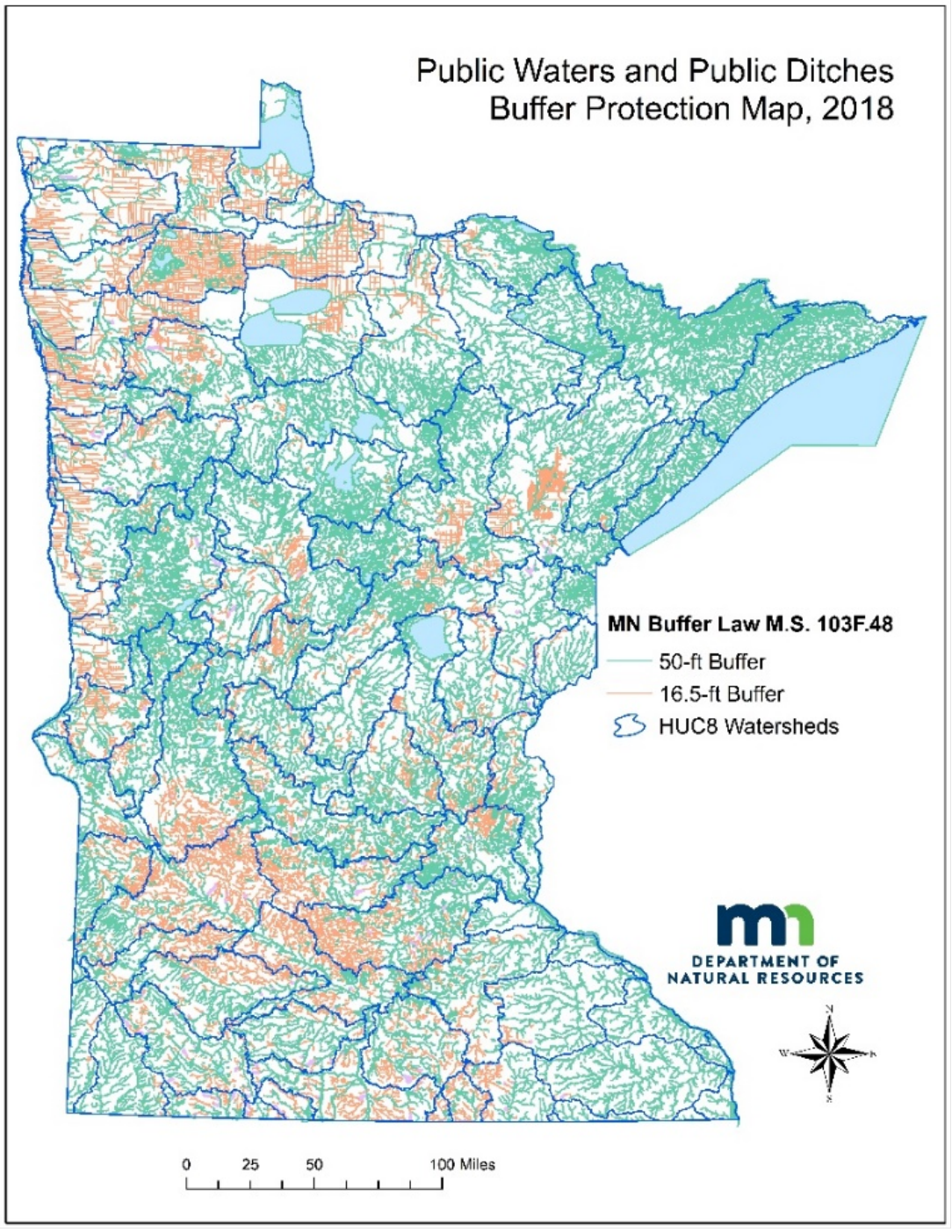

Figure 53 – Public Waters and Public Ditches Buffer Protection Map.

Water quality in the forested regions of the state benefits from the Buffer Law, as well as, by the Minnesota Forest Resources Council's voluntary Site Level Guidelines, which go beyond the minimum requirements of law. The most recent version of the guidelines is available from MFRC and described in further detail in the section outlining Indicator 17.

9.2 Forest Land by Watershed

Minnesota is a headwaters state with water draining to the Gulf of Mexico, Hudson Bay, and Lake Superior. Over half of Minnesota's 81 HUC8 watersheds have 20 percent or greater forest land (including woody wetlands; source: NLCD2016). The watersheds with higher percentages of forest cover are found in the northern half of the state (Figure 54). This includes areas along the north shore of Lake Superior, along the northern border of Minnesota and Canada, and areas that flow into the Mississippi River Basin. There are also three major watersheds in the southeastern corner of the state with forest cover greater than 20 percent.

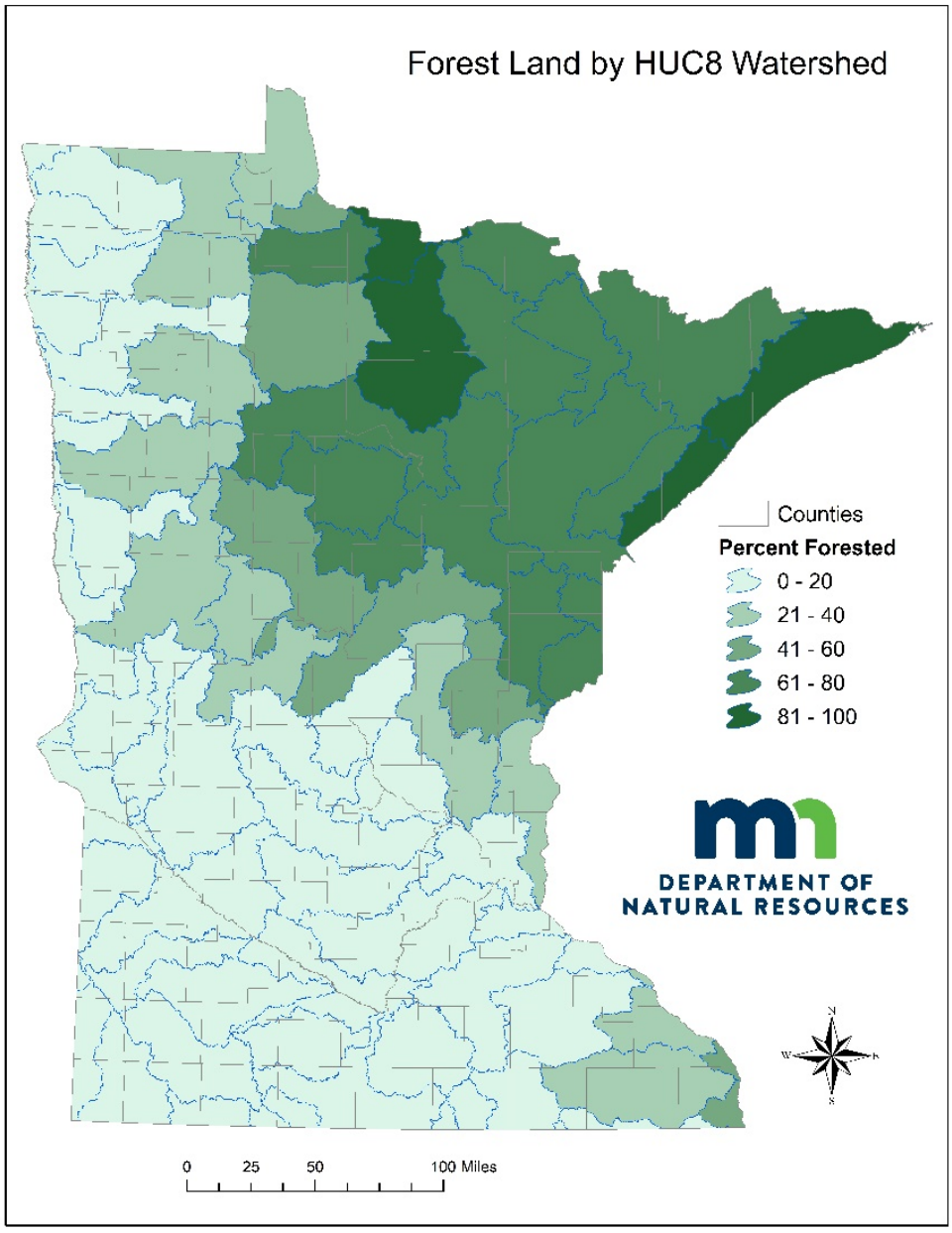

Figure 54 – Forest Land by HUC8 Watershed.

Indicator 10. Water Quality in Forested Areas

10.1 Water Quality in Forested Areas

Every two years, the Minnesota Pollution Control Agency (MPCA) updates the list of waters that do not meet water quality standards, and reports that to the US Environmental Protection Agency (EPA). The most current list is from 2018. Surface water quality monitoring by the MPCA suggests, on average across the state, about 40 percent of Minnesota's lakes and streams are impaired for conventional pollutants (nitrogen, phosphorous, and suspended solids, Figure 55). In forested regions where historical logging practices may have been a source of impairment, modern forest management practices and greater implementation of best management practices are found to be important factors in reducing impairments. The forested parts of the state generally have fewer waters impaired by conventional pollutants than those in other parts of Minnesota. Research and analyses done in the DNR's Guideline Monitoring Program are instrumental to understanding these trends and relationships between forest management practices and water quality at the watershed scale.

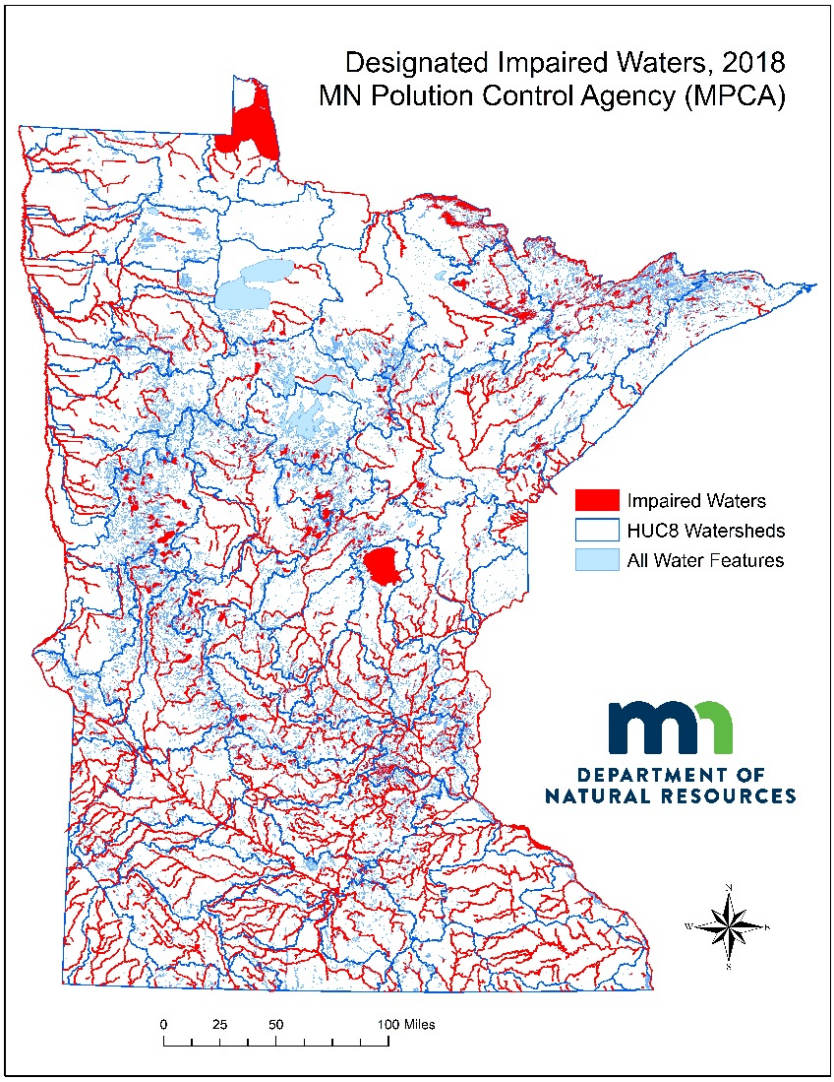

Figure 55 – MPCA Designated Impaired Waters in Minnesota, 2018.

10.2 Stream Miles Impaired by Percentage of Watershed Forested

No explicit connection between stream miles of impaired waters and percent of forest cover within a watershed, exists. Two key programs in Minnesota address protecting and improving quality of water within a watershed. These programs implement strategies that involve protecting and maintaining forest cover: the Watershed Restoration and Protection Strategies (WRAPS), administered through the Minnesota Pollution Control Agency (MPCA), and One Watershed, One Plan (1W1P), administered through the Minnesota Board of Soil and Water Resources (BWSR). Each of Minnesota's 81 watersheds will have intensive water quality monitoring and assessments conducted every ten years as part of the MPCA WRAPS process. During WRAPS, local professionals evaluate water conditions, establish priorities and goals for improvement, and define actionable outcomes designed to restore or protect water quality. When a watershed's 10-year cycle is completed, a new cycle begins.

The 1W1P Program is a partnership between BWSR and local units of government across the state to develop prioritized, targeted, and measurable (PTM) implementation plans at the major watershed (HUC 8) scale. Plans are being developed for all 81 watersheds in the state. As described in *Minnesota Statutes* chapter 103B, these plans must address: 1) surface water and ground water; 2) storage and retention systems; 3) groundwater recharge; 4) flooding and water quality problems; 5) wetlands; 6) riparian zone management and buffers; and 7) fish and wildlife habitat and water recreational facilities. Monitoring and assessment of the effectiveness of these two water resource programs, with emphasis on the outcomes of forest management activities, and the influence of scale on the outcome, is a data gap. Frequent collection of remotely sensed data, such as lidar and stereo aerial photography, are needed.

Watersheds in northern Minnesota benefit from the high quantity of public lands that are mostly forested or covered with other native plant species. Regardless of ownership, the primary risk to water quality is poor best management practice implementation, where land use practices and land cover conversion or development results in increased stormwater runoff, thus resulting in declining water quality. Increasing private forest management and conducting outreach in using best management practices is critical to protecting water quality and wildlife habitat. The amounts and patterns of public and private lands vary greatly within the 81 major watersheds across the state. Though potentially complicated, it is important to proactively plan and attempt to coordinate the management of forest resources on a landscape-scale with major watersheds in mind, to protect water quality.

DNR Forestry is working together with the US Forest Service, BWSR, and project partners to protect water quality and habitat through the development and implementation of watershed-based landscape stewardship plans in the forested regions of the state. These plans will identify and prioritize privately owned forest land down to the parcel level to encourage forest land protection and sustainable forest management, including timber harvesting. This landscape stewardship initiative is an "all lands" approach to forest management. Created by the US Forest Service, it addresses multiple conservation challenges through the practical application of science and collaboration. The watershed based landscape stewardship plans provide critical context for the development of 1W1Ps.

Investments by the US Forest Service in the DNR's Forest Stewardship and Forest Legacy programs support the development of watershed-based landscape stewardship plans. These plans are helping to enhance the effective delivery of forest stewardship and conservation services to landowners in priority watersheds, so that forest resources can continue to provide clean and sustainable drinking water to people downstream. In other words, actively managed, healthy and sustained forests protect drinking water supplies.

The study completed by the US Forest Service and the Timmons Group, "Forests to Faucets II" (F2F2), determined which catchment areas could be targeted for S&PF investment because they are a key source for municipal drinking water supply

(Figure 56). In other words, F2F identifies catchments important to downstream drinking water supplies (including source water protection areas, shown in Figure 57), as well as evaluates a catchment's natural ability to produce clean water. In Minnesota, there are over 572,000 acres of stewardship, defined as "service delivery", in over half of the available catchments, servicing nearly 700,000 people downstream from the forest management activities targeted in those watersheds. Most of the priority watersheds are concentrated within the Mississippi River Basin and the Lake Superior Basin.

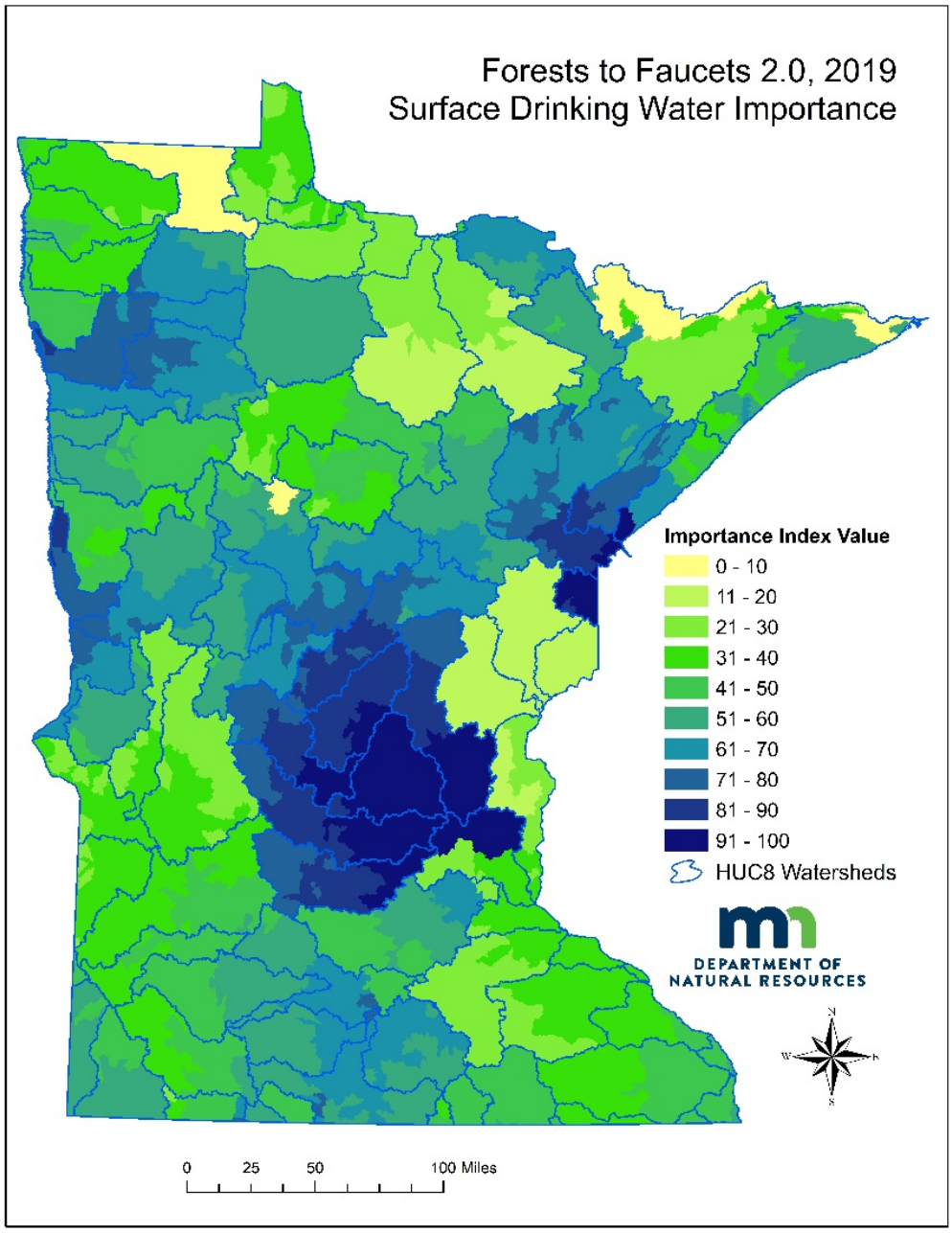

Figure 56 –Results of Forests to Faucets II (F2F2), Showing Watersheds With Higher Importance for Surface Delivery to Drinking Water Downstream in Darker Greens and Darker Blues.

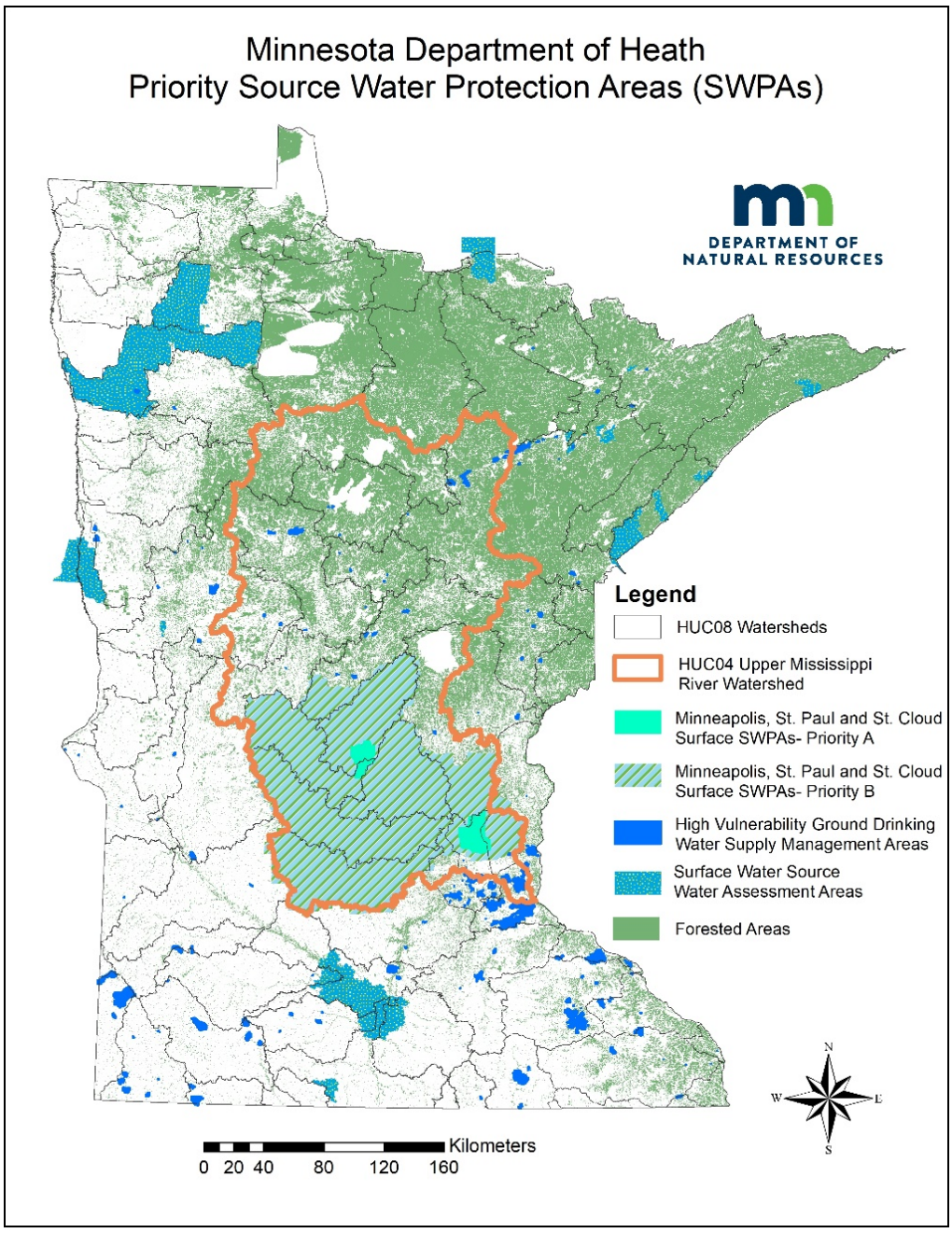

Figure 57 – Priority Source Water Protection Areas in Minnesota.

Criterion 5. Maintenance of Forest Contribution to Global Carbon Cycles

Criterion 5 ties to the national priority *Enhancing Public Benefits from Trees and Forests*.

Indicator 11. Forest Ecosystem Biomass and Forest Carbon Pools

The following sections outline details about forest carbon pools using FIA data, including biomass and carbon stocks, and distribution of carbon pools by type and public land ownership.

11.1 Forest Ecosystem Biomass by Forest Carbon Pools

According to FIA, biomass from hardwoods (Figure 58) exceeds that of softwoods, both of which have been steadily increasing since 2004.

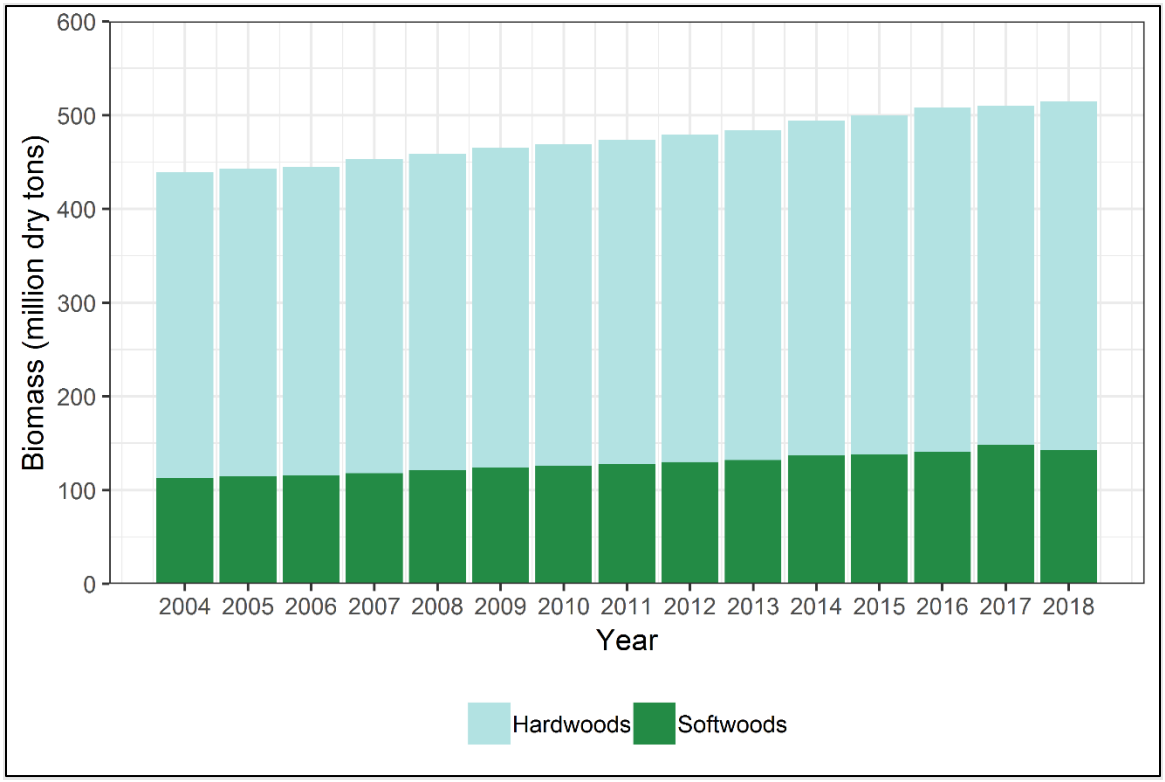

Figure 58 – Biomass (dry tons) Trends on Forest Land by Major Species Group. Source: FIA.

11.2 Change in Forest Carbon

Forest carbon stocks have been increasing in Minnesota over the past several decades. This is largely attributed to the continued sustainable management of Minnesota forests, both on public and private lands, as well as to the reversion of degraded, erosion-prone agricultural and marshlands back to forest lands. As an example, examination of FIA data shows that forest land in Minnesota increased by two percent from 2008-2013, resulting in an additional 4.5 million metric tonnes Carbon (tC) in stored carbon in forest lands, or a three percent increase over a 5-year period.

For quantifying carbon stock changes on Minnesota forest lands, all carbon pools are considered and measured in metric tonnes. The pools include: above and below ground biomass, standing and laying deadwood, litter, and soil organic carbon. Remotely sensed information could also be used to measure all of the above-ground aspects. Table 8 shows a summary of FIA data estimating total stored carbon based on pool type, and changes over a 10-year period (from 2008-2018).

Carbon Pool	Tonnes Carbon (tC)	Δ over 10-year period	Percent change over 10-year period
Above ground biomass (AGB)	246,335,314	26,532,206	12.07
Below ground biomass (BGB)	49,992,615	5,599,259	12.61
Dead wood – all	65,366,500	4,742,178	7.82
Litter	116,970,316	8,413,604	7.75
Soil organic carbon (SOC)	1,200,200,727	54,653,990	4.77
Total	**1,678,865,472**	**99,941,237**	**6.33**

Table 8 – Minnesota Carbon Stocks, Measured in Tonnes, and Changes Over a 10-year Period from 2008-2018.

Figure 59 below further illustrates how the different carbon pools compare and contribute to total carbon stocks within Minnesota forest lands.

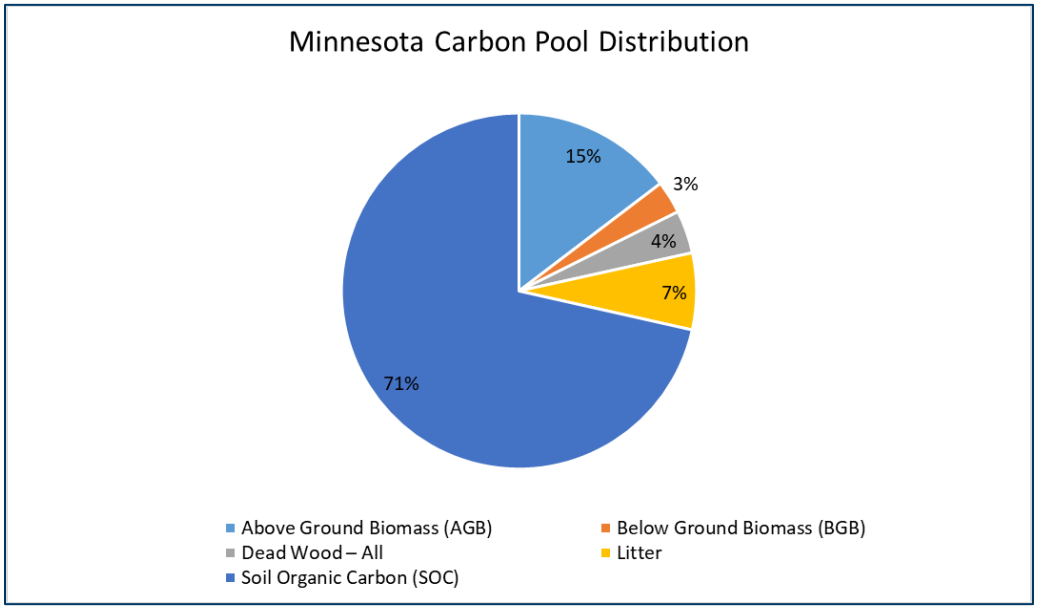

Figure 59 – Minnesota Carbon Pools by Type-2018. Source: FIA.

Average forest carbon stocks within Minnesota are 95 tC acre $^{-1}$/year $^{-1}$, or 349 tCO_2-e acre $^{-1}$/year $^{-1}$. This accounts for all pools, with soil organic carbon (SOC) storing the majority of carbon, as seen in the figure above. In contrast, the remaining average forest carbon stocks, i.e., without SOC, are 27 tC acre $^{-1}$/year $^{-1}$, or 99 tCO_2-e acre $^{-1}$/year $^{-1}$, a substantial difference when assessing all carbon pools (i.e., 250 percent increase in carbon with SOC contribution).

Total forest ecosystem carbon stocks in Minnesota are estimated to be 1.67 billion tC or 6.15 billion tCO_2-e, ranking the state sixth in the nation for highest *total* carbon stocks, and first for highest soil organic carbon (note: Alaska is not included in this assessment). Other than soil organic carbon, the largest changes seen in the table above, have been in above and below ground biomass. This largely a result of increased forest land area as well as increased stocking, and tree volume on public and private forest lands. As an example, more than 54 percent of carbon stocks for live AGB are held in stands with an age class range of 61 to 100 years, representative of larger biomass volumes within the higher age classes.

Figure 60 below shows the 10-year increase in carbon stocks, with an average increase of 9.9 million tC, or one percent year-over-year increase across all pools.

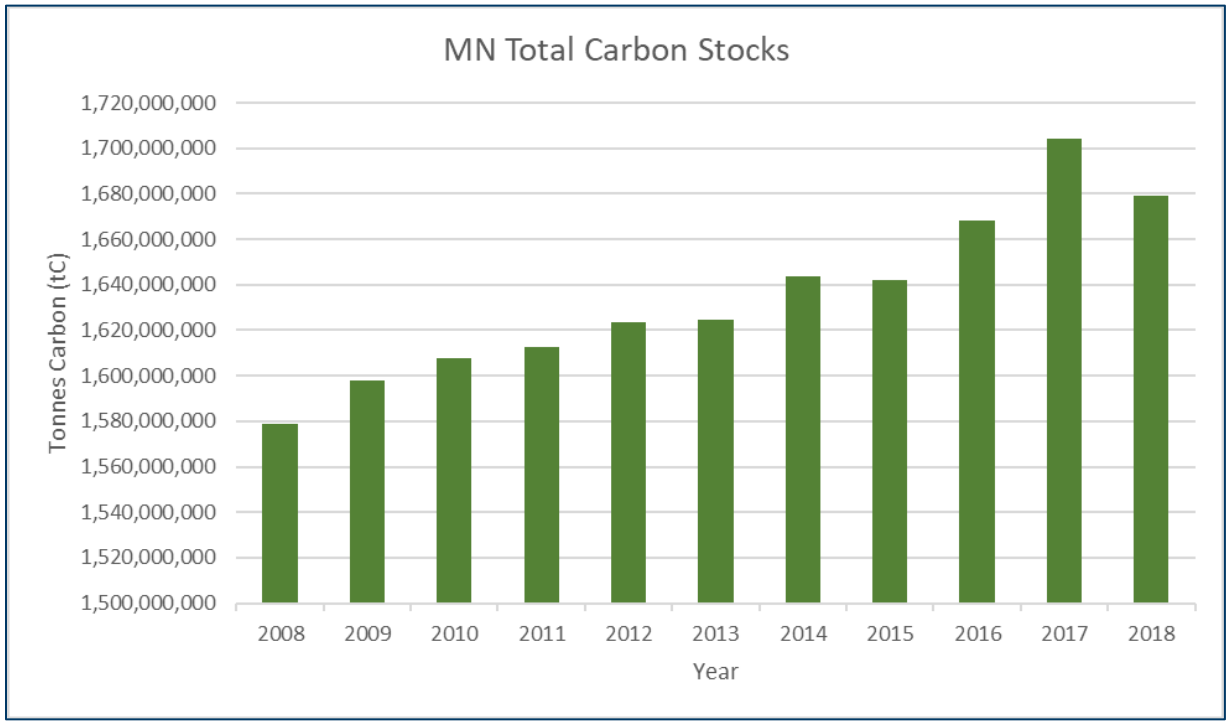

Figure 60 – Minnesota Total Forest Carbon Stock (above and below ground) Changes, 2008-2018; Source: FIA.

