MINNESOTA'S
FOREST RESOURCES 2023

**DEPARTMENT OF
NATURAL RESOURCES**

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Division of Forestry   **Resource Assessment**

500 Lafayette Road   **438 Peterson Rd.**

St. Paul, MN 55155   **Grand Rapids, MN 55744**

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Executive Summary

Background information

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 ranging from current conditions and trends to industrial utilization of Minnesota's forest resources. Foresters, natural resource managers, planners, forest industry, and forest policy makers will find items of interest in these pages.

This report uses the most recent version of periodic survey data sets including the national Forest Inventory and Analysis (FIA) and Timber Products Output (TPO) by the U.S. Forest Service. This publication is updated as new data becomes available. However, FIA data-based estimates including tables and figures in this report are the same as in the previous Forest Resources Report 2022 because the FIA data have not been updated since then. The updates are made based on TPO data, forest product industry data and stumpage price. 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 also thank the FIA and TPO unit of the U.S. Forest Service for their data analysis and support. Minnesota DNR Forestry staff Scott Burns deserves appreciation for his roles in data collection and review.

All FIA summary data were obtained from FIA database version 1.9.200. This current version of the FIA database calculates volume, biomass and carbon estimates based on a nationally consistent new modeling system called National Scale Volume and Biomass Estimators (NSVB) released in September 2023 (Westfall et al., 2024). Hence, the volume, biomass/carbon, growth, mortality and harvest removal numbers presented in this report may not align precisely with the numbers reported in the preceding Minnesota's Forest Resources Reports.

Forest resource highlights

- According to 2022 FIA database, Minnesota currently has approximately 17.59 million acres of forest land, from which 15.75 million are classified as "timberland" (Figure 1-2)
- Privately owned forests make up almost half of Minnesota's timberlands (49%), followed by the state (24%) and county and local government (16%) (Figure 1-4)
- Aspen is the most abundant forest type in Minnesota (30% of timberland). Oak (10%), northern hardwoods (9%), lowland hardwoods (9%), black spruce (9%), and tamarack (7%) also make up a large percentage of Minnesota forests (Figure 1-8).
- Overall, net growth for all species continued to outpace harvest levels. According to 2022 FIA figures, annual net growth of growing stock on timberland was approximately 7.06 million cords, with mortality of approximately 3.42 million cords (Figure 3-1).

Timber harvest highlights

In 2023, Minnesota industry and fuelwood users harvested and used approximately 2.56 million cords of wood which is down from 2.7 million cords in 2022 and one million cords lower than the average annual harvest levels in the 1990's and early 2000's. The last year the annual harvest level in Minnesota was below 2.56 million cords was 1982.

Forest industry highlights

- Since the 2022 Report was produced (linked here), industry highlights have not changed significantly, but key differences and trends are still critical to understand.
- Pulp, paper, and engineered wood products continue to be the dominant sectors for wood utilization; nearly 66% of the total roundwood harvest volume in the state was consumed within these sectors.
- After the decline in the mid-2000's, mainly due to OSB mill closures, total statewide wood utilization remained relatively steady between 2.8 and 3 million cords. In the past few years a slight downward trend has developed.
- Aspen species utilization has remained relatively stable since 2007.
- Oak, ash and basswood show an increasing utilization trend within the other main hardwoods with maple on the decline. For the first time since 1992, ash harvest volume exceeded maple harvest volume.
- Spruce utilization has seen a sharp decline since 2018. Balsam fir utilization has suffered a steady decline since the late 1990's. Tamarack utilization has also been in decline since 2010 but has leveled off in recent years. White cedar shows a slight upward trend, though still at relatively low harvest levels.
- Red pine utilization has increased dramatically over the last two decades while jack pine has declined significantly. White pine utilization has remained at relatively steady, but low levels.
- Several species above are underutilized, highlighting opportunity for expanding the sustainable harvest of these species in the state.

Citation and contact information

How to cite this report

Where to direct questions or requests for additional information

Jeremy Fauskee Utilization and Marketing Consultant
Minnesota Department of Natural Resources, Division of Forestry
85894 County Road 61, Willow River, MN 55795
jeremy.fauskee@state.mn.us, (218) 220-7094

Other acknowledgements

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Chapter 1 - Forest Resource Overview

Brief overview, tables, figures, and graphs

This chapter outlines Minnesota's forest resources, including total forest land and timberland acreage, cover type percentages, and an ownership breakdown for timberland.

According to 2022 FIA data, Minnesota currently has approximately 15.75 million acres of forest land that is classified as "timberland" (Figure 1-1). Timberland is the forest land that is capable of producing at least 20 cubic feet per acre per year of industrial wood on a sustainable basis and is not reserved from harvesting by policy or law. The total forest land (17.59 million acres) is the combined acres of timberland, reserve forest land and other forest land. The estimates of timberland and forest land acres are available since 1977 in the 2022 FIA database (Figure 1-2).

Reserved forest land is land reserved from harvest by policy or law, including designated wilderness areas such as the Boundary Waters Canoe Area Wilderness (BWCAW), old-growth reserves, and others. Other forest land is mostly forested land of very low productivity for tree growth, such that it is incapable of producing a commercial crop of trees.
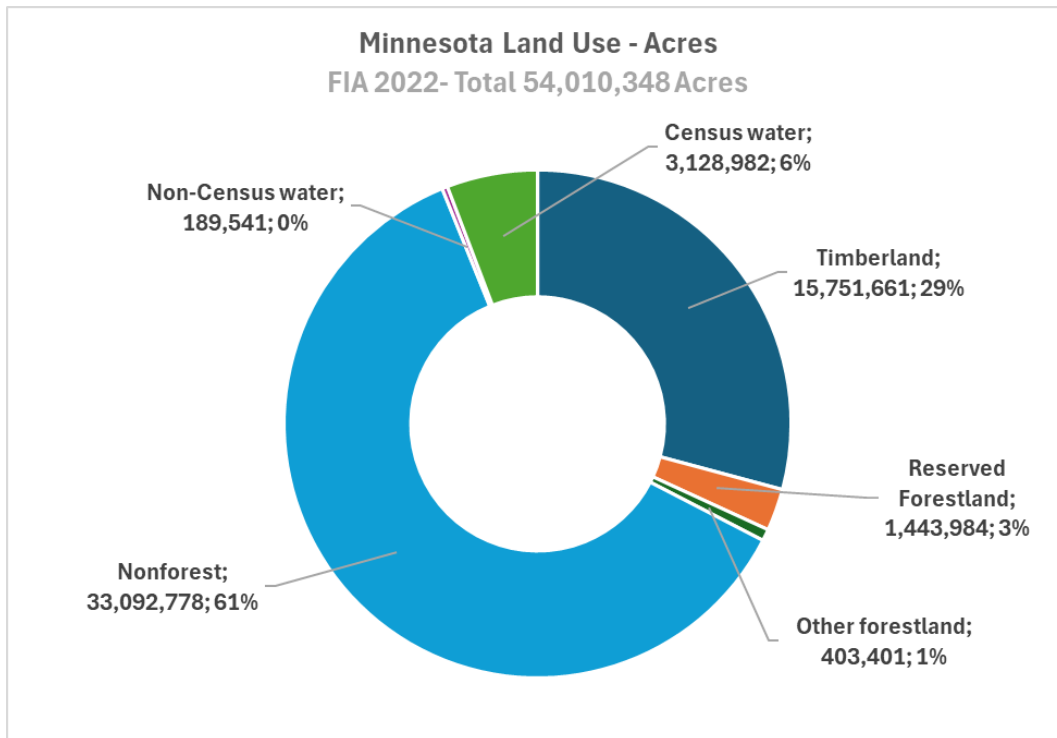
Figure 1-1: Minnesota Land Use Acres. Source: U.S. Forest Service 2022 FIA database.
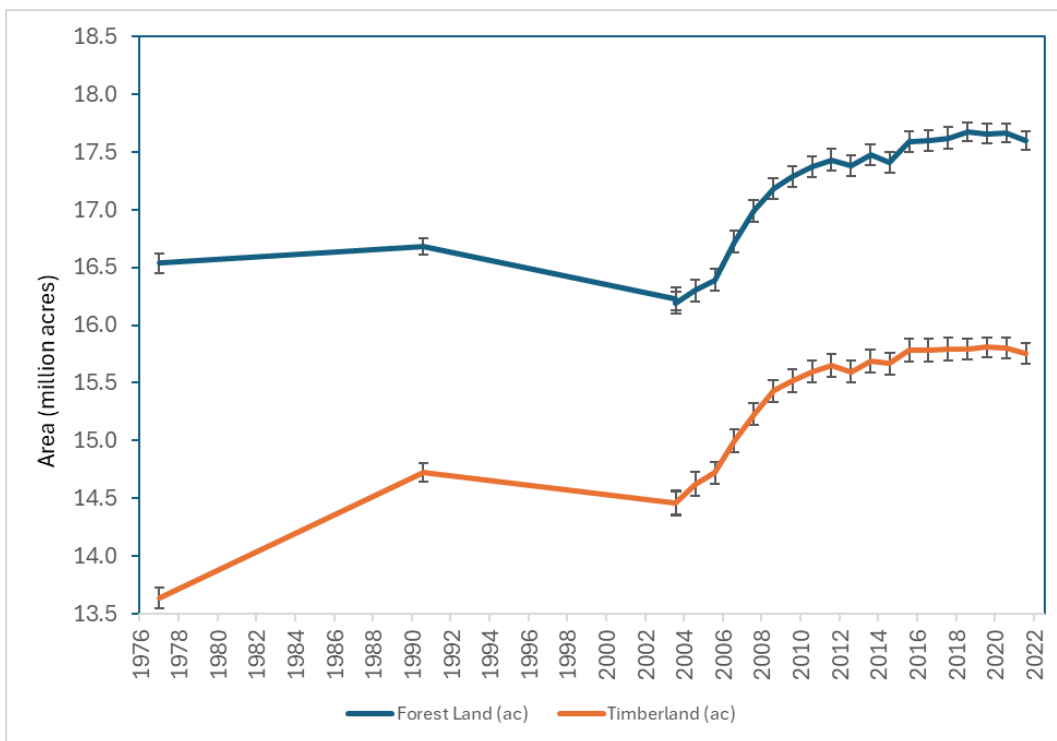
Figure 1-2: Minnesota Land use 1977-2022. Source: U.S. Forest Service 2022 FIA database. Black brackets represent 68% confidence interval of the estimates.
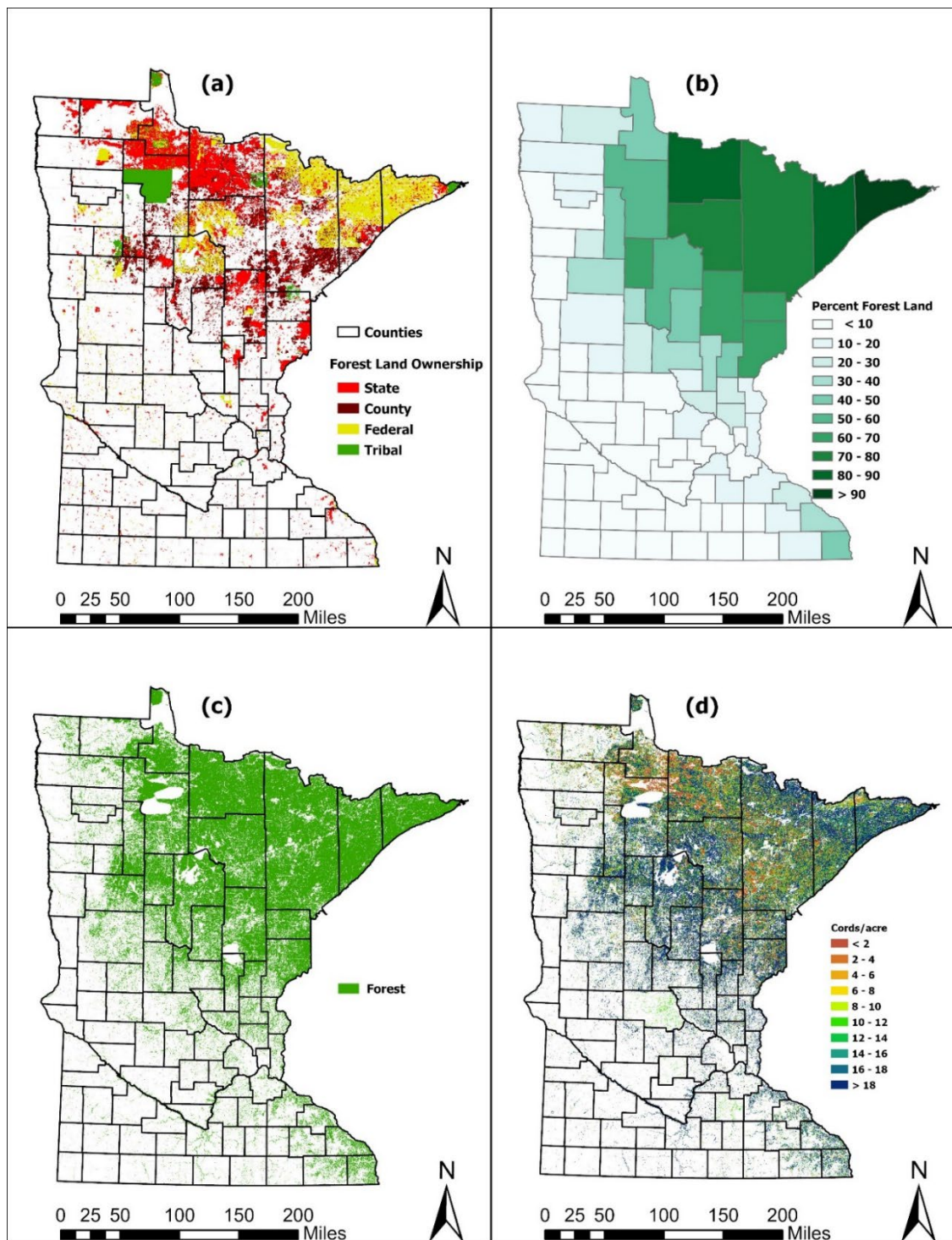
Figure 1-3: Minnesota Land Use a) Forest ownership distribution according to the DNR ownership database, 2024 b) county level percent forest cover estimates based on FIA database, 2022 c) forest canopy distribution based on National Land Cover Database (NLCD) 2023, and d) estimated standing volume (cords/acre) on forest lands based on integration of the statewide lidar and FIA data.

Minnesota has dense forest cover in the northeastern counties while the western and southern regions have sparse or no canopy coverage (Figure 1-3, b). Although the forest cover generally decreases as one heads south, the exception is in the southeastern counties such as Winona, Fillmore, and Houston counties where dense forest canopy occurs. Forest density can have a number of impacts on wildlife habitat, as well as forest resource productivity.

Minnesota Timberland Ownership
FIA 2022- Total Timberland Acres = 15,751,661

- National Forest; 1,810,037; 11%
- Other Federal & BLM; 18,278; 0%
- State; 3,716,249; 24%
- County and Local Govt.; 2,516,961; 16%
- Private; 7,690,137; 49%
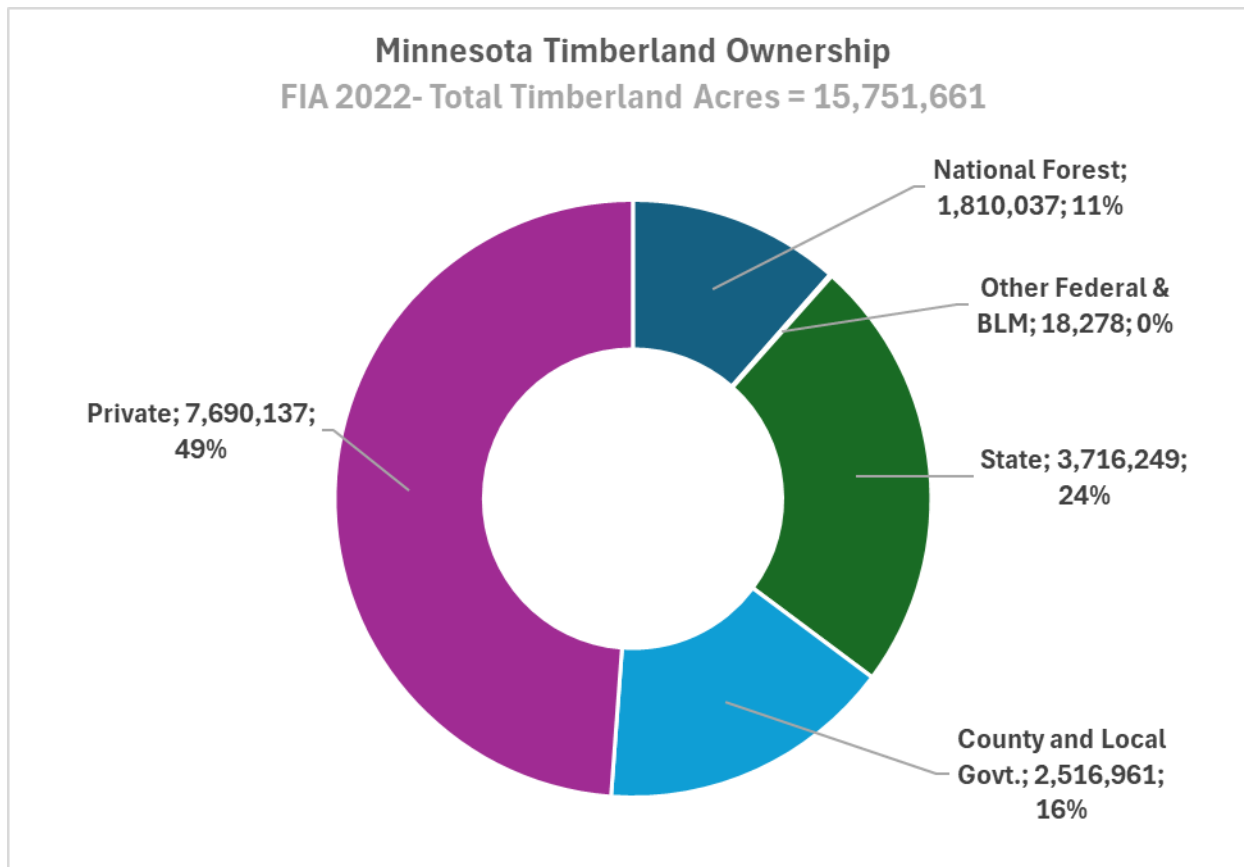
Figure 1-4: Minnesota Timberland Ownership. Source: U.S. Forest Service, 2022 FIA Database.

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 land base that may limit the acres available for fiber harvesting.

Timberland ownership is an important factor when assessing forest resources. Privately owned forests make up almost half of Minnesota's timberlands (49%, Figure 1-4) and may have varying management objectives compared to forests managed by government agencies. The FIA database also tracks several categories of private lands (Figure 1-5), however, it does not provide detailed private owner land codes in the publicly accessible database because of the FIA confidentiality policy. According to the FIA ownership class codes, the tribal (Native American) and non-governmental organization/club lands are included under the other-private category. For inventory estimates at finer scales such as to the extent of tribal lands, please contact the FIA program's spatial services.

Minnesota Private Timberland

FIA 2022- Estimated Area (in thousand acres) by Ownership

Other private; 752.8; 10%

Corporate; 1,138.0; 15%

Family or individual; 5,799.3; 75%
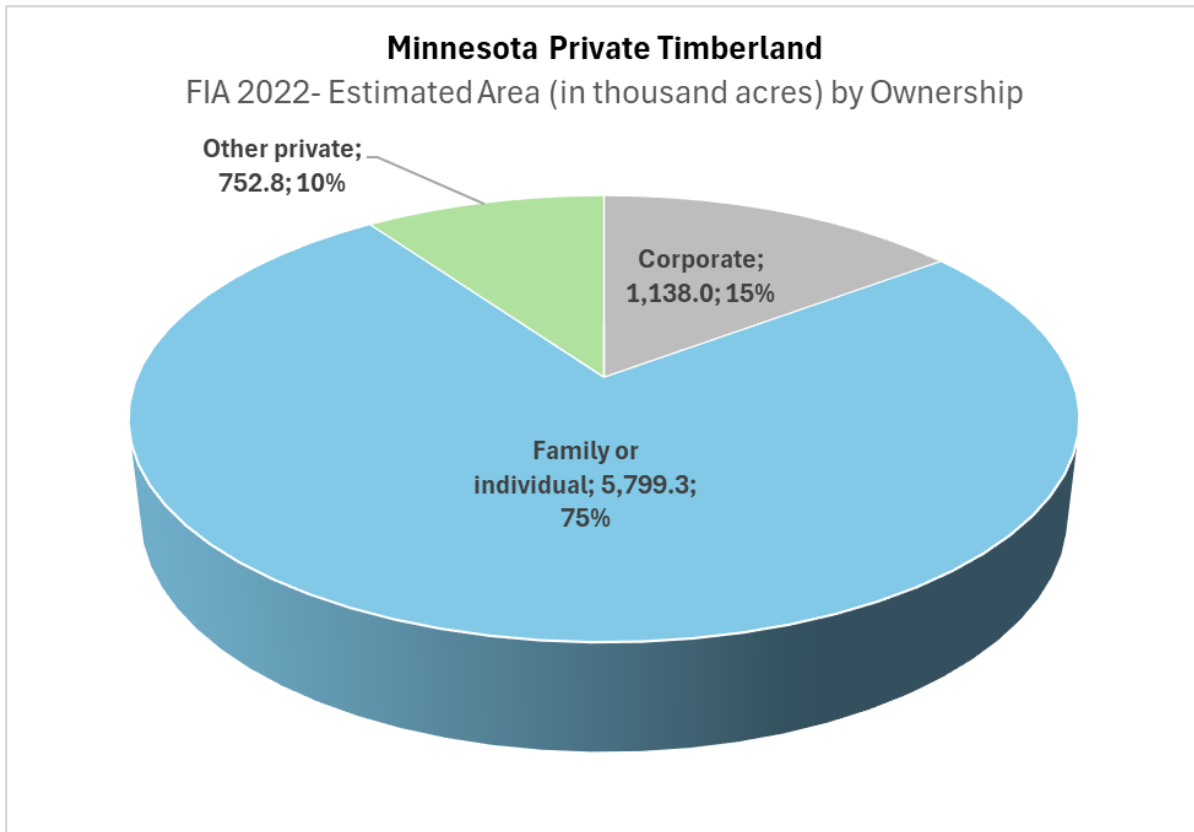
Figure 1-5: Minnesota Private Timberland acres. Source: U.S. Forest Service Spatial Services; 2022 FIA Database.

Although FIA data-based inventory estimates at finer scales may not be reliable, the large area estimates by ownership or land basis presented in this report are accurate and follow the national forest inventory standards. Note that much of the forest and timberlands in northern Minnesota are publicly owned and the southeast region has more prevalent private forest and timberland.
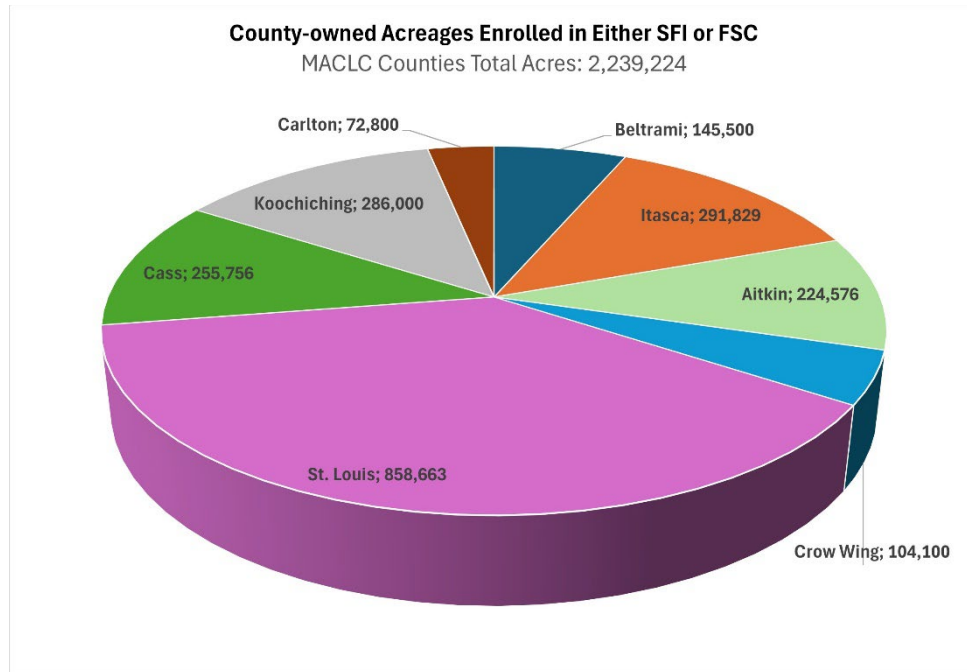
Figure 1-6: County Forest Acreages Enrolled in Either SFI or FSC. Source: Minnesota Association of County Land Commissioners (MACLC), December 2024.
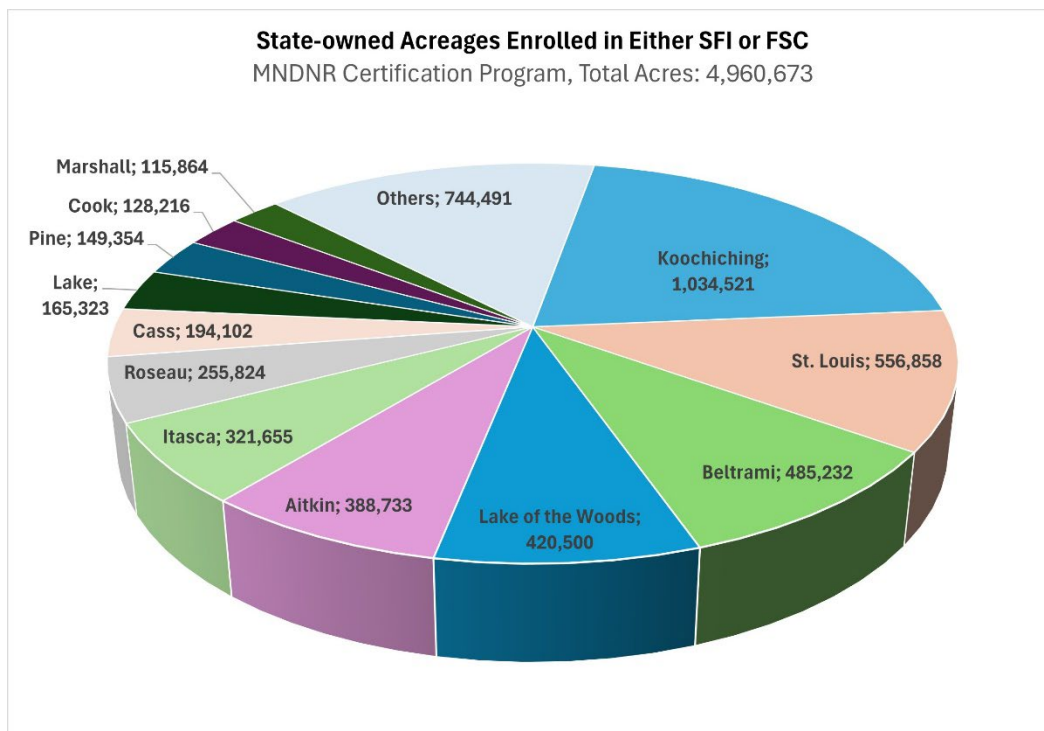
Figure 1-7: State Forest Acreages Enrolled in Either SFI or FSC. Source: Minnesota DNR Certification Program, December 2024.

A large area of State-owned and County-owned forest lands are enrolled in certification programs under different sustainability agreements. The Sustainable Forestry Initiative (SFI) or the Forest Stewardship Council (FSC) certify lands as being managed to environmental best practices. According to the Minnesota Association of County Land Commissioners (MACLC), consisting of 15 Counties across Northeast Minnesota, a total of 2,239,224 acres of County-owned forests are enrolled in either SFI or SFC (Figure 1-6). The Minnesota DNR Certification Program has reported a total of 4,960,673 acres of State-owned forests from 62 Counties being enrolled in either SFI or FSC (Figure 1-7). MN DNR is the largest single FSC-certified land manager in the United States with nearly 5 million acres of DNR administered forest lands certified under SFI and FSC. There are also over 600,000 acres of private forest lands certified under SFI, FSC, or the Program for the Endorsement of Forest Certification Schemes (PEFC).

Forest type

Minnesota has a dominance of broadleaf species with the aspen forest type alone covering about 30% of the total timberland acreage in the state (Figure 1-8). Aspen, together with oak, northern hardwoods, lowland hardwoods, birch and balsam poplar forest types constitute about 65% of Minnesota's timberland. Black spruce, tamarack, red pine, northern white-cedar, balsam fir, jack pine, eastern white pine, and white spruce forest types constitute about 25% of the timberland.

Timberland in Minnesota has increased from 15,518,356 acres in 2010 to 15,751,661 acres in 2022, according to the FIA database. Several factors contribute to this increase, such as agricultural land converting to forest. This is a dynamic process depending on the different economic drivers between agricultural or forestry land use. Improved assessment techniques also contribute to classifying former forest land as timberland.
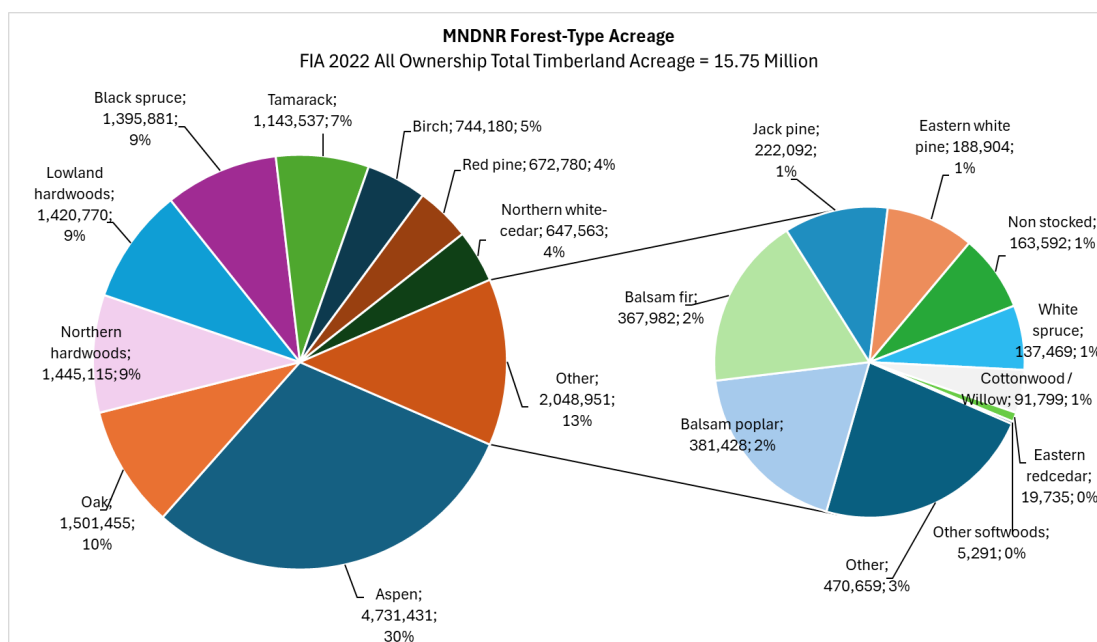
Figure 1-8: Minnesota DNR Forest-Type Acreages. Source: U.S. Forest Service 2022 FIA database.

Chapter 2 - Timber Harvest Overview

This chapter provides summary information on pulpwood and sawlog timber harvest from timberland in Minnesota by product category and ownership contribution in 2023.

All the information presented in this chapter have been obtained from the following sources:

- MN DNR Timber Product Output (TPO) survey 2023, and U.S. Forest Service TPO survey 2022 (draft) for pulpwood quantity (including import and exports),
- MN DNR TPO survey 2023, and U.S. Forest Service TPO survey 2018 (draft) for saw timber quantity (including import and exports),
- Minnesota Pollution Control Agency (MPCA) residential fuelwood consumption survey 2020/2021, and MN DNR industrial energy survey 2023 for fuel wood quantity (including import).

The TPO surveys use an annual sample design to estimate industrial and non-industrial uses of round wood at primary wood-using mills. The questionnaires used are designed to determine location, size, and types of mills in the state, and the volume of round wood received by product, species, and geographic origin. The volume, type, and disposition of wood residues generated during primary processing is also determined.

