MINNESOTA'S
FOREST RESOURCES 2019

DEPARTMENT OF NATURAL RESOURCES

Division of Forestry
500 Lafayette Road
St. Paul, MN 55155

Resource Assessment
438 Peterson Rd.
Grand Rapids, MN 55744

December 2021

mndnr.gov/forestry/um

Preface

This report is compiled annually by the Forest Biometrician and Utilization and Marketing Program staff of the Minnesota Department of Natural Resources' Forestry Division. The report answers frequently asked questions about Minnesota's forest resources, such as current conditions and trends in forest resources and forest resource industrial use. Foresters, natural resource managers, planners, forest industry, and forest policy makers will find items of interest in these pages. This report uses multiple survey data sets.

This publication is updated as new data becomes available. Please use the online version and cite by date accessed.

We thank those who provided and updated information for this report, including many of Minnesota's wood product companies. We thank Ron Piva U.S. Forest Service Forest Inventory and Analysis (FIA) timber products output unit for his data analysis and Minnesota DNR staff Scott Burns for his data collection.

All FIA summary data was obtained from FIA database version 1.8.0.01.

Resource and Industry Highlights

- Overall, net growth for all species continued to outpace harvest levels. According to 2019 FIA figures, annual net growth of growing stock on timberland was approximately 5.65 million cords, with mortality of approximately 4.03 million cords.
- Pulp and paper continues to be the dominant sector for utilization, with 57% of roundwood harvested in the state being used within this sector.
- Since 2008, utilization has held steady (with slight variations) after dropping from 2006 to 2007 due mainly to OSB mill closures.
- There are several species, which are largely underutilized, highlighting opportunity for continued sustainable growth.
- Ash and maple species show an increasing utilization trend within hardwoods. Softwood species utilization remains relatively flat or decreasing, with the exception of spruce species which has shown increased utilization over the last decade.
- Tamarack utilization increased in 2018, the first year of increased Tamarack offerings by the state. It is too early in the initiative to quantify the effect.

Harvest Levels

In 2019, Minnesota industry and fuelwood users harvested and used approximately 2.8 million cords of wood.

Based on analysis of mill consumption (actual survey figures are not yet available), it appears that 2020 harvest levels are within the 2.7 to 2.9 million cord range.

Direct questions or requests for additional information to:

Kristen Bergstrand, Timber Utilization and Marketing consultant
Minnesota Department of Natural Resources, Division of Forestry, Resource Assessment Office
483 Peterson Road, Grand Rapids, MN 55744
kristen.bergstrand@state.mn.us, (218) 322-2511

FIA data analysis and report compiled by Scott Hillard, Ph.D., forest modeler, Minnesota DNR.

Table of Contents

Table of Figures

Table of Tables

How to cite this report:

Chapter 1 Forest Resource Review

Brief overview, tables, figures, and graphs

Outlines Minnesota's forest resources, including total forestland and timberland acreage, cover type percentages, and an ownership breakdown for timberland.

According to 2019 FIA data, Minnesota currently has approximately 15.8 million acres of forestland that is classified as "timberland." Timberland is forestland that is productive enough to produce a commercial crop of trees and is not reserved from harvesting by policy or law.

Reserved forestland is land reserved from harvest by policy or law, including designated wilderness areas like the Boundary Waters Canoe Area Wilderness (BWCAW), old-growth reserves, and others. Other forestland is mostly forested land of very low productivity for tree growth, such that it is incapable of producing a commercial crop of trees.

FIGURE 1-1: MINNESOTA LAND USE ACRES

Minnesota Land Use Acres

2019 FIA: Approximately 54 Million Total Acres
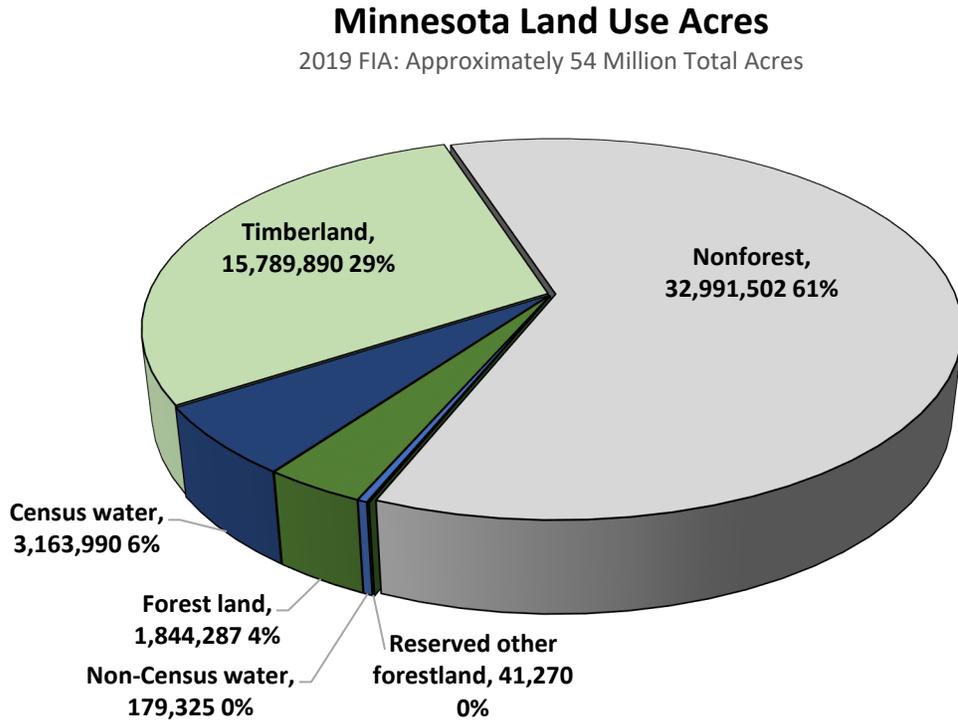
Source: U.S. Forest Service 2019 FIA database

FIGURE 1-2: MINNESOTA LAND USE 1935-2019
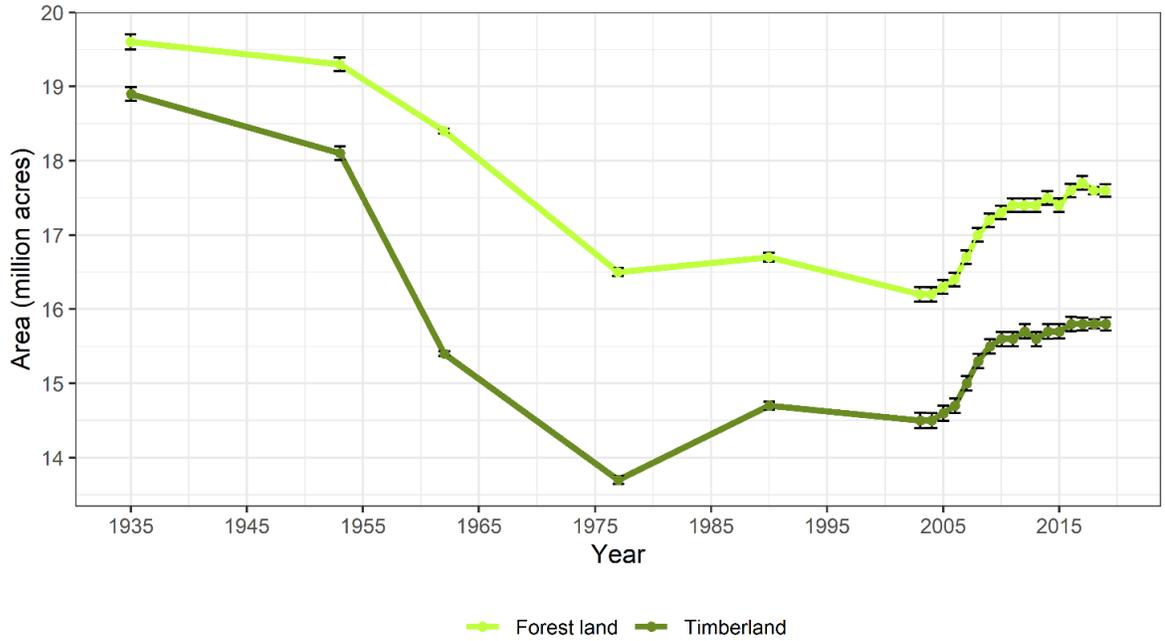
Source: U.S. Forest Service 2019 FIA database. Black brackets represent 68% confidence interval (multiply by 1.96 for 95% confidence interval) of estimate.

FIGURE 1-3: MINNESOTA AND USE MAPS
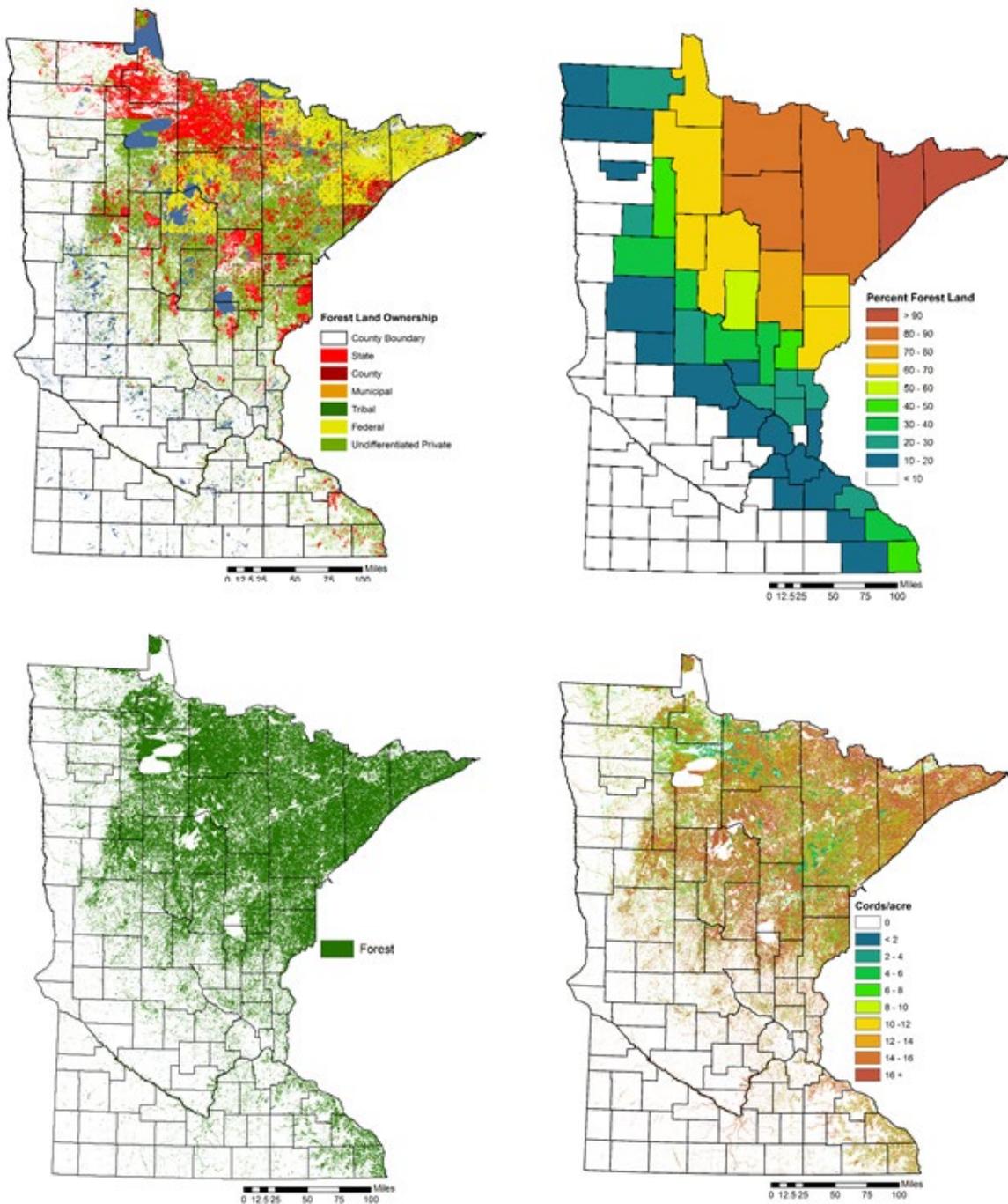
Map:Clockwise from left, Minnesota forest cover and ownership, percent forest coverage by county, estimated volume (cords/acre) for forest cover, and National Land Cover Database (NLCD) forest cover. **Source**: NLCD 2016, FIA 2018.

Generally, Minnesota's densest forest cover occurs in the northeastern portion of the state (refer to map). Forest cover decreases as one heads south, however, forest density increases in the southeastern corner of Winona, Fillmore, and Houston counties. Forest density can have a number of impacts on wildlife habitat, as well as forest resource productivity.

FIGURE 1-4: MINNESOTA TIMBERLAND OWNERSHIP

Minnesota Timberland Ownership
FIA 2019-Total Timberland Acres = 15,789,890

- Other Federal, 24,719, 0%
- National Forest System, 1,833,851 12%
- County & Local Govt., 2,492,308 16%
- Private, 7,745,273 49%
- State, 3,693,738 23%
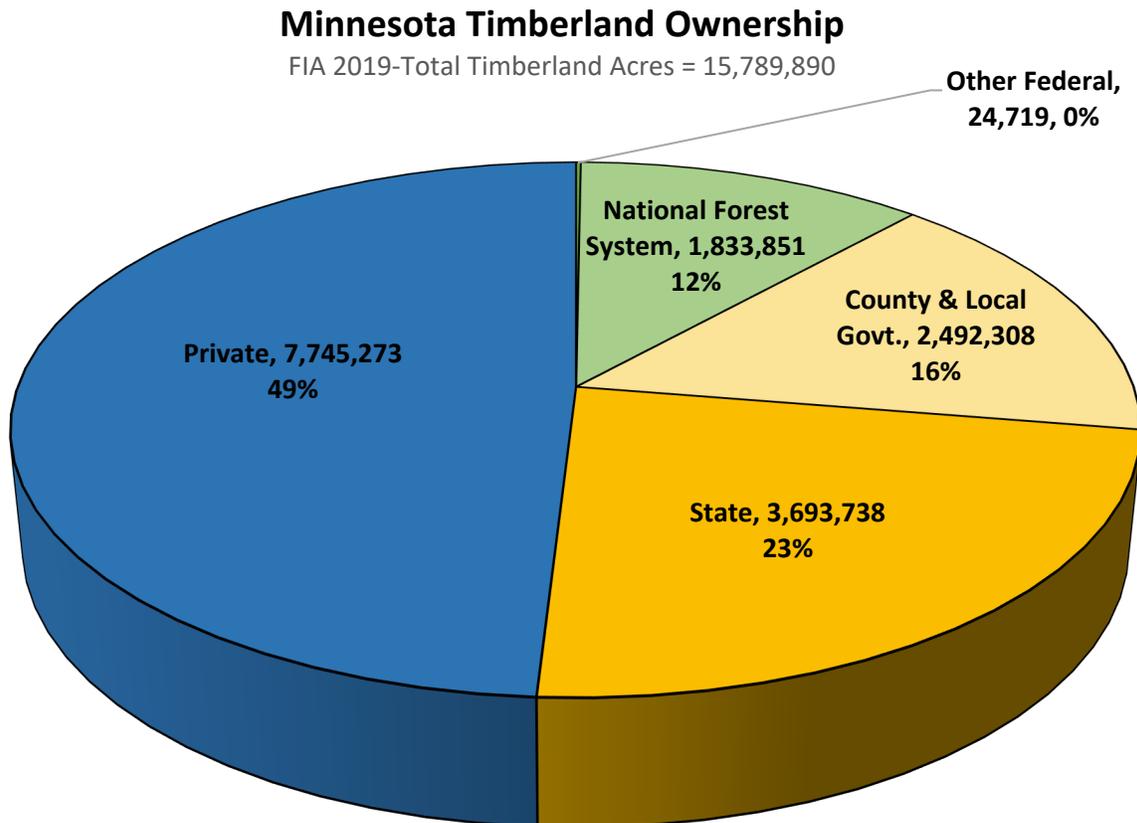
Source: U.S. Forest Service 2019 FIA Database **Note*:** *FIA Timberland classification provides an accurate assessment of lands meeting a certain productivity and non-reserved status criteria; however, it is not an assessment of acres available for utilization. Timberland does not assess marketability or other limitations (statutory, policy, physical, etc.) that may be present within a particular landowner or administrator and limit the acres available for fiber harvesting.*

Timberland ownership is an important factor when assessing forest resources. Privately owned forests make up half of Minnesota's Timberlands (49%), and may have varying management objectives compared to publically owned forests. The Forest Inventory Analysis (FIA) database tracks some additional categories of private lands (see figure 1-5). For additional resolution at finer scales, please contact the FIA program's spatial services.

FIGURE 1-5: MINNESOTA PRIVATE TIMBERLAND ACRES

Minnesota Private Timberland
FIA 2018-Estimated Acres by Ownership

Other Private, 689,814, 9%

Unincorporated Partnerships, 39,248, 1%

Corporate, 1,189,497, 15%

Individual and Family, 5,826,324, 75%
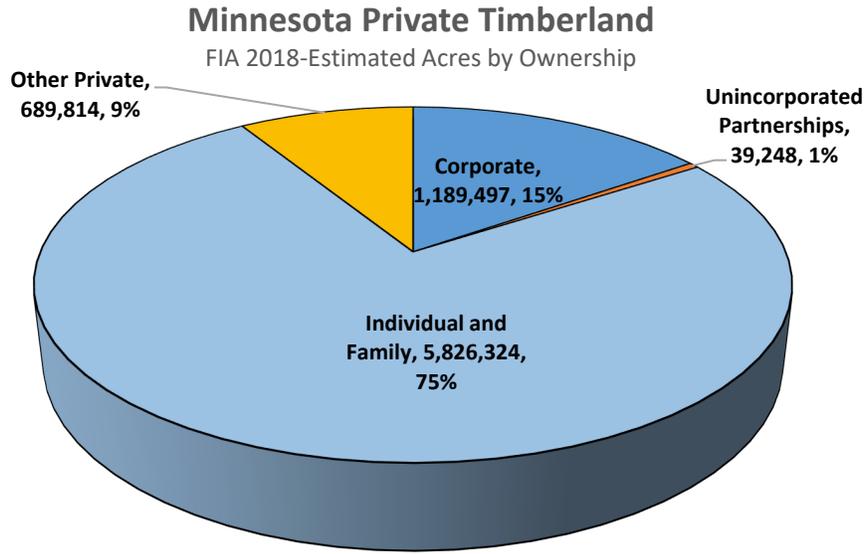
Source: U.S. Forest Service Spatial Services; 2018 FIA Database

To protect privacy and plot locations, private land data is estimated and manipulated slightly. However, it is an accurate representation of private land ownership on timberland in Minnesota. In general, much of the forest and timberland in the northern part of the state is publically owned, in the southeast privately owned forest and timberland is more prevalent.

FIGURE 1-6: COUNTY ACREAGES ENROLLED IN EITHER SFI OR FSC

County Acreages Enrolled in Either SFI or FSC
MNDNR Certification program-Total Acres: 2,198,461

Beltrami, 145,500

Koochiching, 286,000

St. Louis, 893,158

Itasca, 287,806

Cass, 257,970

Aitkin, 223,027

Crow Wing, 105,000
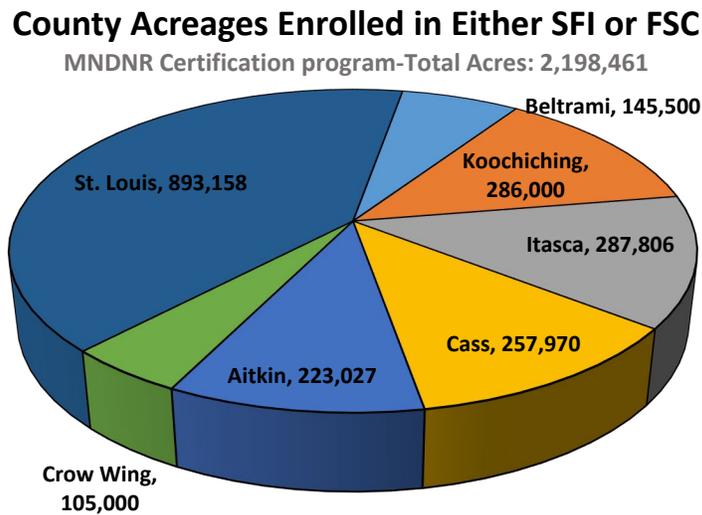
Source: Minnesota DNR certification program 2018/2019. These are county acres as assessed by the MNDNR certification program

Some counties have enrolled their lands under different sustainability agreements. The Sustainable Forestry Initiative (SFI) or the Forest Stewardship Council (FSC) certify lands as being managed to environmental best practices. Estimates of the number of enrolled acres come from the Minnesota DNR Certification Program. In general, most county-administered acres are certified in those counties labeled "certified."

FIGURE 1-7: MINNESOTA DNR FOREST-TYPE ACREAGES

MNDNR Forest-Type Acreage
All Ownerships 2019
Total Timberland Acreage = 15.7 Million

Northern hardwoods, 1,500,731
Lowland hardwoods, 1,458,870
Oak, 1,509,515
Black spruce, 1,366,014
Tamarack, 1,103,157
Aspen, 4,704,111
Birch, 719,428
Red pine, 679,064
Northern white-cedar, 622,262
Other, 491,536
Balsam fir, 418,515
Other softwoods, 8,793
Eastern redcedar, 19,022
White spruce, 139,155
Balsam poplar, 404,677
Jack pine, 216,864
Cottonwood / Willow, 64,847
Eastern white pine, 177,203
Non stocked, 186,127

Source: U.S. Forest Service 2019 FIA database

Forest Type

Forest Type is a classification of forestland based on the species forming a majority of live tree stocking.

Aspen is by far the largest forest or "cover" type in Minnesota. Oak, northern hardwoods, black spruce and tamarack also make up a large percentage of Minnesota forests.

Timberland in Minnesota has increased from approximately 15,599,930 acres in 2013 to approximately 15,789,890 acres in 2019. A number of factors play a part of this increase, such as agricultural land converting to forest. This is a dynamic process depending on the fortunes in the

agricultural or timber industry sector. Improved assessment techniques also contribute to classifying former forestland as timberland.

TABLE 1-1: AREA OF TIMBERLAND IN MINNESOTA BY DNR FOREST TYPE 2019

Forest Type[1]	Acres
Aspen	4,704,111
Balsam fir	418,515
Balsam poplar (Balm of Gilead)	404,677
Birch	719,428
Black spruce	1,366,014
Cottonwood / Willow	64,847
Eastern red cedar	19,022
Eastern white pine	177,203
Jack pine	216,864
Lowland hardwoods	1,458,870
Non stocked	186,127
Northern hardwoods	1,500,731
Northern white cedar	622,262
Oak	1,509,515
Other (FIA codes not mapped to DNR)	491,536
Other softwoods	8,793
Red pine	679,064
Tamarack	1,103,157
White spruce	139,155
Total	**15,789,890[2]**

Source: U.S. Forest Service, 2019 Forest Inventory Analysis (FIA) database

---

[1] Forest-type is also known as cover-type.
[2] May not sum due to rounding, may also differ from past estimates, as the FIA database is refined.

Chapter 2 Wood-Using Industry

A brief overview of Minnesota's wood-using industry, including mill location, product information, and total industry economic impact.

Minnesota's Forest Industry at a Glance

Economic Impact 2019[3]

- $10.1 billion direct value of shipments with $17.2 billion total output effect.
- $3.5 billion direct value added with $7.8 billion total value added effect.
- 5th largest manufacturing sector in Minnesota by employment (#1 food products, #2 computers & electronics, #3 fabricated metal products, and #4 machinery).
- 30,360 direct jobs with 63,825 jobs total employment effect.
- $1.8 billion in direct labor income with $3.9 billion total labor income effect.
- $217 million direct state and local tax receipts with $457 million state and local tax receipts effect.

FIGURE 2-1: VALUE OF FOREST PRODUCTS MANUFACTURED IN MINNESOTA
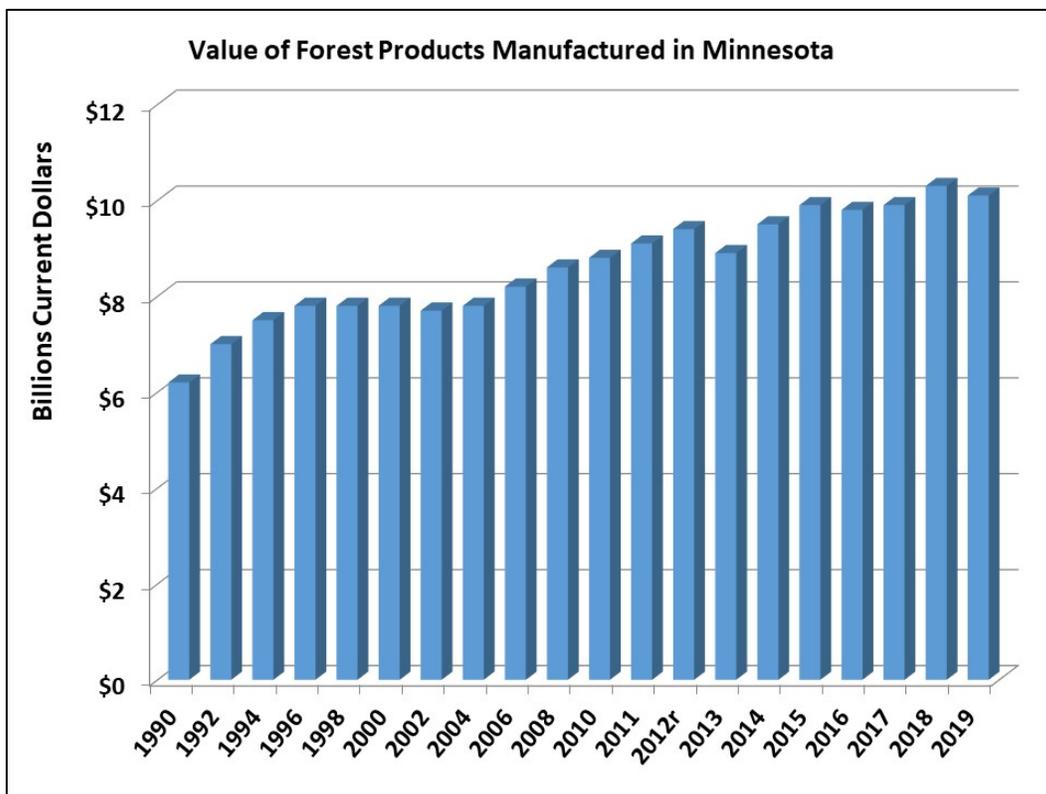
Important Industrial Sectors

Pulp, paper, paperboard, engineered wood products, converted paper products, window & door components (MN # 2 in U.S.), kitchen cabinets and cabinet parts, store fixtures, wood office & residential furniture, pallets & crating, millwork and wood shavings for animal bedding.

---

[3]CY2019 data unless otherwise noted; compiled by Don Deckard, Ph.D., Forest Economist, Minnesota DNR

Non-Timber Industries Dependent on Minnesota's Forestlands

Balsam boughs for the Christmas wreath industry with annual sales exceeding $20 million. Other non-traditional forest decorative material industries include decorative spruce tops, birch poles, maple syrup, wood for grilling and smoking (e.g. ash, black walnut, birch, hickory, maple, oak), medicinal plants and birch bark.

Value Added (Gross State Product) per Capita

In 2019, Minnesota was ranked #14 nationally in forest products manufacturing with $536 direct value added (Gross State Product) per capita. In 2017, Minnesota ranked #12 nationally.

FIGURE 2-2: FOREST INDUSTRY GROSS STATE PRODUCT PER CAPITA
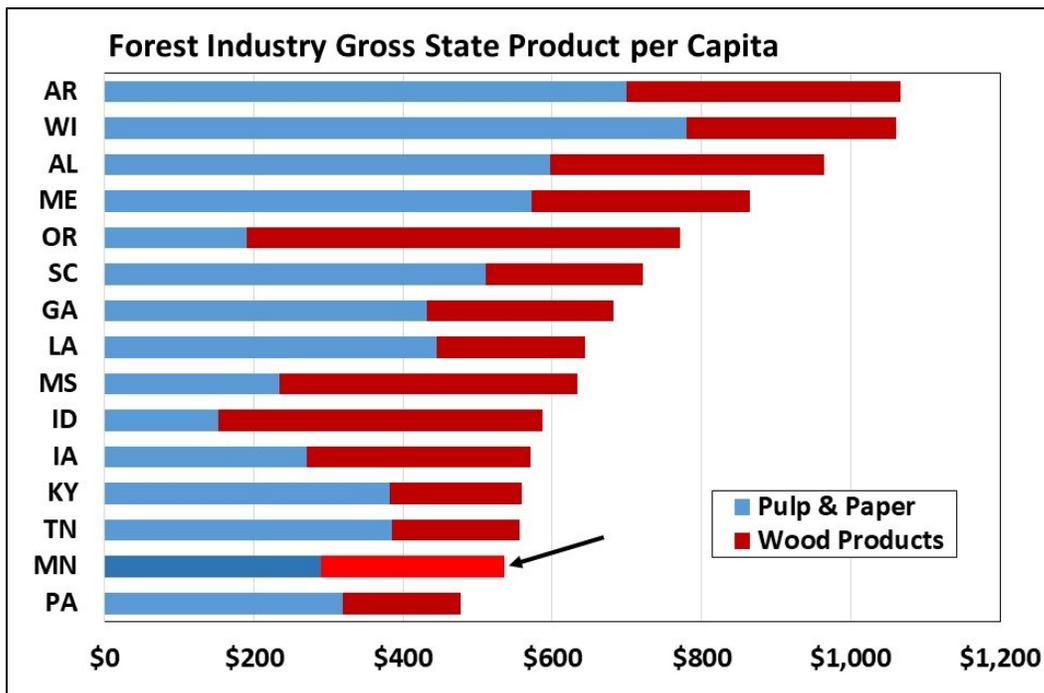
Manufacturing Facilities as of January 2019 [4]

- 4 primary pulp & paper mills and
- 3 recycled pulp & paper mills
- 87 converted paper products plants
- 329 sawmills and wood products plants
- 331 wood kitchen cabinet and countertop manufacturers
- 46 wood furniture
- 28 custom architectural woodwork shops

---

[4] Source: Minnesota Department of Employment and Economic Development, Quarterly Census of Employment and Wages (QCEW), retrieved August 2021.

Volume of Timber Harvested

Annual harvest volume = 2.81 million cords including:

- Pulpwood = 2.08[5] million cords (2018 draft)
- Sawlog and specialty Mills = 303[6] million board feet (2019 draft)
- Residential fuelwood = 108,000 cords live trees from timberland (2017 and 2018)
- Commercial wood fuel = 16,316 cords (2019 draft)

TABLE 2-1 MINNESOTA PULP AND PAPER, 2019

Firm	Wood Used	Product
UPM - Blandin Paper Mill, Grand Rapids	Balsam Fir, Spruce, Aspen*	Lightweight Coated Magazine and Catalog Printing Papers
PCA - Packaging Corporation of America d.b.a. Boise White Paper, LLC, International Falls	Aspen, Balm of Gilead, Maple, Spruce, Pine* Balsam Fir*, Tamarack*, Birch*, Ash*	Office Papers, Label and Release Papers, Base Sheets, Business and Specialty Printing Grades
Verso, Duluth (Idled Indefinitely June 2020)	*Balsam Fir, Spruce*	*Uncoated, Lightweight Super Calendar Magazine and Publication Papers*
SAPPI North America, Cloquet	Aspen, Maple, *Birch, *Ash, *Balm of Gilead	Coated Freesheet Fine Printing and Publication Paper, Market Pulp- Dissolving or Bleached Kraft

Recycling Mills

Rock-Tenn Company, St. Paul	Recycled paper and corrugated	Cardboard and Corrugated Boxes
Verso Recycled Fiber Mill, Duluth (Idled Indefinitely June 2020	*High grade office paper and computer paper*	*Market Pulp*
Liberty Paper Company, Becker	Recycled paper and corrugated	Cardboard and Corrugated Boxes

TABLE 2-2: MINNESOTA ORIENTED STRAND BOARD AND ENGINEERED WOOD PRODUCTS, 2019

Firm	Wood Used	Product
Louisiana-Pacific, Two Harbors	Aspen, Balm of Gilead	Engineered Siding Panel-OSB
West Fraser d.b.a. Norbord Inc. Bemidji	Aspen, Balm of Gilead, Birch, Maple, *Pine, *Tamarack	Oriented Strand Board - OSB

*minor amounts

---

[5] Rounded number. Source: U.S. Forest Service Timber Product Output pulpwood survey
[6] Rounded number. Source: U.S. Forest Service Timber Product Output sawmill and Minnesota DNR surveys

Industry Information

Forest industry information is reported the year it occurred and prior to the published date of the Forest Resources Report. Mill survey data is reported for a calendar year and is not available until at least the following year. Because of this reporting structure, forest industry information will be reported before the calendar year survey data, covering the time between the releases of the annual Forest Resource Report. Mill and machine closure information remains in the report until no longer represented in calendar year survey data.

In August 2020, Sappi North America Inc. completed the Higg FEM self-assessment, for Verve, Sappi's dissolving pulp brand. This assessment shows value chain sustainability and is a tool used by the apparel industry to measure sustainability performance.

Sappi Cloquet Mill completes the Higg FEM self-assessment for dissolving pulp

In August 2020, UPM-Kymmene Corporation announced plans to restructure and streamline performance. UPM Communication Papers plans to close its Kaipola mill in Finland permanently by the end of 2020. The planned closure of UPM Kaipola's three paper machines would impact approximately 450 positions and lead to a permanent reduction of 720,000 tonnes of graphic paper. UPM also announced its intention to sell its UPM Shotton newsprint paper mill in Deeside, Wales for conversion. Further, UPM Communication Papers plans to reorganize and streamline its business function teams across Europe and North America. These plans will affect approximately 170 positions in more than 10 countries.
UPM Plans Restructuring and Streamlining to Ensure Performance

In November 2020, PotlatchDeltic sold 72,440 acres of forestland in northern and central Minnesota to the Conservation Fund. The Conservation Fund intends to manage the land now called Minnesota's Heritage Forest for wildlife, water quality, sustainable timber harvest and recreation.

The Conservation Fund Purchases 72,440 Acres in Minnesota from PotlatchDeltic

In January 2021, Maverick Wood Products invested in new yard equipment. In business since 2014 Maverick Wood Products has grown from processing hybrid poplar to consuming a variety of species like aspen, pine and other softwoods. Through recent mill upgrades including a debarker they have become a state of the art sawmill. See the Timber Producer Association (TPA) member feature to learn more.

Minnesota Timber Producer Member Feature Maverick Wood Products

In February 2021, LP Building Solutions announced their plans for phased siding capacity expansion, OSB mill restart, and a strategic exploration for the sale of their EWP business. The Houlton, Maine mill will be converted to SmartSide manufacture with production beginning in early 2022. The next siding conversion will likely be Sagola, Michigan. With the Houlton, Maine mill conversion they will cease production of LSL during 2021, and are exploring strategic

alternatives to the remaining EWP business, including a possible sale. LP plans to restart the Peace Valley OSB mill in Fort St. John, British Columbia.

[LP Announces Phased Siding Capacity Expansion Plans Including Peace Valley Restart, Explores Strategic Alternatives for EWP Segment](#)

In February 2021, Packaging Corporation of America announced the conversion of its No. 3 Jackson, AL mill paper machine to linerboard. The company will still operate three-paper machines system wide including two in International Falls capable of producing all of the Jackson mills previous paper grades. The Jackson, AL mill's No. 1 paper machine will continue to produce UFS products.

[Packaging Corporation of America Announces Conversion of Jackson, AL Mill Paper Machine to High-Performance Virgin Linerboard](#)

In February 2021, West Fraser Timber Co. Ltd. and Norbord Inc. announced the completed transaction, where West Fraser acquired all Norbord shares. Norbord Inc.is a wholly owned subsidiary of West Fraser.

https://www.westfraser.com/sites/default/files/February%201%2C%202021%20WFT%20and%20Norbord%20-%20Joint%20News%20Release%20regarding%20Closing.pdf

In April 2021, Nelson wood shims an employee owned business, received a state loan to purchase additional sawmill equipment. In 2022, they will continue to expand production adding 10 new jobs. By adding sawmill capacity in 2015 Nelson wood shims has experienced steady growth, nearly doubling the facilities wood consumption to help support increased shim business.

[Communities and Businesses Receive Over 3.9 Million in Economic Development Funding in Northeastern Minnesota](#)

In May 2021, the Verso Corporation announced they would sell the idled paper mill in Duluth Minnesota, to ST Paper and Tissue to convert into a recycled napkin and tissue manufacturer, restoring 80 jobs to the community.

[Sale of Duluth Mill Points to Paper Industry Trends](#)

In June 2021, Huber Engineered Woods announced plans for a new mill in Cohasset Minnesota. Huber Engineered Woods LLC (HEW), a subsidiary of J.M. Huber Corporation, announced in response to strong market demand for its specialty products they will build a new oriented strand board (OSB) facility in Cohasset, MN. The plant will increase the company's production of ZIP System® and AdvanTech® structural panels. The manufacturing facility will provide 150 direct jobs, while contributing growth opportunities in adjacent local industries including timber and trucking.

[Huber Announces Plan for a Sixth Mill](#)

For additional information about sawmills, specialty mills, pulp and paper mills, engineered wood product mills, shavings mills, and dry-kiln facilities in Minnesota please visit the Utilization and Marketing web page and the Wood Industry Directories.
mndnr.gov/forestry/um

Minnesota's Sawmills and Specialty Mills Sector – 2019

Minnesota's sawmill and specialty mill sector is important to forest management, forest product utilization, and economic health of local communities. Mills are located throughout the state and produce wood products with local tree species. This sector creates market diversity and provides value-added markets for numerous species, sizes, and qualities of timber. Markets are important to landowners through harvest compensations, which help them engage in other management activities such as creating wildlife habitat and improving recreational opportunities and forest health. Sawmills and specialty mills provide products we all use, and provide significant employment and economic benefits for many rural communities. Minnesota's sawmills and specialty mills use 22% of timber harvested annually in Minnesota, or approximately 606,000 cords.

Sawmills affect other wood industry sectors. For example, some sawmills send residue chips to paper mills, benefitting both sectors. Higher-value sawlog markets help make logging and mill residues available as woody biomass for energy. Sawmill byproducts or residues supply animal bedding and landscape mulch markets. Marketing byproducts or residues critically helps sawmills continue to produce primary products.

This sector encompasses a broad size, type, and product range of wood-using facilities. It essentially includes all mills that are not pulp and paper or engineered wood product mills. Minnesota has more than 200 active sawmills or specialty mills, but many are small, portable bandsaw mills that account for a tiny fraction of wood use. In contrast, 38 sawmill and specialty mills in Minnesota utilize more than 1 million board feet or 2,000 cords annually. In fact, those 38 mills (by production volume) account for 98 percent of the total consumption within this industry sector.

Firm	Wood Used	Product
PotlatchDeltic Corporation, Bemidji	Jack Pine, Red Pine, White Pine, Spruce, Balsam Fir	Dimensional Kiln Dry Graded Softwood Lumber
Savanna Pallets, McGregor and Remer	Red Pine, Tamarack, Black Ash, Aspen, Basswood, Paper and Yellow Birch, Red Oak	Boxes or Crates, Pallets/Skids, Hardwood Lumber, Cants, Ties, Landscape Mulch
Hedstrom Lumber Co., Grand Marais	Aspen, Birch, Jack Pine, Red Pine, White Pine, Spruce, Balsam Fir	Kiln Dry Lumber, Softwood and Graded Hardwood, Specialty Products, Mouldings, Siding
Rajala Timber Co., Deer River	Black Ash, Aspen, Balsam Fir, Basswood, Paper Birch, Jack Pine, Red Pine, Black Spruce	Lumber Green and Air Dried Graded, Hardwood Dimension Parts, Cants, Chips
Mala Mills, Little Falls	Aspen, Basswood, Red Pine, Balsam, Spruce Live Tamarack	Shavings for Animal Bedding
Hawkins Sawmill, Isle	Red and White Oak Family, Red and Sugar Maple, Ash, Birch, Aspen, Basswood	Hardwood Lumber, Cants, Specialty, Ties and Pallet Parts
Sylva Corporation, Princeton	Cedar, Red Pine, Basswood, Black Ash	Landscape Mulch
Lonza, Cohasset	Tamarack	Arabinogalactan Extract used in Food, Beauty and Health Products
Bell Lumber and Pole Inc., New Brighton	Red Pine	Telephone Poles
Land O Lakes Wood Preserving Company Tenstrike	Red Pine	Poles, Pilings and Posts

Sawmill Overview

From 1986 to 1992, sawmills processed between 475,000 to 575,000 cords annually. Starting in 1992 consumption of wood began increasing and Minnesota's sawmills processed between 650,000 - 730,000 cords annually from 1992 - 2001. The sector continued to change as the production capacity of sawmills decreased from 2001-2010 even though the numbers of sawmills remained steady. Wood availability during this time, especially aspen, was challenged by a competitive market place. The market changed after several pulpwood consuming facilities closed.

Softwood sawlog manufacturing has been stable over the years and recently has seen an increase in red pine, balsam fir and spruce consumption. Hardwood sawlog manufacturing has increased in

basswood, ash, white, and bur oak. Aspen, maple and spruce, which are preferred by pulpwood mills and utilized in the sawmill sector– tend to see the largest volume shifts between the pulpwood mill and sawmill sectors annually.

In recent years the sawmill sector has seen an increase in the number of small to mid-size stationary sawmills producing industrial grade products like cants, pallet parts, and railroad ties. Specialty mills in the state have experienced growth, having found a niche in environmental remediation and home construction products.

In 2019, the U.S. Forest Service changed the Timber Product Output (TPO) Sawmill Survey. The survey had canvassed all mills every three years. Since 2019, the U.S. Forest Service has implemented a 40% stratified random statistical sampling method on an annual basis. The U.S. Forest Service's first year of reporting the new sampling method will be 2018 data. For more details, see Annual Monitoring of U.S. Timber Production Rationale and Design. This report uses sawlog volumes from the most recent (TPO) survey year data for all known active mills.