When analyzing carbon stocks at a county scale, instead of statewide, there's an observable difference between ownership types (i.e., public and private lands). Below is a graph (Figure 61), depicting the 10 largest total forest land carbon stocks by county in Minnesota, which account for approximately 73 percent of total forest carbon, separated into public and private ownerships. As seen, these public forest lands store a proportionally higher amount of carbon when compared to private lands, with a total of 4.86 million tonnes more stored carbon (private forest ownership accounting for 44 percent of total Minnesota forest lands). The higher volume of carbon stocks on public lands is also reflective of the forest acreage and stocking levels, where approximately 31 percent and 43 percent of the assessment area are medium and fully stocked forests, respectively. Although total carbon stocks are higher on public lands, private forests are significant contributors to total stored forest carbon. This underlines the importance of taking a landscape-level approach to forest carbon

management, and working together across ownership boundaries to support healthy and contiguous forest cover. FIA data is reliable at state and county scales. To get a detailed look at the landscape and down to the parcel scale, derivative models of forest inventory metrics using remotely sensed information are needed. It should also be noted that calculations of carbon storage in urban forests and trees are not included in this summary, as FIA data is lacking for many communities. This is a data gap and needs further exploration.

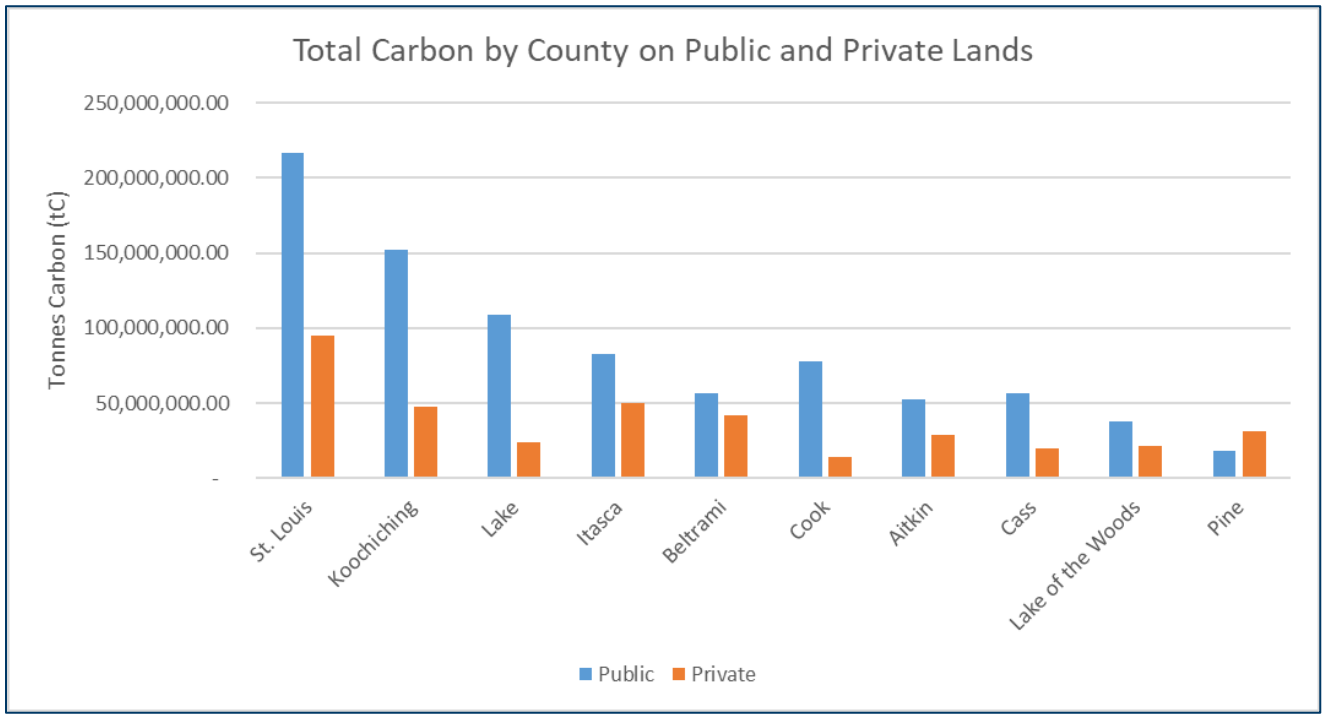

Figure 61 – Minnesota Carbon Stocks on Private and Public Land by County; Source: FIA; 2018.

Criterion 6. Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies

Criterion 6 ties to the national priority *Enhancing Public Benefits from Trees and Forests.*

Indicator 12. Wood and Wood Products Production, Consumption, and Trade

12.1 Value of Wood-related Products

The monetary value of Minnesota wood products has been generally increasing over the last 16 years. Value-added products are produced primarily by the paper products industry, as well as manufactured and finished wood products. These include window and door components as well as cabinets and other residential products (Figure 62).

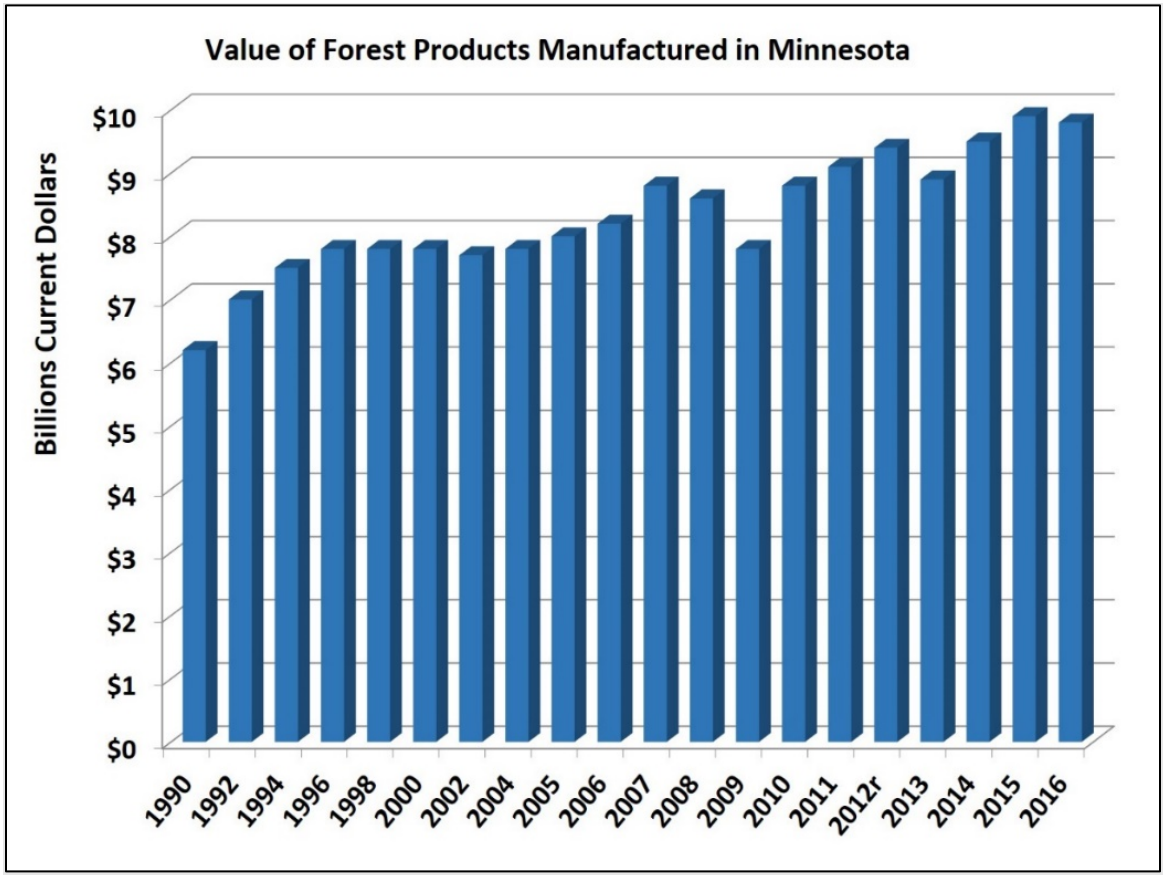

Figure 62 – Value of Forest Products Produced in Minnesota 1990-2016. Source: DNR.

While the value of Minnesota wood products has increased over the last 16 years, Minnesota's gross state forest products per capita ranking has fallen. In 2012, Minnesota was ranked seventh nationally in forest products manufacturing with $524 direct value added Gross State Product (GSP) per capita. In 2016, Minnesota was ranked twelfth nationally in forest products manufacturing with $473 direct value added GSP per capita. See Indicator 16 for additional discussion of this topic.

12.2 Production of Roundwood by Product and Species Group

The DNR tracks three categories of wood products including pulpwood, sawlog, and fuelwood. These products compromise the total roundwood harvested in the state. Reporting is typically two years behind the current year due to annual survey data collection. The DNR collaborates with the US Forest Service and relies on pulpwood and sawlog timber product output mill surveys, residential fuelwood surveys, and commercial fuelwood surveys to gather data on the three sectors in the state.

Generally, hardwoods and in particular quaking aspen have made up the vast majority of roundwood production in the state (Figure 63). Recently, the state began reporting on mixed species, generally utilized as fuelwood (Figure 64). Roundwood harvest declined significantly from 2005 to 2007 and has remained relatively stable since, with typical annual harvests between 2.7 and 3.1 million cords. As shown in Figure 64, most of the decline in harvest was in hardwood, with softwood harvest remaining relatively constant.

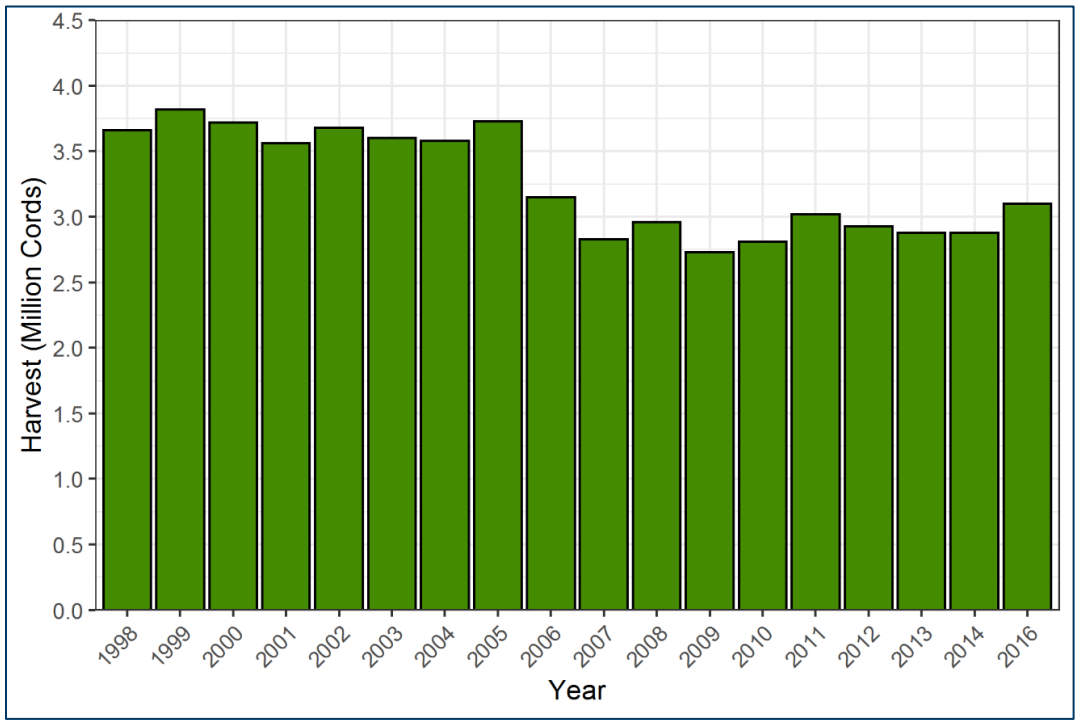

Figure 63 – Total Roundwood Harvest from Minnesota Timberlands, 1998-2016. Source: DNR.

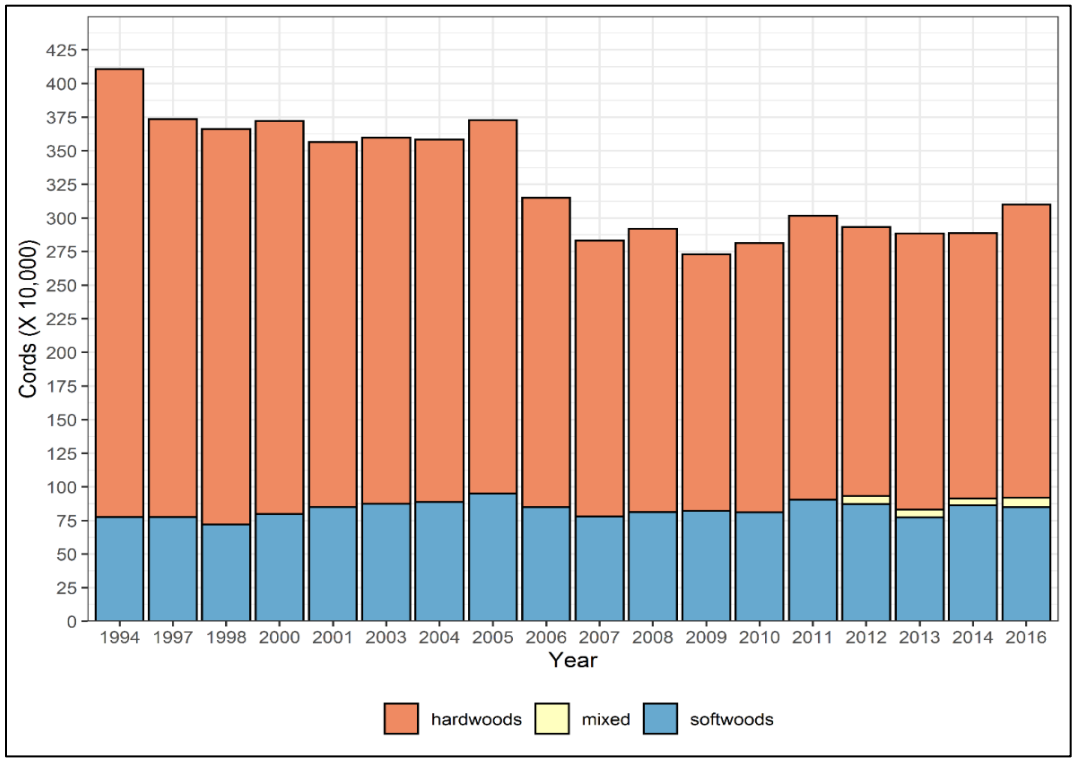

Figure 64 – Roundwood Harvest by Species Groups; Source: DNR Mill Surveys and USFS-TPO, 1994-2016.

Hardwoods have generally contributed most to the pulpwood production category, particular quaking aspen, maple and birch. In the sawlog production, oak, basswood and birch have made up a majority of the sawlog production (Figure 65).

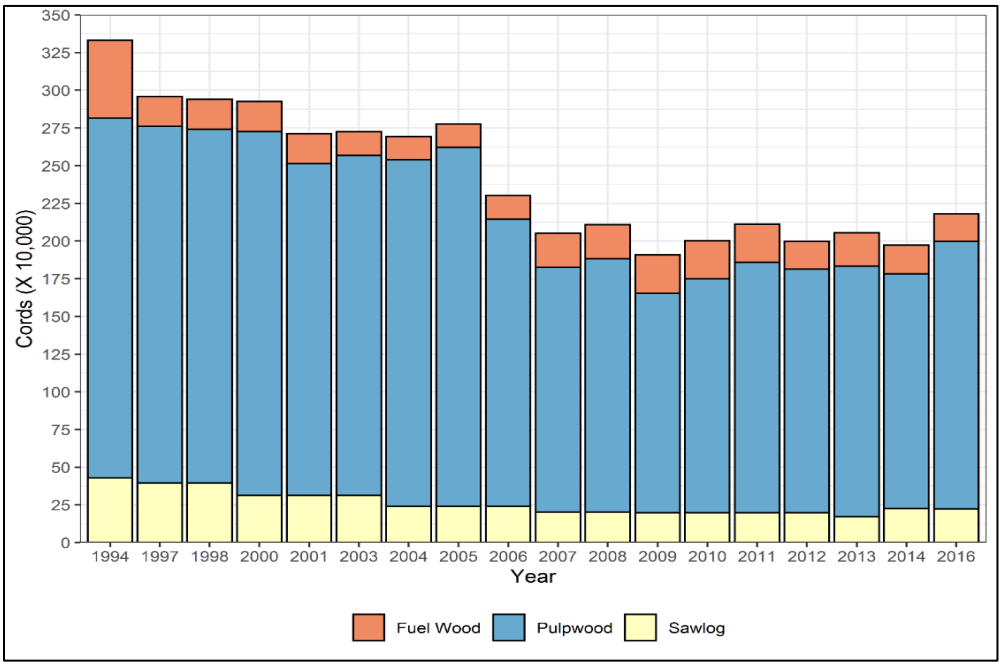

Figure 65 – Hardwood Harvest by Product Class; Source: DNR Mill Survey and USFS-TPO Reports. 1994-2016.

Softwood production is dominated by pines (red, white, and jack) for sawlogs, while black spruce and balsam fir makes up a significant share of the pulpwood. Saw log and fuelwood production have increased in recent years (2013-2016) (Figure 66).

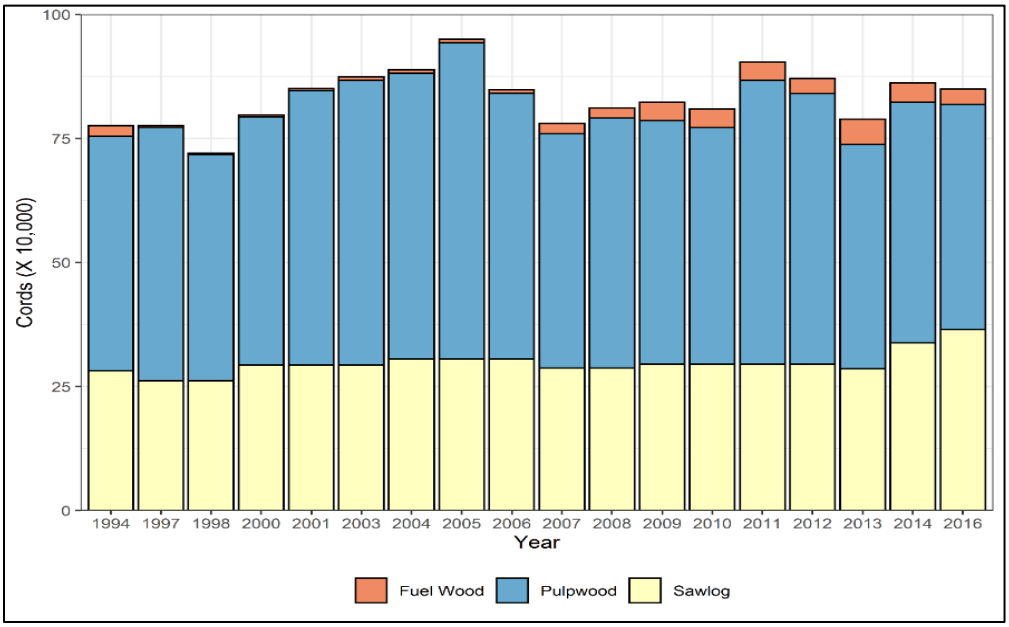

Figure 66 – Softwood Harvest by Product Class; Source: DNR Mill Survey and USFS-TPO Reports. 1994-2016.

12.3 Production and Consumption of Roundwood Equivalent

From at least 1996 to 2005, the oriented strand board (OSB) and pulp and paper industries each used between 35-40 percent of the annual roundwood harvest comprising an average 76 percent of the roundwood consumption. Quaking aspen made up 55 percent of the pulp and paper industry's roundwood consumption, while OSB manufacturing utilized up to 90 percent quaking aspen according to a DNR Forest Resources Report from 2000. Starting in 2007, the roundwood consumption by the OSB industry constricted as mills closed. Since 2007, the pulp and paper sector now accounts for a higher percent of roundwood harvest due to reductions in other sectors. Consumption by the wood energy sector increased gradually from 2007-2014, but has since declined dramatically. The lumber and specialty sector has remained consistent, consuming between 15-20 percent of the annual roundwood harvest (Figure 67).

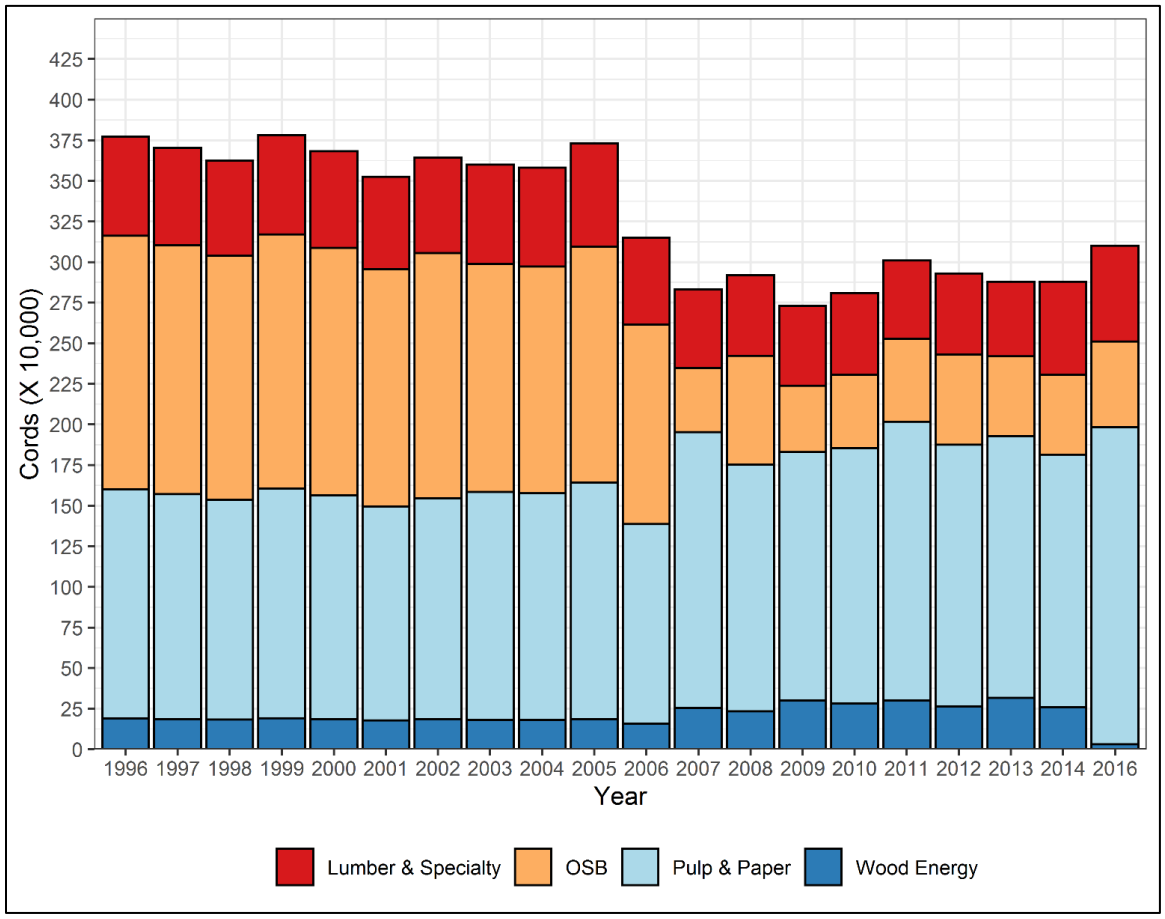

Figure 67 – Consumption of Roundwood by Major Forest Industry Sectors; Source: DNR Mill Survey and USFS-TPO Reports. 1994-2016.

12.4 Percent Recovered Paper Consumption

The Minnesota Pollution Control Agency (MPCA) houses data related to statewide recycling. The data can be broken down to reveal "recycling by category." In general, trends in combined recycling (including organics) has been rising steadily since 1991. Paper makes up the largest share of recyclables statewide. In 2010, paper accounted for 44.5 percent of all recycling in the state with a total of 711,727 tons of paper recycled that year. In 2017, the most recent year for which data are available, paper accounted for 35.9 percent of all recycling in Minnesota but a total of 944,826 tons of paper were recycled

that year; this indicates an increase of almost 25 percent in paper recycling over seven years, though it was a smaller share of overall recycling.

Minnesota has three mills that use recycled paper to make recycled pulp, bags, cardboard and corrugated box products. Nearly half of the paper recycled in Minnesota is processed at the West Rock facility in St. Paul and turned into linerboard. Liberty Paper in Becker, recycles cardboard boxes into new linerboard and bags and the Verso Corporation in Duluth, uses recycled paper fiber and produces recycled pulp, which is used to make a variety of new paper products.

12.5 Percent of Energy from Wood Biomass

Woody biomass comes in several forms and continues to be a source of renewable energy for both industrial and non-industrial applications in Minnesota. The forest products industry has been using biomass for heat, power or both for over 30 years. District and residential thermal heating remains an attractive option due to the volatile price of fossil fuels and the potential for local energy savings and benefits. Wood provides opportunities to efficiently use a high BTU value, carbon-neutral product as energy. In 2018, Xcel Energy Corporation terminated power purchase agreements with three woody biomass facilities under two entities: the Laurentian Energy Authority and Benson Power. This led to significant changes in the wood energy markets in the state, starting in 2018. Currently commercial wood fuels account for just one percent of the estimated wood use by primary industry sector. Minnesota wood energy information can be located on the Minnesota bioenergy website, and does not yet reflect the large contraction of the wood biomass industry beginning in 2018.

Further information that is specific to Minnesota can also be located on the US Energy Information Administration website.

12.6 Trade of Wood Flow

Minnesota has generally run a trade deficit with surrounding states and Canada for pulpwood. This trade deficit (Minnesota imports exceed exports), began in 2000, and has persisted since. This deficit was narrowed in 2014, but has since increased again (Figure 68). Trade deficits occur for a number of reasons. Typically, these occur when an industry cannot procure desired roundwood within close proximity to their facilities, and looks elsewhere for sources. However, imports can also be high due to supply chains that may exist in border areas. These sources can still contribute to local economies, especially as some logging operators may operate interstate.

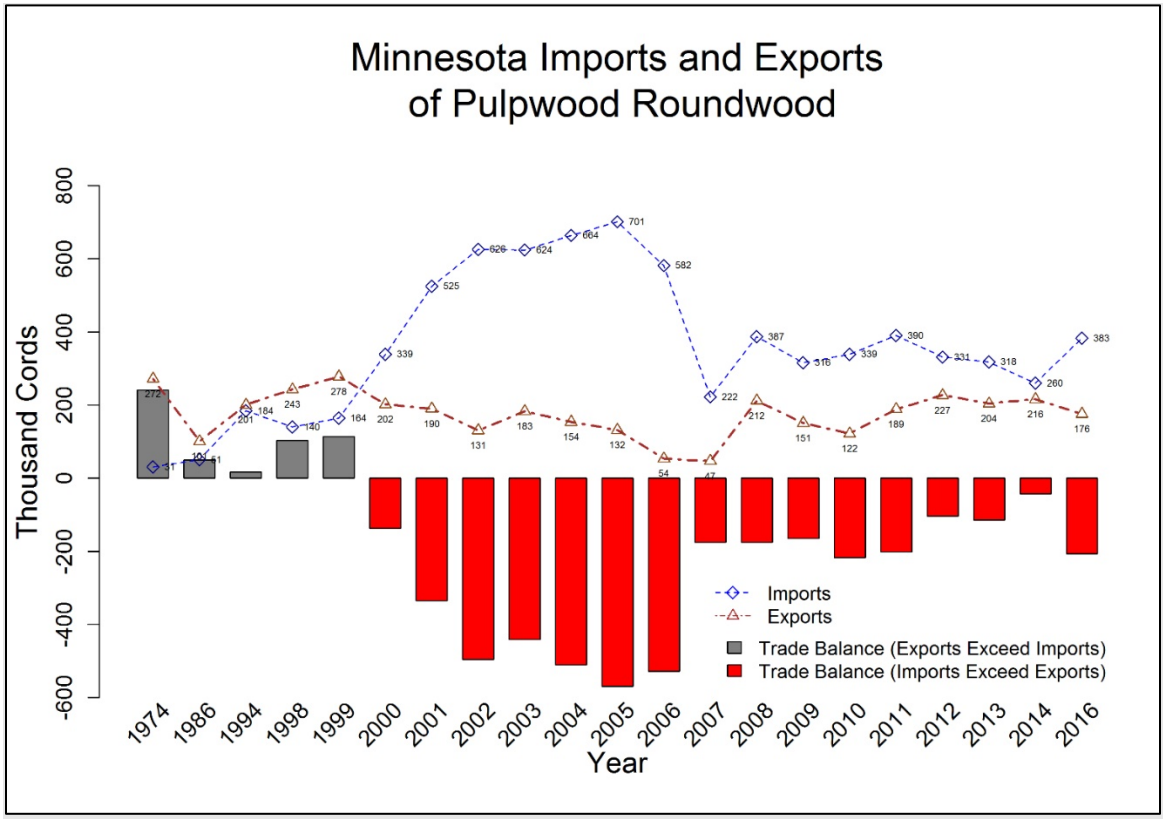

Figure 68 – Minnesota Imports and Exports of Pulpwood Roundwood; Source: USFS Northern Research Station Survey of Industrial Wood Using Industry. Based on draft 2016 pulpwood data; does not include sawtimber. In 2016, estimated imports were approximately 383,000 cords.

12.7 Non-timber Forest Products

Decorative or "special" (i.e., non-timber) forest products, means woody and herbaceous plants, plant parts, seeds, fungus, soil, gravel, and forest substrate for consumption, decoration, or medicine or for any other specialty use.

Non-timber forest products include botanics and medicines (e.g., ginseng), foods (e.g., mushrooms, berries), decorations (e.g., boughs, spruce tops, birch bark, ferns), hay, and gravel. Permits are required to harvest special forest products from public lands in Minnesota.

Table 9 summarizes the special permits issued for non-timber forest products from 2016-2018. These products are tracked by DNR Forestry. Currently, there is no breakdown for products such as birch poles, chaga, princess pine, maple syrup, etc. Some of these products may be tracked under the 'Other' category but they are not tracked separately through DNR Forestry in 2019. The unit of measure for volume include the following: cords (fuelwood), cubic yards (gravel), tons (boughs and hay), and pieces (other; represents a count of number of units sold, e.g., 3 Christmas trees, 1 bushel of princess pine, 50 square feet of birch bark, 30 pounds of chaga, and 10 pieces of birch stems).

Type of Permit (Statewide)	Year Sold	Permits Issued	Volume Sold	Value Received
Fuelwood	2016	822	8,501	$29,020.25
Gravel	2016	66	22,719	$49,150.20
Boughs	2016	62	384	$3,353
Hay	2016	5	231	$715
Other	2016	94	69,295	$8,166.60
2016 Special Product Total	**2016**	**227**	**92,628**	**$61,384.80**
Fuelwood	2017	767	7,893	$23,567.61
Gravel	2017	113	23,843	$50,118.11
Boughs	2017	59	361	$2,743.44
Hay	2017	9	305	$1,287
Other	2017	98	62,030	$22,760.63
2017 Special Product Total	**2017**	**280**	**86,549**	**$77,099.18**
Fuelwood	2018	820	8,370	$25,768.93
Gravel	2018	62	10,581	$22,233.02
Boughs	2018	53	378	$2,393.44
Hay	2018	6	85	$627.20
Other	2018	190	23,770	$10,513.22
2018 Special Product Total	**2018**	**311**	**34,814**	**$35,766.88**

Table 9 – Record of Special Permits Issued for Non-timber Forest Products in Minnesota from 2016-2018.

Indicator 13. Outdoor Recreational Participation and Facilities

13.1 Participation in Outdoor Recreation

Minnesota prides itself on being home to a renowned outdoor recreation system that provides a wide range of recreation opportunities. As the demographics, interests, and needs of Minnesotans change, it is important that the state's outdoor recreation system adjust to meet new demands. Minnesota developed a State Comprehensive Outdoor Recreation Plan (SCORP) for the years 2020 to 2024, with the goal of the plan to increase participation in outdoor recreation by all Minnesotans and visitors. The plan identifies several current and future trends that impact outdoor recreation: public health and the effect on recreation participation; diversity, equity, and inclusion issues; Minnesota's changing population (declining population growth, aging, and growing multicultural, racial, and ethnic groups): and providing accessible experiences. Minnesota's SCORP established four strategic directions for outdoor recreation in the state:

1. Connect people and the outdoors by providing a welcoming environment, improving access and affordability, increasing marketing efforts, expanding programming, creating partnerships, and providing a quality experience.
2. Acquire land and create opportunities by placing a priority for acquisition and development in parts of the state that have the fewest opportunities per person now and projected into the future, particularly densely settled and growing areas; regional centers; private in-holdings in existing parks; trail connections; and lands and facilities that serve tourists and local residents.
3. Take care of existing facilities with regular reinvestment to ensure safe, high-quality experiences for current and future users.
4. Coordinate among partners by creating integrated and accessible information and enhancing coordination across jurisdictional boundaries, funding resources, and among agencies, organizations, and nonprofits.

The SCORP's strategic directions are directly linked to the strategic directions outlined in the Parks and Trails Legacy Plan, a 25-year plan requested by the legislature that outlines the long-range vision, goals, and plans for the Parks and Trails Fund, which is part of the Minnesota Clean Water, Land and Legacy Amendment (Legacy Amendment) passed in 2008. Under the Legacy Amendment, the Parks and Trails Fund receives 14.25 percent of the sales tax revenue generated by the amendment that is to be spent on parks and trails of regional or statewide significance.