General estimates

Total Round Wood Harvest from Minnesota Timberlands (1998-2023)
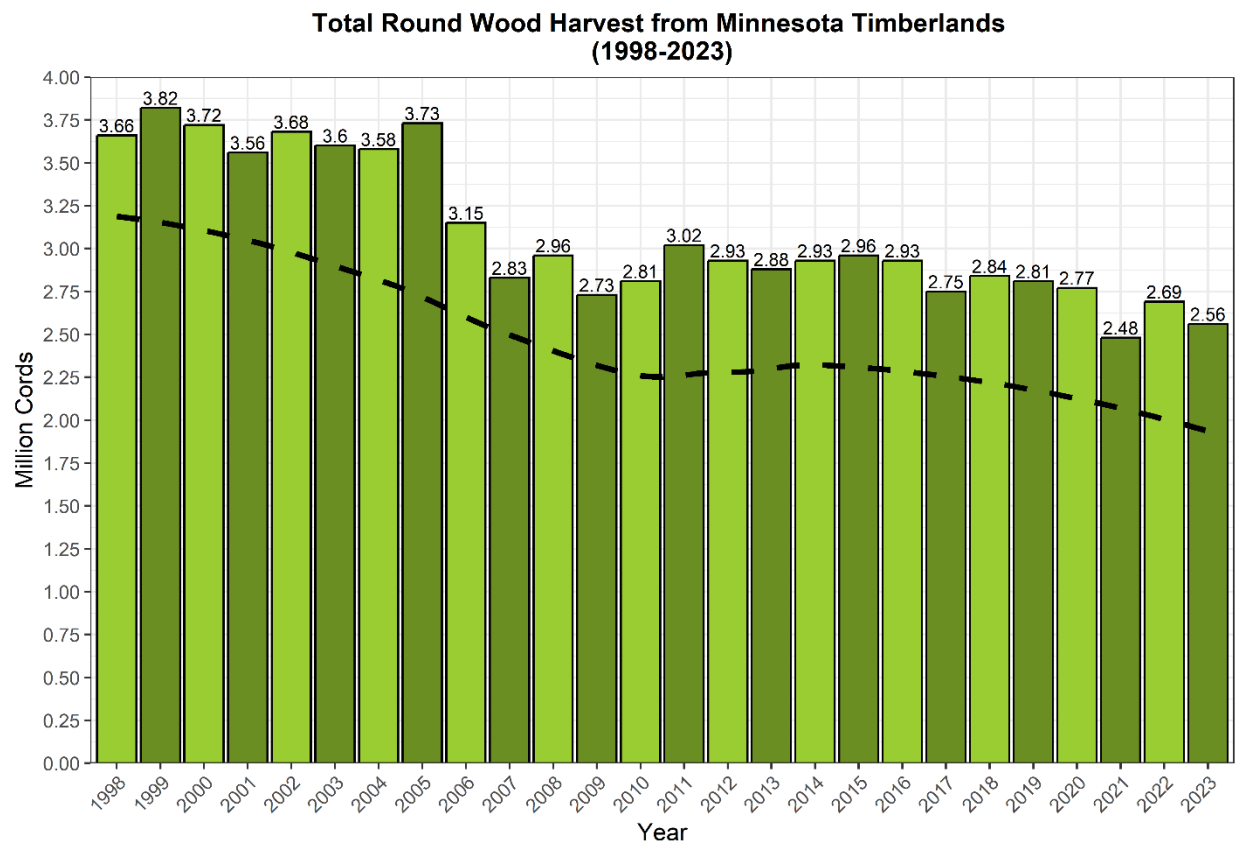
Figure 2-1: Total Round Wood Harvest (Million Cord Equivalents) from Minnesota Timberlands (1998-2023), dotted line showing the trend.

Sources for Figure 2-1 include survey data on pulpwood (MN DNR, TPO Survey 2023 and U.S. Forest Service, TPO survey, DRAFT 2022), sawtimber (MN DNR, TPO survey 2023 and U.S. Forest Service, TPO survey, DRAFT 2018) and fuelwood (MPCA residential fuelwood consumption survey 2020/21 and MN DNR industrial energy survey 2023).
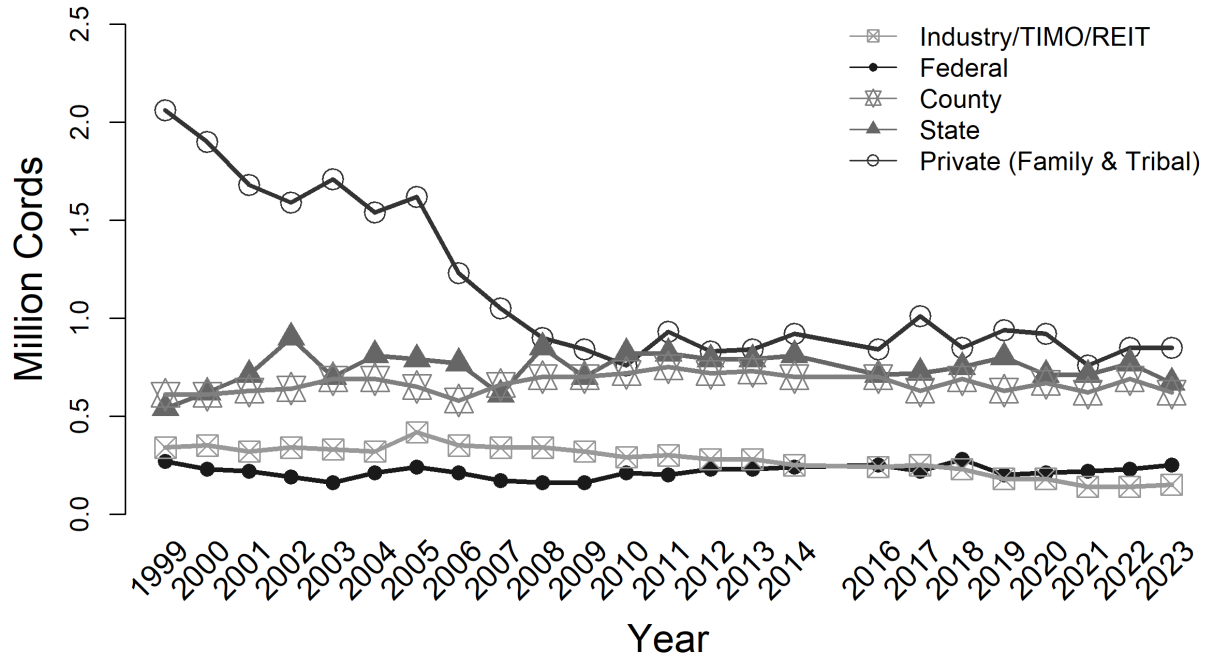
Figure 2-2: Estimated Volume of Timber (in Million Cords) Harvested in Minnesota by Public (State, County and Federal), Private (Family and Tribal) and Industry Ownerships.

Total harvest volume of 2.69 million cords in 2022 was reduced to 2.56 million cords in 2023. State and County lands continue to produce most of the public timber volume (Figure 2-3). Industrial land contributed only 151 thousand cords (about 5.6%) to the total harvest volume, whereas pulpwood-based industries utilized more than 1.6 million cords for pulp & paper and engineered wood (OSB, oriented strand board) products (Figure 2-4, Figure 2-5).
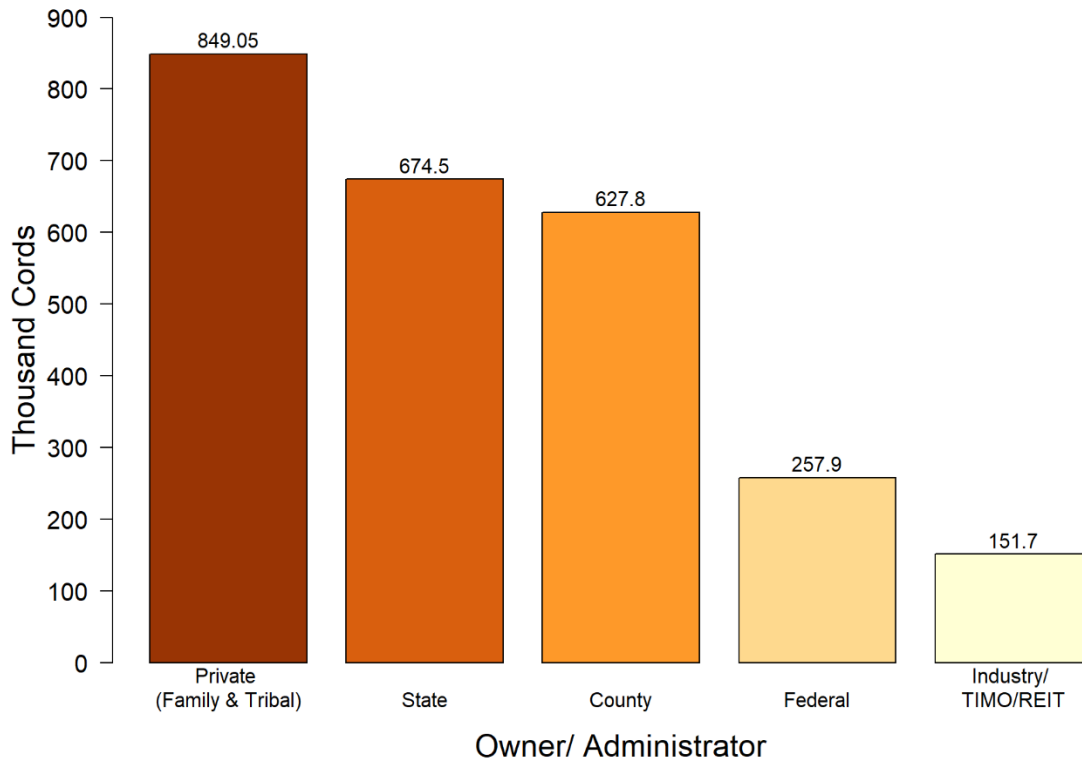
Figure 2-3: Contribution to Estimated Harvest in Minnesota in 2023.

Sources for Figure 2-3:

- State Lands: Calendar year 2023 Harvest, DNR Timber sales scaled.
- Federal: Fiscal year 2023 harvest, Superior National Forest Timber Statistics, and Chippewa National Forest.
- County Lands: Public Stumpage Price Review 2023 sold.
- Industry Lands: Minnesota Forest Industries survey of 2023 on harvested volume.
- Private Lands: Calculated from total estimated harvest in 2023 minus state, county, national forest and Bureau of Indian Affairs (BIA) volume harvested, minus estimated industry volume harvested.

Statewide total timber harvest in 2023 was below the harvest level in 2022. The harvest volumes in 2023 increased on industry (including Timber Investment Management Organization, TIMO, and Real Estate Investment Trust, REIT) and federal lands but decreased on private (family and tribal), state and county lands which resulted in net decline in 2023 compared to 2022.
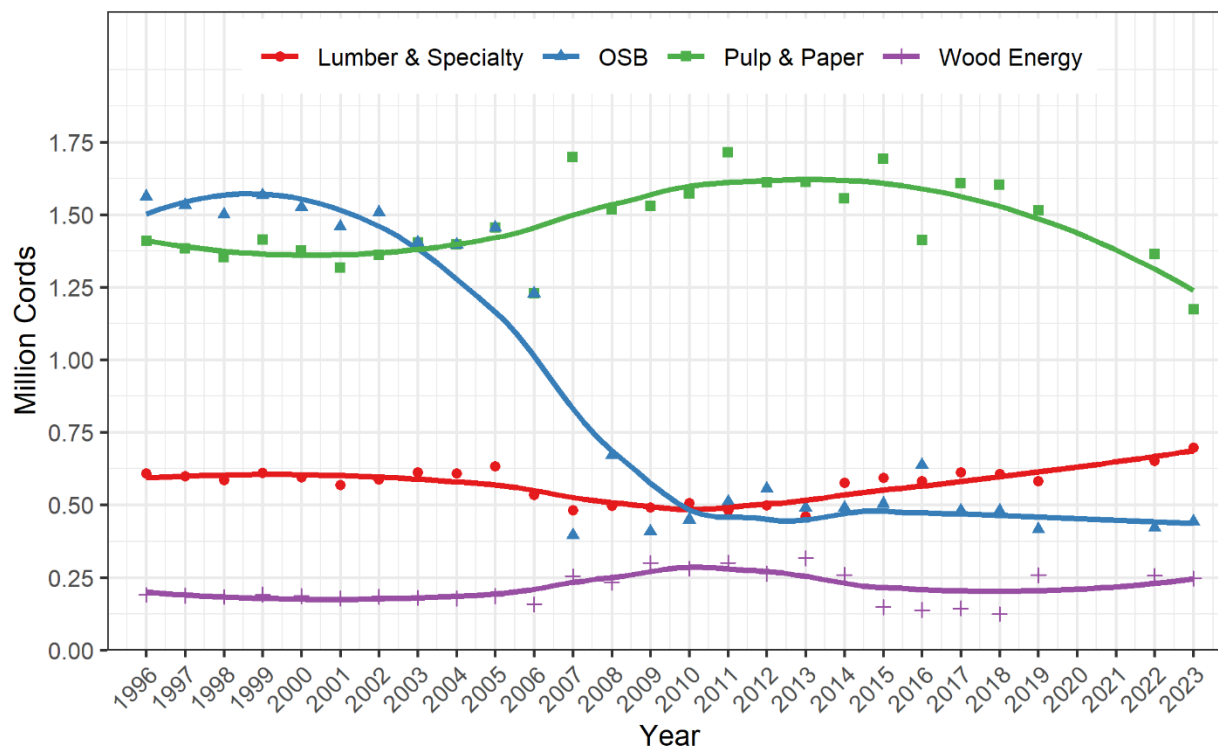
Figure 2-4: Wood Utilization Trends by Industry Product Class. Source: Wood use data from mill TPO surveys and fuelwood surveys conducted by the U.S. Forest Service, Northern Research Station and Minnesota DNR.

Wood consumption in the pulp and paper industries has continuously declined in Minnesota since 2015 while the lumber & specialty sector has shown an upward trend in that same period (Figure 2-4). The oriented strand board (OSB, engineered wood) and wood energy sectors have roundwood consumptions at similar levels as in the previous reporting years since 2015. The specialty products in Figure 2-4 and Figure 2-5 include veneer, posts and poles, shavings, and landscape chips. The wood energy refers to the combined volume of industrial/commercial and residential fuelwood. The trends in Figure 2-4 are fit using a localized regression model.

Wood Volume Utilization (in cords) by Industry Product Classes in MN, 2023

Wood Energy;
246,576; 10%

Lumber & Specialty
(Exports Included);
697,676; 27%

Pulp and Paper;
1,173,877; 46%

OSB & Engineered;
443,033; 17%
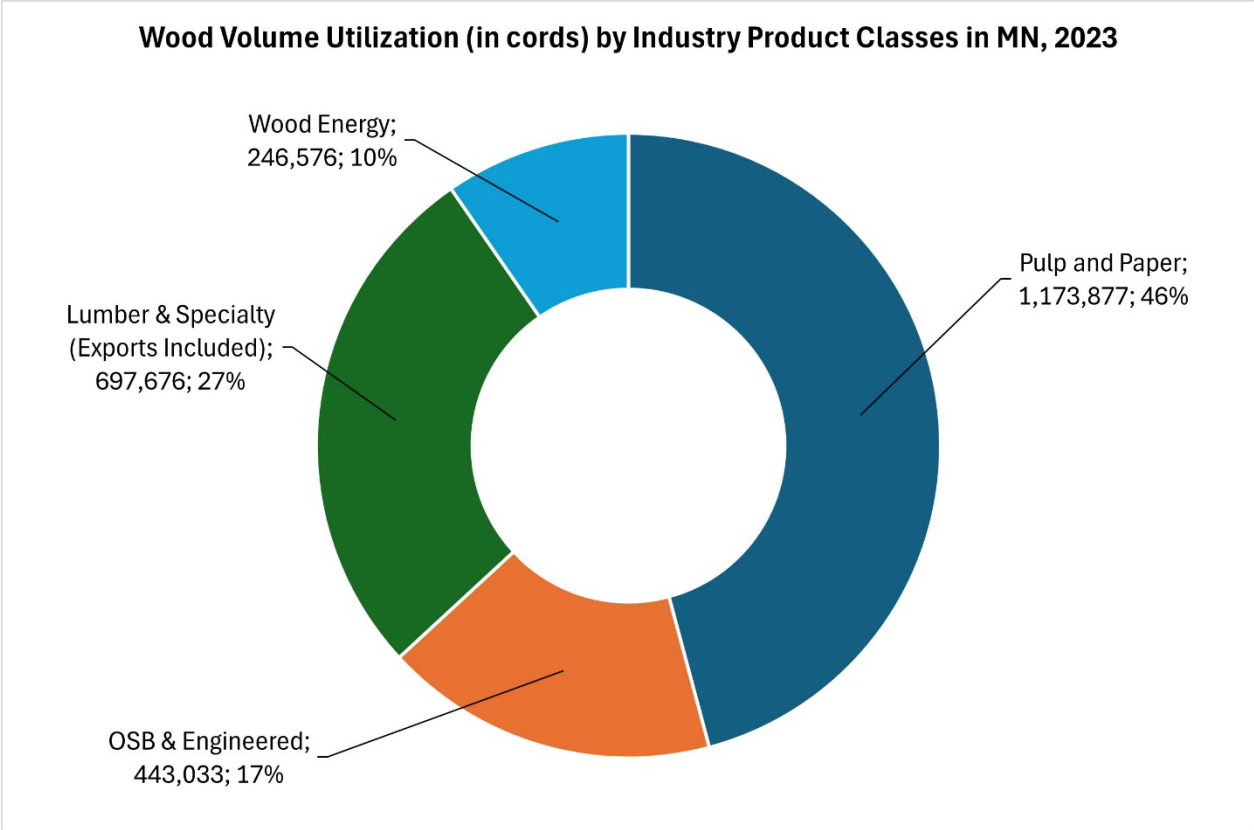
Figure 2-5: Wood Volume Utilization by Industry Product Class in 2023. Source: TPO surveys conducted by U.S. Forest Service.

Table 2-1: Total wood harvested and utilized by industry and fuelwood users in Minnesota (In cords, by species, from timberland).

Species	Pulpwood[1]	Saw logs & other[2]	Saw log Exports[3]	Residential Fuelwood[4]	Commercial Wood Uses[5]	Total
Aspen/ Balm	1,217,793	77,416	475	20,606	2,362	1,318,651
Paper Birch	61,569	21,558	914	11,448	414	95,902
Ash	37,298	25,148	604	27,474	1,733	92,256
Oak	123	83,924	24,909	70,975	2,207	182,139
Basswood	12,108	36,330	1089	20,606		70,133
Maple	55,785	9,233	4649	16,027	48	85,742
Cottonwood		3,613	438			4,051
Other Hardwoods	23	3,873	3,130	20,606	2,308	29,940
Hardwood Sub-Total	1,384,698	261,095	36,208	187,742	9,073	1,878,815
Pine		8,567		16,027		24,594
Red Pine	40,086	244,662	2,611		1,348	288,707
White Pine	2,265	23,608	1525		1,093	28,490
Jack Pine	18,008	36,373			2,048	56,430
Pine Sub-Total	60,359	313,210	4,136	16,027	4,489	398,221
Spruce	95,521	42,607			533	138,661
Balsam Fir	61,633	11,749			189	73,571
Tamarack	14,699	18,221			591	33,510
White Cedar		10,451				10,451
Other Softwoods					2,747	2,747
Softwood Sub-Total	171,853	83,028	0	0	4,060	258,941
Mixed Species				25,185		25,185
Total	1,616,910	657,332	40,344	228,954	17,622	2,561,162

[1] Preliminary 2023 pulpwood and draft 2022 pulpwood exports.

[2] Preliminary 2023 sawlog.

[3] 2018 sawlog exports.

[4] MPCA 2020/21 Residential Fuelwood Consumption.

[5] Preliminary 2023 industrial energy.

Sources for Table 2-1 are the same as in Figure 2-1. However, the numbers in the Figure and the Table may not match exactly due to rounding. The pulpwood and saw log quantities in Table 2-1 do not include imports from other states/counties, but does include exports to other states in the US and Canada. Total pulpwood imports of 293,318 cords (209,127 from WI, 51,658 from MI, 200 from ND and 32,333 from Canada) took place in 2023 whereas export quantity was only 31,668 cords to WI according to the 2022 TPO survey (which is the most recent available data). The large proportion of imported pulpwood belong to maple (187,146 cords) and aspen/ balm (74,378 cords) from Wisconsin, Michigan and Canada. The hardwood species have a larger share in both import and export volumes of pulpwood (hardwood import: 274,368 cords *versus* softwood import: 18,950 cords; hardwood export: 31,520 cords *versus* softwood export: 148 cords). In contrast, hardwood sawlog import is only 20% of total softwood saw log import (4,665 cords hardwood *versus* 22,857 cords softwood). The saw log export is still dominated by hardwoods (36,208 cords hardwoods and 4,136 cords pine).

Pulpwood

Pulpwood consumption in the state is dominated by pulp and paper mills and engineered wood product (OSB) manufacturers. The idling and eventual closure of three OSB mills in 2006 resulted in a drastic fall (from 3.02 million cords in 2005 to 2.1 million cords in 2007) in pulpwood consumption in Minnesota. Additional pulpwood mill closures, and machine shutdowns have resulted in stable and then declining pulpwood harvest numbers after 2010 (Figure 2-6). Despite expanding consumption by some existing mills, the amount of pulpwood utilized in 2023 followed an overall declining trend, relative to the peak use in 2005.
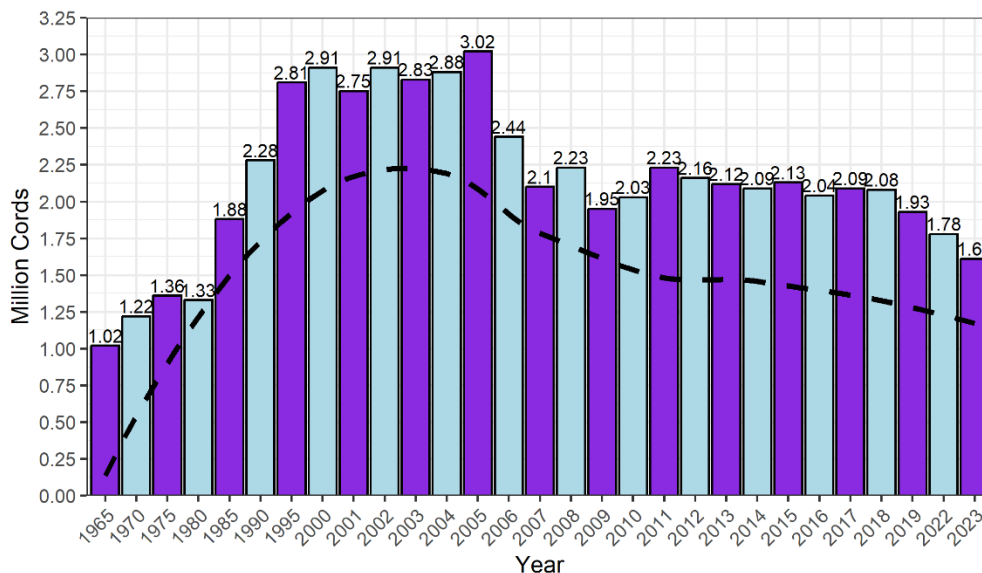
Figure 2-6: Total Pulpwood Harvest Volume from Minnesota Timberlands (1965-2023). Dotted line represents a trend (based on local regression) in pulpwood utilization. Source: MN DNR TPO survey (2023 pulpwood combined with 2022 pulpwood exports).

Beginning in 2000, Minnesota became a net importer of pulpwood with the expansion of several mills during 2000-2001 (Figure 2-7). However, the imports declined in 2007 due to the closure of large mills in 2006 and have remained relatively stable since then. Pulpwood exports have seen a more rapid decline since 2018. The top five pulpwood species imported in 2023 are maple (187,146 cords), aspen/balm (74,378 cords), ash (8,141 cords), spruce (6,594 cords), and jack pine (6,276 cords) (Table 2-2).
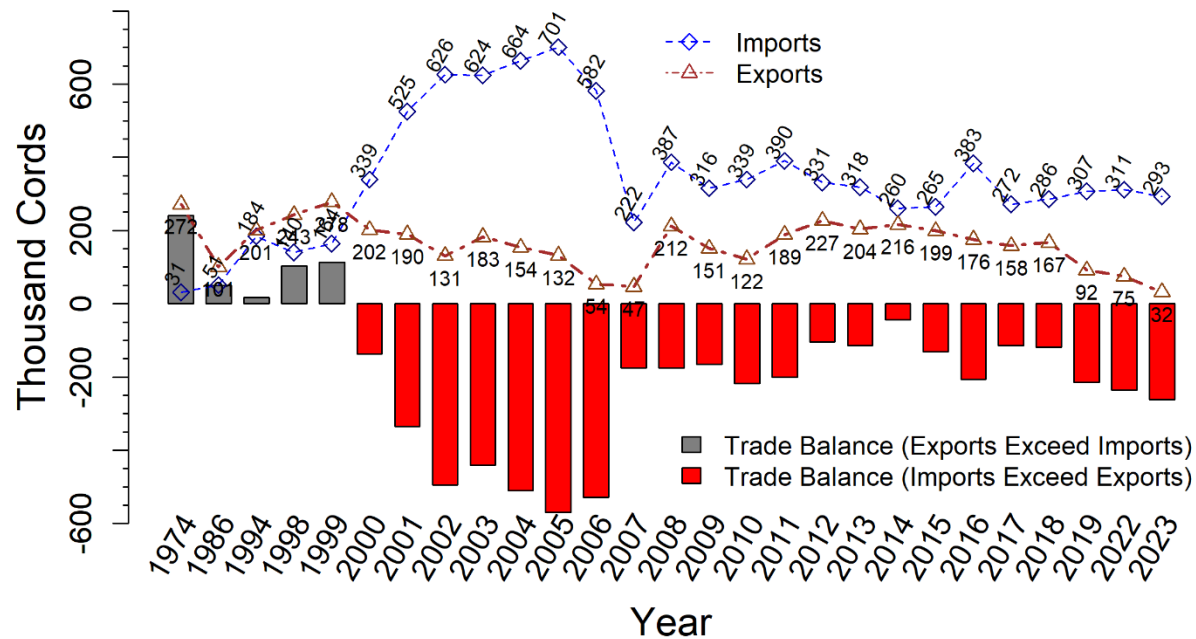
Figure 2-7: Imports and Exports of Pulpwood in Minnesota. Source: U.S. Forest Service TPO survey of wood-based industries.

The harvest volume for pulpwood fiber production is traditionally dominated by aspen and balsam poplar (Table 2-2), and the combined volume of hardwoods constituted more than 85% of total pulpwood volume in 2023. The pulpwood figures include cords exported, all of which went to Wisconsin (Table 2-3).

Table 2-2: Total pulpwood produced in Minnesota by species, including exports (in thousand cords).

Year	Aspen/balsam poplar	Balsam fir	Birch	Maple	Other hardwoods	Other softwoods	Pine	Spruce
2015	1,410	119	120	90	36	27	87	243
2016	1,337	113	99	178	44	18	105	226
2017	1,375	117	116	100	43	16	96	226

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2018	1,351	92	104	93	69	42	83	250
2019	1,307	95	88	89	61	34	70	186
2022	1,301	75	74	78	55	18	74	113
2023	1,218	62	62	56	50	15	60	95

Table 2-3: Pulpwood exports, 2023 (in cords).

	Volume
Aspen/Balm	28,289
Basswood	3,209
Red pine	64
White pine	84
Other hardwoods	23

Source: MN DNR draft 2022 TPO data on pulpwood exports. The export happened only to Wisconsin.

Sawtimber

Sawtimber is often the highest value product from wood that meets merchantability requirements. In general, a log needs to be at least 8 feet in length with an 8 inch minimum diameter inside bark at the small end to be of merchantable sawlog size. However, there are an increasing number of sawmills that can utilize smaller diameter materials profitably.

Red pine and aspen continued to make up most of round wood used by sawmills (Figure 2-8). In comparison to the volume utilized by sawmills and specialty mills in 2022, the total board feet volume consumption in 2023 has increased. The increased volume was due to more consumption of jack pine, oak (red and white), soft maple, basswood, ash, balsam fir, spruce and cottonwood (Figure 2-8), however, utilization of red pine, aspen, cedar and hard maple sawlogs has declined.

Total sawtimber (lumber and specialty products) consumption in 2015 was 593,470 cords. This number increased to 697,676 cords in 2023 (Figure 2-4, Figure 2-9). There was a decline in sawtimber consumption to 582,330 cords in 2020, which can be attributed to the covid pandemic impact and additional closures of processing mills.
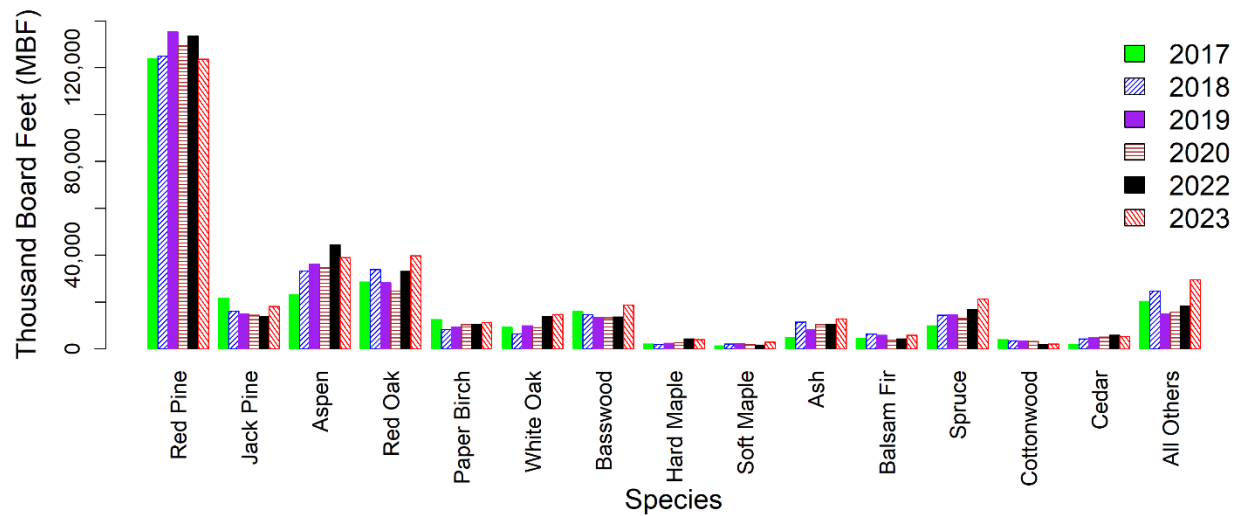
Figure 2-8: Volume Harvested from Minnesota timberland and utilized by sawmills and specialty mills. Source: U.S. Forest Service TPO survey.
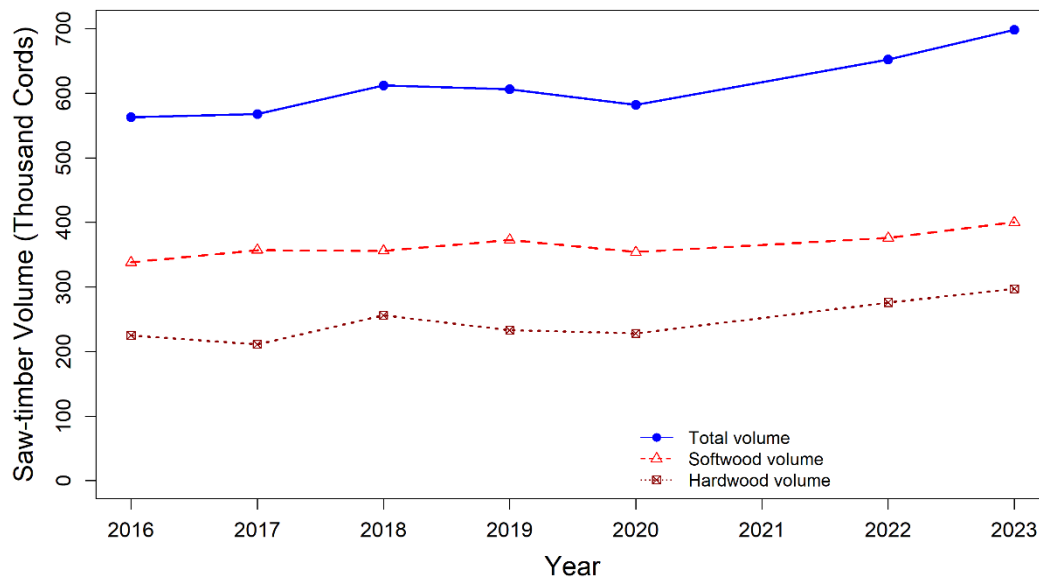
Figure 2-9: Sawtimber production in MN (last seven years). Source: U.S. Forest Service TPO survey.

Sawlogs were exported to Wisconsin, Iowa, North Dakota and South Dakota with nearly 70% of exports going to Wisconsin in 2023. The export volume (in cords) included Aspen/Balm: 475,

paper birch: 914, ash: 604, oak: 24,909, basswood: 1,089, maple: 4,649, cottonwood: 438, red pine: 2,611, and white pine: 1,525. The total sawlog export was 40,345 cords.

Utilization trends

Understanding trends in wood utilization is valuable to forest stakeholders. The trend graphs presented below are produced using a localized regression method in the R statistical package "ggplot2" (e.g., Figure 2-10). The recent and long-tern trend depictions help users interpret the availability of resources and give stakeholders a tool to pinpoint issues and implement thoughtful forest policy decisions.