FIGURE 2-3: 2018 AND 2019 HARDWOOD USE IN SAWMILLS AND SPECIALTY MILLS AND 2018 AND 2019 SOFTWOOD USE IN SAWMILLS AND SPECIALTY MILLS
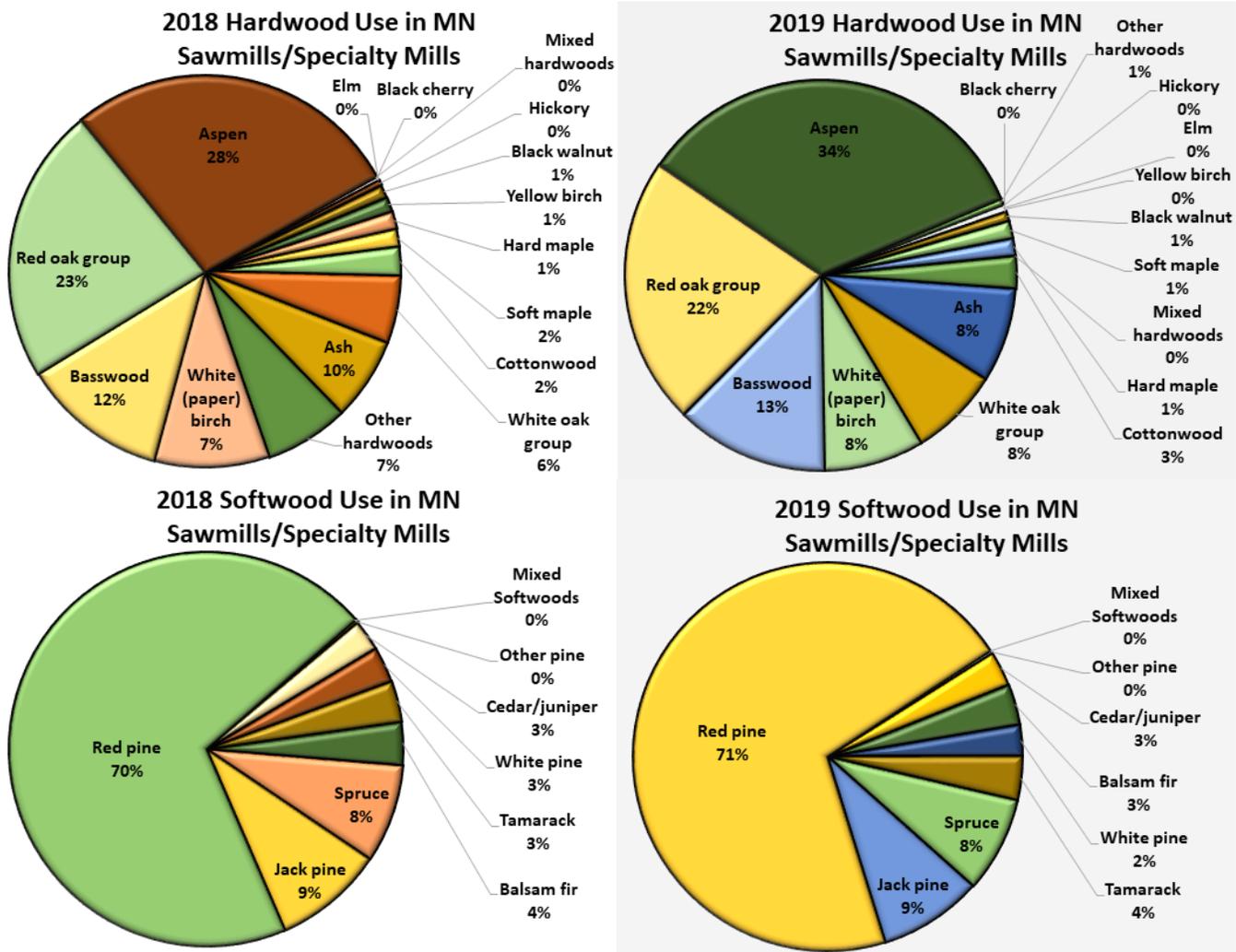
TABLE 2-4: MINNESOTA SAWLOG ROUNDWOOD PRODUCTION (CORDS)

Sawlogs*	2010	2014	2017 (Draft)	2018 (Draft)	2019 (Draft)
Softwoods	331,253	318,532	322,434	358,793	357,843
Hardwoods	190,633	197,823	211,851	233,196	208,290
Total	**521,886**	**516,355**	**534,285**	**591,989**	**566,133**

*124 sawmills that reported less than 5 thousand cubic feet of receipts in 2010 were not surveyed in subsequent years. Sawlog production only, does not include other or specialty mill production. Source: U.S. Forest Service and Minnesota DNR Timber Product Output sawmill survey (draft 2019)

Locations of mills is an important factor in determining markets for wood. Figure 2-4 shows pulpwood-consuming mills. Pulpwood mills utilize various species of wood material, with aspen pulpwood being half the total volume consumed. In 2018 pulpwood mills, consumed a ratio of 77 percent hardwood and 23 percent softwood. Wood energy facilities can utilize the most species of wood.

FIGURE 2-4: PRIMARY PULPWOOD-CONSUMING MILLS GREATER THAN 2,000 CORDS ANNUAL PRODUCTION, JUNE 2021
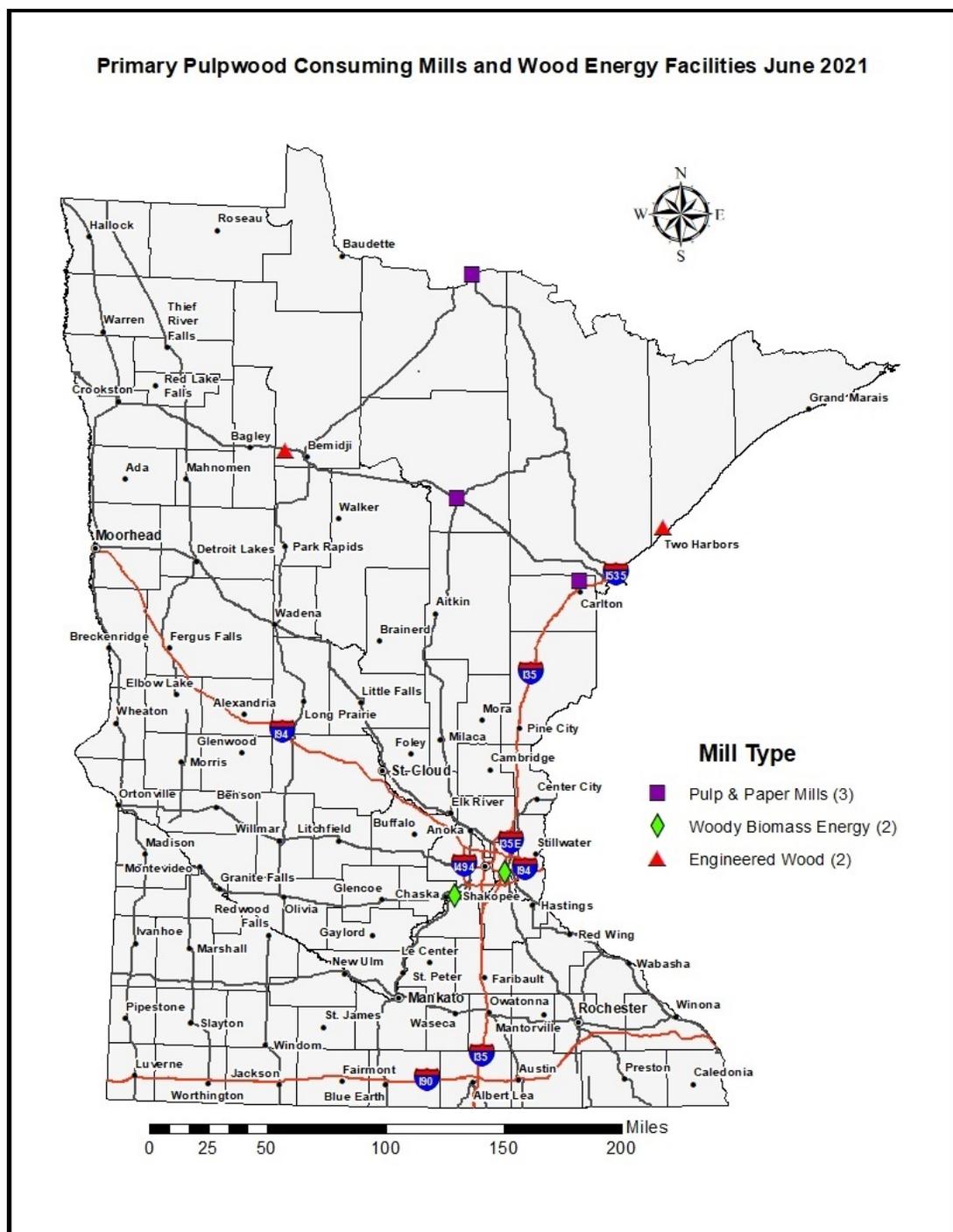
Figure 2-5 shows sawmills, post, pole and piling mills, shavings mills and specialty mills listed in the primary producer directory. These mills utilize various species of wood material, with a ratio of 62 percent softwood and 38 percent hardwood in 2019.

FIGURE 2-5: SAW AND SPECIALTY MILLS GREATER THAN 2,000 CORDS ANNUAL PRODUCTION, JUNE 2021
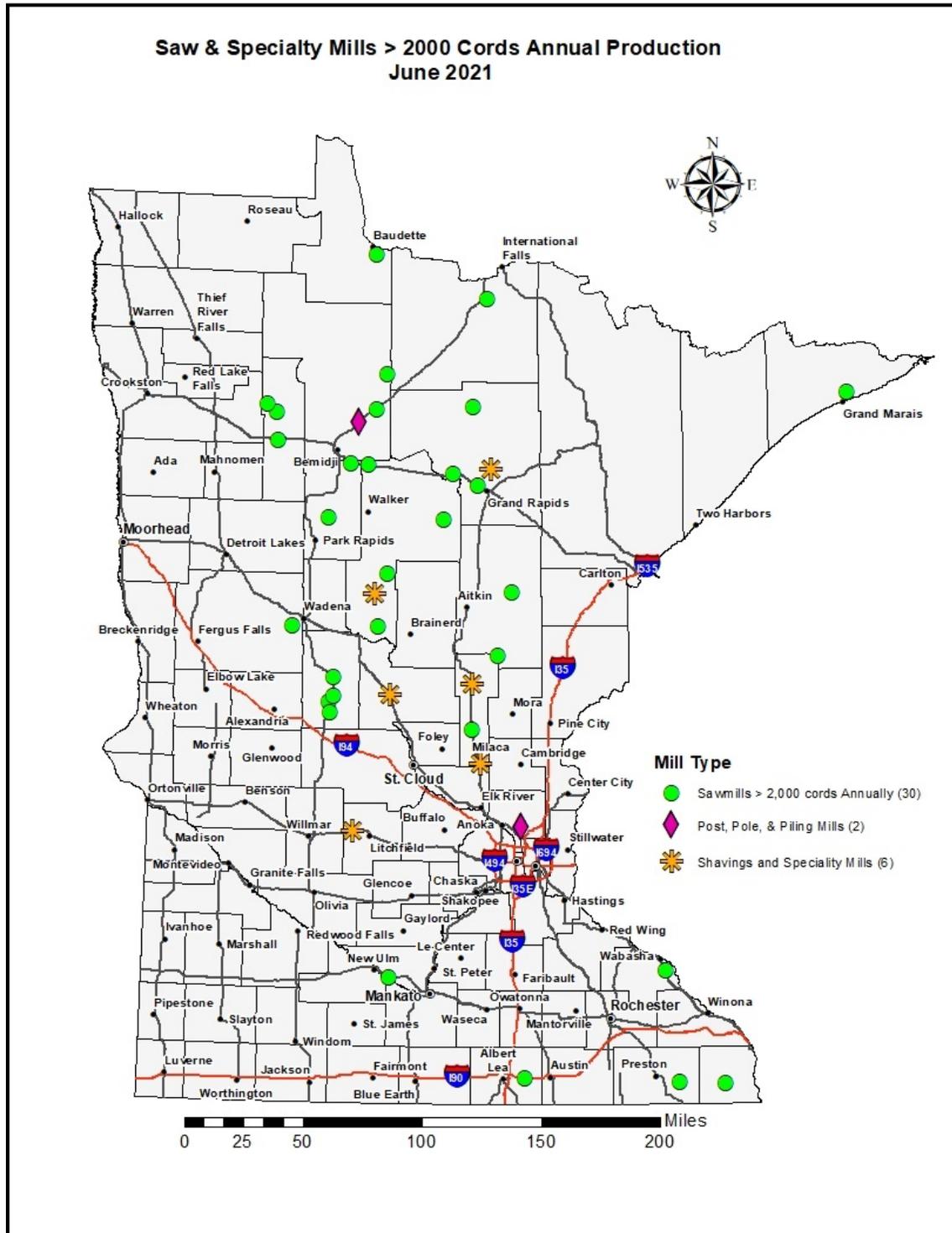
Current Wood Market Trends and Resource Opportunities

Current Trends

In 2019 pre-pandemic the forest products industry had experienced mixed economic conditions. Softwood lumber, pallet parts and engineered wood products experienced growth while other market segments like hardwood lumber and dissolving wood pulp struggled with international trade tariffs and markets. Overall, the economy and housing starts were experiencing growth and trending up then the Coronavirus pandemic hit in early 2020.

The pandemic continues to impact economic conditions across the world, including the forest products industry in Minnesota. MN forest products sectors experienced varied impacts directly related to their product types, customers and end markets. The worst impacts were in the pulp and paper sector seen in the Verso mill closures in Wisconsin Rapids, WI and Duluth, MN. The least impacts were in softwood lumber and engineered wood products primarily due to housing starts and renovation and remodel demand driven by consumers spending time at home. Currently in 2021, the forest products industry is at full production. The demand for products is high in all segments including pulp and paper due to machine closures, mill conversions, international trade disruptions and supply chain concerns. While demand has stabilized, global competitive marketplaces change and it is, yet to be determined the structure of the global forest products industry as the pandemic continues to impact consumer demand, workforce, supply chain dynamics, and raw material availability. Timberland managers, associations, private landowners, and public agencies need to work together to support existing and new wood manufacturers. Mill closures, layoffs, and downtime result in reduced forest management. Less forest management can negatively affect wildlife habitat, increase risk of forest fragmentation or development, increase risks to society (e.g. hazardous fuel loading, dead insect and disease infestation), and weaken economic benefits (e.g. rural jobs, rural tax base).

Minnesota's forest industries changed landscape over the last fifteen years, has created a sustainable wood fiber surplus. This surplus will support new mill announcements and has recently supported expansions for existing mills. This fiber will develop industries for in demand forest products using our local, renewable, climate friendly wood resource. Climate mitigation efforts highlight the many benefits of managed forests versus non-managed forestland and converted forestland. Managed forests provide essential products society needs, ecosystem services such as air and water filtration, carbon sequestration, and carbon storage in harvested wood products.

Wood as a raw material (compared to steel, concrete, and petroleum) has a reduced carbon footprint and a favorable carbon life cycle assessment. Actively managed forests make sustainable, wood products as well as create thermal energy, generate electricity, provide renewable chemicals and liquid fuels. Compared to products based on fossil fuels, all forest products are better for the climate, recyclable and reduce the amount of carbon dioxide and other greenhouse gas emissions. Trees and forests help mitigate a changing climate by sequestering and storing carbon in wood and harvested wood products. The future is bright for expanding wood use as a preferred raw material. There are more forested acres in Minnesota today then there were 50 years ago.

New research and technology continues to find commercial opportunities for wood-based chemicals, fuels, energy, and engineered wood products, the climate friendly products of the future.

Resource Opportunities

Several different species of wood in Minnesota are currently underutilized based on the 1994 Minnesota's Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota (GEIS). The U.S. Forest Service's Forest Inventory and Analysis (FIA) data shows that Minnesota grows almost twice as much wood a year as harvested. Opportunity exists now to grow wood product markets while maintaining the current forest resource in a static sustainable condition. Utilizing more wood products will support keeping forests as forests. Forests act as climate mitigation tools on the landscape supporting renewable materials and closed carbon cycles. Closed carbon cycles decrease the amount of new carbon released in the atmosphere through fossil fuels extraction.

Wood biomass is a large untapped resource in Minnesota. Wood biomass comes in different forms as manufactured residues or in-woods chips. Manufactured residues from sawmills continues to be available as a surplus. Manufactured residues in most pulpwood mills is used as a source of renewable energy for industrial applications in Minnesota. The forest products industry has been using biomass for heat or power or both for over 35 years. District and residential thermal heating remains a cost-effective option when compared to the historical volatile prices of fossil fuels. In woods biomass consisting of tops, limbs, poorly formed, dead and diseased fiber remains underutilized.

The prospect of expanded woody biomass harvesting and processing has many potential benefits, including:

- Reduced dependence on foreign energy sources
- Improved bottom lines for logging and processing operations
- Increased opportunities for forest management through timber stand improvement
- Pre-commercial thinning
- Sanitation or salvage operations
- Wildlife management through brush land clearing
- Invasive species control
- Other potential complementary value-added products for the forest products industry
- Aesthetically pleasing creating an open park like environment.

In fact, increased utilization of wood for bioenergy can improve ease and success of regeneration on some sites. It can also reduce fuel loading and fire risk, directly reducing the costs of fighting forest fires and planting.

Residential Fuelwood Consumption

Since 1960, the Minnesota Pollution Control Agency (MPCA), with assistance from the Minnesota Department of Natural Resources (MDNR) and the U.S. Forest Service, periodically conducts a statewide survey to find out how much wood is harvested and burned annually for heat or pleasure in Minnesota. A variety of state, federal agencies and trade organizations use the survey data to track firewood consumption, inform policy makers and scientists, and assist the hearth and fireplace industry by examining trends in wood burning. However, use caution when comparing across survey years to identify trends—survey questions and format have changed over the years. The MPCA conducted the survey reported in this document in 2017-2018.

The forest resources data on timber harvests used in this annual report focuses on using live trees harvested from the state's timberlands from all ownerships. The residential fuelwood survey collected the total volume of wood burned from all fuel types and sources including roundwood, slab wood, wood pellets, wax logs, and pallets. The fuelwood survey also collected data on harvest sources from dead trees, cut trees and or tops and branches after a timber harvest, live or dead trees from pasture, croplands, and yards inside city limits or other non-forestlands. Using the findings from the 2017/2018 MPCA survey report, the total fuelwood consumption of 1,450,000 cords can be separated by fuel types and source to determine the amount of fuelwood from live trees from timberlands. The Minnesota Pollution Control Agency is currently completing survey data collection and analysis on the 2020/2021 residential fuelwood consumption survey.

TABLE 2-5: FUELWOOD

Total residential fuelwood consumption	1,450,000 cords
Percent of roundwood/logs and split wood	93%
Percent of wood from live trees from forestland	8%
Calculated volume of cords from live trees	108,000 cords *(rounded number)*

Chapter 3 Sustainable Harvest Levels

This section contains information on estimated sustainable harvest levels for many of Minnesota's most significant tree species, as well as information concerning the MN DNR state lands sustainable timber harvest analysis project (STHA).

A note to readers: No direct correlation exists between current harvest levels and long-term sustained harvest levels because there are many options for moving toward a targeted age-class structure. Normally, transitions from the current structure to a target age-class structure require several rotations. Harvest amount and timing can vary considerably by decade. Harvest plans are typically assessed periodically as changes to the resource, markets, and other conditions dictate.

No best way or time exists to reach a target age-class structure. Transition harvests may differ from long-term sustained yield estimates. Additionally, it is possible to raise future timber availability through intensified forest management resulting in fewer losses to mortality and improved timber productivity. Sustainable harvest estimates can also vary significantly because of differing assumptions used in deriving the estimates, such as rotation age, harvest restrictions, growth and yield, etc. An active forest management and harvesting program is key to sustaining habitat for diverse wildlife and maintaining a healthy forest.

Please view the levels as helpful benchmarks–one part of the picture in determining long-term sustainability of our forest resources. Harvest levels should not be viewed as absolute targets.

In 1994, Minnesota's Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota (GEIS) was complete. This study was commissioned by the Minnesota Environmental Quality Board in response to a citizen petition. The GEIS assessed three levels of

statewide timber harvesting activity related to Minnesota's environmental, economic, and social resources. The GEIS studied Base, Medium and High annual harvesting scenarios projected over a 50-year planning horizon: 4 million cords, 4.9 million cords, and 7 million cords. The GEIS made no recommendations and is not a plan. It simply analyzed three harvest levels to determine effects.

In March 2018, the DNR completed its Sustainable Timber Harvest Analysis (STHA), which studied timber harvest on only DNR-administered lands capable of producing timber. Mason Bruce and Girard, a forestry consulting firm based in Portland, Oregon, conducted the modeling. This effort was conducted over 18 months; involved the DNR Divisions of Forestry, Fish and Wildlife, and Ecological and Water Resources; and evaluated and approved by the commissioner's office.

The DNR concluded that an appropriate harvest level, taking into account the many goals of the department, would be 870,000 cords offered annually over the next 10 years. In addition, an initiative to harvest more ash and tamarack was initiated to offer up to 30,000 additional cords of ash and tamarack in the next five years, adjusting net harvest levels to 900,000 cords in the first five years. In the second five years, levels would drop to 870,000 cords. This analysis will likely be reevaluated in 10 years.

FIGURE 3-1: ANNUAL HARVEST COMPARED TO GEIS SUSTAINABLE HARVEST AND FIA GROWTH/MORTALITY METRICS
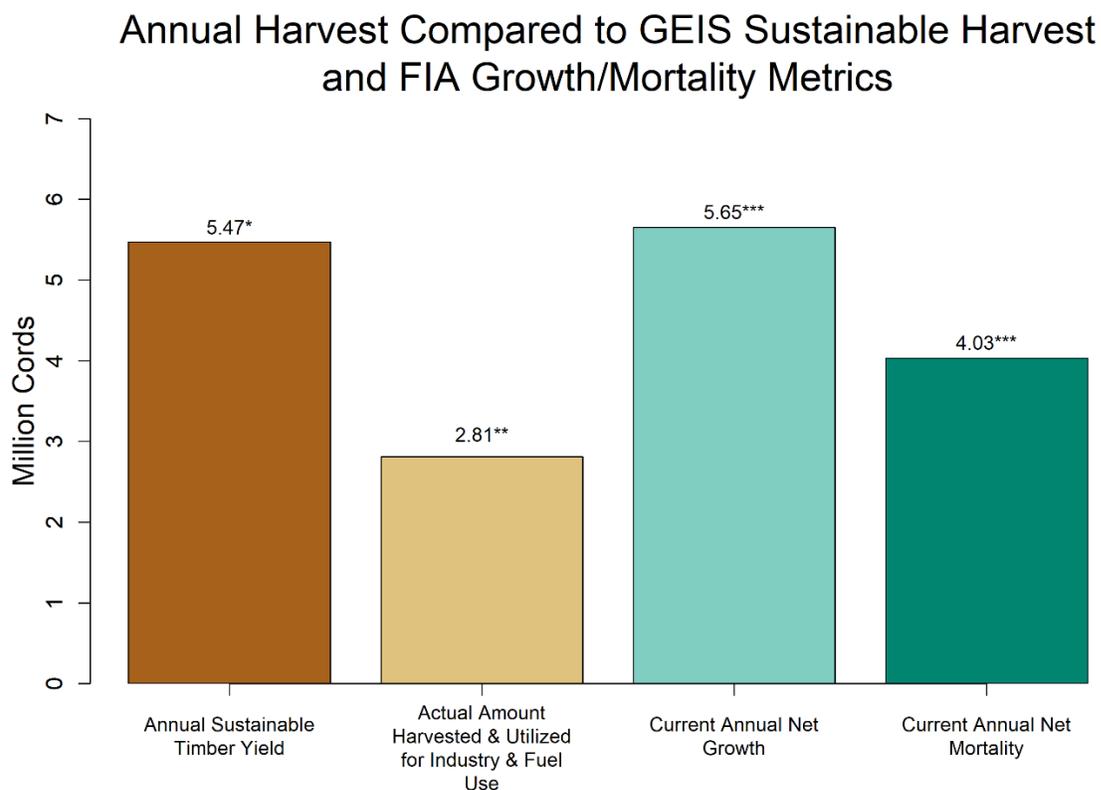
Source: Table accessed from Table 6.25, GEIS, High Long-Term Sustainable Level, Timber Productivity Technology. Paper, December 1992.

Figure 3-1 includes data from 2018 U.S. Forest Service Timber Product Output pulpwood survey (*draft*), DNR 2019 Timber Product Output survey sawmill (*draft*) and 2018/19 fuelwood survey (*draft*. To compare harvest to net growth, it is necessary to add annual "growing stock" logging residue of approximately 275,000 cords to this figure.

Includes data from U.S. Forest Service FIA 2018 database annual net growth and mortality on forestland.

Note: While complete capture is not realistic, capture of a portion of annual mortality of approximately 4.03 million cords has the potential to increase net growth and sustainable harvest levels.

FIGURE 3-2: GROWTH TO HARVEST RATIO
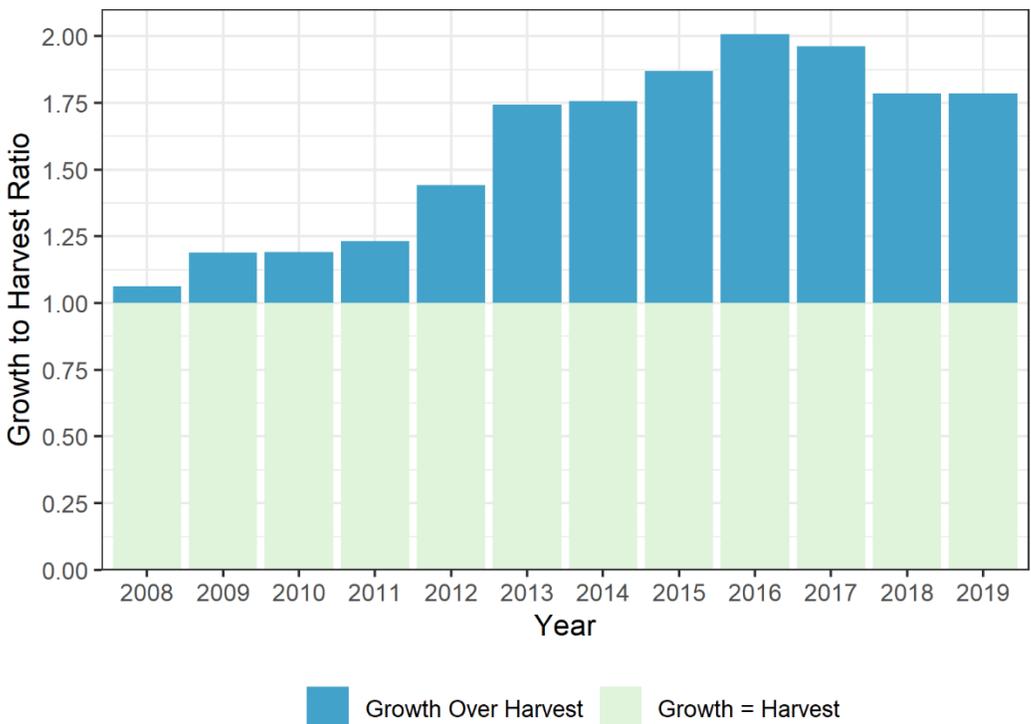
Source: FIA 2019

Net growth-to-harvest ratio accounts for non-harvest removals and mortality in terms of net growth (subtracts mortality and non-harvest removals from gross growth) and allows for comparison to determine if the harvest rate is exceeding the growth after all the natural removals and mortality have been accounted for. A value of one means net growth and harvest are equal. Figures higher than 1 indicate the forest is accumulating volume.

Harvest removals will differ from DNR methodology and will likely not match. This ratio is an indicator of sustainability, and is not the sole measure to drive decision-making. Short-term management goals may allow for increasing harvest above rates of growth.

FIGURE 3-3: ESTIMATED LONG-TERM ANNUAL SUSTAINABLE TIMBER YIELD AND ACTUAL HARVEST OF SELECTED SPECIES

Estimated Long Term Annual Sustainable Timber Yield
and Actual Harvest of Selected Species
Minnesota 2018
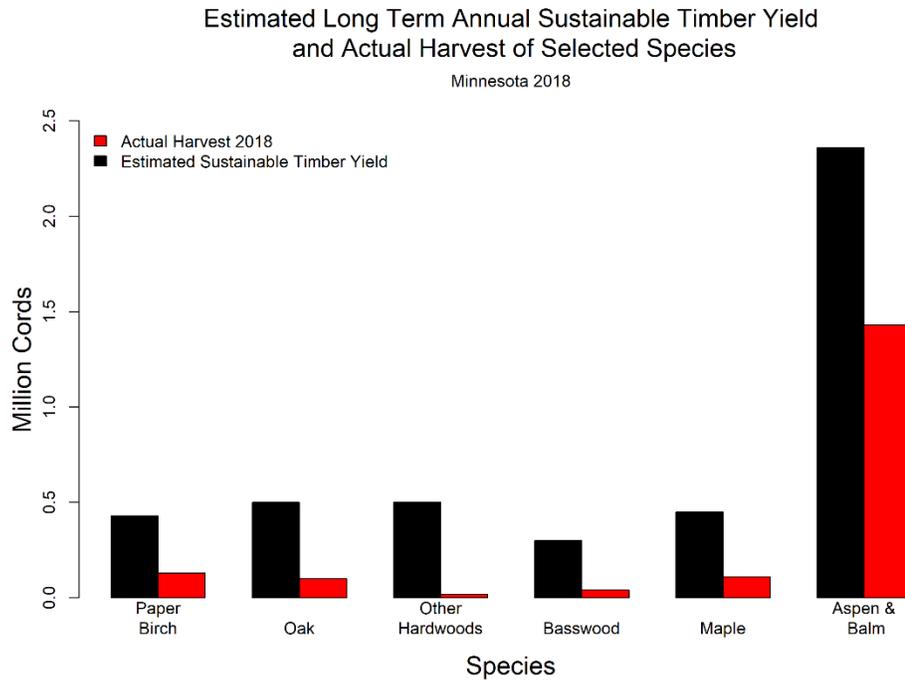
Source: Harvest data 2018 U.S. Forest Service Timber Product Output pulpwood survey (*draft*), DNR 2019 Timber Product Output survey sawmill (*draft*) and 2018/19 fuelwood survey (*draft*).

FIGURE 3-4: ESTIMATED LONG-TERM ANNUAL SUSTAINABLE TIMBER YIELD AND ACTUAL HARVEST OF SELECTED SPECIES

Estimated Long Term Annual Sustainable Timber Yield
and Actual Harvest of Selected Species
Minnesota 2018

Source: Harvest data 2018 U.S. Forest Service Timber Product Output pulpwood survey (*draft*), DNR 2019 Timber Product Output survey sawmill (*draft*) and 2018/19 fuelwood survey (*draft*).

35
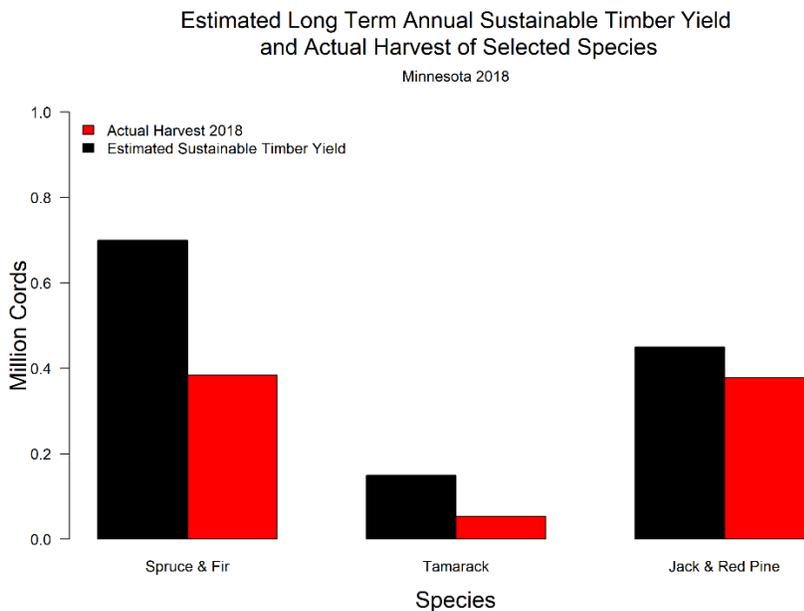
NOTES:

Sustainable timber yield for aspen and spruce-fir in the figures above are from the UPM-Blandin Thunderhawk Draft Environmental Impact Study (DEIS) analysis (Tables C-20 and C-21 average of high aspen A and B scenario model runs, 40-year planning horizon). Estimates from the Thunderhawk DEIS analyses focused on aspen-balsam poplar and spruce-fir product groups, recognizing considerable detail regarding the mixed species nature of all cover types and projections of forest growth. Generally, the EIS estimates can serve as upper bound estimates of harvest levels sustainable at least until year 2040. These estimates assume that demand for other species will not limit aspen or spruce-fir harvesting from other cover types such as birch or northern hardwoods. However, the estimates omit potential volumes from additional investments in short-rotation intensive silviculture or potential volume increases resulting from investments in pre-commercial thinning. The estimates do consider allowable cut procedures use by public land management agencies.

Sustainable timber yield levels for birch, oak, basswood, maple and other hardwoods, tamarack, jack pine, and red pine are based on the DNR method of calculating long-term sustainable harvest levels, which consists of area regulation for cover types typically managed as even-aged, and volume regulation for types typically managed as mixed-aged. Estimates are adjusted downward as appropriate by ownership for potential timber supply restrictions that can apply to timberlands (riparian: 3%, old growth: 0.5%, leave tree: 5%). Rotation ages used to determine the estimates are based on average ages used in the DNR's Subsection Forest Resource Management Plans.

Chapter 4 Harvest Levels

Information on 2018 pulpwood timber harvest and 2019 saw log harvest in Minnesota by product category and estimation of contribution by timberland ownership.

TABLE 4-1: TOTAL WOOD HARVESTED AND UTILIZED BY INDUSTRY AND FUELWOOD USERS IN MINNESOTA (BY SPECIES FROM TIMBERLAND)

Species	Pulpwood[7]	Saw logs and Other[8]	Residential Fuelwood[9]	Commercial Wood Uses[10]	Total
Aspen/ Balm	1,350,719	72,254	5,400	7,334	1,435,707
Paper Birch	102,161	18,570	10,800	389	131,920
Ash	45,523	16,772	9,720	1,187	73,202
Oak	442	76,150	23,760	510	100,862
Basswood	11,258	26,827	3,240	149	41,474
Maple	93,249	9,079	9,720	704	112,752
Cottonwood	---	6,678	---	---	6,678
Other Hardwoods	1,834	6,762	11,880	---	20,476
Hardwood Sub-Total	**1,605,186**	**233,091**	**74,520**	**10,273**	**1,923,070**
Pine	---	880	11,880	2,949	15,709
Red Pine	51,703	270,481	---	---	322,184
White Pine	4,448	9,410	---	---	13,858
Jack Pine	26,548	29,807	---	402	56,757
Pine Sub-Total	**82,699**	**310,578**	**11,880**	**3,351**	**408,508**
Spruce	250,161	29,109	---	110	279,379
Balsam Fir	91,750	11,562	---	1,968	105,280
Tamarack	41,985	12,228	---	123	54,336
White Cedar	---	9,504	---	---	9,504
Other Softwoods	---	254	4,320	---	4,574
Softwood Sub-Total	**383,896**	**62,657**	**4,320**	**2,201**	**453,074**
Mixed Species	11,631	30	17,280	491	29,432
Total	**2,083,412**	**606,356**	**108,000**	**16,316**	**2,814,084**

Source: U.S. Forest Service and Minnesota DNR Timber Product Output mill and wood energy surveys and Minnesota Pollution Control Agency residential fuelwood survey. *Figures in chart may not total exactly due to rounding* Pulpwood Timber Product Output survey 2018 (DRAFT); Sawtimber Timber Product Output survey 2019 (DRAFT); Residential Fuelwood 2018/19; Commercial Wood Fuels 2019 (DRAFT)

Pulpwood figures include cords of pulpwood exported to Wisconsin:

---

[7] Draft

[8] Draft 2019; includes 2017 Timber Product Output survey estimated exports (total estimated exports equaled 60,562 cord equivalent)

[9] Fuelwood removed from live trees on timberland.

[10] Draft

- Aspen: 40,495 (also to Canada)
- Spruce: 51,755
- Red Pine: 8,842
- Maple: 13,270
- Jack Pine: 9,347
- White Birch: 30,019
- Yellow Birch: 1,267
- Ash: 5,260
- Basswood: 5,100
- White Pine: 1,791
- Red and White Oak: 443
- Tamarack: 101

In addition to pulpwood exports, sawlogs were also exported to various states, mostly Wisconsin. However, some sawlogs were exported to Iowa and North Dakota as well. Exports (in MBF) include Aspen: 871 Spruce: 1,038, Red pine: 15,404, Maple: 1,775, Jack pine: 276, Birch: 701, Ash: 318, Basswood: 359, White pine: 290, Red and White oak: 7,025. Total sawlog exports (2017 estimate) were 60,562 cord equivalents.

Beginning in 2000, Minnesota became a net importer of wood when several mill expansions completed between 2000 and 2001. Mills located near the border and specific species requirements drove a need for more raw material, especially in 2018 aspen (55,214 cords), balsam fir (13,190 cords), and maple (182,991 cords).

In 2018, Minnesota exported 148,578 cords to Wisconsin. In 2018, Minnesota exported 10,290 cords of residue to Canada and 3,778 cords to Wisconsin (residues not included in roundwood numbers). In 2018, Minnesota remained a net importer mainly from Wisconsin but also Canada and Michigan. Figure 4-4 shows the import and export trends. The trade balance is calculated as exports-imports. Since 2000, Minnesota has had a negative trade balance with neighboring states and Canada.

Overall, sawtimber increased from 563,000 cords in 2014 to 653,000 cords in 2017. Sawtimber decreased to 606,000 in 2019. Commercial fuelwood use in 2019 dropped approximately 40,000 from 2014 and 2015. Sawlog exports in 2017 (draft) are lower than 2014 exports. Pulp use has remained consistent, although reporting issues in the last few years of draft Timber Products Output (TPO) survey data have required updates to past reports.

Total Round Wood Harvest from Minnesota Timberlands (1998-2018)
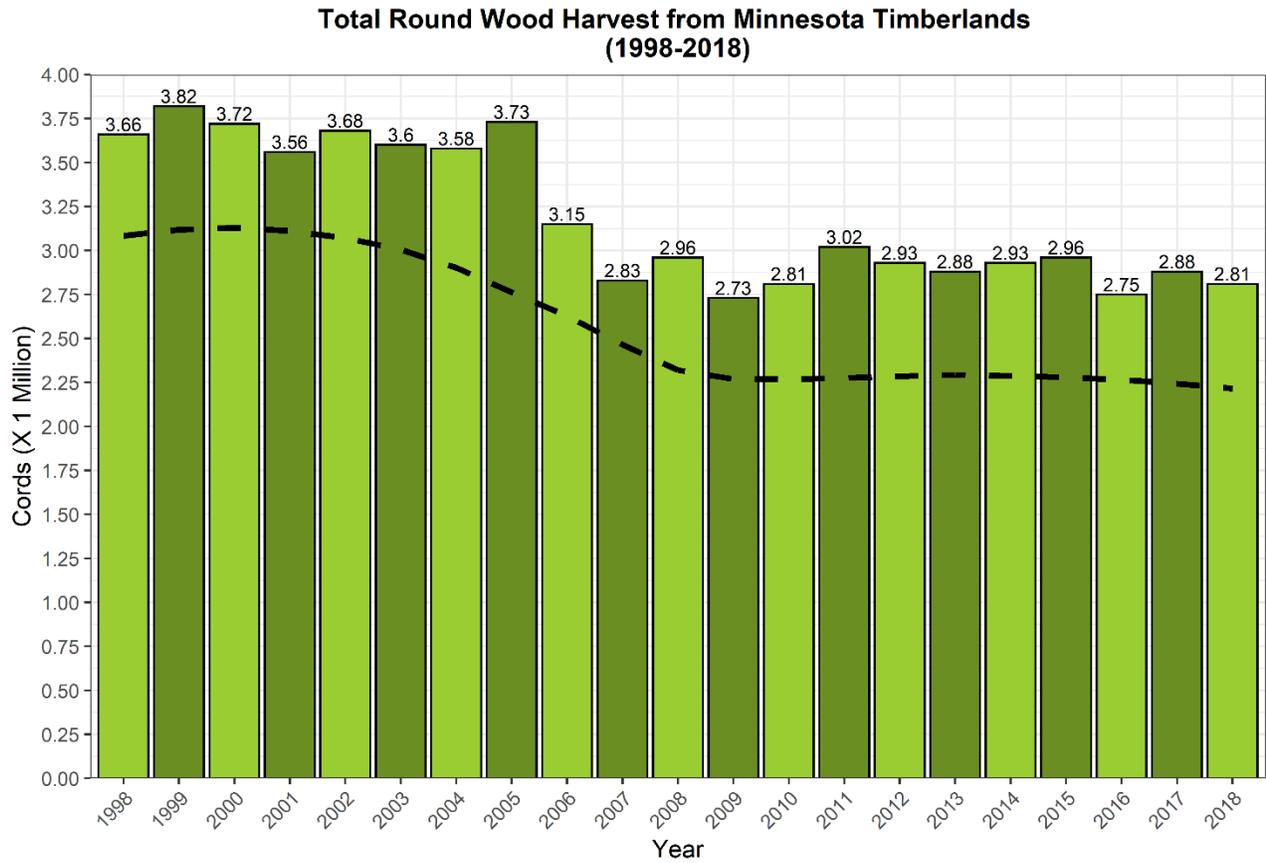
Source: 2018 Pulpwood (U.S. Forest Service, Northern Research Station Timber Product Output survey, DRAFT), Sawtimber (Timber Product Output Minnesota DNR survey DRAFT 2019) and fuelwood (Minnesota DNR surveys, DRAFT 2019). Dotted line shows trend in data.

Estimated Volume of Timber Sold/Harvested in MN By Ownership
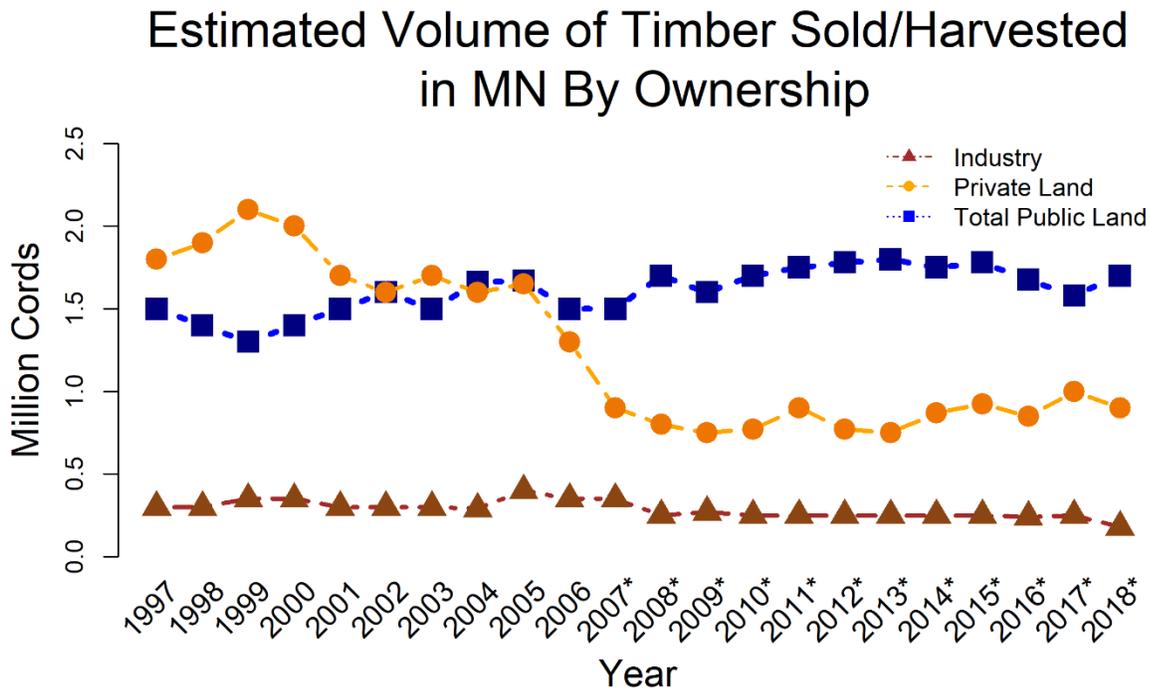
Source: Public Lands: Public Stumpage Price Review through 2006. **Beginning in 2007, annual volume scale reports (harvested) are used for state and federal lands rather than volumes sold. Change necessary because public agencies re-offered and sold large volumes of wood.**

On industry lands, Minnesota Forest Industries estimated harvested volume from 2018.

On private lands, an estimate calculated as follows:

Total estimated harvest 2018
   – minus 2018 public volume harvested (sold through 2006)
   – minus 2018 estimated industry volume harvested
(Molpus Woodlands Group—formerly Forest Capital Partners timberlands—contained in "Industry" totals.)