Additionally, many outdoor recreation agencies have developed targeted programs to increase participation in outdoor recreation in the state. This includes the DNR's I Can! Program, which seeks to teach individuals and families new outdoor recreation skills so they feel more comfortable doing them on their own, and the Metropolitan Council's Regional Parks Ambassador Program, which is designed to help non-park users become familiar with and use the Regional Parks System.

13.2 Land Open to Recreation and Recreational Facilities

Minnesota has an abundance of recreational opportunities across the state. Minnesota's forests provide opportunities for camping, hiking, biking, snowmobiling, boating, fishing, ATV'ing, horseback riding, snowmobiling, cross country skiing, in-line skating, and much more. Federal, state, county, and local government agencies administer land that contribute to Minnesota's world-renowned recreation system. DNR Resource Assessment created the Recreational Values map in Figure 69 (also shown in Figure 97 of the Geospatial Priorities Chapter with much greater detail about the methods), which is based on integrated scores of the degree of public access to natural areas via roads, trails or waterways, and a scenic assessment or naturalism value. The result of the model is the identification of high, medium, and low recreation value areas across the state. **Note**: There may be additional county and city recreational facilities that are not currently included in this assessment.

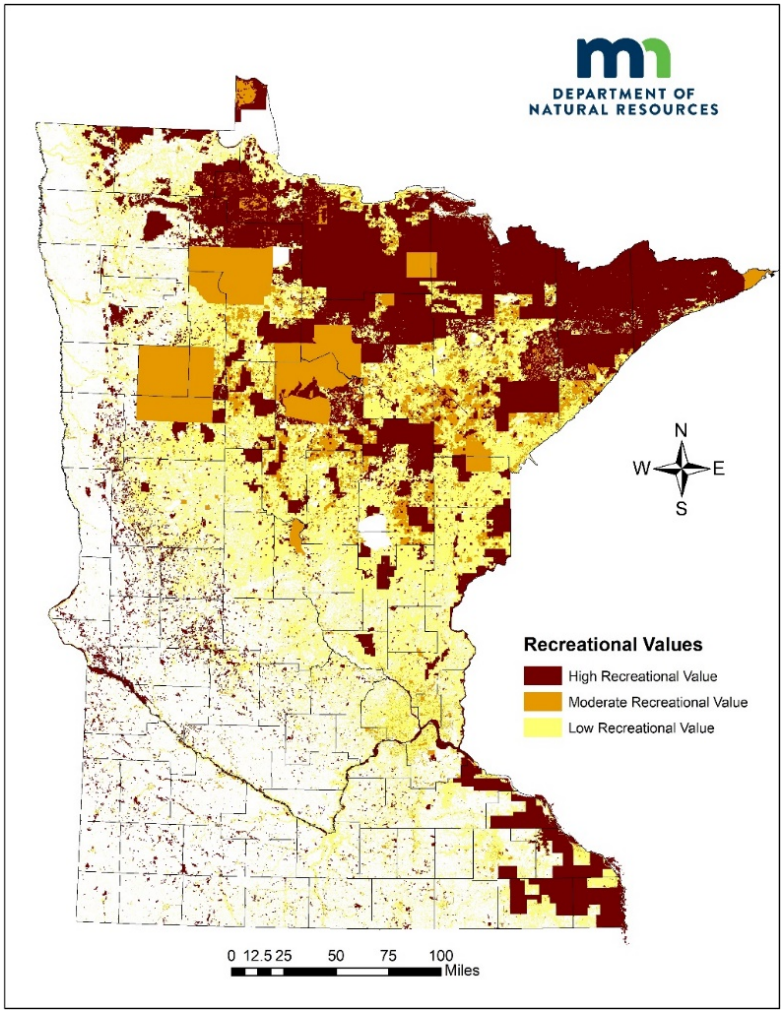

Figure 69 – High, Medium, and Low Recreational Value Land Map of Minnesota.

Federally Administered Recreation Facilities

- Superior National Forest
  - 2,000 miles of trails
  - 23 fee campgrounds, 18 rustic campgrounds
  - 77 lake accesses and 13 accessible fishing piers
  - 700 miles of snowmobile trails; hundreds of miles of cross-country ski trails
- Chippewa National Forest
  - 298 miles of non-motorized trails, 21 developed campgrounds, 100 backcountry-managed campsites
  - 315 miles of motorized trails
  - 21 developed campgrounds, 100 backcountry-managed campsites
- Boundary Waters Canoe Area Wilderness
  - 1200 miles of canoe routes; 12 hiking trials
  - Over 2,000 designated campsites

- National Park Service
    - Voyageurs National Park
    - Mississippi National River and Recreation Area
    - Grand Portage National Monument
    - North Country National Scenic Trail
    - Pipestone National Monument
    - Saint Croix National Scenic Riverway
- US Army Corps of Engineers
    - 49 recreation areas
    - 9 campgrounds; 17 picnic/day use areas
- US Fish and Wildlife Service
    - 488,000 acres - many of which are open to varying levels of recreation opportunities. The public needs to contact each individual refuge or wetland management districts (WMD) for specifics on each location.

State-Administered Recreational Facilities (Figure 70)

- 66 state parks, 9 state recreation areas, and 9 state waysides, totaling 234,500 acres
- 43 state forest campgrounds, 12 state forest horse campgrounds, and 29 forest day-use areas
- 25 state trails, totaling over 1,500 developed trail miles
- 35 state water trails, totaling over 4,500 miles
- 22,000 miles of snowmobile trails
- 2,700 miles of off-highway vehicle trails
- 1,100 miles of cross-country ski trails

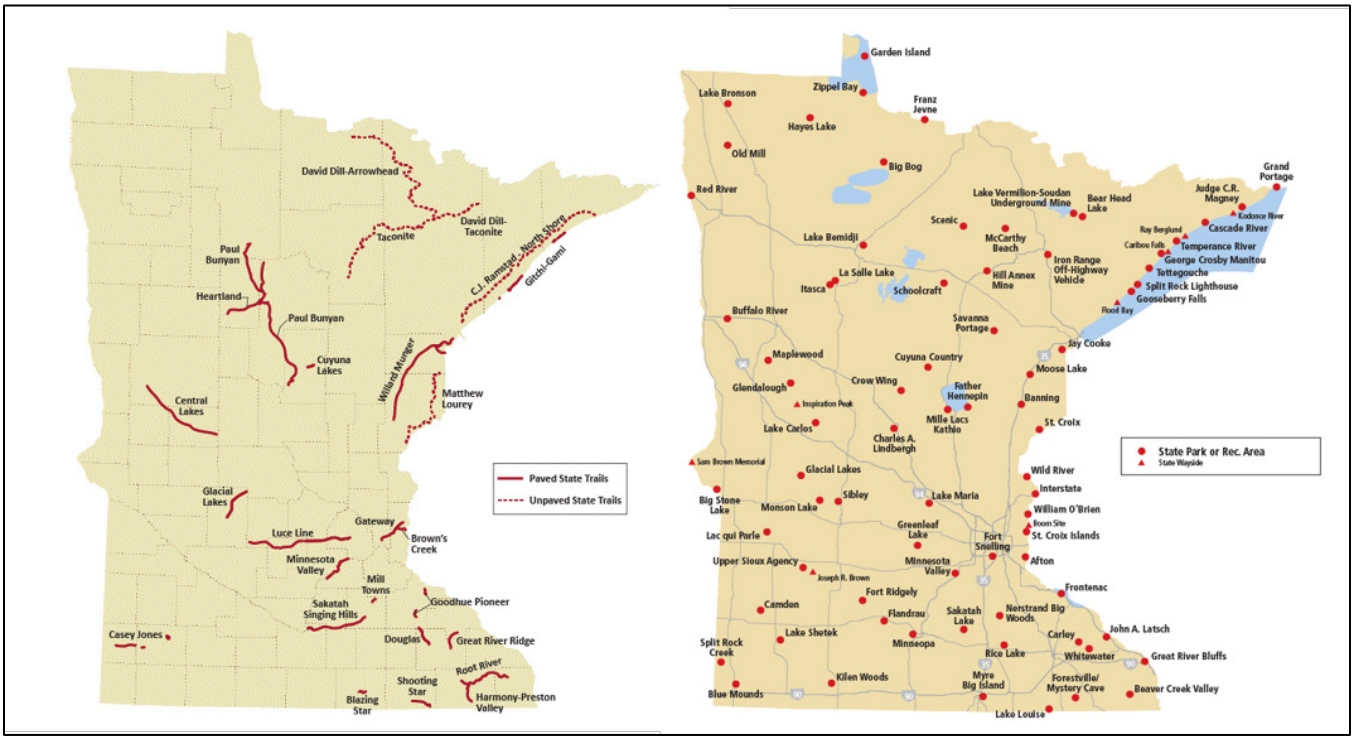

Figure 70 –Minnesota State Trail System (Left) and Minnesota State Parks and Wayside System (Right). Source: DNR; 2019.

Indicator 14. Investments in Forest Health, Management, Research, and Wood Processing

14.1 USDA Forest Service Eastern Region State and Private Forestry Funding

The following Table 10 and Table 11 depicts US Forest Service Eastern Region-9 State and Private Forestry funding for Minnesota in fiscal years 2017 and 2018. N/A indicates that no funds were received, either because no funds were sought after or because no funds were successfully awarded.

S&PF Program (Core)	FY 2017	FY 2018
Forest Health Management	$450,276	$277,563
Forest Legacy	N A	N A
Forest Stewardship	$220,500	$163,525
State Fire Assistance	$970,646	$913,477
Urban and Community Forestry	$256,200	$324,000
Volunteer Fire Assistance	$317,619	$302,145

Table 10 – Funding of Core Programs by US Forest Service Eastern Region-9 State and Private Forestry. This funding is for all entities within the state, not just the State Forester's office.

S&PF Program (Competitive)	FY 2017	FY 2018
Landscape Scale Restoration	$335,000	$124,300
Forest Health Pest Suppression	N A	$29,620

Table 11 – Funding of Competitive Programs by US Forest Service Eastern Region-9 State and Private Forestry. This funding is for all entities within the state, not just the State Forester's office.

14.2 State Forestry Agency Funding

The DNR is the state's lead agency for forestry funding. Funding for forestry activities are a combination of legislatively appropriated general fund dollars and statutorily authorized dedicated sources. Non-general funds include revenue-generating programs like timber permits, geographic and remote sensing services, seedling sales, and other products and services. Direct appropriations for fiscal year 2018 were $46.6 million and $8.6 million was from state dedicated funds. The total from these state sources was $55.2 million for that year.

The DNR also has authorization to access an open appropriation from the general fund for emergency firefighting. These funds are not directly appropriated by the legislature, but are authorized in statute for use as needed for fire suppression and pre-suppression activities. In fiscal year 2018 the DNR spent $16.5 million from this fund.

A biennial break-down of state forestry funding revenue is completed by the state for the NASF and can be accessed through NASF State Foresters by the Numbers Biennium Reports.

The following Table 12 and Table 13 represents state forestry agency funding of core US Forest Service State and Private Forestry programs for fiscal years 2017 through 2019.

S&PF Program (Core Funding)	State Match FY 2017	Federal Funding Received FY 2017	State Match FY 2018	Federal Funding Received FY 2018	State Match FY 2019	Federal Funding Received FY 2019
Forest Health Management	$169,545	$169,545	$182,700	$182,700	$189,000	$189,000
Forest Legacy	$6,666	$0	$6,666	$40,000	$13,333	$40,000
Forest Stewardship	$195,800	$195,800	$220,500	$220,500	$163,525	$163,525
State Fire Assistance	$603,000	$590,646	$603,000	$590,646	$714,500	$638,477
Volunteer Fire Assistance	$247,003	$247,003	$317,619	$317,619	$302,145	$302,145
Urban and Community Forestry	$244,600	$244,600	$256,200	$256,200	$274,000	$274,000

Table 12 – State Matches to US Forest Service Eastern Region-9 State and Private Forestry Core Program Funding.

The following information represents state matches to competitive US Forest Service Eastern Region State and Private Forestry grants for fiscal years 2017 through 2019. N/A indicates that no funds were received, either because no funds were sought after or because no funds were successfully awarded.

S&PF Program (Competitive)	State Match FY 2017	Federal Funding Received FY 2017	State Match FY 2018	Federal Funding Received FY 2018	State Match FY 2019	Federal Funding Received FY 2019
Landscape Scale Restoration	$332,920	$329,640	$95,000	$95,000	N/A	N/A

S&PF Program (Competitive)	State Match FY 2017	Federal Funding Received FY 2017	State Match FY 2018	Federal Funding Received FY 2018	State Match FY 2019	Federal Funding Received FY 2019
Forest Health Pest Suppression	$61,699	$56,000	N/A	$29,620	N/A	N/A

Table 13 – State Matches to Competitive US Forest Service Eastern Region-9 State and Private Forestry Grants.

14.3 Funding for Forestry Research at Universities

The State of Minnesota and its universities and affiliates have a long history of forest and forest-related research over 100 years. Funding for forestry research at universities comes from state dedicated funds including: Legislative Citizens Commission on Minnesota Resources (LCCMR); Clean Water Fund; and, state general funds provided to agencies, including the DNR, Minnesota Pollution Control Agency (MPCA), and Minnesota Forest Resources Council (MFRC). Additional funding is available from the National Science Foundation, the USDA Agriculture and Food Research Initiative, and US Forest Service initiatives such as Landscape Scale Restoration (LSR). Smaller amounts of funds or grants are available from non-profits and philanthropic entities and industry.

In 2019, a new research report Priority Research to Sustain Minnesota's Forest Resources, published by the MFRC, prioritized forest research needs across ownerships towards achieving sustainable forest management in Minnesota. A Research Advisory Committee (RAC) was formed, and tasked to identify critical forest resource issues and prioritize forest research activities, as a roadmap, for key research projects and funding opportunities. Partners for this report include: US Forest Service - State & Private Forestry; National Forest System; Northern Research Station - Experimental Forests; State of Minnesota - Department of Natural Resources; Pollution Control Agency; Department of Agriculture; University of Minnesota Departments of Forest Resources, Biosystems, Bioproducts, and Engineering; Conservation Biology; Institute of the Environment, and Extension; Natural Resources Research Institute (NRRI); MN Invasive Terrestrial Plant and Pest Center; The Nature Conservancy; and Wisconsin Department of Natural Resources.

This MFRC report will inform future forestry research projects and requests, in the state of Minnesota.

14.4 USDA Forest Service Research Funding

Table 14 below shows US Forest Service Research and Development expenditures for the years 2018-2020 for Minnesota. Funds are listed as dollars in thousands. Further information is available through the FIA website.

Minnesota	2018 Actual	2019 Actual	2020 Enacted
Northern Research Station (including FIA expenditures)	$10,514	$ 11,310	$12,014

Table 14 – USFS Research and Development Expenditures 2018-2020 Source: NRS-FIA

14.5 Capital Expenditures by Manufacturers of Forest Products

The following Table 15 represents capital expenditures by Minnesota's forest products manufacturers. Data sources were the 2012 economic census and estimates derived from US Census annual surveys of manufacturers for 2010, 2012, 2014, 2016.

Capital Expenditures by Manufacturers of Wood-Related Products	Year
$206.5 million	2010
$381.7 million	2012
$447.2 million	2014
$251.9 million	2016

Table 15 – Capital Expenditures for Manufacturers of Wood-related Products, 2010-2016. Source: DNR

Indicator 15. Forest Certification

15.1 Area of Forests Certified by Forest Stewardship Council®, Sustainable Forestry Initiative®, and American Tree Farm System®

In 1997, DNR and Aitkin County Land Department pursued and obtained third-party forest certification for approximately 150,000 acres of state and 220,000 acres of county-administered forest lands within Aitkin County. These were the first public forest lands to be certified by the Forest Stewardship Council® (FSC) in the United States. This established the DNR and Aitkin County as national leaders in forest certification.

In 2019, Minnesota forest agencies are among the states with the largest total acres of forest lands certified by both the FSC® and the Sustainable Forest Initiative® (SFI) in the United States. The American Tree Farm System® (ATFS), another certification body, is not currently a certification scheme employed in the state. Minnesota has approximately 8 million acres of certified forests across private and public ownerships, and DNR holds the largest single FSC® Forest Management Certificate in the United States. Certification provides unique market access to support and sustain healthy and diverse forests. These forests support industries that produce certified products including lumber, siding, office paper, magazines, windows, furniture, and cabinets. To maintain certification, all certified landowners (certificate holders) go through annual audits to verify their conformance and recommend improvements to indicators of sustainable forest management.

Table 16 below displays certified forests by landowner and landowner type in Minnesota. Please see the acronym list at the end of this document for clarification on certifying body acronyms. N/A indicates that no funds were received, either because no funds were sought after or because no funds were successfully awarded. A detailed synopsis of the success of Minnesota's Forest Certification Program is highlighted in the Success Story: '*Forest Certification – Minnesota's Model of Leadership*' in the Part II: Strategies section of this document.

Landowner	Landowner Type	Acres FSC	Acres SFI	Total	Current Certifying Body
DNR	State Govt.	4,972,286	4,972,286	4,972,286	SCS/NSF
Beltrami County	County Govt.	N A	145,500	145,500	PWC
Koochiching County	County Govt.	286,000	286,000	286,000	NEPCon/PWC
Itasca County	County Govt.	287,806	N A	287,806	NEPCon
Cass County	County Govt.	257,970	N A	257,970	NEPCon
Aitkin County	County Govt.	223,027	N A	223,027	NEPCon
Crow Wing County	County Govt.	N A	105,000	105,000	PWC
St. Louis County	County Govt.	N A	893,158	893,158	NSF
Carlton County	County Govt.	72,439	72,439	72,439	NEPCon/PWC
Blandin Corp.	Industry	N A	188,620	188,620	SAI Global
PotlatchDeltric Corp.	Industry	N A	126,105	126,105	BV
Molpus Woodlands	Private Non-Industry	N A	281,790	281,790	BV
Aitkin County SWCD	Private Non-Industry	4,382	N A	4,382	NEPCon
The Nature Conservancy	Private Non-Industry	8,795	N A	8,795	NEPCon
Total	**N A**	**6,112,705**	**7,070,898**	**7,852,878**	**N A**

Table 16 – Certified Forests in Minnesota. Source: DNR.

Indicator 16. Employment and Wages in Forest-related Sectors

16.1 Forest Products-related Manufacturing Employment and Productivity

In 2017, Minnesota's forest products industry produced $17.8 billion of shipment value (gross sales) and provided 8.5 percent of all manufacturing payroll employment. The forest products industry is the state's fifth largest manufacturing sector by employment. Minnesota ranks 12th nationally in forest industry value-added products (Gross State Product-GSP) per capita. The total employment effect to the state's economy is 64,500 jobs. Of this number, 30,700 are direct jobs including 28,200 manufacturing jobs and 2,500 logging and forestry jobs. This represents a 6.6 percent forest industry employment increase since 2010 (Figure 71).

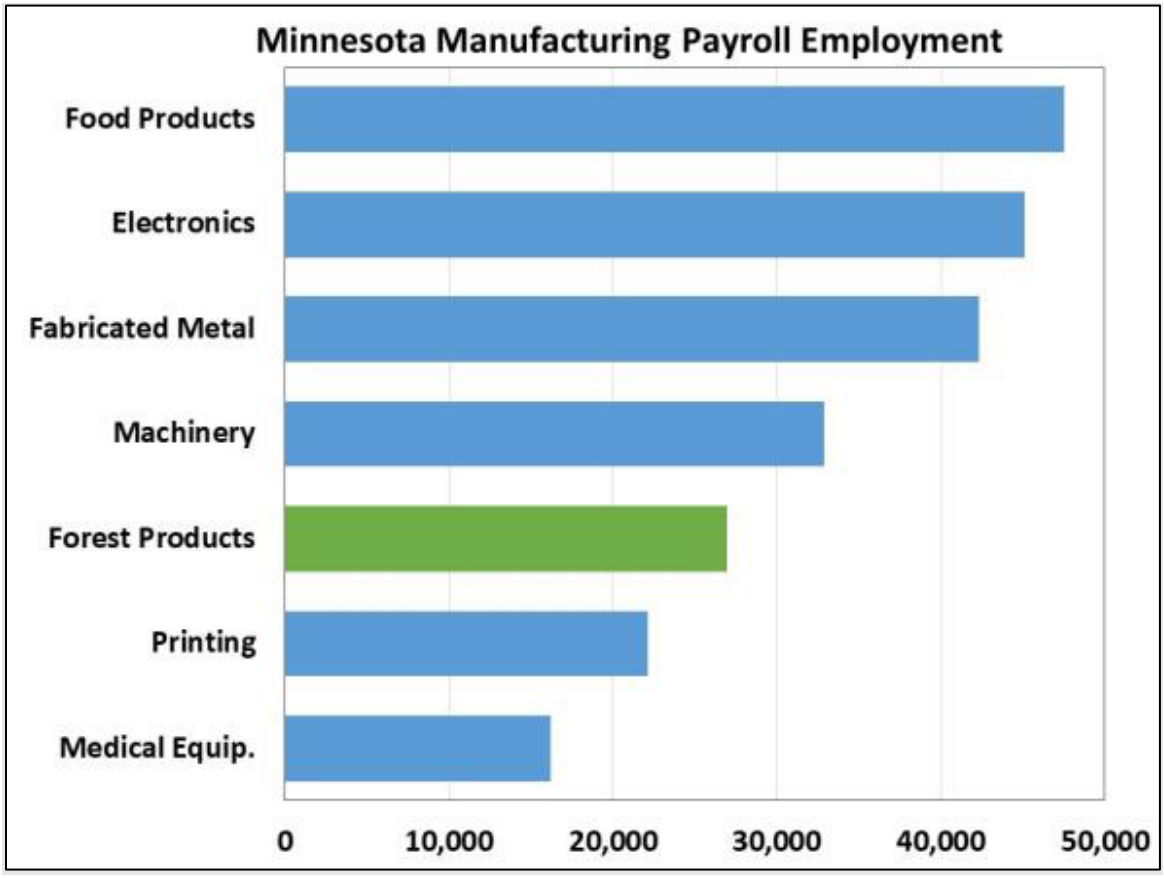

Figure 71 – Manufacturing Payroll Employment in Minnesota. Source: DNR.

16.2 State Forestry Employees

All forestry employee positions listed below are for fiscal year 2018 and reported to National Association of State Foresters (NASF) for the 2019 Biennial Survey. The first part (Table 17) represents the number of permanent employees, measured in full-time equivalents (FTE). The second part (Table 18) represents the number of seasonal employees. For 2018, the DNR Forestry employed 1,382 employees. The state also receives both professional and administrative support from personnel in other divisions within the DNR and from other agencies. These personnel are not tracked for the NASF report, at this time.

Permanent Employee Position	Category	Number of Employees
State Forester/Director	Professional	1
Regional/District Foresters	Professional	47
Forestry/Fire Program Managers and Staff Foresters	Professional	13
Service or Field Foresters	Professional	166
Entry-level Foresters	Professional	30
Other Professional Employees	Professional	41
Total Number of Professional Employees	Professional	298
Total Number of Technical Employees	Technical	94
Total Number of Admin/Clerical Employees	Admin/Technical	40
Total Number of Permanent Employees	All Categories	730

Table 17 – Type and Number of Permanent State Forestry Employees, Measured as FTEs. Source: DNR.

Seasonal or Temporary Employee Position	Number of Employees
Fire Control	541
State Nursery	106
State Land Management	5
Total Seasonal/Temporary Employees	652

Table 18 – Type and Number of Seasonal or Temporary State Forestry Employees, Measured in FTEs. Source: DNR.

16.3 US Forest Service Employees

The US Forest Service has employee positions representing all three branches of the agency within Minnesota supporting and assisting forestry efforts. The following numbers (Table 19) also include employees (scientists, professional, technical, and support staff) of the Northern Research Station (NRS) and Forest Inventory Analysis (FIA) branches.

US Forest Service Branch Employee Positions in Minnesota	Number of Employees
State & Private Forestry (St. Paul and Chicago)	16
Superior National Forest (Tower)	220
Chippewa National Forest (Cass Lake)	110
National Research and Development (Grand Rapids and St Paul)	64
Total	**410**

Table 19 – USFS Employee Positions by Branch in Minnesota. Source: USFS S&PF.

16.4 Forest Products Manufacturing Payroll and Wages

The forest products industry is one of the major cornerstones of Minnesota's economy and is the fifth largest manufacturing sector by payroll employment. In 2017, the forest products manufacturing average wage was $57,600 per year, whereas the all-manufacturing average wage was $65,700 per year. In 2017, forest products contributed over $17.8 billion in value of shipments through gross sales and provided 8.5 percent of all manufacturing payroll employment. Minnesota ranks 12th nationally, in terms of forest industry value-added generalized systems of preference; US trade program per capita, and brings in over $461 million in state and local tax revenues per capita annually. Forest products contributing to this success include; the manufacture of pulp, paper, oriented strand board (OSB) sheathing and siding, pallets, railroad ties, utility poles, cabinets, millwork, wood furniture, veneer, specialty products such as bio-energy (raw biomass and manufactured pellets), bio-chemicals, logging, and forest management, including restoration and silviculture to adapt to climate changes.

In 2017, the total economic effect of the forest products industry was 64,500 jobs considering the indirect and induced employment multipliers of the industry. Direct forest products industrial sectors include electricity generation, combined heat and power (CHP) and fuel pellet manufacturing facilities with over 10,000 cords annual consumption. See Table 20 and Table 21 below.

Direct Economic Effect	2010	2016	2017
Employment	28,800 jobs	30,500 jobs	30,700 jobs
Annual Payroll	$1.4 billion	$ 1.6 billion	$ 1.7 billion
Value of Shipments (gross sales)	$8.8 billion	$ 9.8 billion	$ 9.9 billion

Direct Economic Effect	2010	2016	2017
Value Added (gross state product)	$2.9 billion	$ 3.4 billion	$ 3.5 billion
State and Local Taxes Paid	$ 206 million	$ 218 million	$ 220 million

Table 20 – Direct Economic Effect of Wood-related Products Manufacturing in Minnesota.

Total Economic Effect	2010	2016	2017
Employment	60,500 jobs	64,000 jobs	64,500 jobs
Annual Payroll	$2.9 billion	$ 3.4 billion	$ 3.5 billion
Value of Shipments (gross sales)	$15.8 billion	$ 17.6 billion	$ 17.8 billion
Value Added (gross state product)	$6.7 billion	$ 7.9 billion	$ 8.0 billion
State and Local Taxes Paid	$433 million	$ 458 million	$ 461 million

Table 21 – Total Economic Effect of Wood-related Products Manufacturing in Minnesota. Source: DNR.

16.5 State Forestry Salaries

In 2019, Minnesota Management and Budget (MMB), the state agency responsible for negotiating and implementing state employee collective bargaining agreements, negotiated a new 2-year contract for all state employees including forestry. All state of Minnesota Executive Branch payroll data is found at the Minnesota Management and Budget website. Information from this section is provided by the NASF biennial report and can be found at the State Foresters by the Numbers, 2018 website.

16.6 Worker Safety in Wood-related Products Manufacturing

In Minnesota, *Minnesota Statutes,* chapter 90.145 requires Logger Safety Training for operators of timber sales on state lands. Purchasers of state timber permits must meet the safety requirements as stated in the statute as well as Minnesota OSHA Logging Standard.

Criterion 7. Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

Criterion 7 ties to the national priorities *Conserving and Managing Working Forest Landscapes for Multiple Values and Uses; Protecting Forests from Threats; Enhancing Public Benefits from Trees and Forests.*

Indicator 17. Forest Management Standards and Guidelines

17.1 Types of Forest Management Standards and Guidelines

The Forest Stewardship Council® (FSC) and the Sustainable Forestry Initiative® (SFI) are two major internationally recognized forest certification systems for public land:

In 2005, the DNR obtained dual (FSC® and SFI®) certification of 4.5 million acres covering all state forests and most wildlife management areas (WMAs). In December 2010, the DNR's Forest Certification program grew to 4.96 million acres, covering 90 percent of the total acres managed by DNR. Today, the DNR is the largest single FSC-certified land manager in the United States.

Each of the certification systems maintains a set of normative standards with national level indicators. The department annually utilizes an internal program review and third-party external audit to determine how well the departments policies and process conform to these sustainability standards.

Certification systems in Minnesota directly apply and benefit from voluntary guidance at site and landscape levels as developed by the Minnesota Forest Resources Council (MFRC) over the past 25 years. The MFRC is a 17-member organization working to promote long-term sustainable management of Minnesota's forests as directed by the Minnesota Legislature in the Sustainable Forest Resources Act of 1995 (SFRA - *Minnesota Statutes,* chapter 89A). The Council's four primary roles as outlined in the SFRA are:

- Advise the Governor and federal, state, county, and local governments on sustainable forest resource policies and practices.
- Develop and periodically revises site-level forest management guidelines used by loggers and public and private forest owners statewide to assure sustainable forest resource management, use, and protection.
- Via regional committees, develop and coordinate the implementation of landscape plans for Minnesota's six major forested regions (see Indicator 18).
- Support forest resources research.

17.2 Voluntary and Mandatory Standards and Guidelines

Minnesota is a leader in providing voluntary site-level forest management guidelines for landowners, loggers, and resource managers. The SFRA requires the MFRC to develop and periodically revise voluntary guidelines for use on public and private forest land in Minnesota to minimize negative impacts of timber harvest and other forest management activities.

The guidelines are a set of recommended voluntary practices designed to mitigate harvest-related impacts on water quality, wildlife, soil productivity, cultural resources, biodiversity, visual quality, and other forest values. These guidelines were initially published in 1999 in the guidebook *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers* (MFRC 1999), and have been revised twice since their inception. New guidelines related to biomass harvesting were added in 2007, and substantial changes in recommendations related to riparian management zones (RMZ), allowable infrastructure, leave trees, and others, were made in 2012. The most recent version of the guidelines is available from MFRC.

17.3 Monitoring of Standards and Guidelines

The SFRA (*Minnesota Statutes*, section 89A.07, subd. 2) requires the DNR to monitor implementation of the site-level guidelines on public and private forest lands. The DNR's Guideline Monitoring Program (GMP) has monitored guideline implementation at nearly 1,400 harvest sites since 2000, and has published seven reports summarizing the findings through 2017. Monitoring reports are available through MFRC.

Starting in 2014, the monitoring program was modified to provide inference at the watershed scale (compared to the historic statewide approach), enhanced with inclusion of forest disturbance mapping using satellite imagery, and program emphasis was focused on water quality as related to forest management. This new approach will provide information at relevant scales for outreach while simultaneously engaging stakeholders to maintain supplies of high-quality water provided from working forested landscapes. Funding is provided by the Clean Water Land and Legacy fund.

Indicator 18. Forest-related Planning, Assessment, Policy, and Law

Forest planning occurs at several levels within the state of Minnesota, including federal, tribal, state, county, and private. At the state level, forest-related planning falls under the following four categories.

Funding Plans: Guides the investment of public funds and often focuses on collaborative projects. Examples include: State Forest Action Plan (SFAP), and State Wildlife Action Plan (SWAP).

Program Plans: Guides the administration and operations of specific Cooperative Forest Management (CFM) programs. Examples include: Forest Legacy Assessment of Need (AON), Forest for the Future Plan, PFM System Framework, Fire Program Plan, Forest Health Program Plan, Urban & Community Forestry Program Plan, Utilization & Marketing Program Plan, Community Wildfire Protection Plans (community fire prevention plans).

Forest Management Plans: Guides the tactical management of specific land ownerships. Examples include: US Forest Service National Forest land and resource management plans (Chippewa and Superior), Tribal land and resource management plans. Examples include: Leech Lake, Fond du Lac, White Earth, DNR Section Forest Resource Management Plans (SFRMPs).

Strategic Guidance Plans: Provide strategic guidance on an all-lands basis. Examples include: MFRC Regional Landscape Plans, and Landscape Stewardship Plans (major watersheds, townships).

State policies and laws are highlighted under section 18.5 below.

18.1 Forest Planning and Assessment by State Forestry Agencies

Minnesota has a rich tradition of planning for the sustainable use of its forest resources. The unique land ownership patterns that include major holdings by federal, tribal, state, county, municipal, industry, timber investment management organizations (TIMOs), non-governmental organizations (NGOs), and non-industrial private forests (NIPF), create a myriad of planning processes managed by the relevant jurisdiction or controlling party. Further complicating the inventory and assessment of current forest resource plans are plans directed at specific programmatic areas or topics as well as conservation planning efforts.

The DNR develops plans to provide for the harmonious coordinated management of forest resources providing for multiple uses and sustained timber yield off of forest lands. The DNR periodically updates these plans to reflect changes in the forest environment to meet the needs of Minnesota.

State Forest Resource Management Planning

Section Forest Resource Management Plans (SFRMPs) are 10-year forest management plans that guide sustainable forest management on timber-producing state forest lands. Plans cover forested areas of the state based on the Ecological Classification System (ECS), which classifies forested landscapes into geographical units based on geology and ecology. There are seven ECS sections in Minnesota, and each plan covers one section. The plans are developed, reviewed, and updated on a scheduled basis with teams of experts from the DNR Divisions of Forestry, Fish and Wildlife, and Ecological and Water Resources. These teams also work with partners and the public to write and review the plans and review feedback through webinars, surveys, and open comment periods. These plans are focused on approximately 5 million acres of Forestry and Fish and Wildlife state-managed lands. The plans help ensure that state forest management activities meet statewide goals for ecological protection, timber production, and cultural and recreational values.

Minnesota Forest Resource Council (MRFC) Landscape Level Planning

Landscape planning and coordination is a way of assessing and promoting forest resource sustainability across large forested landscapes. The SFRA laid the foundation for large-scale forest management by establishing the Landscape Program. The MFRC oversees this program to support a broad perspective and approach to sustainable forest management. This program is a voluntary, grassroots effort that builds and strengthens partnerships by supporting collaborative forest management projects that address local and regional needs.

Since 1997, regional forest resource plans have been prepared for each forested landscape. These regions cover 4 to 9 million acres. The plans describe desired future conditions for the region's forest resources over a long-term horizon (100 years or more). The plans also include shorter-term goals and strategies to guide efforts by landowners, forestry professionals, industry, tribal, and public agency managers in the sustainable management of each region's forest resources. The MFRC landscape plans cover six major forested regions of the state, including: East Central (EC); Northern (N); North Central (NC); Northeast (NC); Southeast (SE); and West Central (WC) regions. These six MFRC landscapes cover approximately 34.5 million acres across the state (Figure 72). All plans are available on the MFRC website.