Hardwoods

Ash, basswood and oak have generally upward trends in terms of wood harvest volume and utilization in the past ten years (i.e., after 2014). The utilization of maple shows a continuous downward trend after 2009, while the consumption volume was increasing from 1998 until 2008 (Figure 2-10). Oak harvest and utilization is, however, opposite to maple. Oak demand continually declined until 2010 and has generally followed an upward trend since then. Ash and basswood have relatively low utilization but has increased in recent years. It is important to highlight that ash harvest volume exceeded maple volume for the first time in 2023, based on the records from 1998-2023.
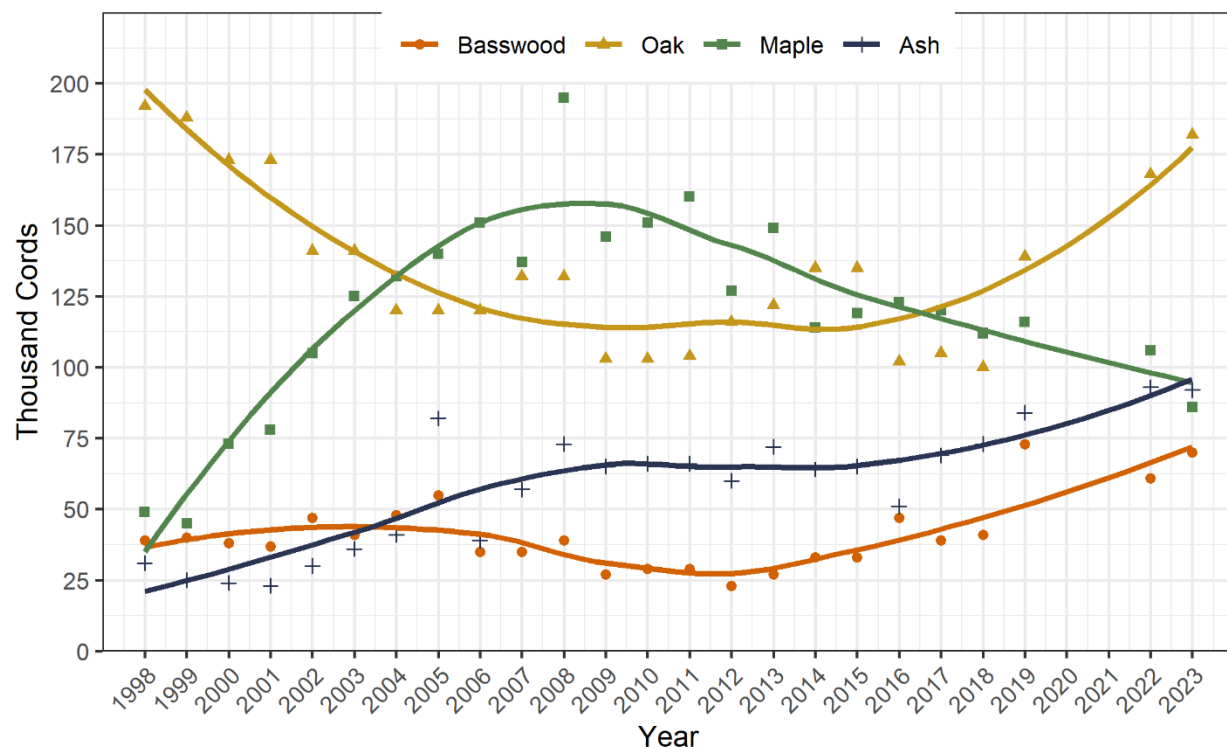
Figure 2-10: Trends in Hardwood Utilization (Localized Regression). Source: U.S. Forest Service TPO draft survey data.

Softwoods

The utilization of balsam fir has declined since 1998 (Figure 2-11). Other softwood species such as spruce and tamarack had generally trended upward until 2015 and 2010, respectively but have been on downward trends since then. Tamarack and white cedar utilization have remained relatively low and flat in the long run. In recent years, white cedar has seen a slight increase in utilization (3.4 thousand cords in 2014 *versus* 10 thousand cords in 2023).
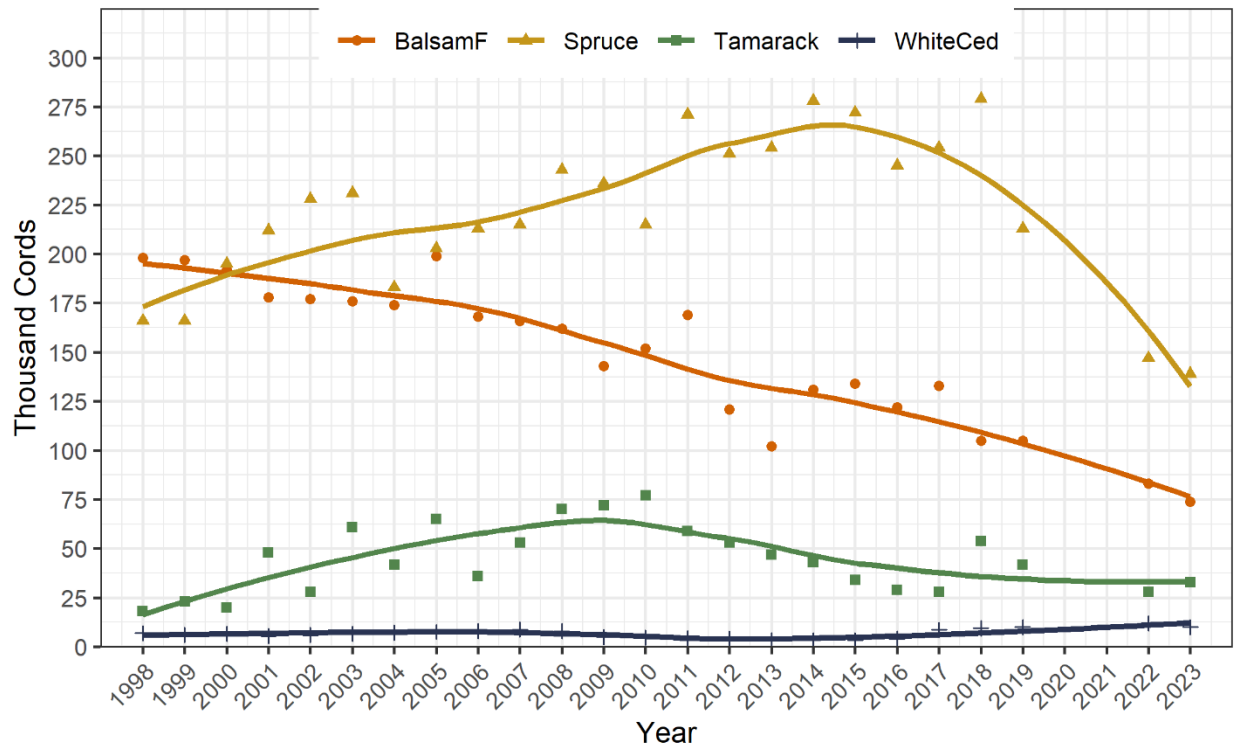
Figure 2-11: Trends in Softwood Utilization (Local Regression). Source: TPO draft survey data by U.S. Forest Service Northern Research Station and DNR.

Pines

Red pine utilization has increased substantially, while jack pine has seen significant declines. White pine utilization has remained flat (Figure 2-12).
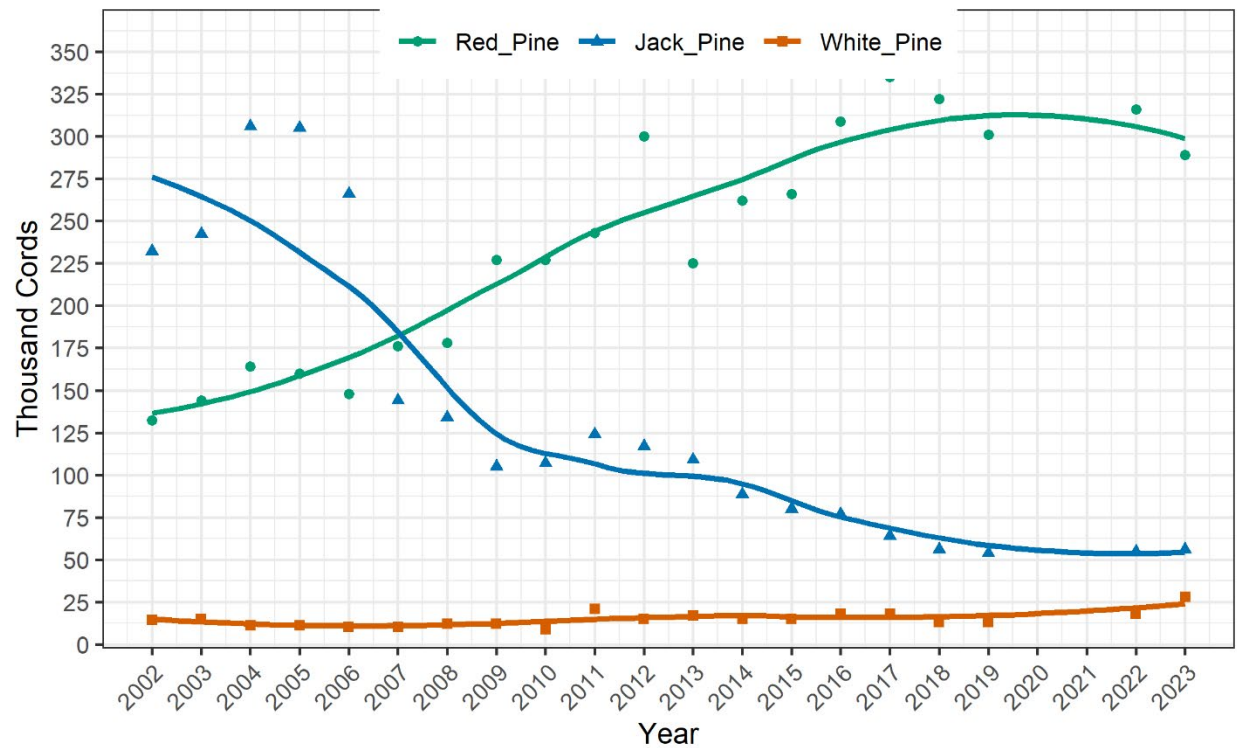
Figure 2-12: Trends in Pine Utilization (Local Regression). Source: Timber Product Output draft survey data by U.S. Forest Service Northern Research Station and DNR compiled in Minnesota Forest Resources Reports.

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; the latter typically included with aspen utilization figures. Compared to consumption levels 20 years ago, aspen consumption has been decreasing but has remained stable for the last decade or so (Figure 2-13).
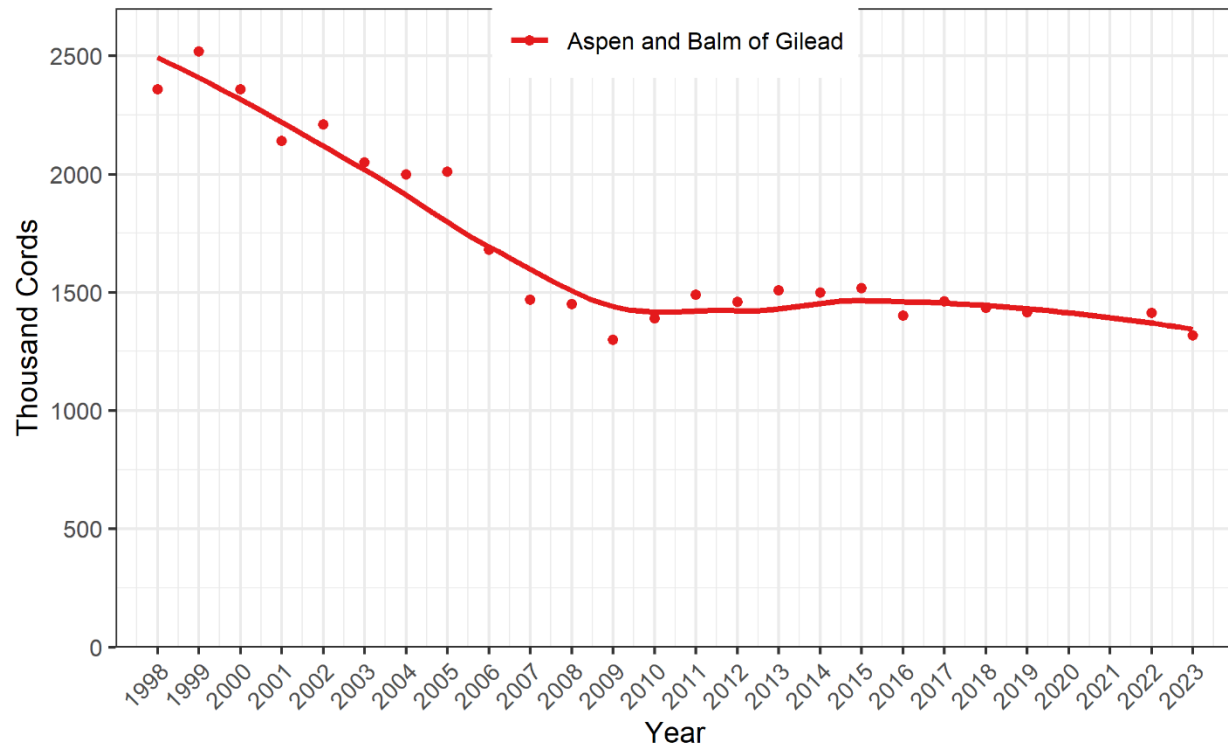
Figure 2-13: Trends in Aspen and Balm of Gilead Utilization (Localized Regression). Source: TPO draft survey data by U.S. Forest Service Northern Research Station and DNR.

Chapter 3 - Sustainable Harvest Levels and Potential Opportunities

This section provides information on the estimated sustainable harvest levels for Minnesota's most significant timber species, as well as information concerning the sustainable timber harvest analysis (STHA) project focused on MN DNR administered lands.

A note to readers: There is no direct correlation between current harvest levels and long-term sustainable 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. The choice of 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.

There is no single method nor single time frame used to reach a target age-class structure. Planned and actual harvest levels may differ (i.e., transition harvests at some time may be higher or lower) from long-term sustainable yield estimates. Additionally, it is possible to increase future timber availability through intensified forest management resulting in lower 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, accessibility, growth and yield, etc. An active forest management and harvesting program is also key to sustaining habitat for diverse wildlife and healthy forest ecosystems.

Please view the harvest levels described in this chapter as helpful benchmarks representing one part of the picture in determining long-term sustainability of our forest resources. The harvest levels should not be viewed as absolute targets.

In 1989, a citizen petition was brought before the Minnesota Environmental Quality Board as an indication of an increasing concern about the cumulative impacts associated with forest management and timber harvesting in Minnesota. Consequently, a study was commissioned by the Minnesota Environmental Quality Board and a Generic Environmental Impact Statement (GEIS) on Timber Harvesting and Forest Management in Minnesota was completed in 1994 in response to the citizen petition. The GEIS assessed how different levels of harvesting activity and forest management impact Minnesota's environmental, economic and social resources. Activities related to timber harvesting and forest management such as logging, site preparation, reforestation, and forest road construction were considered, and changes in ecological processes (such as age of forest stands or potential impact of disturbances) were also examined. The study included commercial forest lands (timberlands) as well as reserved and unproductive forests.

The Minnesota Environmental Quality Board prescribed three levels of statewide timber harvesting activity to be assessed by the GEIS. These levels were referred to as the base, medium and high harvesting scenarios: 4.0 million cords annually (the most recent statewide harvest level information available at the time of the study), 4.9 million cords annually (an estimation of the harvest level by 1995 if the planned forest products industry expansions were to fully materialize) and 7.0 million cords annually (the estimated maximum sustainable annual volume of timber growth that would be available for harvest statewide in year 2000). Each scenario was projected over a 50-year planning horizon by considering the spatial and temporal distribution of the timber harvesting activities and their environmental impacts. The GEIS did not recommend these as levels of harvest to follow, nor should their development and analysis be considered a plan. They are rather the harvest levels the GEIS considered when assessing the potential impacts if those harvest levels were to occur.

In March 2018, MN DNR completed the Sustainable Timber Harvest Analysis (STHA) project that evaluated harvest levels on MN DNR-administered lands. The analysis and modeling was conducted by Mason Bruce & Girard (MB&G), a forestry consulting firm based in Portland, Oregon. This project, conducted over 18 months, involved multidisciplinary team of experts from the DNR Divisions of Forestry, Fish and Wildlife, and Ecological and Water Resources. The DNR Commissioner's office then evaluated and approved the project.

The MN DNR, understanding the status of forest resources and need for forest protection and ecological services, concluded that a suitable harvest level would be 870,000 cords per year until 2030. In addition, in the first five years of the plan (fiscal years 2020-2024), an additional 30,000 cords of ash and tamarack would be offered to address immediate forest health concerns. In the second half of the plan, the annual volume offered would drop back to 870,000 cords. This analysis is planned to be re-evaluated every 10 years.
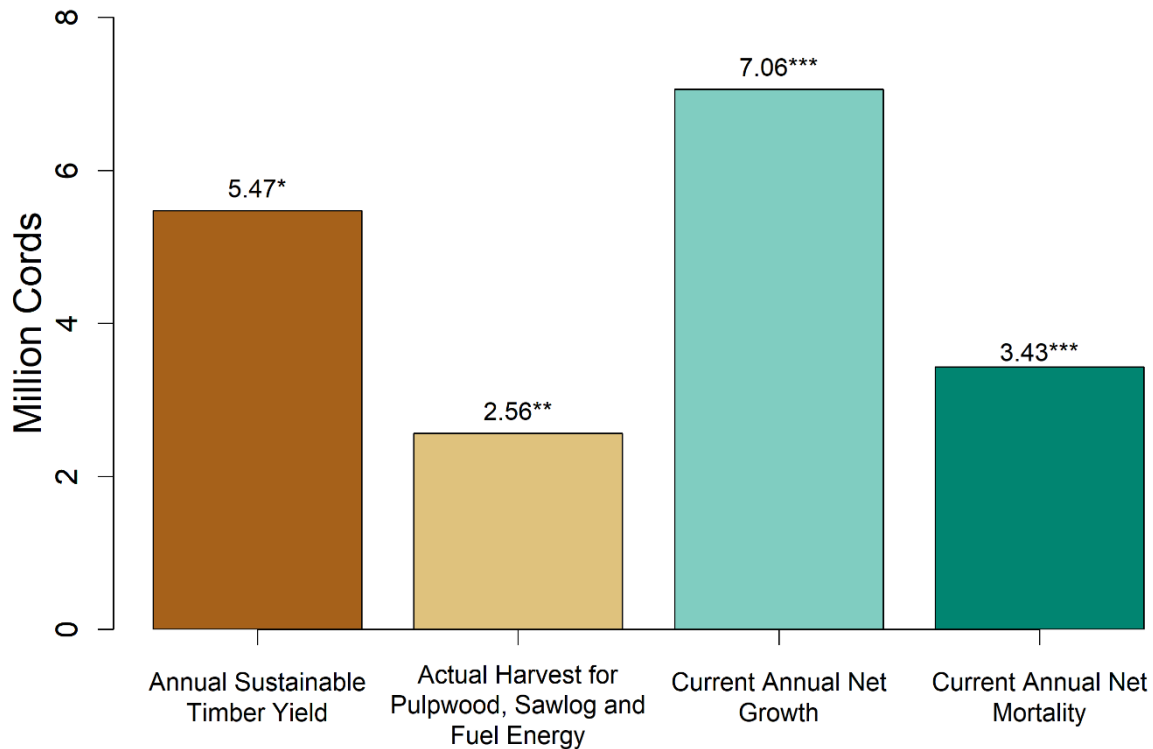
Figure 3-1: Harvest Volume in 2023 Compared to GEIS Sustainable Harvest Volume and FIA 2022 Growth/Mortality Estimates.

Sources used in Figure 3-1 include *GEIS Table 6.25- High Long-Term Sustainable Harvest Level, Timber Productivity Tech. Paper, Dec. '92. **USFS TPO pulpwood survey, 2023 (draft); MN DNR TPO sawmill survey, 2023 (draft), and MPCA fuelwood survey, 2020/21; ***USFS FIA 2022 database on tree growth and mortality (see Appendix A: Definitions of gross growth, net growth, ingrowth, mortality, and removals). Current annual net growth is the average growth of merchantable bole wood volume of growing-stock trees (timber species at least 5 inches d.b.h.), in cubic feet, on timberland. Current annual net mortality is the average mortality of merchantable bole wood volume of growing-stock trees (at least 5 inches d.b.h.), in cubic feet, on timberland.

Note: While complete capture is not realistic, capture of a portion of the annual mortality of approximately 3.43 million cords has the potential to increase net growth and sustainable harvest levels.
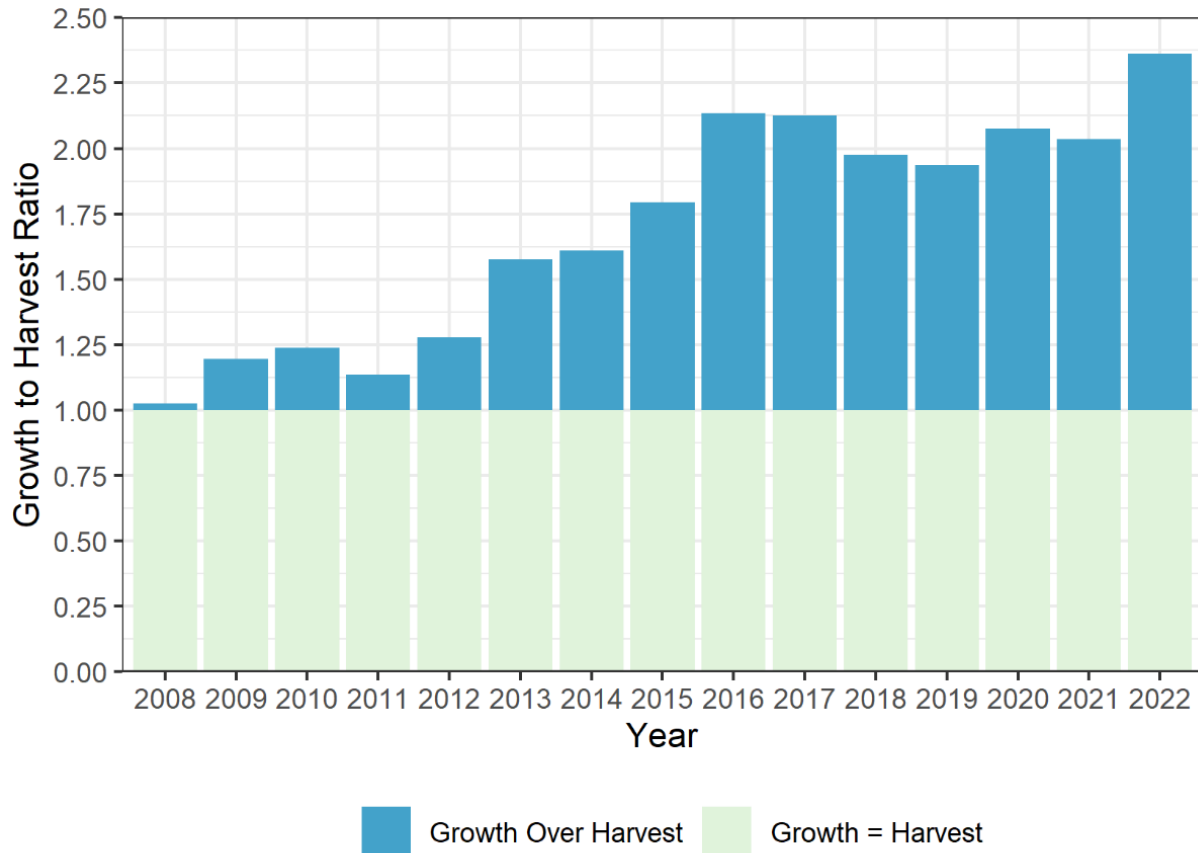
Figure 3-2: Growth to Harvest Ratio. Source: FIA 2022 Database.

Net growth-to-harvest ratio allows for a comparison to determine if the harvest rate is exceeding the growth after all the natural removals and mortality have been accounted for. (Net growth equals gross growth minus mortality and non-harvest removals). In Figure 3-2, a value of one means net growth and harvest are equal. Any number larger than one on the y-axis (growth to harvest ratio) indicates the forest is accumulating volume. Please note that data for this figure is drawn exclusively from FIA so there may be discrepancies between the harvest data in this figure and TPO data. This ratio is an indicator of sustainability but is not the sole measure to drive decision-making. Short-term management goals may allow for increasing harvest above rates of growth.

The sustainable timber yield (harvestable volumes), estimated based on DNR methods and UPM-Blandin's study (see Additional background information and notes), were greater than the actual harvest levels in 2023 for all timber species (Figure 3-3, Figure 3-4).
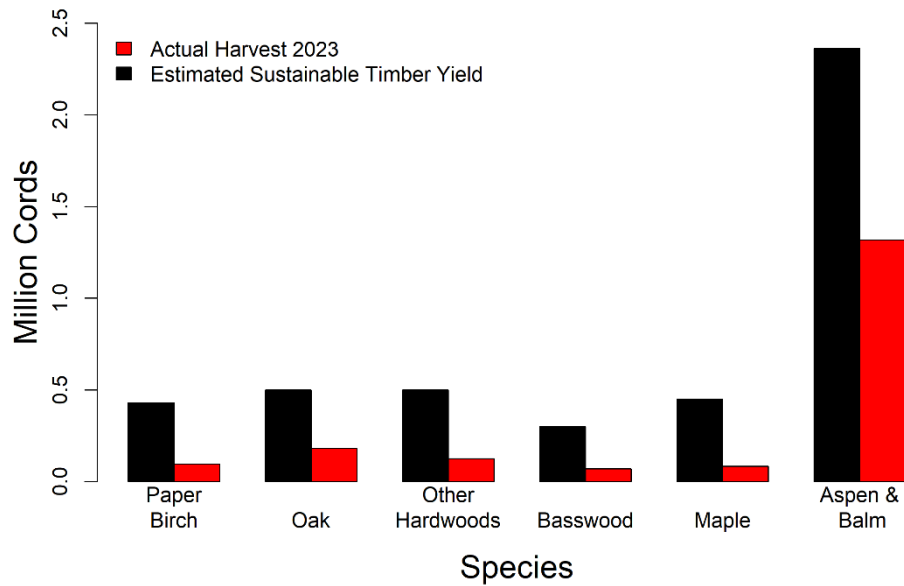
Figure 3-3: Estimated Long-Term Annual Sustainable Timber Yield and Actual Harvest of Selected Broadleaf Species.
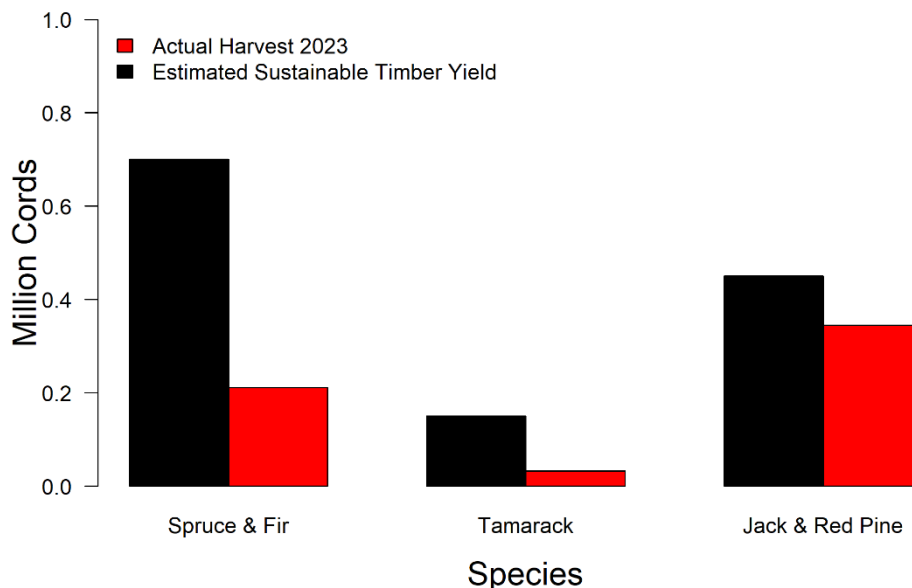
Figure 3-4: Estimated Long-Term Annual Sustainable Timber Yield and Actual Harvest of Selected Conifer Species.

The following sources were used in Figure 3-3 and Figure 3-4: MN DNR TPO pulpwood and sawtimber survey 2023; U.S. Forest Service TPO surveys (*draft*): pulpwood export-2022, sawlog exports-2018 and sawlog-2023; MPCA 2020/21 fuelwood survey; and MN DNR Wood Energy survey 2023.

Additional background information and notes

-Sustainable timber yield for aspen and spruce-fir in the figures above are from the UPM-Blandin Thunderhawk Environmental Impact Study (EIS) report (Tables C-20 and C-21 average of high aspen A&B scenario model runs, 40-year planning horizon). Estimates from the Thunderhawk EIS analyses are used for the aspen-balsam poplar and spruce-fir product groups, as the EIS analyses focused on these product groups, with considerable detail regarding the mixed species nature of all cover types and projections of forest growth. Generally, the EIS estimates used can serve as upper bound estimates of harvest levels, sustainable until at least 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 do not include potential volumes from additional investments in short-rotation intensive management, or potential volume increases resulting from investments in pre-commercial thinning. The estimates do consider allowable cut practices by public land management agencies.

-Sustainable timber yield levels for birch, oak, basswood, maple, other hardwoods, tamarack, jack pine, and red pine are based on the MN DNR method of calculating long-term sustainable harvest levels. The method applies area regulation for cover types typically managed as even-aged, and volume regulation for cover 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 MN DNR's Subsection Forest Resource Management Plans (SFRMP).

Resource opportunities and challenges

Several tree species in Minnesota are currently underutilized based on the 1994 Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota (GEIS). The USFS Forest Inventory and Analysis (FIA) data shows that Minnesota's forests grow over twice as much wood a year as is harvested. Opportunity exists now to grow wood product markets while maintaining the current forest resource in a sustainable condition. Utilizing more wood products will support keeping forests intact. 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.

Certified forests

There are a total of 7,852,878 acres of certified forests across all ownerships in Minnesota. This includes 7,247,568 acres of public and 605,310 acres of private forests certified under SFI, FSC, or the Program for the Endorsement of Forest Certification Schemes (PEFC). MN DNR administered forests alone constitute 4,960,673 acres (Figure 1-7) of certified land, making MN DNR the largest single FSC-certified land manager in the United States. There are 2,239,224 acres of county lands (Figure 1-6) over the eight counties under the Minnesota Association of County Land Commissioners (MACLC) enrolled in a certification program (SFI or FSC) until December 2024.

Hardwood species

The hardwood species in Minnesota that have the potential for increased utilization include aspen, maple, basswood, oak, and ash. The opportunities to increase harvest of these species is significant, however most of these opportunities exist on private lands. Please refer to the detailed species reports in Chapter 5 for more information. It is also important to note that the FIA data in this report is for the entire state and not all standing volume on timberlands is available for harvest. A localized wood basket analysis will help identify these regional differences.

Softwood species

White pine, red pine, spruce, balsam fir, and cedar are the softwood species that have the potential for increased utilization in the state. The opportunities to increase the harvest of these species is less significant than the hardwood species identified above but still notable. Most of the pine and cedar in Minnesota occur in the northern half of the state; with most of the spruce and balsam fir in the northeast arrowhead region. Like hardwoods, most softwood species occur on private lands.

Woody biomass

Woody biomass is a largely untapped resource in Minnesota. Woody biomass comes in different forms such as manufacturing residues and woods chips. Surplus manufacturing residues from some composite mills and sawmills continue to be available. Manufacturing residues in most pulpwood mills are 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 remain a cost-effective option when compared to the historically 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:

- Reduced dependence on foreign energy sources
- Carbon neutral energy production
- 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
- Development of aesthetically pleasing open park like environment.

In fact, increased utilization of wood for bioenergy or other uses 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 site preparation for tree planting.

Forest health

There are two primary invasive insect species in Minnesota that have the potential to impact wood movement, spongy moth and emerald ash borer. Spongy moth quarantines are in place for both Lake and Cook counties in the northeast corner of the state. Emerald ash borer quarantines are in place in multiple counties across Minnesota. More information about the quarantines and required compliance agreements can be found on the Minnesota Department of Agriculture website: (http://www.mda.state.mn.us).

Native insect outbreaks of eastern larch beetle and spruce budworm are also significantly impacting the state's tamarack, balsam fir, and spruce species. More information on these, and other forest health impacts can be found on the MN DNR Forest Health website: (https://www.dnr.state.mn.us/treecare/forest_health/index.html).

Chapter 4 - Minnesota's Forest Products Industry

This section presents an overview of Minnesota's wood-using industry, including mill location, product information, and total industry economic impact.

Minnesota's forest industry and wood market trends

The forest products industry experienced mixed economic conditions prior to the covid pandemic in 2019. 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 prior to the covid pandemic beginning in early 2020.

The covid pandemic impacted economic conditions across the world, including the forest products industry in Minnesota. Minnesota 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 as seen with the closure of the Verso mills in Wisconsin Rapids, WI and Duluth, MN. Lesser impacts were seen for softwood lumber and engineered wood products, primarily due to housing booms and renovation and remodel driven demands from consumers spending more time at home. By 2021, the forest products industry was in full production. The demand for products was high in all sectors including pulp and paper due to machine closures, mill conversions, international trade disruptions, supply chain concerns, and increased building renovation and construction. Forest product demand remained high until the spring of 2023 when

the housing market and economy slowed, product inventories rose, and mill orders declined. The housing market and economy remained stagnant through 2024 as anticipated mortgage rate reductions did not materialize and inflation impacts continued.

Timberland managers, associations, private landowners, and public agencies are tasked with working together to support existing and new wood manufacturers. Mill closures, layoffs, and downtime result in reduced forest management. Decreased forest management can negatively affect wildlife habitat, increase risk of forest fragmentation and land conversion, 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).

The changed landscape of Minnesota's forest industries over the last fifteen years has created a sustainable wood fiber surplus. This surplus will support new mill announcements and expansions. 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 or converted forest land. Managed forests provide essential products that 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 fossil fuel based products, 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 than there were 50 years ago.

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

Economic impact of Minnesota's forest products industry in 2023[1]

The forest product industry provides:

- $14.2 billion direct value of shipments with $25.6 billion total output effect and 8.5 percent of all manufacturing payroll employment.

- $5.0 billion direct value added with $11.0 billion total value-added effect.

- 5th largest manufacturing sector in Minnesota by payroll employment (#1 food products, #2 fabricated metal products, #3 computers & electronics, and #4 machinery).

- 31,449 direct jobs with a 72,635 job total employment effect.

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[1]CY2023 data from Minnesota's Forest Industry at a Glance, April 2025. Data compiled for MN DNR by Steigerwaldt Land Services and published by Samantha Grover, MN DNR Division of Forestry, Fiscal & Administration Manager.

- $2.15 billion in direct labor income with a $4.7 billion total labor income effect.

- $132 million direct state and local tax receipts with a $291 million state and local tax receipts effect.

Value of Forest Products Manufactured in Minnesota

Figure 4-1: Value of Forest Products Shipments Manufactured in Minnesota (Source: Minnesota's Forest Products Industry at a Glance, April 2025).

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 furniture, pallets & crating, millwork, wood shavings for poultry industry, and wood energy.

Non-timber industries dependent on Minnesota's forest lands

Balsam fir boughs for the Christmas wreath industry with annual sales exceeding $20 million, decorative spruce tops, birch bark, maple syrup, wood for grilling and smoking (e.g., ash, black walnut, birch, hickory, maple, oak), and medicinal plants.