FIGURE 4-3: CONTRIBUTION TO ESTIMATED HARVEST IN MINNESOTA IN 2018

Contribution to Estimated Harvest in Minnesota 2018

Total Estimated Harvest=2,814,084 Cords-All Sources
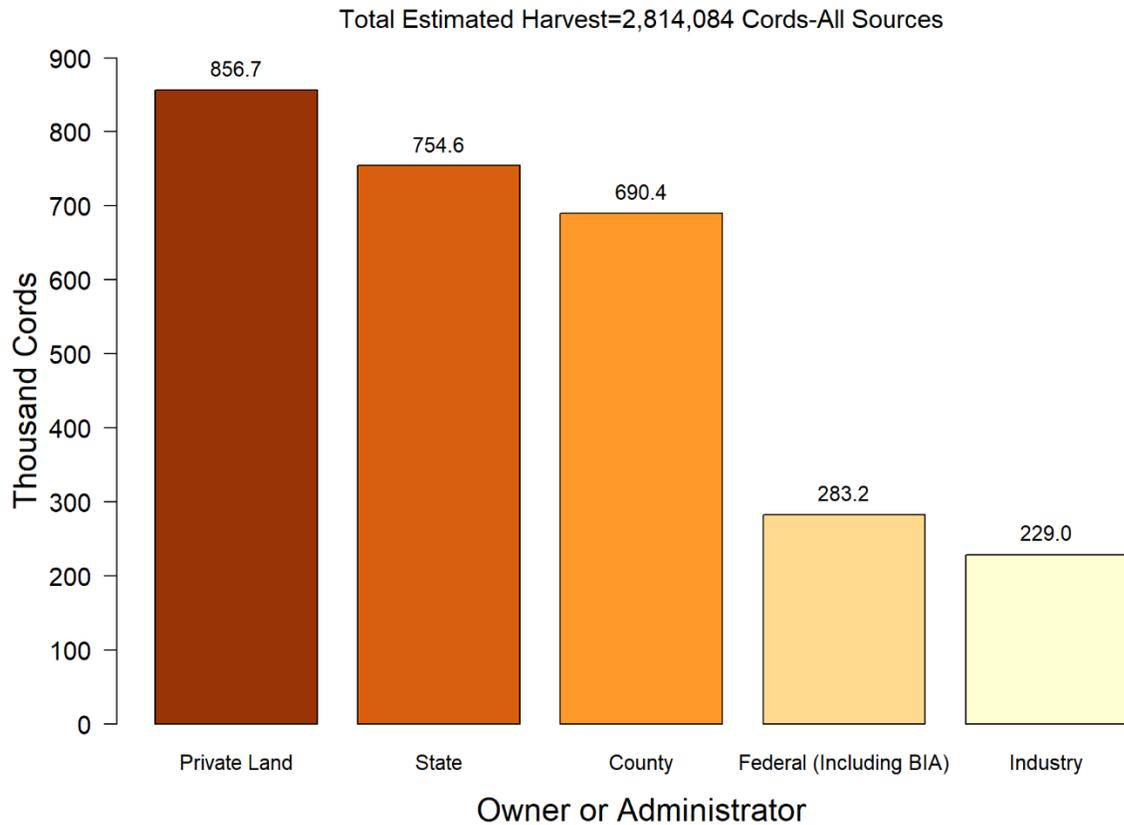
Sources:

- **State Lands**: Calendar year 2018 Harvest, DNR Timber sales scaled.
- **Federal:** Fiscal year 2018 harvest, Superior National Forest Timber Statistics, and Chippewa National Forest
- **Timber Statistics:** Bureau of Indian Affairs (BIA), Public Stumpage Price Review 2018 sold.
- **County Lands:** Public Stumpage Price Review 2018 sold.
- **Industry Lands:** Minnesota Forest Industries survey of 2018 harvested volume. Molpus Woodlands Group (formerly Forest Capital Partners) timberlands included in industry totals.
- **Private Lands:** Calculated from total estimated harvest in 2018 minus state, county, national forest and BIA volume harvested, minus estimated industry volume harvested. Total harvest was down overall in 2018. State and counties produced the majority of public timber volume.

May not sum due to rounding

FIGURE 4-4: MINNESOTA IMPORTS AND EXPORTS OF PULPWOOD AND ROUNDWOOD

Minnesota Imports and Exports of Pulpwood Roundwood
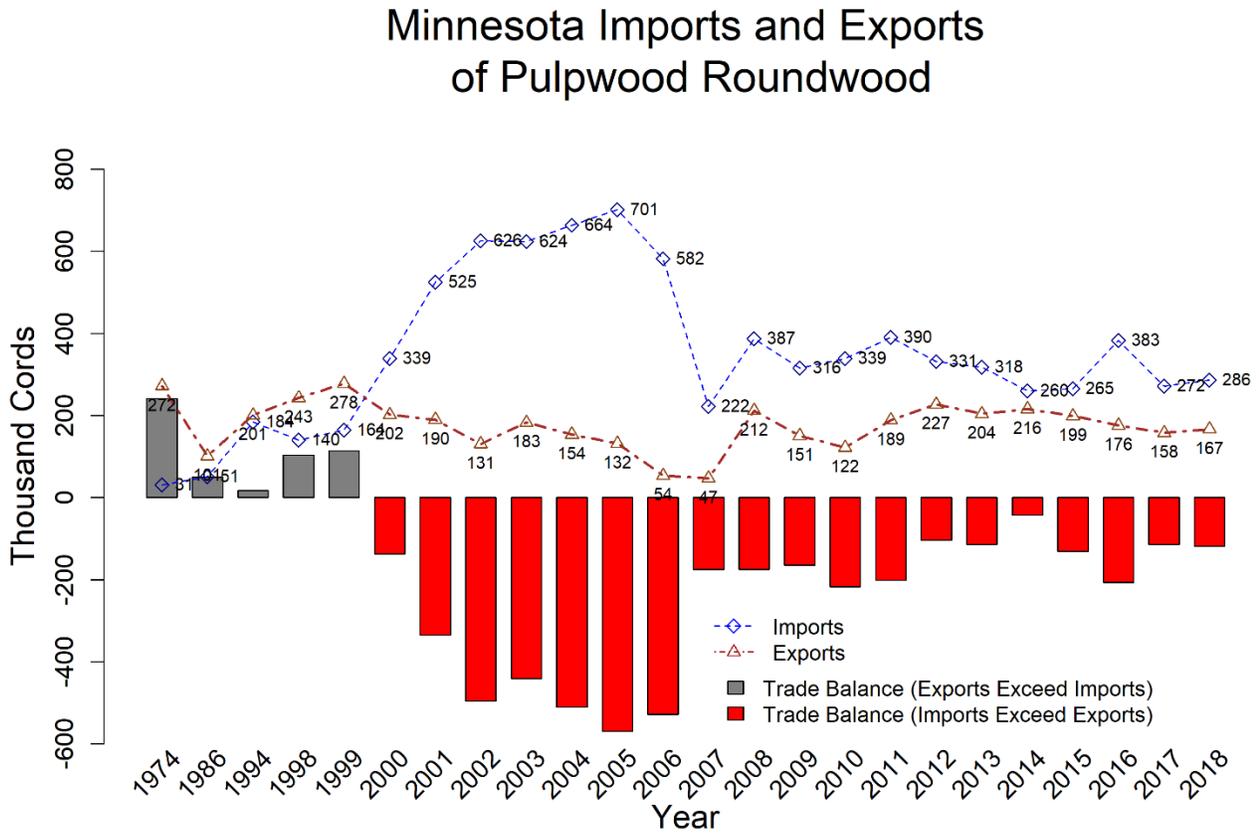
Source:
U.S. Forest Service Northern Research Station Timber Product Output survey of industrial wood-using industry.

Estimated Fiber Use From MN Timber Harvest by Primary Industry Sector 2018

Total Est. Harvest 2.81 Million Cords

Pulp & Paper, 1,603,209, 57%

OSB & Engineered, 480,203, 17%

Lumber & Specialty (Exports Included), 606,356, 22%

Wood Energy, 124,316, 4%
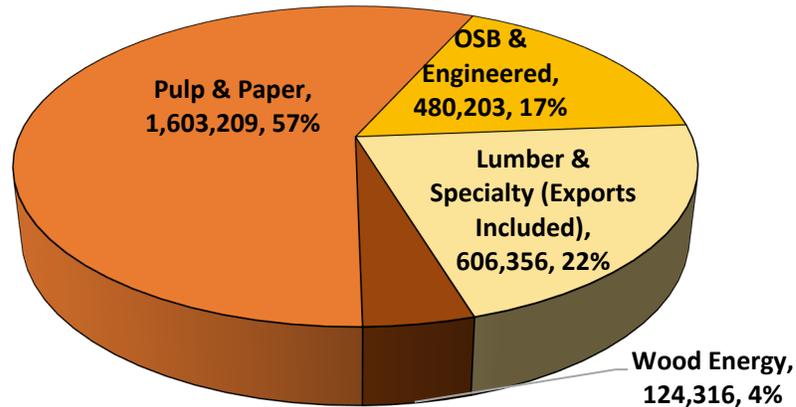
Source: Wood use data from Timber Product Output mill and fuelwood surveys conducted by U.S. Forest Service Northern Research Station and Minnesota DNR. Specialty products include veneer, posts and poles, shavings, and landscape chips. Includes residential fuelwood in the Wood Energy Sector.

FIGURE 4-6: TRENDS IN UTILIZATION BY SECTOR

Trends in Utilization by Sector (Local Regression)

Legend: Lumber & Specialty · OSB · Pulp & Paper · Wood Energy
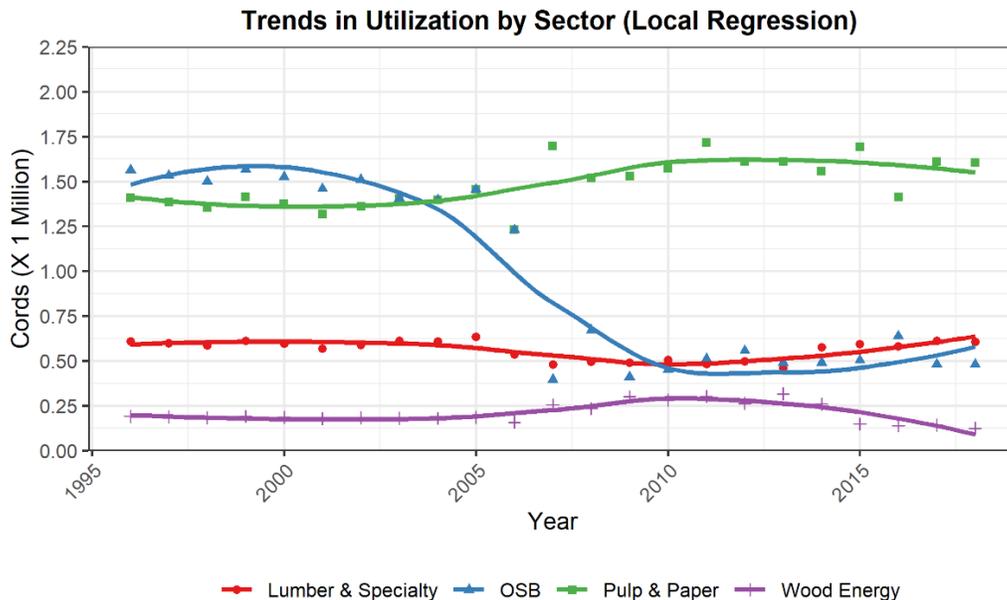
Source: Wood use data from mill Timber Product Output surveys and fuelwood surveys conducted by the U.S. Forest Service, Northern Research Station and Minnesota DNR. Specialty products include veneer, posts and poles, shavings, and landscape chips. Wood energy only includes commercial wood fuels. Trends fit using a local regression model.

Total Fiber Harvest from Minnesota Timberlands Utilized by Pulpwood Mills (1965-2018)
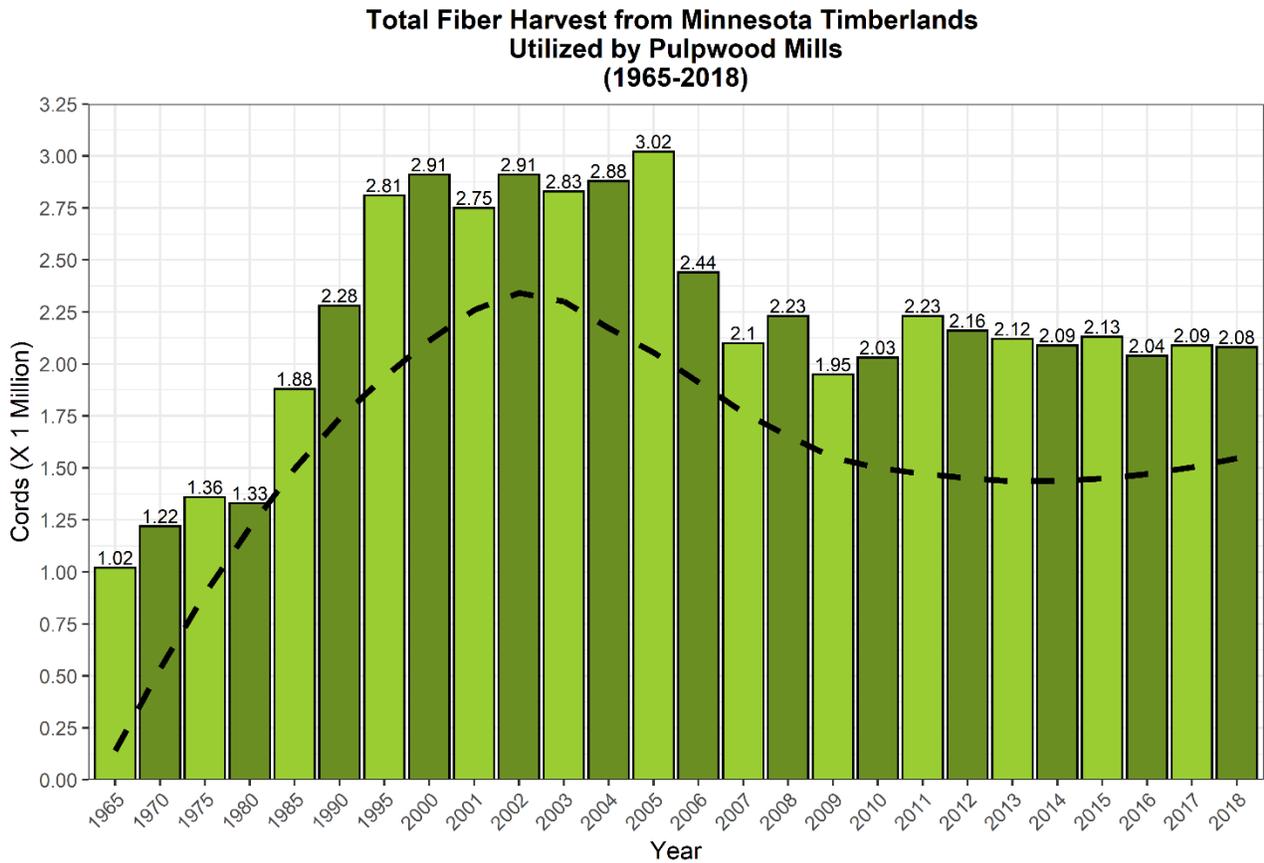
Source: U.S. Forest Service Northern Research Station Timber Product Output survey (includes roundwood and residues). DRAFT 2018. Dotted line represents the trend in pulpwood utilization using a local regression.

Pulpwood utilization includes the pulp and paper mills and engineered wood manufacturers. Limitations on specific species use, lack of additional private timberland harvests, and an increase in imports were key reasons for leveled-off harvests in the early to mid-2000s. Most imported pulpwood was aspen and maple from Wisconsin and Canada. The amount of pulpwood utilized has continued to decline overall in 2018, relative to peak use in 2005.

Volume Harvested from MN Timberland & Utilized by Sawmills & Speciality Mills

Total Volume: 2007: 248 MMBF; 2010: 248 MMBF; 2014: 281 MMBF; 2017: 284 MMBF; 2018: 326 MMBF; 2019: 303 MMBF
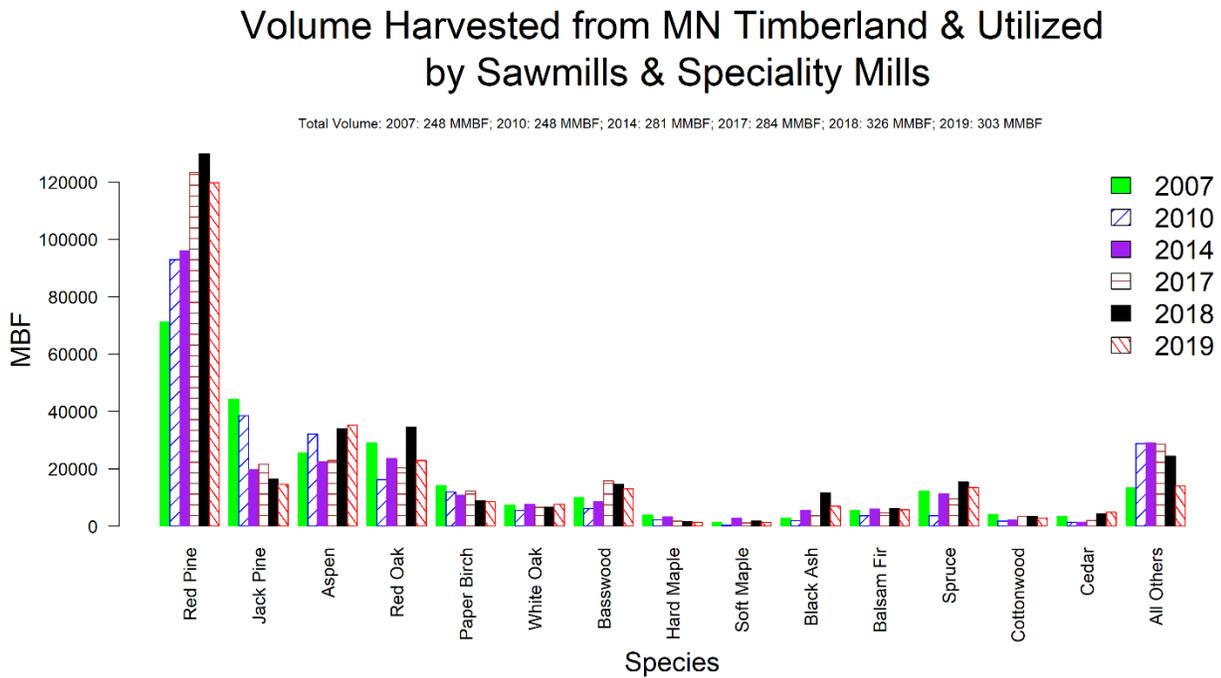
Source: Minnesota DNR and U.S. Forest Service Northern Research Station (DRAFT 2019) sawmill and specialty mill Timber Product Output surveys.

Sawtimber is often the highest value wood product that meets merchantability requirements. Merchantable sawlogs must measure at least 8 feet in length and 8 inches in dimeter inside bark at the small end. However, an increasing number of sawmills can use smaller diameter material profitably. After dropping between 2001 and 2010, sawmill capacity is increasing. Relative to 2018, sawmills increased their use of aspen, but slightly decreased use of red pine and red oak. Red pine has continued to make up the majority of board feet in use by sawmills.

Chapter 5 Wood Supply and Demand Information for Important Cover Types and Species

Forest resource and harvest level information for Minnesota's most significant cover types and tree species.

Aspen/Balm of Gilead

Aspen is a relatively short-lived, fast growing tree species that requires nearly full sunlight to regenerate. Aspen is by far the predominant cover type and species in Minnesota's forests. It is also the species of greatest industrial use by a wide margin. The aspen resource is why the engineered wood manufacturers are located here. Aspen is also an important resource for the pulp and paper sector and the solid wood industrial segment. Many of Minnesota's largest mills are specifically designed to use aspen–it ideally fits the products they make and their manufacturing processes.

The aspen cover type consists of a wide mixture of species. Predominant secondary species include balsam fir, paper birch, and oak. Aspen is also a significant component in many other upland cover types.

FIGURE 5-1: ASPEN—VOLUME ON TIMBERLANDS BY SPECIES, FIA 2019
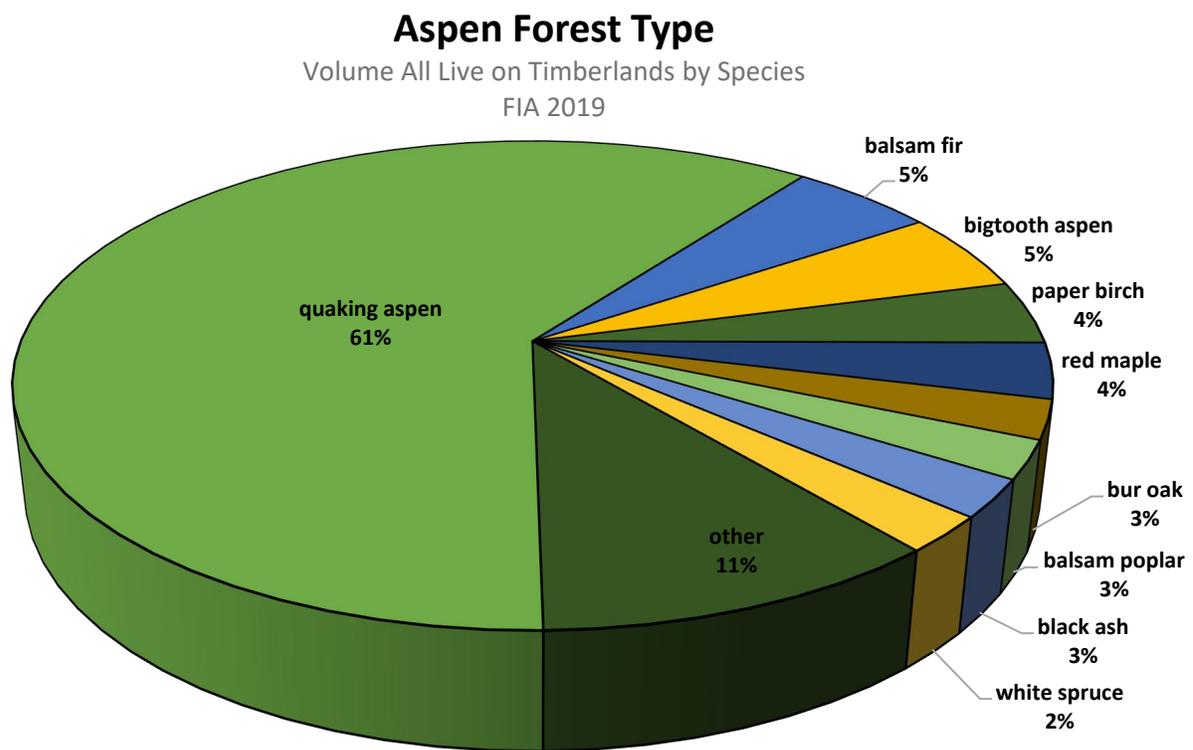
Aspen Forest Type
Volume All Live on Timberlands by Species
FIA 2019

- quaking aspen 61%
- balsam fir 5%
- bigtooth aspen 5%
- paper birch 4%
- red maple 4%
- bur oak 3%
- balsam poplar 3%
- black ash 3%
- white spruce 2%
- other 11%

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Aspen and Balm Forest Types
Timberland Acres by Owner & Age Class FIA 2019
Total Timberland Acres in Forest Type: 5,108,789
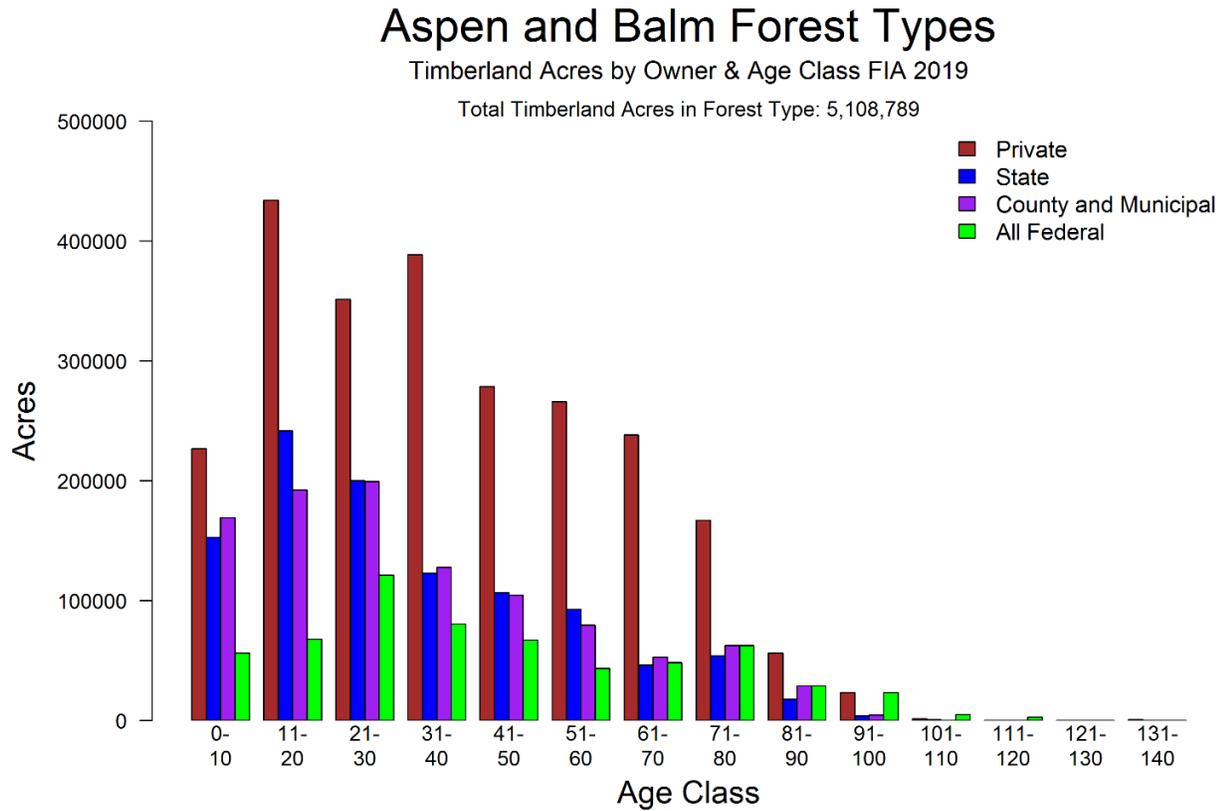
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Most aspen is found on private lands. The 2019 FIA inventory indicates divergence in age class distribution between ownerships. Federal lands skew toward older age classes compared to other ownerships. State and county administered lands display similar age class distributions, likely stemming from similar management.
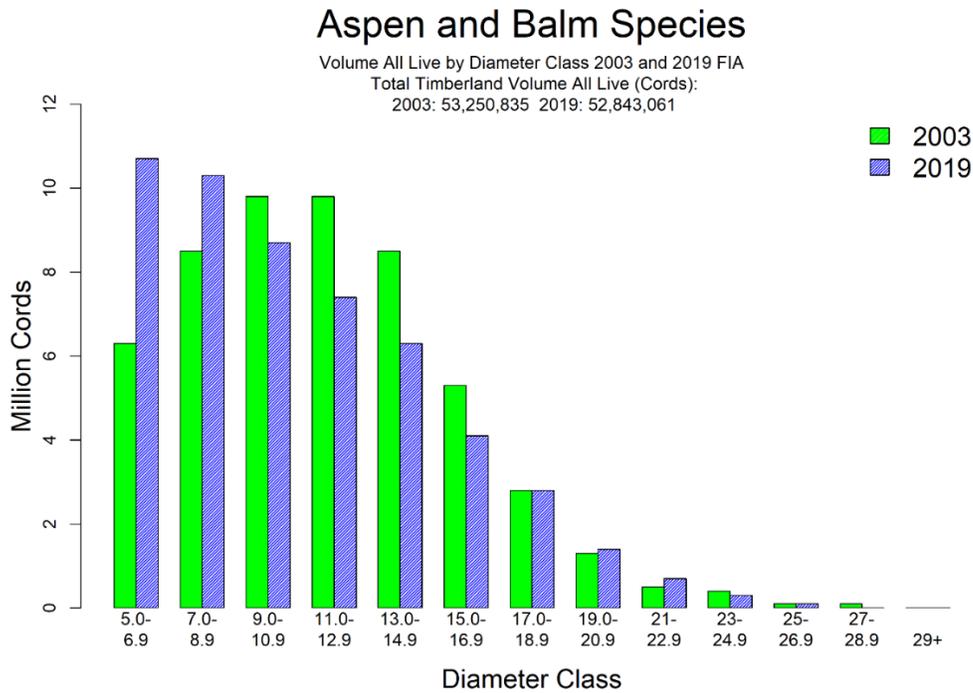
Source: FIA 2019 database provided by U.S. Forest Service Northern Research Station

FIGURE 5-4: ASPEN (COVER-TYPE) NET GROWTH AS PERCENT OF GROWING STOCK VOLUME IN MINNESOTA (2008-2019)
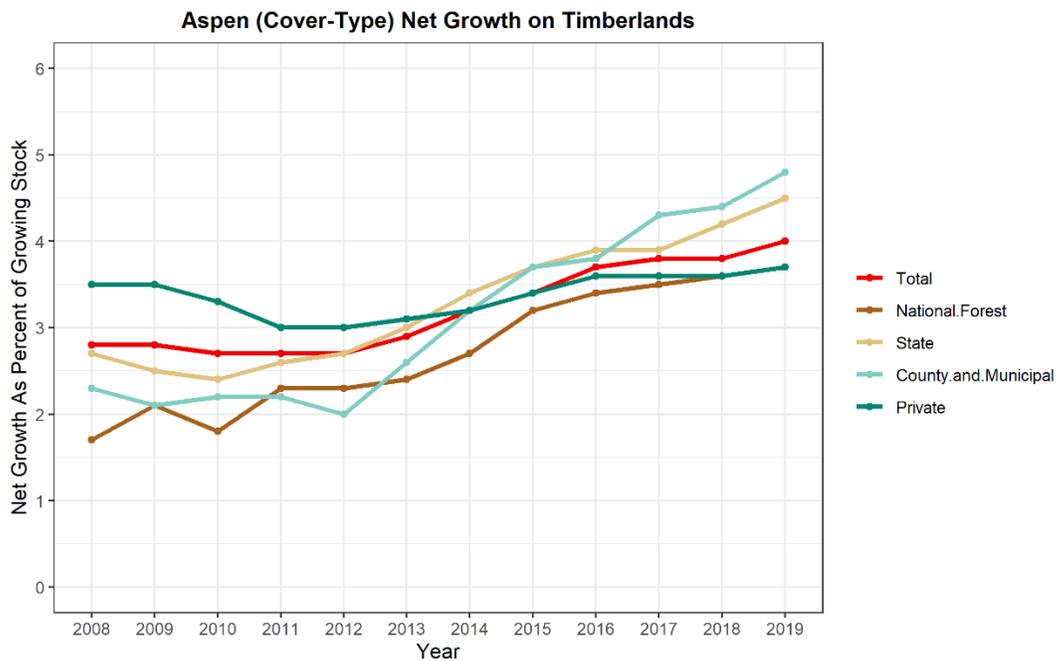
Source: FIA 2019 database provided by U.S. Forest Service Northern Research Station.

Net growth is the result subtracting mortality and non-harvest removals from gross growth. It is estimated from volume change on FIA-remeasured plots. Percent is calculated by dividing by current inventory and multiplying by 100, which allows for comparison between ownerships.

Total FIA aspen and balsam poplar ("balm") volume has decreased since 2003 as significant acreages have been harvested and managed. For at least the next 10 years, more of the available aspen is likely to be found in stands that are smaller diameter than past harvests, which may or may not effect volume per acre and efficiencies for loggers and mills.

FIGURE 5-5: TOTAL ASPEN AND BALM-OF GILEAD HARVEST FROM MINNESOTA TIMBERLANDS (1994-2018)
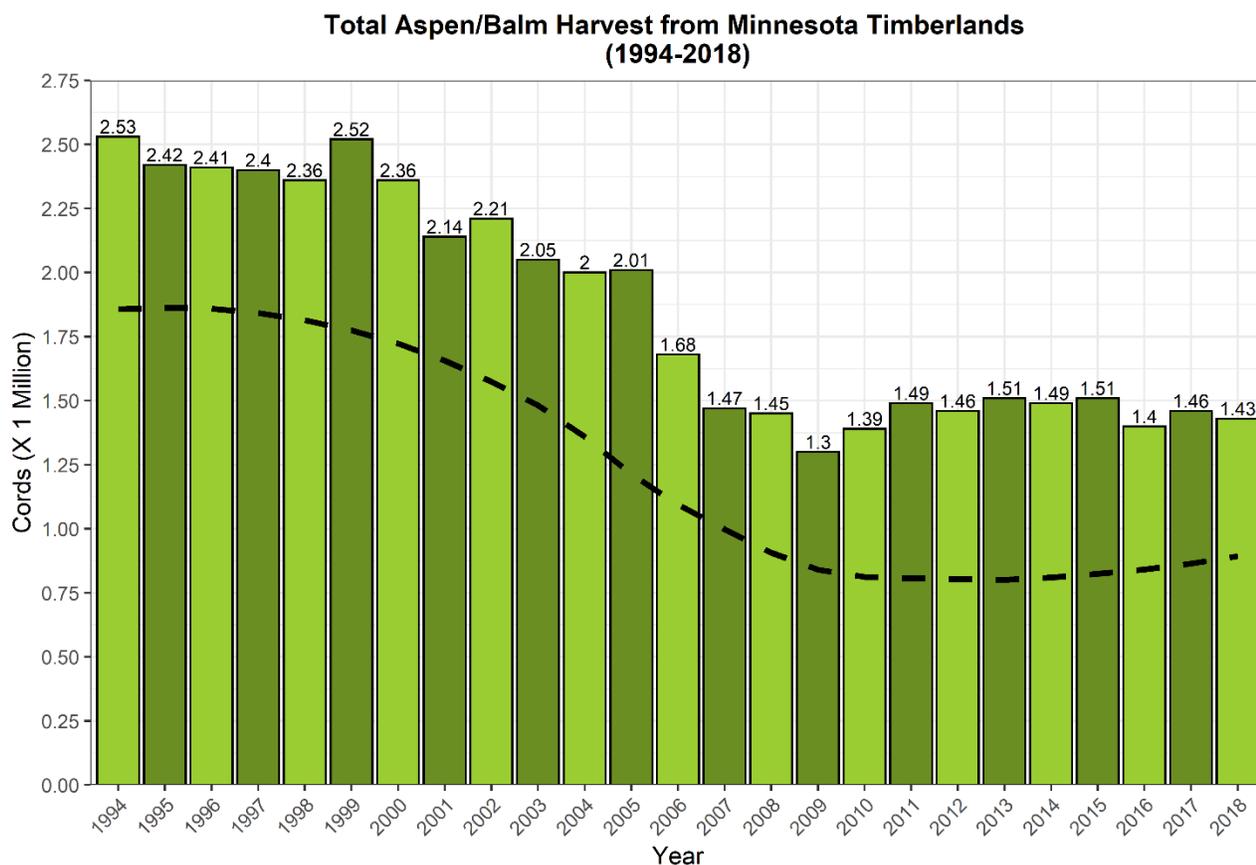
Total Aspen/Balm Harvest from Minnesota Timberlands (1994-2018)

Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Dotted black line shows relative trend for reference.

Annual long-term allowable harvest equals 2.358 million cords based on Table C-20 UPM-Thunderhawk DEIS average of high aspen A and B scenarios, 40-year planning horizon.
Based on the 2019 U.S. Forest Service FIA database.
Estimated average net annual growth of aspen and balm growing stock: 2,015,279 cords
Estimated average annual mortality of aspen and balm growing stock 1,315,959 cords.
Estimates are for timberland.

Several factors caused the reduction in aspen and balm harvest from its peak in 1994, including:

- Reductions in harvests from private timberlands.
- Closure of several large mills.
- Permanent paper machine shutdown.
- Substitution of alternative species by most large mills.

Current Demand for Aspen/Balm of Gilead from Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	1,310,224
2018 Pulpwood Export (To Canada and Wisconsin)	40,495
2019 Sawlogs (with est. Exports) and Other (DRAFT)	72,254
2019 Fuelwood (from live trees on timberland)	12,734
Total harvest	**1,435,707**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT, The amount utilized by industry is higher because of imports from Wisconsin and Canada

Resource Opportunities

- The reduction in aspen harvest levels has resulted in a situation where current harvest levels are below long-term sustainable levels.
- Many acres of aspen and balsam poplar forest-type on private land are at typical rotation ages (40-60) years.

Resource Issues

- Aspen-birch decline continues. These stands should be harvested to avoid additional volume losses due to top kill and mortality.
- A great deal of the resource is in private hands. Managing it may require more private landowner incentives and assistance.
- Parts of northeastern Minnesota are under gypsy moth quarantine. Loggers and mills should contact the Minnesota Department of Agriculture to learn about compliance agreements.

Table 5-1 shows average percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top diameter) by percent of basal area per acre of aspen (quaking, bigtooth) <u>ON FIA PLOTS</u>. This table shows that aspen forest types can differ significantly and shows other species that can be harvested within these forest types. This is FIA aspen and balm forest types. Acres statewide provides some idea of the relative nature of different percent species compositions within a particular forest type. Only FIA plots age 20 and older were included.

TABLE 5-1: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (ASPEN) ON FIA PLOTS

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	**336,089**	**910,811**	**1,149,679**	**1,147,571**
Species				
Balsam Fir	12.8	8.1	3.6	1.1
Tamarack	1.4	0.2	0.2	0.1
White spruce	4.8	3.2	2.3	0.8
Black spruce	3.3	1.6	0.3	0.2
Pine (jack, red, white)	4.9	3.1	2.3	1.3
White cedar	2.6	1.3	0.3	0.1
Aspen (quaking, bigtooth)	43.1	55.9	69.8	88.2
Paper birch	8.8	5.7	3.6	1.2
Balsam poplar	2.2	2.8	3.4	1.9
Basswood	1.7	2.2	1.6	0.5
American elm	0.5	0.9	0.6	0.5
Maple	6.6	5.7	4.5	1.2
Ash	3.3	4.6	2.6	0.8
Oak	3.2	4.3	4.3	1.9
Other	0.9	0.4	0.5	0.1

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

Figure 5-6 shows the predicted spatial distribution of aspen and balm cubic foot volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

FIGURE 5-6: PREDICTED DISTRIBUTION OF ASPEN AND BALM-OF-GILEAD IN MINNESOTA
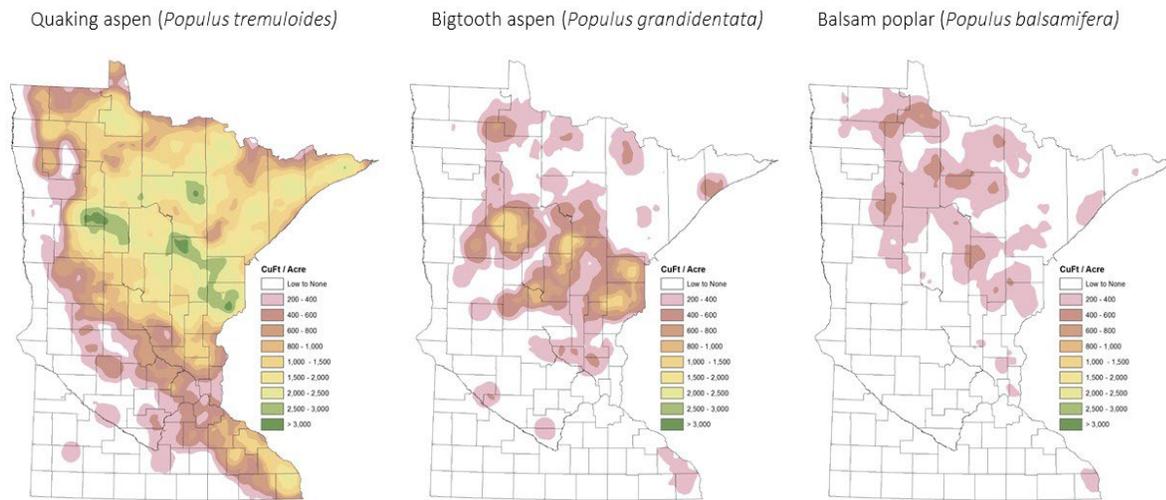
Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

Paper Birch

Paper birch is a relatively short-lived species that requires nearly full sunlight for regeneration. It can grow in nearly pure stands, or as a component in mixed stands. It comprises the large majority of the volume in the birch cover type, but it is also a significant component of several other upland cover types, including aspen.

FIGURE 5-7: BIRCH FOREST TYPES—TIMBERLAND ACRES BY OWNER AND AGE CLASS, FIA 2019

Birch Forest Types
Timberland Acres by Owner & Age Class FIA 2019

Total Acres in Forest Type: 719,428

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Paper Birch Species
Volume All Live by Diameter Class 2003 and 2019 FIA
Total Timberland Volume All Live (Cords):
2003: 15,091,936 2019: 11,548,550
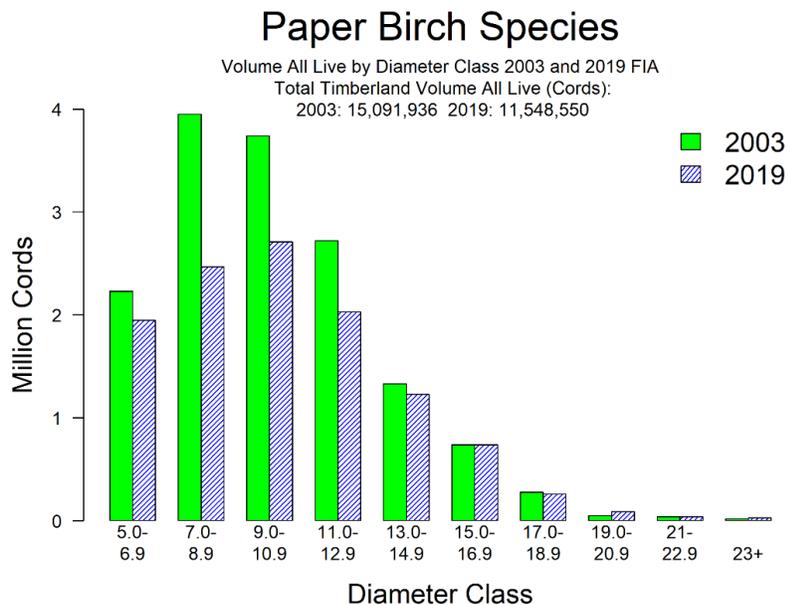
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Total volume of paper birch has declined since 2003 because of serious mortality trends associated with age, bronze birch borer and stress caused by periodic drought and increased number and severity of weather events.

FIGURE 5-9: PAPER BIRCH NET GROWTH AS PERCENT OF GROWING STOCK VOLUME
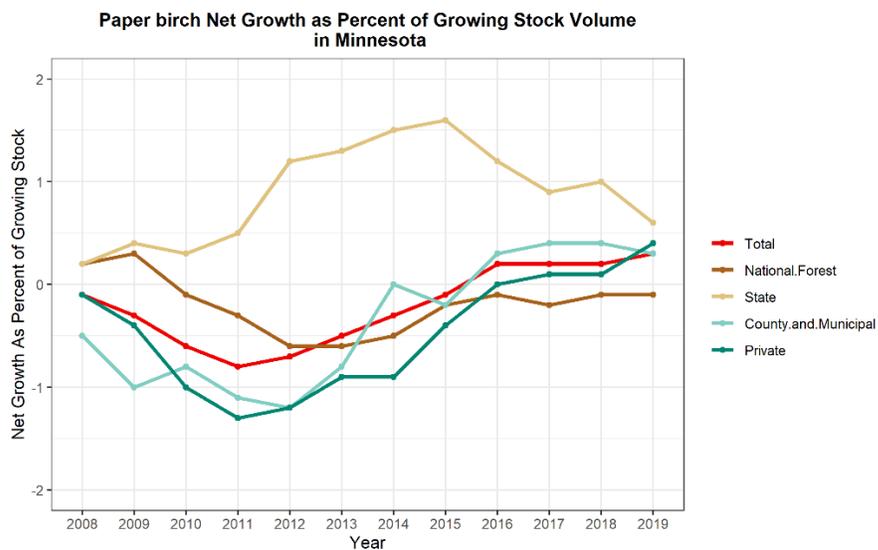
Paper birch Net Growth as Percent of Growing Stock Volume
in Minnesota

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth is the result subtracting mortality and non-harvest removals from gross growth. It is estimated from volume change on FIA remeasured plots. It is turned into a percent by dividing by current inventory and multiplying by 100 to compare ownerships.

56
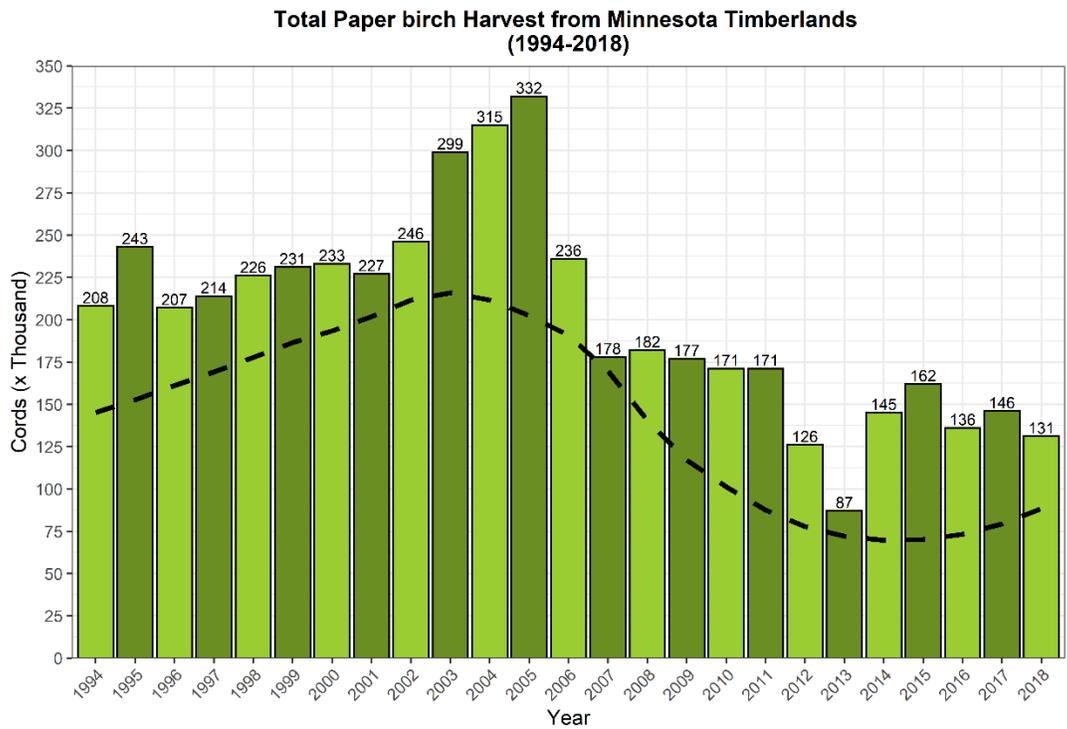
Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Dotted black line shows relative trend for reference...