Regional landscape committees provide public forums for diverse interests to cooperatively promote forest sustainability. By bringing together representative interests from landscape regions, the committees serve as springboards for supporting effective forest management activities that address specific needs and challenges in each landscape region. After the landscape plans are approved by the MFRC, the regional landscape committees meet quarterly to: 1) Encourage agencies, non-governmental organizations, industry and private landowners, to integrate the regional context when they develop their forest resource management plans and implementation projects; 2) Promote sustainable forest management practices recommended in the landscape plans to support forest certification processes; and 3) Develop and coordinate collaborative projects that proactively implement the landscape plans and monitor the strategies used and outcomes from these projects.

By working together through the landscape planning and coordination processes, the six regional committees have helped partners secure over $30 million in federal, state and private funding. The MFRC and its programs, including landscape-scale efforts, have been working collaboratively for over 20 years, and are considered by the US Forest Service as a national model.

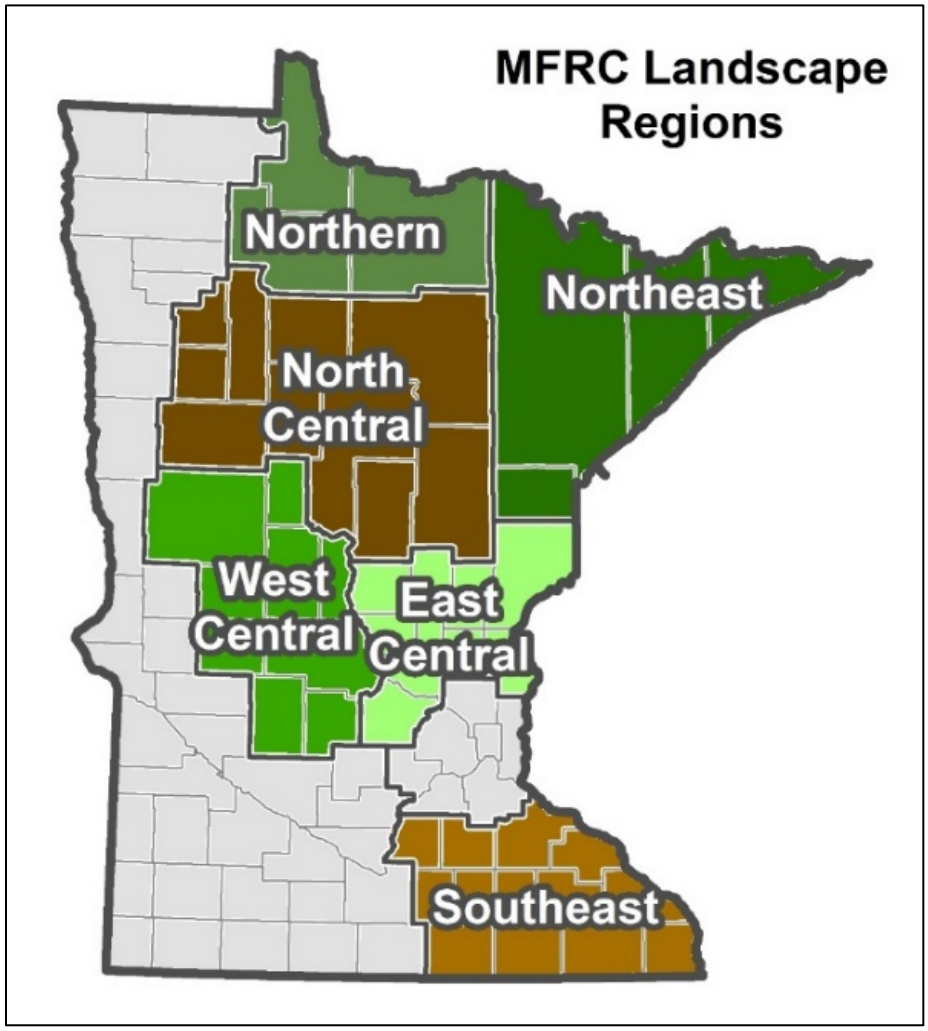

Figure 72 – Six Minnesota Forested Landscape Regions. Source: MFRC.

State and Private Forestry Program Plans

Topic-specific plans or programmatically based plans relating to aspects of forest management have been developed as key forest plans related to the US Forest Service Cooperative Forest Management Program, including:

- Forest Legacy Program and Assessment of Need (AON)
- Private Forest Management (PFM) System Framework
- Community Wildfire Protection Plans (CWPP)

Two of these three program plans (Forest Legacy AON and PFM System Framework) are included in the appendix of Part 2 - Strategies document.

Forest Legacy Program and Assessment of Need (AON)

The Forest Legacy Program (FLP) is a partnership program between the US Forest Service and the states to protect important forest areas that are threatened by conversion to non-forest uses. The program provides matching funds to the

states to acquire fee-title or conservation easements to protect priority forests. All states joining the FLP must prepare a plan referred to as an assessment of need (AON). The AON lists the specific goals and objectives, and spells out the guidelines the state uses to determine project priorities, describes eligibility criteria, and maps the specific Forest Legacy Areas for designation.

Minnesota's latest AON was completed in 2017 and approved by the USDA Forest Service in August 2019. The entire AON and approval letter can be found in Part 2- Strategies document - Appendix A and B of this 2020 SFAP.

PFM System Framework

In June of 2014, at the Minnesota Forest Stewardship Council (MNFSC) meeting, the Minnesota State Forester and Natural Resources Conservation Service (NRCS) State Conservationist charged a team representing a broad range of interests related to family-owned forests, to develop a system framework that focuses on sustainable forest management and diverse, healthy, family-owned forests for future generations in Minnesota. The result of this work is the PFM System Framework, which is designed to engage and organize the MNFSC in a leadership role in assuring services for Minnesota's family forest landowners. The plan includes an overarching goal statement, strategic objectives, a service delivery model, that outlines a practical approach for providing service offerings, supporting strategies and implementation action stops, and proposed system framework responsibilities. The entire PFM plan can be found in Part 2- Strategies document- Appendix C of this 2020 SFAP.

Community Wildfire Protection Plans (CWPP)

Community Wildfire Protection Plans (CWPP) meet Firewise USA program requirements for a "written wildfire risk assessment." The Firewise program encourages and recognizes increased wildfire awareness and preparation. Owners of homes and structures in wildland urban interface (WUI) areas of Minnesota are provided training and information to mitigate/minimize wildfire risk. Partners in these efforts include DNR, State Fire Marshall, Emergency Management (state and local), and fire departments. The DNR Forestry oversees Firewise Community Mitigation Grants. These grants help communities and counties address wildfire emergencies by: 1) addressing potential wildfire emergencies by identifying and correcting wildland fire hazards; 2) preparing themselves in the event a wildfire threaten; and 3) educating the community on fire prevention. Further information on CWPP grants is available on the Minnesota DNR website. External Firewise information is available at Firewise-USA.

18.2 Forest Assessment and Planning by Private Forest Owners

Minnesota private forest owners have many different options and opportunities to plan for the sustainable management of their forests. Assistance is available from state and federal programs, the Tree Farm System, and private forestry consultants. These options are voluntary and rely on good relations and coordination between public agencies, private consulting foresters, and private landowners themselves. As such, private forests are more vulnerable to threats of poor harvesting practices, parcelization, and conversion to other uses outside of forest management.

Private landowners can seek management assistance from the USDA Natural Resources Conservation Service (NRCS) through voluntary programs such as the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP). The Farm Service Agency (FSA) also offers private landowners the options of the Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP) programs with technical assistance from the NRCS.

The DNR Forest Stewardship Program helps Nonindustrial Private Forest (NIPF) landowners manage their woods through advice and education, cost-share programs, and Woodland Stewardship Plans. Also called Woodland Owners, NIPF landowners are private individuals or an organization that do not also own a wood processing facility.

The DNR Forestry works through a statewide network of state, public, private, and industry foresters specially trained in forest stewardship. They help NIPF landowners achieve their woodland goals. Woodland stewardship plans are written for woodland owners with 20 to 5,000 acres where at least 10 acres have or will have trees. These woodland stewardship plans need to be updated every 10 years, and are periodically monitored for plan implementation. Woodland stewardship plans registered with the DNR can qualify plan holders for woodland tax and financial incentive programs.

Table 22 below, sourced by the National Woodland Ownership Survey, represents the amount of private forest land in Minnesota that is 20 acres to 5,000 acres in size and currently managed under a woodland stewardship plan. Approximately, 17 percent of the eligible lands are being managed under a woodland stewardship plan.

	Area (acres)	Standard Error	Ownerships (#)	Standard Error
Minnesota	5,144,000	132,000	82,000	4,000
Managed under a woodland stewardship plan (2011-2013)	897,939	NA	6,437	NA

Table 22 – Estimated Area and Number of Private Forest and Woodland Ownerships (20-5000 ac) by state. Source: DNR.

Local Soil and Water Conservation Districts (SWCDs) work with private forest owners to link water quality and forest management. SWCDs provide many services and cost-share funds for private forest owners. Erosion control, riparian forest management, stewardship planning services, promotion of urban forestry with municipalities, and education and outreach for forest health are some of the services that SWCDs provide.

In addition, SWCDs work to secure funding for the Reinvest in Minnesota (RIM) conservation easement work for forested lands and encourage collaborative work in this arena. A good example is the conservation easement work at Camp Ripley using the Army Compatibility Use Buffer (ACUB), which has been developed in a team setting including Camp Ripley, Morrison County SWCD, DNR, and BWSR. The project has secured 85 easements with partners for a total of 5,933.40 acres for $7,053,480.36 in easement payments. This collaborative approach is a good model for other forest conservation easements. Other examples include Wild Rice River (69 easements of 4,341.67 acres for $4,457,660.40), Mississippi Headwaters (16 easements of 1,830 acres for $1,401,249.19), and Pine River (5 easements of 166.40 acres for $235.233.43).

Numerous private forestry consultants and forest industry foresters within Minnesota also write Woodland Stewardship Plans and provide other forestry consulting services such as timber harvesting and reforestation for private landowners. This allows an opportunity to collaborate with the DNR PFM program and often leads to identification of critical forest issues that may otherwise be overlooked on private lands due to their size or location within the state.

18.3 Forest Assessment and Planning for Federal Lands

National Forests

The National Forest Management Act (NMFA) requires the US Forest Service to develop land management plans that guide management of its national forests. In Minnesota, there are two national forests. The Chippewa National Forest (CNF) comprises 667,094 acres managed by CNF, within a checkerboard ownership boundary of 1.6 million acres, and includes the majority of the Leech Lake Band of Ojibwe reservation, which is within the boundary of the CNF. The other national forest in Minnesota, the Superior National Forest (SNF), comprises 3,900,000 million acres. Each has a national forest plan that was updated in 2004. Both national forest plans are slated to be updated within the next three to five years, pending funding availability and national priorities. Each of the current plans is organized into four chapters: Introduction; Forest-wide Management Direction; Management Area Direction; and Monitoring and Evaluation. An environmental impact statement (EIS) accompanies each plan and describes the analysis used in its development. The SNF plan also includes management direction that is unique to the Boundary Waters Canoe Area Wilderness, which is part of the national forest.

Bureau of Indian Affairs

The Bureau of Indian Affairs (BIA) works with 35 Tribes in the Upper Midwest Region as shown in Figure 73 below. In Minnesota, the BIA administers over 1 million acres in trust for 11 Tribes. Of these acres, approximately 1,400 are available to the public. The Branch of Forest Resources Planning (BOFRP) is the technical branch of the BIA Division of Forestry and Wildland Fire Management. According to their website,

> "BOFRP provides staff assistance and advice to the Division relative to the formulation and implementation of nation policies affecting the analysis, evaluation, development and coordination of forest inventories, data utilization and resource planning. The BOFRP serves as the Division's national archive for reservation forest data and the national library of forest planning documents. The BOFRP's highest priority is to serve Tribes and forestry field staff by providing technical expertise in forest inventory, data collection design and analysis, and the management planning process. The BOFRP maintains facilities for data processing, application development, biological modeling and automated systems for practical forest management in Indian Country."

In addition to the planning that takes place on federal tribal land, many of the Tribal Nations within Minnesota do their own forest resource assessments and planning. See indicator 18.7 for information on tribal forest planning in Minnesota.

Figure 73 – Map of Bureau of Indian Affairs Midwest Regional Office Area, Agencies, and Field Office. Source: BIA.

National Park Service

The **National Park Service** (NPS) manages Voyageurs National Park, which is over 218,000 acres and is the largest water-based park in the National Park System. In 2002, Voyageurs NP completed their general management plan with extensive input from cooperators and stakeholders. The mission of the National Park Service is: "to preserve unimpaired, the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world."

US Fish and Wildlife Service

The **US Fish and Wildlife Service** (USFWS) manages 13 national wildlife refuges in Minnesota totaling more than 216,000 acres. USFWS also manages seven Wetland Management Districts (WMDs) totaling over 272,000 acres. The mission of the USFWS national wildlife refuge system is: "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

US Army Corps of Engineers

The **US Army Corps of Engineers** (USACE) manages approximately 9,000 acres of Mississippi River floodplain forest within Minnesota. Nearly all this land is also included in the Minnesota State Wildlife Management Area or the Upper Mississippi River National Wildlife and Fish Refuge through real-estate grant or cooperative agreements. In 2011, the Corps updated their Upper Mississippi River master plan. In addition, the USACE manages six recreation areas in the Mississippi River Headwaters area of Minnesota. These are located at Leech Lake, Lake Winnibigoshish, Sandy Lake, Gull Lake, Cross Lake, and Pokegama Lake. These recreation areas total approximately 300 acres. The civil works mission of the USACE is "to contribute to the national welfare and serve the public, by providing the Nation and the Army with quality and responsive development and management of the Nation's water resources; protection, restoration, and management of the environment; disaster response and recovery; and engineering and technical services in an environmentally sustainable, economic, and technically sound manner through partnerships."

National Guard

The **National Guard** has one military facility in Minnesota called Camp Ripley, which is a 53,000 acre regional training center located in the heart of Minnesota. Camp Ripley has partnered with NRCS, BWSR, DNR, Morrison County, and other partners to create and manage one of six national Sentinel Landscapes across the US. This landscape includes 40 of the first 400 miles of the Mississippi River and four of its tributaries. The area is an extremely important drinking water source protection area and supplies clean water to over 1.2 million people from Camp Ripley to the Twin Cities of Minneapolis and St. Paul. On May 11, 2015, the Camp Ripley Sentinel Landscape statute (*Minnesota Statutes,* chapter 190), was unanimously approved by the Minnesota Legislature and is the first law of its kind in the US.

18.4 State Forest Assessments

See 18.1 for text related to state forest assessments.

18.5 Forest Laws and Policies, Including Forested Acres in State Current Use Taxation Programs

Minnesota State Statute (*Minnesota Statutes,* chapter 89A), provides the overarching stewardship framework for state and private forest management in the state. Forest resources are defined as "those natural assets of forest lands, including timber and other forest crops; biological diversity; recreation; fish and wildlife habitat; wilderness; rare and distinctive flora and fauna; air; water; soil; and educational, esthetic, and historic values" (Minnesota Legislature 2018). Under DNR's authorizing statutes (*Minnesota Statutes,* chapter 89A), the Department is required to "pursue the sustainable management, use, and protection of the state's forest resources to achieve the state's economic, environmental, and social goals." Minnesota has a well-documented and rich history of forest-related laws and policies. A brief outline of the most critical statutes are included below in Table 23.

State Legislative Statute Number	Key Information
Chapter 16	Definition and authority of forestry. Contains Forest Legacy (FL) and Forests for the Future (FFF). Contains both state and federal statutes. School forest trust lands are located in several chapters.

State Legislative Statute Number	Key Information
Chapter 41	Pertains to energy and biomass.
Chapter 84	Contains a variety of laws pertaining to the use of forest lands including across ownership, FFF, off-highway vehicles (OHVs), reforestation. Also contains direction for species designated as state endangered or threatened species.
Chapter 86A	This statute addresses State Trails, Scientific and Natural Areas, State Wilderness Areas, State Forests, Wildlife Management Areas, and Aquatic Management Areas.
Chapter 88	Contains guidance and laws pertaining to wildfire fighting and all related efforts, special food products, state lands and non-state lands.
Chapter 89	Contains the bulk of forestry laws and gives clear statutory direction for Urban and Community, Forest Pests (also cross-references to the Minnesota Department of Agriculture), Shade Trees, First Detector, Utilization and Marketing, state forest lands, Minnesota Forest Resources Council, forest planning coordination, forest investments, roads, trespass, campgrounds, school forests, timber income.
Chapter 89A	Provides the overarching stewardship framework for forest management in the state.
Chapter 90	Contains guidance and laws pertaining to timber management, permits to cut, special use permits.
Chapter 273.13	2c managed forest land property tax classification
Chapter 290C	Contains the Sustainable Forest Incentive Act (SFIA)

Table 23 – Forestry Related State Statutes in Minnesota. Source: DNR.

Further and more detailed information is available by searching the Minnesota Legislative website using key words such as "forests" or searching by statute number.

Incentive Programs

To foster investment into and retain forest lands for economic and ecological benefits, the state of Minnesota developed two incentive programs for private forest land owners.

The Minnesota Sustainable Forest Incentive Act (SFIA), jointly managed by Minnesota Department of Revenue and the DNR, is an incentive program to keep forests as forests on Minnesota's landscape. Landowners with at least 20 acres of forest land managed under a forest management plan registered with the DNR, may be eligible to participate and can receive a payment for each acre of qualifying forest land they enroll in SFIA. Currently, there are approximately 837,569 acres enrolled in the program in Minnesota. Out of that number, approximately 496,686 acres are managed under a Woodland Stewardship Plan by woodland owners on properties with less than 5000 acres per landowner. The other 340,883 acres are managed by large landowners under a forest management plan. Some of these lands include industrial forest lands.

Minnesota also offers a reduced property tax rate called 2c Managed Forest Land. Woodland owners who have between 20 and 1,920 acres of forest land, are actively following their registered woodland stewardship plan, and are not enrolled in SFIA, may be eligible for a reduced property tax rate of .65 percent on any eligible land. Currently the exact amount of acres enrolled into this program is unknown, but the estimated number is approximately 350,000 acres.

Clean Water, Land, and Legacy Constitutional Amendment

In November 2008, Minnesotans overwhelmingly voted for a constitutional amendment called the Clean Water, Land and Legacy Amendment or Green Initiative, to increase funding for the outdoors and the arts through a 3/8 of one percent sales tax increase over a 25-year period beginning on July 1, 2009 and sun-setting on June 30, 2034. Over 1.6 million voters stated they wanted funds constitutionally dedicated to preserving the state's outdoor heritage, clean water, parks and trails and the arts. The Minnesota Legislature created a website to monitor investments from the Clean Water & Legacy Amendment and the separate Environment and Natural Resources Trust Fund, another constitutionally dedicated fund.

18.6 State Forest Advisory Committees

The following represent advisory committees that work directly with forestry issues in the state and region, some of which are also discussed elsewhere in this report.

- Minnesota Forest Stewardship Committee assists woodland owners with forest management through education, advice, cost-share programs and woodland stewardship plans. Plans are drafted by professional foresters and registered with the DNR. These plans qualify a woodland owner for tax and financial incentive programs, including cost-share, SFIA, and 2c reduced property tax rates. The Minnesota Forest Stewardship Committee is a primary advisory group to guide the implementation of the 2020 SFAP.
- Minnesota State Technical Advisory Committee (MSTC) serves in an advisory capacity to the Natural Resources Conservation Service (NRCS) on the implementation of the natural resources conservation provisions of Farm Bill legislation. The committee includes members from a wide variety of natural resource and agricultural interests. Chaired by the State Conservationist, the MSTC is composed of representatives from federal and state natural resource agencies, Tribes, agricultural and environmental organizations, and agricultural producers.
- Minnesota Forest Resources Council (MFRC) is a state council established by the Sustainable Forest Resources Act (SFIA) of 1995, under *Minnesota Statutes*, chapter 89A.06, to promote long-term sustainable management of Minnesota's forests.
    - Minnesota Forest Resources Council Regional Landscape Committees provide overall leadership and direction to the MFRC's Landscape Program as described in the Sustainable Forest Resources Act (SFIA) of 1995 under *Minnesota Statutes*, chapter 89A.06.
    - Minnesota Forest Resources Research Advisory Committee (RAC) was formed under the SFRA to address information needs concerning Minnesota forests. The purpose of the advisory committee is to foster the identification and undertaking of priority forest resources research activities by encouraging collaboration

between organizations conducting research, linking researchers in different disciplines conducting forest resources research, and encouraging interaction and communication between researchers and practitioners in the development and use of forest resources research.

- Minnesota Forest Resources Partnership was established in 1995 and is recognized in *Minnesota Statutes*, chapter 89A.04. It is a voluntary, self-funded partnership of forest landowners, managers, and professional loggers dedicated to improving the health and productivity of Minnesota's forest resources and economically viable forest dependent communities.
- Sustainable Forests Education Cooperative (SFEC) was established in 1997 to alert natural resource professional to continuing education opportunities and current research findings, new technologies, and state-of-the-art practices, in a broad range of fields, including forest ecology and management, wildlife biology, forest hydrology, botany, best management practices, technology transfer, and others.
- Minnesota Forest Industries (MFI) is an association with over 50-years experience, representing several primary forestry product companies. In 2020, MFI members include: Bell Lumber and Pole Inc.; Boise Paper, a subsidiary of Packaging Corporation of America; Hedstrom Lumber Company; Louisiana-Pacific Corporation; Minnesota Power; Molpus Timberlands and Management LLC; Verso Corporation; Norbord Minnesota; PotlatchDeltic Land and Lumber; Sappi Fine Paper North America; Savanna Pallets; and UPM Blandin. MFI works with the Minnesota Timber Producers Association (MTPA), which was established in 1937. MTPA is the oldest forestry association in the state. This trade association represents loggers, wood brokers, truckers, sawmills, and allied businesses in Minnesota. Both organizations' members encourage conservation, proper forest management, and industry development that foster sound environmental stewardship, multiple use of timberlands, and sustainable, long-term timber supply.
- The Minnesota Logger Education Program (MLEP) was established in 1995 to assist logging business owners in meeting the ever-changing demands of their profession. The MLEP provides educational programming to Minnesota's logging community by partnering with several groups, to identify logging needs within sustainable forest management practices. Logging business owners who achieve membership within MLEP are required to meet educational and legal business requirements as set out by the organization.
- Minnesota Shade Tree Advisory Committee (MnSTAC) was established in 1974 to advise Minnesota's Governor, Legislature, other legislative and administrative branches of the state, the University of Minnesota, the counties, and communities, and the Minnesota public on the best ways to preserve, protect, expand, and improve Minnesota's urban and community forests.

18.7 Tribal Forest Planning

The US Forest Service's 2020 State Forest Action Plan requirements checklist, states that federal land agencies must be consulted as part of the SFAP assessment and strategies process. Both the 2010 and 2020 SFAPs include information about federal land agencies and a section on tribal forest planning. In 2010, information and feedback was received and coordinated with the Bureau of Indian Affairs, through BIA staff in Bemidji, as well as tribal forestry staff who participate on the six MFRC Landscape Committees.

The DNR has maintained a long and successful forestry collaboration with the 11 Tribes in the state, especially in the areas of fire and timber management. For the 2020 SFAP revision, the DNR extended the opportunity to solicit more in-depth information and feedback from each of the Tribes, to be included in the documents. In 2019-2020, a series of one-on-one interviews were conducted with tribal forestry and natural resources staff and directors, with subsequent email correspondence and follow-up. Tribes have brought forth in their own words the state of tribal planning efforts on each of the 11 reservations. These forestry and natural resources comments are captured below under each individual Tribe.

Further discussion with each Tribe, as to opportunities for partnerships, are located in the Strategies section (Part 2) of this document.

All Tribes are involved in natural resource planning efforts, including forest management on over 1 million acres (Figure 74). As sovereign nations, the 11 Tribes are responsible for their own forests, but scattered ownership patterns create opportunities to work cooperatively with all levels of government (federal, tribal, state, county, local) and private forest landowners on forest issues that cross all ownerships. Tribal forests are vital to all communities. The forests are an important source of employment and income, especially in fire and timber activities. The forests are settings for artistic expression, worship, and religious ceremonies. Forests provide opportunities for hunting, fishing, and gathering of forest and lake products such as wild rice, berries, mushrooms, venison, and walleye. They also provide materials for shelter, fuel, canoes, clothing, house wares, plant medicines, and forest product enterprises. While each Tribe plans and manages their own forests, there are collaborative efforts between Tribes and other governing entities related to fire and smoke management, invasive species management, timber harvesting, biomass development, water quality management, recreation and trail management, fishing and hunting management, and recognition and management of significant cultural and historic outdoor spaces including traditional burial grounds.

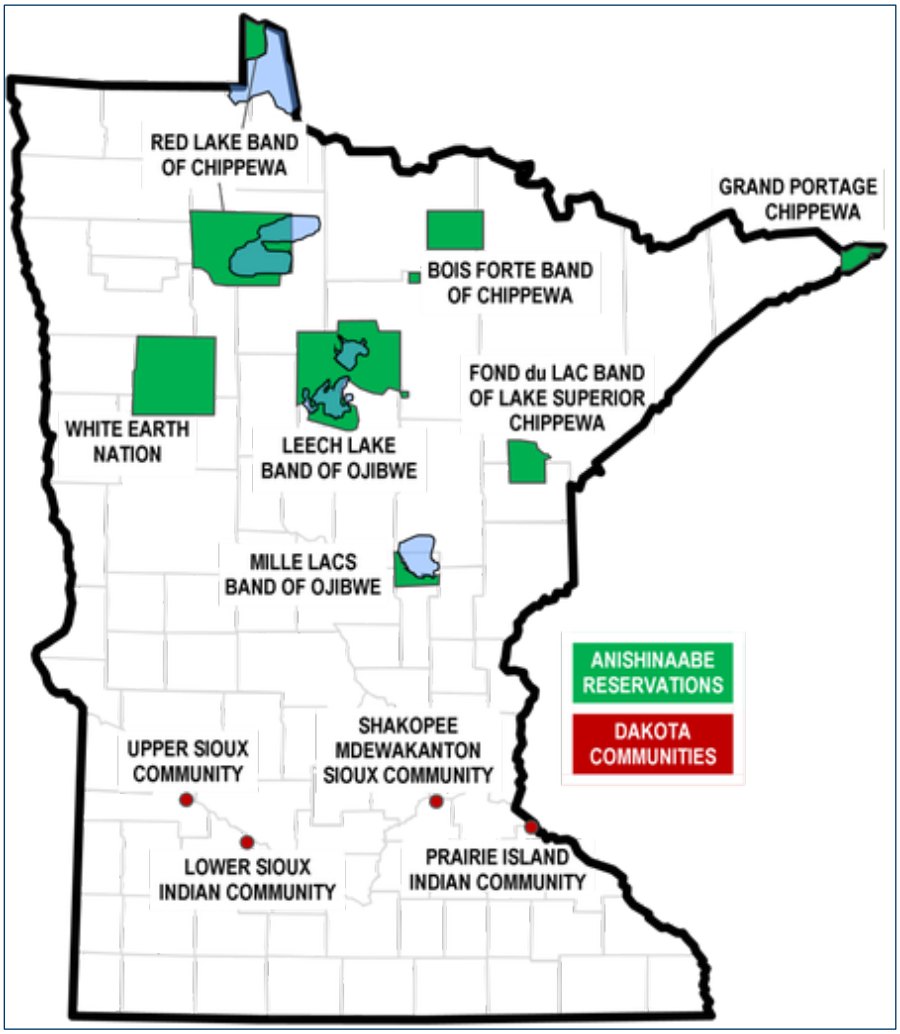

Figure 74 – Map of Federally Recognized Native American Reservations in Minnesota. Source: MDH.

Minnesota tribal forestry plans are sometimes incorporated under wider natural resource initiatives such as the Great Lakes Indian Fish and Wildlife Commission (GLIFWC), an agency consisting of 11 Ojibwe nations in Minnesota, Wisconsin, and Michigan. The agency is committed to implementing off-reservation treaty rights of hunting, fishing, and gathering and to the protection of treaty rights and natural resources. Several federal treaties apply to the 11 Tribes in Minnesota including Dakota and Ojibwe Treaties, the 1837 Treaty, the 1854 Treaty, the 1855 Treaty. All treaties can be reviewed through the following website Treaties Matter.

Below are current tribal forestry planning initiatives by the 11 Tribes in Minnesota as provided by each Tribal Forestry or Natural Resources Director. Please note that four Tribes, Prairie Island Community, Lower Sioux Community, Upper Sioux Community, and Shakopee Mdewakanton Sioux Community, are not located primarily in forested regions of the state and do not have extensive forested land bases. However, these Tribes are heavily involved with environmental stewardship and work with partners on stewardship programs to restore prairies, forests, wetlands, and aquifers as well as promote and engage in green energy projects.

The Red Lake Nation, or Miskwaagamiiwi-zaaga'igan, has the largest tribal land base in the state at approximately 806,698 acres of land, located in the north-central part of the state. A portion of the Tribe's land-base borders the Canadian border. Red Lake Nation participates cooperatively on fire management and suppression with other agencies under the umbrella of the BIA and is a member of the Minnesota Interagency Fire Center (MIFC).

The Red Lake Nation also partners with USDA and DNR on issues related to invasive species such as EAB. Other tribal natural resources, such as fisheries management and maintaining cooperative relationships with outside partners such as the DNR. For example, Red Lake tribal staff sit on the Fisheries Advisory Board, which sets out slot limits (the number of fish that is legally allowed to be harvested) for fish species, especially walleye.

The Red Lake Nation has a robust forestry staff of 45 employees and includes timber management, planning and GIS, a fire center, and greenhouse complex with capacity to grow 1 million seedlings. A standing BIA contract funds forest planning. The current forest management plan is on a 15-year cycle 2013-2028.

The White Earth Nation, or Gaa-waabaabiganikaag Anishinaabeg, is the second largest Tribe in Minnesota, with approximately 77,967 acres of land. The Tribe is actively pursuing new purchases and acquisitions to expand their tribal boundaries and to reclaim isolated land parcels that may still be within the Tribe's boundaries.

The White Earth Nation participates extensively in fire management and hazard mitigation under the umbrella of BIA and is a member of MIFC.

Timber management is done on a case-by-case basis with partners such as the DNR when applicable. Currently, the forestry and fire program has been funded to treat roughly 615.7 acres of DNR, Minnesota Trust Fund, and county lands near Lower Rice Lake in Clearwater County. The work done so far has been by mechanical treatment using a Marshmaster© tracked vehicle with a mowing attachment. Other coordinated efforts include invasive insects management (EAB and gypsy moth) with the USDA, and selected projects with the USFWS.

The Grand Portage Band of Lake Superior Chippewa, or Kitchi-Onigaming, consists of over 47,024 acres and is located on the northeastern tip of the state bordering Lake Superior. Grand Portage Band is very active with partners in several areas including fire activities, limited timber management, and other projects such as invasive species control. Grand Portage Band is considered a forest management leader in cooperation with other partners and has over 20 years cooperative forestry experience including with the forest blowdown in 1999. Contracting services are current with other agencies such as SNF, NRCS, NPS, DNR State and Private Forestry, and MFRC Landscape Committees that represents the Tribe's

geographic location. Grand Portage Band is a member of the Intertribal Timber Council and its fire sub-committee work closely with the BIA on several issues important to 'Indian Wildfire and Forestry' issues. This is considered unique in the nation. BIA also has signed cooperative agreements with the US Forest Service for prescribed burning and assists the Superior National Forest with these burns.

The Bois Forte Band of Chippewa, or Zagaakwaandagowininiwag (Men of the Thick Fir-Woods), has over 42,131 acres in a checkerboard land ownership pattern. The Tribe participates cooperatively on fire management with other partners under the umbrella of the BIA and is a member of MIFC. Timber management is done on a more case-by-case basis with both private, county, and DNR partners, due to the checkerboard land ownership patterns. There are also partnerships related to invasive species and silviculture prescriptions with county, state, and federal agencies.

The Leech Lake Band of Ojibwe, or Gaa-zagaskwaajimekaag, has approximately 27,391 acres of land and water within a checkerboard land ownership pattern, most notably with both Chippewa National Forest (CNF) and state lands. The Leech Lake Band works collaboratively with other Minnesota Tribes on fire suppression and hazards, as well as other partners through MIFC. Timber management is done on a more limited basis with partners. However, Leech Lake Band does have a large protection and timber management project with the CNF focused on snowshoe hare habitat and protection. The Tribe is also participating as a full cooperating agency on several large vegetative management projects with CNF. These have been outlined in a Memorandum of Understanding (MOU) between the Tribe and CNF, which was signed on Oct. 4, 2019.

The Tribe is currently working on climate change and invasive species management through a black ash project. This project is funded through the BIA via the Tribal Forest Protection Act that also funds other tribal forest projects. The CNF is a partner to some of these projects through the US Forest Service.

The Leech Lake Band Forestry Division serves as a tribal representative for the pilot Landscape-Level Arrowhead project proposed in northeast Minnesota, in 2019.

The Fond Du Lac Band of Lake Superior Chippewa, or Nagaajiwanaang (where the water stops), has approximately 24,709 acres on their reservation. Fond Du Lac Band does participate cooperatively with counties, DNR, and the US Forest Service on fire management under the umbrella of BIA. The Tribe is also a member of MIFC. Fond Du Lac Band is in the process of establishing a memorandum of understanding (MOU) on mutual aid with the University of Minnesota's Cloquet Forestry Center for increased cooperation on fire management in relation to roads and trails.

Timber management and timber sales have not been active lately due to checkerboard ownership with counties and private landowners. The Tribe is interested in buying back ceded lands. Due to private landowners trespass issues within the Tribe's boundaries, limited private timber sales are done. These are handled either through phone calls or individual requests to the Tribe.

The Fond Du Lac Band has limited interaction with the Superior National Forest but does have an MOU for taking wood off federal forest lands. There is also collaboration with county, state and federal agencies on water, invasives, climate change issues, as well as, the need for new tree species, as invasives (EAB) and climate change alter the forests.

Management planning (IRMP), including forest inventory, is done on a 10-year cycle and is funded through BIA contracts.