Value added (gross state product) per capita

In 2023, Minnesota was ranked #14 nationally in forest industry value added (Gross State Product) per capita (Figure 4-2). In 2017, Minnesota ranked #12 nationally.

Forest Industry Gross State Product per Capita
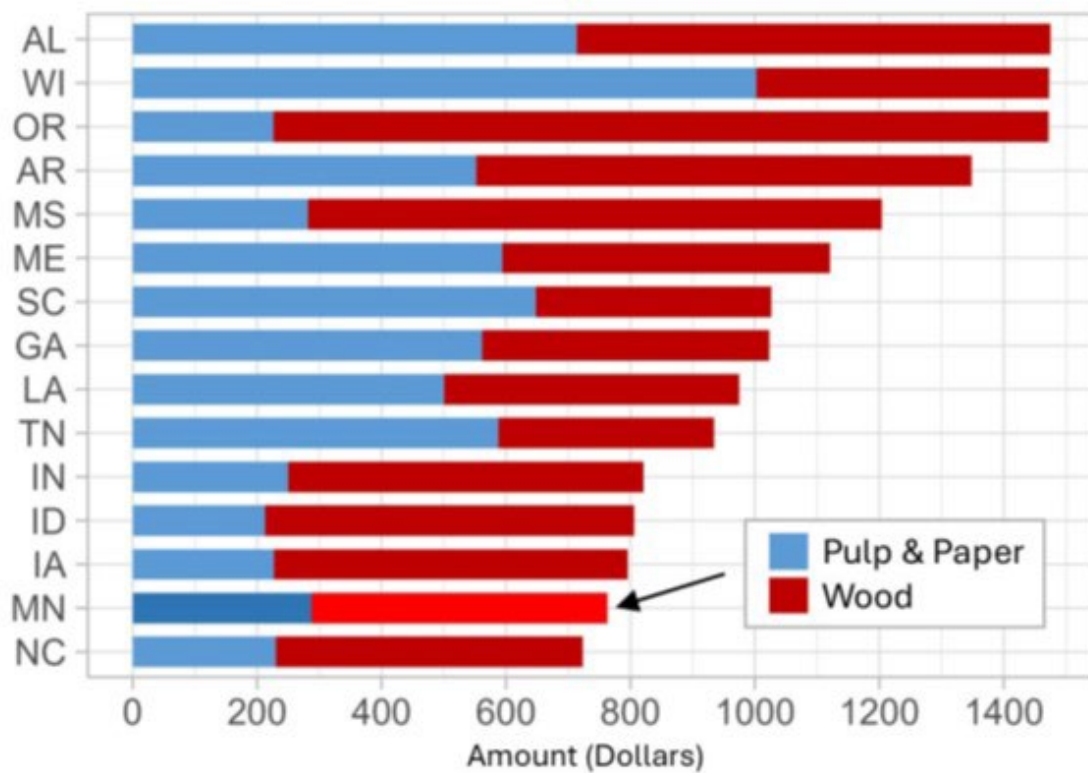
Figure 4-2: Forest Industry Gross State Product per Capita (Source: Minnesota's Forest Products Industry at a Glance, April 2025).

Number of manufacturing facilities in 2023[1]

- 3 primary pulp & paper mills
- 3 recycled pulp & paper mills
- 84 converted paper product plants
- 357 lumber & wood product plants
- 366 millwork & wood furniture

Minnesota's pulp, paper, and composite wood product sector

The pulp, paper and composite wood mills constitute the dominant consumer of forest resources in Minnesota. These mills utilize various tree species for woody materials, with aspen pulpwood

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[1] Verso Duluth paper mill closed in 2020 resulting in statewide pulpwood demand reduction of about 160,000 cords per year.

being half of the total volume consumed. In 2023, pulp, paper, and composite mills consumed a ratio of 85% hardwood and 15% softwood. Nearly 82% of the pulpwood consumed in these mills come from Minnesota's forests, and the remaining volume was imported from Wisconsin, Michigan, North Dakota and Canada. The pulpwood export volume for 2023 is not available but about 2% of the pulpwood harvest was exported (only to Wisconsin) in 2022. Some of these mills also consume residue chips from local sawmills.

Table 4-1: Minnesota pulp and paper, 2023.

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, 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
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

WestRock, St. Paul	Recycled paper and corrugated	Coated recycled board
Liberty Paper Company, Becker	Recycled paper and corrugated	Cardboard liner board

Table 4-2: Minnesota Oriented Strand Board and Engineered Wood Products, 2023.

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

Minor amounts

Figure 4-3: Primary Pulpwood-Consuming Mills greater than 2,000 Cords Annual Production, June 2023.

Minnesota's sawmills and specialty mills sector

Minnesota's sawmill and specialty mill sector is important to forest landowners, wood product users, and the economic health of local communities. Mills are located throughout the state and
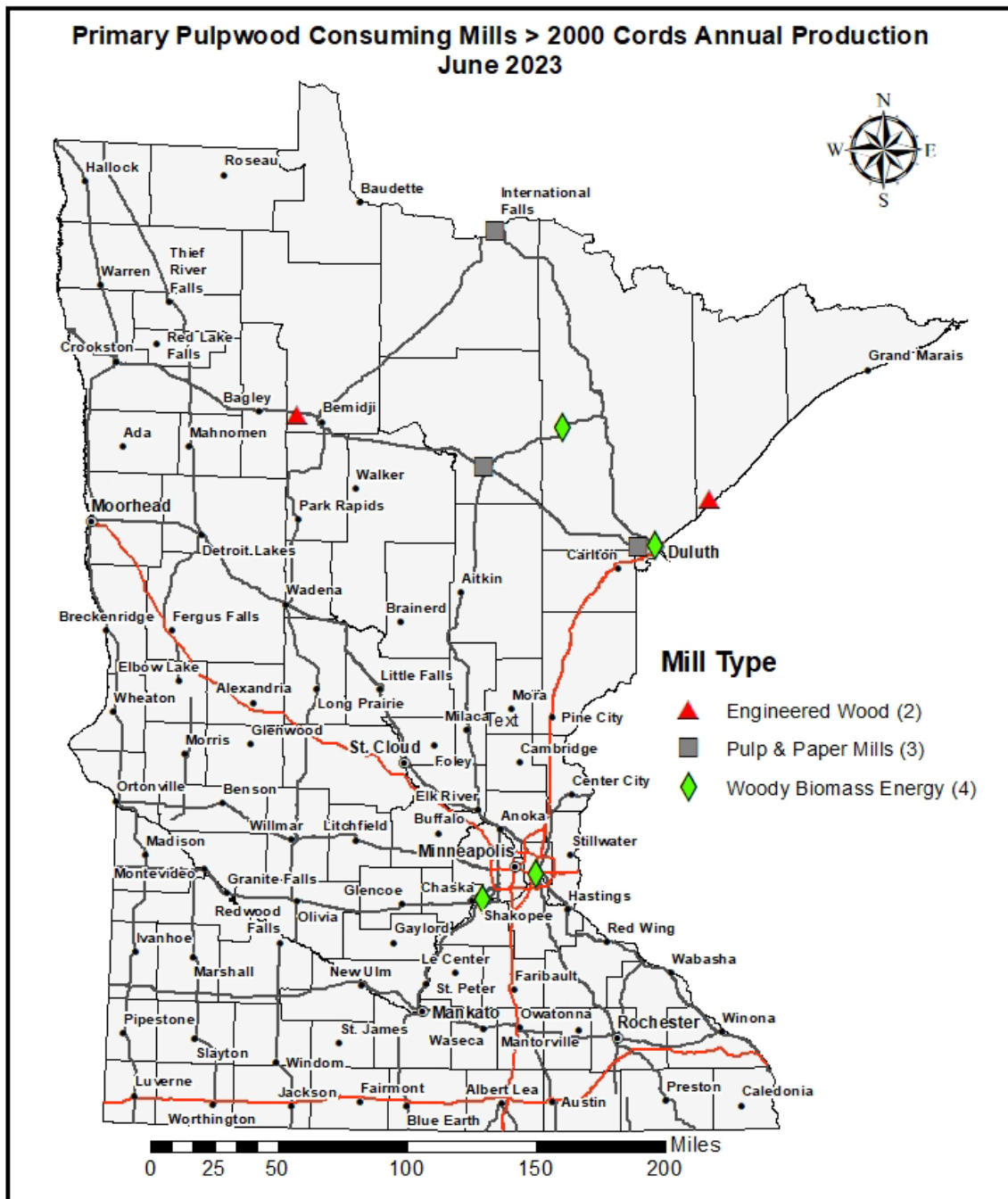
produce wood products with local tree species. This sector creates market diversity and provides value-added markets for numerous species, sizes, and qualities of timber. Markets are important to landowners through harvest compensations, which help them engage in other management activities such as creating wildlife habitat, 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. In 2023, Minnesota's sawmills and specialty mills used nearly 25% of the timber harvested in the state, or approximately 657,300 cords.

Sawmills affect other wood industry sectors as well. 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 is critical to helping sawmills continue to produce their 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 300 active sawmills or specialty mills. There are 45 mills in the state that utilize more than 1 million board feet or 2,000 cords each year (Figure 4-3) and they account for 95% of the total consumption within this industry. The remainder of the mills are smaller stationary mills or portable bandsaw mills.

Sawmill overview

From 1986 to1992, 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, though the number of sawmills remained steady. Wood availability, especially aspen, was challenged by a competitive marketplace during this period. 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, and 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.

Table 4-3: Examples of Products Produced by Minnesota Sawmills and Specialty Mills, 2023.

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

Dometic Consumption (in cords) of Hardwood Sawlog in Minnesota Sawmills/Specialty Mills, 2023

Aspen; 77,416; 30%
Cottonwood; 3,613; 1%
Other hardwoods; 3,874; 1%
Soft maple; 4,564; 2%
Hard maple; 4,669; 2%
Paper birch; 21,558; 8%
White oak; 22,181; 8%
Red oak; 61,744; 24%
Basswood; 36,330; 14%
Ash; 25,148; 10%
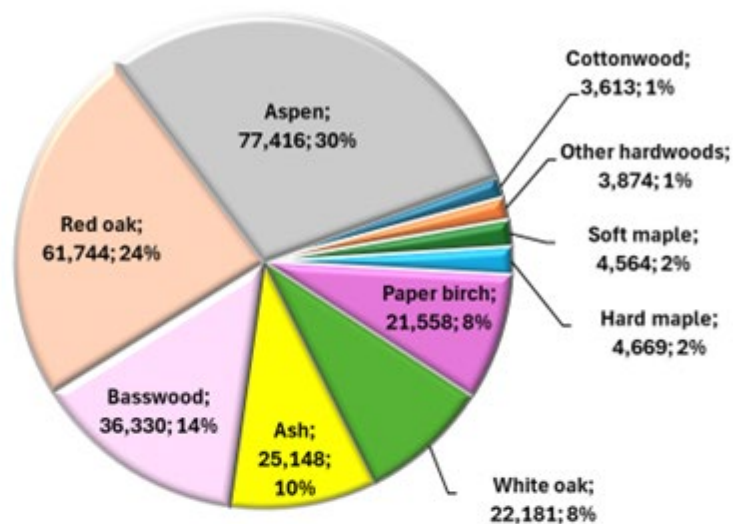
Dometic Consumption (in cords) of Softwood Sawlog in Minnesota Sawmills/Specialty Mills, 2023

Red pine; 244,662; 62%
Other pine; 8,567; 2%
Cedar; 10,451; 3%
Balsam fir; 11,749; 3%
Tamarack; 18,221; 4%
White pine; 23,608; 6%
Jack pine; 36,373; 9%
Spruce; 42,607; 11%
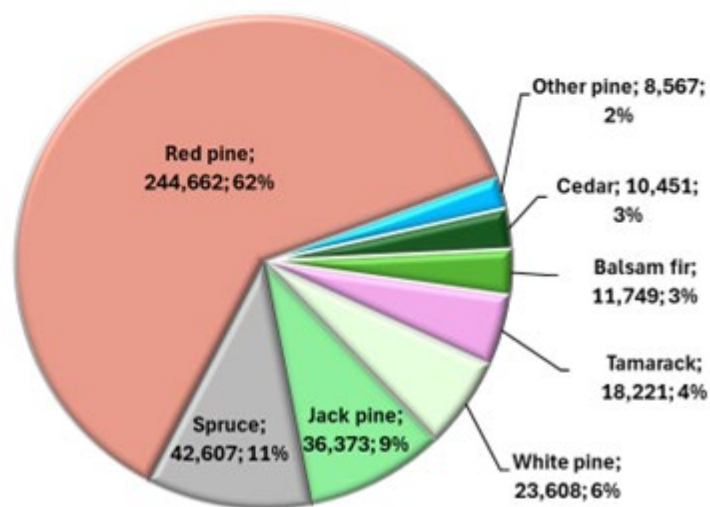
Figure 4-4: 2023 Hardwood and Softwood Use in Sawmills and Specialty Mills.

Figure 4-5 shows sawmills, post, pole and piling mills, shavings mills and specialty mills listed in the primary producer directory. These mills utilized wood material of various species in a ratio of nearly 60% softwood and 40% hardwood in 2023.
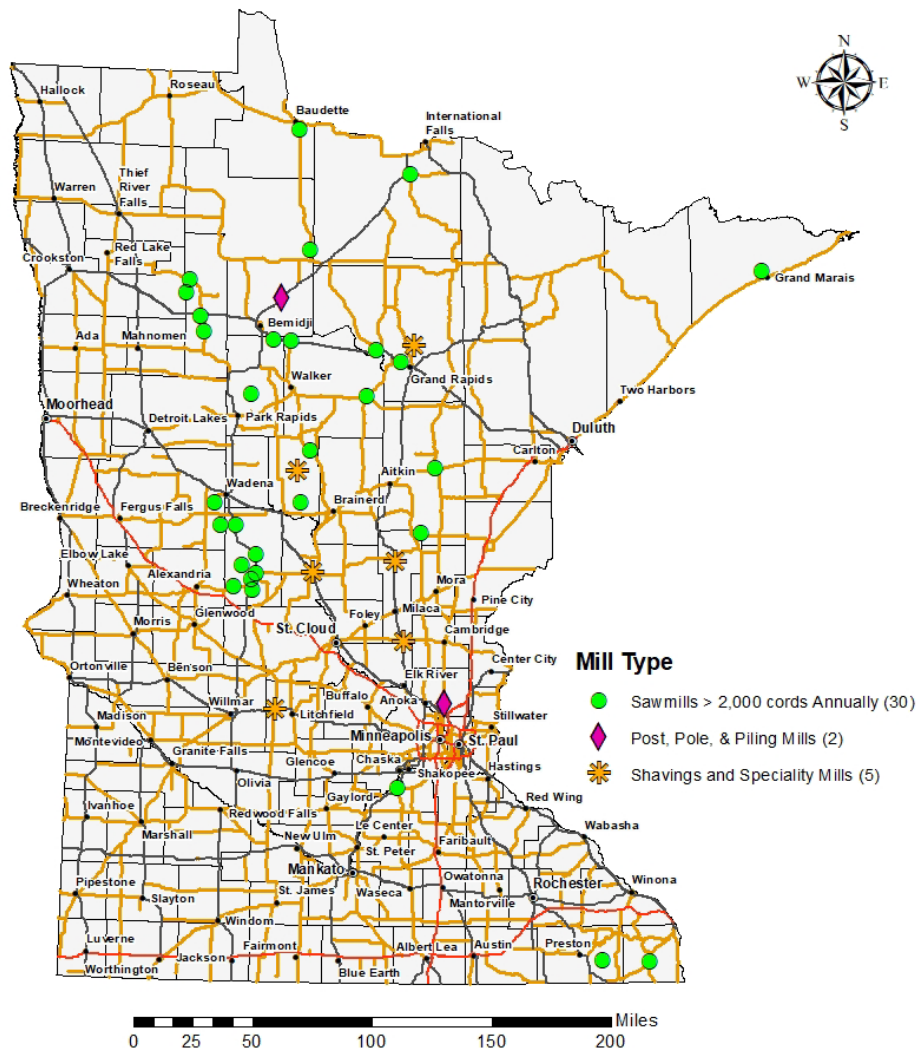
Figure 4-5: Saw and Specialty Mills greater than 2,000 Cords Annual Production, June 2023

Commercial biomass energy sector

Commercial energy produced through the consumption of woody biomass remains a small component of Minnesota's total energy production. Less than 1% of Minnesota's electrical generation comes from biomass (2023 MN Energy Factsheet, Clean Energy Economy MN).

Energy production from mill residues have long been used at wood using facilities and mill residue continues to be the largest feedstock in the state. In the early 2000's, new biomass energy facilities came online and began consuming larger quantities of logging residue (tops and limbs) and urban forest wood waste.

Woody biomass utilization peaked around 2010 with approximately 2.7 million green tons consumed. Biomass energy production fluctuated since then with a gradual trend downward until 2018. Total biomass consumption in 2023 is presented in Table 4-4.

2017 legislation led to the closure of three biomass energy facilities which caused a significant reduction in logging residue consumption. From 2018 to 2022, total biomass utilization has remained flat.

Mill residue, logging residue and urban wood waste generated an estimated 2,730,000 green tons of biomass (Table 4-5). Mill residue production alone is estimated to be 1,544,668 green tons (Table 4-6). There is substantial room for additional woody biomass consumption. The state is currently only utilizing approximately 35% of what is potentially available as logging residue and urban wood waste. There is also additional opportunity to utilize biomass from tree species and forest currently experiencing heavy mortality due to forest insect infestations in portions of the state (ash, tamarack, and balsam fir).

Table 4-4: Reported Biomass Consumption for Commercial/Industrial Energy, 2023 TPO.

Total estimated woody biomass consumption	1,190,000 green tons
Percent from mill residues	74%
Percent from urban tree and industrial wood waste	18%
Percent roundwood from timberlands	3%
Percent from logging residue (tops & limbs)	5%

Table 4-5: Estimated Statewide Biomass Production/Availability – 2023 (green tons)

Mill Residue	Logging Residue	Urban Wood Waste*	Total
1,545,000	790,000	395,000	2,730,000

* 394,900 green tons from Twin Cities Metro Area EAB Wood Waste Study, Partnership on Waste & Energy, October 2022

Table 4-6: Mill Residue Disposition Estimates – 2023 TPO

Residue Type	Industrial/ Residential Fuel	Pulp	Mulch	Bedding	Other	Not Used	Total
Green Tons	1,000,277	149,536	177,540	144,146	8,392	64,777	1,544,668

Residential fuelwood sector

Since 1960, the Minnesota Pollution Control Agency (MPCA) with assistance from the MN DNR and the USFS, periodically conducts a statewide survey to estimate how much wood is harvested and burned annually for heat or pleasure in Minnesota. A variety of state and 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 data across survey years to identify trends, as survey questions and format have changed over the years. MPCA conducted the survey reported in this document in 2020-2021.

The forest resources data on timber harvests used in this annual report focuses on using live trees harvested from 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-forest lands. Using the findings from the 2020/2021 MPCA survey report, the total fuelwood consumption of 1,540,000 cords can be separated by fuel types and source to determine the amount of fuelwood from live trees from timberlands.

Table 4-7: Fuelwood

Total residential fuelwood consumption	1,540,000 cords
Percent of roundwood/logs and split wood	99%
Percent of wood from live trees from forest land	15%
Calculated volume of cords from live trees	229,000 cords *(rounded)*

Non-timber forest product sector

Balsam boughs for the Christmas wreath industry have 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.

Industry information updates, 2023

Forest industry information is reported for 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.

Huber axes $440 million, 400,000 cords-per-year greenfield OSB mill project in Minnesota

February 10, 2023 (lptv.org) A proposed mill by North Carolina-based Huber Engineered Woods will no longer be in Cohasset, Minn. Announced by the company on Thursday, the decision comes three days after a Minnesota Court of Appeals ruling that stated the company had to reconsider the environmental impact of its review. The $440 million, 400,000 cords-per-year project was announced in June 2021 and estimated to bring about 150 direct jobs to the small Itasca County town. But due to protests and legal challenges from environmental groups, the project had problems getting off the ground.
"Due to delays that jeopardize our ability to meet product demand deadlines, we will pursue development of our sixth mill in another state," said Huber Engineered Woods President Brian Carlson. "We will be seeking a new location where we can produce critical home building products that are desired by American home builders and homeowners in a timely manner and consistent with Huber's environmental and social commitments."

The mill was planned to be 750,000 square feet in area originally set to break ground in spring of 2022. Plans included multiple oriented strand board (OSB) products. OSB is a type of compressed wood panel used in housing and light commercial construction for sheathing, siding, and sub-floors.

LP Building Solutions Announces Grand Opening of LP Innovation Center at NRRI

June 22, 2023 (newswire.ca) LP Building Solutions (LP), a leading manufacturer of high-performance building products, announced the grand opening of the LP Innovation Center. The facility, located at the Natural Resources Research Institute (NRRI) at the University of Minnesota Duluth, marks a significant milestone in LP's commitment to growth, innovation and sustainability, emphasizing its focus on driving future growth through new product development.
In this unique industry-university collaboration, the LP Innovation Center seeks to advance the use of sustainable technology in engineered wood products and applications to move the building materials industry forward. The facility provides a controlled environment for rigorous evaluation and testing in partnership with NRRI's building science and engineering teams, enabling LP to achieve its ambitious roadmap of future LP® SmartSide® Trim & Siding and LP Structural Solutions products slated for release within the next five to 10 years.

Minnesota SAF Hub Launches First-Of-Its-Kind Coalition to Scale Sustainable Aviation Fuel

August 29, 2023 (greatermsp.org) A first-of-its-kind coalition is launching in Minnesota to scale sustainable aviation fuel (SAF) with the urgency commercial aviation needs to reach net zero by 2050.
Through the GREATER MSP Partnership, Bank of America, Delta Air Lines, Ecolab and Xcel Energy have established the Minnesota SAF Hub – the first large-scale SAF Hub in the U.S. with unparalleled collaboration among key players across the value chain committed to scaling SAF production to replace conventional jet fuel. These anchor members are joined by other leading institutions, including the State of Minnesota, to implement an ambitious shared strategy for aggressively decarbonizing the airline industry.

Sofidel Acquires ST Paper's Tissue Mill in Duluth

January 4, 2024 (paperage.com) Sofidel today announced the acquisition of ST Paper's tissue mill in Duluth, Minnesota. Terms of the deal were not disclosed.

The mill has the capacity to produce 65,000 metric tons per year of bath, napkin and towel grades of tissue. In addition, the mill has a groundwood pulp plant and a recycled pulp plant.

"This is an important acquisition, allowing us to immediately meet the growing demand, which saw a significant upturn in 2023," said Luigi Lazzareschi, CEO of Sofidel. "What we are acquiring is a technologically advanced plant that further improves our geographic coverage and creates the conditions to strengthen and sustain growth in what is our main market."

ST Paper acquired the mill in May of 2021 from Verso Corporation with the intention to convert the mill's production from specialty paper grades to tissue.

Announcement of New Minnesota SAF Plant Advances Strategy to Lead the World in Decarbonizing Air Travel

November 1, 2024 (dgfuels.com) DG Fuels announced the selection of a site for a roughly $5 billion manufacturing facility and hundreds of good jobs in Moorhead, Minnesota, that will produce 193 million gallons per year of low-carbon aviation fuel (SAF) using agricultural and wood waste as feedstock.

This news is a notable milestone for the MN SAF Hub and is the most significant commitment towards commercial-scale SAF production in the state. The announcement also reflects Minnesota's compelling value proposition to SAF producers, which includes abundant and diverse feedstocks, clean electricity, mature rail networks, and strong state support. The 193 million gallons projected by DG Fuels would represent nearly half of the fuel used at the MSP International Airport.

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

Chapter 5 - Main cover types and species in Minnesota: description, presence, growth and harvest

In this section, we present forest resource and harvest level information for Minnesota's most significant cover types and tree species. Each of these most common species have one-page layouts for cover type, presence, and growth and harvest statistics.

Note, the following pages and their figures and tables are independently labeled, numbered, and referenced, in comparison to other chapters. This chapter is numbered relative to each main cover type's set of pages. Also note, these figures and tables are not included in the document's overall Table of Figures or Table of Tables.

Aspen and balm of Gilead forest cover type

Aspen and balm of Gilead (balsam poplar) together are the predominant cover type in Minnesota's forests (5.11 million acres of timberland, Figure 2). The aspen cover type consists of a wide mixture of species (Figure 1). Predominant secondary species include balsam fir, paper birch, red maple, and black ash.

FIGURE 1. VOLUME OF ASPEN COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022

bigtooth aspen ; 6%
balsam fir ; 5%
paper birch ; 4%
red maple ; 3%
black ash ; 2%
balsam poplar ; 2%
bur oak ; 2%
white spruce ; 2%
Others; 10%
quaking aspen ; 64%

TABLE 1. % AREA OF ASPEN AND BALM COVER TYPE IN TIMBERLAND BY OWNERSHIP, FIA 2022

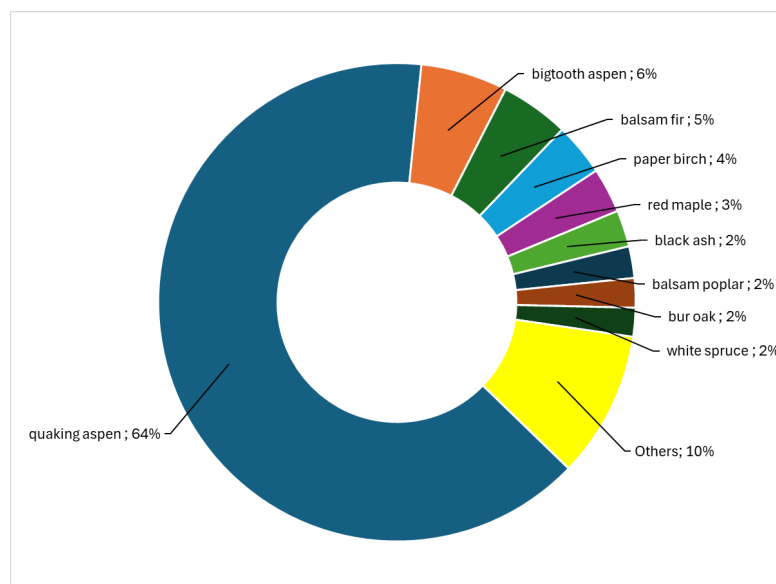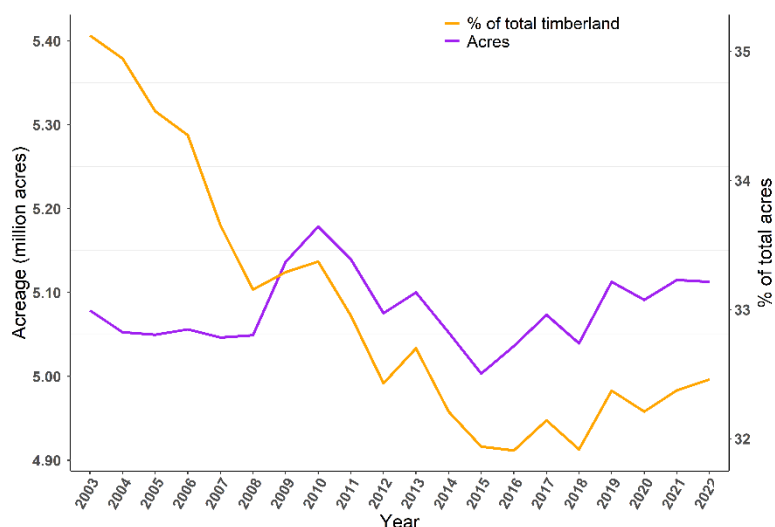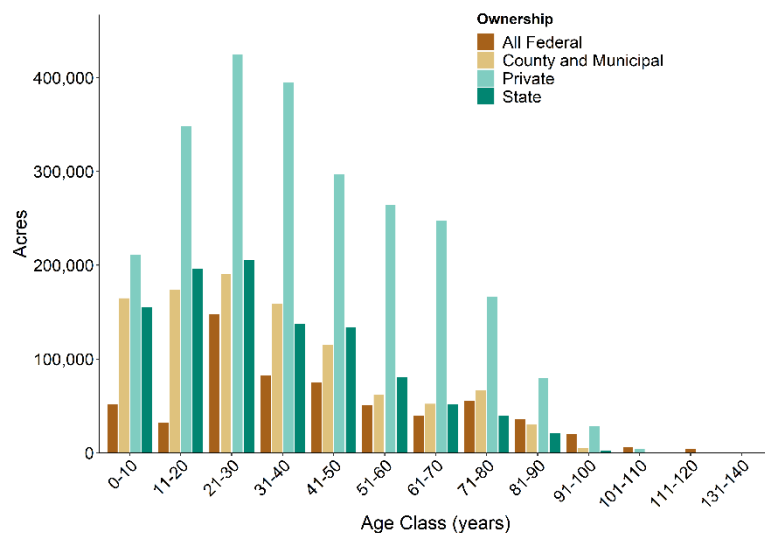|	Area
All Federal	11.7%
State	20.0%
County/Municipality	20.0%
Private	48.3%

FIGURE 2. ACRES OF ASPEN AND BALM COVER TYPE ON TIMBERLAND, FIA

A high percentage of the aspen and balm of Gilead cover types is located on private lands (Table 1). Increasing active forest management on this land base may require more private landowner incentives and assistance.

Federal lands skew toward older age classes compared to other ownerships (Figure 3). State and county administered lands display similar age class distributions.

There are significant acres of this cover type over the age of 40 and in stands nearing maturity.

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP ASPEN AND BALM OF GILEAD, FIA 2022

Aspen and balm of Gilead species: presence

Aspen species (quaking and bigtooth aspen and balm of Gilead) are the predominant tree species in Minnesota's forests (Figure 4). Based on FIA 2022 data, the current merchantable volume of aspen species represent 25.5% of the total merchantable volume in Minnesota.

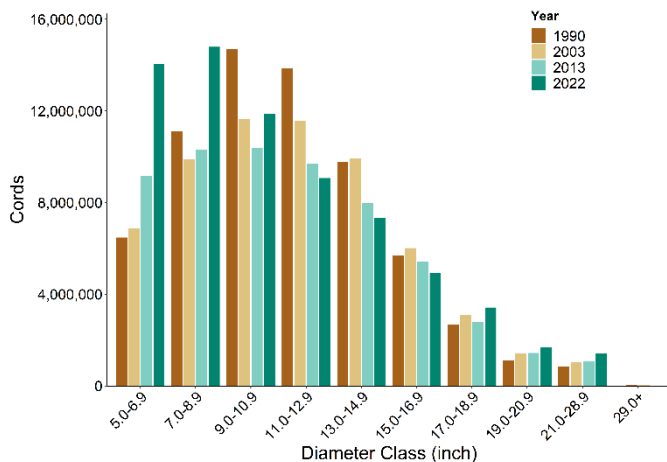**FIGURE 4. VOLUME OF ASPEN AND BALM OF GILEAD SPECIES (2003-2022), FIA**

FIGURE 5. VOLUME OF ASPEN AND BALM OF GILEAD SPECIES BY DIAMETER CLASS, FIA (1990-2022)
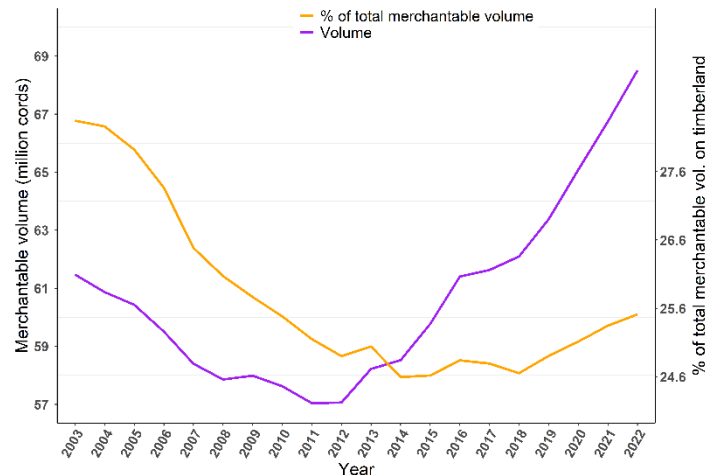
TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF ASPEN AND BALM OF GILEAD BY OWNERSHIP, FIA 2022

|	Volume
All Federal	15.4%
State	16.4%
County/Municipality	18.8%
Private	49.2%

Almost 50% of their volume can be found on private lands (Table 2). Their presence is a significant component in many other upland cover types. 22.8 % of the volume of aspen species is found in cover types other than aspen (Table 3).

TABLE 3. % OF PRESENCE ASPEN AND BALM OF GILEAD TREE SPECIES BY FOREST COVER TYPES, FIA 2022

	Aspen	Balsam poplar	Birch	Lowland hardwoods	Northern hardwoods	Oak	Other*	Red pine
% of total Volume of aspen species	77.2	4.0	2.3	1.7	4.8	4.0	3.8	2.2

*Other includes forest cover types with less than 1% of the volume

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF QUAKING ASPEN, BIGTOOTH ASPEN AND BALSAM POPLAR RESPECTIVELY, FIA 2017
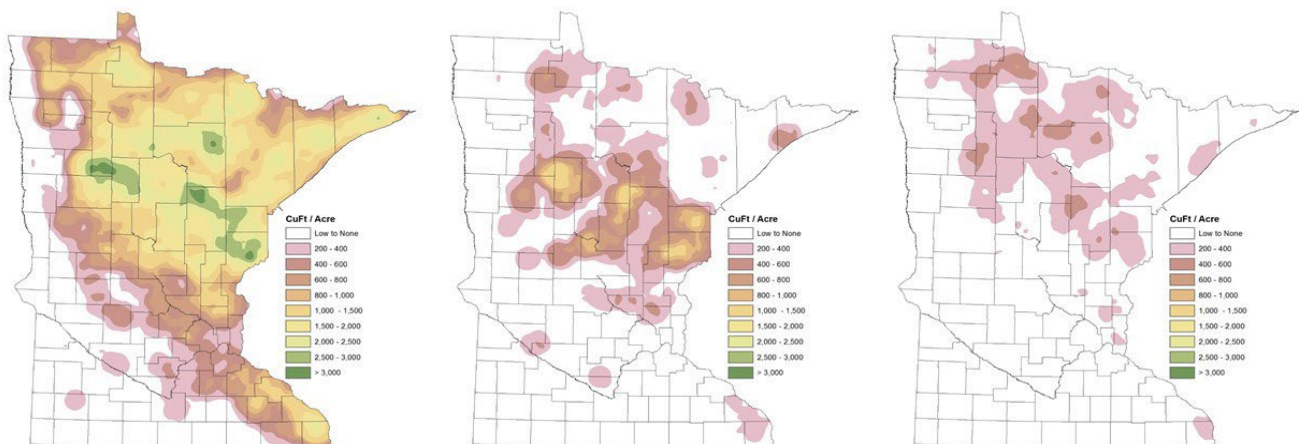
Aspen and balm of Gilead species: growth and harvest

Aspen species are relatively short-lived, fast growing tree species that require nearly full sunlight to regenerate. They are also the species of greatest industrial use in pulp, paper and composite mills. Aspen harvest has declined since the late 1990's but has remained relatively stable since 2007 (Figure 7).