Minnesota DNR estimated long-term annual sustainable harvest level: 371,500 cords/year.
Estimated average net annual growth of paper birch growing stock: 40,493 cords
Estimated average annual mortality of birch growing stock: 326,643 cords based on 2019 FIA data.

Current Demand for Birch From Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	72,141
2018 Pulpwood Export (To Wisconsin)	30,019
2019 Sawlogs and Other (draft survey)	18,570
2019 Fuelwood (from growing stock)	11,189
Total harvest	**131,920**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

Resource Opportunities

- Birch harvest is well below long-term sustainable levels.

- Birch in northeastern Minnesota is "fleck-free" (fleck is a common appearance defect in birch), so larger, high-quality stems are a fit for veneer markets.
- Birch decline is prevalent in certain regions of the state, most of which were newly declining areas relative to the previous year. These stands should be harvested to avoid additional volume losses due to top kill and mortality.

Resource Issues

- There is a need to improve the consistent regeneration of birch stands.
- Wood quality can be highly variable from high-value to significant rot in some older birch.
- There is a major age class imbalance, with significant volumes of older birch.
- Birch volume is declining due to mortality from age, drought, bronze birch borer and *Armillaria* root disease.
- Parts of northeast Minnesota are under gypsy moth quarantine. Loggers and mills should contact Minnesota Department of Agriculture to learn about compliance agreements.

Table 5-2 shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top diameter) by percent of basal area per acre that is paper birch ON FIA PLOTS. This table shows that a birch forest type can differ significantly and provides some idea of what other species can be harvested within these forest types. This FIA birch forest type acres statewide provides some idea of the relative nature of different percent species compositions within a particular forest type. Only FIA plots age 20 and older were included.

TABLE 5-2: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (PAPER BIRCH) ON FIA PLOTS

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	178,103	322,631	137,657	41,081
Species				
Balsam Fir	14.0	10.3	4.1	1.2
Tamarack	0.9	0.8	0.1	0.4
White spruce	6.8	6.3	5.3	3.7
Black spruce	1.4	2.5	2.0	0.0
Pine (jack, red, white)	3.9	3.7	3.3	1.6
White cedar	5.8	3.8	1.6	0.0
Aspen (quaking, bigtooth)	12.2	14.3	12.0	9.4
Paper birch	31.9	43.3	63.3	74.5
Balsam poplar	1.8	0.5	0.4	0.2
Basswood	0.9	1.4	0.3	0.0
American elm	0.2	0.5	0.2	0.5
Maple	10.4	7.1	4.4	2.1
Ash	6.2	2.7	0.5	0.5
Oak	1.8	2.4	2.3	5.7
Other	1.8	0.3	0.1	0.0

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

Figure 5-11 shows predicted spatial distribution of paper birch CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

FIGURE 5-11: PREDICTED DISTRIBUTION OF PAPER BIRCH IN MINNESOTA

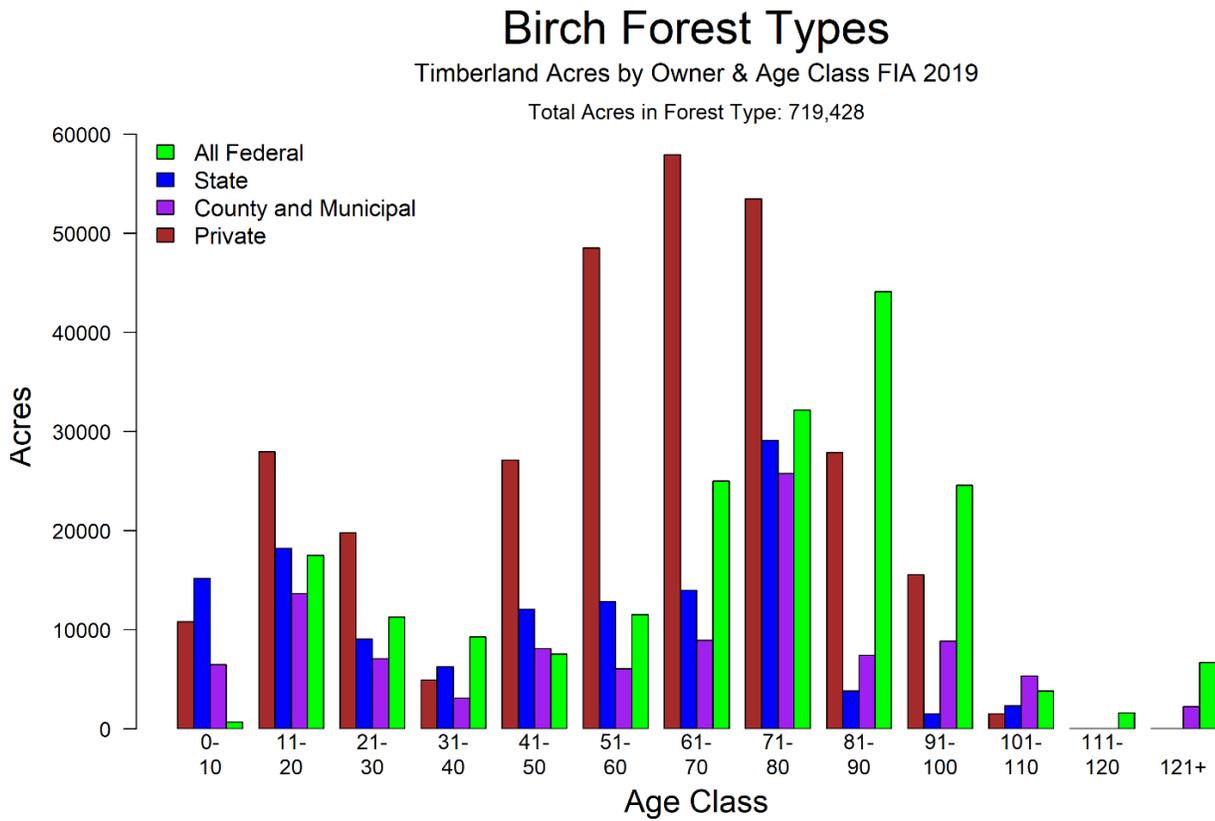Paper birch (*Betula papyrifera*)
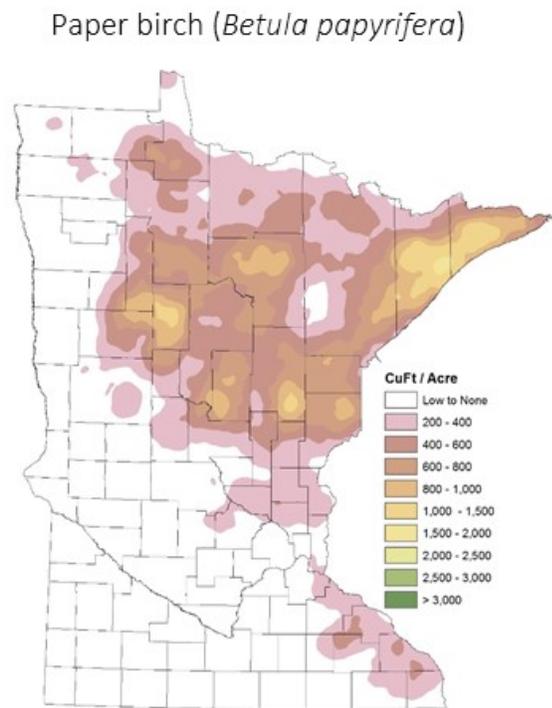
Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

Balsam Fir

Based on 2019 FIA data, the estimated average net annual growth of balsam fir growing stock is 239,495 cords. The estimated average annual mortality of balsam fir growing stock is 357,334 cords.

Balsam fir industrial use is similar to that of spruce. Industry uses it to make high quality paper prized for excellent fiber qualities. Some is also used by the sawmill industry, mostly in making studs but also in small quantities for other types of lumber.

Spruce-fir estimated annual sustainable harvest level 705,500 cords/year based on Table C-20 UPM-Thunderhawk DEIS, average of high aspen A and B scenarios over a 40-year planning horizon.

FIGURE 5-12: ESTIMATED ANNUAL SUSTAINABLE HARVEST OF SPRUCE-FIR IN MINNESOTA
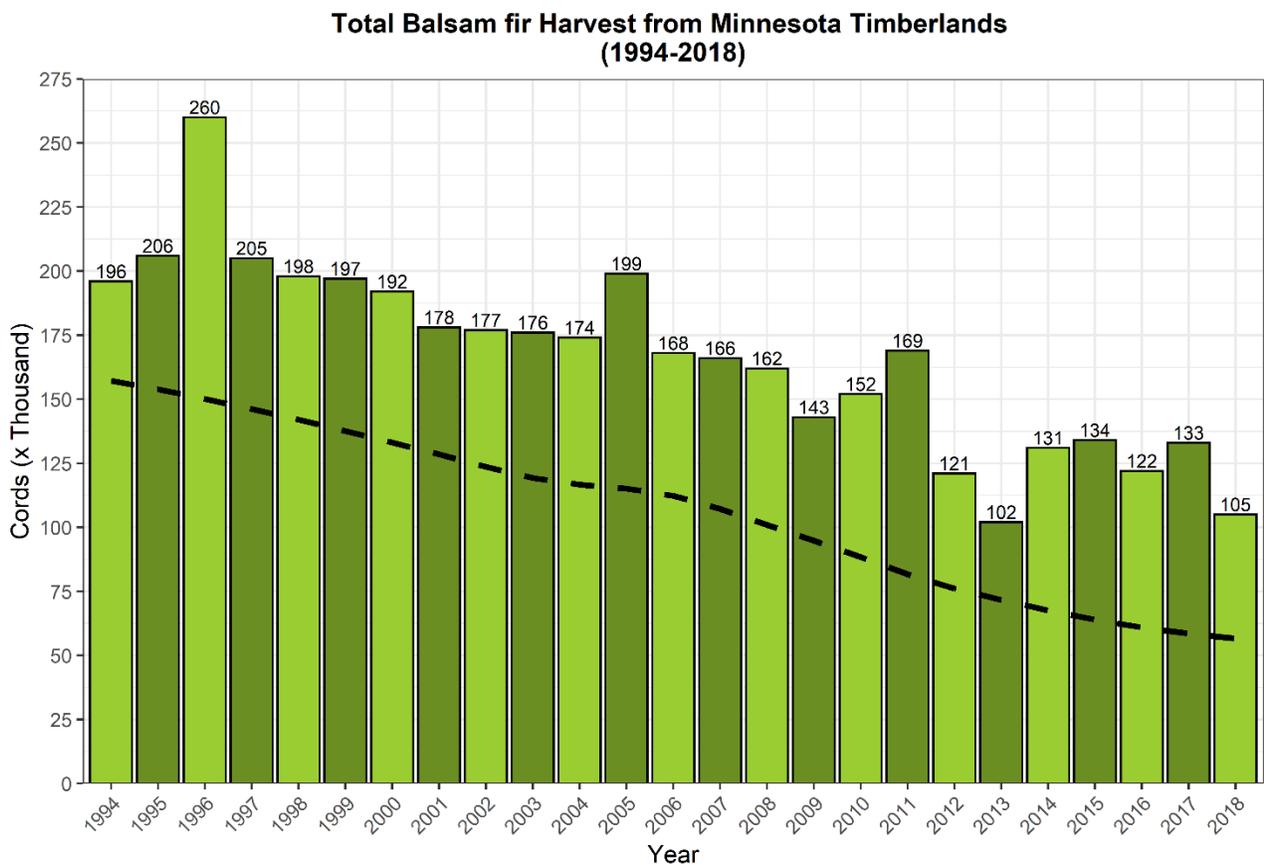
Total Balsam fir Harvest from Minnesota Timberlands
(1994-2018)

Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Dotted black line shows relative trend for reference.

Current Demand for Balsam Fir from Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	91,750
2018 Pulpwood Export (To Wisconsin)	---
2019 Sawlogs and Other	11,562
2019 Fuelwood (from growing stock)	1,968
Total harvest	**105,280**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

Resource Opportunities

- 2011 harvest was 168,600 cords, reduced to 101,900 cords in 2013 and has only increased slightly to 105,280 cords in 2018.
- High-quality balsam fir has excellent qualities for pulp and paper and stud manufacture.
- Pre-salvage and salvage operations of fir and white spruce should be occurring now, primarily in western Lake and eastern St. Louis counties, since spruce budworm populations have affected spruce/fir forests there for several years.

Resource Issues

- Balsam availability depends on harvest of aspen (39% of balsam fir grows in the aspen-balm of Gilead forest type).
- Balsam fir stands older than 45 years are susceptible to mortality from repeated outbreaks of spruce budworm. Landscapes that have ample forests with high percentages of older balsam fir promote and sustain periodic spruce budworm outbreaks.
- There is an age class imbalance.
- Older stands have rot. High rot levels have a major impact on stand merchantability, and therefore ability to manage these stands. Rot is undesirable for higher-value wood products.
- Parts of northeastern Minnesota are under gypsy moth quarantine. Loggers and mills should contact Minnesota Department of Agriculture to learn about compliance agreements.

FIGURE 5-13: BALSAM FIR TIMBERLAND ACRES BY OWNER AND AGE CLASS, FIA 2019

Balsam Fir Forest Type
Timberland Acres by Owner & Age Class FIA 2019
Total Acres in Forest Type: 418,515

Legend: All Federal, State, County and Municipal, Private

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

The cover type is dominated by stands at and above 40 years, making this a relatively old resource for such a short-lived species. Recommended rotation ages can vary with stand productivity and site condition, with 50 years a common average (stands managed as extended rotations are carried beyond this age).

FIGURE 5-14: BALSAM FIR VOLUME BY DIAMETER CLASS, 2003 AND 2019 FIA

Balsam Fir Species
Volume All Live by Diameter Class 2003 and 2019 FIA
Total Volume All Live (Cords):
2003: 8,191,218 2019: 8,926,543

Legend: 2003, 2019

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth, is the result subtracting mortality and non-harvest removals from gross growth, it is estimated from volume change on FIA measured plots. It is turned into a percent by dividing by current inventory and multiplying by 100 to compare between ownerships.

Much of the balsam fir volume in Minnesota (roughly 51%) is found mixed in with the aspen/balm and birch cover types, and is therefore tied to aspen and birch harvest. Total balsam fir volume has increased slightly since 2003.

Table 5-3 shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top DOB) by percent of basal area per acre that is balsam fir ON FIA PLOTS. This table shows that a balsam fir forest type can differ significantly and provides some idea of what other species can be harvested within these forest types. This is FIA Balsam Fir Forest Type. Acres statewide provide some idea of the relative nature of different percent species compositions within a particular forest type. Only FIA plots age 20 and older were included.

TABLE 5-3: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (PAPER BIRCH) ON FIA PLOTS

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	**36,001**	**141,937**	**193,596**	**66,423**
Species				
Balsam Fir	9.7	21.0	38.2	60.0
Tamarack	11.4	1.5	2.4	`1.2
White spruce	4.1	12.6	6.4	4.2
Black spruce	35.3	15.9	8.5	5.1
Pine (jack, red, white)	9.4	8.5	10.1	8.0
White cedar	10.7	13.3	5.7	4.5
Aspen (quaking, bigtooth)	3.8	8.6	13.7	4.3
Paper birch	9.0	7.4	8.6	11.7
Balsam poplar	0.0	1.4	0.7	0.5
Basswood	0.0	0.0	0.0	0.0
American elm	0.0	0.3	0.5	0.0
Maple	0.0	2.5	2.9	0.3
Ash	5.6	6.0	1.3	0.2
Oak	1.0	0.8	0.5	0.0
Other	0.0	0.2	0.6	0.1

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

Figure 5-16 shows the predicted spatial distribution of balsam fir CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

FIGURE 5-16: PREDICTED DISTRIBUTION OF BALSAM FIR IN MINNESOTA
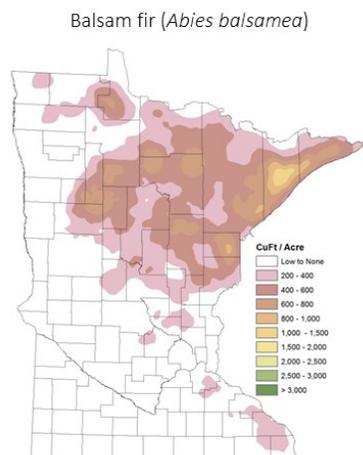
Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

Spruce (Black, White)

Spruce-fir estimated annual sustainable harvest level 705,500 cords per year based on Table C-20 UPM-Thunderhawk DEIS, average of high aspen A and B scenarios, 40-year planning horizon. Based on the 2019 FIA database, the estimated average net annual growth of spruce (black and white) growing stock is 355,891 cords and the estimated average annual mortality of spruce (black and white) growing stock is 241,907 cords.

FIGURE 5-17: TOTAL SPRUCE HARVEST FROM MINNESOTA TIMBERLANDS
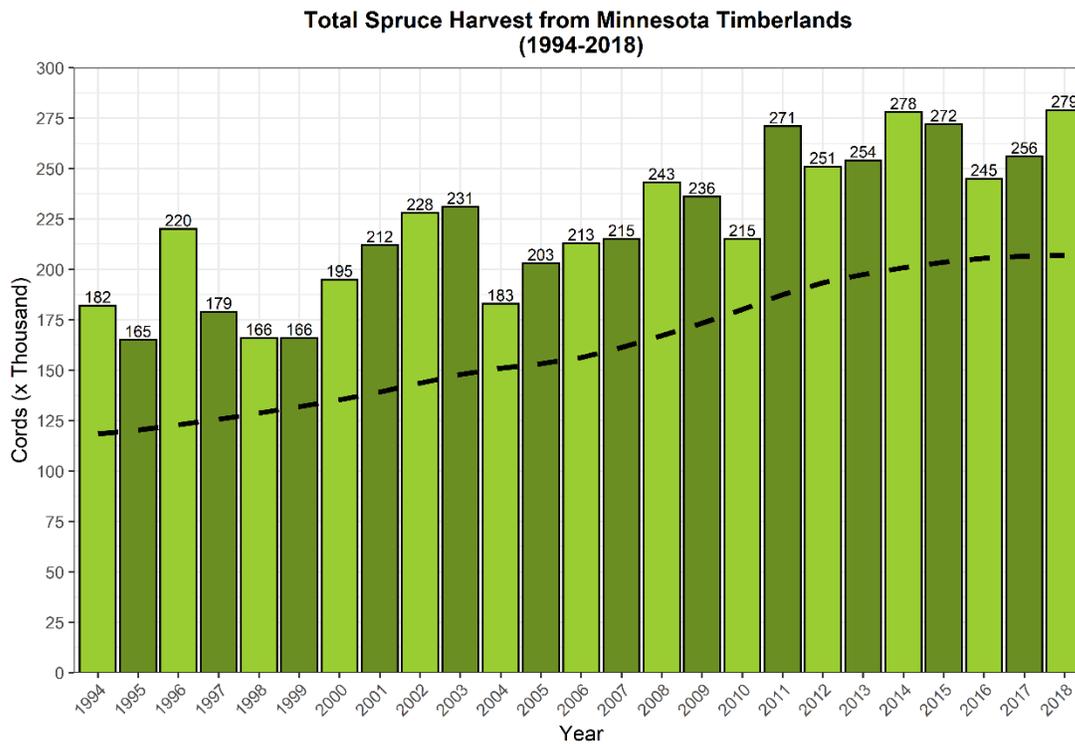
Total Spruce Harvest from Minnesota Timberlands (1994-2018)

Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Dotted black line shows relative trend for reference.

Current Demand for Spruce From Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	198,406
2018 Pulpwood Export (To Wisconsin)	51,755
2019 Sawlogs (with est. Exports) and Fuelwood *draft survey*	29,219
Total harvest	**279,379**

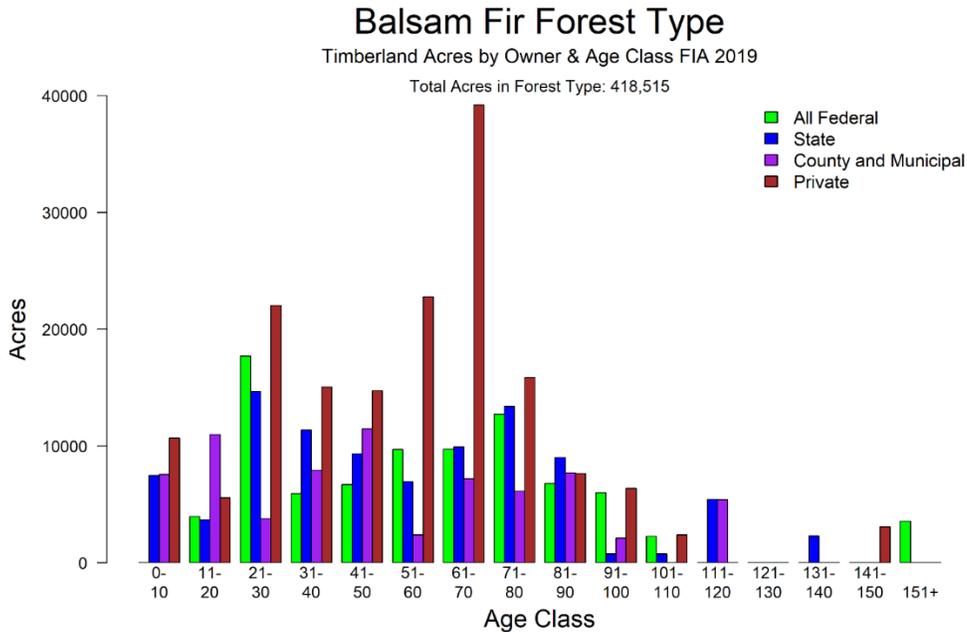**Source:** U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

Resource Opportunities

- High-quality spruce has excellent properties for pulp and paper and stud manufacture. Along with our balsam fir resource, it is the major reason several pulp and paper originally located in Minnesota.
- Increasing opportunities for thinning white spruce plantations, as stands move into merchantable size classes. Thinning normally yields excellent quality pulp with little or no loss to rot or decay.
- Pre-salvage and salvage operations of fir and white spruce should be occurring now, primarily in western Lake and eastern St. Louis counties, since spruce budworm populations have affected spruce/fir forests there for years.

Resource Issues

- Many stands have very low volume per acre of spruce. Volume could influence the ability to manage some stands.
- Black spruce is normally found on lowland sites and is only accessible during frozen conditions.
- Spruce budworm has caused top kill and mortality on white spruce, including plantations. This impact can be lessened by management activities such as pre-outbreak thinning to maintain stand vigor and by discriminating against balsam fir in some mixed stands.
- Parts of northeastern Minnesota are under gypsy moth quarantine. Loggers and mills should contact Minnesota Department of Agriculture to learn about compliance agreements.
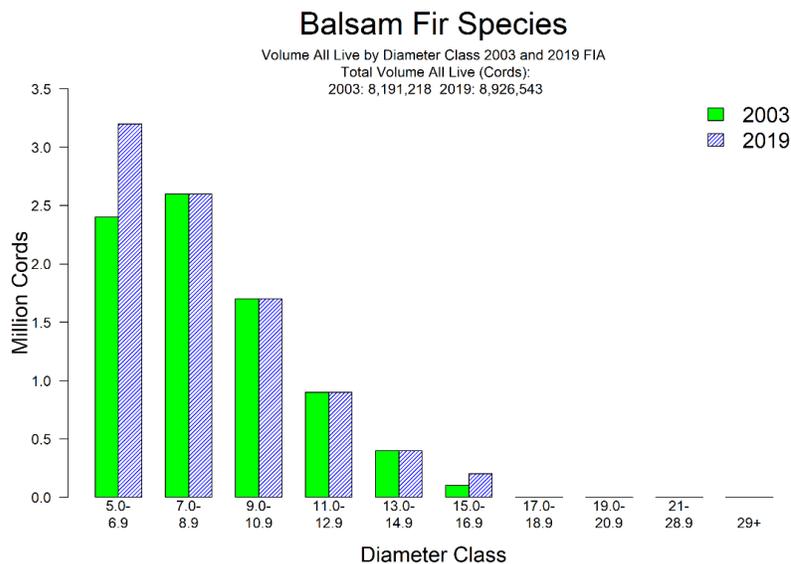- The incidence of eastern dwarf mistletoe in black spruce stands is significant statewide. In black spruce stands that are heavily infested, the disease will be difficult, if not impossible, to manage.

Black Spruce

FIGURE 5-18: BLACK SPRUCE TIMBERLAND ACRES BY OWNER AND AGE CLASS, 2019 FIA

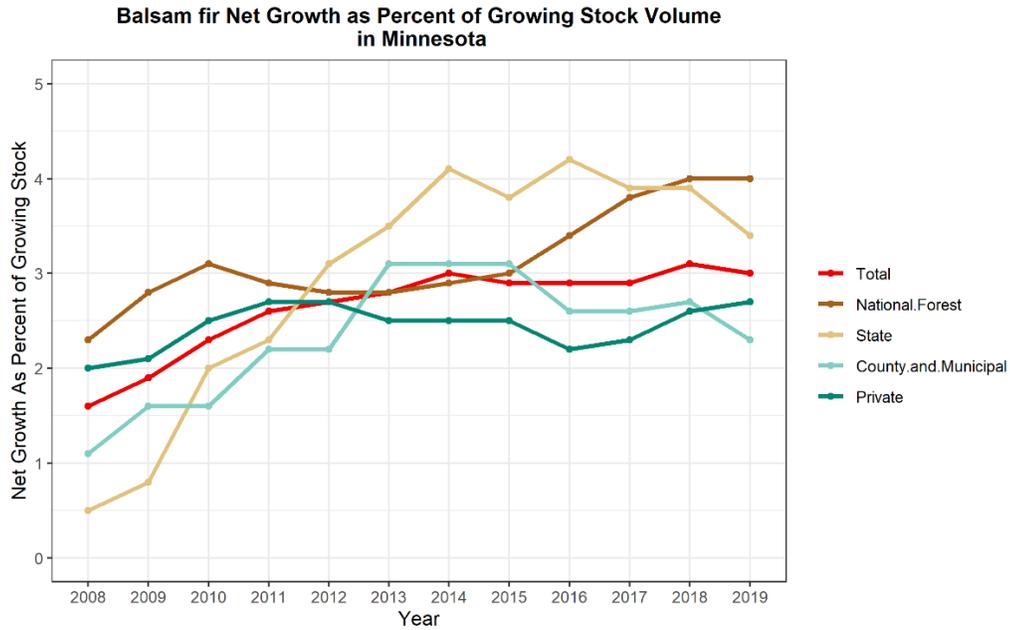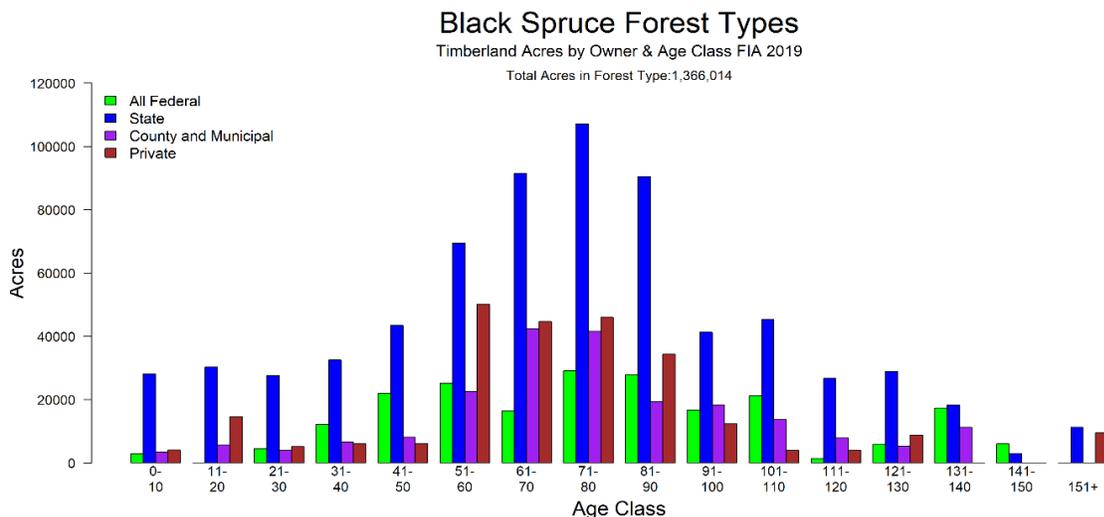**Source:** 2019 FIA database provided by U.S. Forest Service Northern Research Station

66

Black spruce cover type acreage is heavily weighted to ages 40 through 80, with a fair amount of acreage also above age 100. Recommended harvest or "rotation" ages can vary with site productivity and site condition between 50 and 120 years of age, with 80 to 100 years on average. Stands managed as "extended rotation" are carried beyond these ages. Black spruce exists largely on lowlands, often in nearly pure stands, or mixed with tamarack and/or white cedar and a variety of minor associated species.

The state of Minnesota is by far the largest owner of black spruce cover type acres, but counties, private owners, and our two national forests all have significant acreage.

The vast majority of spruce in Minnesota (over 93%) is used to make high quality paper, prized for its excellent fiber qualities. Some is also used by the sawmill industry, mostly in making studs but also in small quantities for other types of lumber.

FIGURE 5-19: BLACK SPRUCE VOLUME BY DIAMETER CLASS, 2003 AND 2019 FIA
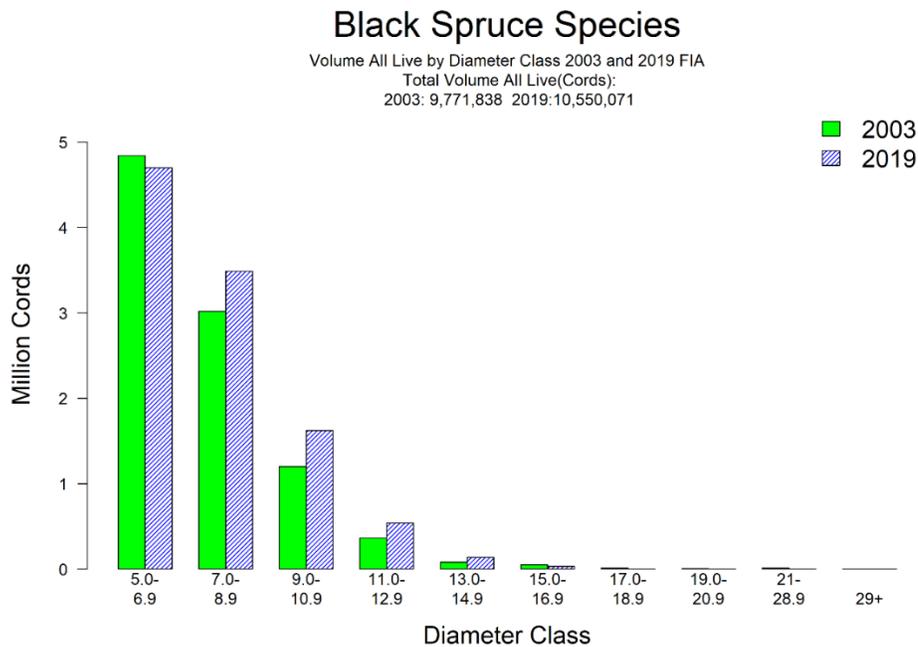
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station
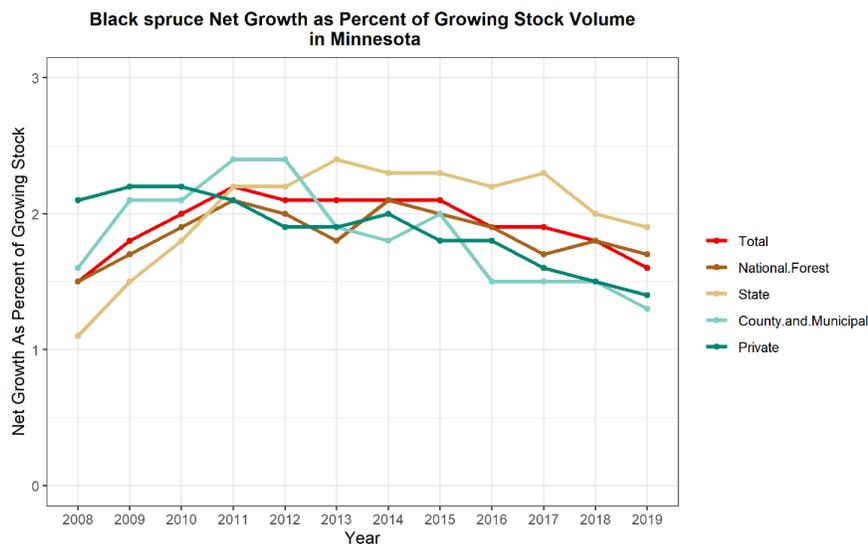
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth is the result subtracting mortality and non-harvest removals from gross growth; it is estimated from volume change on FIA measured plots. It is turned into a percent by dividing by current inventory and multiplying by 100 to compare between ownerships.

White Spruce

White spruce is a relatively young resource. The cover type is dominated by stands aged 50 years or less, many in the form of plantations. Many of these stands likely require a first (e.g. ages 25 to 40) or second thinning (e.g. ages 35-50). Recommended rotation ages can range from 40 to 90 years; depending on site productivity and condition, (some stands managed as extended rotation are held beyond these ages). White spruce is located most often on upland sites. In natural stands, it is commonly found mixed in as a component in aspen, birch, balsam fir, and all upland cover types. A great deal of white spruce volume exists as a component in mixed stands of other upland cover types.
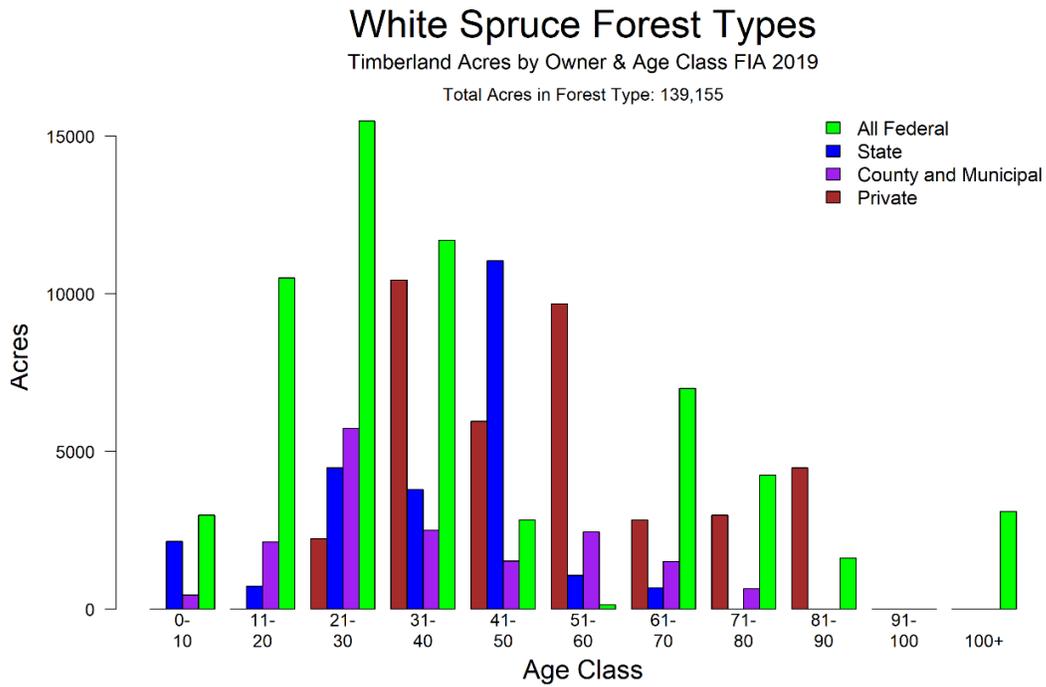
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

FIGURE 5-22: WHITE SPRUCE VOLUME BY DIAMETER CLASS, 2003 AND 2019 FIA
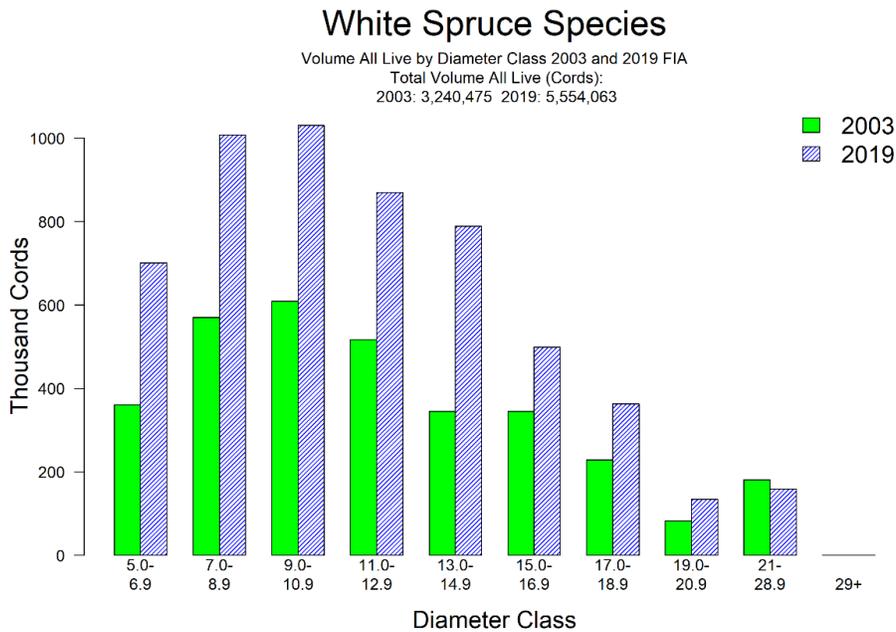
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station
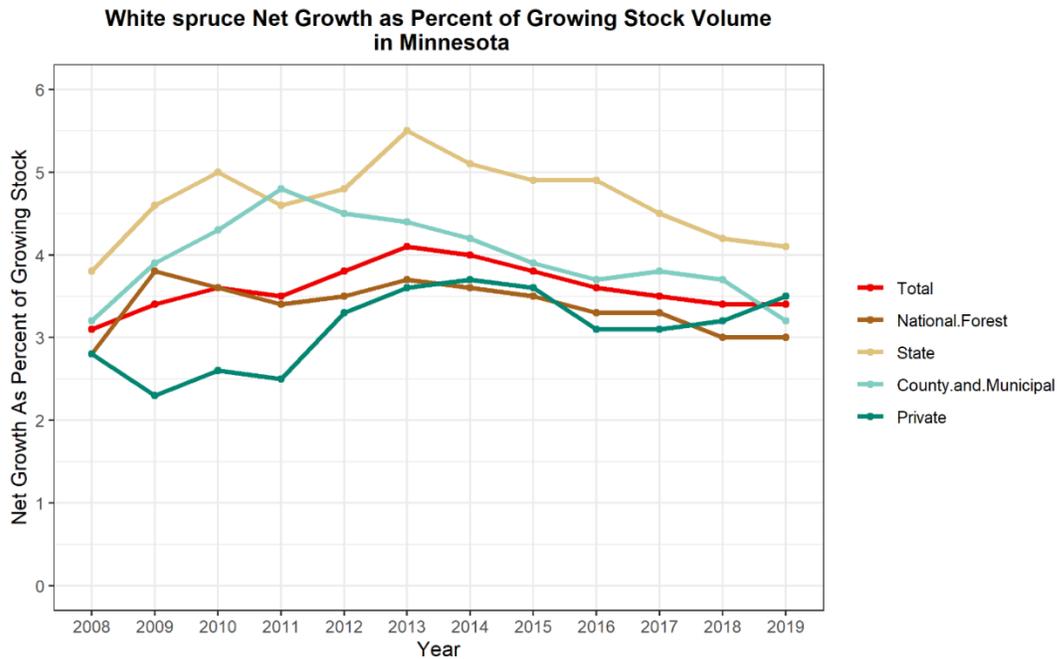
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth, is the result subtracting mortality and non-harvest removals from gross growth, it is estimated from volume change on FIA measured plots. It is turned into a percent by dividing by current inventory and multiplying by 100 to compare between ownerships.

Tables 5-4 through 5-6 show AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top diameter) by percent of basal area per acre that is black spruce and white spruce ON FIA PLOTS. These tables show that these forest types can differ significantly and provide some idea of other species that can be harvested within these forest types. This is FIA Black Spruce, White Spruce-Natural, and White Spruce-Planted Forest Types. Acres Statewide provides some idea of the relative nature of different percent species compositions within a particular forest type.

TABLE 5-4: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (BLACK SPRUCE) ON FIA PLOTS 35 YEARS AND OLDER.

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	**25,855**	**120.839**	**308,983**	**785,433**
Species				
Balsam Fir	6.1	6.0	4.7	0.4
Tamarack	29.7	27.8	18.6	7.5
White spruce	0.6	0.2	2.1	0.3
Black spruce	14.2	34.3	63.2	88.3
Pine (jack, red, white)	25.4	11.5	2.2	1.2
White cedar	15.9	11.0	2.3	0.9
Aspen (quaking, bigtooth)	4.1	4.3	3.7	0.9
Paper birch	1.3	4.2	2.7	0.4
Balsam poplar	0.0	0.1	0.1	0.1
Basswood	0.0	0.0	0.0	0.0
American elm	0.0	0.0	0.0	0.0
Maple	2.0	0.2	0.4	0.0
Ash	0.7	0.6	0.0	0.0
Oak	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.0	0.0

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

TABLE 5-5: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (NATURAL WHITE SPRUCE) ON FIA PLOTS AGE 20 AND OLDER.