The Mille Lacs Band of Ojibwe, or Misi-zaaga'igani Anishinaabeg, is located in the central portion of the state and has scattered ownership patterns of over 4,189 acres with 3,300 of these acres within the ceded territory. Mille Lacs Band has an active fire program within their Wildland Department. Prescribed and controlled burns are often done with NRCS as a partner. Mille Lacs Band does their own forest land management and are currently working on a Golden Wing Warbler

project with the aid of NRCS funding. BIA also provides the Tribe with funding but this is related to operational costs and does not include planning in 2019. Mille Lacs Band has access to many federal programs and grants through EPA (GLRI).

Mille Lacs Band natural resources staff are cross-trained and constantly on the lookout for invasive species such as EAB and gypsy moth. There are approximately 40 natural resources staff within the Tribe. Tree plantings are done with the assistance of SWCDs and private contractors such as Bailey's out of Minneapolis.

Both Mille Lacs Band and Fond Du Lac Band are members of the Great Lakes Indian Fish and Wildlife Commission (GLIFWC).

Prairie Island Indian Community (PIIC), or Tinta Winta, is a Dakota community located in Goodhue County, north of Red Wing. The main lands of PIIC are in the Mississippi floodplain encircled by both the Vermillion and Mississippi rivers making it a unique island. Since the 1930's, Lock-and-Dam operations have greatly affected river hydrology, which has caused significant changes to forest and wetland systems. Over this time period, PIIC lost over 700 acres of land and several hundred acres of marsh lands. Today, PIIC is active in land acquisition with total current ownership at 5,208 acres including fee acreage of 1,896 acres and trust lands of 3,312 acres.

PIIC natural resources staff partner with other Tribes and BIA on fire suppression and prescribed burns. Burn and forest plans only cover trust lands, not fee ownership lands.

A portion of PIIC's natural resources work is dedicated to keeping ahead of EAB in partnership with USDA APHIS. PIIC has a greenhouse and gravel pit nurseries to grow stock for future EAB replacement and other needs. PIIC is involved with wild rice restoration but recent flood years has set back this development. Flooding has become a major factor in the last decade, which is not only affecting wild rice production, but also agricultural production, native restoration, and forestry efforts.

PIIC's Natural Resources Department oversees a large variety of environmental concerns, including land management, invasive species control, environmental control, water quality, non-point source pollution, and coordination of health issues related to the environment.

The Upper Sioux (Dakota) Community, or Pejuhutazizi Oyate, is a Dakota Community located in a portion of the unceded Dakota homeland along the Minnesota River near Granite Falls. The Community is bounded on the west, east, and south by Yellow Medicine County and the Minnesota River to the north. The USC population is made up of primarily Wahpetonwan ("Dwellers in the Leaves") Dakota. However, there is also a small population of Mdewakanton ("Dwellers by Mystic Lake") and Yankton ("Dwellers at the End"). The Community lands consist of approximately 1,773 acres of which 1,464 acres are held in federal trust. The USC's land is located on the eastern edge of extensive areas of tallgrass prairie and the western edge of the prairie-forest transition zone.

The UCS landscape and its adjacent areas have experienced significant changes over time. The extensive lush native prairies, which once covered the southwestern Minnesota landscape, is now dominated by the agricultural industry and its resulting anthropogenic activities. The Minnesota River and its tributaries continue to experience degradation in both water quality and ecological health due in large part to sediment loading, nutrient pollution, and elevated bacterial levels. Approximately 80 percent of the tribal lands lie within the flood plain and escarpment; the remainder lies on an adjacent upland area.

The Community does not have a written master land use plan that states its land use and environmental conservation goals. However, the Community engages in several efforts to restore and protect areas of native vegetation, and these areas are given conservation management priority. These areas include remnant and planted prairies, degraded oak

savanna, lowland forests, rock outcrops, springs and seeps, ponds, surface waters, and other associated areas within tribal lands. The Tribe's Office of the Environment works cooperatively with federal, state, local governments, and regional partners to ensure the ecological health of the Community's natural resources.

The Lower Sioux (Dakota) Community, or Cansa'yapi, is located along the Minnesota River Valley. The Tribe's population is approximately 932 residents who reside along a 10 mile stretch of the Minnesota River Valley homeland known as Cansa'yapi (where they marked the trees red). The Tribe owns approximately 1,700 acres of which a portion is wooded oak riparian lands along the river. The Tribe participates in wildfire work through BIA and offers firefighting staff to outside agencies for wildfire suppression. The Tribe does some cooperative work with the Department of Agriculture to monitor for EAB. The Tribe is actively restoring both wild rice and prairie plants in various locations. The Tribe also actively participates in climate change adaptation and is concerned about the possible loss of birch as a viable species on their lands.

The Tribe works cooperatively with federal, state, and county governments such as EPA, BIA, NRCS, SWCDs, DNR, PCA and non-profits on various projects. Consistent funding can be a challenge and initiation of new projects limited due to a small two-person core staff.

The Shakopee Mdewakanton Sioux (Dakota) Community (SMSC), or Bdemayato Oyate, sits just south of the Twin Cities and is considered urban. The Band manages approximately 580 acres of forest and woodland within the maple/basswood Big Woods complex. Forest restoration includes maple/basswood stands, oak savannas, and mixed hardwood/oak forest. Due to their urban location, the biggest invasive species to tackle currently are Asian carp and buckthorn. Approximately 80-100 acres of the Tribe's land is a maple/basswood Big Woods parcel. To keep buckthorn at bay, the Band practices intensive species management, including partnering with local units of government and has hired a contractor for buckthorn removal using goats. A current buckthorn eradication project is a 16-acre parcel in the Big Woods.

The SMSC participates in wildfire management through the BIA, other federal and state partners and MIFC along with managing a prescribed burning program.

The SMSC consults with the BIA Midwest Region Branch of Forestry on available projects. Other natural resources land projects include prairie restoration and 100 acres of tree planting. The SMSC collects acorns and has a nursery planting stock bed. The SMSC is in the process of inventorying water bodies to assess water quality for future wild rice plantings.

18.8 Other Forest Planning Efforts in Minnesota

Board of Water and Soil Resources

The Board of Water and Soil Resources (BWSR) is the state soil and water conservation agency and administers programs that prevent sediment and nutrients from entering lakes, rivers and streams; enhance fish and wildlife habitat; and protect wetlands. The agency works in partnership with local units of government such as counties and Soil and Water Conservation Districts (SWCDs), state and federal agencies such as Natural Resources Conservation Service (NRCS), Tribes and other organizations. The mission of the BWSR is "to improve and protect Minnesota's water and soil resources by working in partnership with local organizations and private landowners."

BWSR manages and monitors over 210,000 acres of permanent conservation easements within Minnesota. In 2019, the Reinvest in Minnesota (RIM) program administered 175 easements totaling 12,271 acres in the ACUB, Mississippi Headwaters, Wild Rice and Pine River watersheds alone. Further details can be found at the BWSR website.

County Forest Plans

Minnesota has approximately 2.8 million acres of forest land in county ownership, a result of the 1930s when depleted and abandoned farms and forest land were acquired through tax-forfeits. Fifteen counties located primarily in the northern regions of the state began to appoint land commissioners to serve as stewards of the lands, adopt forest resource policies, and initiate forest management programs. These professional forest managers founded the Minnesota Association of County Land Commissioners, and began the daunting task of renewing the soils and growing trees on a sustainable-yield basis. In 1979, the state legislature enacted "Payment in Lieu of Taxes" that encouraged the counties to retain the lands and manage them sustainably. While tax relief is a primary objective, a portion of the payment is dedicated to intensifying the management and improvements of natural resources. Counties now supply 38 percent of the wood commercially harvested from public lands in Minnesota.

Conservation Agenda: DNR's 10-Year Strategic Plan

The Conservation Agenda articulates DNR's mission, goals, challenges, trends, strategies, and actions that the agency uses to measure progress over a 10-year period (2015-2025). The plan presents a broad and aspirational vision for the state organized around four goals:

- Conserve and enhance Minnesota's waters, lands, and habitat
- Provide quality outdoor recreation opportunities for all
- Support Minnesota's natural resource-based economy while protecting environmental quality
- Efficiently and effectively serve Minnesotans

For each of the four goals, the plan identifies key challenges that Minnesota will face over the 10-year plan period along with strategies and actions the DNR will use to address these challenges. In 2020, an update of the 10-year Conservation Plan is expected to be completed.

Minnesota's Wildlife Action Plan

In 2001, the United States Congress created the State Wildlife Grants Program and required all states to develop a comprehensive wildlife conservation strategy to identify and manage species in greatest conservation need. This mandate, which is to be revisited every 10 years, provided a historic opportunity to consider the condition of all native wildlife, including birds, mammals, fish, amphibians, reptiles, mussels, spiders, and insects. Minnesota's first State Wildlife Action Plan (SWAP) was completed in 2005. The 2015-2025 Wildlife Action Plan builds upon the foundation established in the 2005 version and was updated to better reflect the state's understanding of wildlife conservation needs and the approaches to addressing them. The plan concentrates on species in greatest conservation need (SGCN) to ensure the long-term health and viability of the state's most vulnerable species. The plan is administered through the DNR Division of Fish and Wildlife.

Chapter 3: Issues, Threats, and Opportunities

Minnesota forests and ecosystems face several major issues and threats. The following key issues and threats to be addressed by forest land management, have been identified by forest managers and stakeholders as being the most critical to the success of healthy and sustainable forests. While in no particular order, these identified issues occur at state, regional, and local scales.

1. Conserve and Manage Working Forest Landscapes for Multiple Values and Uses

1.1 Identify and Conserve High Priority Forest Ecosystems and Landscapes

Historically Minnesota has enjoyed a large forest land base. Recent changes in land ownership patterns, timber industry, and climate, along with increased invasive pest pressures, are demanding the reprioritization of forest management practices to provide for present and future needs. Collaboration with partners in tackling these many-faceted issues is key to sustaining a healthy forest land base in the state. The Forest Legacy Program and Forests for the Future are examples of administrative programs that address these issues. The federal Forest Legacy Program provides matching federal funds to state funds for purchasing forest lands or conservation easements. The state Forests for the Future program gives landowners a way to sell conservation easements on their land. Since 2000, public and private funding sources have provided more than $92 million to protect more than 360,000 acres of forest with permanent easements and fee title through these two programs. Over 60 percent of the funding came from state funds, 20 percent from private donations, and 18 percent from federal funds.

A variety of forest systems provide important values to Minnesota. These include old growth (OG) and high conservation value forests (HCVF), along with areas that support listed species of special concern (federal or state). Maintenance and management of these rarely occurring areas should be considered, to maintain the health and resilience Minnesota's forests. However, natural disturbances and climate change will play a role in ever-changing forest systems, thus protecting and saving all OG and HCVF systems may not be feasible over time.

1.2 Actively and Sustainably Manage Forests

Minnesota forest agencies are among the nation's first and largest public land managers to have their lands certified by both the Forest Stewardship Council® (FSC) and the Sustainable Forest Initiative® (SFI). Minnesota has approximately 8 million acres of certified forests across private and public ownerships and the state holds the largest single FSC® Forest Management Certificate in the United States. Certification provides unique market access to support and sustain healthy and diverse forests. These forests support industries that produce certified products including lumber, siding, office paper, magazines, windows, furniture, and cabinets. To maintain certification, all certified landowners (certificate holders) go through annual audits to review their conformance to and recommend improvements to indicators of sustainable forest management.

DNR forest planning efforts provide direction and monitoring to ensure sustainable management for multiple uses on state forest lands. The state's continuous work and 10-year reviews on Section Forest Resource Management Plans (SFRMPs) are a great example of this effort. These plans are administered and updated through the planning section of the DNR Forestry. Site Level Monitoring Guidelines are another example used to inform landowners and monitor how all lands in Minnesota

are managed sustainably. The monitoring guidelines are administered through DNR Resources Assessment, which provides tracking and data support for monitoring efforts throughout the state.

2. Protect Forests from Threats

2.1 Restore Fire-adapted Lands and Reduce Risk of Wildfire Impacts

The state of Minnesota has extensive long-term experience in preventing and fighting forest fires, which was borne out of historic deadly wildfires dating back to the late 1800s and early 1900s. Protecting life, property and natural resources on more than 45 million acres of public and private land from fire and other natural disasters is a core part of the state's forestry mission.

The DNR Forestry trains and tracks current qualifications on the over 800 full-time and emergency personnel who are available to respond to fires statewide. Through the state's partnership with the Minnesota Incident Command System (MNICS), federal fire response personnel are also readily available. Agreements with federal agencies and sovereign nations including US Forest Service, USFWS, BIA, Tribes, NPS, and local fire departments allow for the sharing of personnel and equipment resulting in quick initial response to wildfires throughout the state.

Minnesota works with local communities to help them reduce the impacts of wildfires, through the Firewise and Wildfire Community grant programs.

The DNR Forestry also maintains relationships with the states of Wisconsin and Michigan as well as the provinces of Ontario and Manitoba through the Great Lakes Forest Fire Compact (GLFFC). This relationship allows for the coordination and sharing of, and not only fire response personnel and equipment, but the sponsorship of training and expertise exchanges that benefit the member states and provinces.

The state maintains a strong relationship with US Forest Service Northeast Area State and Private Forestry staff. The US Forest Service S&PF staff supports the state's efforts in the areas of national mobilization for emergency response, grant programs for preparedness, and volunteer/rural fire department assistance, and access to federal excess property as referenced above. This relationship is of great value to the state fire program in Minnesota and throughout the Northeast Region (US Forest Service Region 9).

All the above relationships are very important to the state and provide opportunities to continue to partner and share resources such as personnel, equipment and support with all involved in wildfire preparedness and management.

A major concern in wildfire preparedness and management revolves around the aging of the state's overall workforce, and replacement of knowledgeable and experienced wildfire leadership staff as they reach retirement age. Many of the leaders in fire management in Minnesota and elsewhere are nearing retirement age, are no longer physically able to actively participate in wildfire response and prescribed burning, or both. Replacing these personnel will involve major efforts in wildfire training, along with, acquiring needed experience and leadership skills. Support from federal and tribal partners and coordination among states, is needed, to effectively replace wildfire leadership personnel and to continue the partnering efforts and established relationships.

Prescribed fire is a tool that is periodically used by forest managers to restore and manage existing forest ecosystems. In Minnesota, many of the same personnel conduct prescribed fire and respond to wildfires. The same issues of training and an ageing workforce that affects wildfire suppression, also affects the ability to successfully implement prescribed fire on the landscape.

2.2 Identify, Manage, and Reduce Threats to Forest and Ecosystem Health

Minnesota's forests and trees are critical to the ecological health and financial economy of the state. Ensuring healthy ecosystems, productive forests and quality trees that will exist well into the future is a collaborative goal shared by federal, state, tribal, and county agencies, and private and public community partners throughout the state. Forest health programs including the Forest Pest First Detectors, and collaborations between agencies such as US Forest Service, DNR, and MDA are vital to manage the spread of invasive species. For example, EAB is of urgent concern as Minnesota has over 1 billion black ash trees, more than any other state. Ash trees make up 7 percent of the forest cover and 30 percent of urban tree cover. On-going education efforts both at the urban and rural levels are alerting the public to be vigilant and helping to keep the state's forest resources healthy for future generations. Another current example of an on-going program is the Minnesota Tree Improvement Cooperative, run by the University of Minnesota, Department of Forest Resources, out of the Cloquet Forestry Center. These collaborative efforts can also considered as climate adaptation actions to increase forest resiliency and reduce existing threats to forests.

3. Enhance Public Benefits from Trees and Forests

3.1 Protect and Enhance Water Quality and Quantity

Maintenance and Protection of Water Quality and Quantity

Minnesota has abundant water supplies in both surface and underground systems. However, demand for water is increasing faster than population growth, which presents challenges to balancing water quality and consumptive needs (Figure 57). Coupled with climate change threats of increased storm severity, runoff, flood damages, and drought, the protection and sustainable management of the state's forest lands, are a critical component in ensuring that clean water supplies will continue to be available in the future. Changing land use, poor forest harvesting methods, deforestation, and population growth also threaten aquatic habitats in the state. Protecting and maintaining high-quality aquatic habitats and healthy water ecosystems are essential for sustaining not only human and agricultural water needs and quality of life, but also the multi-million dollar hunting, fishing, and tourism industries. These sectors are large economic drivers for which the state is well known. Minnesotans have invested in the Clean Water Legacy Amendment and the Environmental and Natural Resources Trust Fund to insure that Best Management Practices (BMPs) are put in place during forest management activities and to assess the implications of implementing these BMPs, or not.

Forested watersheds have a significant impact on the quality of Minnesota's water resources. It is very important that the forestry community be aware of the planning and monitoring activities of agencies who regulate water quality and use, because the policies and regulations they develop, can have significant impacts on forest and land management practices. This creates a need for forest management staff to develop and maintain collaborative contact with agencies such as BWSR, MPCA, MDH, and the DNR Division of Ecological and Water Resources, so that they can provide timely pro-active input into individual watershed issues and policies as they are developed. This also requires a commitment of staff time and training to be effective. Minnesota must continue to proactively manage staffing and technology needs and priorities to support important policy-development efforts. Robust research and analyses on the connection between forest land cover and management at the watershed scale, and the effectiveness of best management practices on water quality and quantity are considered a data gap.

3.2 Improve Air Quality and Conserve Energy

Minnesota's forest land currently stores approximately 1.6 billion metric tons of carbon, of which an estimated 74 percent is attributed to soil organic carbon (SOC) stock. Due to the disproportionally high amount of SOC, Minnesota has among the highest amount of total stored carbon in the conterminous 48 states. Carbon sequestration could also be a new source of income for the state's forest landowners. Opportunities to boost carbon storage include creating new forests; using more harvested wood for furniture, lumber, and other long-lasting products that store carbon; planting faster growing trees; reducing disturbance of forest soils; leaving trees on the landscape longer before harvest; and planting more trees per acre. At present, carbon storage is a valuable ecosystem service for the state. The extent to which Minnesota's abundant peatlands and wetlands enhance carbon storage, is an important field of study. The State of Minnesota is exploring the following strategies for the future: 1) Support and promote best practices and protocols for calculating, monitoring, and verifying carbon storage in Minnesota's various forest types; 2) Support incentives that broaden public benefits from forests and reward forest landowners for enhancing carbon sequestration, and 3) Evaluate the potential to develop carbon offset projects, and-or collaborate with neighboring states on regional greenhouse gas market developments and carbon offset protocols for forests. (Source: DNR Forestry discussion with NIACS staff-Nov. 2019).

Pressure to find local, renewable alternatives to petroleum-based fuels and chemicals provides the state with new opportunities, especially in light of the downturn of traditional lumber and paper demands stemming from the 2007-2008 collapse of the housing market and the continued downward market trend of printing and writing paper products. Sustainable use of the state's forest resources can meet the demands of emerging wood markets while supporting the traditional forest products industry. In addition to pulp and paper, trees can be used to make building products, sawn products, thermal energy, electricity, renewable chemicals, and liquid fuels. The development and harvest of underutilized, diseased, damaged and fire-prone species must be pursued as part of a broader strategy to create well-managed, healthy and productive forests. The utilization of wood for the emerging wood cellulosic bioeconomy, must also be considered in the context of environmental, economic, and policy goals of the state.

3.3 Increase Environmental Services by Creating and Maintaining Healthy Urban and Community Forests

Community forests are unique ecosystems that provide vital environmental services such as mitigating stormwater and cleaning the air. Maintaining shade in communities reduces energy consumption and impacts of heat island effects. Trees in community forests strengthen social cohesion and add economic value to homes and businesses. Climate change and the increasing threats of invasive species require continuing research and education for both public and private practitioners to safely continue best management practices (particularly with declining health) and maintain tree cover for environmental services.

Urban and community forestry (U&CF) in Minnesota is a statewide collaboration that unites many agencies, organizations, communities, decision makers, and the public. DNR provides financial and technical assistance to these collaborations to support cooperative programs, research, and education to advance a comprehensive approach to the management of trees in cities. Through the support of the Federal Urban and Community Forestry Program, the following goals have been identified for implementation:

- Support local community urban and community forestry programs
- Support and expand the partnership efforts with the University of Minnesota and non-profits to provide technical assistance, educational outreach and administrative support to meet the increased interest and demand from communities

- Strengthen advocacy and expand volunteer participation to support local, state, and national initiatives through fundraising and legislative efforts

Several challenges have been identified within urban and community forestry including the continued expansion of EAB in parts of the state and the heart of Minneapolis-St. Paul. A need to accelerate public information and community assistance to combat this devastating invasive species exists.

Other challenges include the lack of:

- Expertise, training in current technologies, and technical assistance to Minnesota communities
- Heightened political awareness and support that will result in state funding initiatives
- Partnerships among organizations and communities in Greater Minnesota (outstate)
- Preventing conversion of forest land to urbanization (and subsequent tree losses)
- Technical assistance for shade tree pests and tree maintenance
- Vision for sustainable community design and ecosystem approaches for local land use planning

Specific priorities are emerging within urban and community forestry including the following:

- Follow recommendations listed in the Emerald Ash Borer in Minnesota State Agency Report prepared by the Environmental Quality Board (EQB), which include: slowing the spread; supporting communities; managing ash wood materials; and leading, engaging, and collaborating.
- Expand the DNR-led statewide Tree Inspector certification program to include cities in Greater Minnesota who are facing the greatest threat from EAB.
- Involve more statewide organizations to improve coordination with MDA in monitoring and planning for greater state investments in exotic invasive pest control (gypsy moth, EAB, etc.).
- Involve more private and public tree practitioners in the Minnesota Society of Arboriculture (MSA) and Minnesota Shade Tree Advisory Committee (MnSTAC) in efforts to improve professional standards statewide.
- Build upon the partnership with the US Forest Service iTree Team to promote the use of these tools by public and private practitioners, and continue to build upon the awareness created by the "Trees Pay Us Back" publicity campaign to garner greater state and local investments in urban and community programs.

3.4 Maintain and Enhance the Economic Benefits and Values of Trees and Forests

Minnesota is a leader in timber production in the continental US, harvesting between 2.9 and 3.1 million cords annually with a total economic output effect of over $17 billion annually. The forest products industry is the fifth largest manufacturing sector in the state by employment and impacts over 64,000 jobs. Key forest management capacity is provided in large part by private industry, which currently faces challenges from the loss of mill capacity and competition from other states and countries. Without the robust private timber industry, the state would have very little capacity to manage the forest type and associated forest age-class structure. Timber harvesting is the primary means to accomplish many forest goals, including the manipulation of stand type and age class, creating and improving wildlife habitat, restoring ecological functions, maintaining forest health, reducing wildfire risk, sequestering carbon, mitigating climate change, sustaining rural communities, and generating income for forest landowners. In 2014, the Minnesota Forest Resources Council published a report entitled, Report on the Competitiveness of Minnesota's Primary Forest Products Industry, which listed six key factors that influenced the competitiveness of Minnesota's industry and compared the state with several other wood baskets. Unfortunately, since the 2008 recession, a significant number of mills and paper machines have closed. This has necessitated renewed reinvestment efforts to maintain strong and diverse markets for forest products, while continuing to achieve sustainable forest management goals. It is anticipated that Minnesota will continue to work with private industry to assess near-term and long-term risks, including economic and climate change that affects forest management, timber harvest operations, and the supply chain.

Having a healthy and diverse forest product industry in Minnesota that includes paper, sawtimber, biomass, renewable energy and other opportunities will help the state's ability to adapt to changes in forest economies, climate, and other

forest uses. It will be necessary for all forest landowners including public, industrial, private, mill owners, truckers, loggers, and other segments of the forest industry to work collaboratively and proactively to adjust to changing conditions now and into the future.

3.5 Protect, Conserve, and Enhance Wildlife and Fish Habitat

Minnesota is committed to identifying, protecting, monitoring, and maintaining rare species and ecological systems that contribute to biodiversity, and viability of forest ecosystems. Efforts such as forest certification, the Scientific and Natural Areas Program (SNAs), the State Wildlife Action Plan (SWAP), the DNR native plant community field guides, the Minnesota Biological Survey (MBS), plus efforts such as the Ecological Classification System (ECS), coupled with federal and non-profit identification and restoration efforts, provide guidance for preservation of rare ecological features and systems for the future of forests within the state.

Many rare ecological sites hold the legacy of the state's forested landscapes. As threats such as invasive species, fragmentation, and climate change impact the landscape, careful management and maintenance of identified rare sites can provide a source of resiliency now and into the future.

3.6 Connect People to Trees and Forests, and Engage Them in Environmental Stewardship Activities

Minnesota has always had a strong tradition of nature-based outdoor recreation with participation in outdoor activities well above the national average, especially in hunting, fishing, boating, hiking, swimming, snowmobiling, and skiing. These activities and increasingly bird and wildlife watching, geocaching, motorized and non-motorized activities all rely on access and interaction with abundant natural resources such as forest lands, lakes, rivers, blufflands, grasslands, and parks and recreation facilities. The state is committed to preserving and enhancing outdoor recreation for both present and future generations to enjoy. Training and education are key elements to accomplish these goals through programs such as PlayCleanGo, Arbor Month Program, Project Learning Tree and the Minnesota School Forest Program. Making forest stewardship accessible for increasingly urban populations through these educational programs creates a powerful connection between people and the state's natural forest resources.

Connecting people to the outdoors through forest recreation activities promotes physical and emotional health. The state encourages responsible forest recreation and sees it as an opportunity for people to get beneficial physical exercise and some respite from the daily stress of work and life in general. The forest is also a great learning environment that has many lessons to teach about the value of inter-dependence and the ethical uses of planet earth. Stewardship of the state's natural resources, whether public or private, is encouraged by a better understanding of the way humans are dependent on healthy forests. In turn, healthy forests contribute to a healthy society.

3.7 Manage Trees and Forests to Mitigate and Adapt to Global Climate Change

Climate change is a global phenomenon that is already beginning to significantly impact the future of Minnesota forest resources. Foresters, land managers, and landowners are considering how to prepare for current and changing forest conditions and how to evaluate risks for particular sites. The current trend in Minnesota is warmer winters and higher precipitation rates within the state. Climate change scenarios are predicting this trend to continue and show an increase in Minnesota forests that are stressed with disease, pests, ground compaction, and altered hydrology. This could result in reduced timber, water, and wildlife habitat quality and environmental changes to existing ecosystems.

The state is concerned about these changes and is committed to working with partners to mitigate and adapt to climate change. The following is a list of some of the efforts the state has put forth to address climate change in Minnesota as it relates to natural resources.

Forest Operations and Management Challenges

A changing climate will have an effect on the structure of forests and the distribution of forest plant species in Minnesota's forests. Forest managers need to find new ways to maintain functioning forest ecosystems as forests change. Changes in climate will also have an effect on the timing and type of management of our forests. For example, warmer average winter conditions are posing a challenge to timber harvesting that requires frozen conditions to minimize impacts and successfully complete the harvest and trucking of the wood to market.

Changes in climate are altering the health and productivity of Minnesota's forests and exacerbating the effects of other stressors (e.g., invasive species, pests, and diseases). Suitable habitat for boreal forest species such as black and white spruce and balsam fir may migrate northeastward out of the state to eastern Canada. Increase in tamarack acres infested with casebearer/eastern larch beetles across the state, is already of major concern for forestry interests. Other concerns include hardwood forests expanding to northern Minnesota with more favorable conditions for temperate species. In contrast, hardwood forests may contract in southern Minnesota, if drought becomes a major driver, making it increasingly difficult to manage for these species as they migrate to savannah conditions. While climate-change-driven 'drying effects' may create conditions more suitable for some forests, this could come at the cost of losing wetlands and vulnerable peatlands.

DNR operates a state forest nursery with collected native seeds to guarantee genetic diversity and produces over 6 million native tree seedlings annually for use in statewide public and private forest activities. Each year, the state uses 2.5 million seedlings for reforestation, while 0.5-1 million seedlings are purchased by counties, tribal governments, and other public agencies. Another 2.5 million seedlings are purchased by landowners to reforest private lands. Demand for local, native tree seedlings is expected to increase as climate change impacts Minnesota forest resources. Cognizant of these factors, reforestation projects will continue to be administered on DNR lands to increase stocking volume based on cover type, species diversity, and forest carbon stocks.

The state nursery is experimenting with new tree species that may be suitable for Minnesota under changing climate conditions and is expanding genetic diversity by increasing the geographic size of seed collection zones. The state nursery could partner with universities and private industry to collect, grow, and distribute new species from disparate locations to help address the need for climate change adaptations.

Finally, forests are becoming increasingly identified as important 'sinks' of greenhouse gases and forest managers will need to be more mindful of the role of forest products in, and the consequences of, forest management on carbon stocks. Cap-and-trade systems or other carbon incentive programs designed to help mitigate climate change may influence forest management choices in the state, and create new management options, by offering revenue sources not readily available today.

Minnesota Executive Order 19-37 on Climate Change

In December 2019, Minnesota's Governor Tim Walz issued Executive Order 19-37 establishing the "Climate Change Subcabinet and the Governor's Advisory Council on Climate Change to Promote Coordinated Climate Change Mitigation and Resilience Strategies in the State of Minnesota."

The executive order is intended "to fulfill Minnesota's statutory goals, avoid the severe economic, health, and ecological impacts associated with a changing climate, and fully realize the benefits of a healthy, sustainable, and resilient state, our state government must work across the enterprise in a coordinated approach to develop equitable strategies that will mitigate climate change and achieve greater resilience."

Details of the Climate Change Subcabinet and duties associated with this new subcabinet can be found in Executive Order 19-37.

Minnesota Interagency Climate Adaptation Team

The Minnesota Interagency Climate Adaptation Team (ICAT) includes representatives from several Minnesota agencies including Pollution Control Agency, DNR, Department of Health, Department of Agriculture, Department of Transportation, Department of Commerce (Office of Energy Security), and Department of Public Safety (Division of Homeland Security and Emergency Management). Their 2017 report "Adapting to Climate Change in Minnesota" builds upon two previous reports from this team and further describes observed and projected climate impacts, outlines Minnesota state agency activities related to climate adaptation, and provides recommendations for future state action and interagency collaboration.

In 2010, the DNR created the CLIMATE Team (formally CREST), which provides department-wide coordination and guidance on climate change strategies. A separate Sustainability Team, created in 2019, addressed emission reduction and renewable energy opportunities. The CLIMATE Team helps bring together existing and emerging climate-related efforts at the division, bureau and region levels to create a more unified and comprehensive pathway to addressing pressing climate issues.

Chapter 4: State Geospatial Priorities

Methodology and Analyses Documentation

Summary

This section represents geospatial analyses conducted to identify priority areas to invest in forest conservation and management activities across Minnesota's landscape, spanning ownerships and the urban-to-rural continuum. These analyses are one component of the Minnesota 2020 SFAP, and provide information needed for assessment, but do not replace programmatic priority area requirements. Each of the maps derive from public data, at the statewide scale.

As indicated in the 2018 Northeast-Midwest State Foresters Alliance's Guide for State Forest Action Plans, there are several ways a state may conduct geospatial analyses to identify priority areas. For this Minnesota 2020 SFAP, the geospatial approach is effectively a combination of state issue-based analyses and a composite map. Building off the 2010 SFAP, a series of key issues were identified and corresponding geospatial analyses were completed to identify priority areas for each issue. Many of the composites rely on open data accessed through the Minnesota Geospatial Data Commons; some included light detection and ranging (lidar) data and aerial or satellite photography. The composite maps are comprised of various data layers in four categories of key issues, described below, and display the results as high, medium, or low priority areas. These composites are intended as a tool to help spatially identify where potential short- and long-term actions are needed, which can then be used to develop and revise Program Strategies over time.

There are four spatial models in this section: *Threats and Risks, Economic Impact, Ecological Values*, and *Recreational Values*. Descriptions of the models and methodology are included and further clarification is available upon request. Both the *Threats and Risks* and *Economic Impact* maps were created by simple overlays of the spatial data layers ("input layers", described in more detail below). The cells in each input layer represent the "presence" or "absence" of the given model input data (0 = not present in this area) and in the "present" case a low, medium, or high value (1, 2, 3 respectively) was assigned to represent the impact of that input data in the pixel of interest. Once each contributing layer was created, they were added together to create a map with values from 0 to max, where max was the sum of highest values from each contributing layer. In this intermediate step, pixels with a value of 0 represented areas on the ground with none of the contributing factors, and pixels with a value of max represented areas with all of the highest contributing factors. Once the layers were added, the values of the resulting maps were regrouped into values of high, medium, low, and none. The exact thresholds were determined by creating example maps and asking subject matter experts to determine the appropriate representation.

The *Ecological Values* map was created by The Nature Conservancy (TNC) for a different project, i.e., resilient and connected landscape project. The *Recreational Values* map was created using publically available data layers of designated recreational areas.

Threats and Risks

This model is the result of an overlay analysis of five datasets important to assessing Minnesota's vulnerability to fire, insect and disease impacts, invasive species threats, and the risk of development. The model created from this overlay highlights areas of low, moderate, and high collective risk from all of these threats and risks.

Economic Impact

To depict the potential economic impact of Minnesota's forested areas, seven datasets were evaluated and used in the overlay analysis; these included lands set aside for forest conservation (e.g., forest legacy lands), trust fund lands, lands with Forest Stewardship plans, municipal boundaries, and mill locations. The resulting model highlights areas of low, moderate, and high potential economic impacts based on all of the input data layers.

Ecological Values

TNC produced an ecological values map by combining layers for resilient sites (sites with large number of connected microclimates and numerous physical environments that have high resilience), areas of confirmed biodiversity (sites recognized for their current biodiversity values), and climate flow (corridors that facilitate population movement for climate adaptation). The results are not meant to represent the definitive locations of important ecological areas, but rather are meant to be a prioritization tool for future field assessments related to forest climate adaptation. This landscape-scale product is useful for region-wide planning efforts such as management of parks and conservation corridors or county-wide general planning/zoning.

Recreational Values

This map was created to identify high-value areas for scenic outdoor recreation such as bicycling, walking, camping and sightseeing, and is based on designated state, federal, and county parks, and public land.

Geospatial Priorities Maps

Threats and Risks

The following five data layers were used to create the Threats and Risks map (Figure 75): Risk of Fire, Risk of Forest Pests, Risk for the Wildland –Urban Interface, Risk of Development, and Risk from Terrestrial Invasive Pests. Following the Threats and Risks map are descriptions and maps of the individual layers that were used to create the composite model.