FIGURE 7. TOTAL ASPEN AND BALM OF GILEAD SPECIES HARVESTED FROM TIMBERLAND (1994-2023), TPO

FIGURE 8. AVERAGE ANNUAL NET GROWTH, MORTALITY, AND HARVEST REMOVALS, FIA

Figure 8 shows the average annual net growth (gross growth minus mortality), mortality (non-harvest related mortality), and harvest removals of merchantable volume on timberlands. The net growth to harvest removals ratio has increased in the last 5-years (2018-2022). The federal and private timberlands have the highest average net growth to harvest ratio compared to state and county timberlands (Figure 10). See Appendix A for explanations of these figures.

The decrease in aspen harvest is due to many reasons such as reductions in harvest from private lands, closure of large mills, and substitution of alternative species by most large mills (Figure 7). The harvest volume of aspen species is predominantly used as pulpwood (Figure 9).

FIGURE 9. ASPEN HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO 2023

FIGURE 10. AVERAGE ANNUAL NET GROWTH, MORTALITY, AND HARVEST REMOVALS BY OWNERSHIP IN 2018-2022, FIA
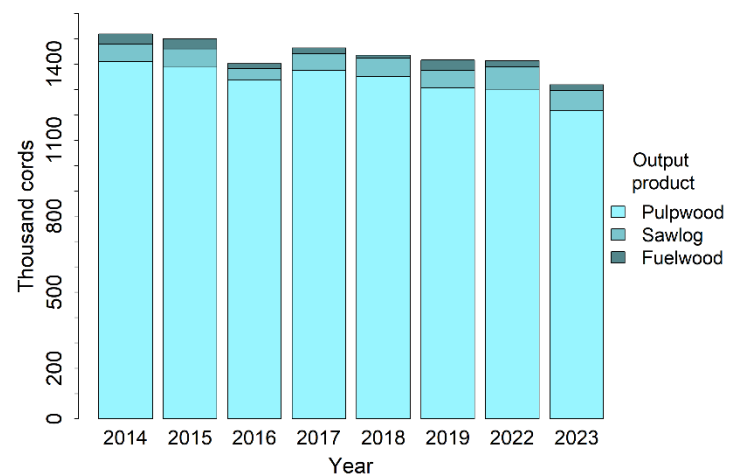
Opportunities:
• Large acreage of the aspen cover type is mature or nearing maturity.
• As aspen stands are harvested closer to economic rotation age, wood quality increases.

Challenges:
• Opportunities to increase the harvest of aspen occur primarily on private lands which may require additional assistance to realize.

Northern hardwoods forest cover type

The northern hardwoods cover type consists of a wide mixture of species, with sugar maple and American basswood the most abundant (25% and 20% respectively). Predominant secondary species include red maple, northern red oak, bur oak, quaking aspen, and paper birch (Figure 1). Based on FIA 2022 data, the timberland area of the northern hardwoods cover type is 1.4 million acres (Figure 2).

FIGURE 1. VOLUME OF NORTHERN HARDWOODS COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022

TABLE 1. % AREA NORTHERN HARDWOODS COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2022

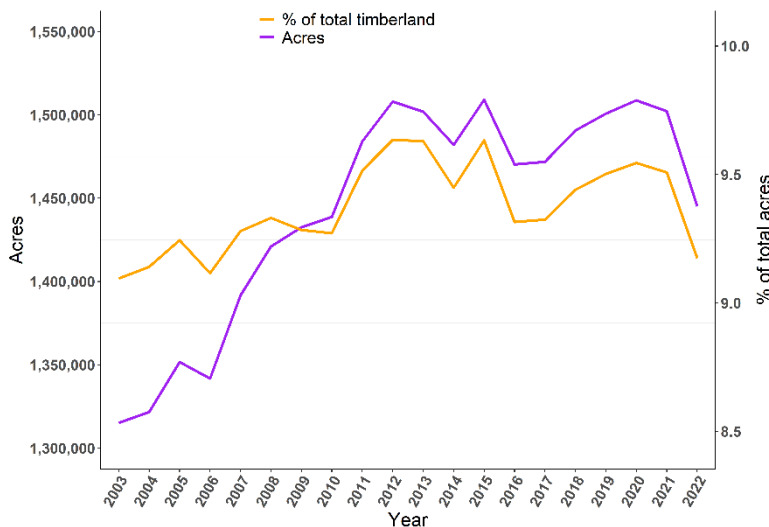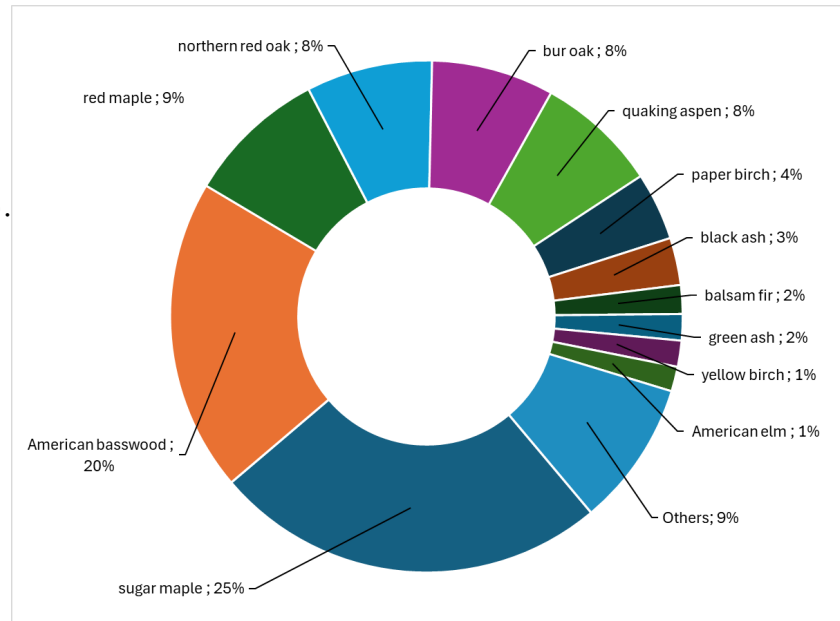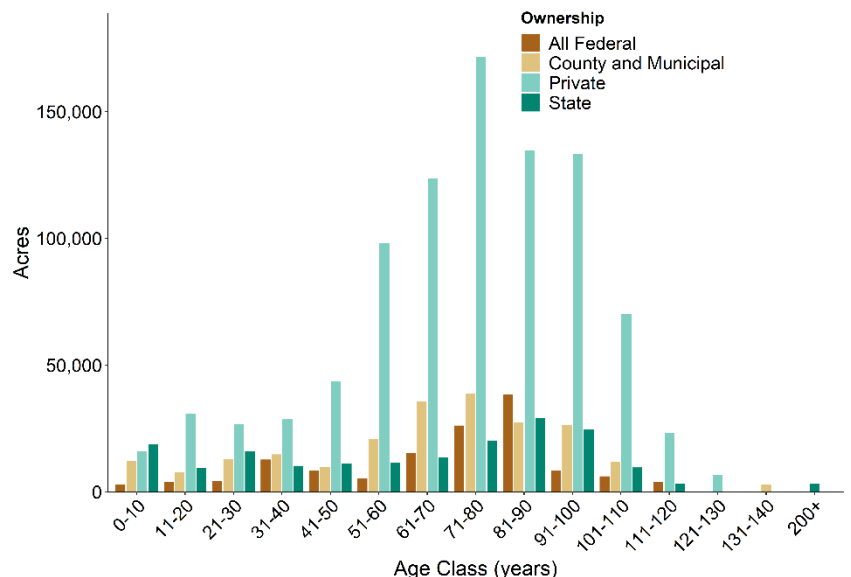|	Area
All Federal	9.4%
State	12.5%
County/Municipality	15.3%
Private	62.7%

FIGURE 2. ACRES OF NORTHERN HARDWOODS COVER TYPE ON TIMBERLAND, FIA 2022

Over sixty percent of the area of northern hardwoods timberland is on private land, with a lower presence on state and federal lands (Table 1). The estimated acres of timberland have decreased after 2020; however, there was an upward trend of area from 2003 until 2020. The present acreage is like what was estimated in 2010 (Figure 2).

The northern hardwoods cover type has a unimodal age-class distribution with a higher presence of late middle-aged stands (51-110 years old). For reference, the average even-aged rotation period for this cover type is established at 80 years. Most of the acres of northern hardwood cover type are on private land, and the distribution is centered between 50 and 110 years (Figure 3).

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP NORTHERN HARDWOODS, FIA 2022

Maple and basswood species: presence

Based on FIA 2022 data, the estimated merchantable volume of sugar maple, red maple and basswood species represents around 12.6% of all the estimated merchantable volume in Minnesota (Figure 4), around 33.7 million cords in 2022. The estimated volume of these species are dominated by smaller diameter trees (Figure 5).

FIGURE 4. VOLUME OF MAPLE AND BASSWOOD SPECIES (2003-2022), FIA

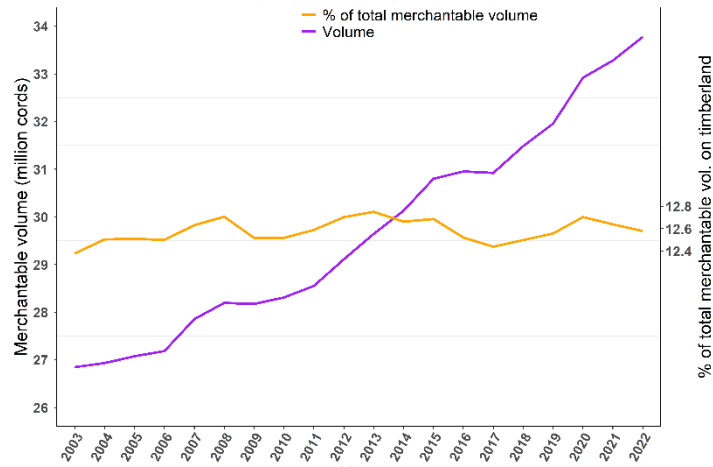**FIGURE 5. VOLUME OF RED AND SUGAR MAPLE AND AMERICAN BASSWOOD SPECIES BY DIAMETER CLASS (1990-2022), FIA**

**TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF RED AND SUGAR MAPLE/A. BASSWOOD BY OWNERSHIP, FIA 2022**

Ownership	Volume Red	Volume Sugar
All Federal	13.3%	8.4%
State	12.4%	9.1%
County or Municipality	16.4%	11.6%
Private	57.9%	70.9%

TABLE 3. % OF VOLUME OF SUGAR AND RED MAPLE AND AMERICAN BASSWOOD TREE SPECIES ON DIFFERENT FOREST COVER TYPES, FIA 2022

% of total volume	Northern hardwoods	Oak	Aspen	Birch	Lowland hardwoods	Other*
Sugar maple	83.2%	6.9%	5.4%	1.7%	0.7%	2.1%
Red maple	37.6%	15.8%	26.9%	6.3%	6.1%	7.3%
American basswood	46.3%	38.6%	6.8%	-	4.5%	3.8%

*Other includes forest cover types with less than 1% of the volume

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF AMERICAN BASSWOOD, RED MAPLE, AND
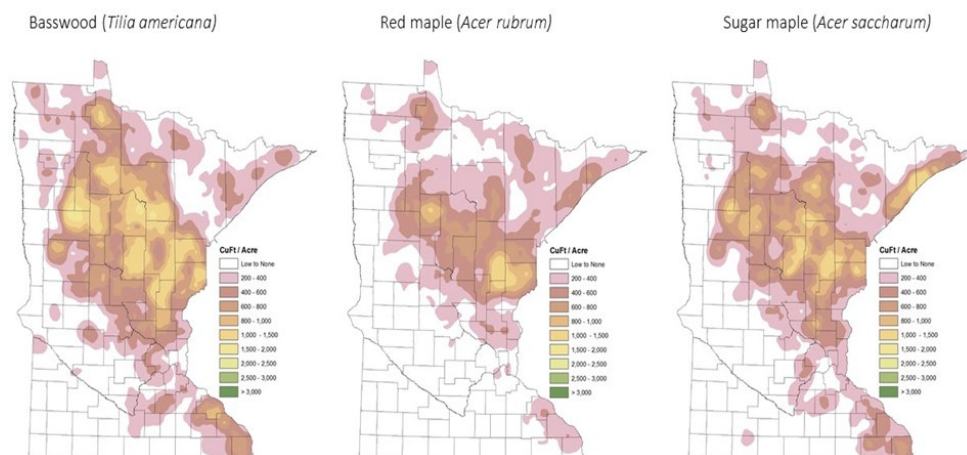
Most of their volume can be found in private and county lands (Table 2). Their presence is a significant component in many other cover types though mostly in northern hardwoods. Over 50% of the American basswood volume is found in oak, aspen, lowland hardwoods and other cover types (Table 3).

Maple species: growth and harvest

Minnesota's maple resource consists of four species: sugar maple, red maple, silver maple, and black maple. While Minnesota has a history of poor markets for many hardwood species, markets for some hardwoods have changed in recent years as pulp and paper mills have increased the use of maple and other hardwoods. The total volume harvest volume of maples has reduced gradually in the recent years (Figure 7).

FIGURE 7. VOLUME OF MAPLE SPECIES HARVESTED FROM TIMBERLAND (1994-2023), TPO

FIGURE 8. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF MAPLE SPECIES, FIA 2022
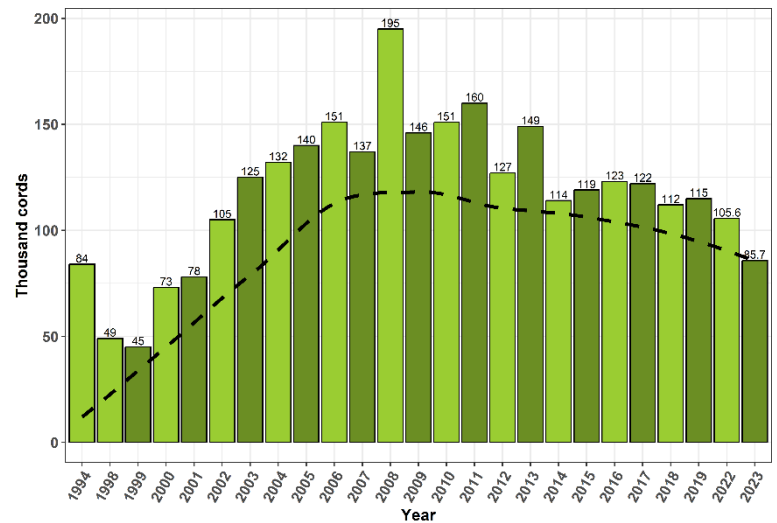
Analysis of harvested wood volume by output product classes shows that maple species are primarily used for pulpwood (Figure 9). A larger volume of maple wood is used as fuelwood than is used for sawlogs.
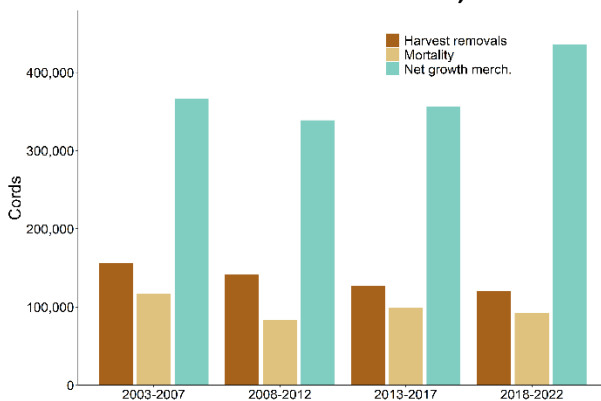
Figure 8 shows the average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of merchantable volume on timberlands of maple species. The combined harvest removals of all four maple species have remained similar in the past two FIA cycles while the growth stock is showing an upward trend and is more than double the harvest amounts. Private timberland has the highest annual average net growth and mortality, and harvest removals are higher on state and county lands.

FIGURE 9. MAPLE SPECIES HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO 2023

FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF MAPLE SPECIES BY OWNERSHIP, 2018-2022, FIA
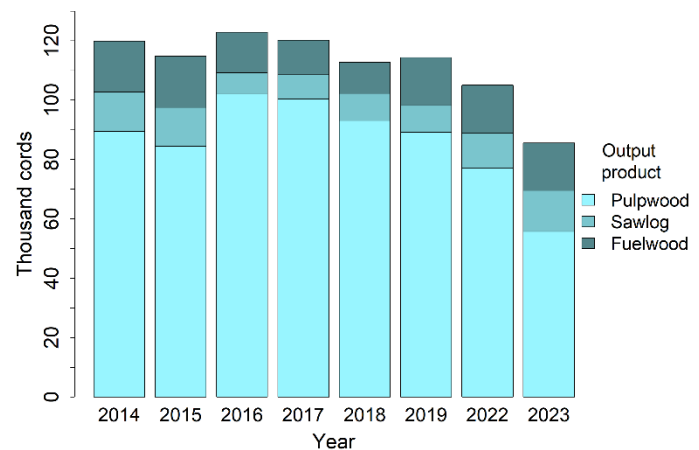
Opportunities:
• Average annual harvest is well below annual net growth
• Increased management could create higher grade maple products.

Challenges:
• Opportunities to increase the harvest of maple occur primarily on private lands which may require additional assistance to realize

Basswood species: growth and harvest

The total harvest volume of basswood has increased significantly in the past 10-years with a continuous upward trend (Figure 11). A large proportion of the wood is used as sawlog, and the ratio of pulp to fuelwood volumes fluctuates over years (Figure 13).

FIGURE 11. VOLUME OF BASSWOOD SPECIES HARVESTED FROM TIMBERLAND (1994-2023), TPO

FIGURE 12. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BASSWOOD SPECIES, FIA 2022
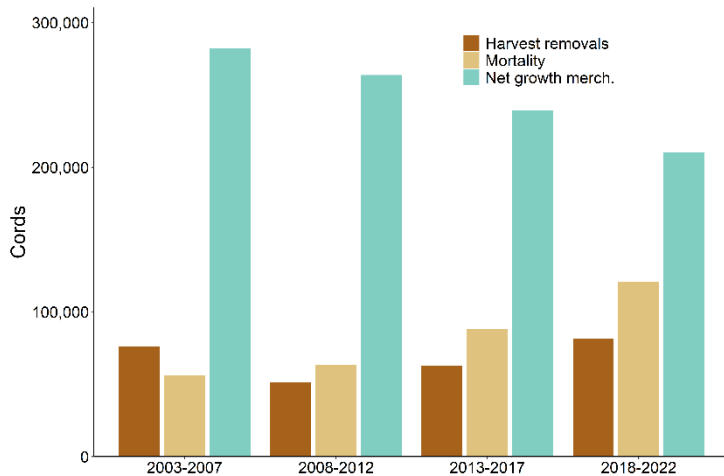

Figure 12 shows the average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of merchantable volume on timberlands. Based on FIA, the estimated annual average mortality has increased in the last 5 years while the net growth has experienced a decline. In 2018-2022, private timberland present the highest annual average values of net growth, mortality and harvest removals (Figure 14). See Appendix A for further explanation of these figures.

Basswood trees characteristically produce a large percentage of high-quality sound wood volume and veneer material on good sites in Minnesota. The harvest volume of basswood shows an even split across output products in 2019, but higher share of sawlog in 2022 and 2023 (Figure 13).

FIGURE 13. BASSWOOD SPECIES HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO 2023

FIGURE 14. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BASSWOOD SPECIES BY OWNERSHIP, 2018-2022, FIA
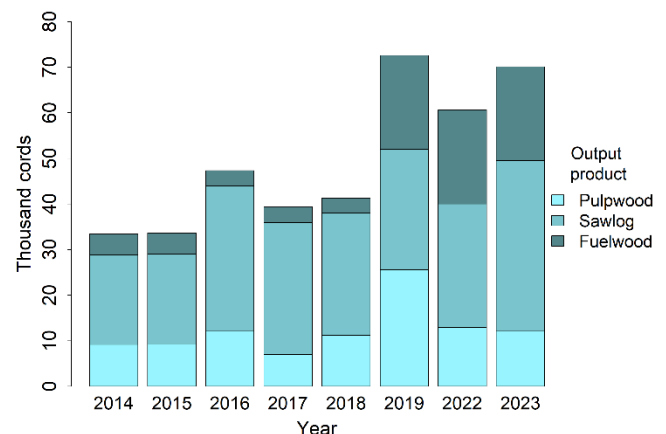
Opportunities:
• Average annual harvest is well below annual net growth
• MN basswood is of exceptional quality.
• Increased management could further the creation of high-grade basswood products.
Challenges:
• Opportunities to increase the harvest of basswood occur primarily on private lands which may require additional assistance to realize

Birch forest cover type

The birch cover type covers 0.74 million acres of timberland in Minnesota (Figure 2). It consists of a wide mixture of species but mainly paper birch. Predominant secondary species include quaking aspen, balsam fir, white spruce, and red maple (Figure 1).

FIGURE 1. VOLUME OF BIRCH COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022

TABLE 1. % AREA OF BIRCH COVER TYPE IN TIMBERLAND BY OWNERSHIP, FIA 2022

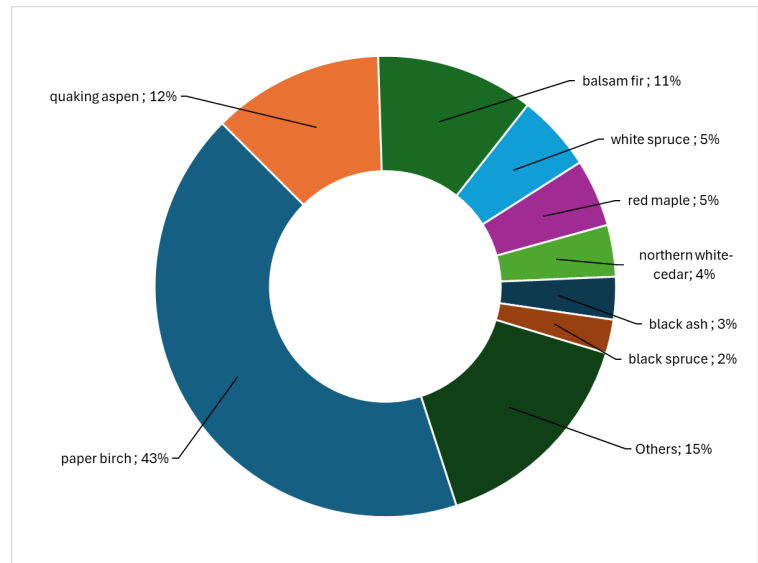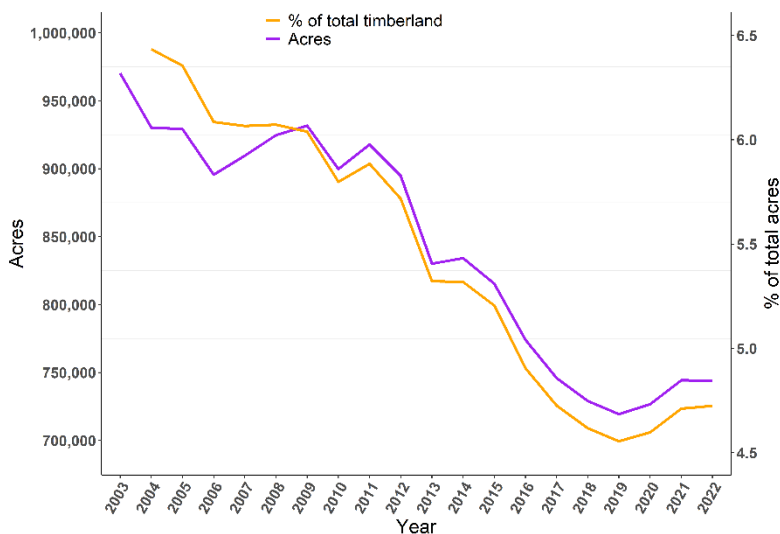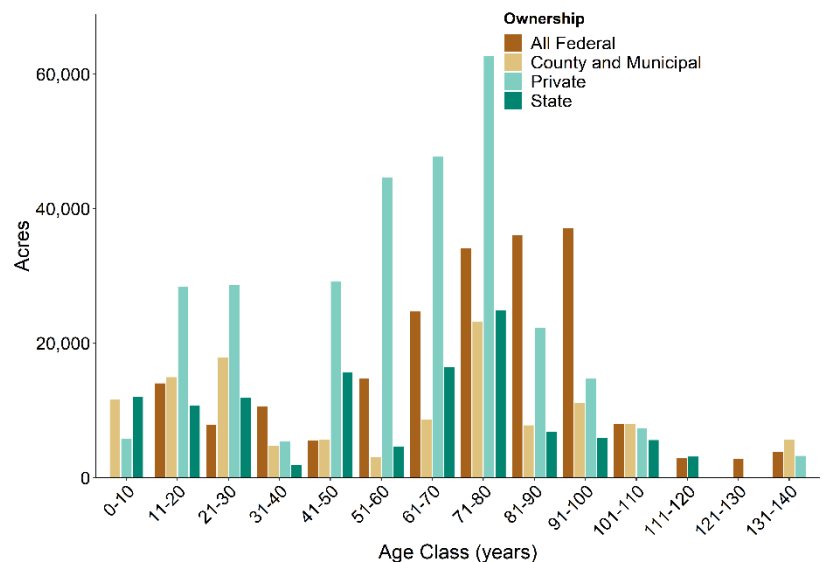|	All Federal	State	County/ Municipality	Private
Area	27.2%	16.1%	16.4%	40.3%

FIGURE 2. ACRES OF BIRCH COVER TYPE ON TIMBERLANDS, FIA 2022

Total acres of birch cover type have decreased since 2003 (Figure 2) because of serious mortality trends of paper birch species associated with age, insects, and stress caused by an increased number and severity of weather fluctuations.

Over 40% of the birch cover type is located on private lands (Table 1). Increasing active forest management on this land base may require more private landowner incentives and assistance.

The age class distribution of the acreage of timberland in 2022 follows a bimodal distribution across all the ownerships (Figure 3), with a higher cluster skewed to the older age classes.

FIGURE 3. AGE CLASS DISTRIBUTION OF BIRCH COVER TYPE ACRES BY OWNERSHIP, FIA 2022

Paper birch tree species: presence

Paper birch is a relatively short-lived species that can regenerate in full sunlight to partial shade. It can grow in nearly pure stands, or as a component in mixed stands (Table 3). Based on FIA 2022 data, the current merchantable volume of paper birch represents about 4.6% of the total merchantable volume in Minnesota (Figure 4).

FIGURE 4. MERCHANTABLE VOLUME OF PAPER BIRCH SPECIES (2003-2022), FIA

FIGURE 5. VOLUME OF PAPER BIRCH SPECIES BY DIAMETER CLASS, FIA (1990-2022)
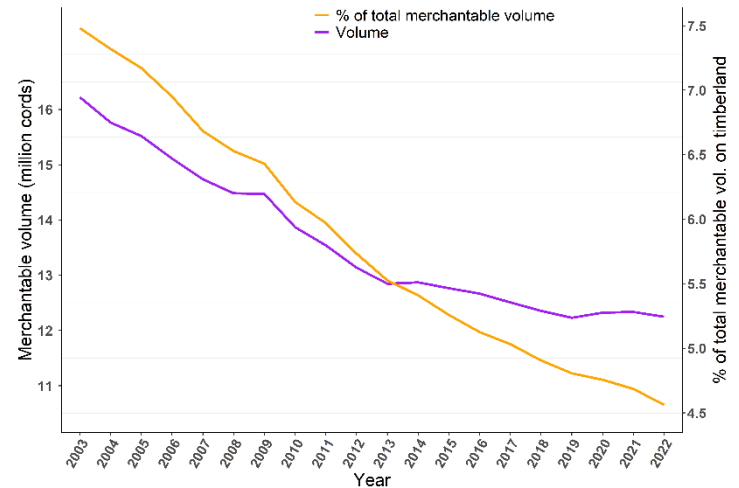
TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF PAPER BIRCH BY OWNERSHIP, FIA 2022

	Volume
All Federal	25.7%
State	15.1%
County/Municipality	16.1%
Private	43.1%

The current merchantable volume of paper birch has decreased since 2003 (Figure 4). Almost half of the volume of paper birch can be found on private lands (Table 2).

Only 38% of the total paper birch volume in the state is found in the birch cover type while the remaining 62% is distributed over other cover types (Table 3).

TABLE 3. % OF PRESENCE PAPER BIRCH SPECIES BY FOREST COVER TYPES, FIA 2022

	% of total Volume of paper birch
Birch	38.2%
Aspen	21.2%
Northern Hardwoods	12.3%
Northern white cedar	5.1%
Red pine	4.5%
Oak	4.5%
Other	14.2%

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF PAPER BIRCH (*BETULA PAPYRIFERA*), FIA 2017

*Other includes forest cover types with less than 5% of the volume
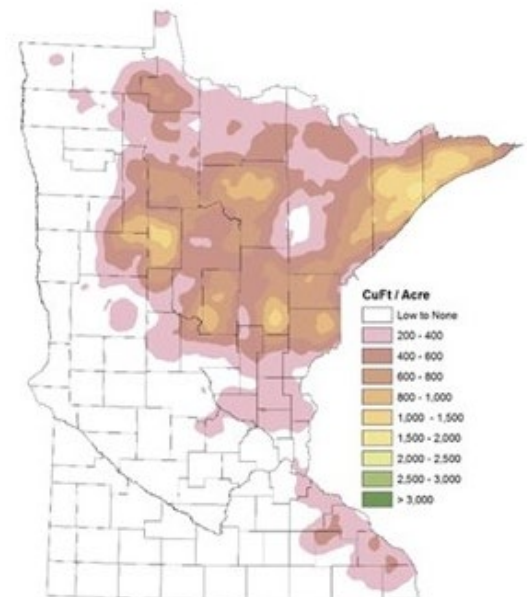
Paper birch tree species: growth and harvest

Paper birch harvest has decreased in the last decade (Figure 7). Non-harvest related mortality of paper birch has declined in the past three cycles, but mortality remains high (Figure 8). The average annual net growth has increased in the last two survey cycles, but average net growth was negative during 2008-2012 due to high mortality.

FIGURE 8. AVERAGE ANNUAL NET GROWTH, MORTALITY, AND HARVEST REMOVALS, FIA (2003-2022)
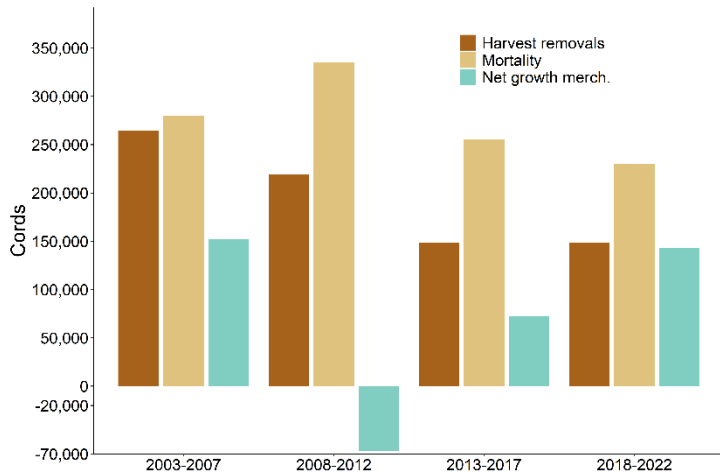
Figure 8 shows the average annual net growth (gross growth minus mortality), mortality (non-harvest related mortality), and harvest removals of merchantable volume on timberlands. In 2018-2022, private timberlands have suffered the highest average annual mortality of paper birch. County and private lands have had the highest average annual harvest (Figure 10). See Appendix A for further explanation of these figures.