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	**11,441**	**16,249**	**16,224**	**6,232**
Species				
Balsam Fir	9.1	9.7	3.3	2.0
Tamarack	7.4	0.0	0.0	0.0
White spruce	35.4	66.6	79.6	92.7
Black spruce	11.2	4.4	0.9	0.0
Pine (jack, red, white)	21.9	4.8	0.0	0.0
White cedar	1.4	0.0	0.0	0.0
Aspen (quaking, bigtooth)	9.2	6.6	7.3	3.8
Paper birch	2.4	3.1	4.4	1.5
Balsam poplar	0.0	0.3	0.1	0.0
Basswood	0.0	0.6	0.0	0.0
American elm	0.3	2.5	2.1	0.0
Maple	0.0	0.8	1.6	0.0
Ash	1.5	0.0	0.0	0.0
Oak	0.2	0.0	0.0	0.0
Other	0.0	0.6	0.8	0.0

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

TABLE 5-6: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (PLANTED WHITE SPRUCE) ON FIA PLOTS AGE 20 AND OLDER

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	**588**	**11,941**	**22,533**	**36,277**
Species				
Balsam Fir	16.3	20.1	7.4	2.4
Tamarack	0.0	1.4	1.5	0.0
White spruce	24.4	49.4	76.7	88.1
Black spruce	0.0	6.0	1.0	0.0
Pine (jack, red, white)	0.0	11.7	0.8	1.0
White cedar	0.0	0.5	0.0	0.0
Aspen (quaking, bigtooth)	36.0	5.4	5.4	3.2
Paper birch	22.4	4.4	2.1	0.5
Balsam poplar	0.0	0.0	1.2	0.1
Basswood	0.0	0.0	0.0	0.0
American elm	0.0	0.0	0.1	0.0
Maple	0.0	0.0	1.5	0.0
Ash	0.0	0.0	0.0	0.8
Oak	0.0	0.0	2.2	3.5
Other	0.0	1.0	0.1	0.6

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

Figure 5-24 shows the predicted spatial distribution of black spruce and white spruce CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

Black spruce (*Picea mariana*)   White spruce (*Picea glauca*)

Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

Tamarack

The GEIS estimates that the long-term annual sustainable harvest level of tamarack is 114,800 cords per year. Based on the 2019 FIA database, the estimated average net annual growth of tamarack growing stock is -1,056 cords, and the estimated average annual mortality of tamarack growing stock is 377,396 cords

FIGURE 5-25: TOTAL TAMARACK HARVEST FROM MINNESOTA TIMBERLANDS, 1994-2018
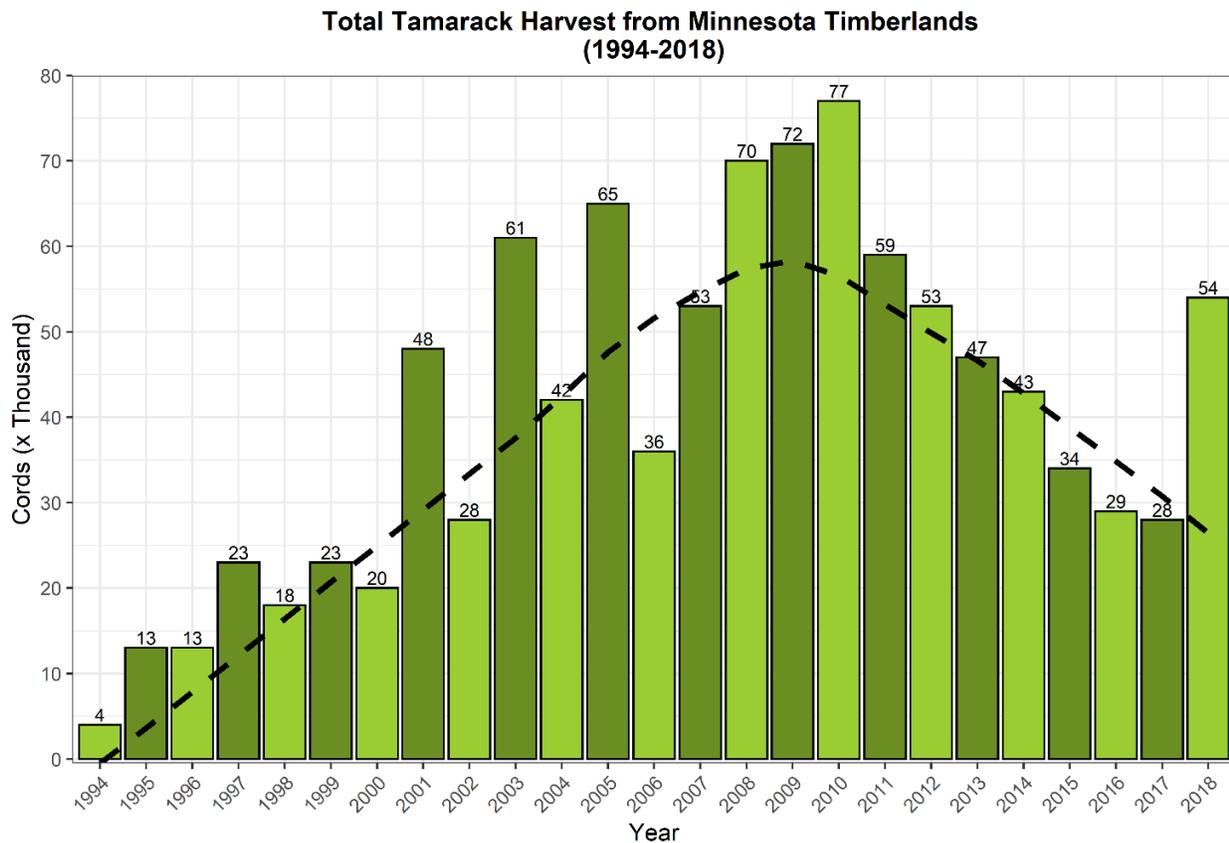
Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Dotted black line shows relative trend for reference.

Current Demand for Tamarack From Minnesota Timberlands

Harvest Sector	Cords
2017 Minnesota Pulpwood Industries	41,985
2018 Sawlogs and Fuelwood *draft surveys*	12,351
Total Harvest	**54,336**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

Resource Opportunities

- Tamarack harvest is below long-term sustainable levels. Tamarack has been in the past quantified as mixed softwood; volume swings are largely due to mill reporting and change in pulpwood mill consumption.
- Since the beginning of the larch beetle outbreak in 2001, about 666,000 acres, or almost 50 percent of tamarack in the state, have been impacted to some degree by eastern larch beetle.
- There is a large amount of standing dead tamarack available now. The long-term outlook indicates a potential future shortage of this cover type.

Resource Issues

- Many stands have low volumes and dead standing wood.
- Serious mortality levels are being experienced statewide. Eastern larch beetles are killing trees, mostly in older stands and especially in Koochiching, Beltrami, Lake of the Woods, and Roseau counties.
- Tamarack grows in lowland areas.
- Tamarack has inconsistent and varying levels of marketability.
- There is additional market development potential for tamarack.
- Tamarack markets include biochemical extraction, OSB and industrial lumber (pallets). Prior to 2019, they included woody biomass energy.

FIGURE 5-26: TAMARACK TIMBERLAND ACRES BY OWNER AND AGE CLASS, 2019 FIA
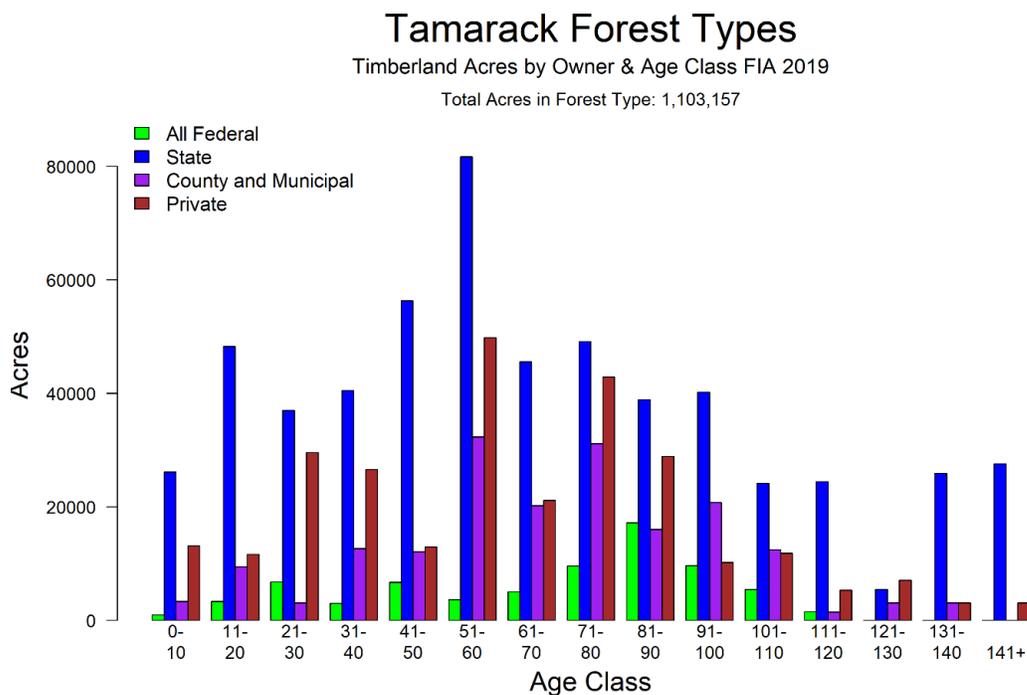
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Tamarack is dominated by "middle-aged" stands, but there is a fair amount of very old tamarack. The state of Minnesota owns close to 54% of acres with tamarack cover type.

Tamarack is used primarily to manufacture *Arabinogalactan* extract[11] and engineered wood products (to a limited extent). In recent years biomass energy facilities had begun to use more tamarack, but those markets have been drastically reduced. Markets for tamarack had been somewhat improved since the 1990s, but with the loss of biomass markets the future is uncertain and consumption has declined dramatically since 2014. Stumpage prices remain quite low.

FIGURE 5-27: TAMARACK VOLUME BY DIAMETER CLASS, 2003 AND 2019 FIA
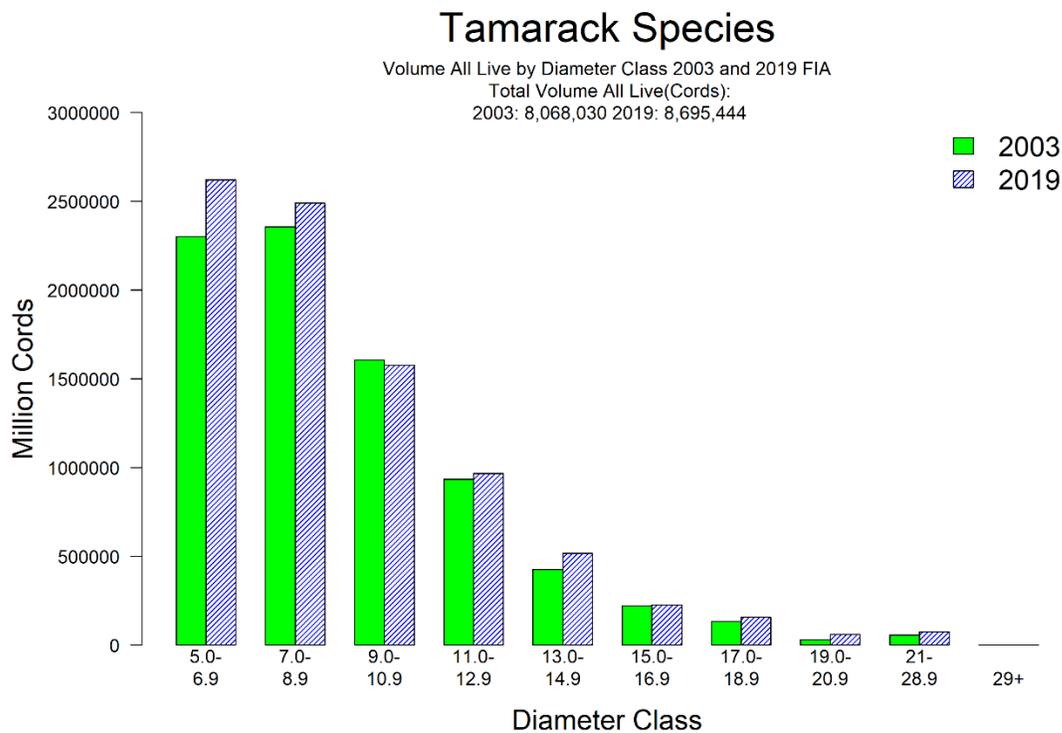
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Total volume of tamarack has increased since 2003; however, in 2019 net growth was negative likely due to the cumulative impact of widespread insect and disease issues.

---

[11] Larch Arabinogalactan is a starch-like chemical used in the food, beauty and medicinal products.
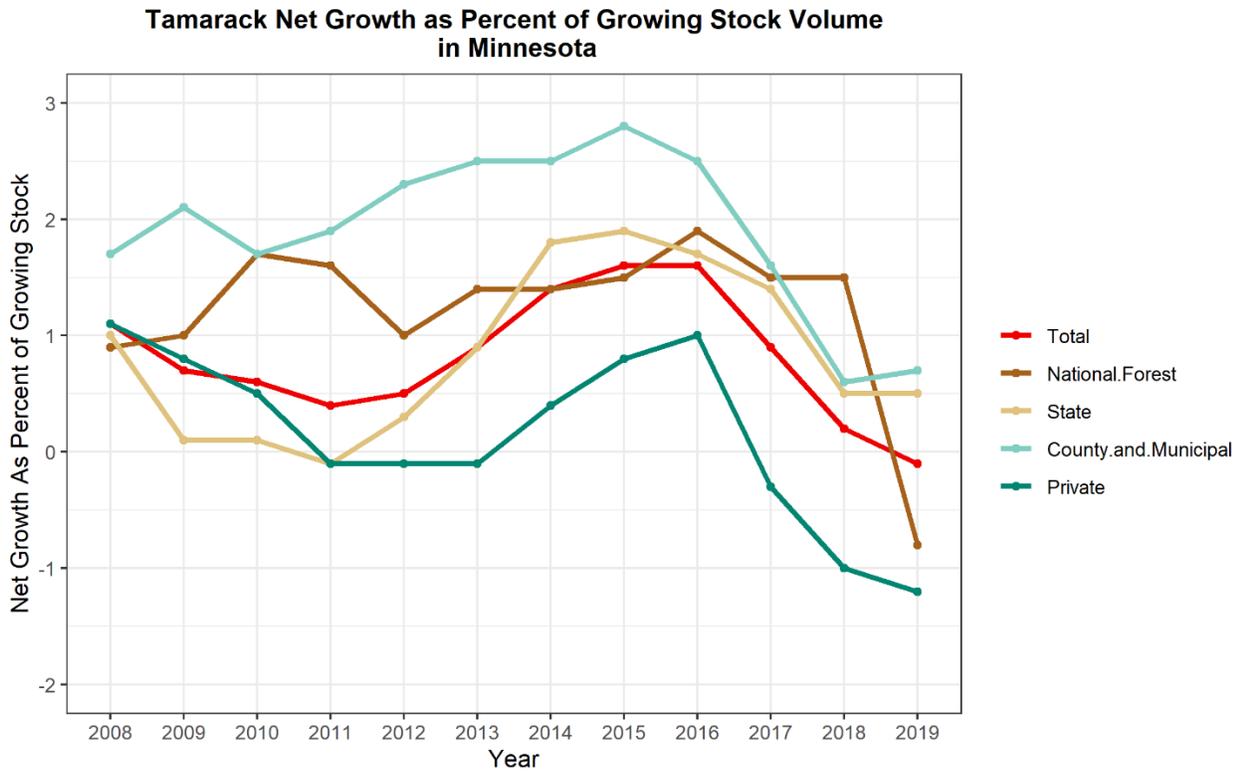
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth, is the result subtracting mortality and non-harvest removals from gross growth, it is estimated from volume change on FIA measured plots. It is turned into a percent by dividing by current inventory and multiplying by 100 to compare between ownerships.

Net growth as a percent of growing stock shows that for tamarack across all ownerships, net growth has decreased dramatically since 2016. Tamarack began to show declining net growth in 2016 on all ownerships with cumulative net growth being negative in 2019. Harvest amounts for Tamarack have dropped dramatically since peaking in 2010 at 77,000 cords annually to approximately 27,000 cords in 2017.

Table 5-7 shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top diameter) by percent of basal area per acre that is tamarack ON FIA PLOTS. This table shows that a tamarack forest type can differ significantly and provides some idea of what other species can be harvested within these forest types. This is FIA Tamarack Forest Type. Acres statewide provides some idea of the relative nature of different percent species compositions within a particular forest type. Only FIA plots age 35 and older were included.

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	43,686	209,155	286,081	396,298
Species				
Balsam Fir	5.1	1.3	0.4	0.1
Tamarack	43.8	56.4	75.6	95.3
White spruce	4.8	0.0	0.6	0.0
Black spruce	18.9	21.2	15.4	3.0
Pine (jack, red, white)	0.2	1.4	1.4	0.0
White cedar	17.2	16.9	4.3	0.9
Aspen (quaking, bigtooth)	1.9	0.9	0.2	0.0
Paper birch	4.6	1.0	0.4	0.5
Balsam poplar	0.2	0.2	0.3	0.0
Basswood	0.0	0.0	0.0	0.0
American elm	0.3	0.0	0.1	0.0
Maple	0.0	0.5	0.3	0.1
Ash	3.0	0.2	0.7	0.1
Oak	0.1	0.0	0.3	0.0
Other	0.0	0.0	0.0	0.1

Source: 2018 FIA database provided by U.S. Forest Service

Figure 5-29 shows the predicted spatial distribution of tamarack CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

FIGURE 5-29: PREDICTED DISTRIBUTION OF TAMARACK IN MINNESOTA
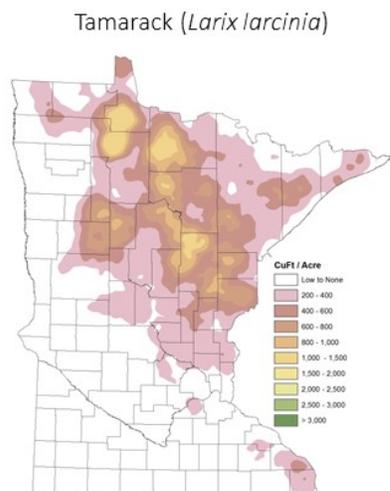
Source: 2017 FIA database provided by U.S. Forest Service

Northern Hardwoods

The Northern Hardwoods cover type is an assortment of a wide group of species. The dominant species are the shade-tolerant sugar maple and basswood. There are also significant oak, red maple, aspen, and birch volumes as well in this cover type.

Late "middle aged" stands (average rotation age is 80 years) dominate the Northern Hardwoods cover type. Many stands in this cover type need thinning to promote optimal growth and forest health especially through periodic "thinning" harvests (or partial cuts). Clear-cutting can be an appropriate tool in some situations, especially in sites with a poor performing overstory or where 50% to 60% of the trees are past their maturity.

Private landowners own most of this cover type. These landowners need significant technical assistance to manage their forests. The Northern Hardwoods cover type has been undermanaged for many years. While Minnesota has a history of poor markets for many hardwood species and sizes, markets for some hardwoods have changed drastically in recent years as pulp and paper mills, have increased use of maple and other hardwoods.

FIGURE 5-30: VOLUME OF NORTHERN HARDWOODS ON TIMBERLANDS
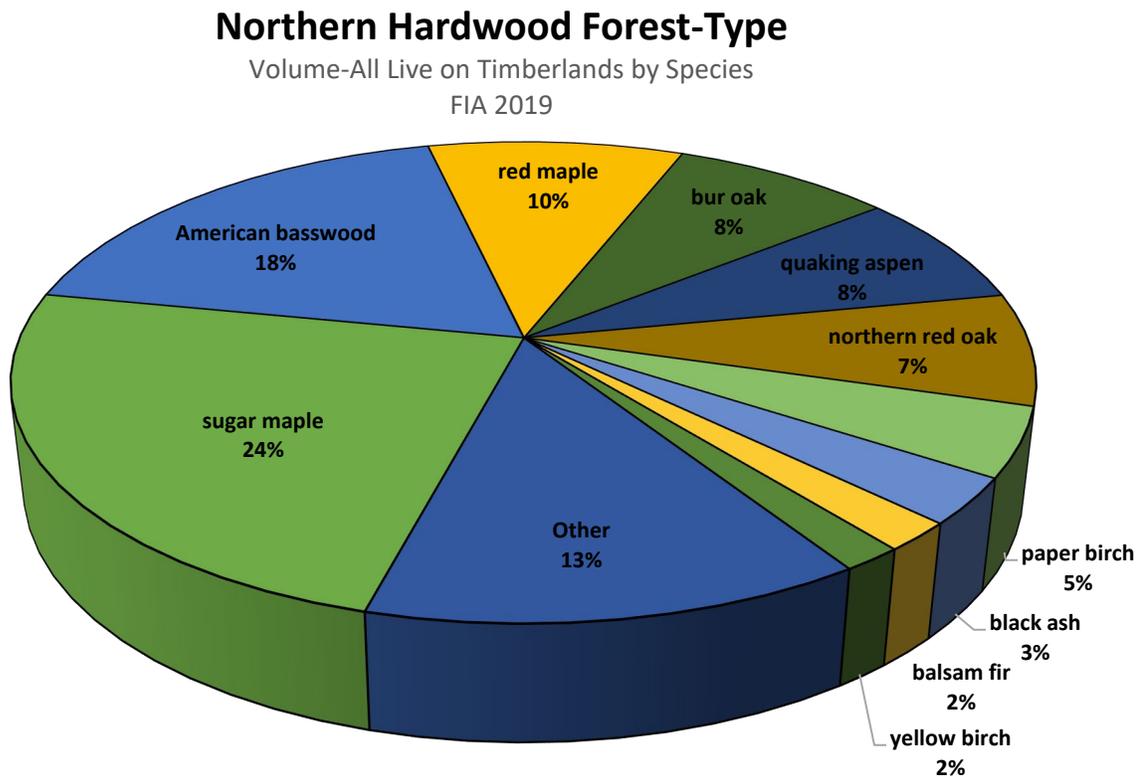
Northern Hardwood Forest-Type

Volume-All Live on Timberlands by Species

FIA 2019

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

FIGURE 5-31: NORTHERN HARDWOOD ACRES BY OWNER AND AGE CLASS, 2019 FIA
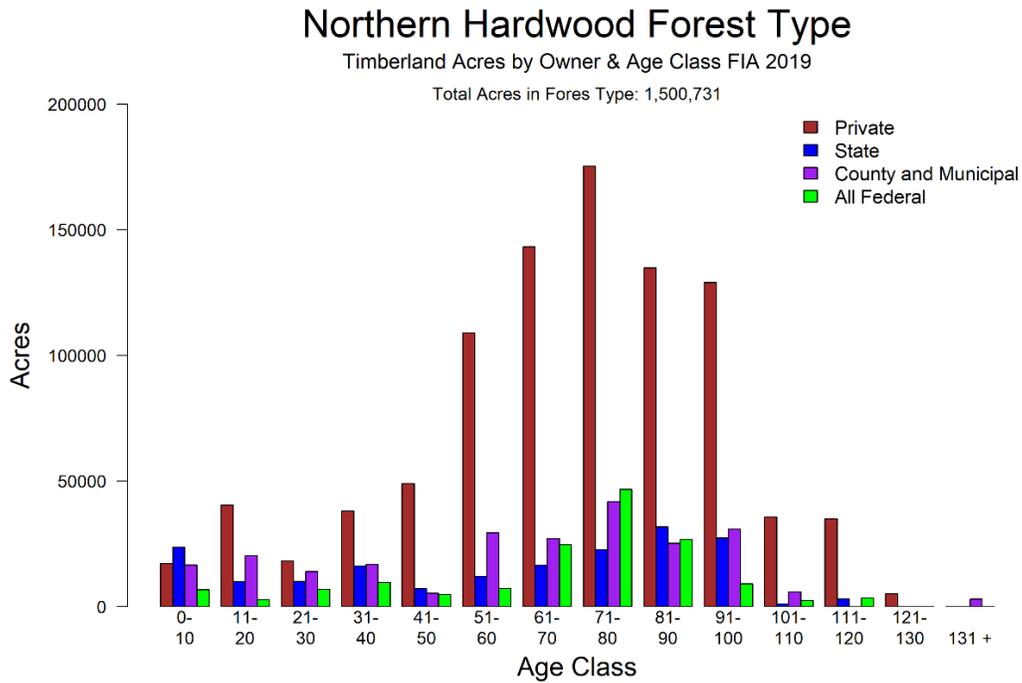
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Maple

Minnesota's maple resource consists of four species: sugar maple, red maple, silver maple, and black maple.

Sugar maple sawlogs tend to be low quality because of small size, and poor form. Minnesota is the western edge of this species' natural growing range. However, some higher quality sugar maple grows in southeastern Minnesota.

FIGURE 5-32: TOTAL MAPLE HARVEST FROM MINNESOTA TIMBERLANDS
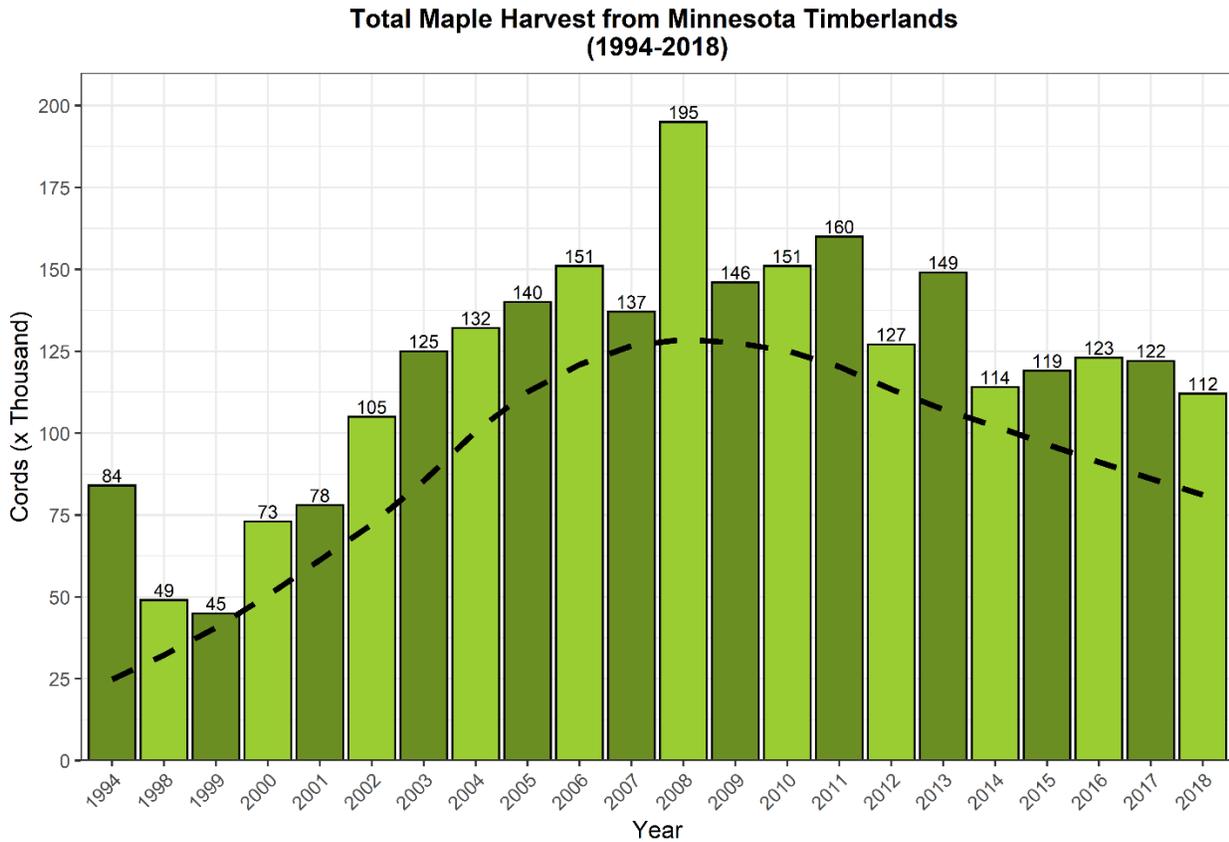
Total Maple Harvest from Minnesota Timberlands
(1994-2018)

Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Dotted black line shows relative trend for reference.

The GEIS estimates maple species long-term annual sustainable harvest level at 429,600 cords. Based on the 2019 FIA database, estimated average annual net growth for maple (sugar and red maple) growing stock in Minnesota is 350,623 cords, estimated average annual mortality of maple growing stock is 183,805 cords. The dotted black line shows a relative trend.

Current Demand for Maple from Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	79,978
2018 Pulpwood Export (To Wisconsin)	13,271
2019 Sawlogs (and est. Exports) and Other	9,079
2019 Fuelwood	10,424
Total Harvest	**112,752**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

Resource Opportunities

- Harvest is well below long-term sustainable levels.
- Investments in appropriate low ground pressure harvesting equipment may improve ability to access this resource.
- Increased management through timber stand improvement and silvicultural treatment could create higher grade maple products, and improve marketing and utilization.

Resource Issues

- Private landowners own most of the maple resource, resulting in the use of a variety of logging equipment, management intensities, and multiple-entry management (i.e., partial cutting, uneven-aged management).
- Parts of northeastern Minnesota are under gypsy moth quarantine. Loggers and mills should contact Minnesota Department of Agriculture to learn about compliance agreements.

FIGURE 5-33: VOLUME OF SUGAR MAPLE STOCK ON TIMBERLAND, 2019 FIA
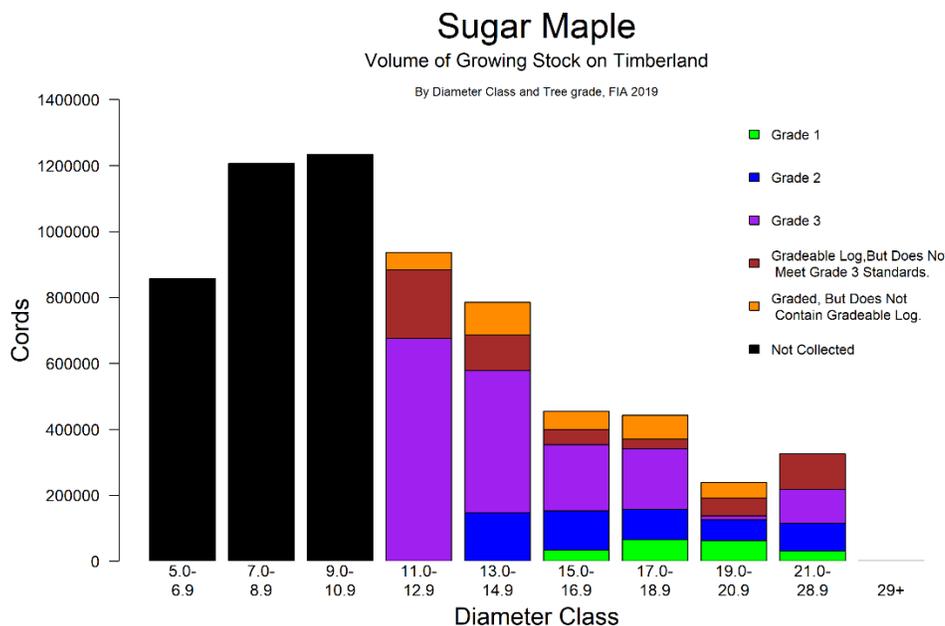
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station
Note: Tree grade 1 is highest quality in the U.S. Forest Service tree grading system.
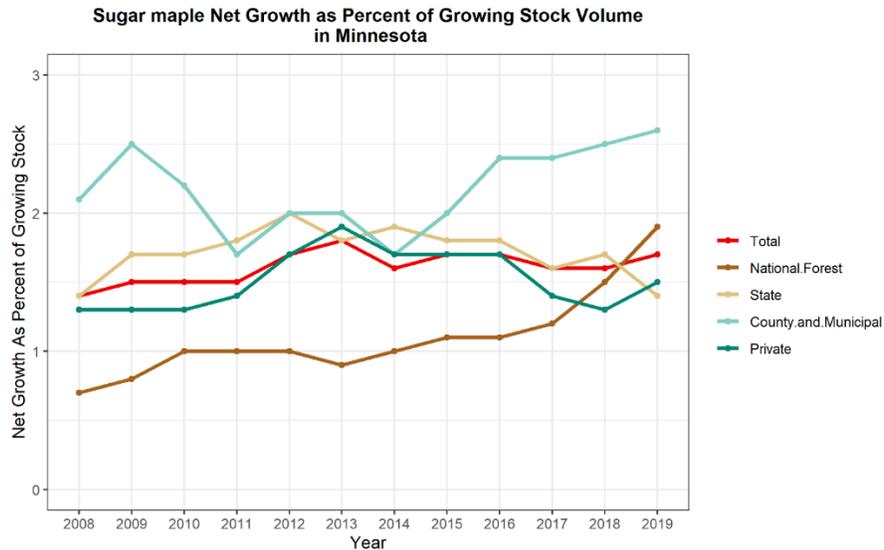
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth is the result subtracting mortality and non-harvest removals from gross growth. Net growth is estimated from volume change on FIA measured plots. It is turned into a percent by dividing by current inventory and multiplying by 100 to compare between ownerships.

Sugar maple growth has been gradually increasing annually on national forests and county lands. However, growth on state and private lands have stayed flat, changing only 1% to 2% net growth annually.

Figure 5-35 shows the predicted spatial distribution of red maple, sugar maple, and basswood CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

Basswood

The GEIS estimated long-term annual sustainable harvest level of basswood at 280,300 cords. Based on the 2019 FIA database, estimated net annual basswood growth is 160,895 cords, and the estimated annual mortality is estimated at 117,865 cords.

FIGURE 5-36: TOTAL BASSWOOD HARVEST FROM MINNESOTA TIMBERLANDS, 1994-2018
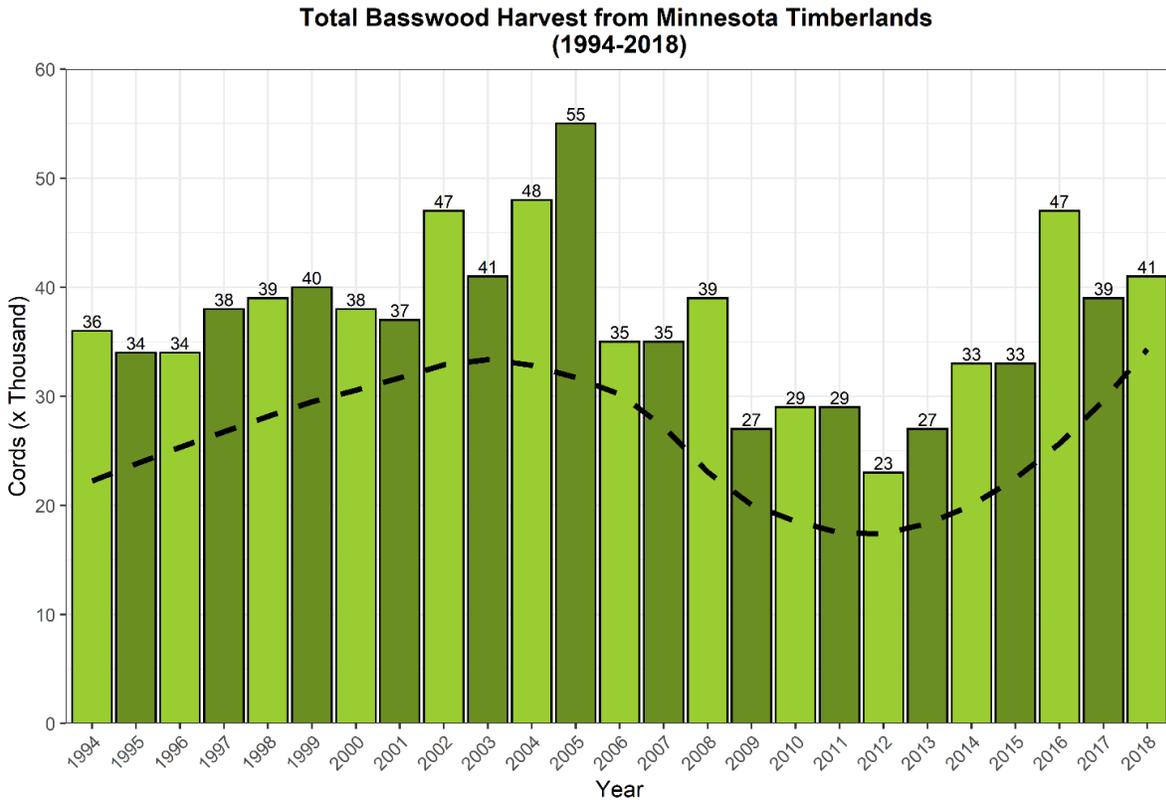
Total Basswood Harvest from Minnesota Timberlands (1994-2018)

Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Dotted black line shows relative trend for reference.

Current Demand for Basswood From Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	6,157
2018 Pulpwood Export (To Wisconsin)	5,101
2019 Sawlogs and Exp. *draft survey*	26,827
2019 Fuelwood *draft survey*	3,389
Total Harvest	**41,474**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

Resource Opportunities

- Harvest is well below long-term sustainable levels.
- There are opportunities to improve future basswood volume and quality through investments in intermediate stand treatments on private and public lands.
- Minnesota grows some of the highest quality basswood in the world. It can be a great fit for craft woods and other niche markets.

Resource Issues

- Private landowners own much of the basswood resource.
- Productive private lands allow a potential harvest of high-quality stems for pulpwood, followed by harvest for sawlogs. Moving quality material to higher-value markets is important.
- Harvest requires a variety of logging equipment, management intensities, and multiple-entry management (i.e., partial cutting, uneven-aged management).
- Parts of northeastern Minnesota are under gypsy moth quarantine. Loggers and mills should contact Minnesota Department of Agriculture to learn about compliance agreements.

Basswood is capable of producing a large percentage of high-quality sawlog and veneer material on good sites in Minnesota.

FIGURE 5-37: VOLUME OF BASSWOOD GROWING STOCK ON TIMBERLAND
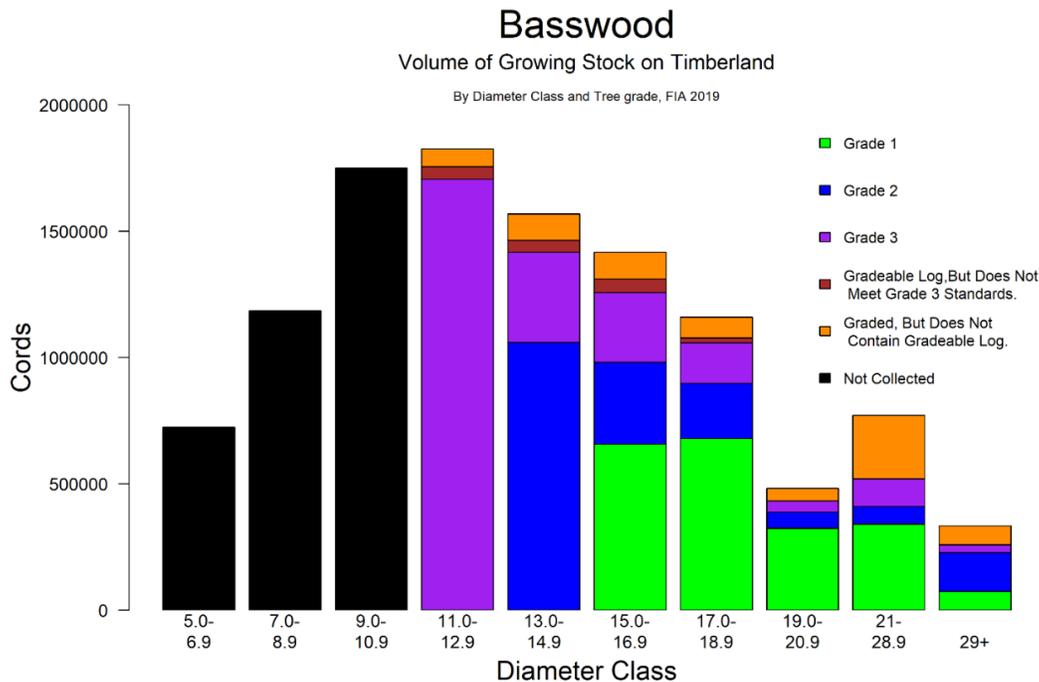
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station.
Note: Tree grade 1 = highest quality in the U.S. Forest Service tree grading system
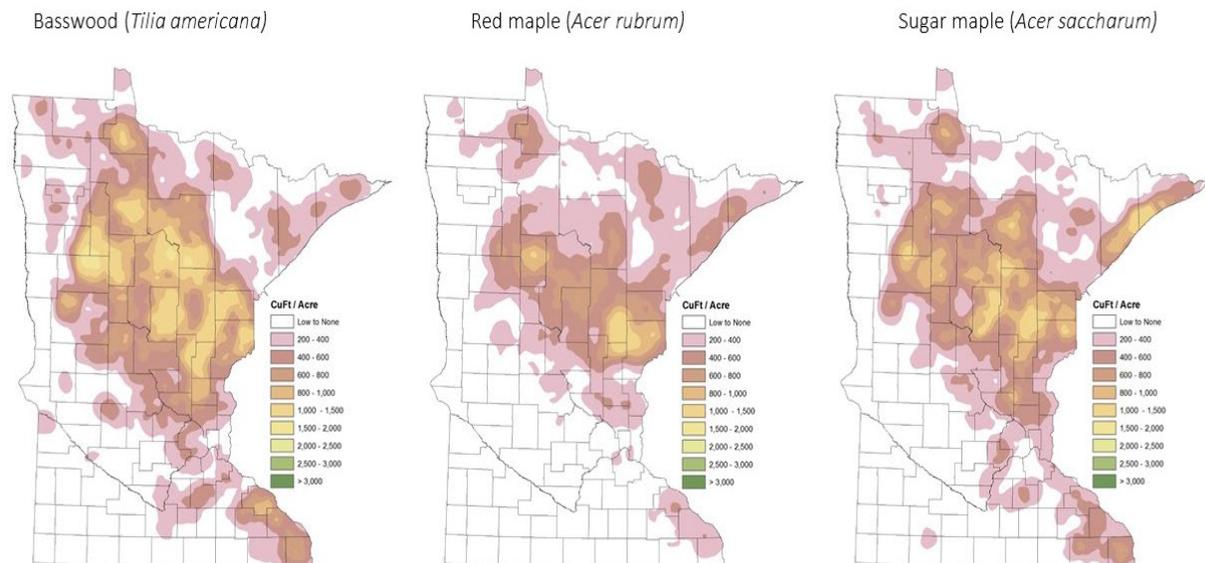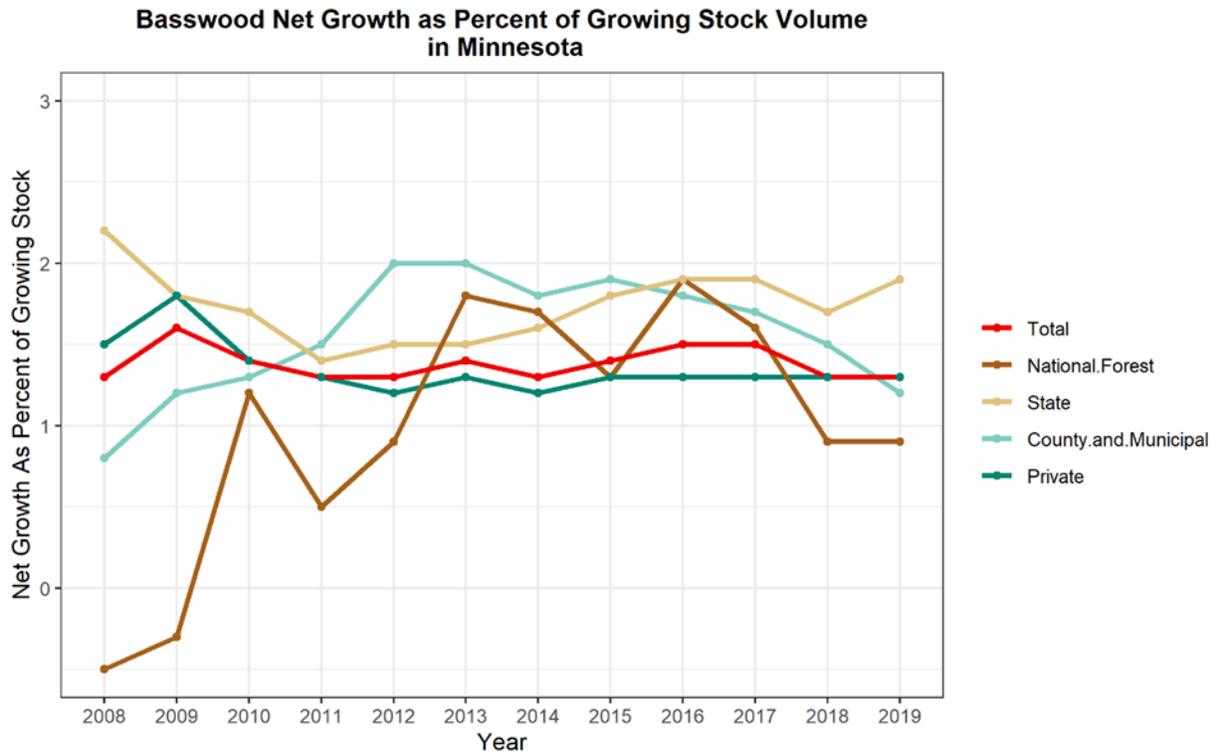
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth is the result subtracting mortality and non-harvest removals from gross growth. Net growth is estimated from volume change on FIA measured plots, and turned into a percent by dividing by current inventory and multiplying by 100 to compare between ownerships. *Private is partially covered, as it was equivalent to Total in 2018 and 2019.*

In recent years, national forests have experienced a general increase in net growth of basswood. In 2008, the net growth was negative, while in 2019 net growth has grown to approximately 1% of growing stock annually.

Oak

Oak is a tremendously important cover type and species in much of Minnesota. Oaks provide acorns and dens for many wildlife species. Additionally, it is the largest hardwood species by volume produced by many sawmills, especially those in the southern two-thirds of the state.