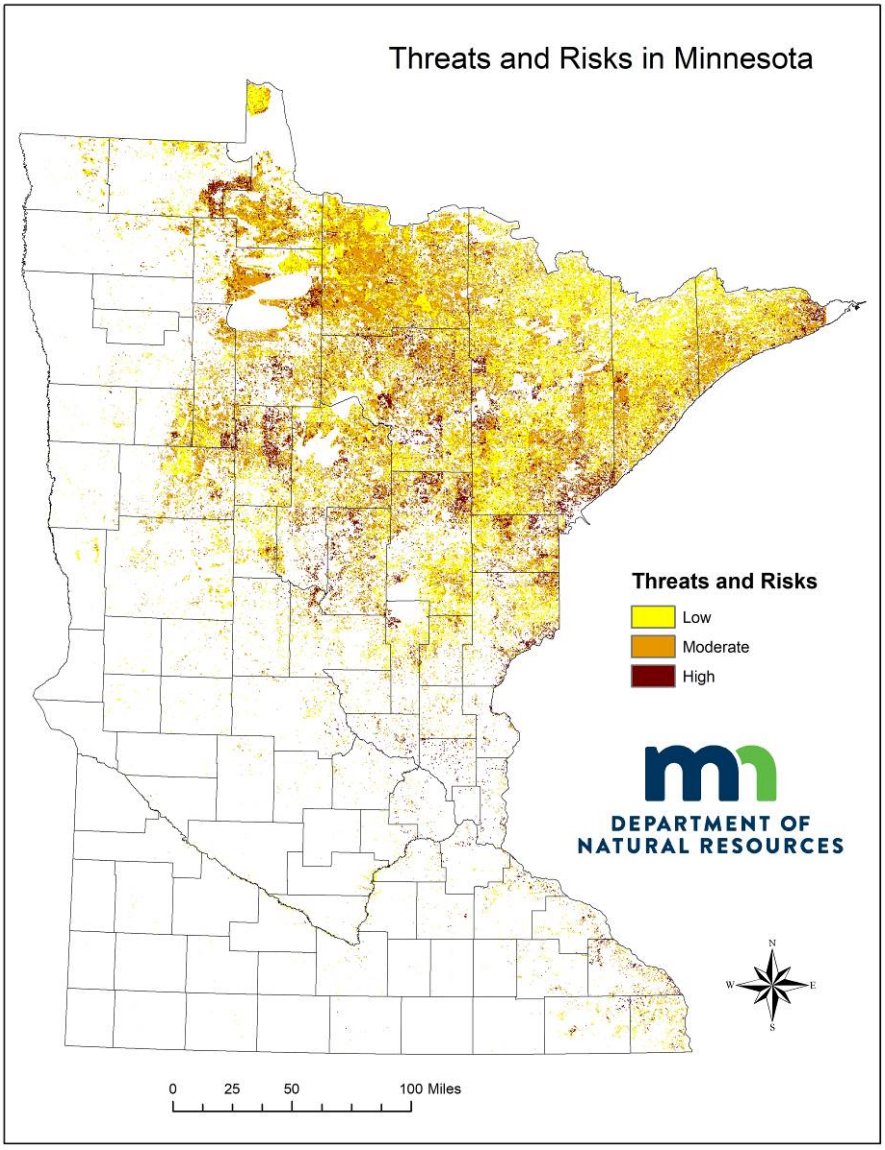

Figure 75 – This Threats and Risks Model is the result of an overlay analysis of five datasets and highlights areas of low, moderate, and high risk to all of the threats included in the model.

Risk of Fire

Woody fuels posing a risk to wildfire spread are characterized by the spatial pattern of woody biomass and canopy structure in Minnesota. The fire risk layer was produced by combining canopy bulk density (CBD) and the fire behavior fuel model (FBFM40, Scott and Burgan, 2005). The two input data layers (i.e., CBD and FBFM40) were obtained from the LANDFIRE project. The fire behavior fuel model accounts for distinct distributions of fuel loading among surface fuel components (live and dead), size classes, and fuel types. The CBD represents density of available fuel in a stand, and is defined as the mass of available canopy fuel per unit canopy volume that would burn in a crown fire. These data do not represent all comprehensive fire risks and primarily represent the risk of fire in areas with woody biomass. The two layers were multiplied and classified into low, moderate, and high risks of fire spread (Figure 76).

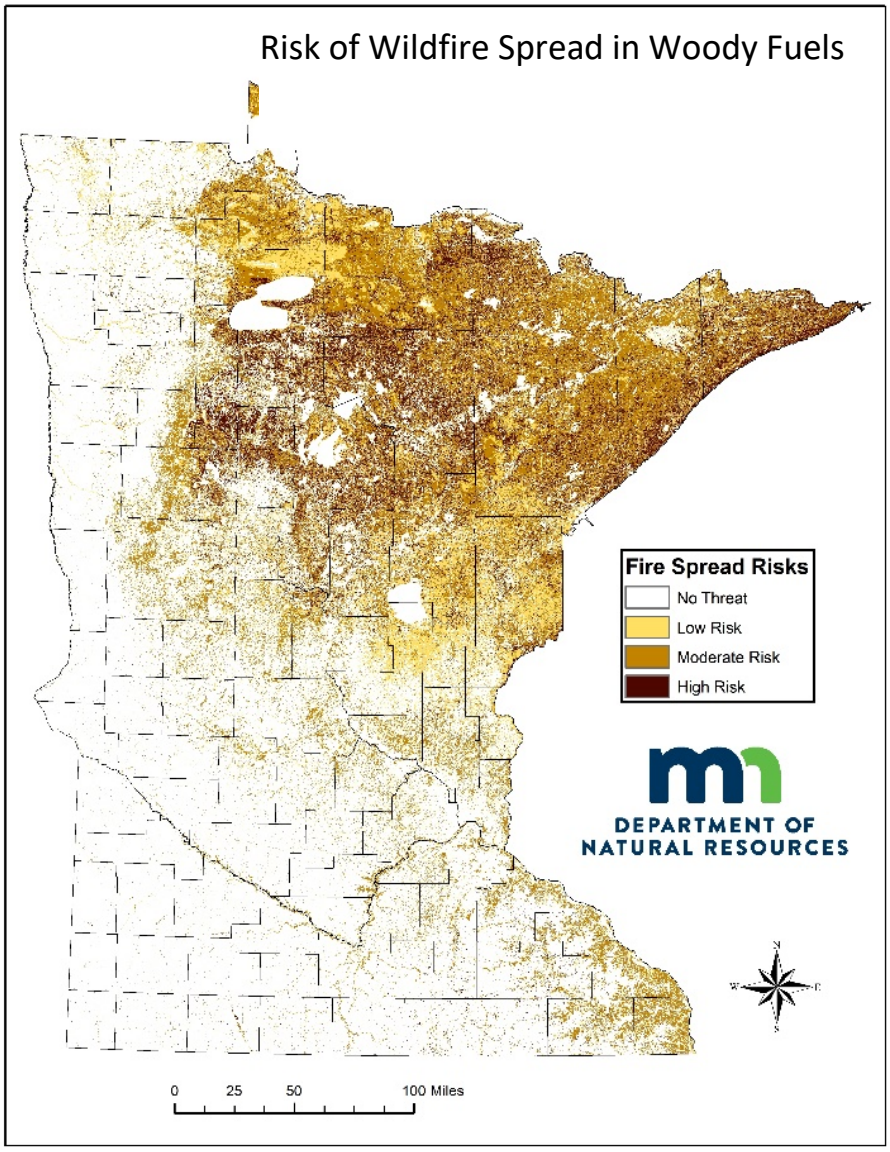

Figure 76 – This LANDFIRE fuel data shows areas with woody biomass at elevated risk from wildfire damage.

Risk of Forest Pests

A data layer characterizing forest areas at risk of mortality from insect and disease infestation was obtained from the Forest Service, U.S. Department of Agriculture, Forest Health Assessment & Applied Sciences Team (FHAAST). This layer was a national effort, and the resolution of the data is 2 × 2 km. The raster data layer is based on the projected basal area loss due to all forest pests and pathogen activity, assuming no remediating management, over the 2013-2027 time-frame. It integrates 186 individual risk models, each of which portrays the expected loss of host basal area (BA) for each pair of damage agents and hosts over each unique landscape where they coexist. This dataset composites the projected BA loss for a target year by tree species host model and then divides the total BA losses from the year by total basal area. The layer was grouped into low-, moderate- and high-risk categories based on percentage of predicted BA loss. The thresholds as used in the metadata (i.e., 0-15, 16-25, 26-35, and >35 percent of the BA loss) were considered to categorize into no, low-, moderate-, and high- risk areas (Figure 77).

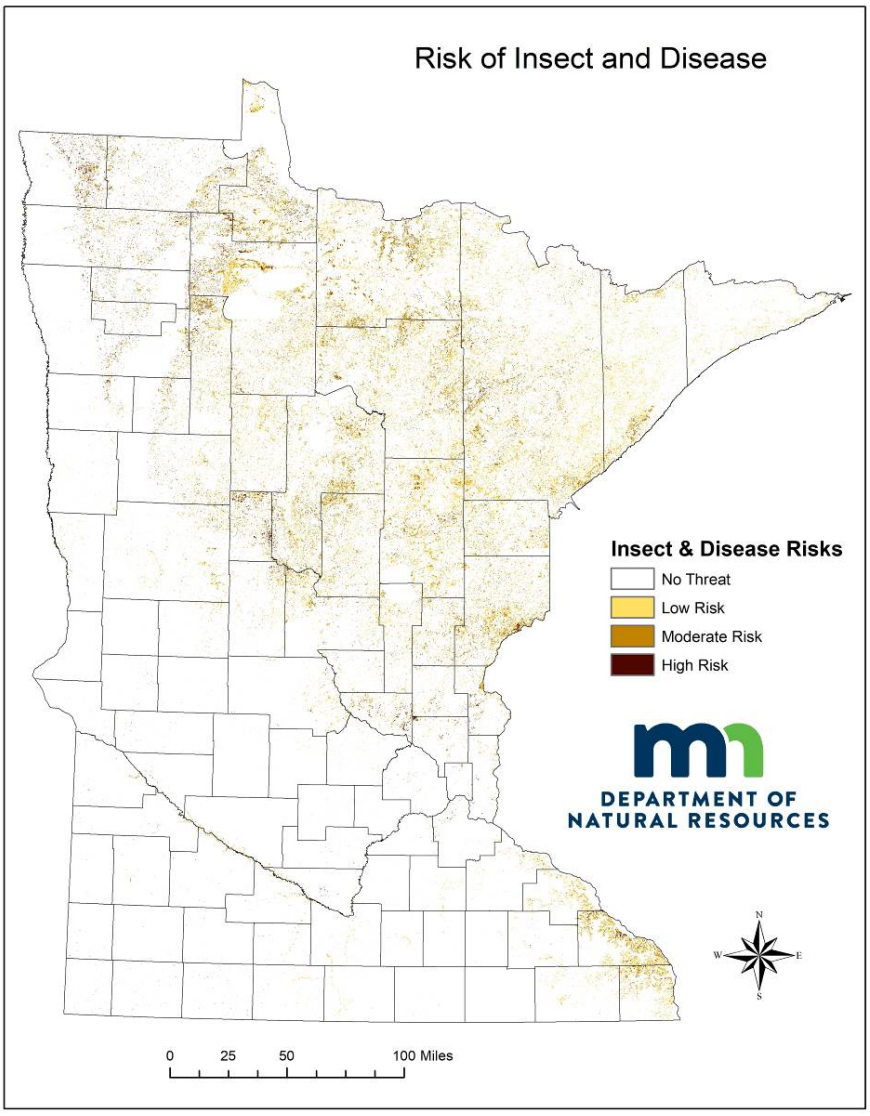

Figure 77 – This map was created by the national "risk mapping" effort performed by the US Forest Service, Forest Health Assessment & Applied Sciences Team (FHAAST) to identify forest areas at risk of mortality from insect and disease infestation.

Risk from the Wildland-Urban Interface

According to the *Federal Register* definition, Wildland-Urban Interface (WUI) is the area where structures intersect with undeveloped wildland vegetation. This WUI layer was created by intersecting underdeveloped wildland vegetation classes from the USGS 2016 National Land Cover Data and municipal boundaries. These data do not represent the only risks of fire in the WUI. Risk assessments like these, including the risk of woody biomass fires, could be used as a broad scale prioritization tool for targeting communications and promotion for the FIREWISE program. The WUI was classified into low, moderate and high risk classed based on the US Census Bureau population density information. Population density was classified into low, medium, and high classes using the thresholds of 0-30, 31-416, and 417-7065 people per sq. miles (Figure 78).

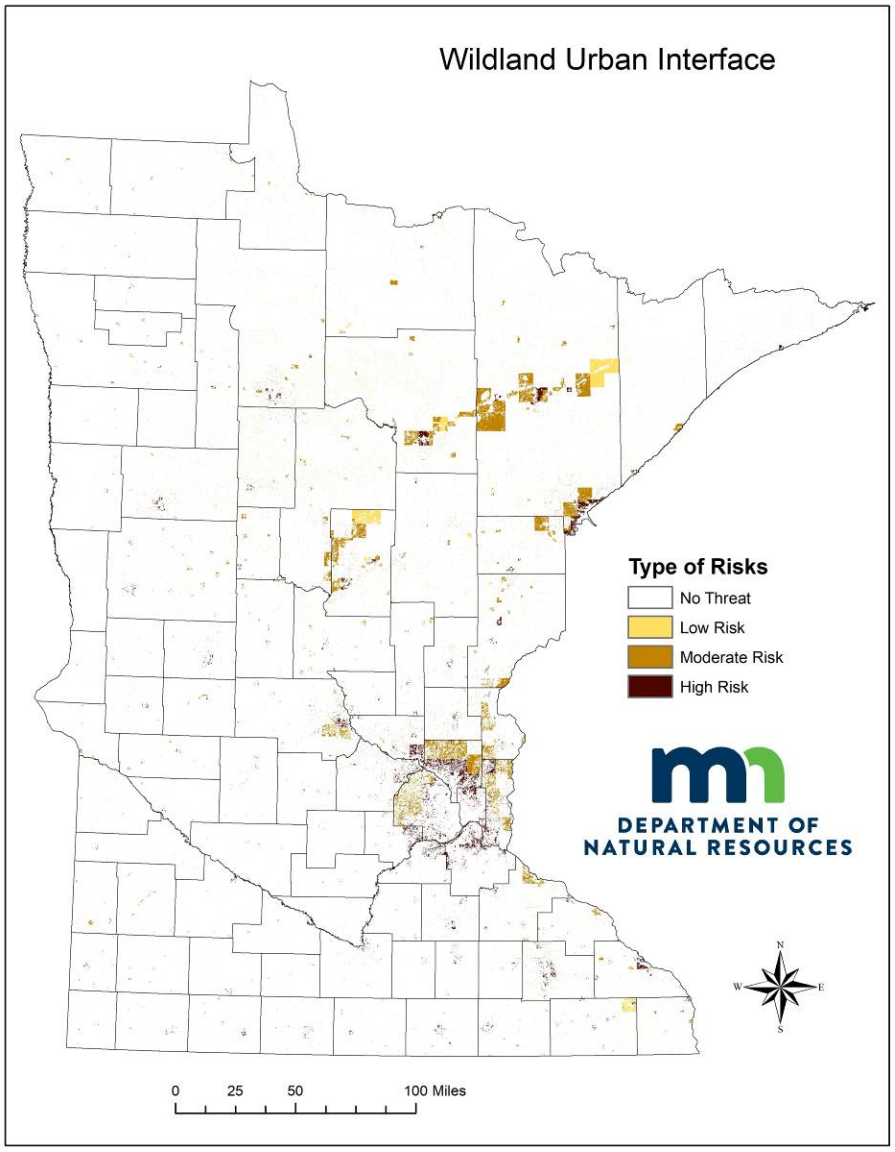

Figure 78 – This Wildland-Urban Interface (WUI) map represents areas where houses meet or intermingle with Undeveloped Wildland vegetation and has been classified to three specific types of risk: low, moderate, and high risk based on population density and proximity to vegetation.

Risk of Development

This Development Risk layer is the result of a subtraction of the US Census Bureau Block 2030 and 2000 datasets to produce a classification of predicted housing density. The development risk data layer is intended to emphasize areas that are projected to experience increase housing development in the next 30 years. The Development Risk layer was then classified to three housing density types: low, moderate, and high development risk based on the original definitions (Figure 79).

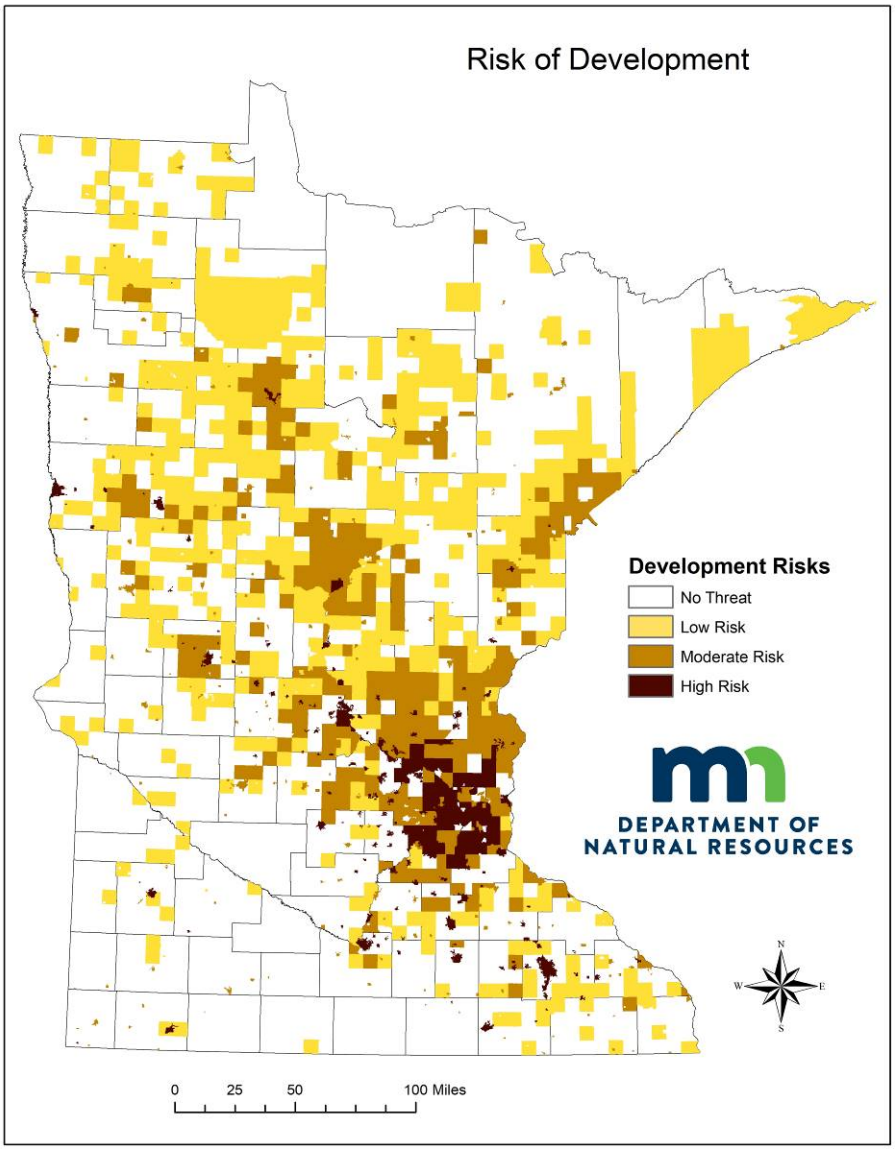

Figure 79 – This Development Risk layer is the result of a subtraction of the US Census Bureau Block 2030 and 2000 datasets to produce a classification of predicted housing density, and has been reclassified to three housing density types, low, moderate, and high.

Risk of Terrestrial Invasive Species

Terrestrial invasive species (TIS) have long been surveyed by DNR and the FIA program of the US Forest Service. The TIS program of DNR and FIA have been conducting systematic sample surveys since 2000 and 2007, respectively, to detect occurrence of TIS. The DNR data collected via EDDMaps are available as point, line (transect), and polygon shapefiles, while FIA data are periodically measured in circular plots as points. The original datasets contain approximate area of infestation, percent cover of the invasives, type of invasives, and other information. The observed data on frequency, relative abundance, and number of invasives combined with forest type, disturbances, and other biophysical factors were analyzed to rank the state forest stands into low, moderate, and high-risk areas. This layer is a shape file with a calculated total risk score assigned to each DNR-managed stand (polygon) to represent the susceptibility (Figure 80).

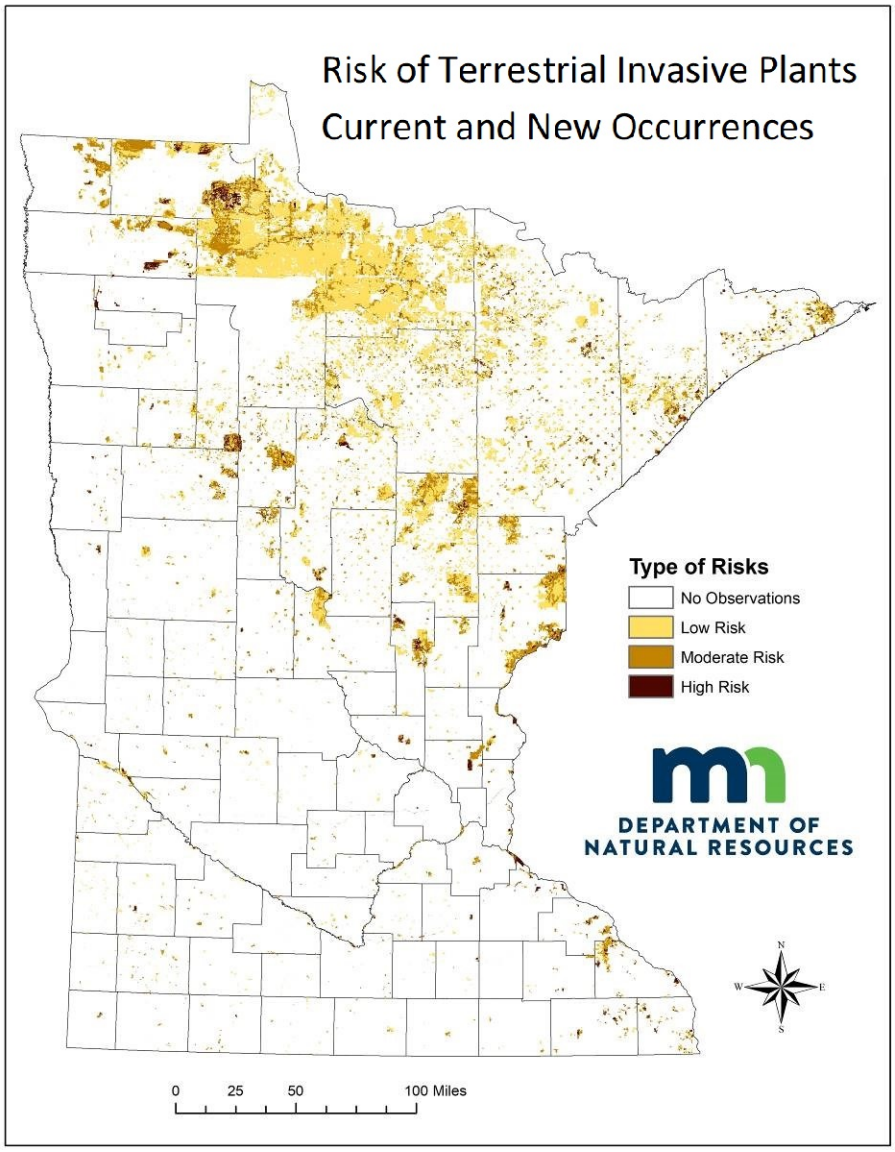

Figure 80 – This map displays location records of selected terrestrial invasive plants on DNR land and other selected locations, buffered to the estimated area of impact.

Economic Impacts

The following ten data layers were used to create the Economic Impacts map (Figure 81): Legacy and Private Forest Management Priority Lands; Registered Legacy Lands; State Trust Lands; Registered Stewardship Lands; Above Ground Biomass; Small, Medium, and Large Mill Radius; Community Boundaries; and Analyses Mask.

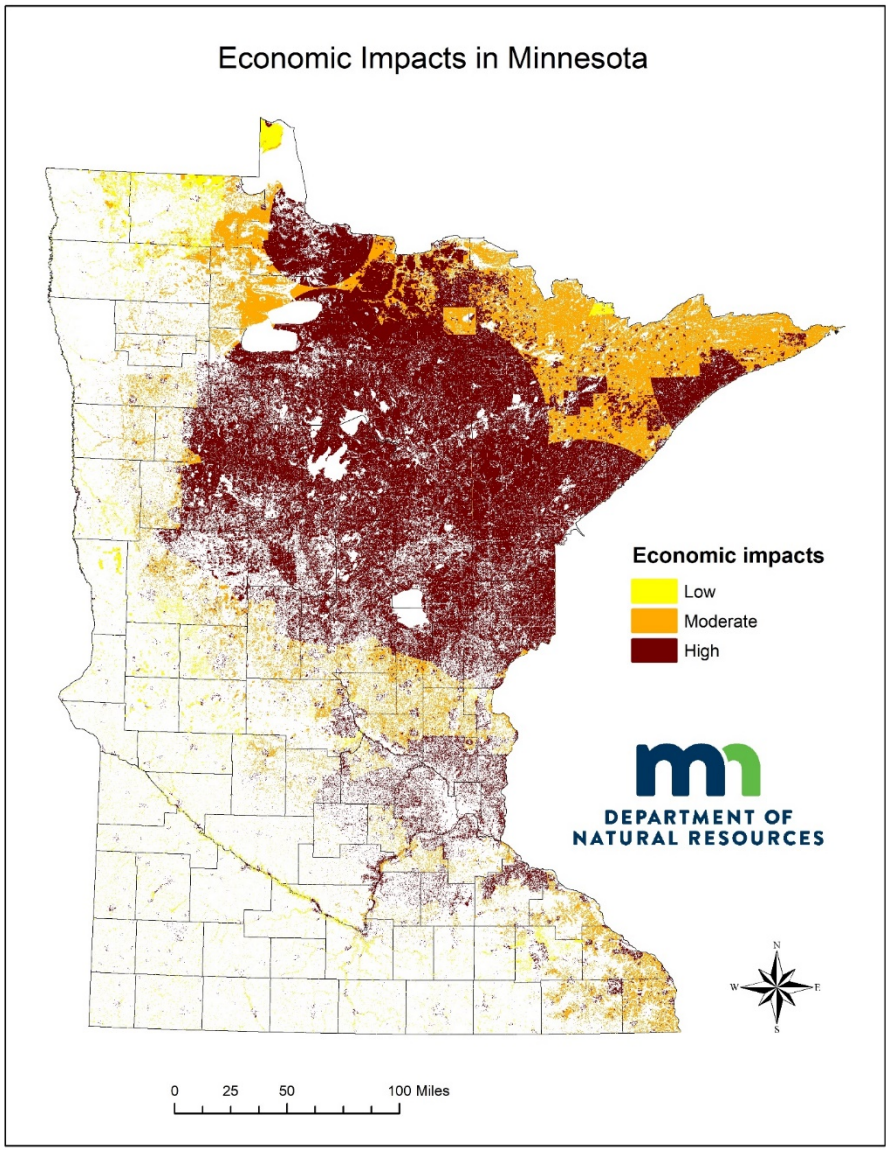

Figure 81 – This Economics Impact Model is the result of an overlay analysis of ten input datasets and highlights areas of low, moderate, and high risk to all of the value impacts included in the model.

Legacy and Private Forest Management Priority Lands

The Minnesota Forest Legacy Program and Private Forest Management Program protects environmentally important privately owned forest lands through conservation easements, land purchases, or forest stewardship plans, by providing incentives or requirements to keep forests forested. Federal funds and DNR Forestry's matching funds are used to purchase development rights and conservation easements on these forests in targeted areas of Minnesota to keep the resources intact and sustainable. The "forest legacy and private forest management priority areas" (Figure 82) and designated "legacy lands" (Figure 83) were used as input layers in the economic impact map given the importance placed on potential and current investment of conservation easement as "working forests". A moderate and high-weight were assigned to the priority areas and designated legacy lands, respectively.

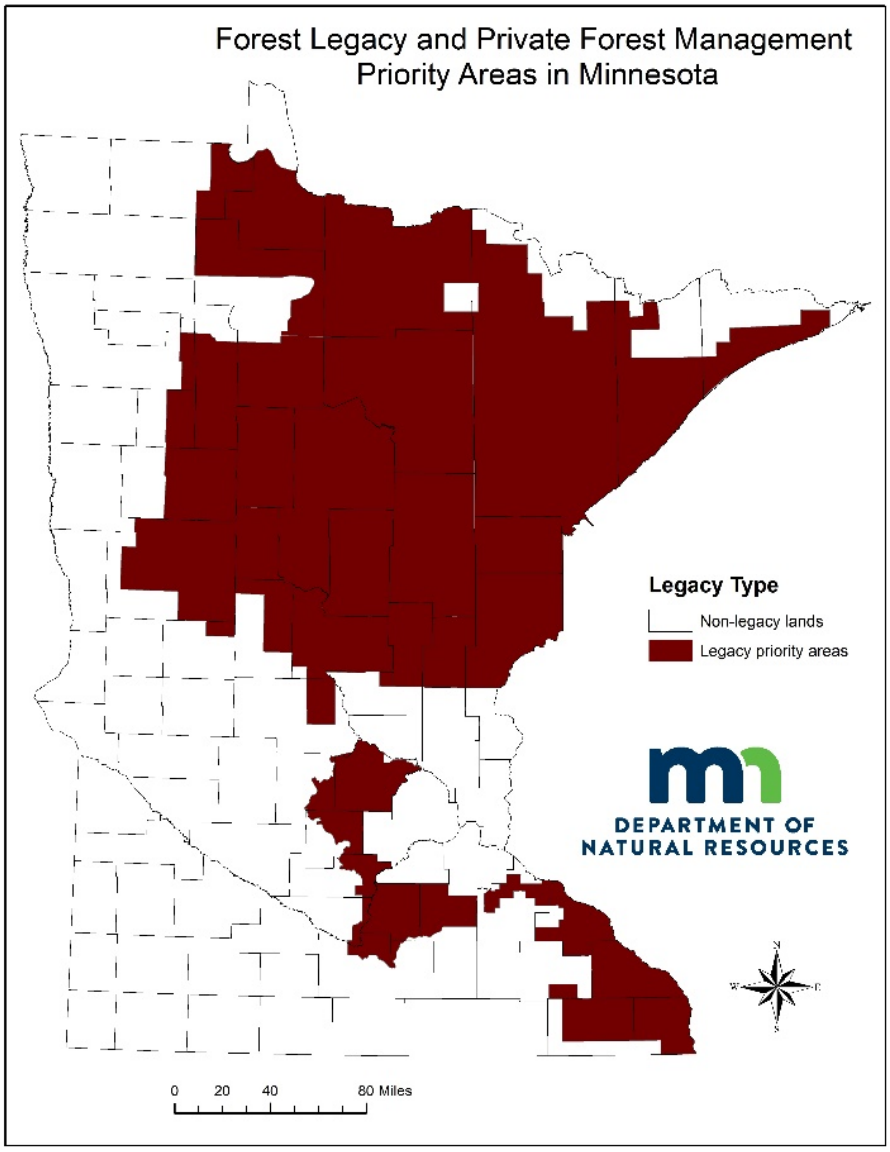

Figure 82 – Minnesota Forest Legacy Program and Private Forest Management Program priority areas. These areas were given a moderate weight in the overall Economic Impact model.

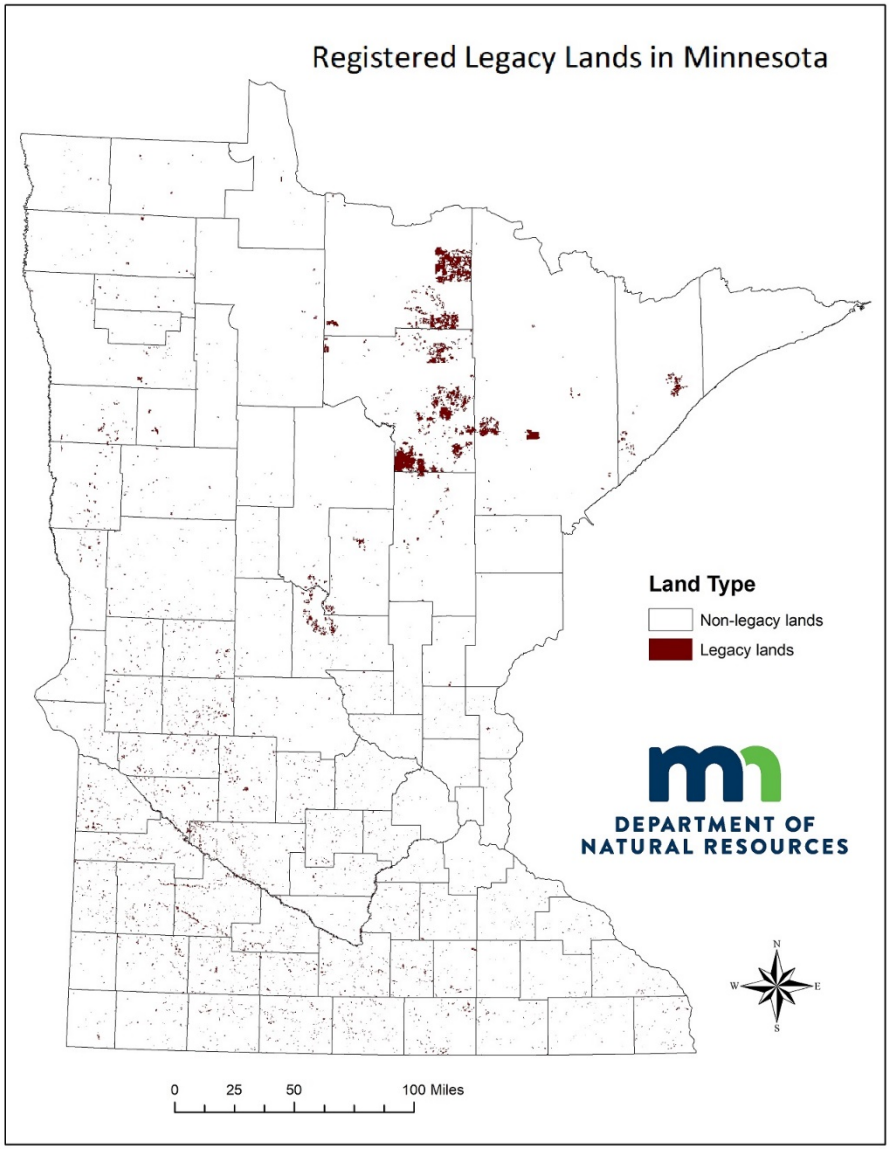

Figure 83 – Registered Forest Legacy lands. These lands were given a high impact weight in the overall Economic Impact model.