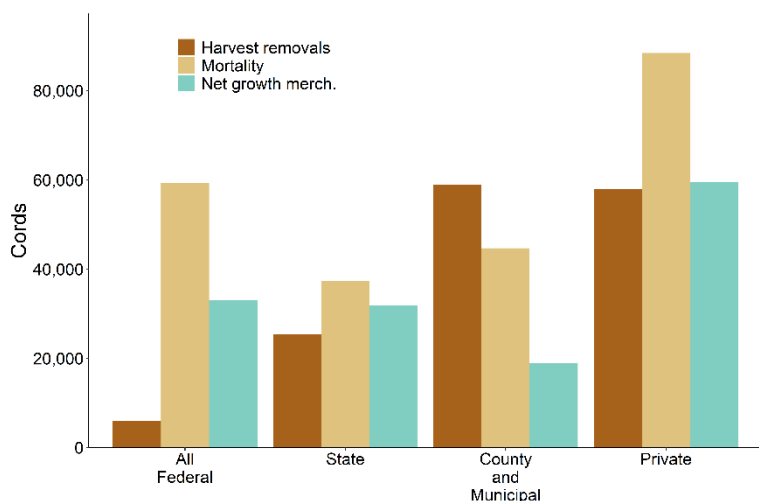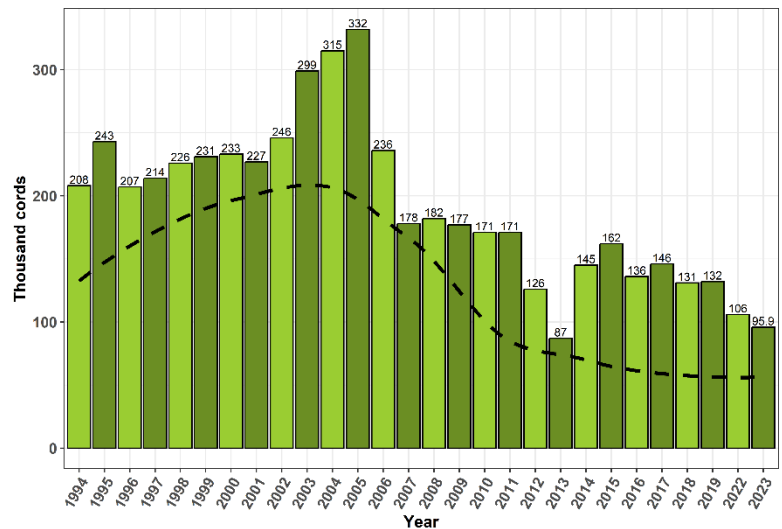**FIGURE 10. AVERAGE ANNUAL NET GROWTH, MORTALITY, AND HARVEST REMOVALS BY OWNERSHIP IN 2018-2022, FIA**

FIGURE 7. TOTAL VOLUME OF PAPER BIRCH HARVESTED FROM TIMBERLAND (1994-2023), TPO

The volume of paper birch species harvested has decreased since 2005 due to mill closures and birch mortality (Figure 7). The main output product for paper birch species is pulpwood (Figure 9).

FIGURE 9. PAPER BIRCH HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO 2023
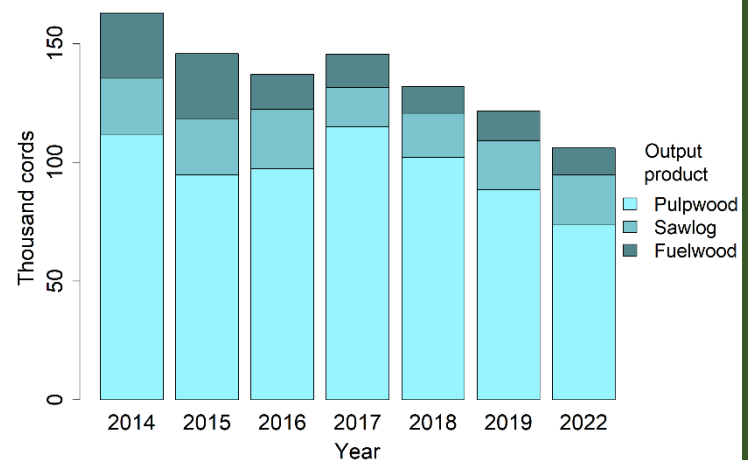
Opportunities:
• A portion of the average annual mortality could be captured with increased harvest and utilization
• High quality, fleck-free sawlogs in the NE
Challenges:
• High mortality rates continue to reduce standing birch volume and the acres of birch cover type
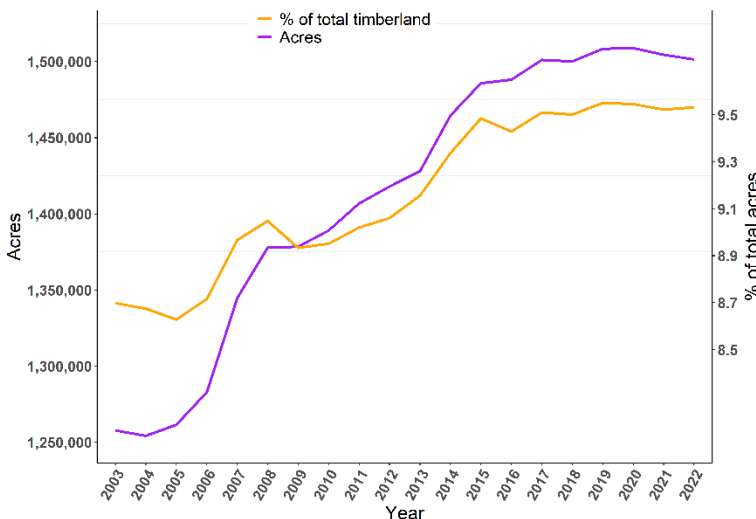• Wood quality can be variable in old birch stands

Oak forest cover type

Oak is a tremendously important cover type distributed in a large portion of Minnesota. Oaks provide acorns and dens for many wildlife species. The oak cover type consists of a wide mixture of species; however, bur and northern red oak are the main species. Predominant secondary species include American basswood, northern pin oak and quaking aspen (Figure 1).

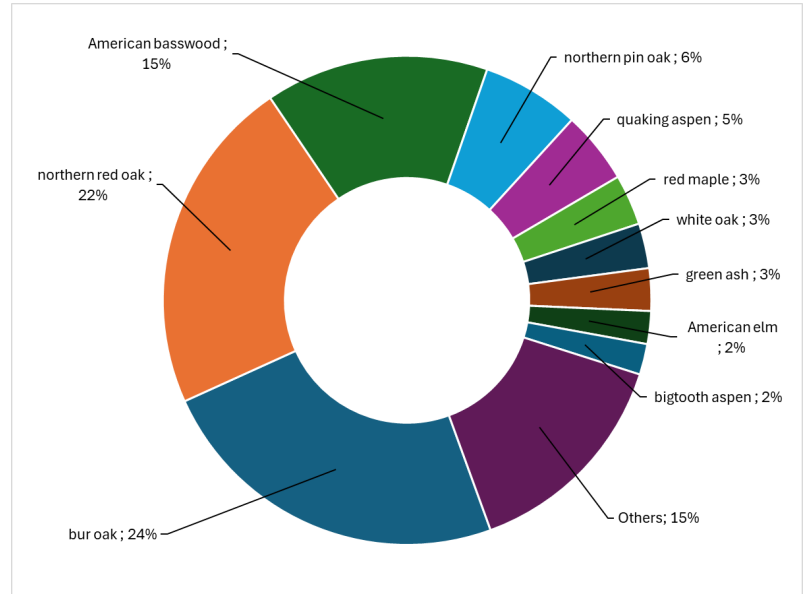**FIGURE 1. VOLUME OF OAK COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022**

TABLE 1. % AREA OF OAK COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2022

	Area
All Federal	1.8%
State	11.8%
County/Municipality	7.8%
Private	78.6%

FIGURE 2. ACRES OF OAK COVER TYPE ON TIMBERLAND, FIA

Based on FIA data, the estimated area of timberland of the oak cover type has increased since 2003, with a current acreage of 1.5 million (Figure 2). About 78% of oak's cover type area is under private ownerships, with a lower component owned by state and county/municipality (Table 1).

The age class distribution of the acres of timberland of this cover type is centered to the late middle age (Figure 3). The rotation age for oak ranges from 80 to 120 years. A large portion of the oak's cover type area under private ownership is occupied by younger stands, which implies active management of this cover type in recent decades.

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP OAK COVER TYPE, FIA 2022
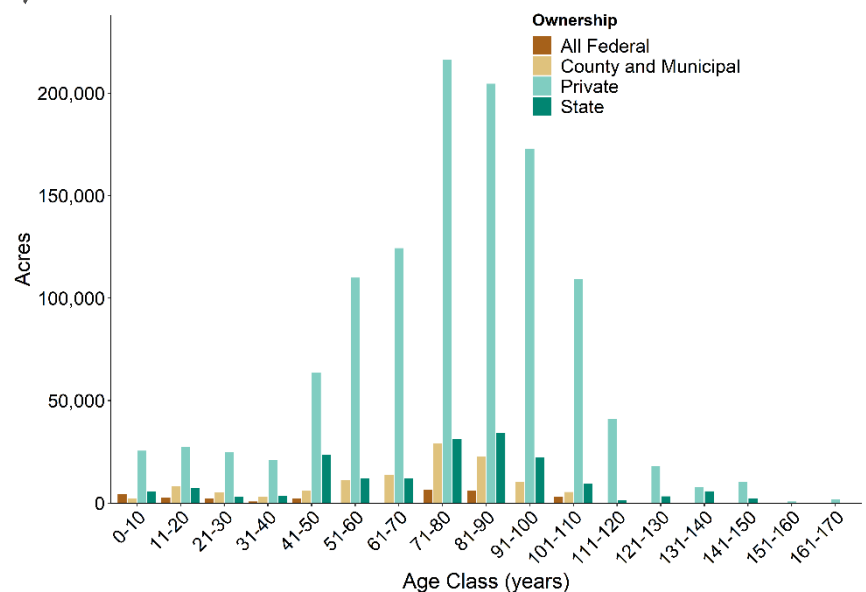
Bur and Northern red oak species: presence

Based on FIA data, combined merchantable volume of bur oak and northern red oak has increased since 2003; these two species represent 10.2% of the total merchantable volume in 2022 (Figure 4). Most of that volume is present in trees below 15-inch diameter (Figure 5).

FIGURE 4. MERCHANTABLE VOLUME OF OAK SPECIES (2003-2022), FIA

FIGURE 5. VOLUME OF BUR AND NORTHERN RED OAK SPECIES BY DIAMETER CLASS, FIA 2022

TABLE 2. % MERCHANTABLE VOLUME OF BUR AND RED OAK SPECIES IN TIMBERLAND BY OWNERSHIP, FIA 2022

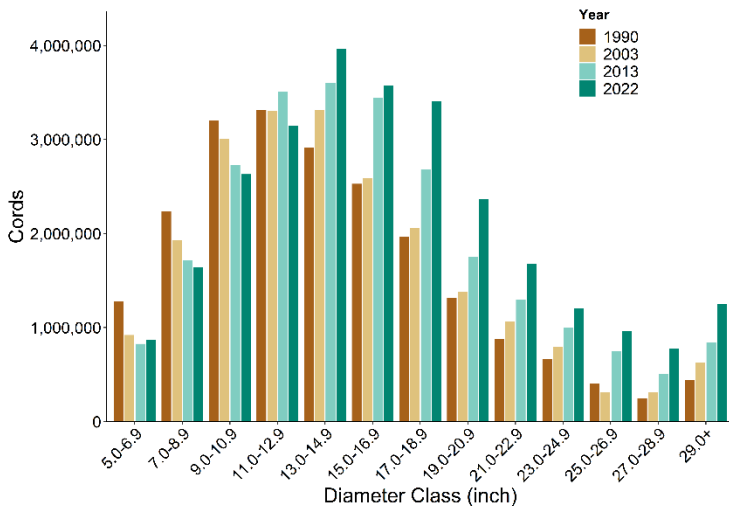|	Volume Bur	Volume Red
All Federal	2.8%	2.1%
State	9.1%	16.6%
County/Municipality	7.6%	11.6%
Private	80.5%	69.7%

TABLE 3. % OF PRESENCE BUR AND NORTHERN RED OAK TREE SPECIES BY FOREST COVER TYPES, FIA 2022

	Oak	Northern hardwoods	Aspen	Lowland hardwoods	Eastern white pine	Other*
% of total volume of bur oak	63.1	18.4	9.8	4.0	0.2	4.5
% of total volume of N. red oak	68.6	22.0	6.5	0.2	1	1.7

*Other includes forest cover types with less than 1% of the volume

Over 70% of the total oak volume is present on private lands (Table 2). The combined merchantable volume of bur oak and northern red oak is nearly 84% (bur oak 45% and red oak 39%) of the total merchantable volume of all oak species in Minnesota. Nearly 37% of the bur oak species volume and over 31% of northern red oak species volume is found in alternative cover types, other than oak (Table 3).

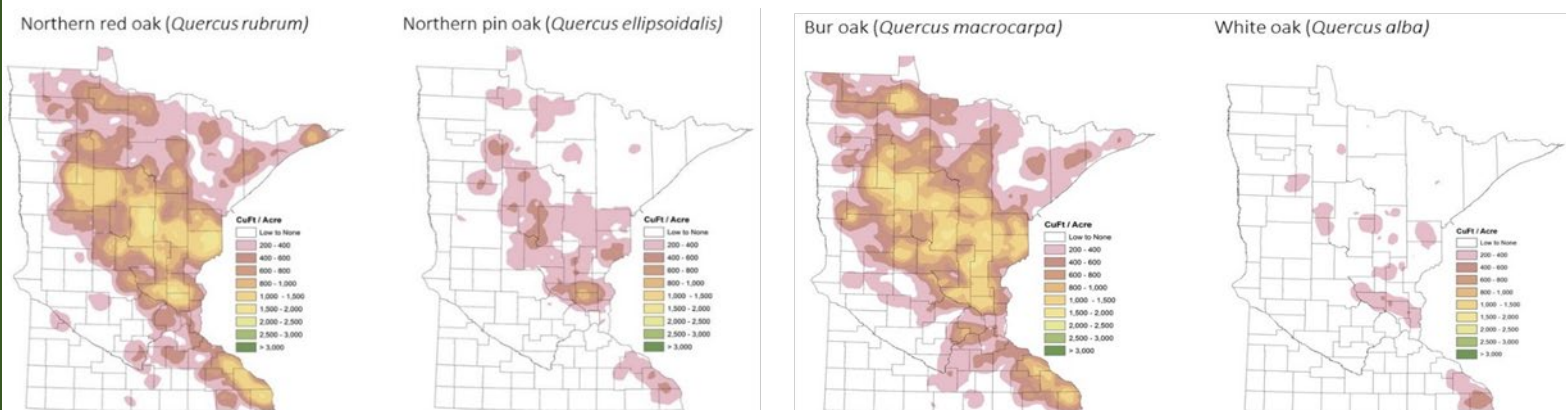**FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF OAK SPECIES RESPECTIVELY, FIA 2017**

Bur and Northern red oak species: growth and harvest

Oak is an important species in Minnesota where many sawmills, especially those in the southern two-thirds of the state, process oak saw logs resulting in the second largest volume (after aspen) among hardwoods. The harvest trend of oak shows continuously rising volume in the recent years (Figure 7).

FIGURE 7. VOLUME OF OAK SPECIES HARVESTED FROM TIMBERLAND (1994-2023), TPO

FIGURE 8. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BUR AND N. RED OAK SPECIES, FIA 2022

The TPO data on Oak harvest volume by output product classes show that the wood is primarily used as saw-timber and fuelwood (Figure 9). The lower amounts of oak fuelwood consumed in 2016-2018 likely reflects the variability of the residential fuelwood survey data and not an actual decline in fuelwood use in those years.
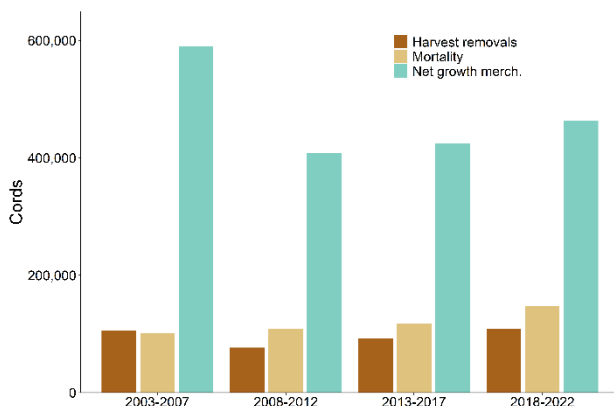
Figure 8 shows the average annual net growth (gross growth minus mortality), harvest removals, and natural mortality of merchantable volume on timberlands. The estimated average annual net growth, harvest and mortality have shown upward trends since 2008. However, the growth estimate in 2022 is relatively less compared to that in 2007. In 2018-2022, private timberlands have the highest average annual net growth, mortality and harvest removal compared to state, county and federal timberlands (Figure 10).

FIGURE 9. OAK SPECIES HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO 2023

FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BUR AND N. RED OAK SPECIES BY OWNERSHIP, 2018-2022, FIA

Opportunities:
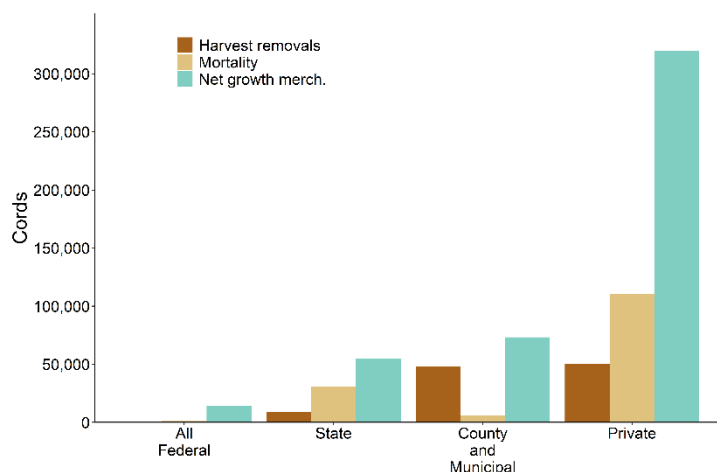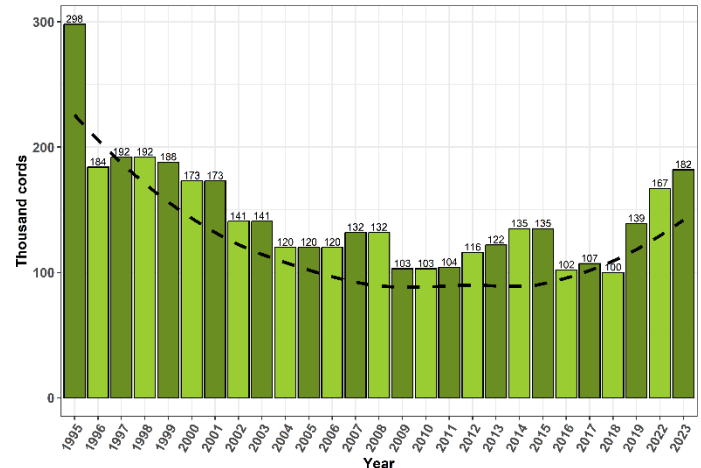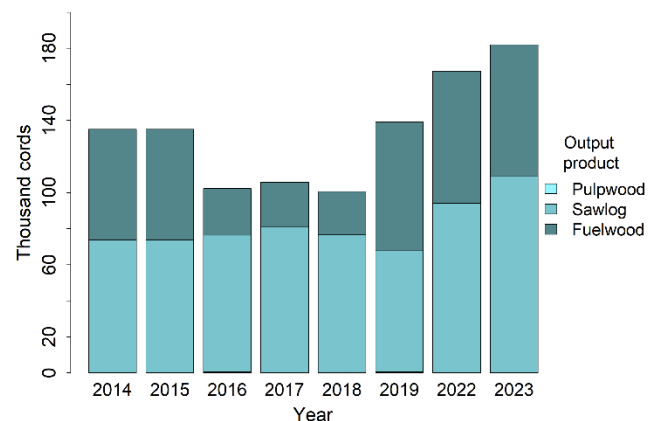• Average annual harvest is well below annual net growth
• High quality red oak grows on good sites in MN
• Additional oak volume/quality improvements could be obtained with investments in young stands.

Challenges:
• Opportunities to increase the harvest of oak occur primarily on private lands which may require additional assistance to realize.
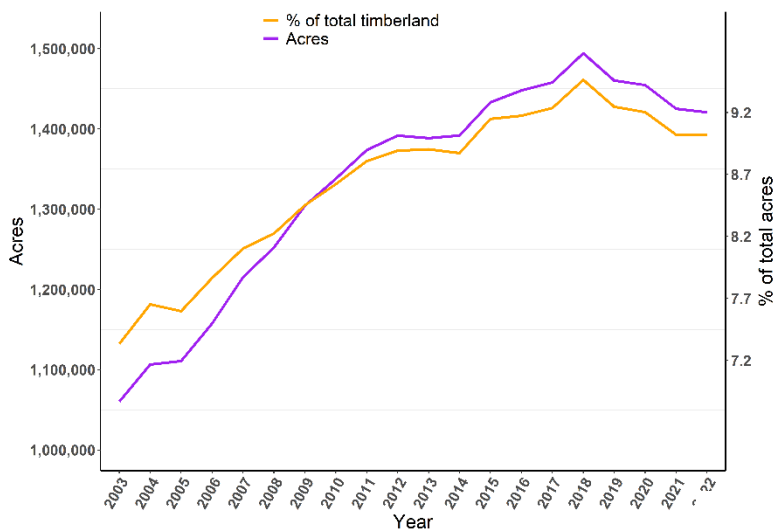• Oak wilt, a preventable disease, is moving north within the state.

Lowland hardwoods forest cover type

The lowland hardwoods cover type consists of a wide mixture of species, with black and green ash as the main species. Predominant secondary species include silver maple, boxelder, and northern white-cedar (Figure 1).

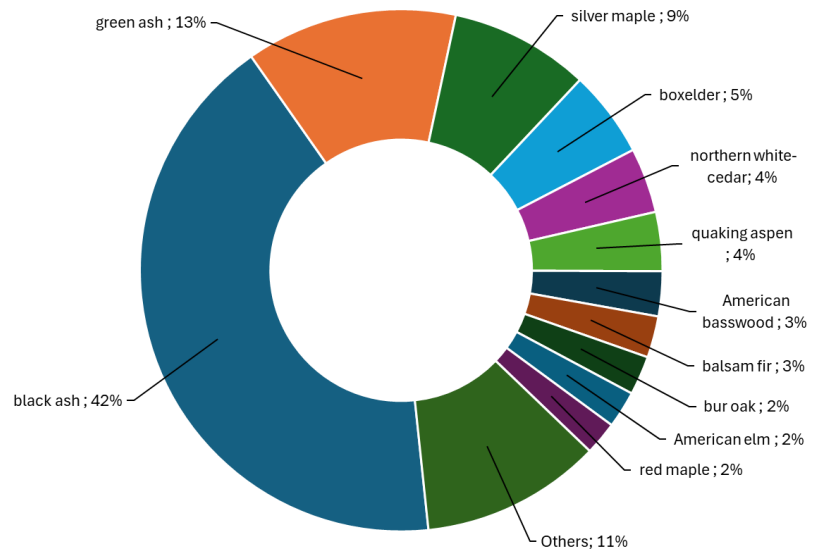**TABLE 1. % AREA OF LOWLAND HARDWOODS COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2022**

	Area
All Federal	5.4%
State	15.4%
County/Municipality	15.3%
Private	63.9%

FIGURE 1. VOLUME OF LOWLAND HARDWOODS COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022

green ash ; 13%
silver maple ; 9%
boxelder ; 5%
northern white-cedar; 4%
quaking aspen ; 4%
American basswood ; 3%
balsam fir ; 3%
bur oak ; 2%
American elm ; 2%
red maple ; 2%
black ash ; 42%
Others; 11%

FIGURE 2. ACRES OF LOWLAND HARDWOODS COVER TYPE ON TIMBERLAND, FIA

Based on FIA data, the estimated area of timberland of the lowland hardwoods cover type has increased since 2003 until 2018, with some decline afterwards; the acreage estimate in 2022 is 1.42 million acres (Figure 2). Nearly 64% of that area is in private ownership, with a lower component owned by state and county/municipality (Table 1).

The age class distribution of the acres of lowland hardwoods timberland is centered to the late middle ages (Figure 3). A common rotation age for black ash is 90 years. Estimated area of timberland under private ownership also presents an increasing acreage of younger stands, which implies active management of this cover type in the last few decades.

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP LOWLAND HARDWOODS, FIA 2022
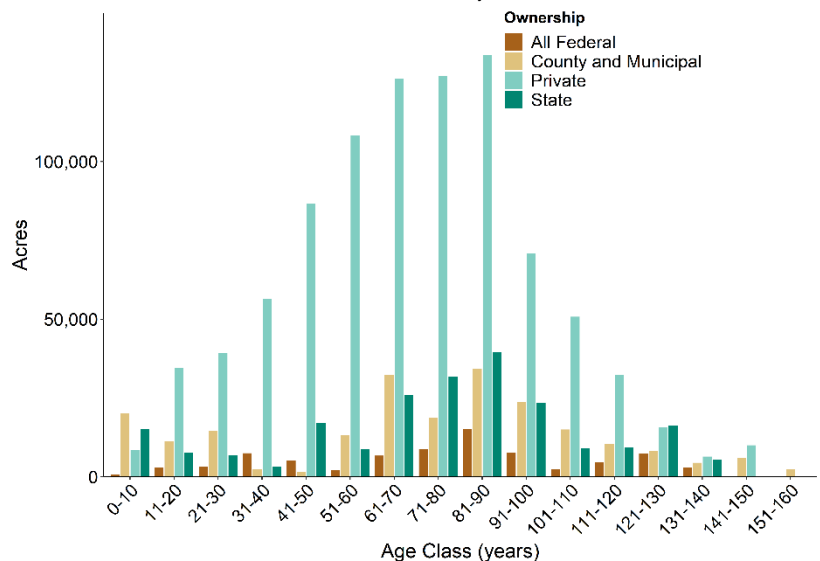
Black and green ash species: presence

Based on FIA data, the estimated merchantable volume of black and green ash species has increased since 2003, representing over 10.5% of the total merchantable volume in Minnesota in 2022 (Figure 4). Most of the volume of black and green ash species is in the smaller diameter classes (<12.9 inches)(Figure 5).

FIGURE 4. MERCHANTABLE VOLUME OF BLACK AND GREEN ASH SPECIES (2003-2022), FIA

FIGURE 5. VOLUME OF BLACK AND GREEN ASH SPECIES BY DIAMETER CLASS (1990-2022), FIA
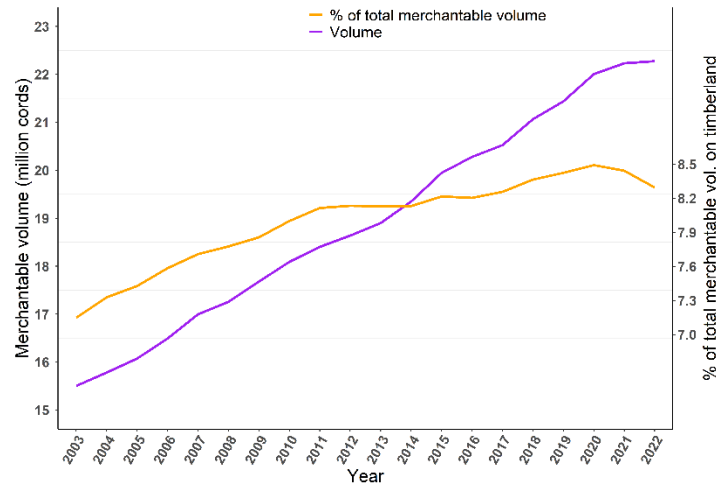
TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF BLACK/GREEN ASH BY OWNERSHIP, FIA 2022

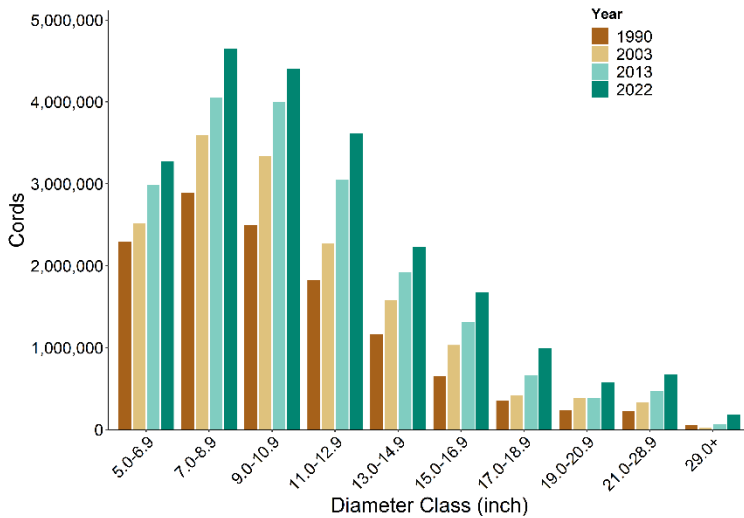|	Volume
All Federal	8.3/1.8%
State	20.1/7.3%
County/Municipality	18.7/9.3%
Private	52.9/81.6%

TABLE 3. % OF PRESENCE BLACK AND GREEN ASH TREE SPECIES BY FOREST COVER TYPES, FIA 2022

	Lowland hardwoods	Aspen	Northern hardwoods	Oak	Birch	Other*
% of total volume of black ash	67.8	12.0	7.0	4.6	2.2	6.4
% of total volume of green ash	43.8	8.3	8.0	15.2	1.0	23.7

*Other includes forest cover types with less than 1% of the volume

Over 52% of the black and 81% of green ash volume is present on private lands (Table2). The black and green ash presence is a significant component in many other cover types. More than 30% of the volume of black and 55% of the volume of green ash is found in alternative cover types, other than lowland hardwoods (Table 3).

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF BLACK AND GREEN ASH SPECIES RESPECTIVELY, FIA 2017
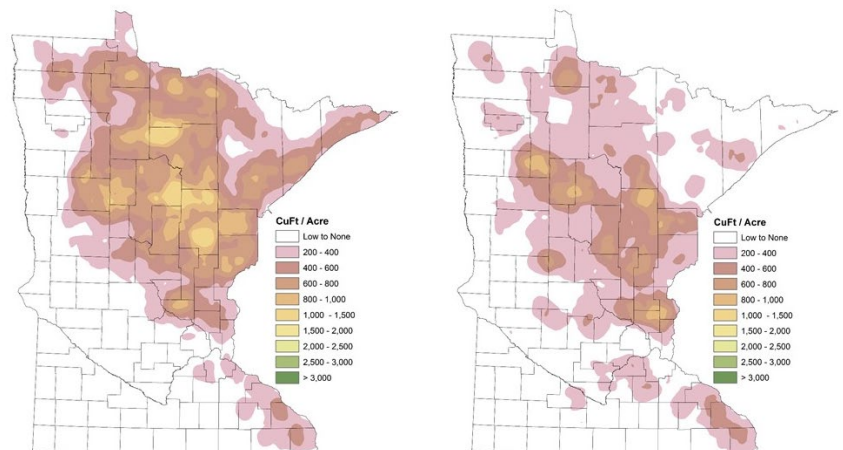
Black and green ash species: growth and harvest

The harvest volume of black and green ash species has increased since 1997 (Figure 7). Ash has not historically had a consistent pulpwood market although several mills have increased the use of ash in recent years. MN DNR has been offering additional ash volume on state lands to manage forest health concerns.

FIGURE 7. VOLUME OF BLACK AND GREEN ASH SPECIES HARVESTED FROM TIMBERLAND (1997-2023), TPO

FIGURE 8. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BLACK AND GREEN ASH SPECIES, FIA
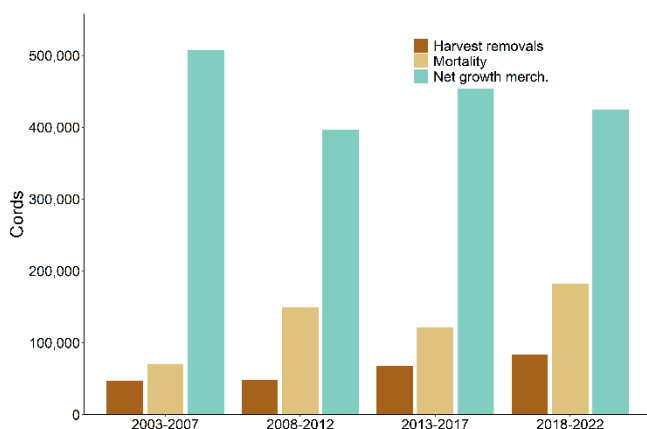

Figure 8 shows the average annual net growth (gross growth minus mortality), harvest removals, and mortality (non-harvest related mortality) of merchantable volume on timberlands. The estimated average annual net growth has decreased in the last 10 years, and the mortality and harvest removals has increased in the same decade. In 2018-2022, private timberlands have the highest average annual net growth and mortality, but lower average harvest removal compared to state and county lands (Figure 10).

Among the three output products, pulpwood constitutes the larger proportion of total ash harvest volume (Figure 9). Ash harvest volume was nearly 92 thousand cords in both 2022 and 2023, and the ratios of pulpwood, sawlog and fuelwood were 40:28:32 and 45:23:32, respectively.