FIGURE 5-39: TOTAL OAK HARVEST FROM MINNESOTA TIMBERLANDS
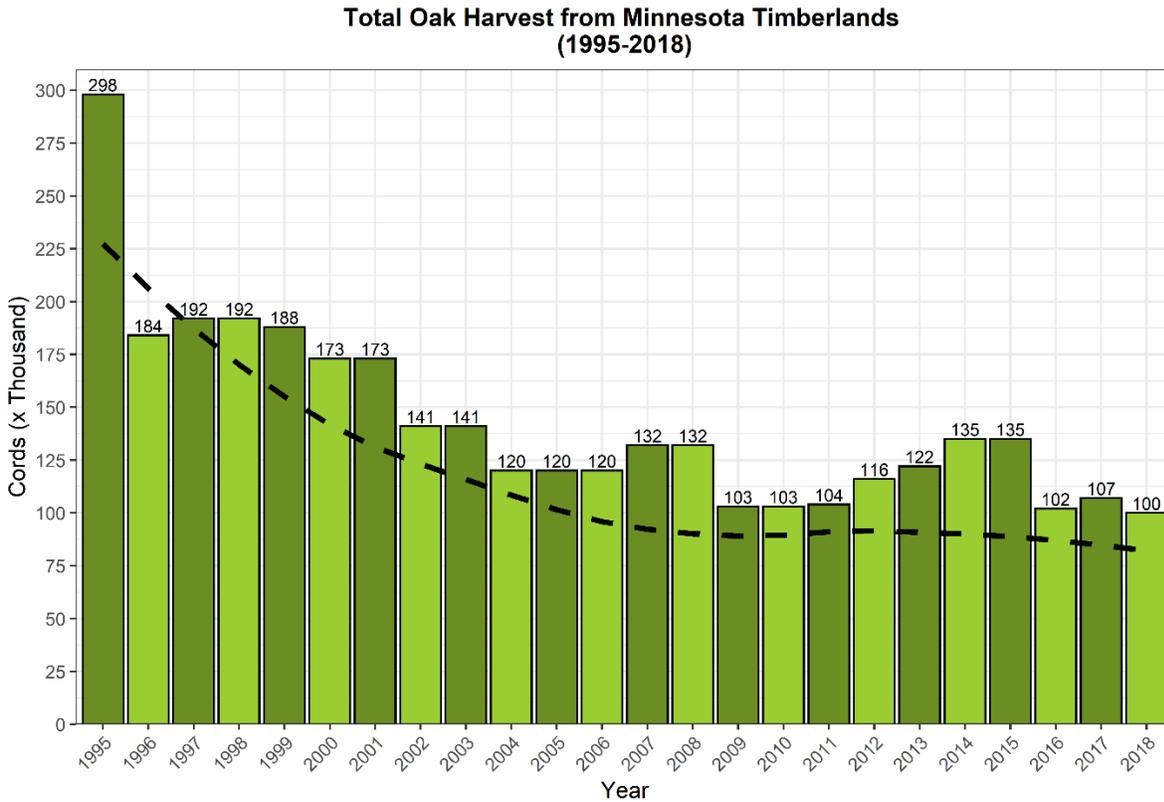
Total Oak Harvest from Minnesota Timberlands
(1995-2018)

Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Dotted black line shows relative trend for reference. Data includes estimated saw log exports.

Current Demand for Oak From Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	0
2018 Pulpwood Export (To Wisconsin)	443
2019 Sawlogs and Exp.*	76,150
2019 Fuelwood *	24,270
Total Harvest	**100,862**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

Resource Opportunities

- Some high quality sawlog and veneer red oak grows on good sites in Minnesota.
- There are opportunities to improve future oak volume and quality through investments in intermediate stand treatments on private and public lands.

Resource Issues

- High quality red oak sawlog resource continues to decline.
- Gypsy moth is making its way into Minnesota. It will likely have a negative impact on the oak resource where forests are primarily comprised of oak and are on shallow or sandy soils.
- Oak wilt is a preventable disease that is continuing to be found further north in Minnesota. Controlling oak wilt is possible but costly.
- Stands dominated by oaks should not be harvested from **April 1–July 15**. If the spring is unusually warm, the risk of oak wilt can occur before April. Oak should not be harvested after severe droughts or defoliation events.

FIGURE 5-40: OAK TIMBERLAND ACRES BY OWNER AND AGE CLASS, 2019 FIA
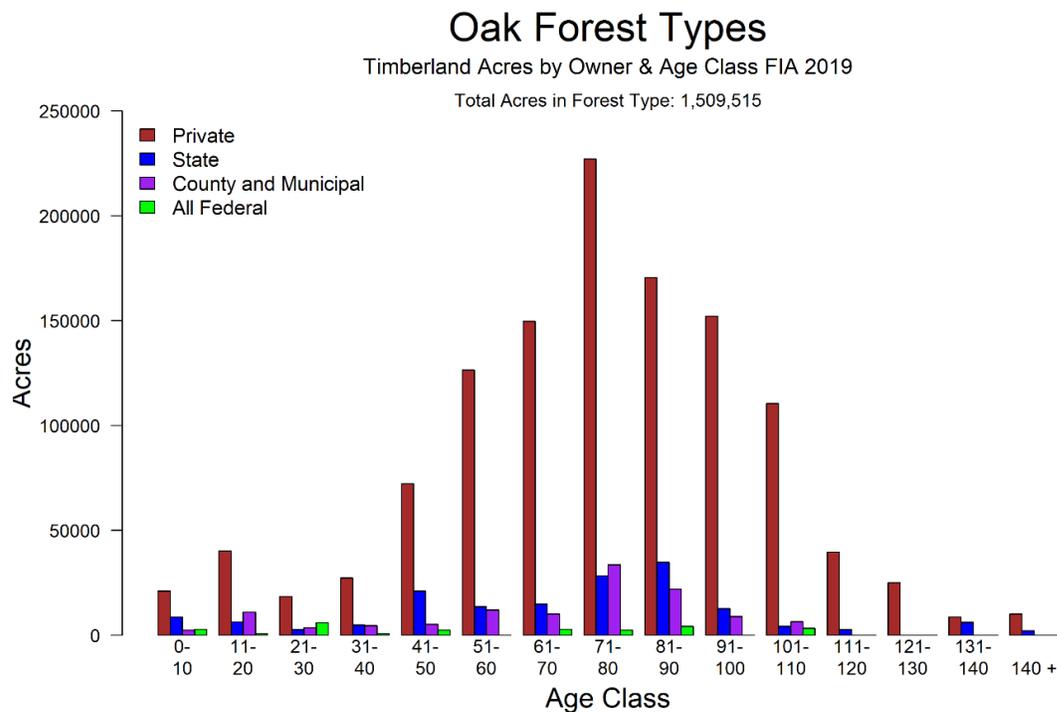
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Late "middle-aged" stands dominate the oak cover type, with an average rotation age of 80 to 100 years. Private landowners own most of the oak resource.

The GEIS estimated long-term annual sustainable harvest level for oak at 499,300 cords. Based on 2019 FIA data, the estimated net annual oak growth (all species) is 571,860 cords. In 2019 estimates of net growth of white oak is 6,209 cords, red oak is 267,470 cords, and bur oak is

228,452 cords. The estimated annual oak mortality (all species) was 270,871 cords. White oak annual mortality was 12,228 cords, red oak was 99,869 cords, and bur oak is 95,589 cords.

FIGURE 5-41: VOLUME OF RED OAK GROWING STOCK ON TIMBERLAND
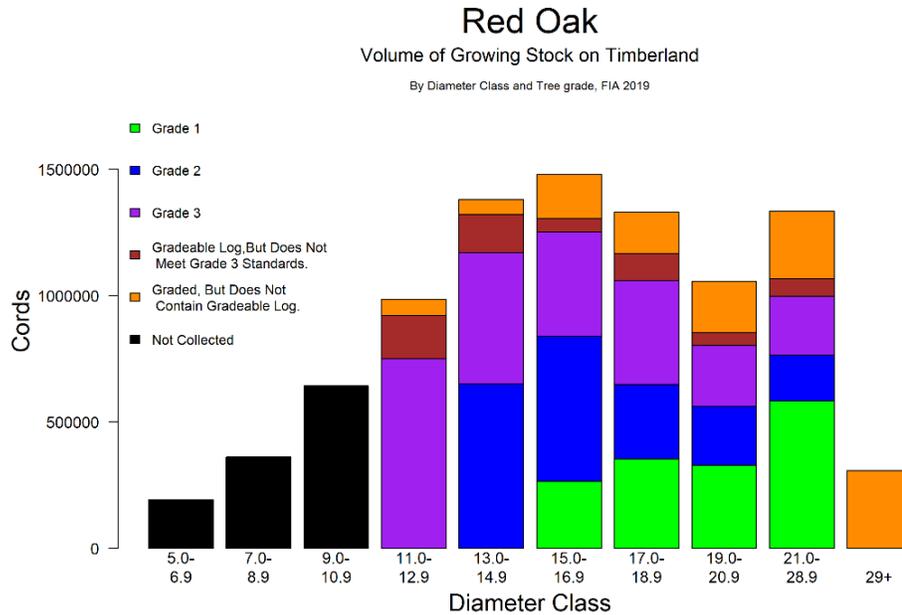
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station (includes black oak, northern pin oak, and northern red oak).
**Note:** Tree grade 1 is highest quality in the U.S. Forest Service tree grading system

FIGURE 5-42: BUR OAK VOLUME GROWING STOCK ON TIMBERLAND

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station
Note: Tree grade 1 = highest quality in the U.S. Forest Service tree grading system

90

**Red oak Net Growth as Percent of Growing Stock Volume in Minesota**
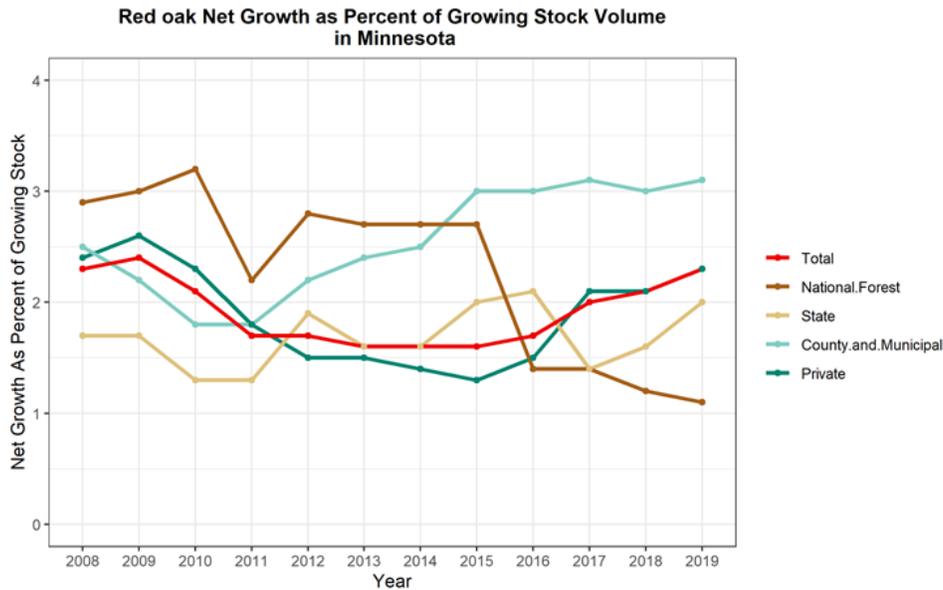
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth is the result subtracting mortality and non-harvest removals from gross growth. It is estimated from volume change on FIA measured plots. It is turned into a percent by dividing by current inventory and multiplying by 100 to compare between ownerships. *Private is partially covered, as it was equivalent to Total in 2018 and 2019.*

FIGURE 5-44: BUR OAK NET GROWTH AS PERCENT OF GROWING STOCK VOLUME IN MINNESOTA
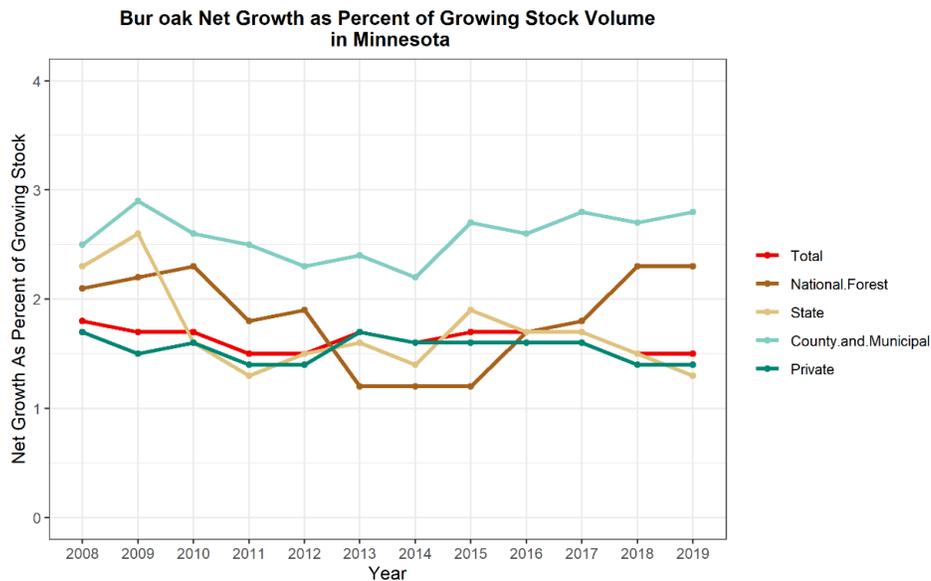
Bur oak Net Growth as Percent of Growing Stock Volume in Minesota

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth is the result subtracting mortality and non-harvest removals from gross growth. It is estimated from volume change on FIA measured plots. It is turned into a percent by dividing by current inventory and multiplying by 100 to compare between ownerships.

91

Some high quality sawlog and veneer red oak is grown on good sites in Minnesota. Bur oak, especially high quality logs 29 inches or more in diameter, is in demand Net growth in red oak varies but is generally steady among ownerships. In the last three years, Productivity decreased the most in national forests, while increasing in county and municipal ownerships. Bur oak has remained steady, increasing in productivity in national forests.

Table 5-8 shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top diameter) by percent of basal area per acre that is Oak ON FIA PLOTS. This table shows that an Oak forest type can differ significantly and provides some idea of what other species can be harvested within these forest types. This is FIA Oak Forest Type. Acres Statewide provides some idea of the relative nature of different percent species compositions within a particular forest type. Only FIA plots age 20 and older were included.

TABLE 5-8: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE OF OAK.

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	570,533	524,304	273,733	130,118
Species				
Balsam Fir	0.6	0.2	0.0	0.0
Tamarack	0.0	0.0	0.0	0.0
White spruce	0.2	0.1	0.1	0.0
Black spruce	0.0	0.0	0.0	0.0
Pine (jack, red, white)	0.8	1.0	0.7	0.4
White cedar	0.1	0.0	0.0	0.0
Aspen (quaking, bigtooth)	6.4	7.6	6.7	2.8
Paper birch	2.0	1.9	1.6	0.4
Balsam poplar	0.5	0.2	0.0	0.0
Basswood	26.6	8.1	2.6	0.5
American elm	4.5	2.0	1.5	0.1
Maple	6.5	5.1	1.9	0.5
Ash	9.3	2.9	1.7	0.1
Oak	30.8	65.6	80.5	94.6
Other	11.8	5.5	2.6	0.6

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

Figure 5-45 shows the predicted spatial distribution of northern red, northern pin, bur, and white oak CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

FIGURE 5-45: PREDICTED SPATIAL DISTRIBUTION OF NORTHERN RED, NORTHERN PIN, BUR, AND WHITE OAKS IN MINNESOTA
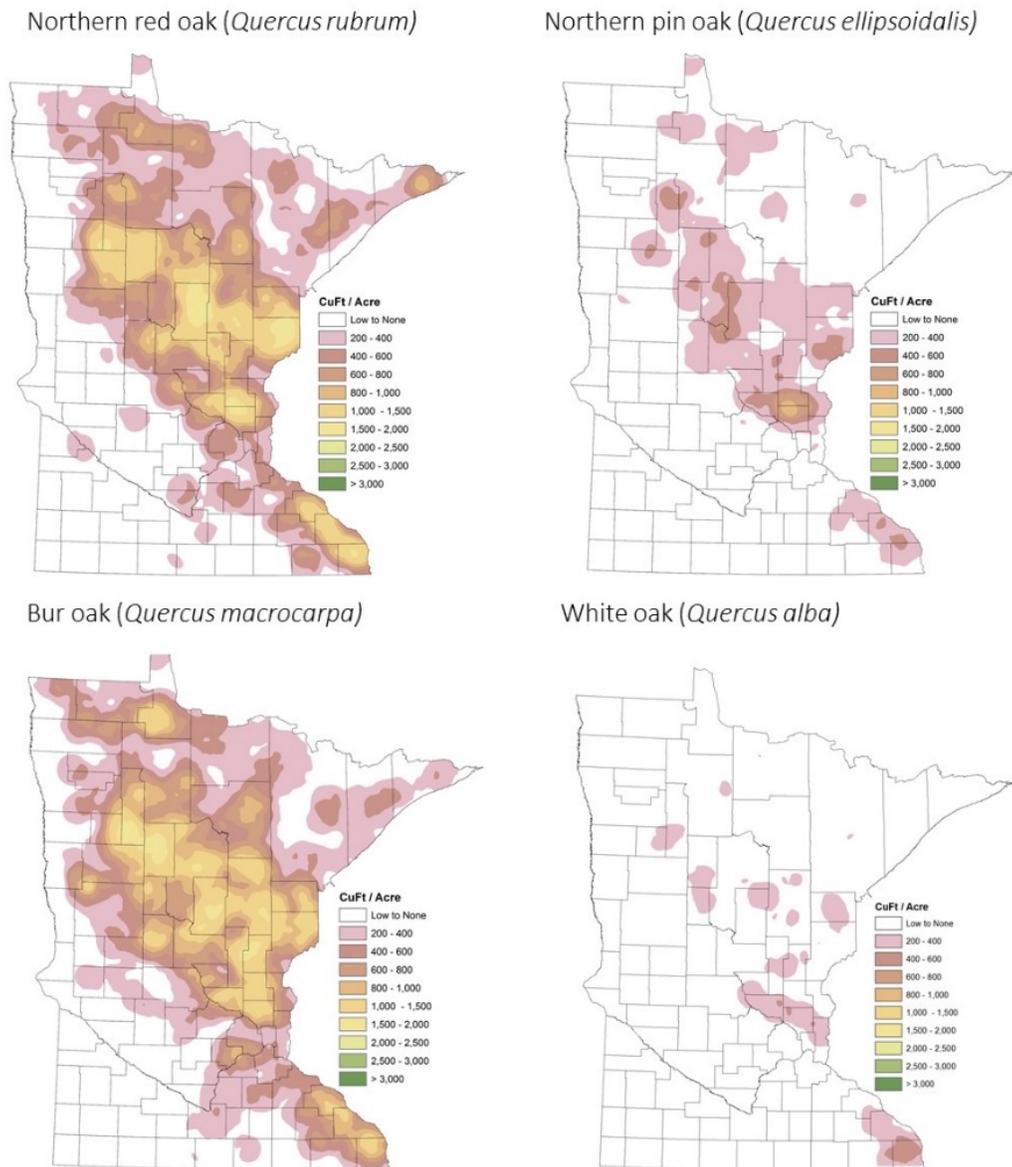
Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

Lowland Hardwoods

The Lowland Hardwoods cover type consists of a variety of species. Most prevalent are black ash, green ash, silver maple, and boxelder.

The Lowland Hardwood cover type is dominated by late "middle age" stands. A common rotation age for black ash is 90 years.

FIGURE 5-46: VOLUME OF LOWLAND HARDWOODS ON TIMBERLANDS, 2019 FIA
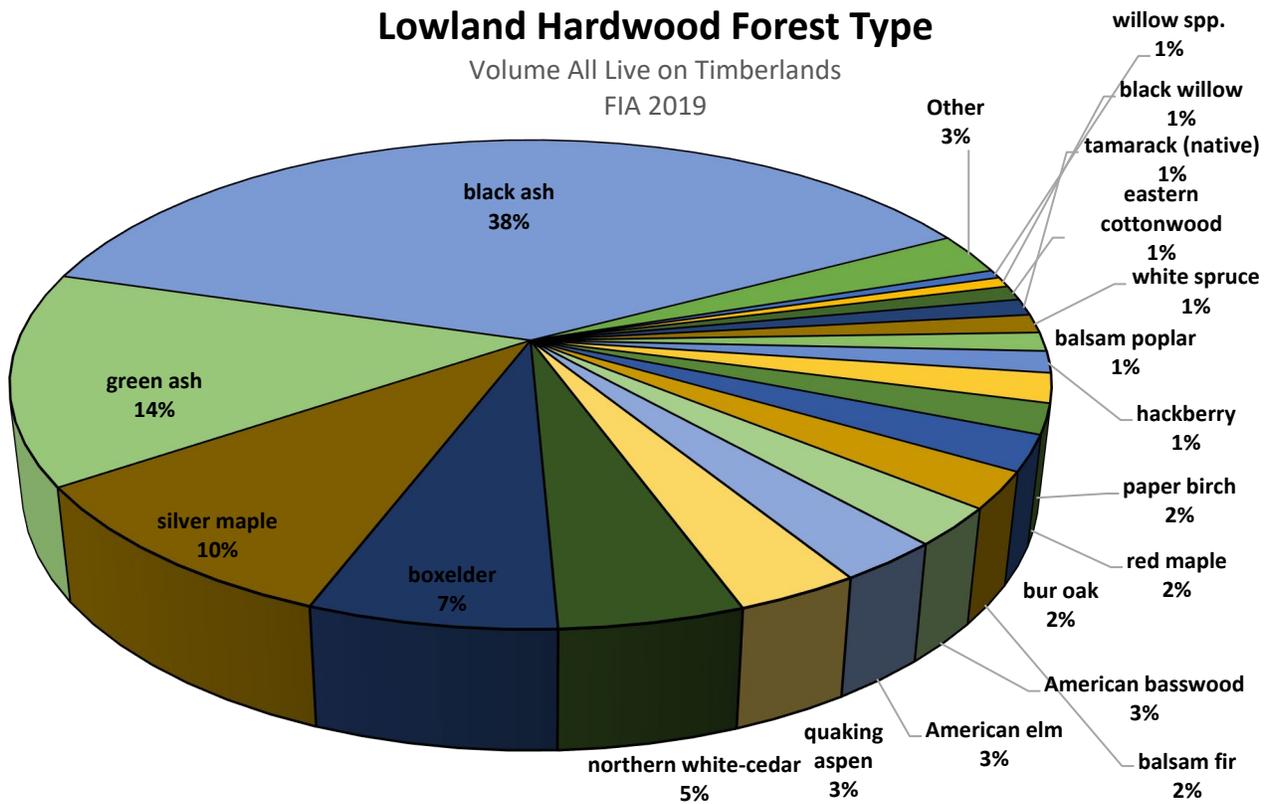
Lowland Hardwood Forest Type
Volume All Live on Timberlands
FIA 2019

black ash 38%
green ash 14%
silver maple 10%
boxelder 7%
northern white-cedar 5%
quaking aspen 3%
American elm 3%
American basswood 3%
bur oak 2%
balsam fir 2%
red maple 2%
paper birch 2%
hackberry 1%
balsam poplar 1%
white spruce 1%
eastern cottonwood 1%
tamarack (native) 1%
black willow 1%
willow spp. 1%
Other 3%

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

94

Lowland Hardwood Forest Types
Timberland Acres by Owner & Age Class FIA 2019
Total Acres in Forest Type: 1,458,870
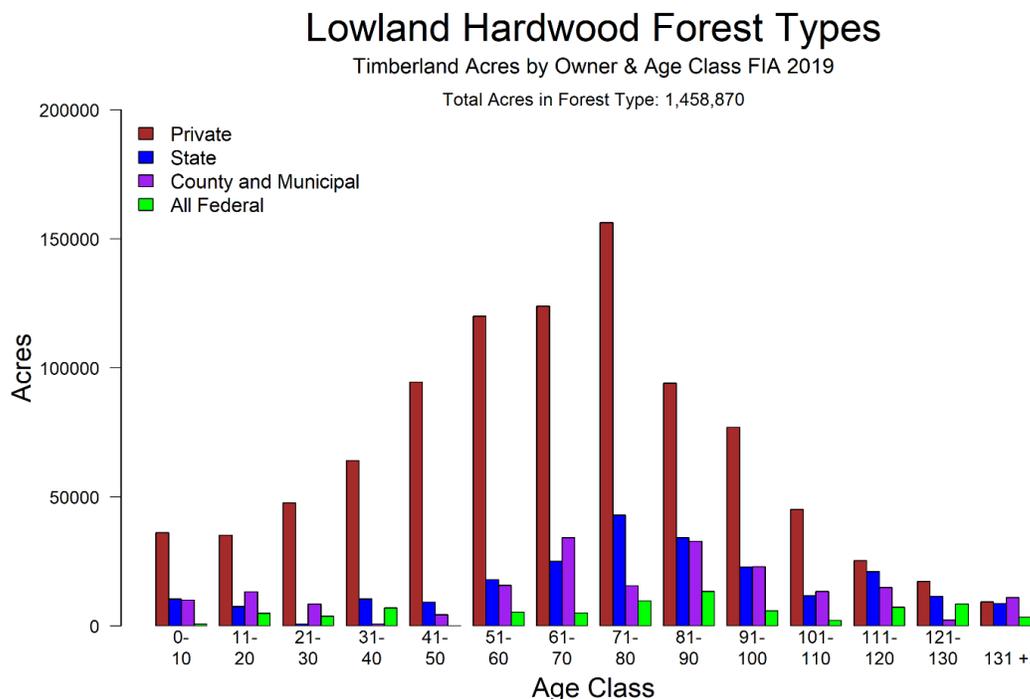
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Ash

Ash has not historically had a consistent pulpwood market although several mills have increased the use of ash in recent years. The DNR, currently on state lands is offering additional ash volume over the next few years to manage forest health concerns. Based on 2019 FIA data, ash (black and green) estimated net annual growth is 403,720 cords and mortality is 197,893 cords, increasing from approximately 30,000 cords in 2017.

Of the ash species found in Minnesota (black, green, and white), black ash has, by far, the largest volume.

Minnesota's ash resource is dominated by smaller diameter material. This affects processing opportunities, making it a good fit for pulpwood mills. A modest amount of high quality sawlog and veneer ash is grown in Minnesota.

FIGURE 5-48: TOTAL ASH HARVEST FROM MINNESOTA TIMBERLANDS (1997-2018)
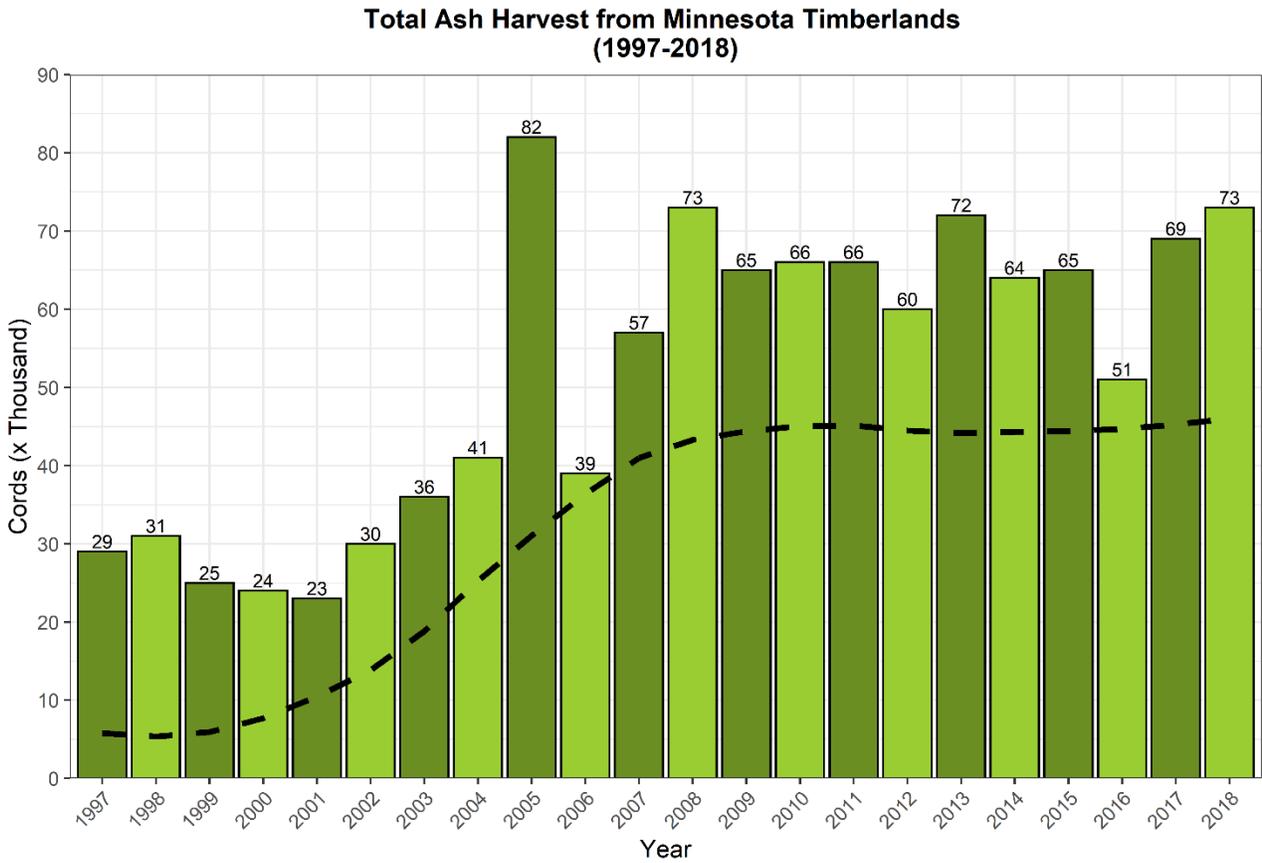
Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Dotted black line shows relative trend for reference.

Current Demand for Ash from Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	40,262
2018 Pulpwood Export (To Wisconsin)	5,261
2019 Sawlogs (including est. exports)	16,772
2019 Fuelwood *draft survey*	10,907
Total Harvest	**73,202**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT.

Resource Opportunities

- Ash harvest is well below long-term sustainable levels.
- Ash harvest is mainly done in winter.

- The best time to log and market ash is before emerald ash borer arrives.
- We expect significant mortality wherever emerald ash borer occurs. Ash supply should increase for the next few years in the early to mid-term.

Resource Issues

- Invasive emerald ash borer has arrived in Minnesota.
- Due to emerald ash borer, the future of black ash (and other ash species such as green and white ash) is fluid, with unknown long-term consequences for the species.
- Appraising high quality black ash sawlogs for higher value markets is difficult.
- Several counties are under emerald ash borer quarantine. Loggers and mills should contact the Minnesota Department of Agriculture for information about compliance agreements when moving ash products and hardwood firewood.
- Elms which are often collocated with ash species are an unlikely replacement for dying black ash as Dutch elm disease continues to take its toll on elms 5 inches dbh or smaller.

FIGURE 5-49: VOLUME OF BLACK ASH GROWING STOCK ON TIMBERLAND
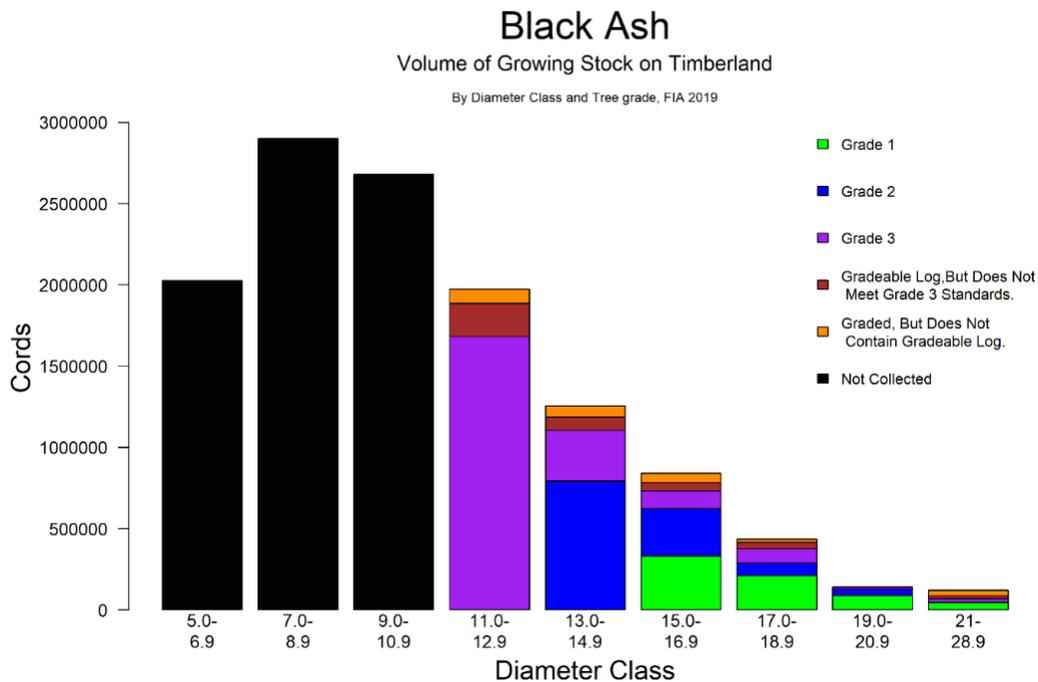
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station
Note: Tree grade 1 = highest quality in the U.S. Forest Service tree grading system
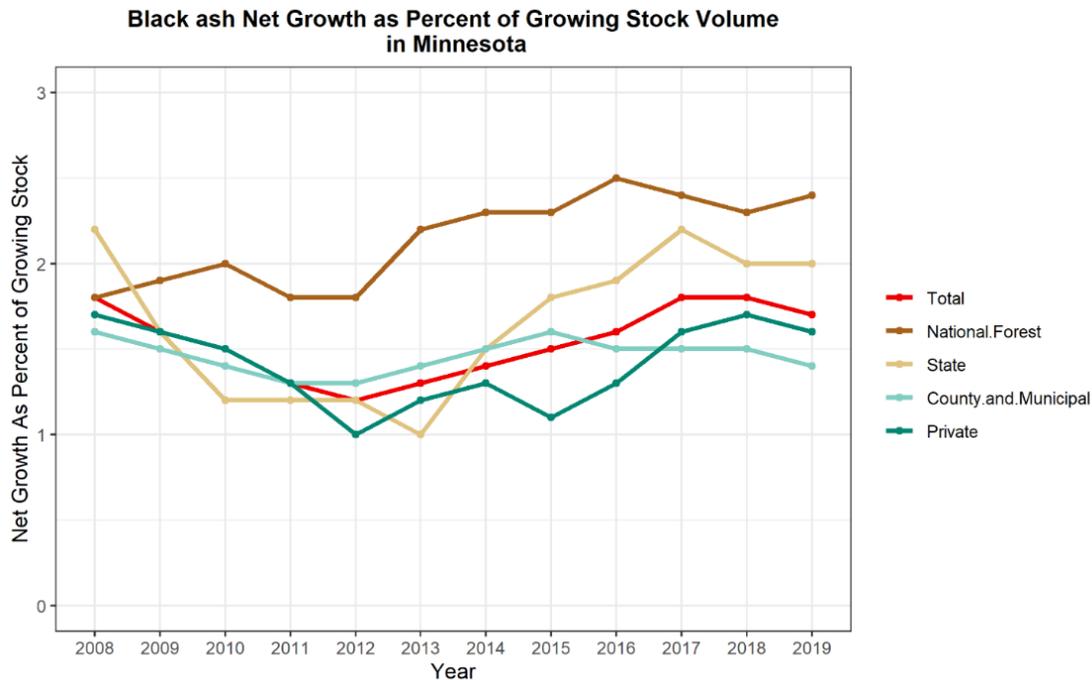
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth is the result subtracting mortality and non-harvest removals from gross growth. It is estimated from volume change on FIA measured plots. It is turned into a percent by dividing by current inventory and multiplying by 100 to compare between ownerships.

Black ash productivity has not started to suffer from widespread infestation by emerald ash borer, which is a major concern for the species statewide. Growing stock continues to increase, with most ownerships increasing in productivity over 2013 estimates.

Figure 5-51 shows the predicted spatial distribution of black ash and green ash. CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.
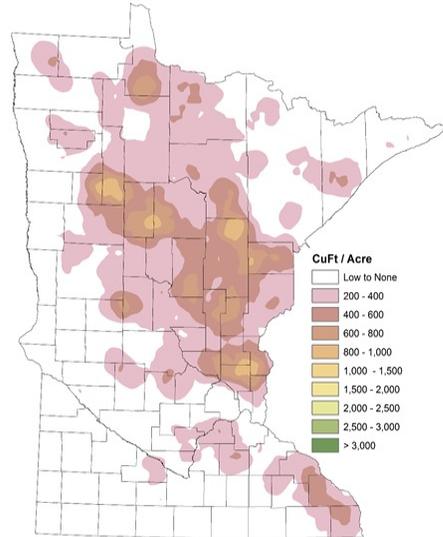
Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

Jack, Red, and White Pine

Minnesota has a substantial and regionally important pine resource, dominated by red pine, jack pine, and white pine (to a lesser extent). Red pine in particular is an important sawtimber species, and occurs primarily in northern Minnesota. Much of the jack and red pine resource is from planted stands with varying degrees of management.

FIGURE 5-52: PINE HARVEST IN MINNESOTA
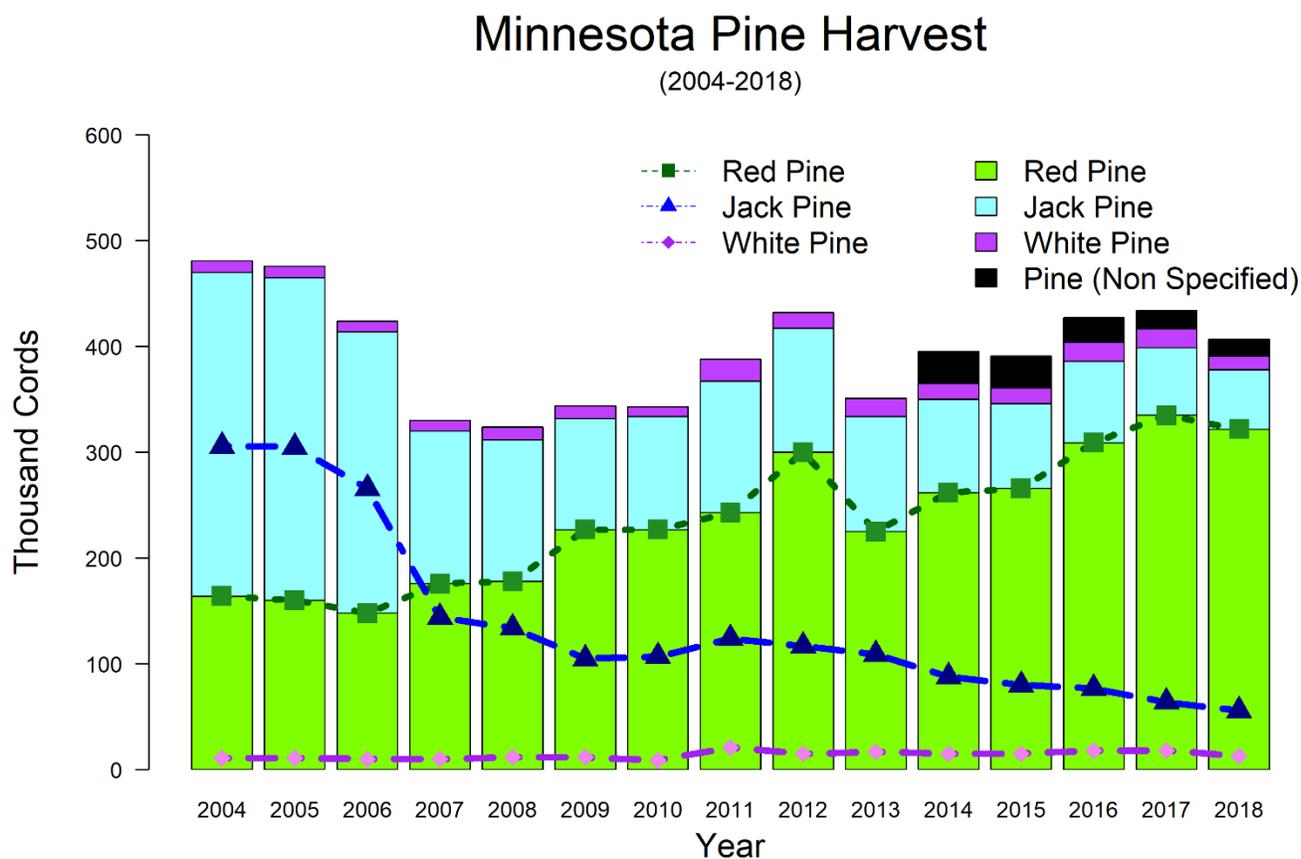
Minnesota Pine Harvest
(2004-2018)

Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Bars represent pine species contribution to total harvest, lines represent actual harvest numbers from 2004-2019. *2018 & 2019 figures based on DRAFT survey data.

Over the past decade, white pine contribution to total harvest has remained relatively steady. Jack pine began a major decline starting in 2007 and continues to decline today. Red pine has gradually increased as jack pine decreased. The decline in jack pine is caused by disease outbreaks such as budworm and inclination to replant other pine species. A rising demand for sawtimber has driven increased red pine harvests. Demand for red pine small-diameter pulpwood fluctuates.

Red Pine

Red pine is dominated by young age classes, mostly in plantations that need periodic thinning. The federal government and private landowners own much of the resource.

FIGURE 5-53: RED PINE TIMBERLAND ACRES BY OWNER AND AGE CLASS 2019 FIA
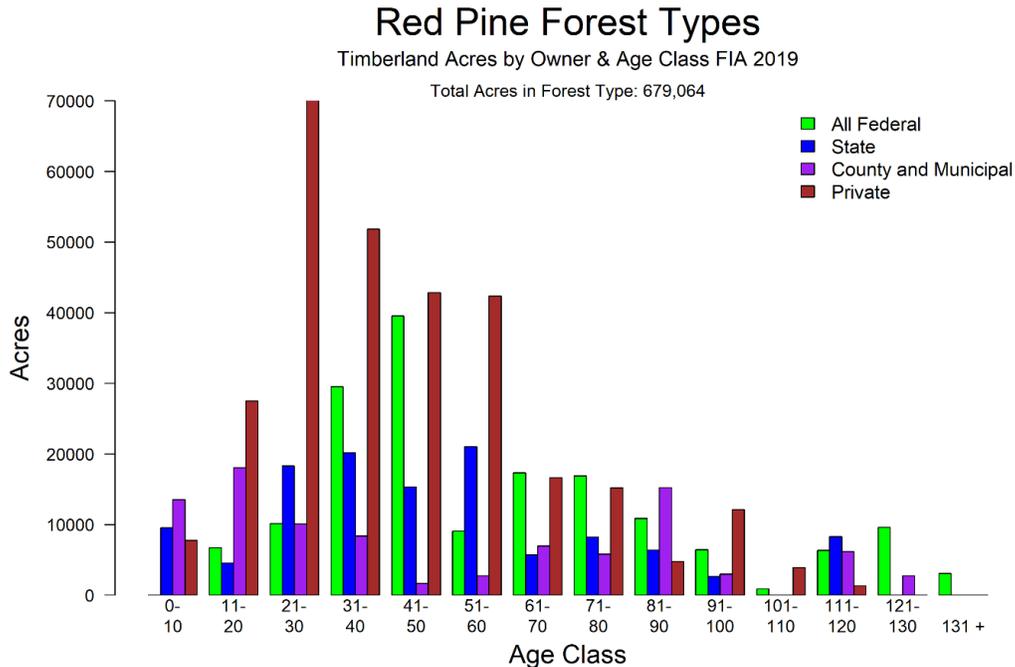
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Current Demand for Red Pine from Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	42,861
2018 Pulpwood Export (To Wisconsin)	8,843
2019 Sawlogs (and est. exports and Other*)	270,481
Total Harvest	**322,184**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

Volume of red pine has increased greatly since 2003 as many plantations have reached merchantable sizes.