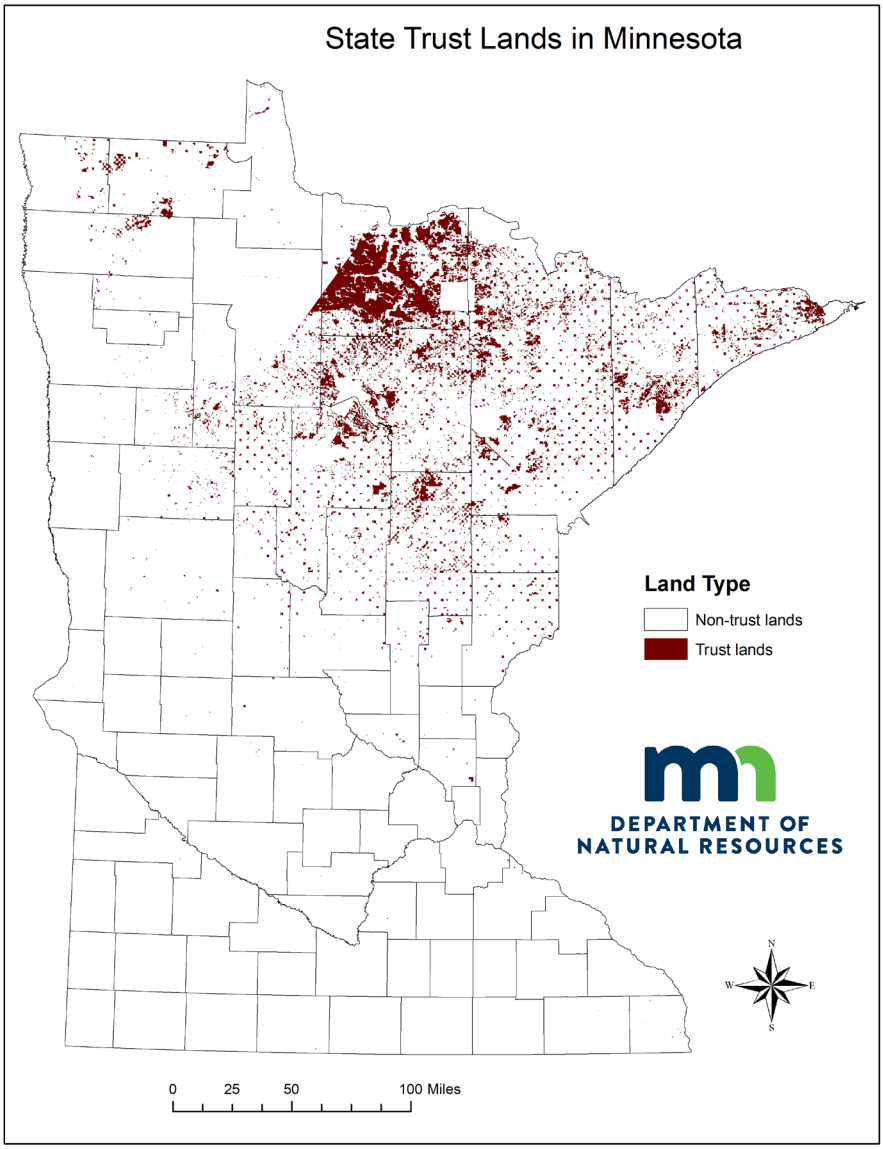

Figure 84 – Designated State Trust Lands.

State Trust Lands

This State Trust Fund Lands layer merges the DNR Control Point Generated Public Land Survey layer with IBM mainframe-based land records. The data are limited to a PLS forty or government lot level of resolution (Figure 83). This layer shows the location of State Trust Fund lands in Minnesota (including University). It is included in the analysis given the importance of these lands in generating revenue for the Permanent School Trust Fund.

Stewardship Lands

In the fall of 2004, DNR and the USFS began working together to create a digital database of existing forest stewardship plans and a GIS layer representing the level of "benefit" gained from potential forest stewardship work. This data set contains all Woodland Stewardship Areas that have been spatially recorded between 2009 and 2019 by the DNR Private Forest Management Program. This program helps woodland owners manage their woods through advice and education, cost-share programs, and Woodland Stewardship Plans. These data also include lands relevant to the Minnesota Sustainable Forest Incentive Act (SFIA), jointly managed by Minnesota Department of Revenue and the DNR. The SFIA is an incentive program to keep forests as forests on Minnesota's landscape. Landowners with at least 20 acres of forest land managed under a forest management plan registered with the DNR may be eligible to participate and can receive a payment for each acre of qualifying forest land they enroll in SFIA. These layers were included in the analysis given the investments and interest of associated landowners in carrying out active forest management (Figure 85).

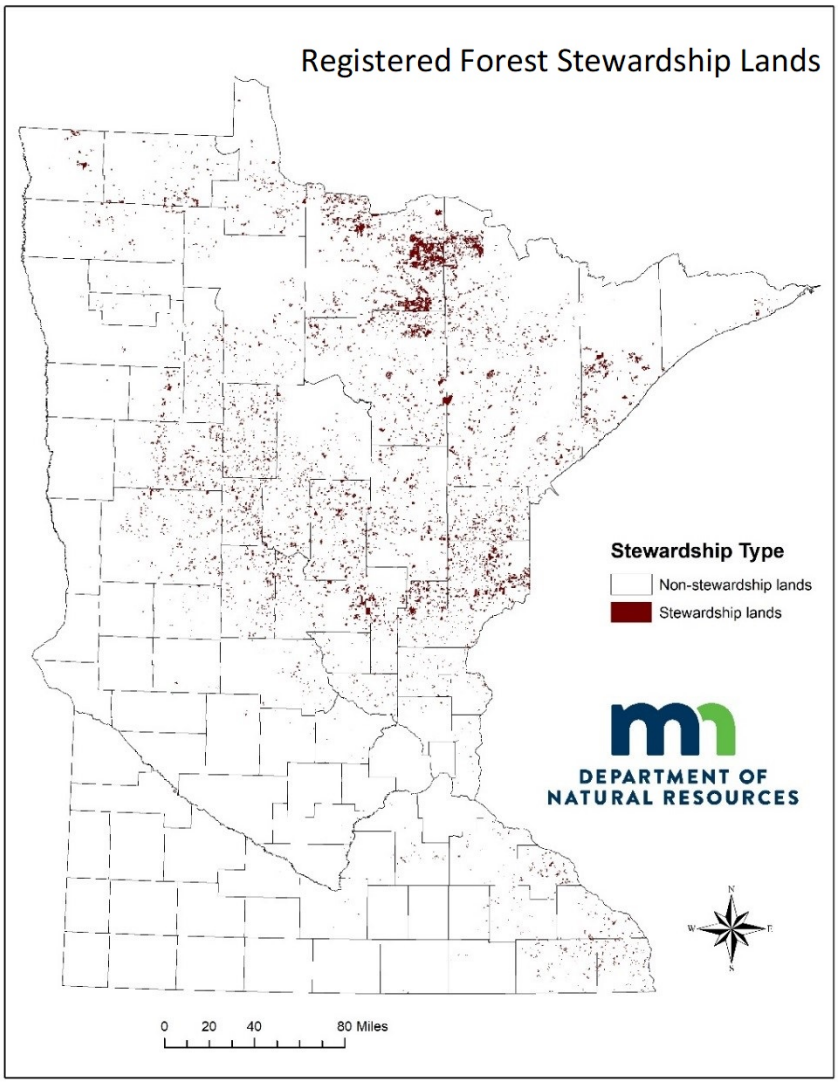

Figure 85 – This map represents lands with registered forest stewardship plans.

Woody Biomass

The woody biomass map essentially shows where there is vegetation present and healthy enough to be measured by remote sensing techniques. This layer was created by integrating ground measurements from sample plot locations of the USDA FIA Program, Normalized Difference Vegetation Index (NDVI) derived from MODIS satellite remote sensing imagery, and maximum canopy height metrics derived from a statewide low-density lidar dataset. The two-step process involved in the woody biomass map production were formulation of a Random Forest model by relating the FIA data with co-located NDVI and canopy height metrics, and extending the model spatially (wall-to-wall) via raster grids of the two predictors (Figure 86).

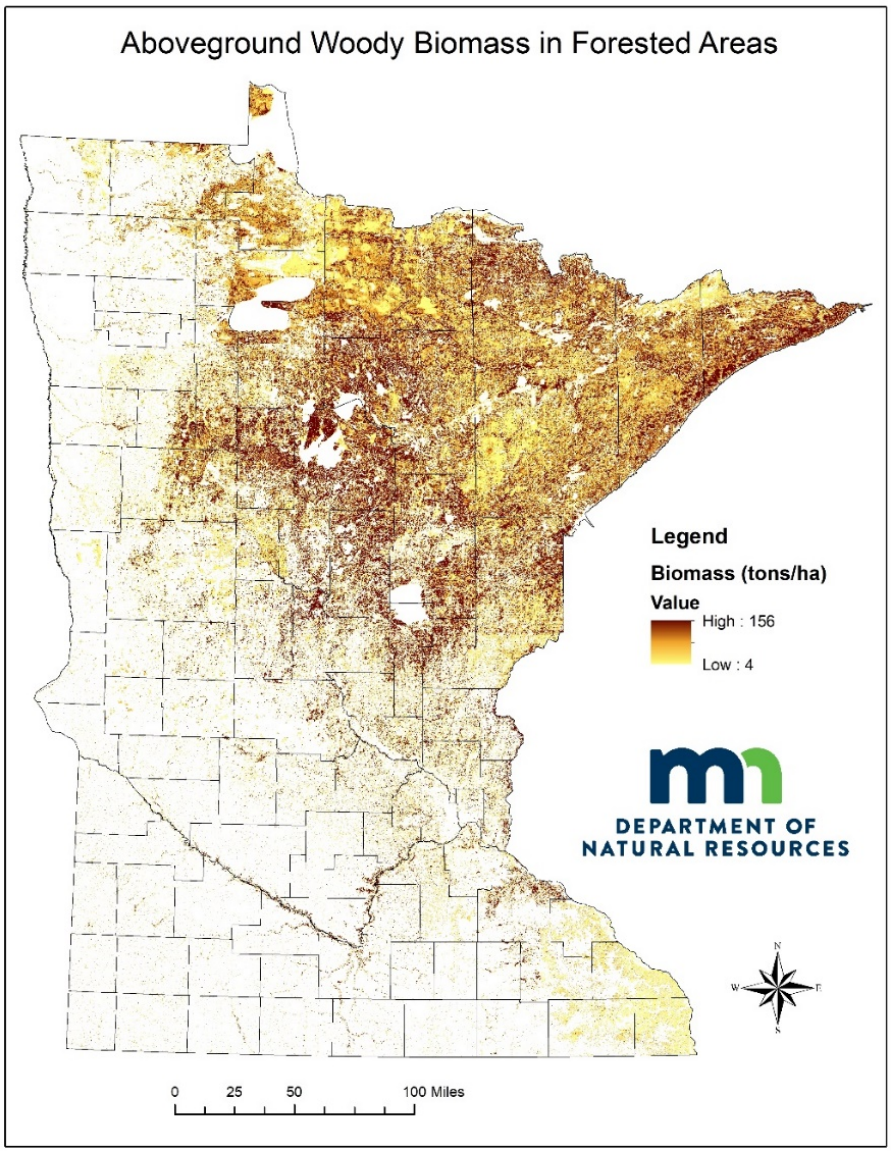

Figure 86 – Map estimateing the amount of the aboveground woody biomass.

Small, Medium, and Large Mills

The largest wood-consuming mills were categorized into small, medium, or large units based on the annual cord consumption. The mills with annual cord consumption between 2,000 to 10,000, between 10,000 to 75,000 and above 75,000 cords were defined as small (Figure 87), medium (Figure 88), and large (Figure 89), respectively. To demonstrate the economic impact of the mills in the neighborhood, a mill locations shape file was obtained from the DNR Timber Utilization and Marketing program, and Euclidean distance buffers of 25, 50, and 75 miles were created around the small, medium and large mills, respectively. The resulting layers were then re-classified into six buffer zones depicting the relative proximity and potential importance to the mill.

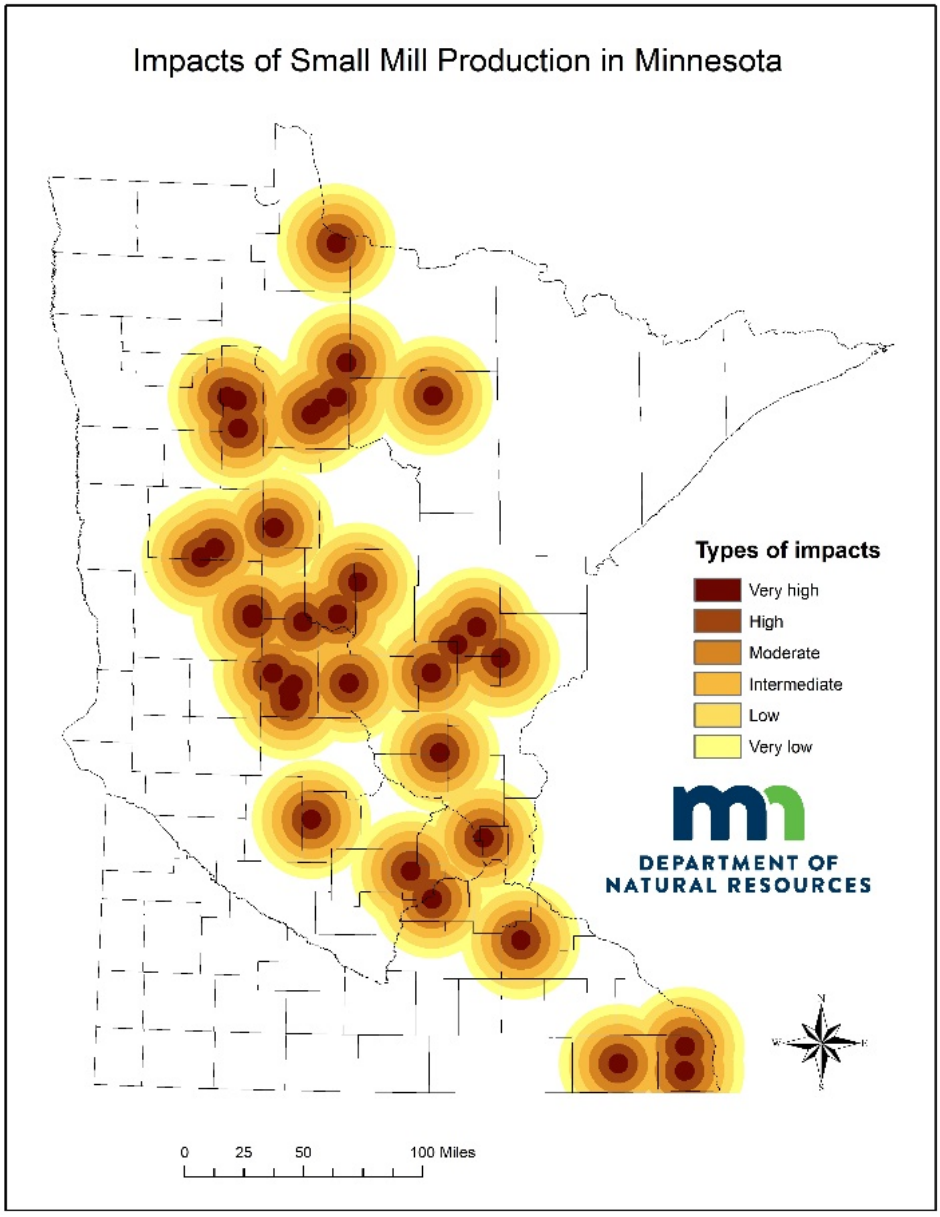

Figure 87 – Map dipicting locations of mills with annual cord consumption between 2,000 to 10,000 (small).

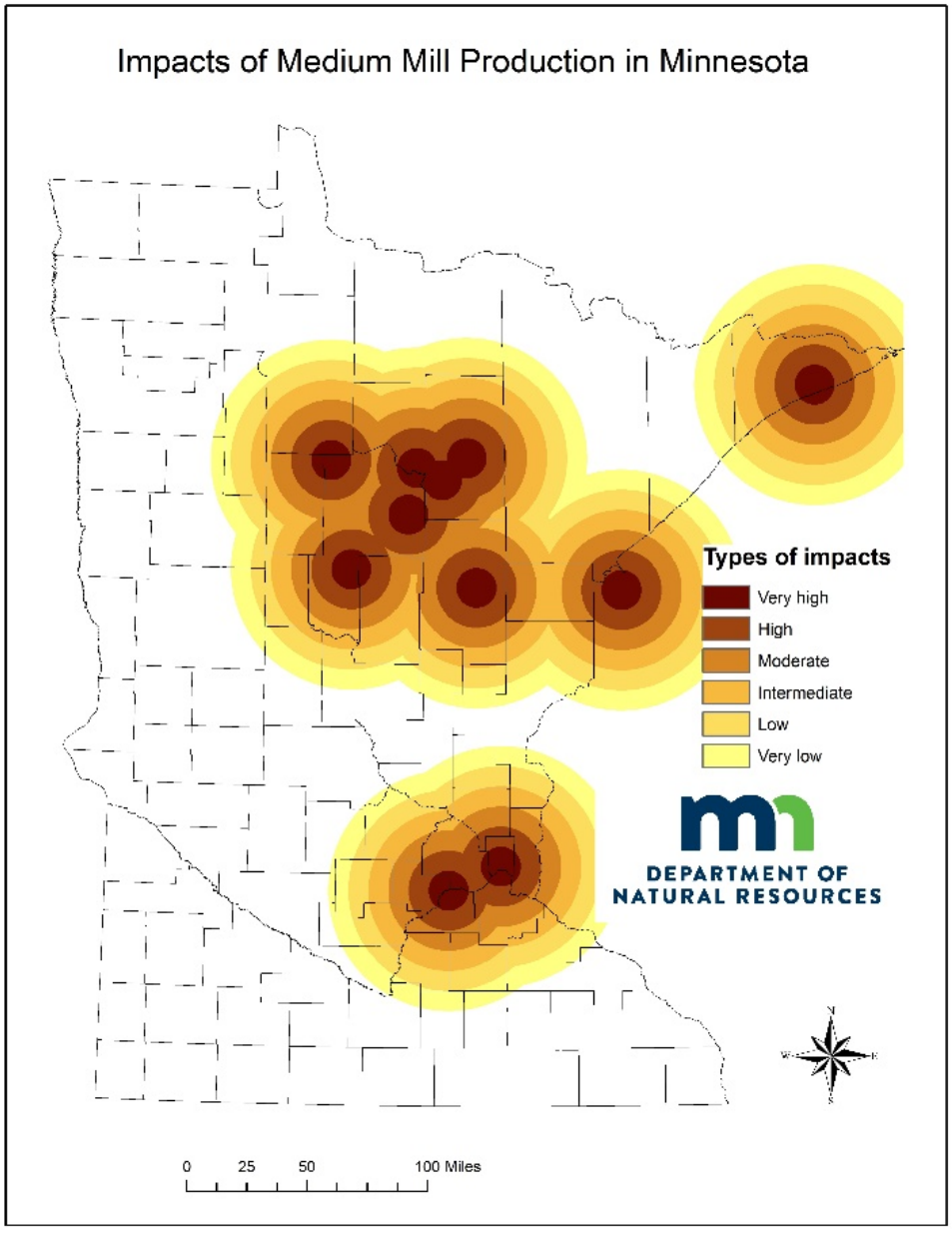

Figure 88 – Map dipicting locations of mills with annual cord consumption between 10,000 to 75,000 (medium).

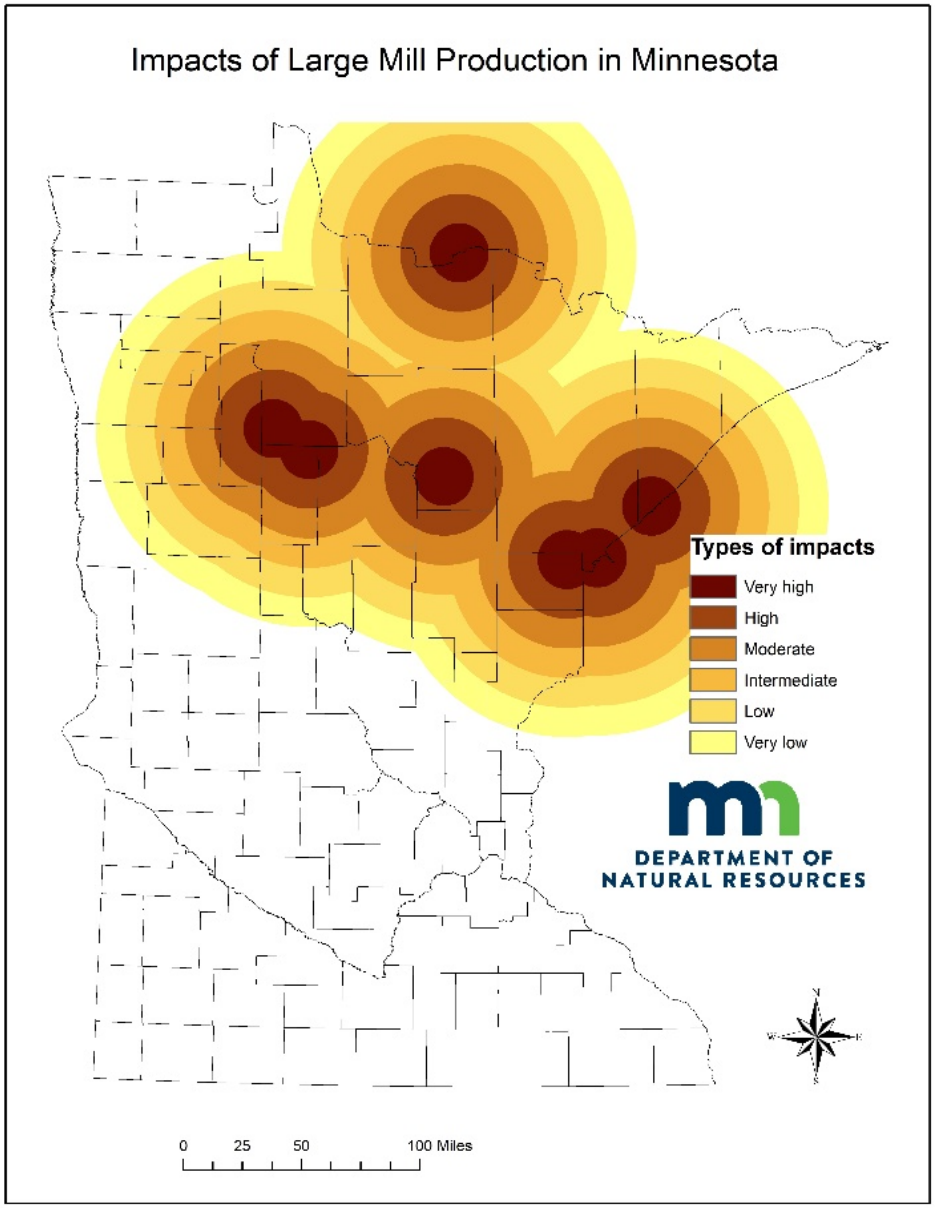

Figure 89 – Map dipicting locations of mills with annual cord consumption above 75,000 cords (large).

Community Boundaries

All the cities in the state were buffered by a distance of 1-km around the municipal boundary (Figure 90) and all mapped forested areas within these areas were categorized as high impact areas (Figure 91).

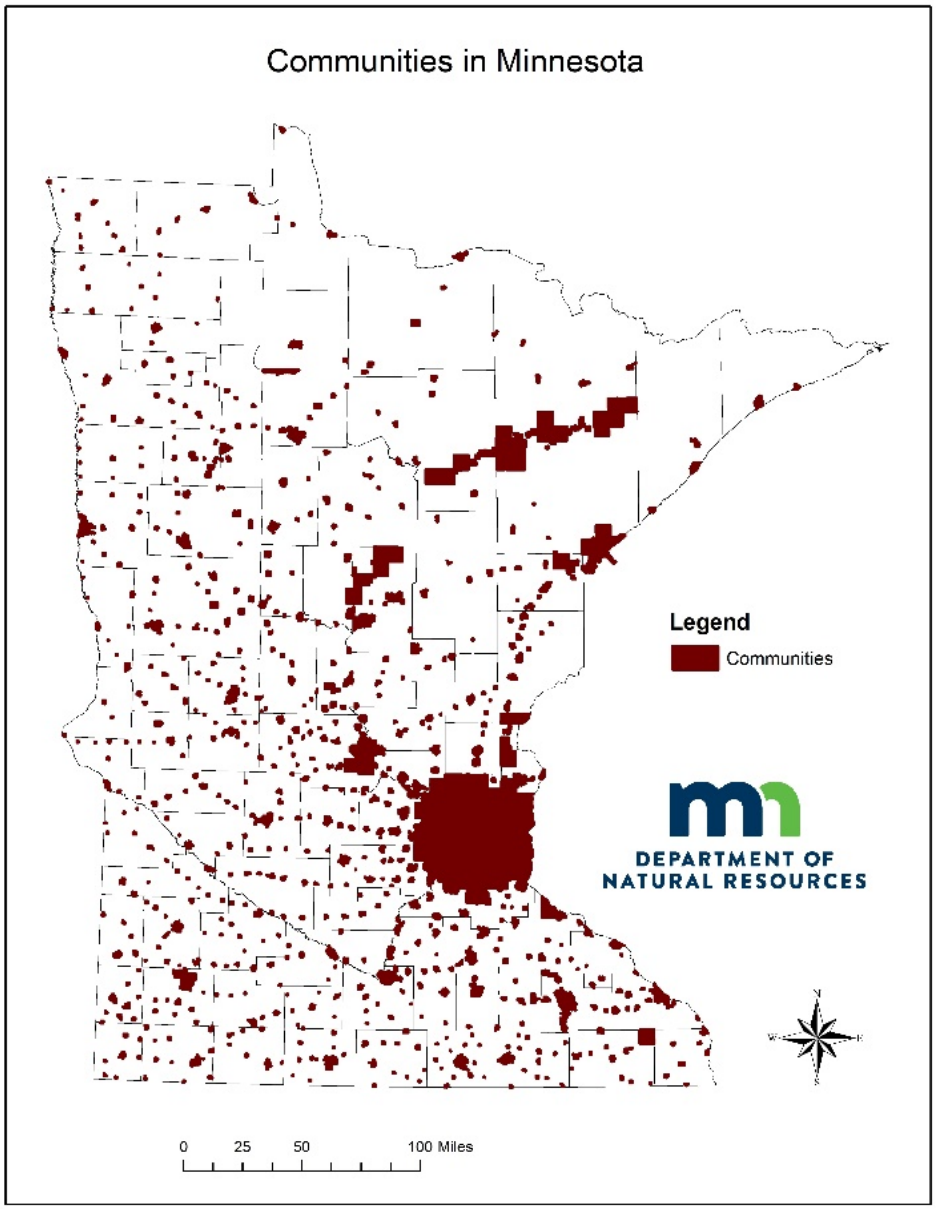

Figure 90 – Municipal boundaries of every city in the state, buffered by a 1 km boundary.

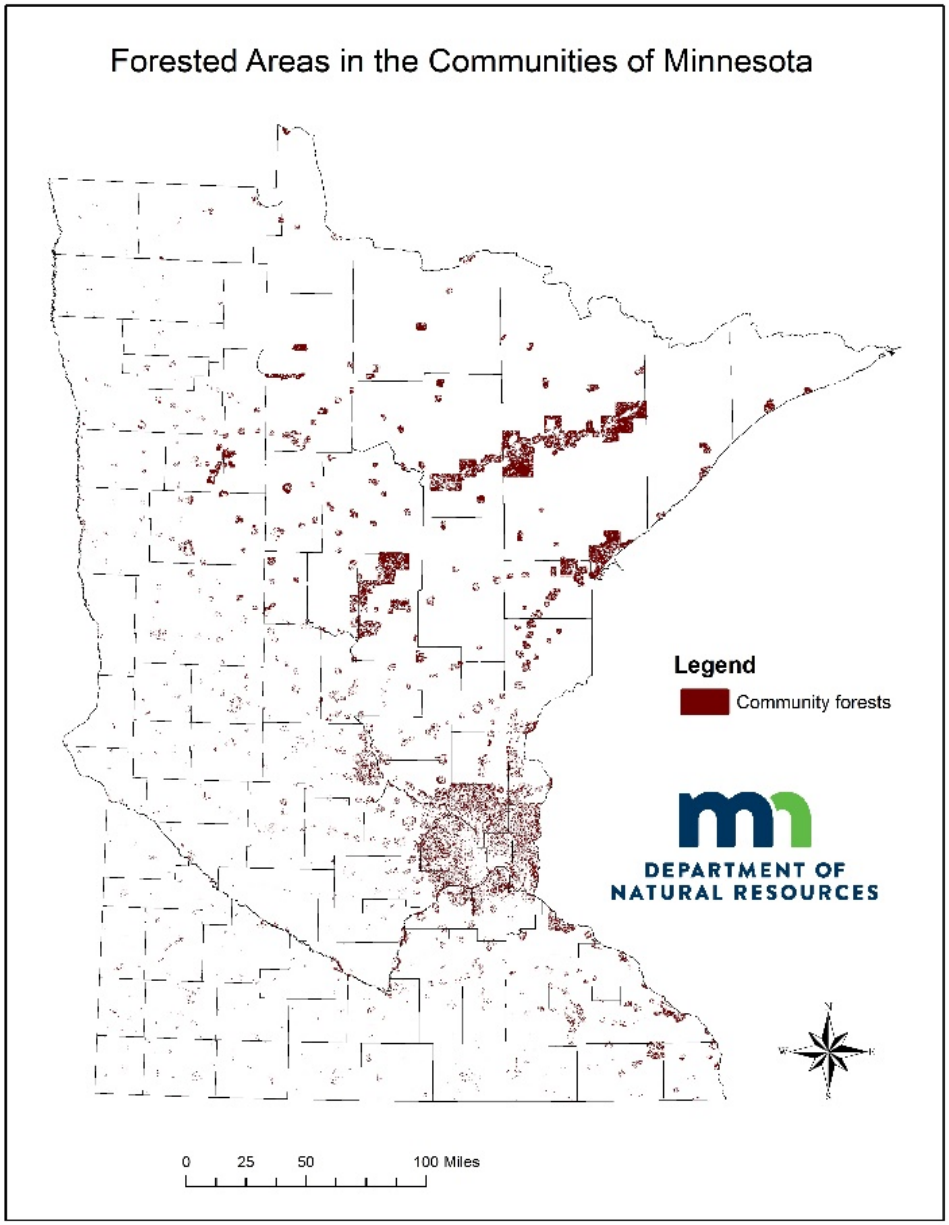

Figure 91 – Forest cover within municipal boundaries of every city in the state, buffered by a 1 km boundary.

Economic Impact Analysis Areas

The area of interest for the Economic Impact model was constrained to areas of the state with woody biomass excluding water, Boundary Water Canoe Area Wilderness, Voyageurs National Park, and Minnesota State Park Lands (Figure 92).

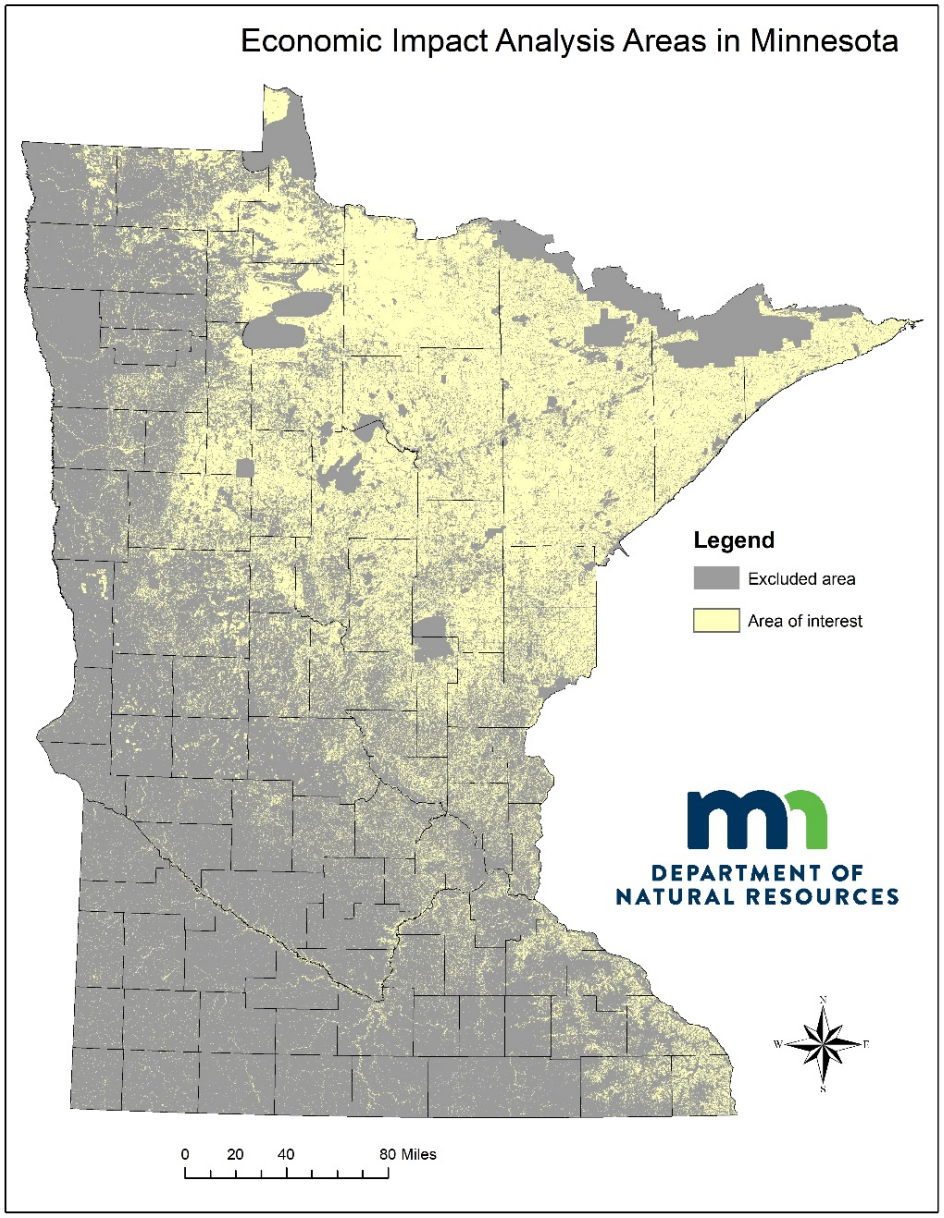

Figure 92 – Areas with woody biomass excluding Boundary Water Canoe Area Wilderness, Voyageurs National Park, and Minnesota State Park Lands.