FIGURE 9. BLACK AND GREEN ASH SPECIES HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO

FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BLACK AND GREEN ASH SPECIES BY OWNERSHIP, 2018-2022, FIA

Opportunities:
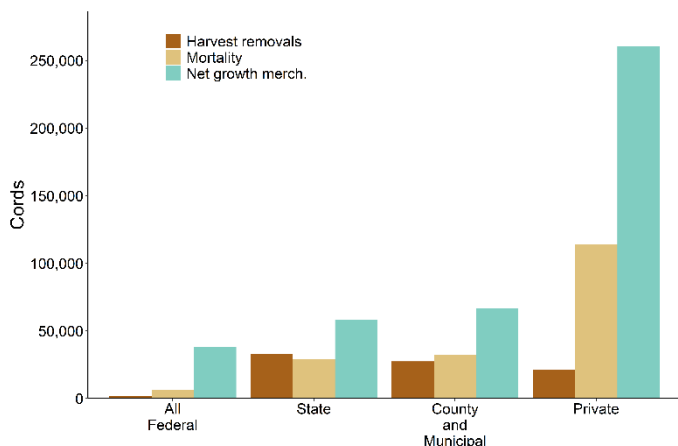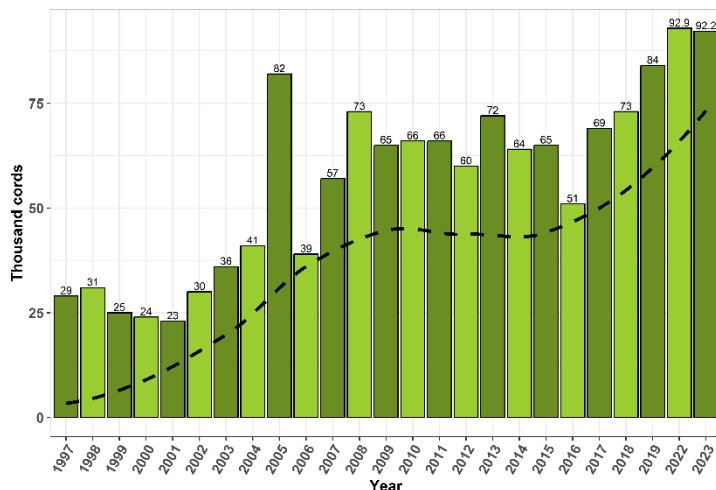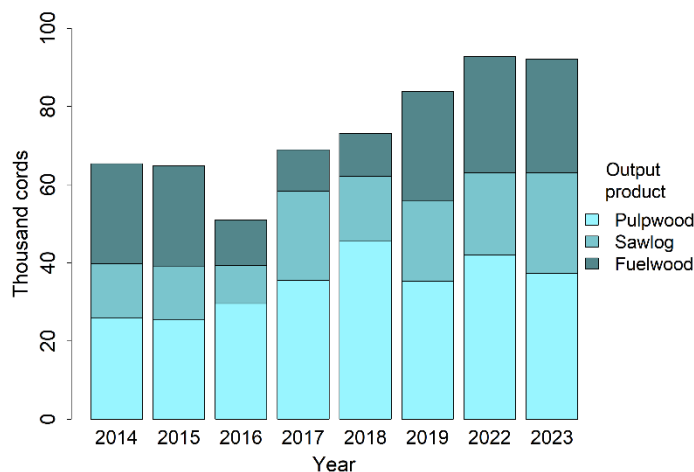• Average annual harvest is well below annual net growth
• High quality ash grows on better drained sites in MN

Challenges:
• Opportunities to increase the harvest of ash occur primarily on private lands which may require additional assistance to realize.
• Emerald ash borer continues to spread within the state and mortality is expected to rise significantly.

Red pine forest cover type

Based on FIA 2022 data, the area of timberland of the red pine cover type is 672 thousand acres (Figure 2). This cover type consists of a wide mixture of species, red pine being the most abundant (78%). Predominant secondary species include quaking aspen, eastern white pine, jack pine and paper birch (Figure 1).

TABLE 1. % AREA OF RED PINE COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2022

	Area
All Federal	24.2%
State	18.6%
County/Municipality	15.4%
Private	41.8%

FIGURE 1. VOLUME OF RED PINE COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022
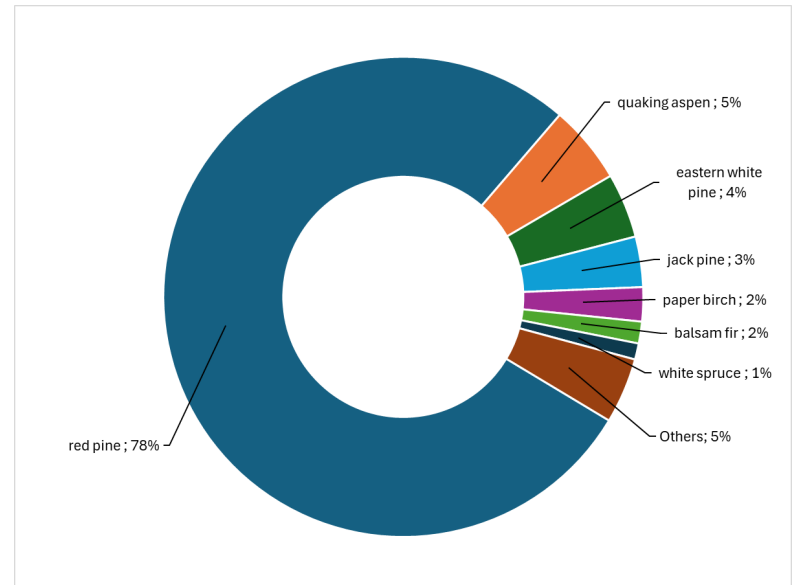

FIGURE 2. ACRES OF RED PINE COVER TYPE ON TIMBERLAND, FIA
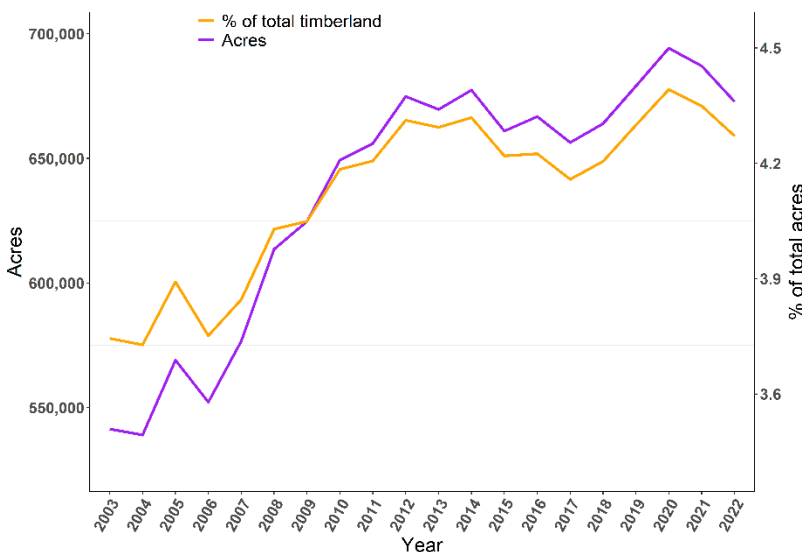
Over 41% of the red pine cover type timberland area is privately owned, with lower portions (<25%) of federal, county/municipality, and state land ownerships (Table 1). In general, the acres of red pine timberland has increased since 2003, with the maximum acres reached in 2020.

Red pine is dominated by young age classes, mostly in plantations that need periodic thinning. It presents a unimodal age-class distribution centered towards younger ages (with a large proportion of acreage between 20 to 60 years). A portion of the acres of timberland are older than 80 years old, mostly on county/municipality and federal land (Figure 3).

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP OF RED PINE, FIA 2022

Red pine species: presence

Volume of red pine has increased continuously since 2003 as many plantations have reached merchantable sizes. Red pine represents about 7.87% of the total estimated merchantable volume in Minnesota (Figure 4). The volume is mostly distributed on privately owned and federal lands, while relatively small quantities are present on county/municipal and state-owned lands (Table 2).

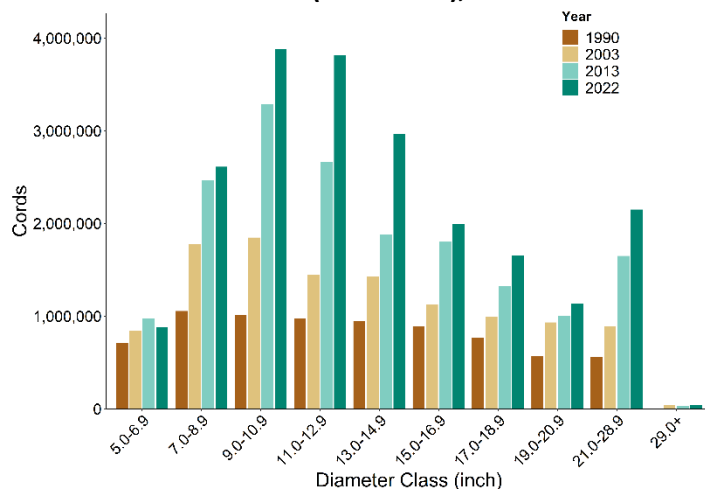**FIGURE 4. MERCHANTABLE VOLUME OF RED PINE (2003-2022), FIA**

FIGURE 5. MERCHANTABLE VOLUME OF RED PINE BY DIAMETER CLASS (2003-2022), FIA
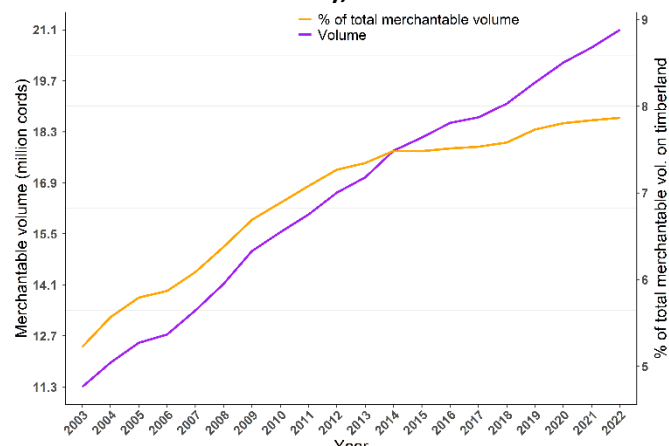
TABLE 2. % MERCHANTABLE VOLUME OF RED PINE ON TIMBERLAND BY OWNERSHIP, FIA 2022

	Volume
All Federal	29.1%
State	18.7%
County/Municipality	11.1%
Private	41.1%

TABLE 3. % OF VOLUME OF RED PINE ON DIFFERENT FOREST COVER TYPES, FIA 2022

	Red pine	Aspen	Eastern white pine	Jack pine	Oak	Other*
% of total volume of red pine	87.5%	4.9%	2.6%	1.8%	1.1%	2.1%

*Other includes forest cover types with less than 1% of the volume

Most of the red pine volume occurs in trees with diameters less than 15 inches (Figure 5).

Less than 13% of red pine volume in the state is present on alternative cover types such as aspen or eastern white pine (Table 3).

Red pine (*Pinus resinosa*)

Red pine species: growth and harvest

Red pine is an important saw timber species and occurs primarily in northern Minnesota. Much of the red pine resource is from planted stands with varying degrees of management. The rising demand for saw timber has driven increased red pine harvests in the past fifteen years (Figure 7). Demand for small-diameter red pine pulpwood fluctuates (Figure 9).

FIGURE 8. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND NON-HARVEST RELATED MORTALITY OF RED PINE, FIA
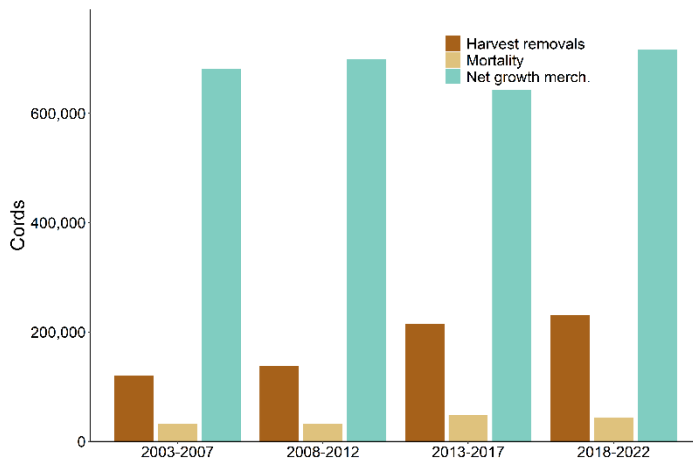
In 2018-2022, red pine maintained the highest net growth and suffered maximum mortality on private timberlands while the highest average annual harvest removals happened on the state-owned lands (Figure 10). See Appendix A for further explanation of these figures.

FIGURE 10. ESTIMATED AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF RED PINE BY OWNERSHIP, 2018-2022, FIA
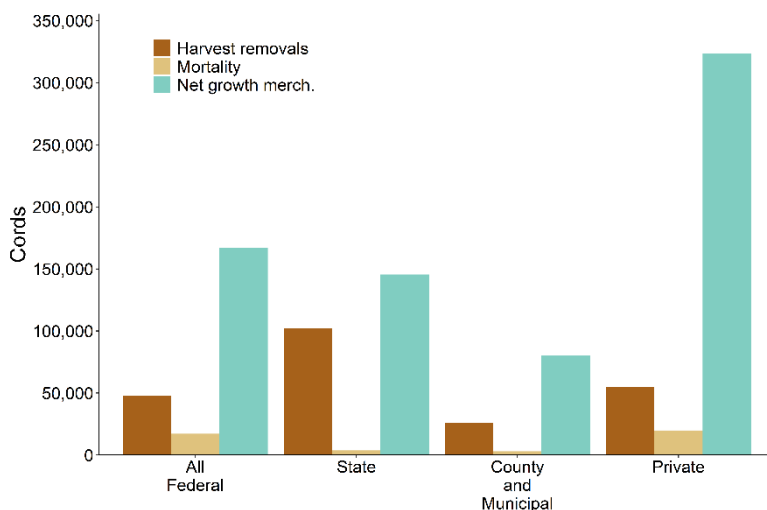
FIGURE 7. VOLUME OF RED PINE HARVESTED FROM TIMBERLAND (2004-2023), TPO
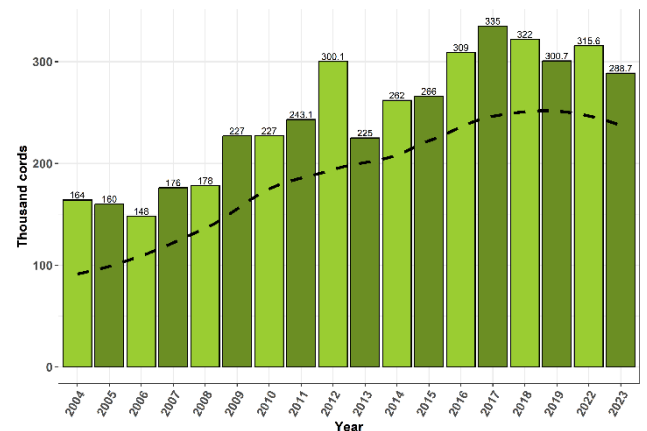
Figure 8 shows the estimated average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of merchantable volume on timberlands since 2003. Harvest removals have increased during this period while net growth and mortality have remained relatively stable.

FIGURE 9. RED PINE HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO
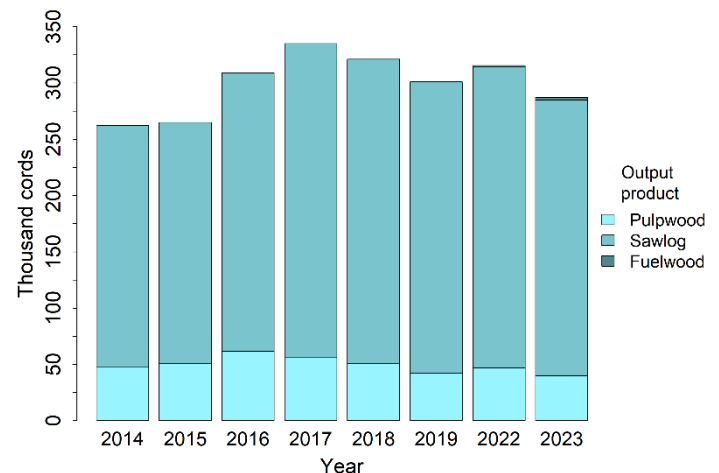
Opportunities:
• Average annual harvest is well below annual net growth.
• Many red pine acres are nearing or within management age range.
• Red pine stands demonstrate excellent response to various thinning regimes.

Challenges:
• Opportunities to increase the harvest of red pine occur primarily on private lands which may require additional assistance to realize.

Jack pine forest cover type

Based on FIA 2022 data, the area of jack pine cover type on timberlands is 222 thousand acres. The area reached minimum coverage in 2020 and increased slightly since then (Figure 2). This cover type consists of a wide mixture of species; however, jack pine is the most abundant (63%). Predominant secondary species include red pine, quaking aspen, balsam fir, and black spruce (Figure 1).

TABLE 1. % AREA OF JACK PINE COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2022

	Area
All Federal	32.2 %
State	20.0 %
County/Municipality	8.4 %
Private	39.4 %

FIGURE 1. VOLUME OF JACK PINE COVER TYPE ON TIMBERLANDS BY SPECIES, FIA 2022

red pine ; 9%
quaking aspen ; 7%
balsam fir ; 6%
black spruce ; 5%
eastern white pine ; 3%
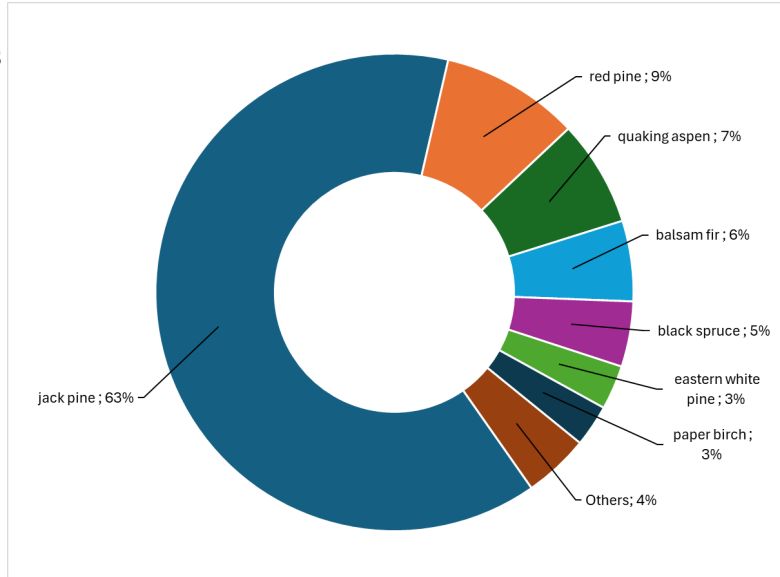paper birch ; 3%
Others; 4%
jack pine ; 63%

FIGURE 2. ACRES OF JACK PINE COVER TYPE ON TIMBERLAND, FIA
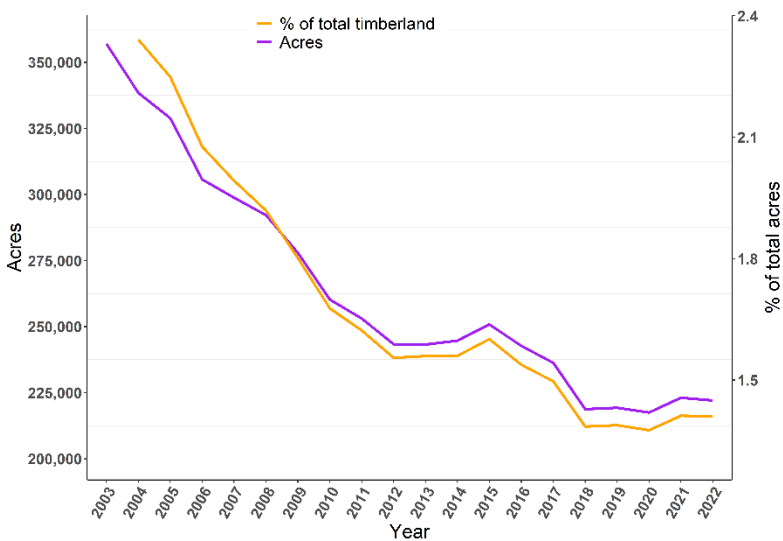
Private landowners control the largest portion (over 39%) of the total area of the jack pine cover type (Table 1) The federal government controls more acres compared to the combined acreage of state and county/municipal lands. The acres of timberland have decreased since 2003 (Figure 2). The decline in jack pine is caused by disease outbreaks such as budworm and an inclination to replant other pine species.

The jack pine cover type presents an irregular age-class distribution with a higher proportion of the land between 31 to 60 years old (mostly on private and federal land). There is also a smaller presence of young (less than 20 years old) and old (above 90 years) on the landscape (Figure 3).

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP OF JACK PINE, FIA 2022

Jack pine species: presence

The merchantable volume of jack pine experienced a declining trend from 2003-2012 and remained relatively stable between 2012-2017 and again followed a downward trend after 2017. Currently, jack pine represents only 1.6% of the total volume in Minnesota (Figure 4).

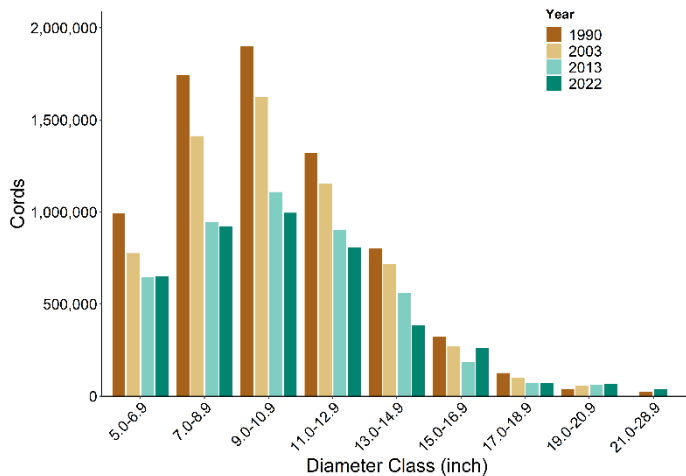**FIGURE 4. V**OLUME JACK PINE OVER TIME **(2003-2022), FIA**

FIGURE 5. VOLUME OF JACK PINE SPECIES BY DIAMETER CLASS **(2003-2022), FIA**
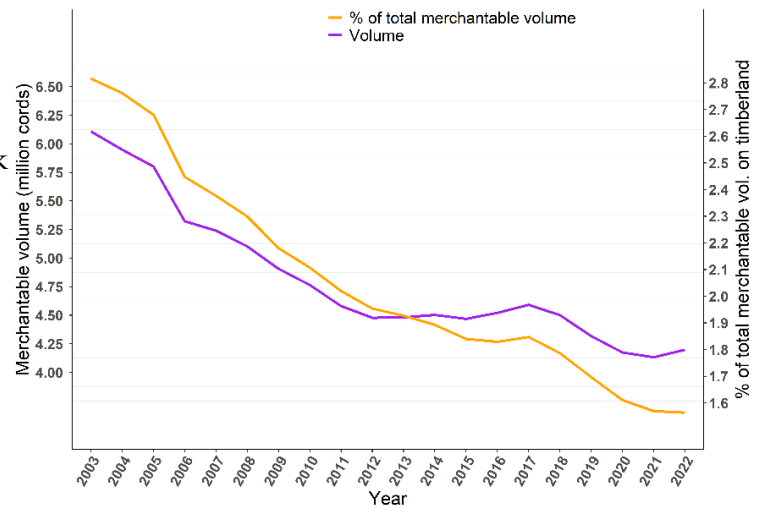
TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLANDS OF JACK PINE SPECIES BY OWNERSHIP, **FIA 2022**

	Volume
All Federal	33.2%
State	17.0%
County/Municipality	12.4%
Private	37.4%

TABLE 3. % OF VOLUME OF JACK PINE IN OTHER FOREST COVER TYPES, **FIA 2022**

	Jack pine	Red pine	Aspen	Black spruce	Balsam fir	Eastern white pine	Other*
% of total volume of jack pine	62.9%	19.3%	7.0%	2.9%	1.8%	1.9%	4.2%

*Other includes forest cover types with less than 1.8% of the volume

Most of the jack pine volume occurs in trees with diameters smaller than 15 inches (Figure 5). More than 37% of its merchantable volume can be found on private lands, with 33% of the volume on federal lands (Table2). Its presence is also a significant component in many other upland cover types. More than 37% of the volume of jack pine is found in alternative cover types, such as red pine, aspen, black spruce or balsam fir (Table 3).

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF JACK PINE, **FIA 2017**
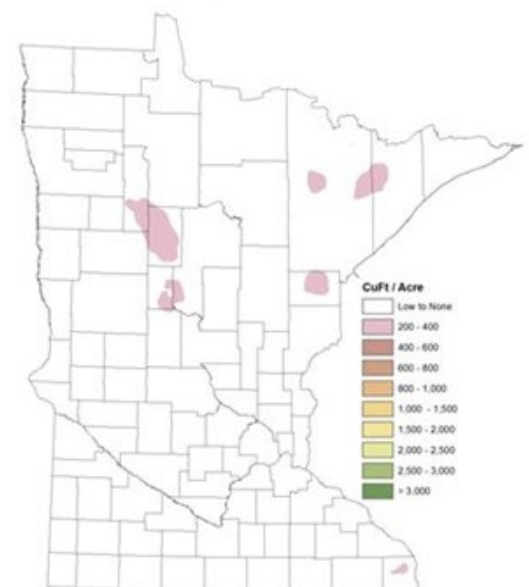
Jack pine species: growth and harvest

Accelerated harvest rates of jack pine species in the middle 2000s were necessary to manage forest health but were unsustainable in the long term. Jack pine harvest levels began to decline in the last decade (Figure 7) but have leveled off in recent years. The volume from young red pine thinning treatments may help supplement the low jack pine harvest volume.

FIGURE 8. AVERAGE ANNUAL NET GROWTH, HARVEST REMOVALS, AND NON-HARVEST RELATED MORTALITY, **FIA**
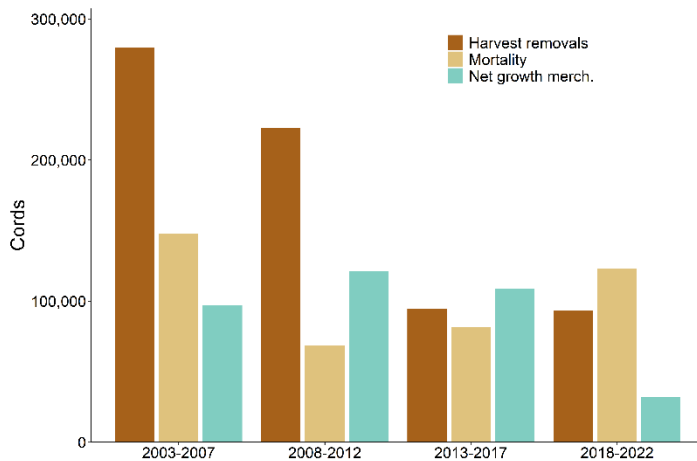
Jack pine on private timberlands experienced the highest average annual mortality during 2018-2022. The federal lands have had the highest average annual harvest removals while the county/municipal lands attained the highest average annual net growth (Figure 10). See Appendix A for further explanation. Jack pine is utilized evenly between sawlog and pulp (Figure 9).

FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY BY OWNERSHIP, 2018-2022, FIA
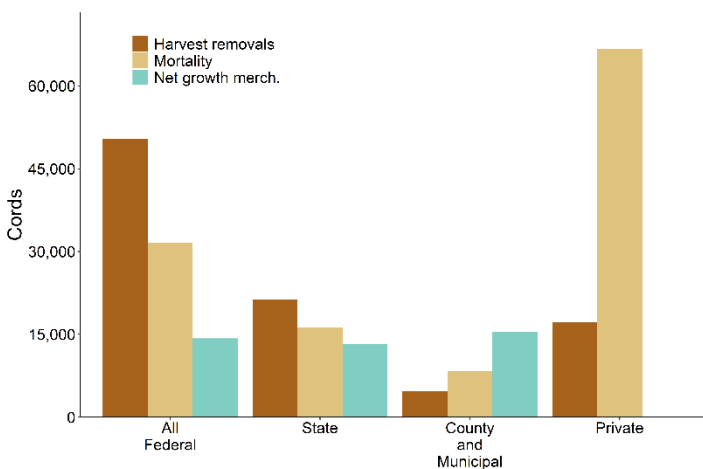
FIGURE 7. VOLUME OF JACK PINE SPECIES HARVESTED FROM TIMBERLAND (2004-2023), TPO
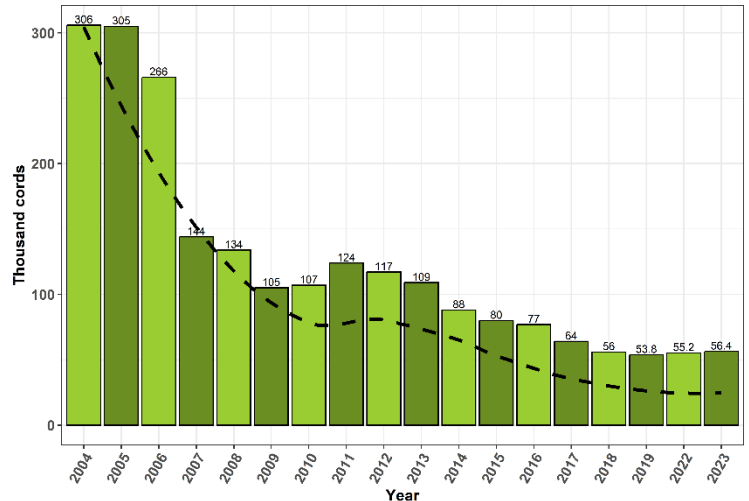
The mortality of jack pine has increased in the recent three FIA cycles but is below the 2003-2007 level. The net growth has steadily declined in the past three cycles (Figure 8). Periodic outbreaks of jack pine budworms have affected growth and mortality and induced fire risks. The most recent outbreak started in the west-central counties in 2015 and lasted through 2019.

FIGURE 9. JACK PINE HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO
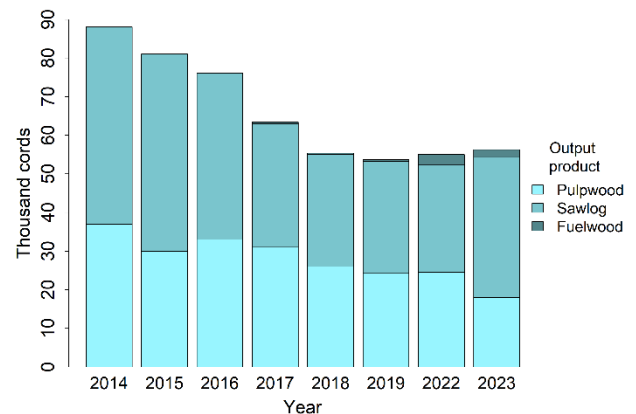
Opportunities:
• There may be opportunities to capture a portion of the mortality volume on private lands before losses occur.
• Jack pine volume reductions could be replaced by the increased volume availability of red pine.
Challenges:
• Jack pine volume declines will likely continue until younger stands reach merchantability.

Eastern white pine forest cover type

Based on FIA 2022 data, the area of timberland of the white pine cover type is 188 thousand acres (Figure 2). This cover type has a dominant proportion (62%) of eastern white pine, and is associated with red pine, quaking aspen, paper birch and other secondary species (Figure 1).

FIGURE 1. VOLUME OF WHITE PINE COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022

TABLE 1. % AREA OF WHITE PINE COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2022

	Area
All Federal	22.9%
State	13.2%
County/Municipality	9.8%
Private	54.1%
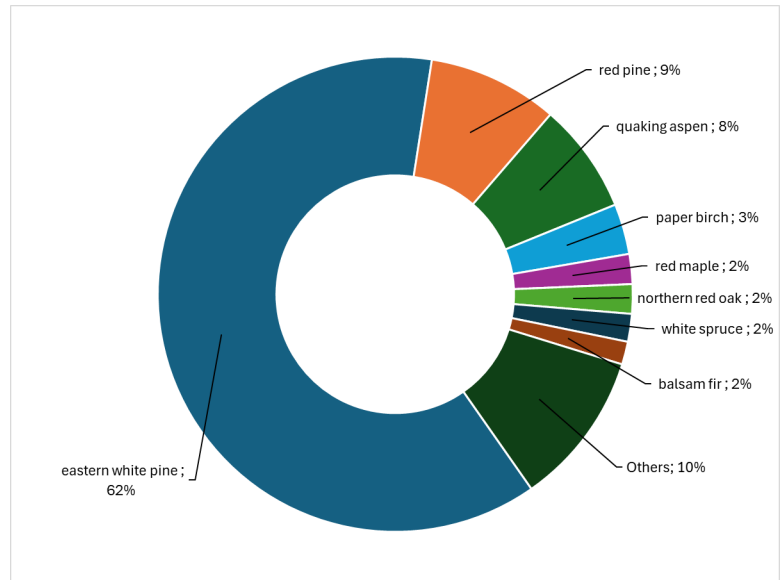
FIGURE 2. ACRES OF WHITE PINE COVER TYPE ON TIMBERLAND, FIA
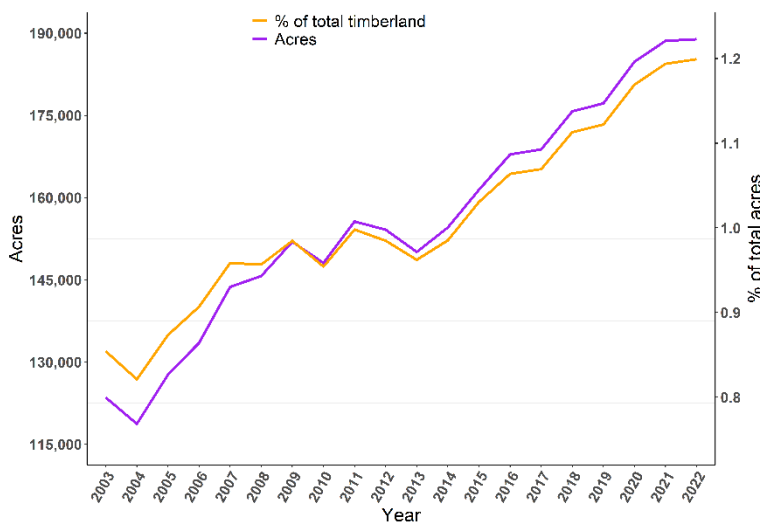
The acres of timberland of eastern white pine cover type have increased since 2003 (Figure 2). Over half of the area of timberland is on private land, with a lower presence on federal, county/ municipality, and state land (Table 1).

The acreage of this cover type is heavily distributed in age classes older than 60 years. Federal and private landowners are by far the predominant ownership groups of the white pine cover type. Most of the acreage on private lands have stands between 60- 100 years old (Figure 3).

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP OF WHITE PINE, FIA 2022

Eastern white pine species: presence

The merchantable volume of white pine species has increased substantially since the 2003 inventory (Figure 4). Based on FIA 2022 data, the current merchantable volume of white pine species represents over 2.6% of the total merchantable volume in Minnesota.