FIGURE 5-54: VOLUME OF RED PINE BY DIAMETER AND VOLUME, 2003 AND 2019 FIA
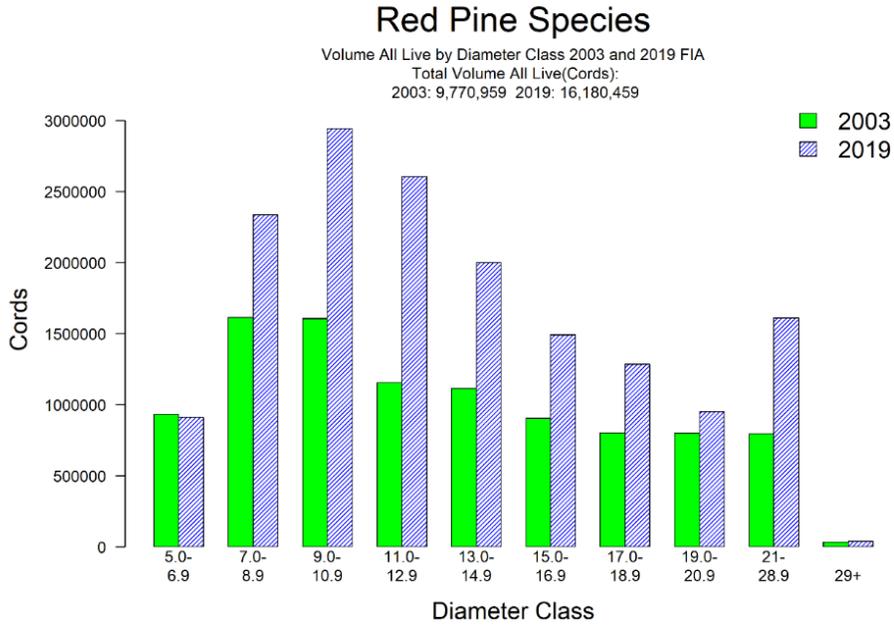
Red Pine Species

Volume All Live by Diameter Class 2003 and 2019 FIA
Total Volume All Live(Cords):
2003: 9,770,959 2019: 16,180,459

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

FIGURE 5-55: RED PINE HARVEST IN MINNESOTA
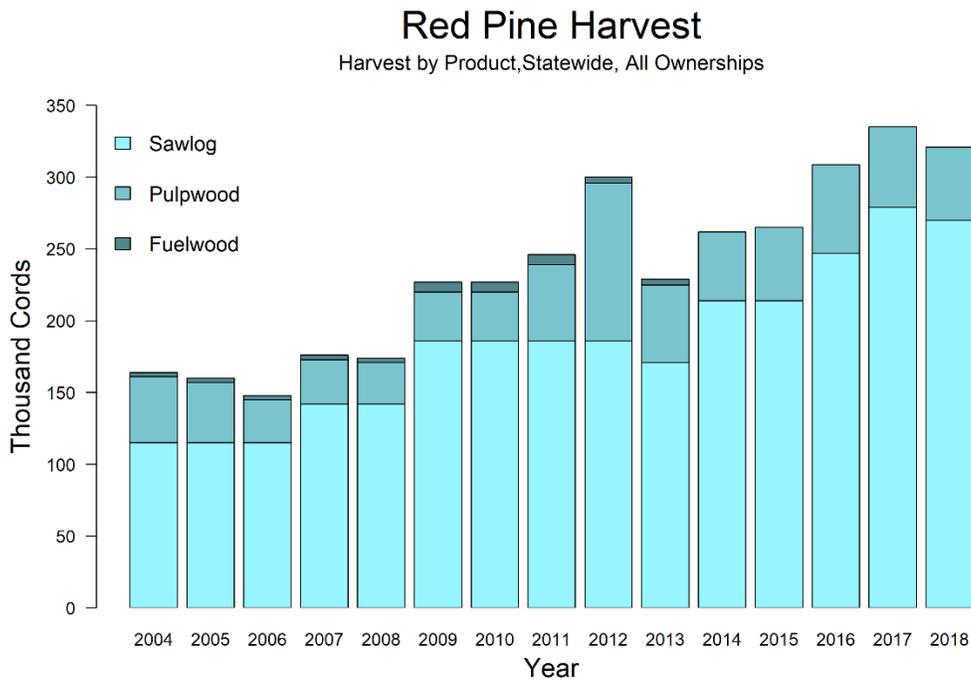
Red Pine Harvest

Harvest by Product, Statewide, All Ownerships

Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy.

The GEIS estimates that the annual sustainable harvest level is approximately 345,000 cords. Based on 2019 FIA data, the average annual net growth of red pine growing stock is 528,899 cords and mortality is 48,335 cords.

Resource Opportunities

- Many red pine stands are moving into size classes that will benefit from additional thinning.
- Red pine plantations demonstrate excellent response to various management techniques. Following basal area recommendations and thinning from below, or above, or in combination, can maintain stand productivity.
- Increasing severity and frequency of droughts will allow bark beetles to chip away at the red pine supply, especially along the western edge of the red pine range.
- Avoid thinning pines during and after severe droughts to minimize mortality.
- Parts of northeastern Minnesota are under gypsy moth quarantine. Loggers and mills should contact the Minnesota Department of Agriculture to learn about compliance agreements.

FIGURE 5-56: VOLUME OF RED PINE GROWING STOCK ON TIMBERLAND
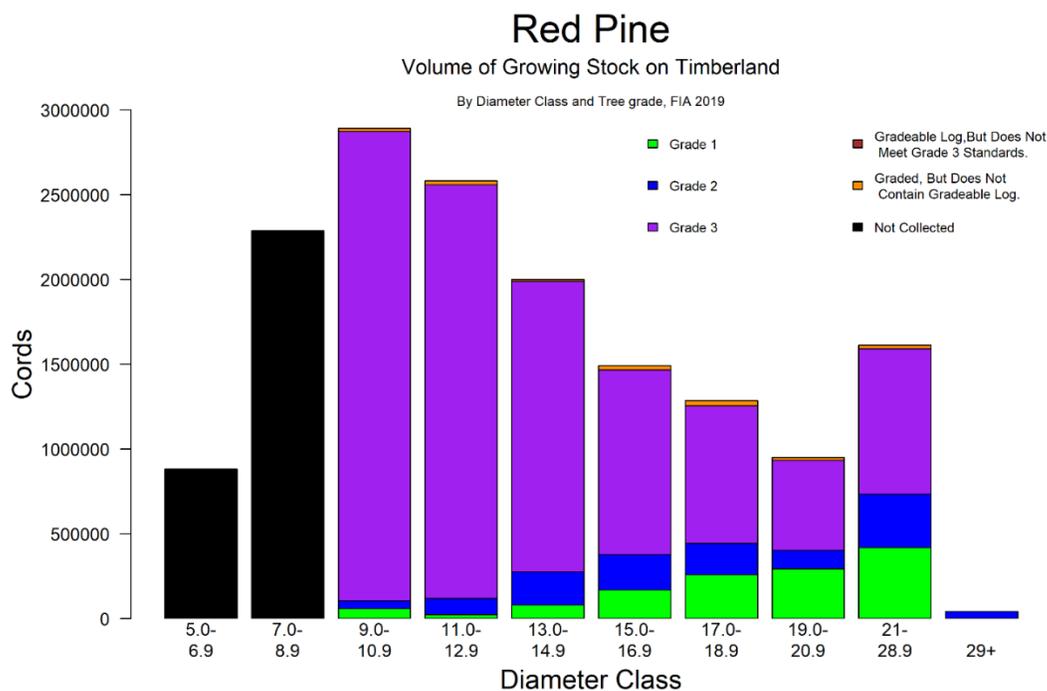
Source: 2019 FIA database provided by U.S. Forest Service, Northern Research Station
Note: Tree grade 1 = highest quality in the U.S. Forest Service tree grading system

Tables 5-9 and 5-10 show AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top diameter) by percent of basal area per acre that is red pine ON FIA PLOTS. These tables show that these forest types can differ significantly and provides some idea of what other species can be harvested within these forest types. This is FIA Red Pine Forest Type. Acres Statewide provides some idea of the relative nature of different percent species compositions within a particular forest type. Only FIA plots age 20 and older were included.

TABLE 5-9: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (NATURAL RED PINE).

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	23,098	52,524	39,709	11,560
Species				
Balsam Fir	1.0	1.5	1.4	0.0
Tamarack	0.0	0.0	0.0	0.0
White spruce	1.0	2.2	0.0	0.0
Black spruce	0.6	0.7	0.2	0.0
Pine (jack, white)	26.3	14.8	14.2	0.0
Red pine	52.4	69.0	78.5	0.0
White cedar	3.0	0.0	0.0	0.0
Aspen (quaking, bigtooth)	4.4	4.3	2.9	0.0
Paper birch	8.7	4.4	1.6	0.0
Balsam poplar	0.0	0.0	0.0	0.0
Basswood	0.4	0.2	0.0	0.0
American elm	0.0	0.0	0.0	0.0
Maple	0.9	1.5	0.2	0.0
Ash	0.1	0.0	0.0	0.0
Oak	1.2	1.4	0.3	0.0
Other	0.0	0.0	0.6	0.0

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

TABLE 5-10: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (PLANTED RED PINE).

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	**8,478**	**47,703**	**108,343**	**183,684**
Species				
Balsam Fir	8.9	3.6	1.8	0.4
Tamarack	0.0	0.0	0.0	0.0
White spruce	1.0	3.9	2.0	0.7
Black spruce	3.2	1.3	0.8	0.0
Pine (jack, white)	7.4	11.0	4.9	1.6
Red pine	68.2	67.5	81.6	95.4
White cedar	0.0	0.0	0.3	0.0
Aspen (quaking, bigtooth)	8.8	8.3	3.9	0.9
Paper birch	2.0	2.4	1.7	0.2
Balsam poplar	0.2	0.2	0.3	0.0
Basswood	0.0	0.3	0.0	0.0
American elm	0.0	0.0	0.2	0.1
Maple	0.2	0.8	0.6	0.1
Ash	0.0	0.0	0.0	0.0
Oak	0.0	0.6	1.1	0.2
Other	0.0	0.1	0.5	0.3

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

Figure 5-57 shows the predicted spatial distribution of red pine CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

FIGURE 5-57: PREDICTED DISTRIBUTION OF RED PINE IN MINNESOTA

Red pine (*Pinus resinosa*)
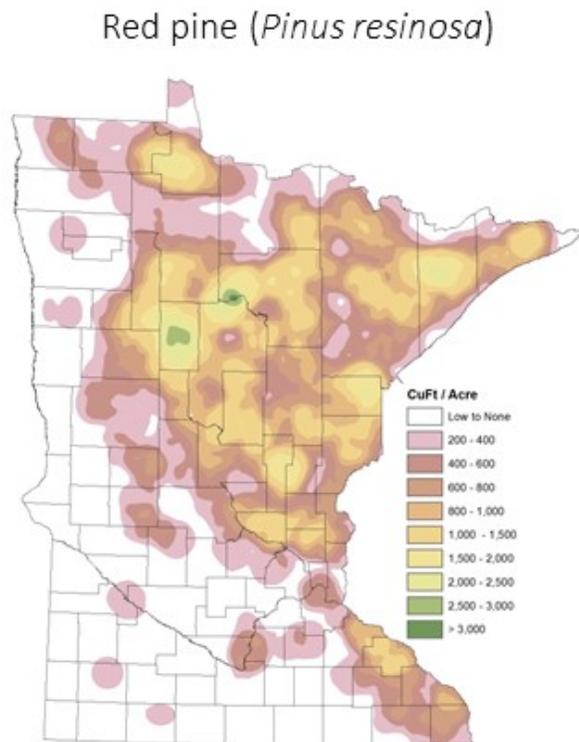
Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

Jack Pine

All ownership groups own jack pine. Private landowners control the largest total acreage, but the federal government controls by far the most acres compared to its total ownership. The jack pine cover type is heavily weighted to the 21 to 60 year age classes. Many stands over age 50 currently need management. Periodic jack pine budworm outbreaks occur in older stands, which can result in heavy mortality and increased fire risk. The current outbreak started in west-central counties in 2015, lasted through 2019, and made more jack pine available.

The accelerated harvest rates in the middle 2000s were necessary to manage forest health, but were unsustainable in the long term. Jack pine harvest levels recently began to decrease, but may be leveling off. Thinning young red pine can replace the slack in jack pine harvest volume.

Based on 2019 U.S. Forest Service FIA data, the average net annual growth of jack pine growing stock is 56,604 cords and the average annual mortality of jack pine growing stock is 85,241 cords.

FIGURE 5-58: JACK PINE TIMBERLAND ACRES BY OWNER AND AGE CLASS, 2019 FIA
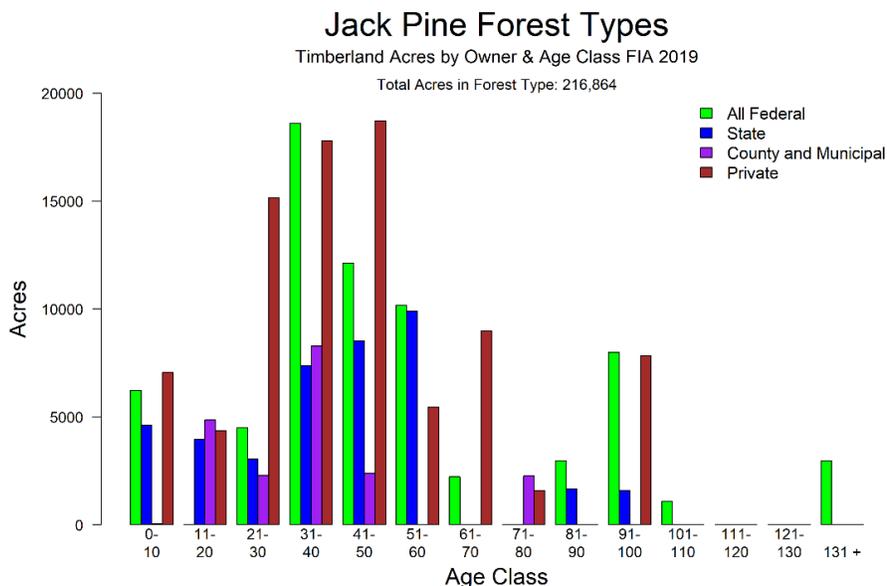
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Current Demand for Jack Pine from Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	17,201
2018 Pulpwood Export (To Wisconsin)	9,347
2019 Sawlogs and Other*	29,807
2019 Fuelwood*	402
Total harvest	**56,757**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

107

FIGURE 5-59: JACK PINE HARVEST BY PRODUCT, ALL OWNERSHIPS

Jack Pine Harvest
Harvest by Product, Statewide, All Ownerships
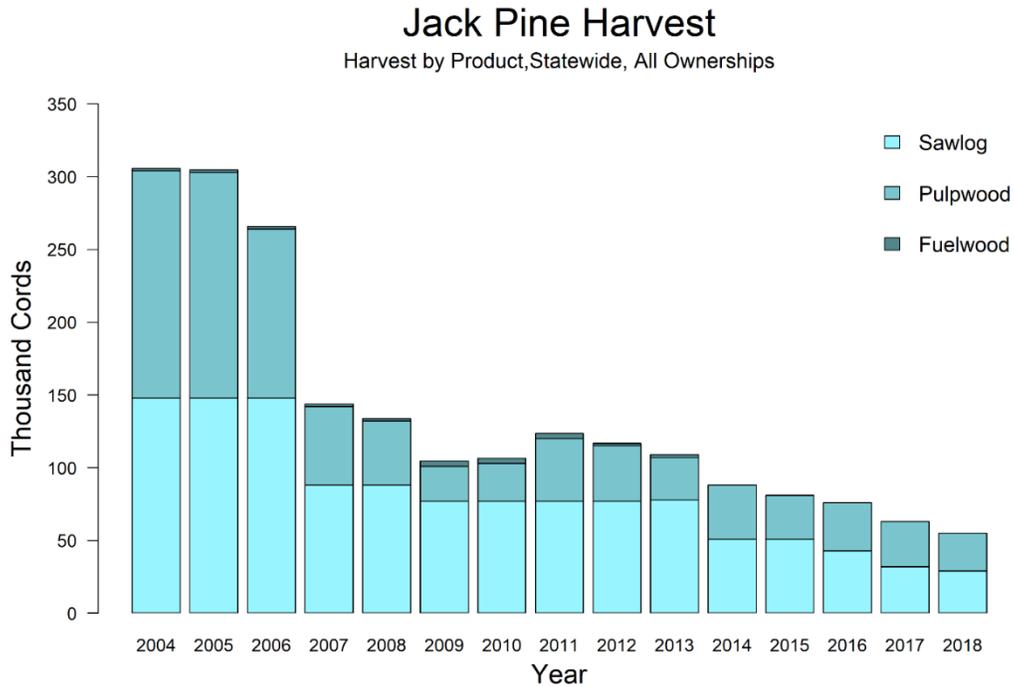
Source: Harvest data (2004-2018) compiled by U.S. Forest Service Northern Research Station and DNR. *2018 estimates based on DRAFT surveys.

FIGURE 5-60: JACK PINE VOLUME BY DIAMETER CLASS, 2003 AND 2019, FIA

Jack Pine Species
Volume All Live by Diameter Class 2003 and 2019 FIA
Total Volume All Live(Cords):
2003: 5,239,170 2019: 3,647,489

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station.

108

Jack pine total volume of all live has declined from 5,239,170 cords in 2003 to 3,647,489 cords in 2019, a 30% decrease relative to 2003 estimates. The vast majority of jack pine volume are trees with diameters smaller than 15 inches.

Table 5-11 shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top DOB) by percent of basal area per acre that is Jack Pine ON FIA PLOTS. This table shows that a Jack pine forest type can differ significantly and provides some idea of what other species can be harvested within these forest types. This is FIA Jack Pine Forest Type. Acres Statewide provides some idea of the relative nature of different percent species compositions within a particular forest type. Only FIA plots age 20 and older were included.

TABLE 5-11: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (JACK PINE).

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	30,995	66,366	58,170	46,943
Species				
Balsam Fir	9.2	7.2	5.3	1.0
Tamarack	0.0	0.5	1.1	0.0
White spruce	3.9	0.7	0.7	0.6
Black spruce	8.7	7.5	3.5	0.8
Pine (red, white)	18.7	12.4	8.5	4.4
Jack pine	37.1	59.2	71.0	89.5
White cedar	0.0	0.0	0.0	0.0
Aspen (quaking, bigtooth)	11.5	6.7	7.9	3.1
Paper birch	4.9	4.2	1.2	0.6
Balsam poplar	0.0	0.1	0.0	0.1
Basswood	0.0	0.0	0.0	0.0
American elm	0.0	0.0	0.5	0.0
Maple	0.3	0.5	0.2	0.0
Ash	0.0	0.5	0.0	0.0
Oak	5.1	0.5	0.1	0.0
Other	0.6	0.0	0.0	0.0

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

Figure 5-61 shows the predicted spatial distribution of jack pine CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

FIGURE 5-61: DISTRIBUTION OF JACK PINE IN MINNESOTA

Jack pine (*Pinus banksiana*)
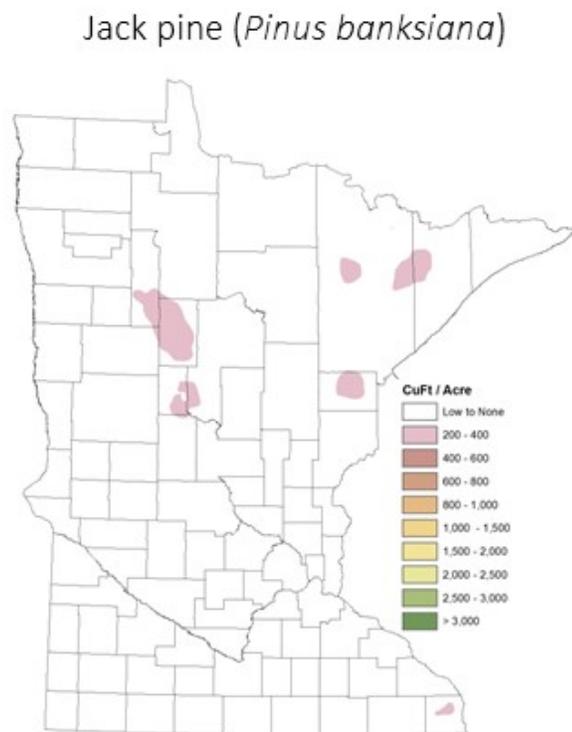
Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

White Pine

The cover type is heavily weighted to age classes of 60 years or more. National forests and private landowners are by far the predominant ownership groups of the white pine cover type.

FIGURE 5-62: WHITE PINE TIMBERLAND ACRES BY OWNER AND AGE CLASS, 2019 FIA

White Pine Forest Types
Timberland Acres by Owner & Age Class FIA 2019
Total Acres in Forest Type: 177,203

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Current Demand for White Pine from Minnesota Timberlands

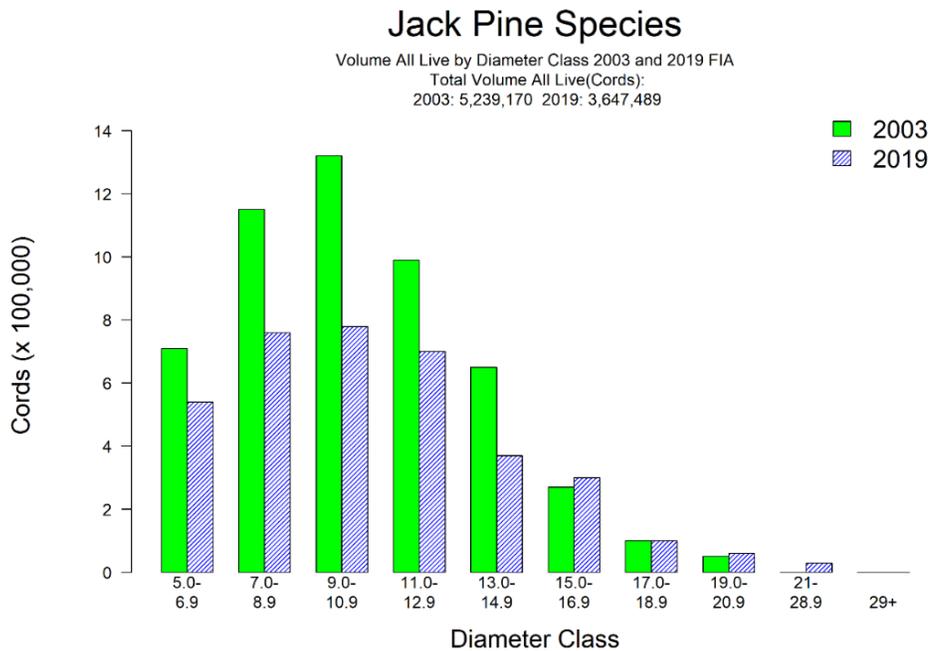| Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	2,657
2018 Pulpwood Export (To Wisconsin)	1,791
2019 Sawlogs and Other*	9,410
Total Harvest	**13,858**

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

111

White Pine Sawtimber Harvest from Minnesota Timberlands (1987-2018)
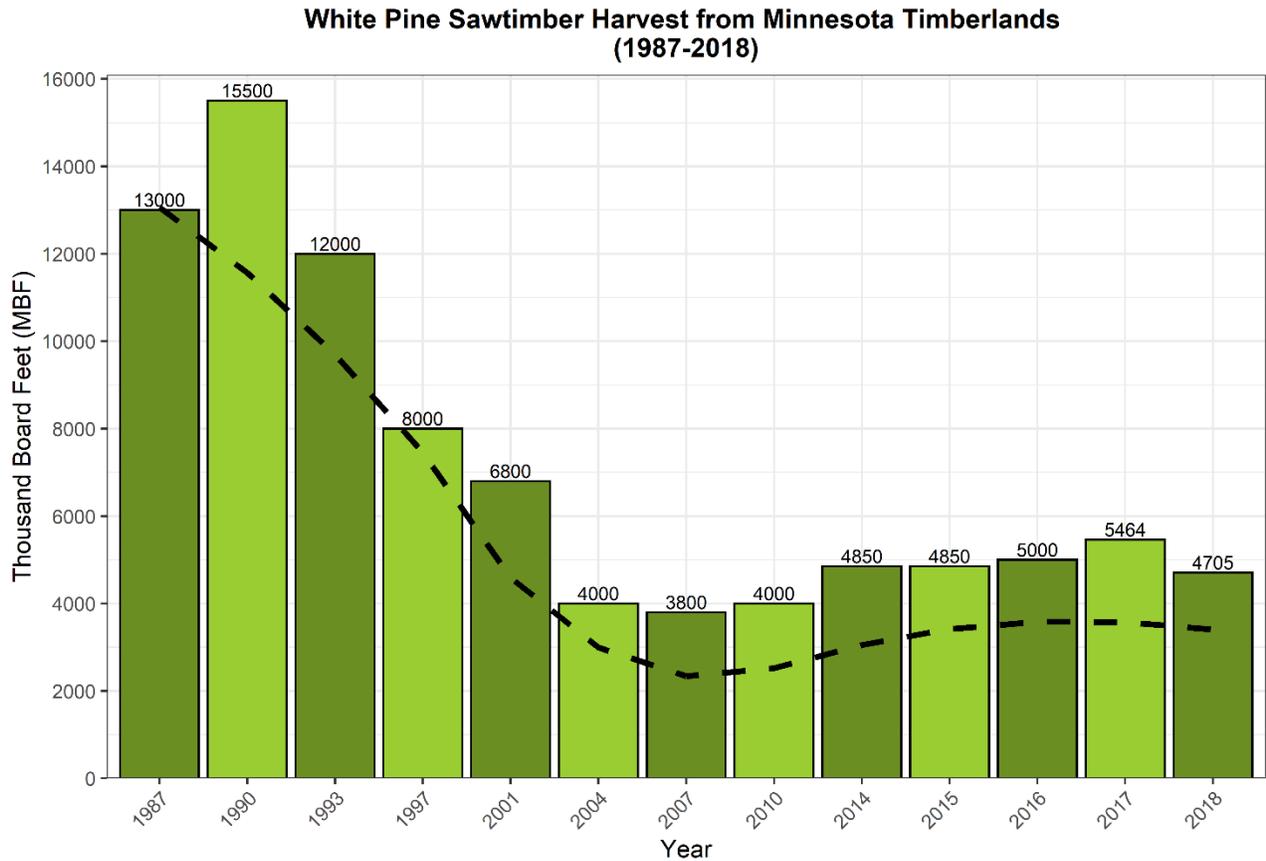
Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, *DRAFT estimate due to surveys includes pulpwood, sawtimber, and wood energy. Dotted black line shows relative trend for reference.

Most white pine volume occurs in the white pine, red pine, aspen and northern hardwoods cover types. The vast majority of white pine volume is in trees with diameters greater than 15 inches. Volume has increased substantially since the 2003 inventory. Based on 2019 FIA data, the average annual net growth of white pine growing stock is 196,090 cords and mortality is 44,982 cords. While the inventory has increased, the harvest of white pine for sawtimber has decreased. Changes in climate may reduce white pine blister rust in parts of the state.

FIGURE 5-64: WHITE PINE BY VOLUME AND DIAMETER, 2003 AND 2019, FIA
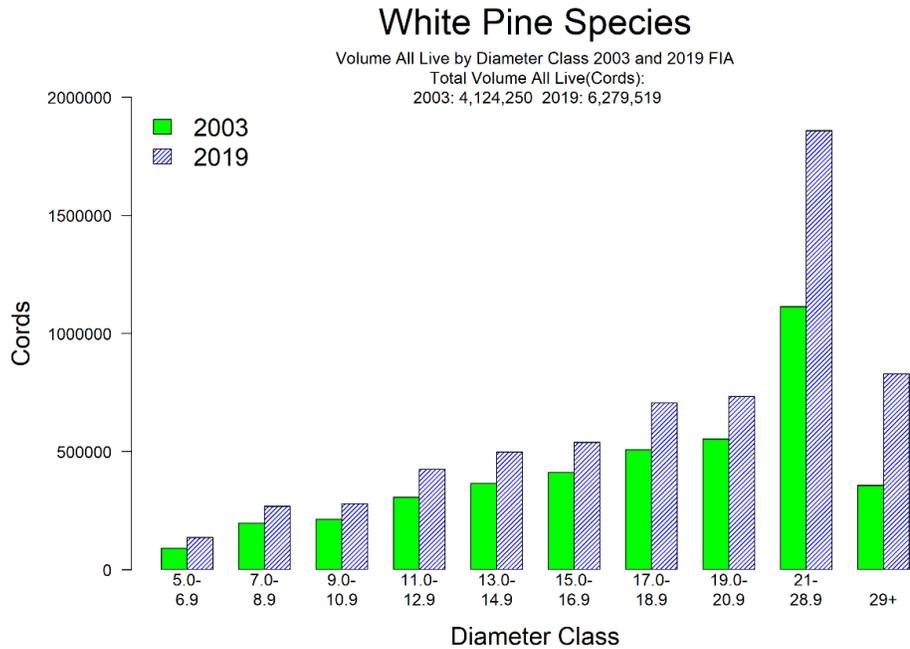
Source: FIA 2019 database provided by U.S. Forest Service Northern Research Station

FIGURE 5-65: WHITE PINE VOLUME ON TIMBERLAND
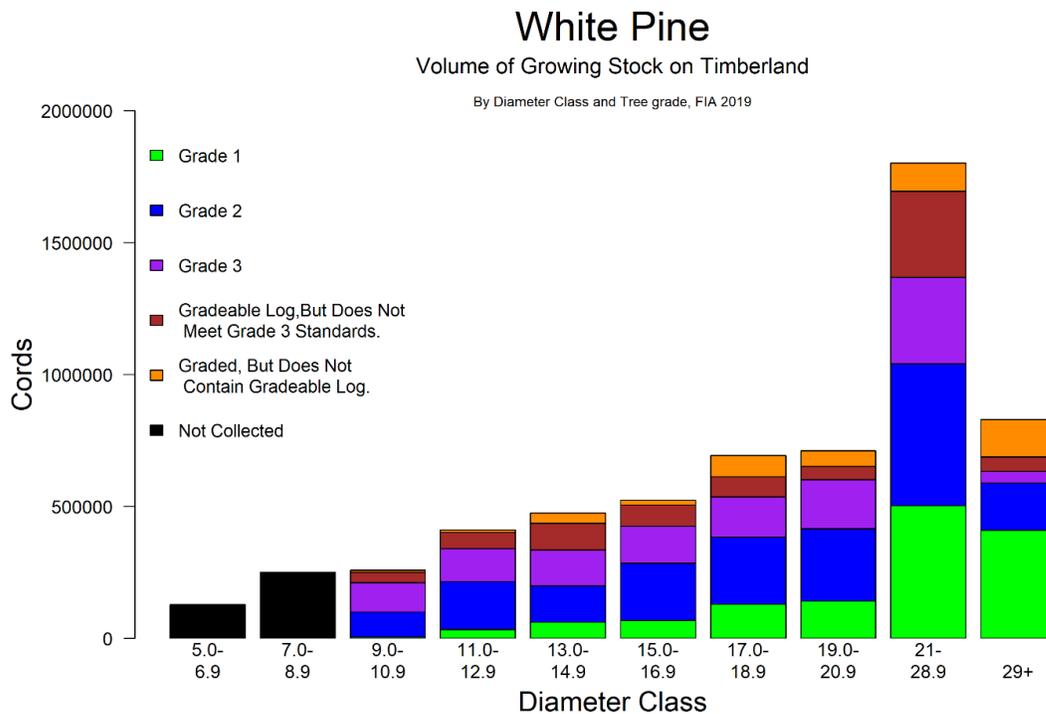
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station
Note: Tree grade 1is the highest quality in the U.S. Forest Service tree grading system

Table 5-12 shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top diameter) by percent of basal area per acre that is white pine ON FIA PLOTS. This table shows that a white pine forest type can differ significantly and provides some idea of what other species can be harvested within these forest types. This is FIA White Pine Forest Type. Acres Statewide provides some idea of the relative nature of different percent species compositions within a particular forest type. Only FIA plots age 20 and older were included.

TABLE 5-12: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (WHITE PINE).

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	29,660	62,635	12,881	5,583
Species				
Balsam Fir	4.7	1.9	3.4	0.0
Tamarack	0.5	0.0	0.0	0.0
White spruce	4.2	2.1	0.8	0.0
Black spruce	2.5	0.6	0.0	0.0
Pine (red, jack)	6.0	12.0	9.9	0.2
White pine	68.6	71.0	72.9	97.8
White cedar	0.0	0.0	0.0	0.0
Aspen (quaking, bigtooth)	4.3	2.7	0.3	0.0
Paper birch	2.8	3.2	3.4	0.0
Balsam poplar	0.0	0.0	1.1	0.0
Basswood	1.9	0.8	0.0	0.0
American elm	0.0	0.0	0.0	0.0
Maple	1.4	1.8	4.1	0.0
Ash	0.3	0.1	0.0	0.0
Oak	0.2	3.0	4.2	0.0
Other	2.5	0.7	0.0	0.0

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

Figure 5-66 shows the predicted spatial distribution of eastern white pine CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.
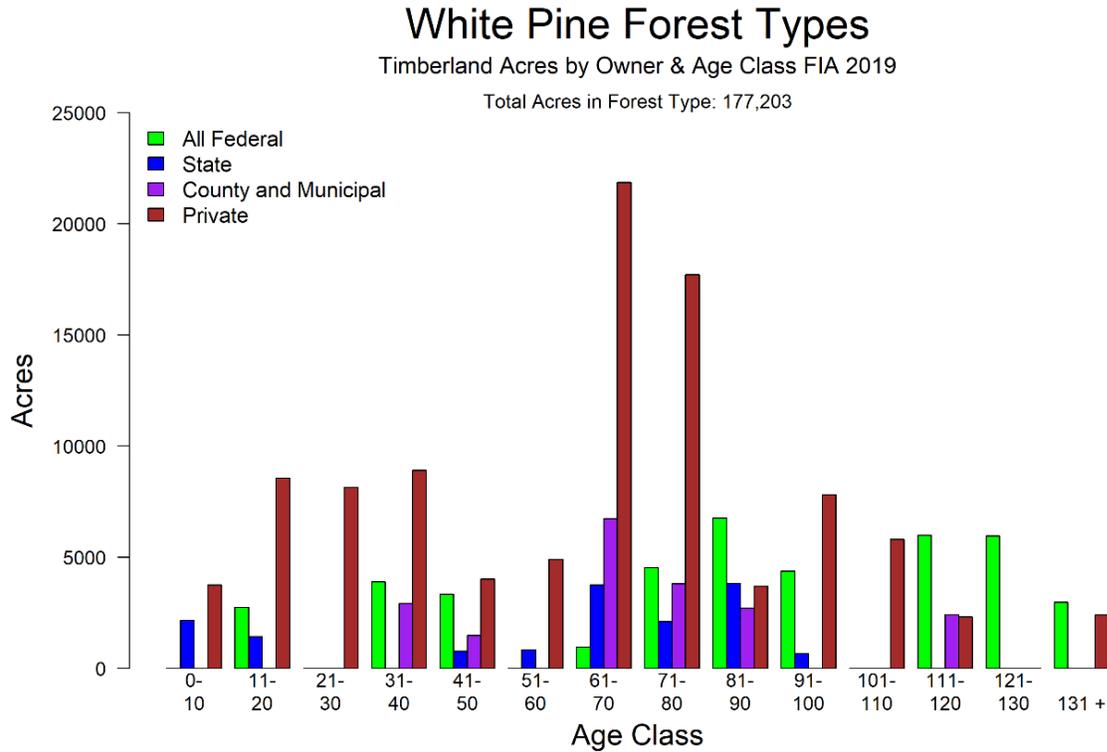
FIGURE 5-66: DISTRIBUTION OF WHITE PINE IN MINNESOTA

White pine (*Pinus strobus*)
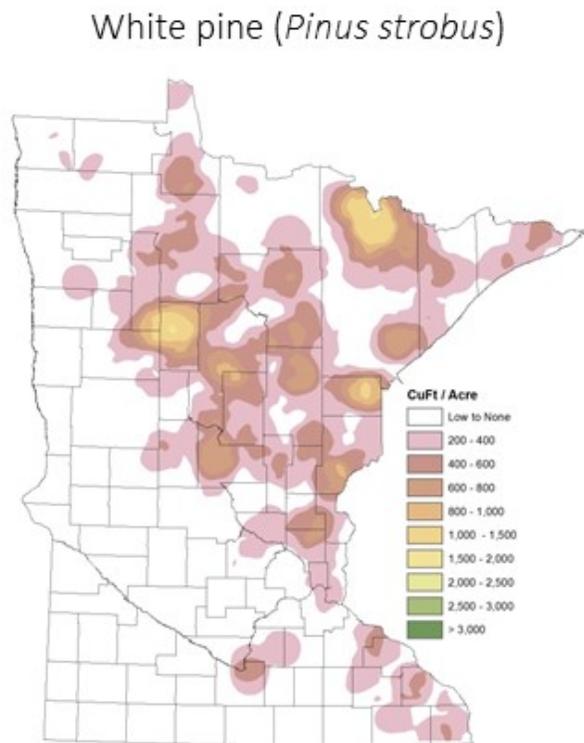
Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

White Cedar

Northern white cedar is a slow-growing, long-lived conifer. The white cedar cover type in Minnesota is located largely in the northeastern third of the state and consists of a variety of species. Cover type volume is dominated by white cedar, includes spruce, tamarack, birch, balsam fir, ash, and several other minor species. Significant volumes of cedar can also be found mixed with other lowland cover types and it also exists as a minor component of some upland cover types. Cedar is significant because it is an in demand timber resource and provides critical habitat for white-tailed deer and many rare plant species, such as the threatened ram's head orchid. Controlled disturbance

FIGURE 5-67: WHITE CEDAR TIMBERLAND ACRES BY OWNER AND AGE CLASS, 2019 FIA
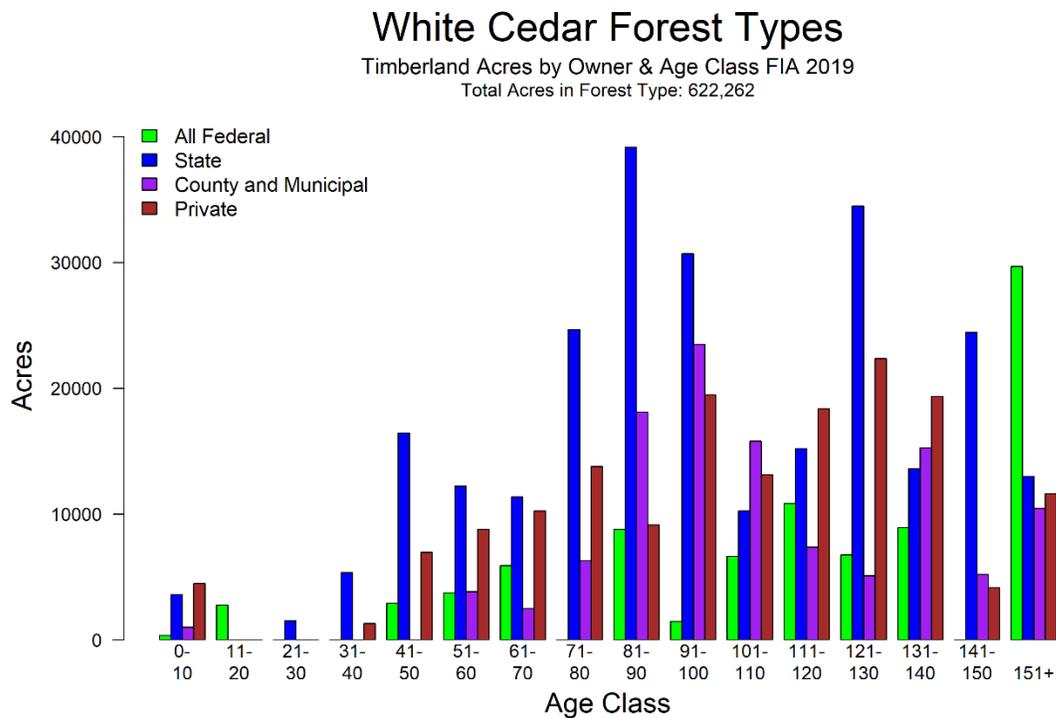
Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Northern white cedar is generally an old resource, and it is getting older. Acres older than 100 have increased from 236,565 in 2003 to 322,008 in 2019. Currently around 13,695 cover type acres are below age 30, or approximately 2% of the cover type acres. Most white cedar grows on very wet

sites with low productivity and slow growth. Heart rot is common in older stands on wet sites. Much of the volume of white cedar is contained in material below 13 inches in diameter.

FIGURE 5-68: NORTHERN WHITE CEDAR HARVEST FROM MINNESOTA TIMBERLANDS
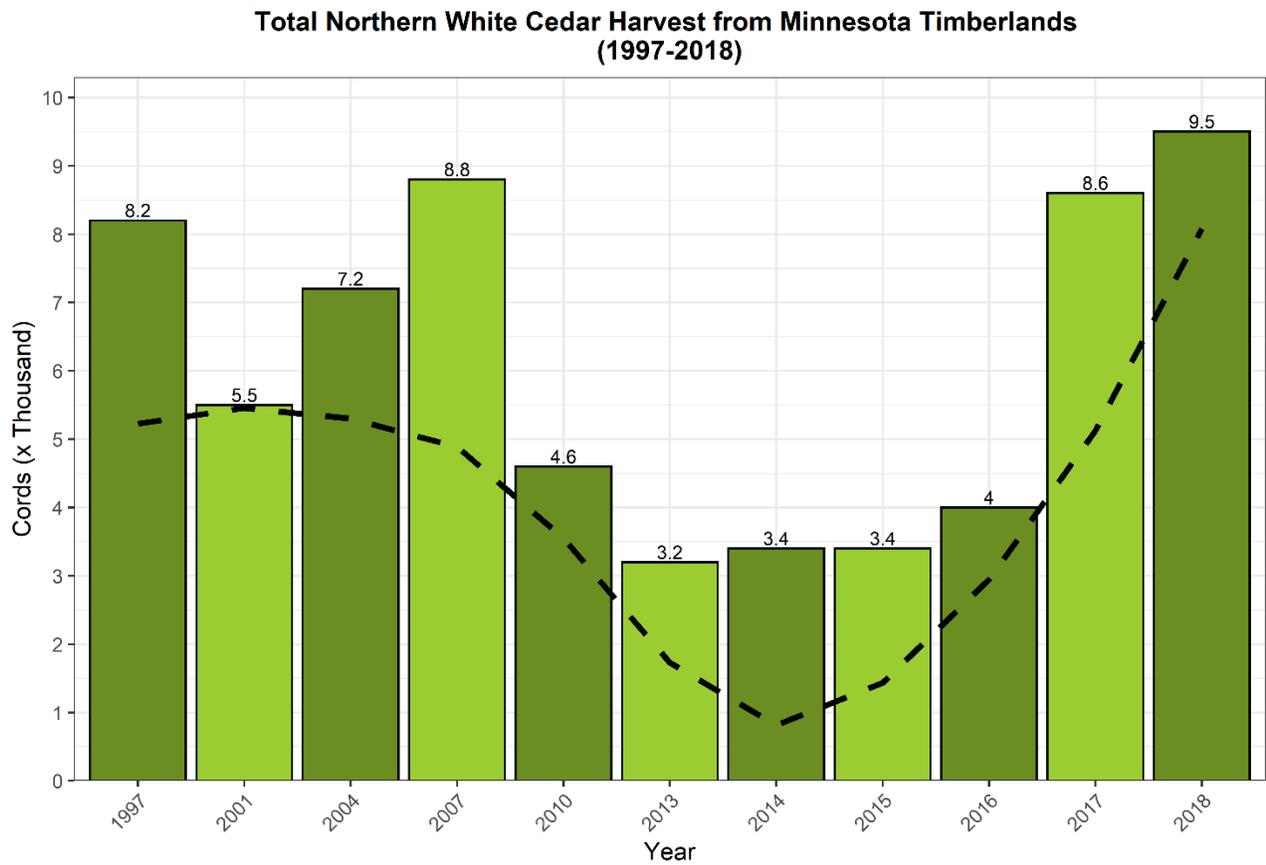
Total Northern White Cedar Harvest from Minnesota Timberlands (1997-2018)

Source: Timber Product Output survey data compiled by U.S. Forest Service Northern Research Station and DNR, Dotted black line shows relative trend for reference.

With limited pulpwood market for cedar (mulch), the small amount of utilization is entirely for sawtimber, specialty products, and fuelwood. Net annual growth for white cedar growing stock is approximately 273,161 cords, and average annual mortality is approximately 68,330 cords, according to the 2019 FIA inventory. Since 2010, annual harvest is less than 5,000 cords, but rising to a 9,504 cord equivalent in 2018, the recent high harvest mark for the species. There is great potential to use and manage white cedar. For the resource to regenerate consistently, managers need to apply existing research and tools.