Ecological Values

This Ecological Values Model (Figure 93) was prepared by The Nature Conservancy (TNC) using the layers for Resilient and Connected sites[1] (Figure 94), Climate Flow[2] (Figure 95), and areas of confirmed biodiversity curated by the DNR's Ecological and Water Resources Division Biological Survey Program (Figure 96). The resilient and climate flow layers were combined to obtain resilient and connected landscapes, which was overlaid with Minnesota Biological Survey (2015-2019) data to obtain the Ecological Value model (Figure 93). The model weighting for individual layers was as follows (Table 24; source: TNC):

Data Selection	Score	Comment
Resilient Land with Confirmed Biodiversity	0.275	High priority-maintain
Resilient Land: Secured	0.1	Important for connectivity etc.
Climate Flow Zone	0.1	Maintain connectivity
Climate Flow Zone with Confirmed Biodiversity	0.275	Highest value
Climate Corridor	0.1	Maintain connectivity
Climate Corridor with Confirmed Biodiversity	0.15	High priority-maintain

Table 24 – The Nature Conservancy Resilient and Connected Landscapes model parameter weighting. Source: TNC.

Synopsis of Resilient and Connected Landscapes Model production steps:

a. Classify Resilient and Connected Networks (RCN) into three resilience classes: Low, Medium, and High
b. Add in 2015-2019 MBS Final and Preliminary Sites of Biodiversity Significance that were not included in original classification.
c. Develop proportional weighting for RCN classes and MBS sites 2015-2019 (see Table above)
d. Add weighted MBS to weighted RCN pixels to create map where RCN weighted pixels are modified by MBS where they coincide. RCN values are increased by 0.05 (preliminary) and 0.10 (confirmed).
e. Classify combined layer into three classes: low, medium, and high based on composite scores.

[1] A place buffered from climate change because it contains many connected microclimates that create options for species.

[2] Areas with high levels of plant and animal movement that is less concentrated than in a corridor, typically an intact forested region. Flow refers to the movement of species populations over time in response to climate.

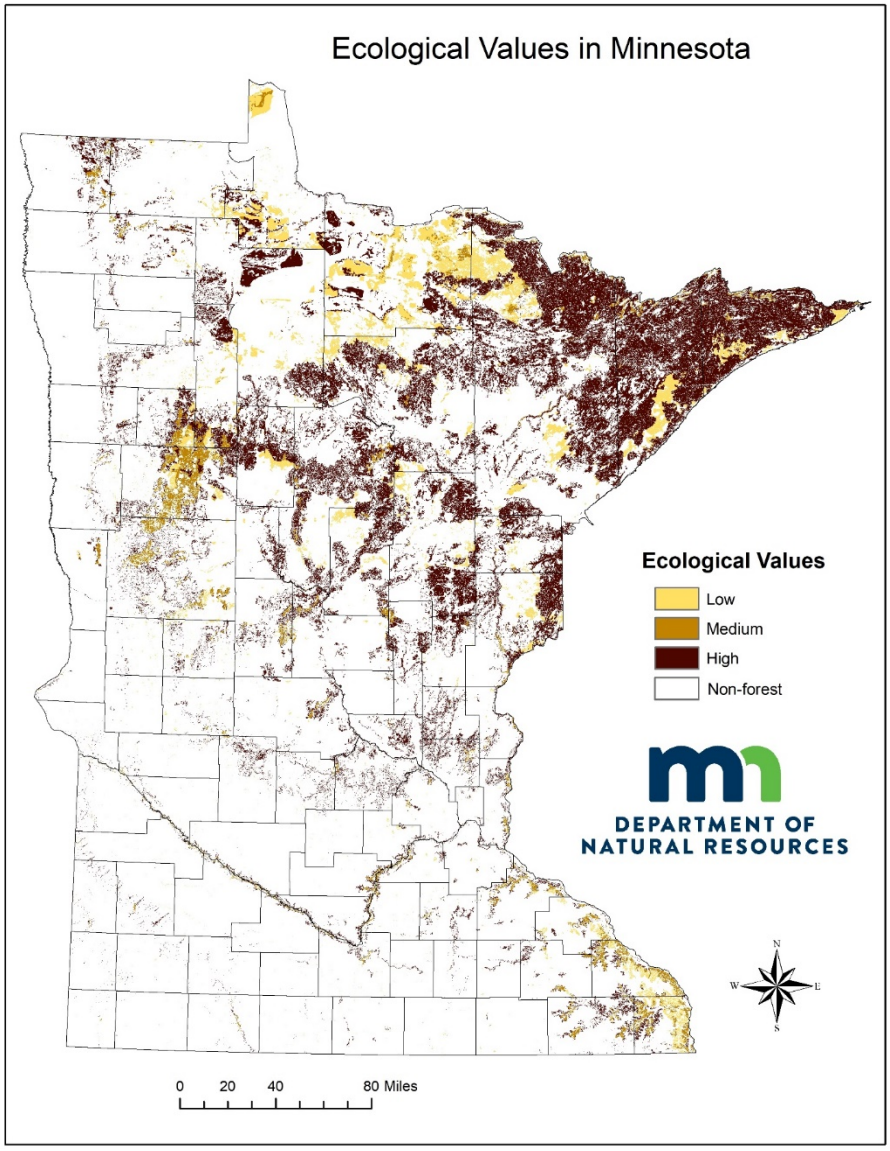

Figure 93 –Ecological Values Model, based on The Nature Conservancy's Resilient and Connected Landscapes.

Resilient Landscapes

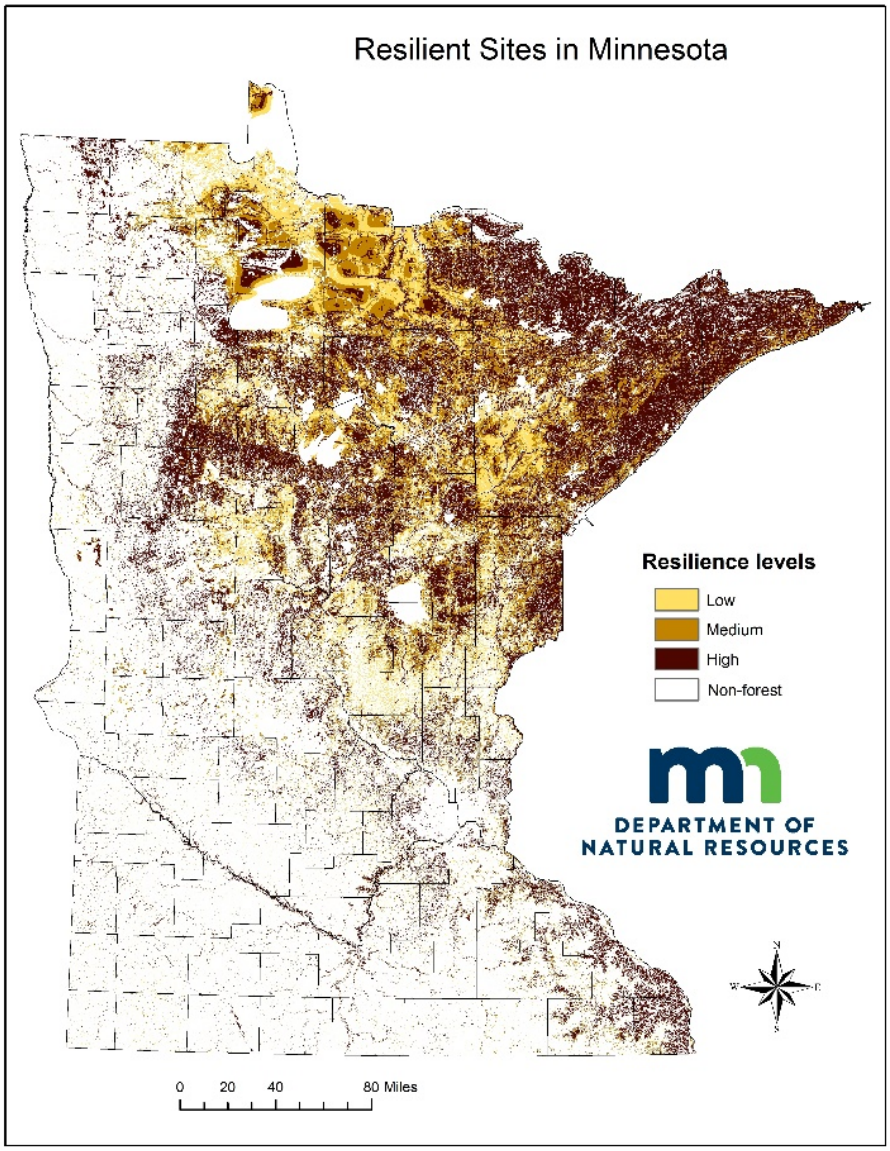

Figure 94 – The Nature Conservancy's Resilient Landscapes, reclassified to three categories.

Climate Flow

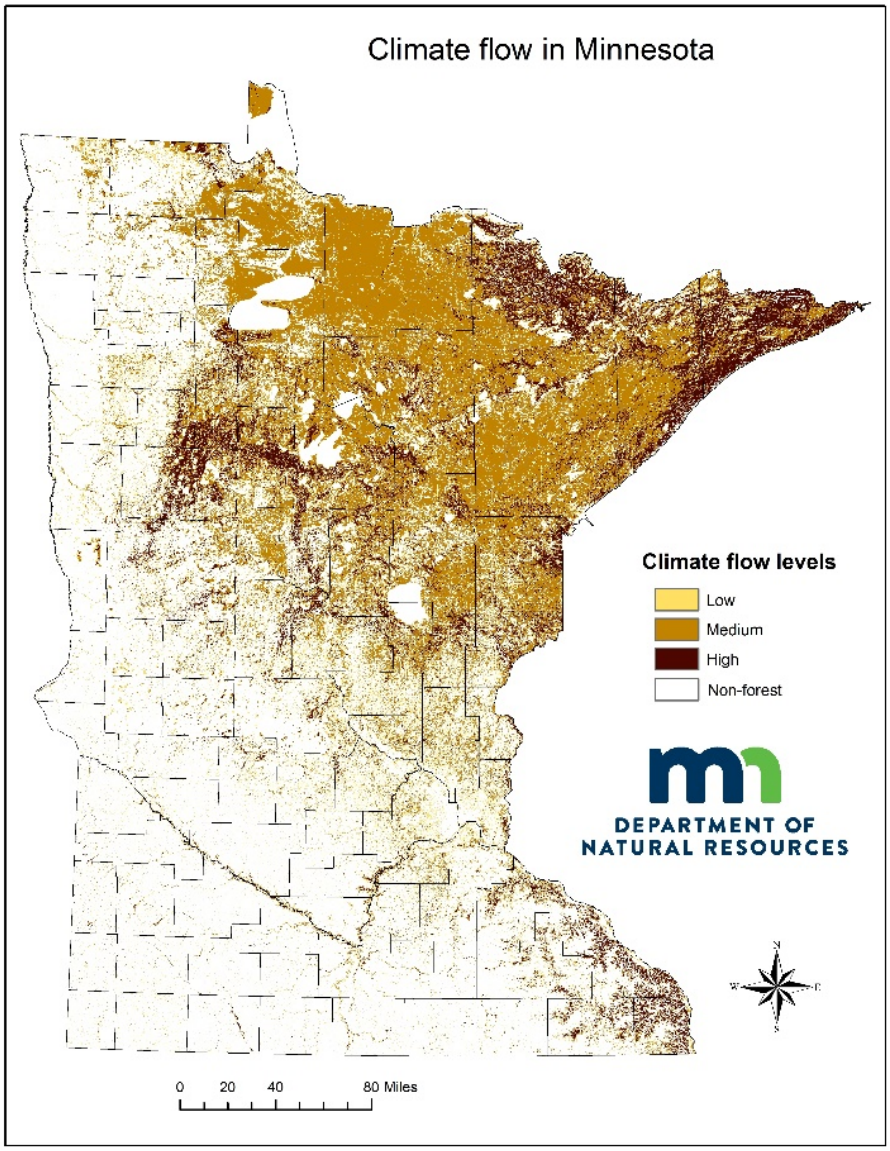

Figure 95 – The Nature Conservancy's Climate Flow Model, reclassified to three categories.

Areas of Confirmed Biodiversity

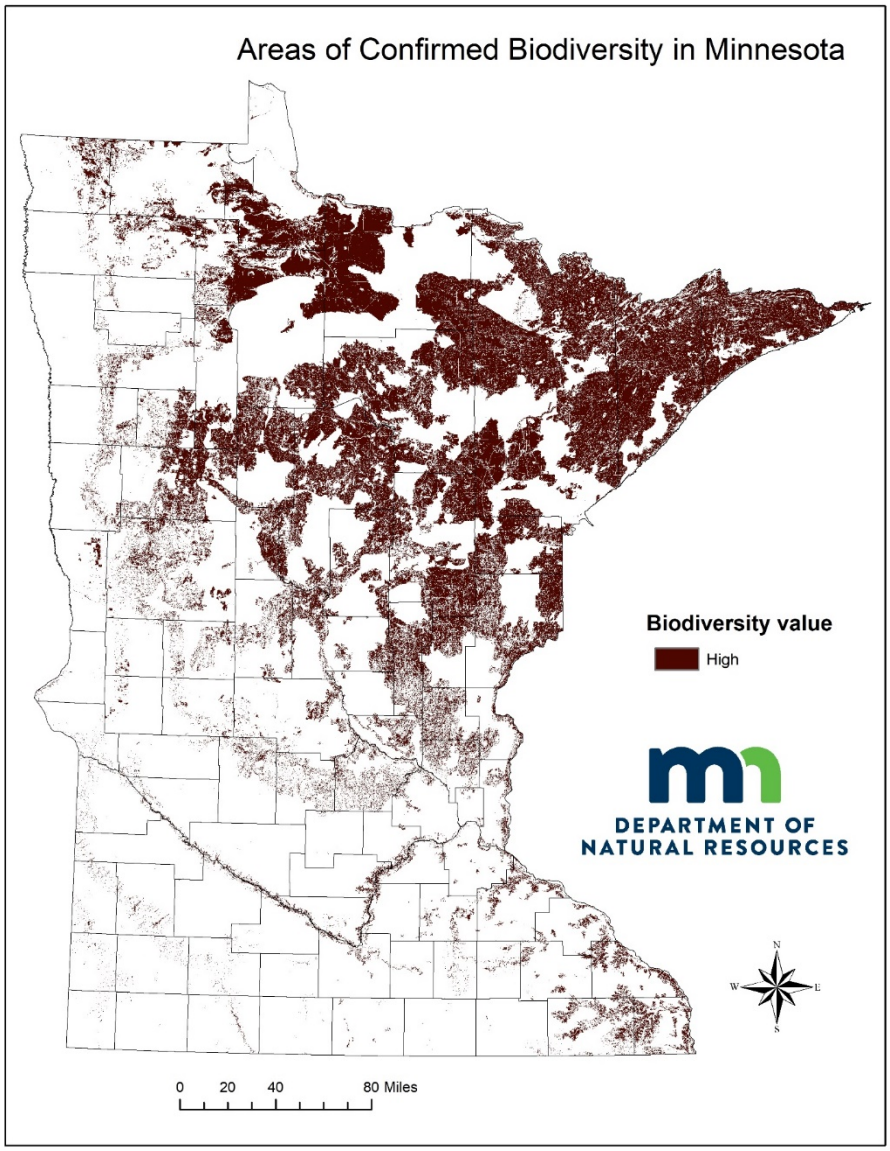

Figure 96 – The Minnesota Biological Survey Areas of Confirmed Biodiversity Significance.

Recreational Values

The Recreational Values map (Figure 97) is based on integrated scores of the degree of public access to natural areas via roads, trails, or waterways, and a scenic assessment or naturalism value. High, medium and low recreation value areas were identified as follows:

High Value Recreational Areas

The PADUS dataset from the USGS Protected Areas Database provided the base for high value recreational areas to capture lands designated specifically for public recreation purposes. All land ownership classes, except the Native American Land, Military Land, and Agricultural Easement, were defined as high recreational value areas. The ownership classes of high recreational importance included: National Wildlife Refuges, USFWS Waterfowl Production Areas (Current), Ruffed Grouse Management Areas, The Nature Conservancy Preserves and Managed Areas, state AMA Acquisitions - Fisheries (Sub 40), Wildlife Management Areas (WMA) - Publicly Accessible, Scientific and Natural Area Boundaries, and Minnesota State Parks, Recreation Areas, and Waysides.

Moderate Value Recreational Areas

The Native American Land, Military Land, and Agricultural Easement areas in the PADU dataset were designated as moderate recreational value, based on the assumption that in many cases, these ownership types have purposes that restrict public access for recreational purposes. In addition, all federal, state, municipal, tax forfeit, and county fee areas, except areas of High Value Recreational Areas, were joined (union) to obtain a full range of medium value recreational areas.

Low Value Recreational Areas

All treed/forested areas except the high and moderate value recreational areas were considered low value recreational areas.

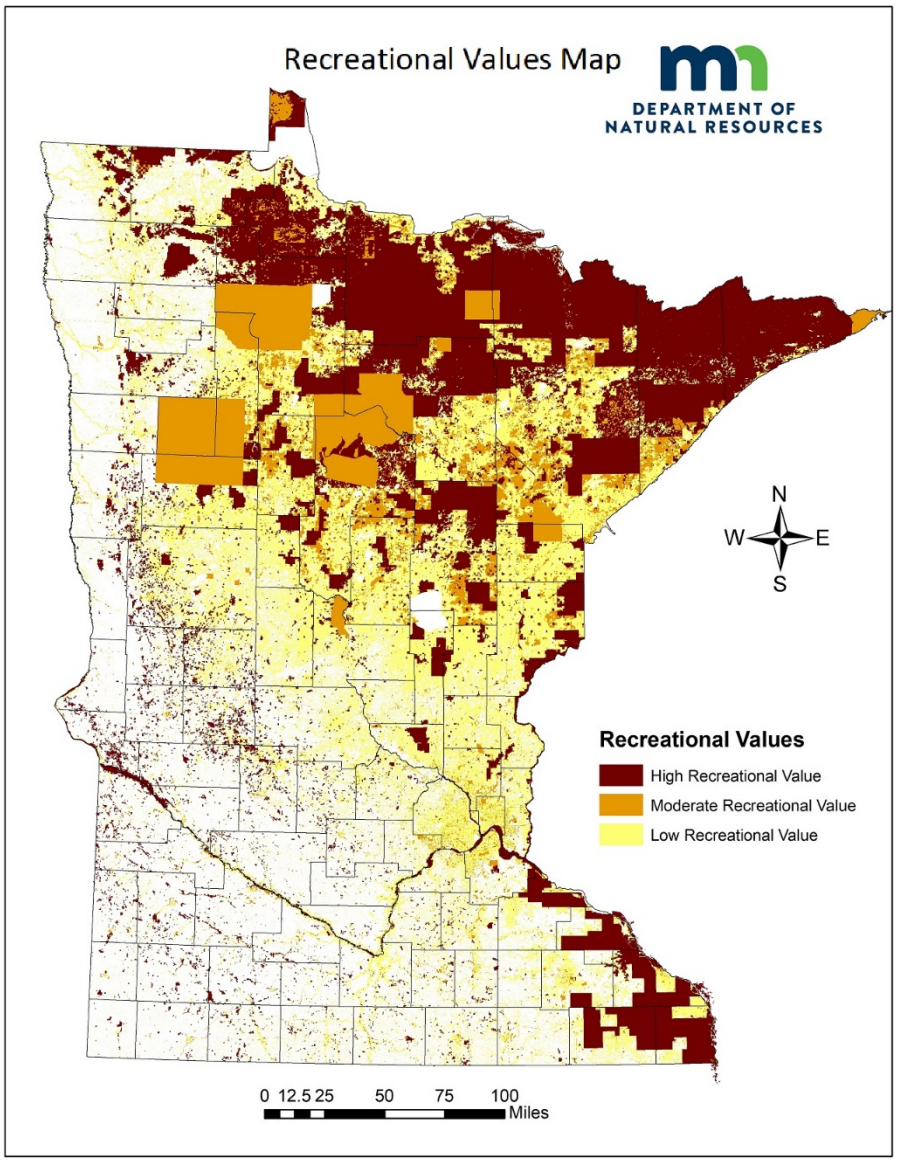

Figure 97 – Recreational Values map, based on designated public parks, forests, and monuments.

Chapter 5: Multi-State Priorities

Multi-state priority issues and areas were compiled and addressed in the Minnesota 2010 SFAP with the assistance of the US Forest Service State and Private Forestry R-9 staff. These are available for viewing at the NASF website. Additionally, in 2016, the US Forest Service wrote two reports that outlined priority areas and issues at a landscape-scale for the Northeast and Midwest regions of the country. Many of these priority areas and issues cross state boundaries and require the coordination and commitment across ownership types to address them. For more information on these landscape- scale conservation priorities, please refer to the following reports:

- Multi-State Priority Areas in the Northeast and Midwest
- Multi-State Priority Issues in the Northeast and Midwest

For the 2020 SFAP, Minnesota reviewed the previous 2010 multi-state priority issues and areas and updated the priorities based on past accomplishments and new partnerships. In addition, the US Forest Service S&PF R-9 held a series of virtual meetings in February 2020, with the Northeast and Mid-west states to review and update the most important multi-state issues and priority areas to include in the 2020 SFAP revisions. These collaborations and partnerships with other states offer opportunities for creating economies of scale on some activities, and for pursuing funding of projects. For example, projects related to climate change, invasive forest pests, wildfire risk mitigation, sustainable forestry, forested wildlife habitat, and forest-water relationships are cross-boundary issues that will continually require multi-state involvement and monitoring to ensure proper forest management well into the future.

Table 25 below lays out the most important multi-state issues from the Minnesota state perspective and Table 26 lays out the most important priority areas for the state.

Multi-State Priority Issues

Multi-state Priority Issues	Partner States	Status
Sustaining forest industry and diversifying markets	Minnesota, Wisconsin, Michigan, Iowa	On-going through multi-state projects
Responding to impacts of climate change	Minnesota, Wisconsin, Michigan. All NE states	On-going through Minnesota CLIMATE Team, Minnesota Climate Change Subcabinet, NIACS and US Climate Alliance
Invasive species management (terrestrial and aquatic including insects, diseases, invasive plants)	Minnesota, Wisconsin, Michigan, Iowa. All NE states	USDA Dept. of Ag partnership
Reducing wildfire risk	Minnesota, Wisconsin, Michigan. Also includes the Canadian provinces of Ontario and Manitoba	On-going through Great Lakes Forest Fire Compact
Retaining water quality through forested watersheds	Minnesota, Wisconsin, Michigan	On-going through several large-scale forest-water initiatives and priority areas. Partners include BWSR and MDH in Minnesota
Promoting sustainable, active private forest management	Minnesota, Wisconsin, Iowa	On-going through multi-state projects
Foresting, Reforesting, and restoring diminished species	Minnesota, Wisconsin, Michigan, Iowa	On-going through forest management programs, and forest wildlife habitat conservation efforts such as SWAP and National Forest Breeding Bird Monitoring Program
Valuing ecosystem services (keep forests forested)	Minnesota, Iowa, Illinois, Missouri, New York, Wisconsin	On-going through large-scale forest-water initiatives
Collecting FIA data in urban areas	All northeast states	On-going. Data gaps being continually identified
Land Sector forest carbon accounting and sequestration	Minnesota, Wisconsin, Michigan, All US Climate Alliance states	New in 2020

Multi-state Priority Issues	Partner States	Status
White Oak Initiative	Minnesota, Wisconsin, Michigan (part of 17 state initiative)	New in 2020
Northern Long-Eared, Tri-Colored, and Little Brown Bats	Minnesota, Wisconsin, Michigan	New in 2020
Collection of remotely sensed data to support monitoring of forest cover and volume trends	Minnesota, Wisconsin, Michigan, Iowa. All NE states	On-going. Data gaps being continually identified

Table 25 – Multi-state Priority Issues for Minnesota.

Multi-State Priority Areas

Multi-state Priority Areas	Partner States	Status
Great Lakes Basin and Midwest Watershed (500,000 acres across 16 states)	Minnesota, Wisconsin, Michigan, Iowa, Missouri, Illinois, Indiana (spillover to North Dakota, South Dakota, Nebraska, Kansas, Arkansas, Oklahoma, Kentucky, Ohio) Also includes the Canadian provinces of Ontario and Manitoba)	On-going through the Great Lakes Restoration Initiative (GLRI)
Great Lakes and St Lawrence Regional Collaboration	Minnesota, Michigan, Wisconsin, New York, Illinois, Indiana, Ohio, Pennsylvania. Also includes the Canadian provinces of Ontario and Quebec	On-going through the Great Lakes Regional Collaboration and other partners
Midwest Glacial Lakes Fish Habitat Partnership	Minnesota, Michigan, Iowa, Wisconsin, Illinois, Indiana, Ohio, North Dakota, South Dakota	On-going through the Midwest Glacial Lakes Fish Habitat partnership and other partners
Upper Mississippi Healthy Watersheds Initiative	Minnesota, Wisconsin, Iowa, Missouri, Illinois, Indiana	On-going through NRCS Mississippi River Basin Initiative, Upper Mississippi River Restoration and other partners

Multi-state Priority Areas	Partner States	Status
Driftless Area Landscape Conservation Initiative	Minnesota, Iowa, Wisconsin, Illinois	On-going through the Driftless Area Landscape Conservation Initiative
Upper Mississippi River Basin	Minnesota, Wisconsin, Iowa, Missouri, Illinois	On-going through Upper Mississippi River Basin Association and other partners
Red River Basin Watershed	Minnesota, North Dakota, South Dakota. Also includes the Canadian province of Manitoba	On-going through Red River Watershed Management Board NRCS, and other partners
White Oak Initiative	Minnesota, Wisconsin, Michigan (part of 17 state initiative)	New in 2020. Reference White Oak Initiative

Table 26 – Multi-state Priority Areas for Minnesota.

Chapter 6: Summary

The Minnesota Department of Natural Resources submits this 10-year revision of the State Forest Action Plan (SFAP) to the US Forest Service, to fulfill the USDA requirement as stated under the 2008 Farm Bill. The two revised and updated documents give the state the opportunity to reassess and reexamine several aspects of sustainable forest management, especially in relation to the Cooperative Forest Management Programs that constitute the foundation of state and private forestry in Minnesota. Using continuous stakeholder input over the past 10 years, trends were formulated on what is important to forest interests across all ownerships. (Refer to Stakeholder section in Part 2-Strategies). It has become apparent over these past 10 years, that sustainable forestry is a long-term endeavor, and so changes are subtle, yet noticeable in the following areas.

In 2010, when the first SFAP was completed, Minnesota was just recovering from an economic downturn that adversely affected the forest industry and forest interests. Energy prices were high and the construction industry (especially housing) had been decimated from the financial crisis of 2007-2008. Large forested industry land tracts in the state were being sold off to REITS, which in turn affected not only forest protection and working forest lands, but recreational access to public lands and changes in land uses. These changes have long-term repercussions for sustaining the state's forest land base and have put increased pressure on public lands to fulfill forest functions, that previously were spread through both public and private land interests.

In 2010, the high cost of energy prompted forest managers to promote the use of biomass as a viable alternative to coal and other petro-chemical use. Forest biomass was abundant and cost-effective. Another alternative fuel that became increasingly viable was ethanol, made from both corn and other vegetative products such as switch-grass. However, these non-forest energy product alternatives, threatened both water and forest resources in areas where the associated management practices did not follow best management practices for sustainability and water quality. Biomass continued to be promoted as a good energy source, until cheap natural gas became abundant in the state a few years later, which in turn caused the downturn of the biomass industry.

By 2015, the state overall, was experiencing strong economic growth, yet timber harvests and forest industry output levels had not returned to pre-recession levels. Declining forest product markets have become a serious concern for the forestry community. All but one OSB mill had closed. Pulp and paper mills have been shutting down production lines and reducing output as global demand for paper declines (see Minnesota Forest Resources Report). Two biomass facilities were closed as a part of the state dropping its terms with Xcel Energy on renewables. The loss of the two biomass facilities made a further dent into the forest economy and ability to do active management. Timber markets are improving in 2020 but remain below previous high levels of production.

In 2020, biomass may not be widely viewed as a viable alternative energy source, but is being explored for accounting for carbon sequestration. This is a new and emerging forest management issue and is being tied to climate change, which was also not of high priority in 2010. State Forest Action Plans serve as records for tracking these forest changes over time, but, as of this writing, it is too early to predict any outcomes or direction for forest management.

Working towards sustainable forest management continues to be the primary goal of all forest interests in Minnesota. One of the most important outcomes of the 2020 SFAP process, is the growing awareness of all forest ownerships of the need to work together collaboratively, on collective management approaches and monitoring needs. Keeping working forests functioning, and protecting forested resources is critical as climate change, forest fragmentation, invasive species, timber management dynamics, threats to water quality, and other forest threats are becoming more a part of the forest management community conversation.

Acronyms

Acronym	Definition
2c	2c Managed Forest Land
ACUB	Army Compatible Use Buffer
AON	Assessment of Need
APHIS-PPQ	Animal Plant & Health Inspection Service Plant Health, Plant Protection & Quarantine
ATFS	American Tree Farm System
BIA	Bureau of Indian Affairs
BMP	Best Management Practices
BOFRP	Branch of Forest Resources Planning
BWCA	Boundary Waters Canoe Area
BWSR	Board of Water & Soil Resources
CARS	Community Accomplishment Reporting System
CFAA	Cooperative Forestry Assistance Act
CFM	Cooperative Forest Management
CHP	Combined Heat and Power
CREST	Climate and Renewable Energy Steering Team (at Minnesota Department of Natural Resources)
CRP	Conservation Reserve Program
CREP	Conservation Reserve Enhancement Program
CWD	Chronic Wasting Disease
CWPP	Community Wildfire Protection Plans
DNR	Department of Natural Resources
DU	Ducks Unlimited
EAB	Emerald Ash Borer
ECS	Ecological Classification System
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FEMA	Federal Emergency Management Agency
FIA	Forest Inventory & Analysis
FLP	Forest Legacy Program
FSC	Forest Stewardship Council
GEIS	Generic Environmental Impact Statement
GLFFC	Great Lakes Forest Fire Compact
GLIFWC	Great Lakes Indian Fish & Wildlife Commission
GLRC	Great Lakes Regional Collaborative
GLRI	Great Lakes Restoration Initiative
GSP	Gross State Product
HFRA	Healthy Forests Restoration Act
IBI	Indices of Biological Integrity
LCCMR	Legislative Citizens Commission of Minnesota Resources
LGU	Local Units of Government

Acronym	Definition
LSOHC	Lessard-Sams Outdoor Heritage Council
LSR	Landscape Scale Restoration
MDA	Minnesota Department of Agriculture
MFF	Minnesota Forests for the Future
MFI	Minnesota Forest Industries
MFRC	Minnesota Forest Resource Council
MFRP	Minnesota Forest Resource Partnership
MIFC	Midwest Interagency Fire Center
MLEP	Minnesota Logger Education Program
MMB	Minnesota Management and Budget
MNBBA	Minnesota Breeding Bird Atlas
MNDOT	Minnesota Department of Transportation
MNFSC	Minnesota Forest Stewardship Council
MNICS	Minnesota Incident Command System
MnSTAC	Minnesota Shade Tree Advisory Committee
MPCA	Minnesota Pollution Control Agency
NASF	National Association of State Foresters
NEPA	National Environmental Policy Act
NGO	Non-Governmental Organization
NIACS	Northern Institute of Applied Climate Science
NIPF	Non-Industrial Private Forests
NLCD	National Land Cover Data Set
NMSFA	Northeast-Midwest State Foresters Alliance
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NRRI	Natural Resources Research Institute
OSB	Oriented Strand Board
OSHA	Occupational Safety Health Administration
PFM	Private Forest Management
PWC	Price Waterhouse Coopers
RC&D	Resource Conservation & Development
REIT	Real Estate Investment Trust
RIM	Reinvest in Minnesota
SFEC	Sustainable Forests Education Cooperative
SFIA	Sustainable Forestry Incentive Act
SFI	Sustainable Forestry Initiative
SFRA	Sustainable Forest Resources Act (Minnesota)
SFRMP	Section Forest Resource Management Plans
SGCN	Species in Greatest Conservation Need
S&PF	State and Private Forestry
SFAP	State Forest Action Plan
SNA	Scientific and Natural Area

Acronym	Definition
SS	Shared Stewardship
SWAP	State Wildlife Action Plan
SWCD	Soil & Water Conservation District
tC	tonnes Carbon
TIMO	Timber Investment Management Organization
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TPO	Timber Products Output
U&CF	Urban and Community Forestry
U&M	Utilization and Marketing Program
UM	University of Minnesota
USACE	US Army Corps of Engineers
USDA	US Department of Agriculture
USFS	US Forest Service
USFWS	US Fish & Wildlife Service
WCA	Minnesota's Wetland Conservation Act
WFCE	Working Forests Conservation Easements
WHIP	Wildlife Habitat Incentive Program
WMA	Wildlife Management Area
WMD	Wildlife Management District
WRAPs	Watershed Restoration and Protection Strategies
WRP	Wetlands Reserve Program
1W1P	One Watershed One Plan

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