FIGURE 5-69: WHITE CEDAR SPECIES VOLUME, 2003 AND 2019, FIA
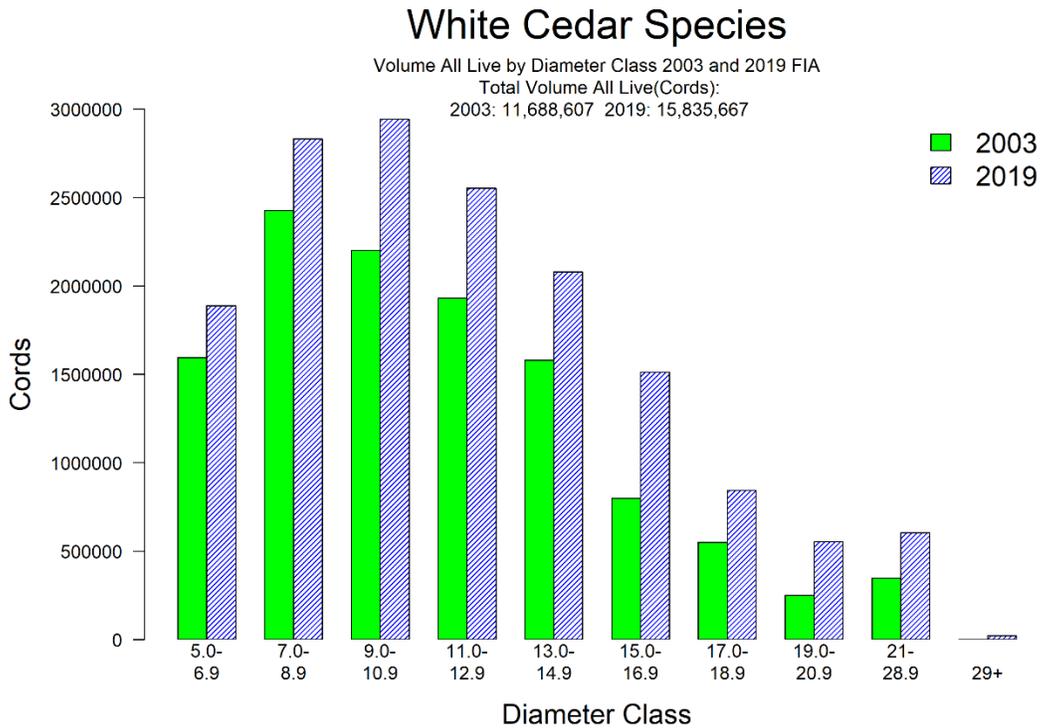
White Cedar Species

Volume All Live by Diameter Class 2003 and 2019 FIA
Total Volume All Live(Cords):
2003: 11,688,607 2019: 15,835,667

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station

Current Demand for White Cedar from Minnesota Timberlands

Harvest Sector	Cords
2018 Minnesota Pulpwood Industries	0
Pulpwood Export (To Wisconsin)	0
2018 Sawlogs and Other	9,504
Total Harvest	9,504

Source: U.S. Forest Service Northern Research Station and DNR Timber Product Output surveys. All surveys DRAFT

Resource Opportunities

- Cedar can be a great fit for some value-added products due to its natural resistance to decay.
- Product markets include fencing, furniture, interior cabin accents, paneling, posts and poles, railings, and rough lumber.

Resource Issues

- White cedar has been a "neglected" resource for many years, mainly because it is difficult to regenerate it consistently on many sites. Cedar regeneration needs more research; studying regeneration response to controlled disturbance could help.

118

- Use of white cedar for industrial products in Minnesota is modest. Limited pulpwood markets (mulch) exist for cedar. The modest amount of utilization in Minnesota is primarily for sawtimber, specialty products, and a small amount for fuelwood.
- Cedar has tremendous importance for wildlife habitat and ecological diversity.
- Cedar is long-lived, and can be difficult to regenerate naturally.

FIGURE 5-70: NORTHERN WHITE CEDAR NET GROWTH AS PERCENT OF GROWING STOCK VOLUME, MINNESOTA
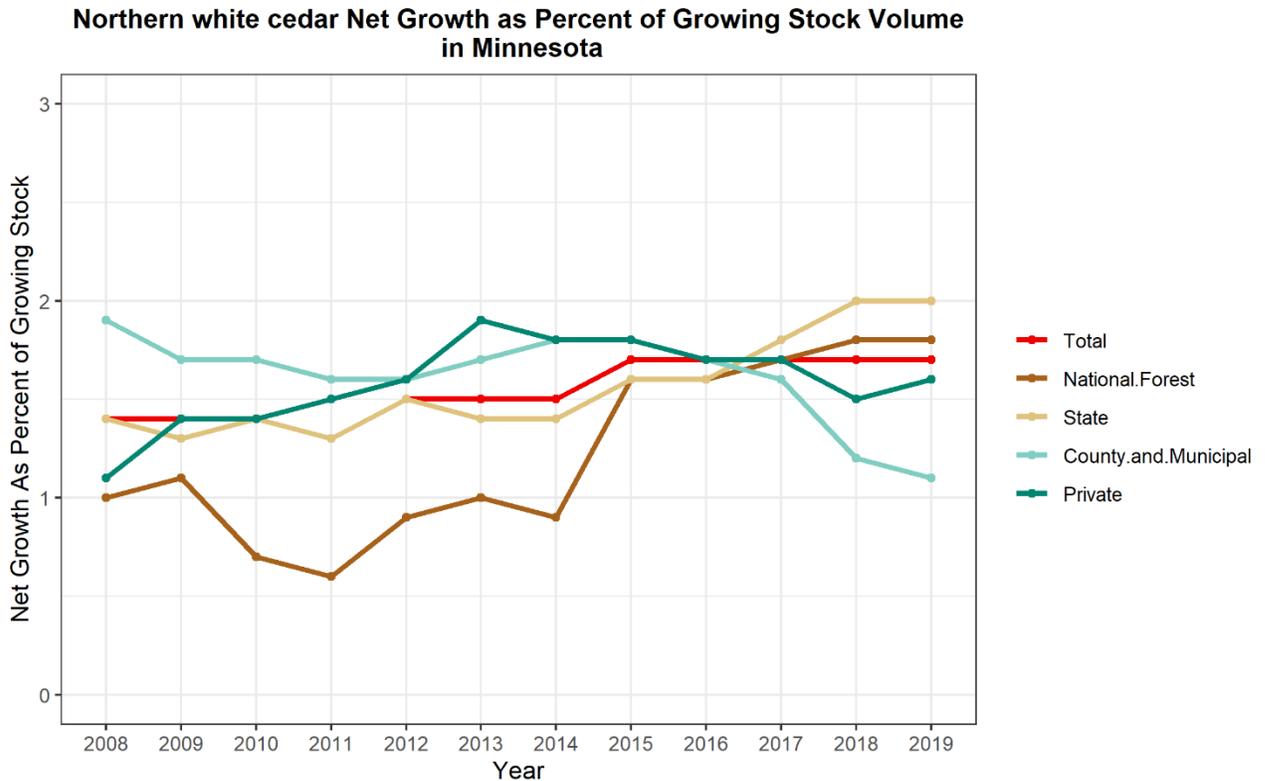
Northern white cedar Net Growth as Percent of Growing Stock Volume in Minnesota

Source: 2019 FIA database provided by U.S. Forest Service Northern Research Station. Net growth, is the result subtracting mortality and non-harvest removals from gross growth, it is estimated from volume change on FIA measured plots. It is turned into a percent by dividing by current inventory and multiplying by 100 to compare between ownerships.

Table 5-13 shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top diameter) by percent of basal area per acre that is northern white cedar ON FIA PLOTS. This table shows that Northern White Cedar forest type can differ significantly and provides some idea of what other species can be harvested within these forest types. This is FIA Northern White Cedar Forest Type. Acres Statewide provides some idea of the relative nature of different percent species compositions within a particular forest type. Only FIA plots age 35 and older were included.

TABLE 5-13: AVERAGE PERCENT SPECIES COMPOSITIONS BY MERCHANTABLE VOLUME BY PERCENT OF BASAL AREA PER ACRE (NORTHERN WHITE CEDAR).

Percent of basal area per acre	< 25%	25 – 50%	50 – 75%	>75%
Acres Statewide	31,822	137,780	231,578	252,171
Species				
Balsam Fir	12.9	6.8	2.1	1.1
Tamarack	3.8	2.1	6.6	3.1
White spruce	3.0	1.7	1.1	0.5
Black spruce	3.6	4.0	4.2	2.4
Pine (red, jack, white)	0.0	2.2	0.1	1.3
White cedar	61.4	65.2	78.0	86.9
Aspen (quaking, bigtooth)	1.6	2.8	1.1	0.9
Paper birch	6.1	8.0	4.0	2.1
Balsam poplar	0.3	1.5	0.4	0.4
Basswood	0.0	0.0	0.0	0.0
American elm	0.3	0.1	0.0	0.0
Maple	1.0	0.7	0.1	0.0
Ash	4.9	3.2	1.8	0.9
Oak	0.0	0.0	0.0	0.0
Other	1.1	1.7	0.4	0.4

Source: 2018 FIA database provided by U.S. Forest Service Northern Research Station

Figure 5-71 shows the predicted spatial distribution of northern white cedar CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map does not necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

FIGURE 5-71: DISTRIBUTION OF NORTHERN WHITE CEDAR IN MINNESOTA

Northern white cedar (*Thuja occidentalis*)
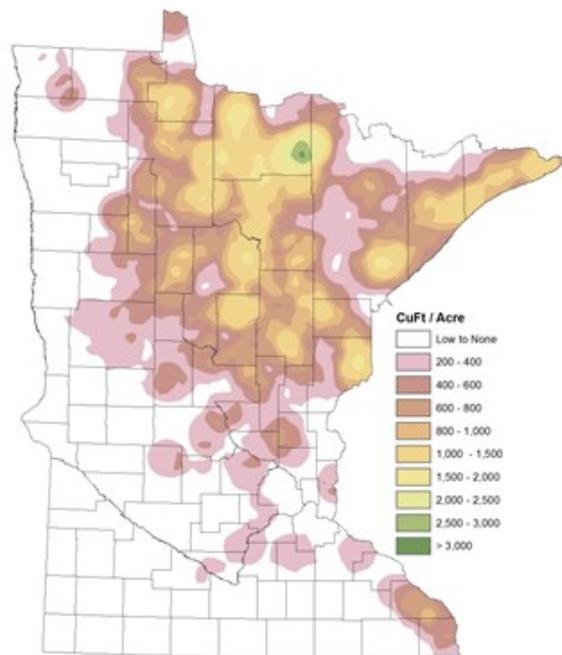
Source: 2017 FIA database provided by U.S. Forest Service Northern Research Station

Chapter 6 Utilization Trends

Credit: Travis Novitsky, Cook County, Minnesota

A brief overview of the trends in utilization for select species.

Utilization Trends

Understanding trends in utilization provides valuable tools for a range of forest stakeholders.

Trends in utilization are evaluated using both localized regression models that show trends that are more recent and linear models to demonstrate the overall direction of the harvest trend (utilization history). Understanding recent and long-term trends helps to interpret the availability of a resource, and gives stakeholders a tool to pinpoint issues and manage forest policy decisions.

Linear and local regressions fit using R package "ggplot2".

Hardwoods

Maple and ash species have shown a general increase in utilization. While both oak species and basswood (*Tilia americana*) show a downward trend over time (Hardwood-General Linear Model). In the last seven years, basswood has shown an increase in utilization (Hardwood-local regression figure).

FIGURE 6-1: TRENDS IN HARDWOOD UTILIZATION (LOCALIZED REGRESSION)
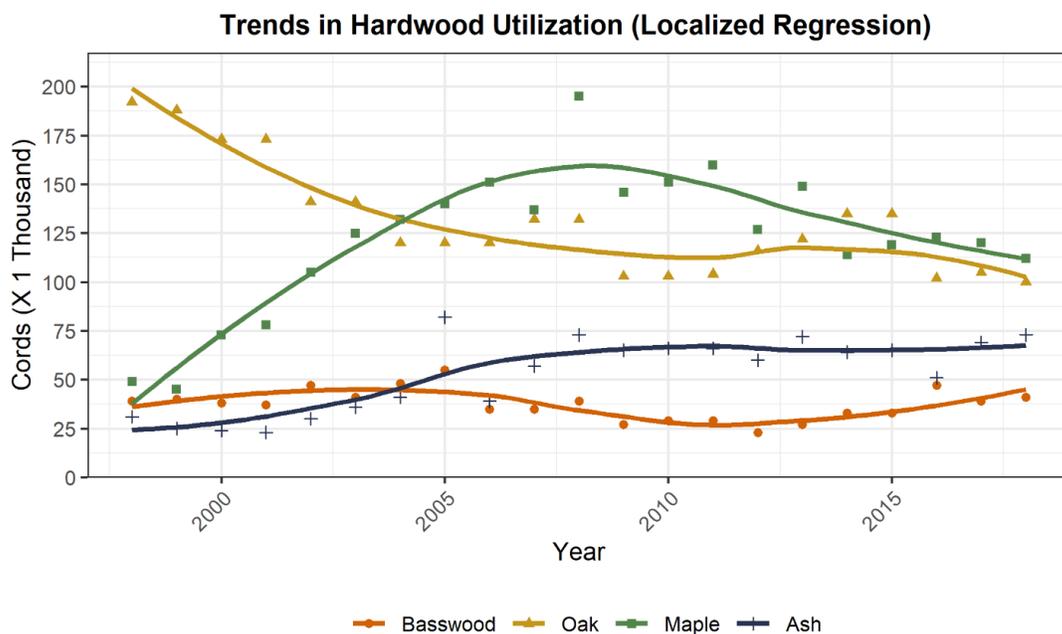
Source: Timber Product Output draft survey data by U.S. Forest Service Northern Research Station and DNR compiled in Minnesota Forest Resources Reports

123

FIGURE 6-2: TRENDS IN HARDWOOD UTILIZATION (GENERAL LINEAR MODEL)
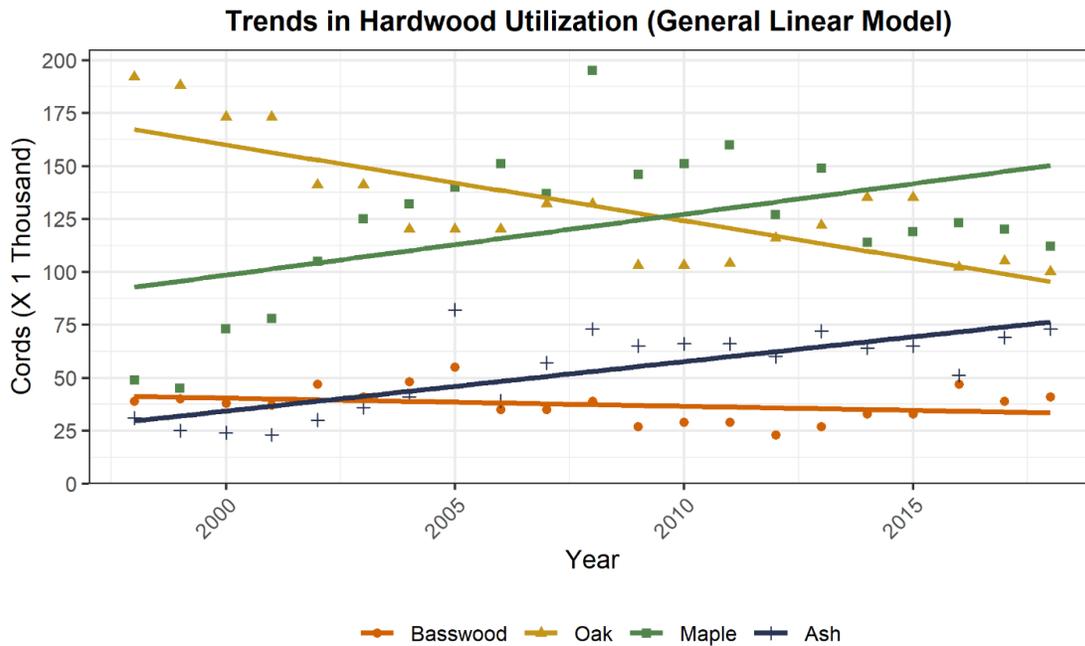
Source: Timber Product Output draft survey data by U.S. Forest Service Northern Research Station and DNR compiled in Minnesota Forest Resources Reports

Softwoods

Softwood species such as spruce have generally trended up (both short and long term), while balsam fir (*Abies balsamea*) has trended downward. Long-term tamarack and white cedar utilization have remained flat. In recent years white cedar has seen an increase in utilization (2018 vs 2017 estimates), while tamarack demand has decreased by approximately 50% since 2014. In the very recent past, tamarack saw a sharp increase in utilization year over year. (2018 vs. 2017).

FIGURE 6-3: TRENDS UTILIZATION FOR SOFTWOODS (LOCAL REGRESSION)

Source: Timber Product Output draft survey data by U.S. Forest Service Northern Research Station and DNR compiled in Minnesota Forest Resources Reports

FIGURE 6-4: TRENDS UTILIZATION FOR SOFTWOODS (GENERAL LINEAR MODEL)
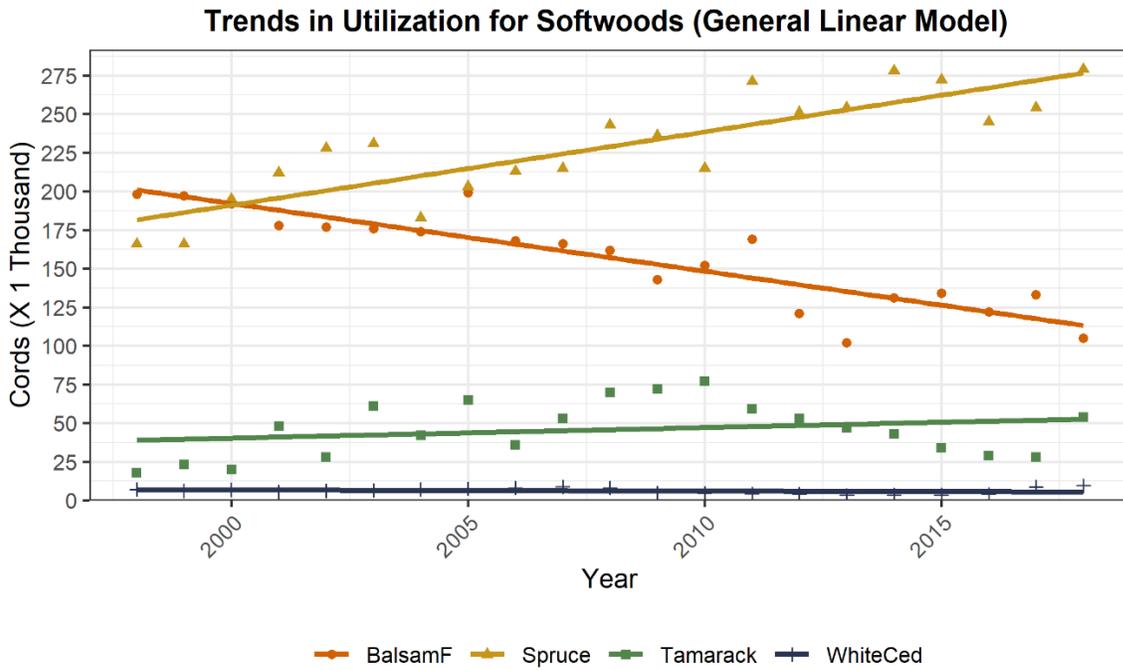
Source: Timber Product Output draft survey data by U.S. Forest Service Northern Research Station and DNR compiled in Minnesota Forest Resources Reports

Pines

Red pine (*Pinus resinosa*) utilization has increased, while jack pine (*Pinus banksiana*) has decreased. White pine (*Pinus strobus*) utilization has remained flat.

FIGURE 6-5: TRENDS IN UTILIZATION FOR PINES (LOCAL REGRESSION)
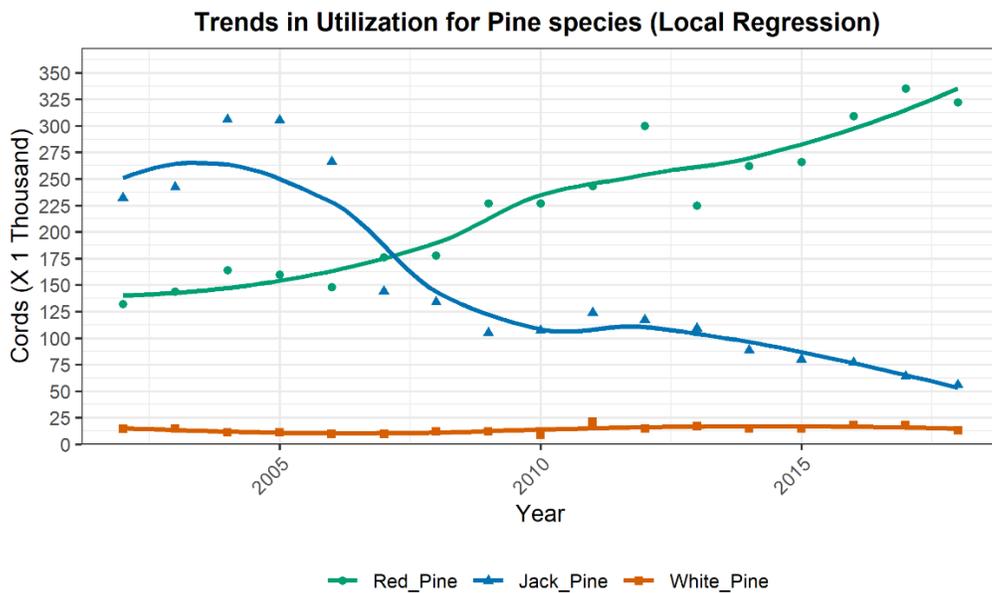
Source: Timber Product Output draft survey data by U.S. Forest Service Northern Research Station and DNR compiled in Minnesota Forest Resources Reports

FIGURE 6-6: TRENDS IN UTILIZATION FOR PINES (GENERAL LINEAR MODEL)
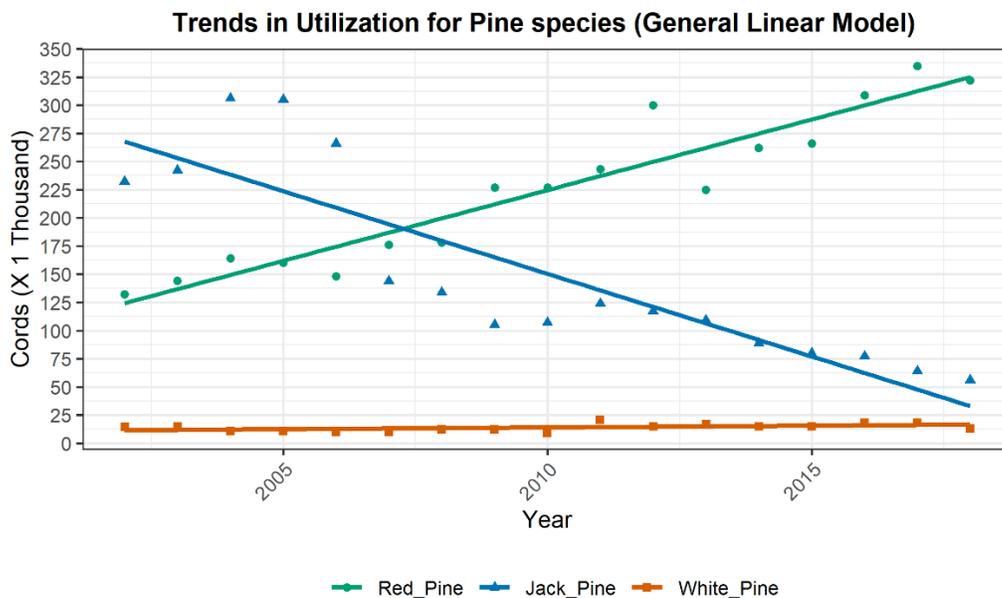
Source: Timber Product Output draft survey data by U.S. Forest Service Northern Research Station and DNR compiled in Minnesota Forest Resources Reports

Aspen and Balm of Gilead

The most utilized species in Minnesota are aspen (bigtooth and quaking, with quaking being the most abundant), and balsam poplar (*Populus balsamifera*), which is typically included with aspen utilization figures. Compared to levels 20 years ago, aspen has decreasing in utilization (aspen-general linear model), but has remained static for the last decade (aspen localized model) where there has been some modest increase in utilization since the low in 2009.

FIGURE 6-7: TRENDS IN ASPEN AND BALM OF GILEAD (LOCALIZED REGRESSION)
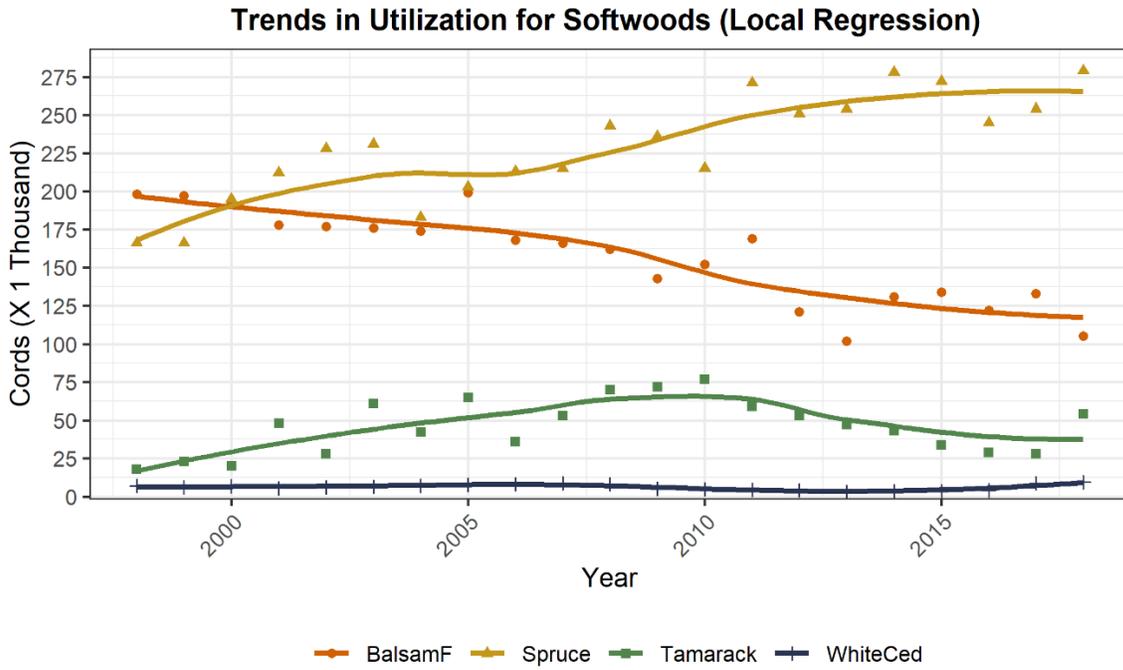

Source: Timber Product Output draft survey data by U.S. Forest Service Northern Research Station and DNR compiled in Minnesota Forest Resources Reports

FIGURE 6-8: TRENDS IN ASPEN AND BALM OF GILEAD (GENERAL LINEAR MODEL)

Source: Timber Product Output draft survey data by U.S. Forest Service Northern Research Station and DNR compiled in Minnesota Forest Resources Reports
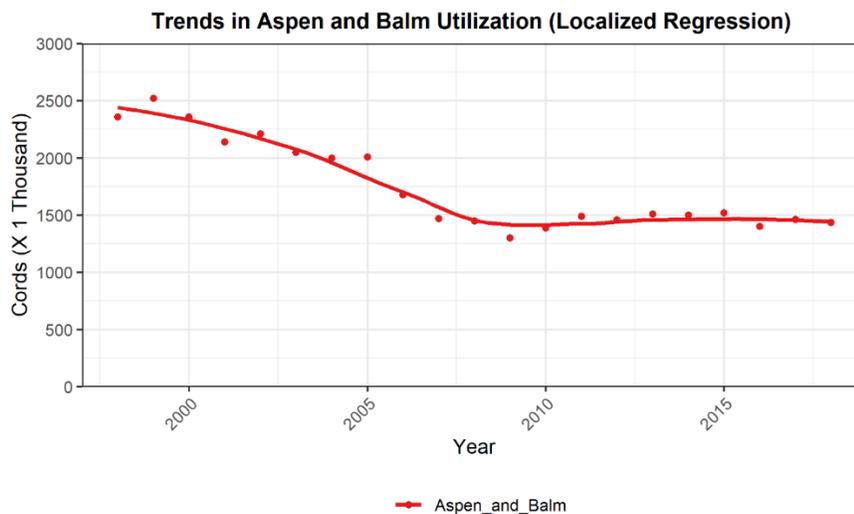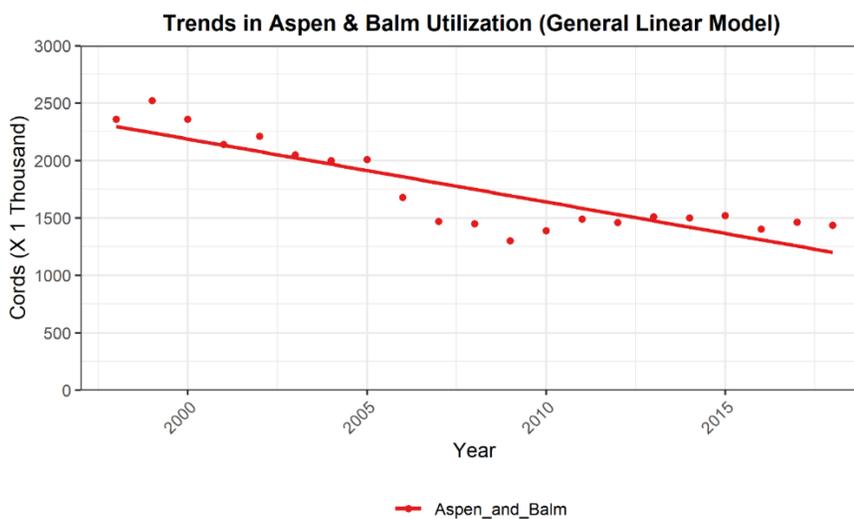
Chapter 7 Timber Price Information

Average Prices Received by Product for Stumpage Sold by Public Land Agencies in Minnesota between 2009 and 2019.

Average Prices Received for Stumpage Sold by Public Land Agencies in Minnesota: 2009-2019

Average prices based on those reported by Minnesota counties (Aitkin, Becker, Beltrami, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Itasca, Koochiching, Lake, Pine, St. Louis, and Wadena), the Chippewa and Superior National Forests, the Bureau of Indian Affairs, and Minnesota DNR–Division of Forestry. The annual Minnesota Public Stumpage Price Review shows agency-specific prices.

Reporting agencies follow different fiscal years and product specifications. Some agencies report their data based on appraised volume estimates; others report based on actual scale receipts. All prices presented as reported.

Use caution when comparing prices shown in these tables with actual prices received or expected on any specific timber sale. See the "DNR Timber Sales Calendar and Archive for recent timber auction results.

TABLE 7-1: PULPWOOD ($ PER CORD)

Table 7-1. Pulpwood ($ per cord)

Species	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Aspen	23.07	25.16	25.55	25.58	24.99	30.62	36.08	34.26	34.33	32.09	28.55
Balm	20.83	21.22	20.01	22.77	20.56	24.8	27.68	24.29	30.56	25.55	25.59
Birch	9.17	8.48	9.41	9.31	8.44	9.89	12.02	13.77	11.33	10.65	10.14
Ash	8.73	6.97	7.41	6.26	6.62	6.82	6	8.07	6.69	7.19	6.32
Oak	15.32	13.41	11.29	11.69	15.44	13.1	14.63	17	16.61	20.61	17.19
Basswood	8.1	7.5	7.58	6.61	9.16	8.82	12.51	8.26	8.49	7.87	8.17
Mixed/Other Hardwoods	11.78	12.29	10.58	10.24	10.59	12.44	11.45	8.06	14.38	6.80	8.9
Balsam Fir	14.67	16.1	17.91	14.19	9.86	10.62	14.18	14.76	16.71	14.64	13.28
W. Spruce	17.44*	21.58*	17.91	15.12	17.57	16.55	19.09	17.25	23.00	20.90	19.88
B. Spruce			23.14	17.77	19.22	16.8	22.63	24.87	24.90	23.11	23.55
Tamarack	5.01	5.03	5.51	6.2	5.05	5.4	7.81	6.26	7.81	5.45	5.35
W. Cedar	5.44	6.19	8.21	5.12	7.86	5.3	6.41	6.8	5.20	5.47	4.97
Jack Pine	13.02	17.21	8.06	16.03	13.5	13.41	15.66	14.2	16.00	15.02	19.32
Red Pine	16.22	9.08	19.25	10.27	15.5	12.44	18.59	11.84	12.30	10.87	6.85
White Pine	-	-	5.37	10.81	13.01	16.56	12.78	15.91	8.44	7.31	9.87
Maple	8.06	9.21	8.99	8.18	9.91	9.82	10.13	12.31	10.47	11.26	10.19

*Spruce species
- Insufficient data

FIGURE 7-1: PULP PRICE FOR SELECT SPECIES (2006-2019)

Pulp Price for Select Species
(2006-2019)
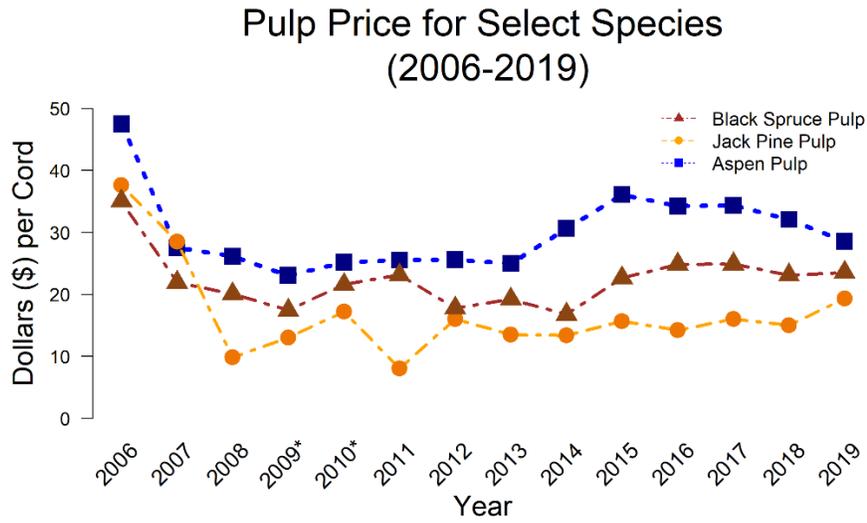
Source: DNR public price stumpage reports 2019

In 2019, across all species and as reported on public lands, 41,783.5 tons of biomass was sold for bioenergy consumption with an average price of $1.28 per ton.

TABLE 7-2: PULP AND BOLTS IN COMBINATION ($ PER CORD)

Table 7-2. Pulp and Bolts[12] in Combination ($ per cord)

Species	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Aspen	36.79	0	0	0	0	36.16	44.24	46.49	39.24	56.73	0
Balm	0	0	0	0	0	0	0	66.8	0	0	0
Birch	13.01	14.48	15.54	14.24	15.17	15.31	17.98	18.11	20.35	16.76	16.90
Ash	10.1	17.41	18.23	18.39	15.81	11.59	14.66	12.55	13.47	12.06	10.56
Oak	21.25	21.49	19.95	20.45	22.2	23.62	27.01	31.71	28.72	28.57	27.63
Basswood	11.62	13.15	10.7	11.58	13.78	12.03	14.52	16.62	15.91	13.56	11.84
Mixed/Other Hardwoods	0	0	18.75	17.3	14.32	16.02	15.67	17.15	16.77	16.57	14.38
Balsam Fir	21.91	23.44	20.39	20.78	16.65	17.93	23.97	24.73	21.70	24.03	21.19
W. Spruce	23.37**	26.54**	24.99	24	25.48	29.57	25.73	27.63	32.82	26.99	27.22
B. Spruce			0	26.91	24.65	27.9	30.48	41.36	27.87	27.10	27.82
Tamarack	0	0	0	16.57	12.75	15.54	13.87	0	15.31	9.82	7.90
W. Cedar	11.65	0	0	0	0	13.04	0	12.07	12.75	8.77	9.18
Jack Pine	25.41	28.34	28.03	29.84	27.31	32.06	30.88	34.03	32.19	28.63	27.73
Red Pine	29.32	31.04	36.29	32.01	40.48	43.09	43.78	37.71	39.73	40.30	38.64
White Pine	-	-	37.95	27.51	36.9	24.95	39.21	28.7	16.68	26.62	30.16
Maple	16.59	17.41	13.86	12.94	13.76	13.57	18.11	17.82	16.19	16.21	16.78

*Spruce species
- Insufficient data

---

[12] A bolt is a short log, usually 100 inches long, with a specific minimum top diameter.

TABLE 7-3: SAWTIMBER ($ PER THOUSAND BOARD FEET)

Table 7-3. Sawtimber ($ per Thousand Board feet (MBF)[13]

| Species	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Aspen	51.11	33.67	52.11	53.48	53.12	0	0	0	0	0	72.00
Balm	0	0	0	0	0	0	0	0	0	0	0
Birch	19.82	38.92	42.15	35.7	36.97	47.04	42.84	45.24	0	61.23	53.33
Ash	51.89	56.27	58.09	36.12	34.06	73.41	54.17	97.67	72.20	196.37	149.81
Elm	53.99	45.08	60.43	42.45	41.41	42.19	42.5	42.54	39.77	54.75	54.07
Oak[14]	193.6	243.1	232.2	225.4	274.5	411.3	265.5	299.03	195.16	194.63	213.20
Basswood	66.24	63.47	66.11	55.87	54.44	68.87	59.24	80.40	104.38	69.55	59.18
Mixed/Other Hardwoods	37.72	29.8	48.31	36.88	28.56	65.4	47.87	47.04	50.28	47.30	78.78
Balsam Fir	58.34	0	0	0	66.51	0	0	0	0	0	0
W. Spruce	87.05*	102.15*	64.23	83.12	87.57	61.12	74.68	73.59	67.58	76.14	83.77
B. Spruce			0	0	0	0	0	0	0	0	0
Tamarack	0	0	0	0	0	0	0	0	0	0	0
W. Cedar	0	0	0	0	0	0	0	0	0	0	0
Jack Pine	106.2	0	145.76	139	112	89.56	0	118.77	139.76	109.56	109.34
Red Pine	107.4	123.4	142.33	121.5	127.1	148.3	177.2	133.22	142.72	144.41	143.27
White Pine	-	-	82.55	106.7	112.8	121.3	88.92	117.50	82.28	127.44	100.32
Maple	81.48	219.8	160.78	292.1	70.92	406.7	126.7	168.50	153.04	95.21	0

*Spruce species
- Insufficient data

---

[13] Includes veneer for certain hardwood species
[14] Primarily for lands in southeastern Minnesota

FIGURE 7-2: SAWTIMBER PRICE FOR SELECT SPECIES

Sawtimber Price for Select Species
(2006-2019)
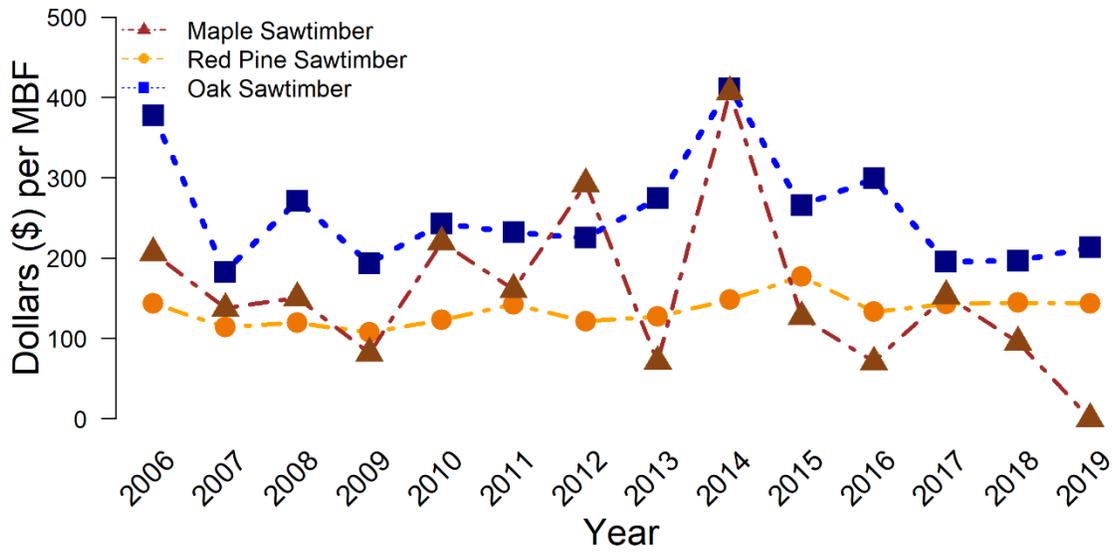
Source: DNR public price stumpage reports 2019

Chapter 8 Glossary

BIA–Bureau of Indian Affairs

Cover Type–A classification of forestland, typically an individual stand, based on the species forming a plurality of live tree stocking.

CSA–Cooperative Stand Assessment. This is the inventory system used on state-owned land. Different vegetative stands are mapped using aerial photography and ground checks. Variable radius sample plots are distributed throughout each cover type and measured on the ground. A variety of information on stand condition is collected. Variables such as timber volumes, species mixes and insect and disease damage for the state forest and wildlife management areas can be determined using CSA data.

Cull–Portions of a tree that are unusable for industrial wood products because of rot, form, missing or dead material, or other defect.

FIA–Forest Inventory and Analysis. In this inventory, permanent plots are measured. Under an older system, where all existing FIA plots were measured during the same year, field measurements were last completed in 1977 and 1990. A new system is now used. Rather than measuring all plots during one year, 20%, or a "panel" of plots, are measured annually. Hence, all existing plots are measured during a five-year "cycle."

Four complete cycles have been completed:

- Cycle 12 (panels of 1999, 2000, 2001, 2002, and 2003)
- Cycle 13 (panels of 2004, 2005, 2006, 2007, and 2008)
- Cycle 14 (panels of 2009, 2010, 2011, 2012, and 2013)
- Cycle 15 (panels of 2014, 2015, 2016, 2017, and 2018)

We are currently in Cycle 16 (panel 2019, 2020 in progress). FIA is a cooperative effort between the U.S. Forest Service and Minnesota DNR.

The FIA provides extremely important information on the condition of the forest resource. Variables such as timber volumes, species mixes, and changes to the forest resource over time can all be determined using FIA data. It is the only way to track condition, changes over time for non-industrial private woodlands, and is the only comprehensive forest data set across all ownerships.

Forest Type–A classification of forestland based on the species forming a majority of live tree stocking.

Growing Stock Trees–Live trees of commercial species excluding cull trees.

MAI–Mean Annual Increment. The average annual change in volume of a stand at a specified point in time. MAI changes with different growth phases in a tree's life, generally being highest in the

middle ages and decreasing with age. The point at which MAI peaks is sometimes used as a guide to identify biological maturity and a stand's readiness for harvesting.

NRS–Northern Research Station. The FIA unit of the U.S. Forest Service is located in St. Paul, Minnesota. U.S. Forest Service staff, in cooperation with state DNR, accomplish the FIA inventory and Timber Product Output surveys.

NIPF–Non-Industrial Private Forestland. Forestland owned privately by people or groups not involved in forest industry. More recently referred to by some as Family Forest Owners.

Primary Forest Industry Manufacturers–Refers to initial processors of trees, including producers of:

1. Solid wood products (lumber, veneer)
2. Engineered wood products
3. Pulp and paper
4. Specialty products
5. Wood energy

These primary products are often inputs into "secondary" or "value-added" products.

Pulpwood–Wood harvested and used by primary mills that make products from reconstituted wood fiber. This includes particleboard and engineered lumber products made from chips, shavings, wafers, flakes, strands, and sawdust.

Real Estate Investment Trust (REIT) –An organization that acquires and manages income producing real estate such as timberlands. Several criteria must be met to qualify as a REIT. At least 90% of its taxable income must be distributed to shareholders in the form of dividends. A REIT structure is advantageous mainly because earnings are considered capital gains and taxed up to 15%, instead of corporate income tax rates (35%).

Rotation Age–Age at which a stand is generally considered mature and ready for harvest. This age can vary depending upon ownership objectives, e.g., desired products, previous treatments (such as thinning), economic and market conditions, and other considerations such as forest age class distribution and wildlife habitat values. In reality, stands may be harvested earlier, at, or beyond the specified rotation age.

Sawtimber–Wood that is harvested and used by sawmills.

Secondary Forest Industry Manufacturers–Are those that use inputs from primary industry such as lumber to further process or manufacture "value-added" products such as cabinets, pallets and many others.

Stumpage–The amount paid to the landowner for the right to cut and remove specified standing timber.

Timberland–Forestland that is producing, or is capable of producing, more than 20 cubic feet per acre per year of industrial wood crops that is not withdrawn from timber utilization by policy or law.

Timberland Investment Management Organization (TIMO) –an organization that acquires and manages timberland investments on behalf of others. TIMOs generally possess large acres of timberland for the value of the land and timber rather than as a source of raw material for company-owned mills.

USDA–United States Department of Agriculture. The U.S. Forest Service is a part of the USDA.

Chapter 9 Conversion Factors

Conversion factors used to prepare this report:

1 cord = 500 board feet

1 cord = 79 cubic feet