FIGURE 4. VOLUME EASTERN WHITE PINE SPECIES (2003-2022), FIA

FIGURE 5. VOLUME OF EASTERN WHITE PINE SPECIES BY DIAMETER CLASS (2003-2022), FIA
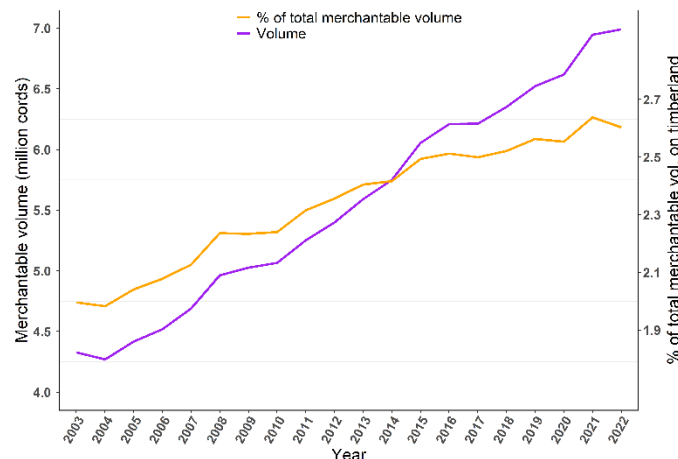
TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF EASTERN WHITE PINE BY OWNERSHIP, FIA 2022

	Volume
All Federal	23.6%
State	10.3%
County/Municipality	16.1%
Private	50.0%

TABLE 3. % OF VOLUME OF EASTERN WHITE PINE TREE SPECIES ON DIFFERENT FOREST COVER TYPES, FIA 2022

	Eastern white pine	Red pine	Aspen	Northern hardwoods	Balsam fir	Other*
% of total Volume of eastern white pine species	54.5%	14.8%	10.0%	5.2%	3.0%	12.5%

*Other includes forest cover types with less than 3% of the volume

Most of the white pine volume occurs in trees with diameters greater than 15 inches (Figure 5).
More than 50% of the volume is present on private lands and around a quarter of it on federal lands (Table 2).
A significant proportion of the total white pine volume occurs in many other upland cover types. More than 45% of the volume of white pine species is available on alternative cover types such as red pine, aspen, northern hardwood, balsam fir and others (Table 3).

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF EASTERN WHITE PINE , FIA 2017
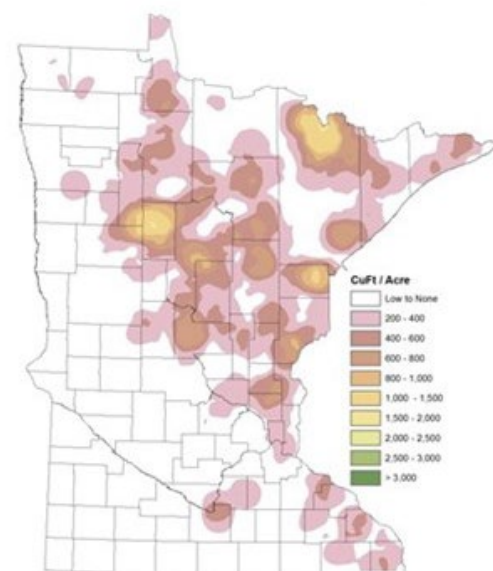
Eastern white pine species: growth and harvest

The largest volume of white pine harvest in the last 20 years took place in 2023. Prior to that, annual harvest was relatively steady (Figure 7). The quantity of saw timber and pulpwood has fluctuated over years (Figure 9).

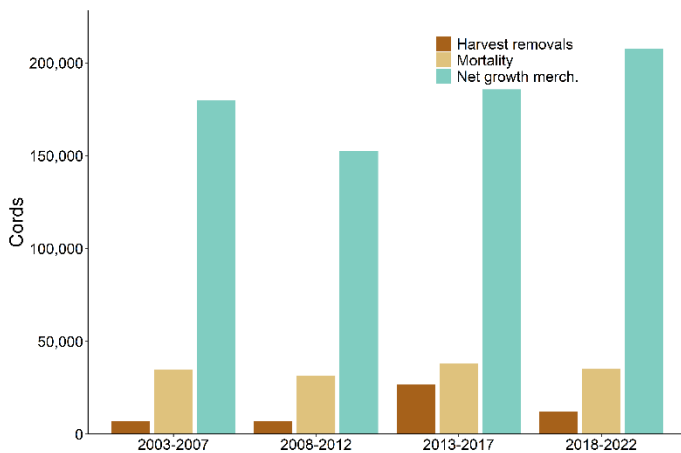**FIGURE 7. VOLUME OF EASTERN WHITE PINE SPECIES HARVESTED FROM TIMBERLAND (2004-2023), TPO**
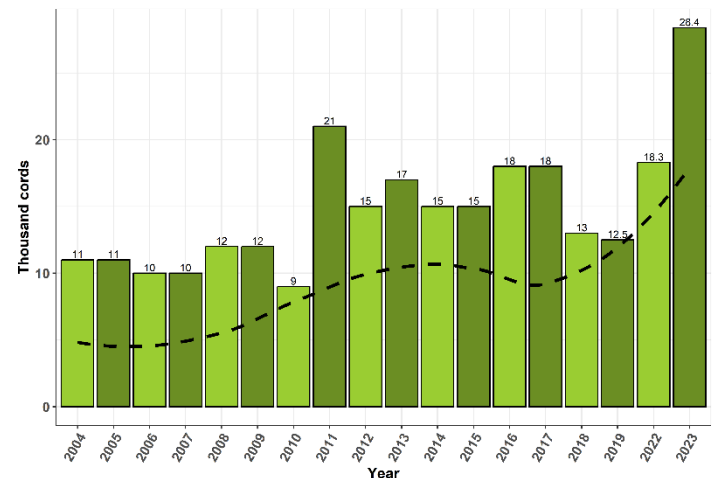
FIGURE 8. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND NON-HARVEST RELATED MORTALITY, FIA

Figure 8 shows the estimated average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of merchantable volume on timberlands since 2003. The net growth has increased in the past fifteen years while mortality has remained relatively stable.

White pine on private timberlands presented the highest average annual net growth during 2018-2022. Private and state-owned lands have had similar average annual harvest removals, but very small harvest removal volumes came from federal lands and county lands (Figure 10). The highest mortality is seen on private and federal lands. See Appendix A for further explanation of these figures.

FIGURE 9. EASTERN WHITE PINE HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO

FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY BY OWNERSHIP, 2018-2022, FIA
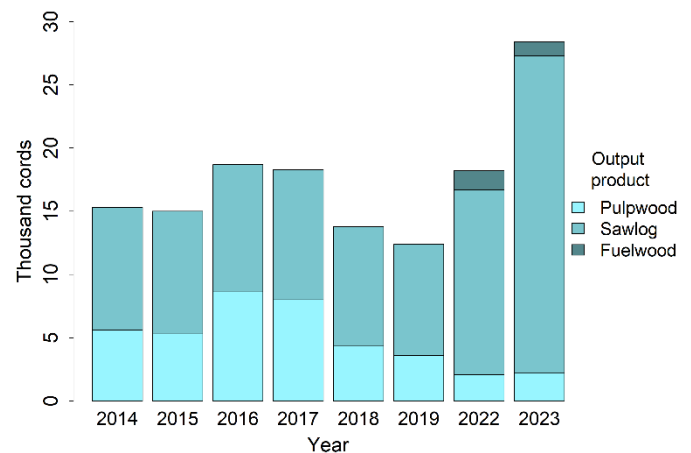
Opportunities:
• Average annual harvest is well below annual net growth.
• Many white pine acres are at management age.
• A significant volume of white pine is over 15" DBH.

Challenges:
• Opportunities to increase the harvest of white pine occur primarily on private lands which may require additional assistance to realize.

Black spruce forest cover type

Based on FIA 2022 data, the area of timberland of the black spruce cover type is 1.39 million acres (Figure 2). This cover type consists of a wide mixture of species where black spruce is the most abundant (75%). Predominant secondary species include tamarack, balsam fir, quaking aspen, and northern white-cedar (Figure 1).

FIGURE 1. VOLUME OF BLACK SPRUCE COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022

TABLE 1. % AREA OF BLACK SPRUCE COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2022

	Area
All Federal	15%
State	51%
County/Municipality	15%
Private	19%
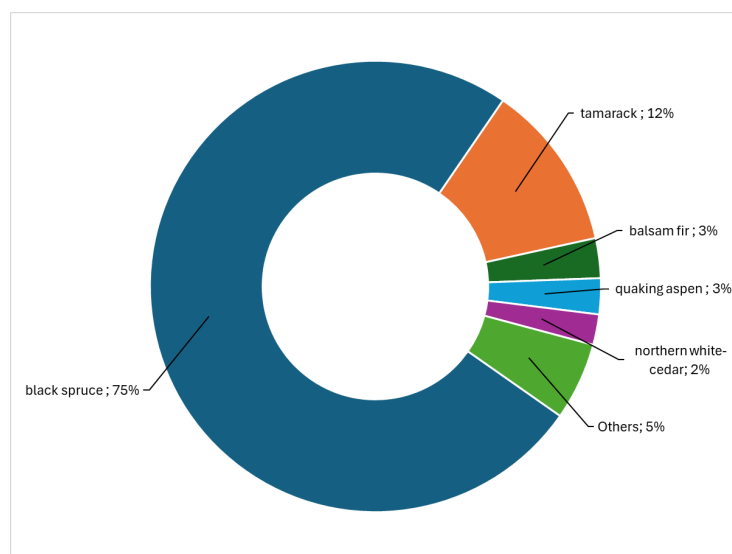
FIGURE 2. ACRES OF BLACK SPRUCE COVER TYPE ON TIMBERLAND, FIA
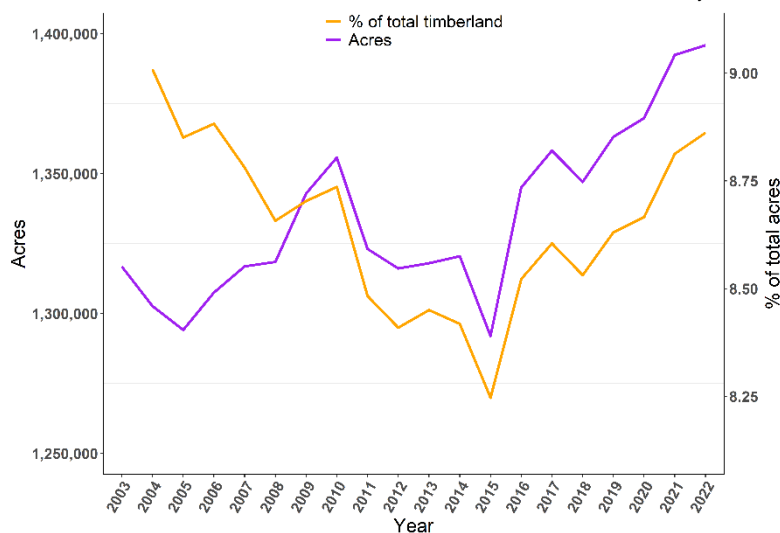
Over half (>51%) of the area of timberland is under state ownership, with lower proportions (<20%) on private, county/municipal, and federal ownerships (Table 1). The estimated acres of timberland have fluctuated in the past 15 years, reaching the highest coverage in 2022 (Figure 2).

The black spruce cover type has a unimodal age-class distribution with most acres centered around the 71–80-year age class. A high proportion of black spruce acres on timberland are older than 50 years. Most acres of the black spruce cover type on state lands are between 50 and 110 years old (Figure 3).

FIGURE 3. AGE CLASS DISTRIBUTION OF BLACK SPRUCE ACRES BY OWNERSHIP, FIA 2022

White spruce forest cover type

Based on FIA 2022 data, the area of timberland of the white spruce cover type is 137 thousand acres (Figure 5). White spruce is located most often on upland sites. In natural stands, it is commonly found mixed with balsam fir, quaking aspen, paper birch, and red pine (Figure 4).

FIGURE 4. VOLUME OF WHITE SPRUCE COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022

balsam fir ; 7%
quaking aspen ; 6%
paper birch ; 4%
black spruce ; 2%
red pine ; 1%
bur oak ; 1%
red maple ; 1%
Others; 4%
white spruce ; 74%

TABLE 2. % AREA OF WHITE SPRUCE COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2022

	Area
All Federal	27%
State	20%
County/Municipality	16%
Private	37%
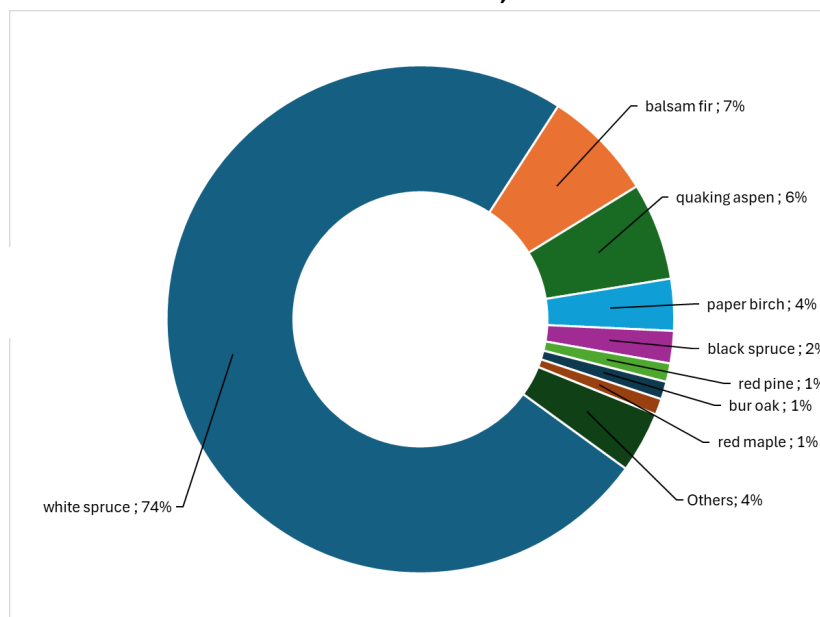
FIGURE 5. ACRES OF WHITE SPRUCE COVER TYPE ON TIMBERLAND, FIA
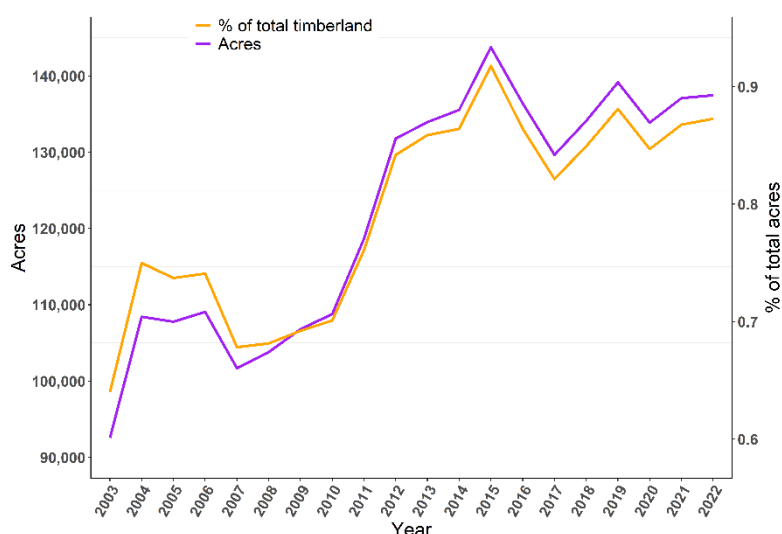
The area of timberland of the white spruce forest type has increased since 2003, with some fluctuations in the past 10 years (Figure 5). This can be due to higher utilization of white spruce species in recent years and increase in white spruce plantations.

Over 36% of the timberland in the white spruce cover type is under private ownership, with lower proportions (<30%) distributed over federal, state, and county/municipal land ownerships (Table 2). 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 (Figure 6).

FIGURE 6. AGE CLASS DISTRIBUTION OF WHITE SPRUCE ACRES BY OWNERSHIP, FIA 2022

Black and white spruce species: presence

Based on FIA 2022 data, the estimated merchantable volume of black and white spruce species represents around 6.3% of all the estimated merchantable volume in Minnesota (Figure 7). Black spruce has twice as much volume as white spruce; black spruce is dominated by small diameter trees.

FIGURE 7. VOLUME OF BLACK AND WHITE SPRUCE SPECIES (2003-2022), FIA

FIGURE 8. VOLUME OF BLACK AND WHITE SPRUCE SPECIES BY DIAMETER CLASS (1990-2022), FIA
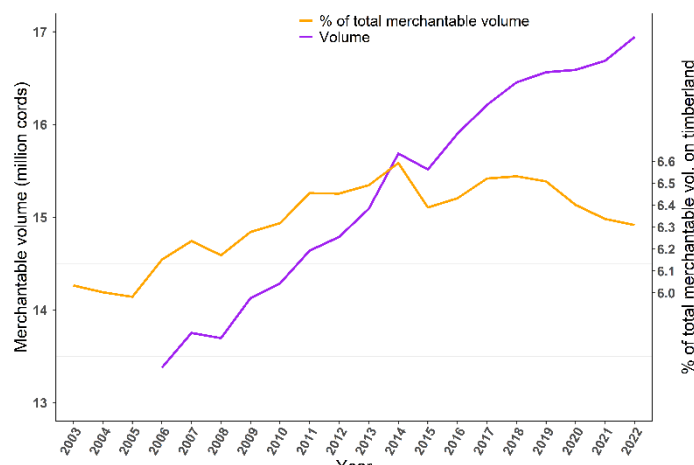
TABLE 3. % MERCHANTABLE VOLUME ON TIMBERLAND OF BLACK/WHITE SPRUCE BY OWNERSHIP, FIA 2022

	Volume
All Federal	24.0%/32.1%
State	35.8%/17.5%
County/Municipality	15.0%/15.0%
Private	25.2%/35.4%

TABLE 4. % OF VOLUME OF BLACK AND WHITE SPRUCE TREE SPECIES ON DIFFERENT FOREST COVER TYPES, FIA 2022

	Black spruce	Tamarack	Balsam fir	Aspen	White spruce	Birch	Lowland hardwoods	Other*
% of total volume of black spruce species	71.8%	8.1%	4.4%	4.4%	0.4	2.3	0.3	8.3%
% of total volume of white spruce species	1.3	0.5	6.6%	25.1%	30.2%	10.5%	5.4%	20.4%

*Other includes forest cover types with less than 5% of the volume

FIGURE 9. SPATIAL DISTRIBUTION OF VOLUME OF BLACK AND WHITE SPRUCE RESPECTIVELY, FIA 2017

Over 35% of black spruce and white spruce volumes are present on state and private lands (Table 3). A significant portion of volumes of these species are also present on other upland cover types. Above 30% of the volume of black spruce and 71% of the volume of white spruce are distributed on alternative cover types (Table 4).
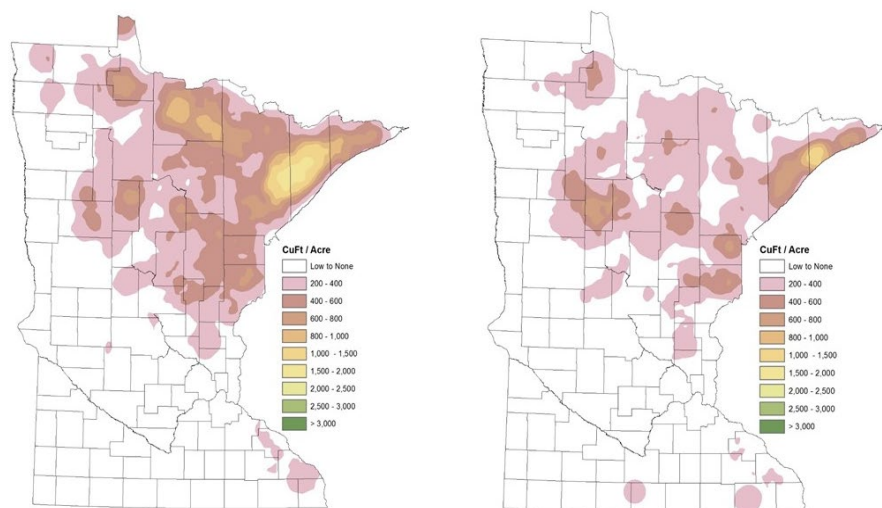
Black and white spruce species: growth and harvest

Spruce contributes the second largest volume of pulpwood materials (after aspen) to pulp and paper mills in Minnesota. Spruce is valued for its excellent fiber qualities and used to make high quality paper. Commercial thinning can occur in healthy white spruce stands.

FIGURE 11. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BLACK AND WHITE SPRUCE, FIA
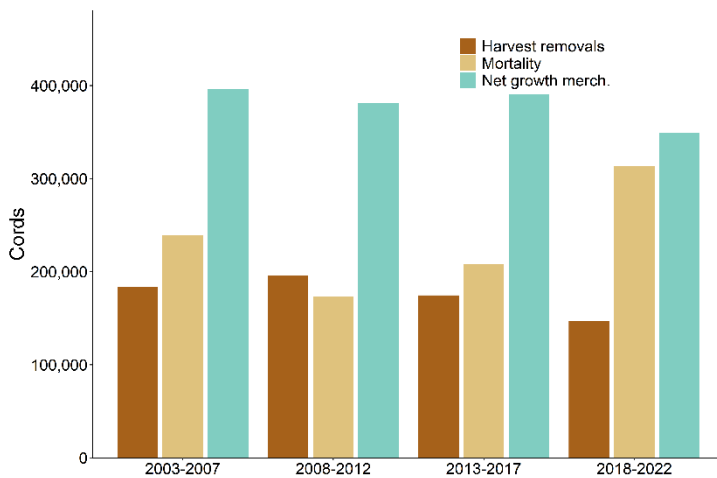
Figure 11 shows average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of merchantable volume on timberlands. Based on FIA estimates, mortality is on an increasing trend since 2008 while the net growth is going down. In 2018-2022 FIA database, state and private timberlands represented larger annual average values of net growth, mortality and harvest removals. See Appendix A for explanations of these figures.

FIGURE 13. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BLACK AND WHITE SPRUCE BY OWNERSHIP, 2018-2022, FIA
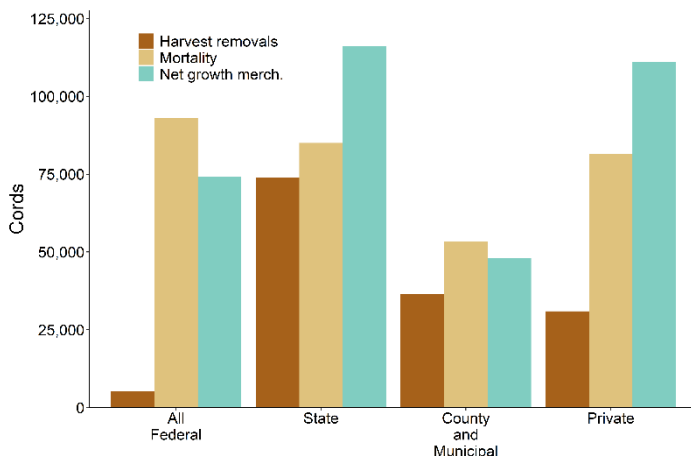
FIGURE 10. VOLUME OF WHITE AND BLACK SPRUCE SPECIES HARVESTED FROM TIMBERLAND (1994-2023), TPO
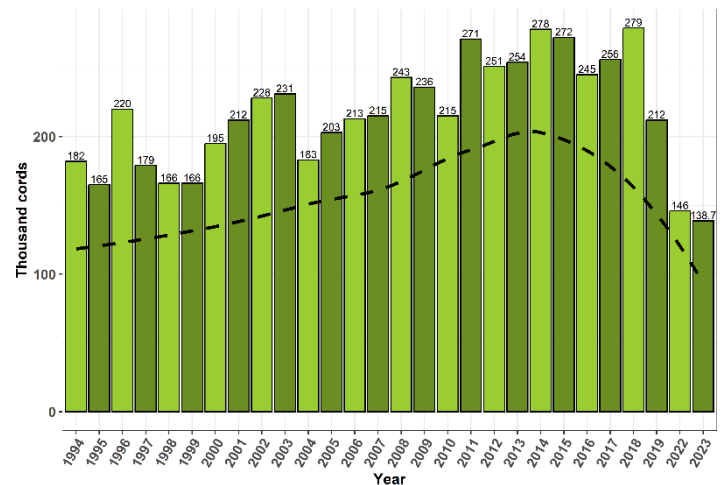
The harvest volume of black and white spruce increased until 2018 but has declined significantly since then primarily due to a pulp mill closure (Figure 10). Pulpwood is by far the main product output of spruce timber (Figure 12). A small quantity is also used in sawmill industry, mostly in making studs, and other lumber.

FIGURE 12. BLACK AND WHITE SPRUCE HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO
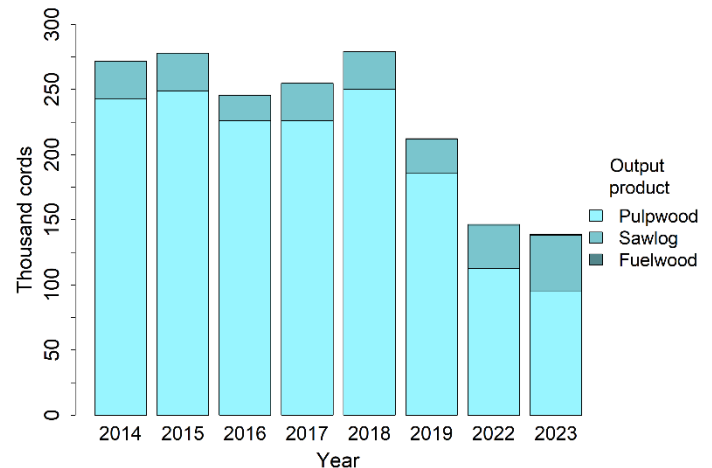
Opportunities:
• Average annual harvest is well below annual net growth
• High quality fiber

Challenges:
• Spruce budworm can cause mortality in spruce and MN is currently in the peak of an outbreak cycle.

Balsam fir forest cover type

Based on 2022 FIA data, the estimated area of timberland of balsam fir cover type is over 367 thousand acres (Figure 2). It consists of a wide mixture of species with dominance of balsam fir (37%). Predominant secondary species include black spruce, quaking aspen, paper birch, and white spruce (Figure 1).

FIGURE 1. VOLUME OF BALSAM FIR COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022

TABLE 1. % AREA OF BALSAM FIR COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2022

	Area
All Federal	21%
State	28%
County/Municipality	18%
Private	33%
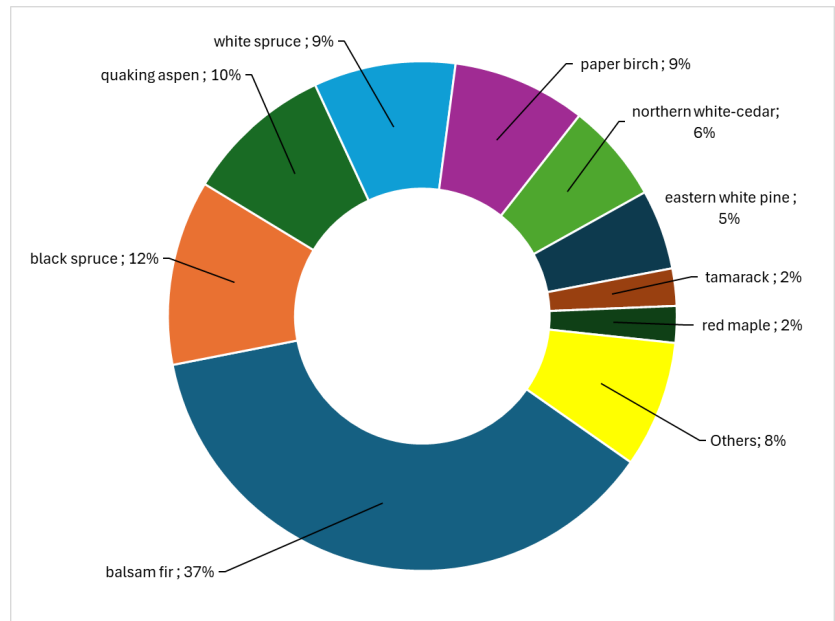
FIGURE 2. ACRES OF BALSAM FIR COVER TYPE ON TIMBERLAND, FIA

A higher percentage (32.8%) of the balsam fir timberland is under private ownership, and the other ownerships (county/municipal, federal and state) have acreage distributions ranging from 18 to 27.7% (Table 1). The area of timberland of balsam fir cover type has decreased since 2016 (Figure 2).

FIGURE 3. AGE CLASS DISTRIBUTION OF BALSAM FIR COVER TYPE BY OWNERSHIP, FIA 2022
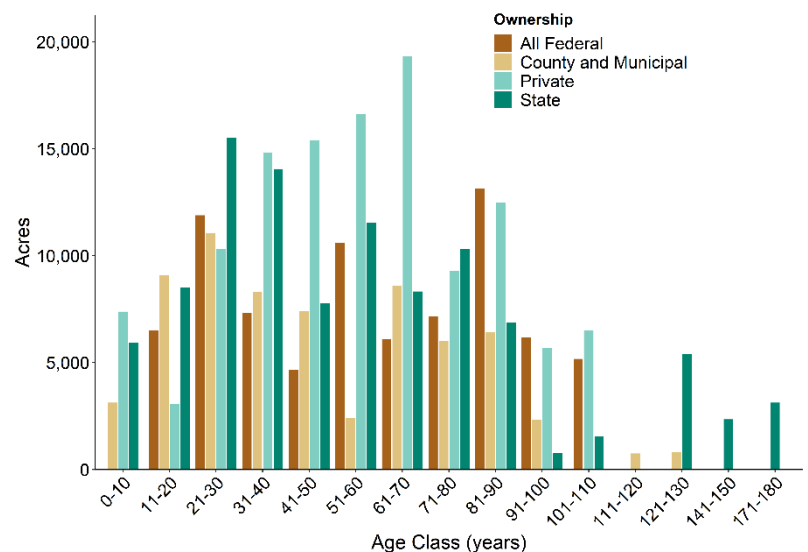
The acreage of the balsam fir cover type is dominated by stands of 40 years of age and older (Figure 3). Figure 3 also indicates that a large proportion of standing volume of balsam fir belongs to older age classes, although the species is relatively short-lived. A common (average) rotation age for the species is 50 years, however, recommended rotation ages vary with stand productivity and site conditions.

Balsam fir tree species: presence

The estimated annual merchantable volume of balsam fir species has increased since 2008. In 2022, it represented around 3.6% of the total merchantable volume in Minnesota (Figure 4). Most of the merchantable volume is present in small diameter classes (Figure 5).

FIGURE 4. Merchantable volume of balsam fir species (2003-2022), FIA

FIGURE 5. Volume of balsam fir species by diameter class (1990-2022), FIA
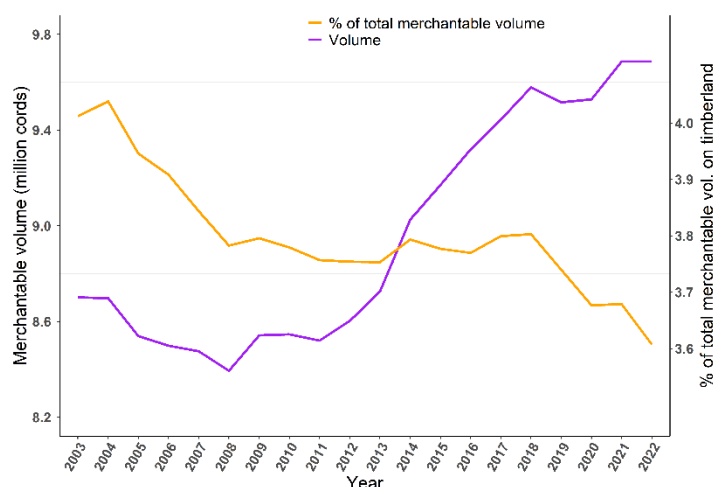
TABLE 2. % merchantable volume on timberland of balsam fir by ownership, FIA 2022

	Volume
All Federal	23%
State	19%
County/Municipality	17%
Private	41%

Over 41% of the total merchantable volume of balsam fir species is on private lands (Table 2). Only 16% of balsam fir volume in the state is found within the balsam fir cover type. A large portion (34.9%) of balsam fir volume occurs in the aspen cover type. It can also be found in other cover types such as birch, northern hardwoods, and lowland hardwoods (Table 3).

TABLE 3. % of presence of balsam fir species on other forest cover types, FIA 2022

	% of total Volume of balsam fir species
Aspen	35%
Balsam fir	16%
Birch	13%
Northern hardwoods	7%
Lowland hardwoods	6%
Northern white-cedar	6%
Red pine	4%
Other	13%

*Other includes forest cover types with less than 3% of the volume

FIGURE 6. spatial distribution of Volume of balsam fir (*Abies balsamea*), FIA 2017
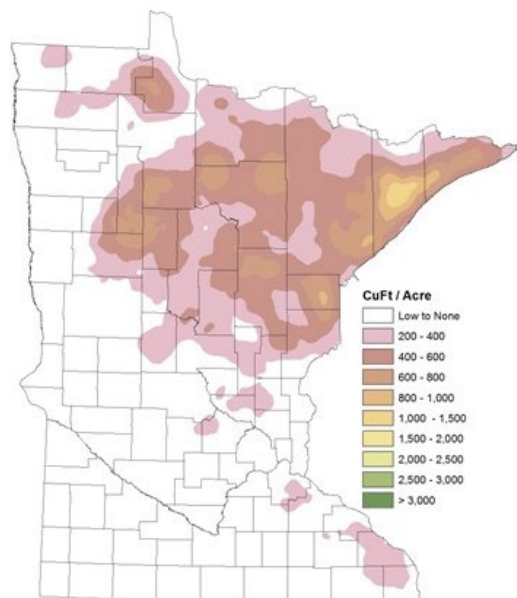
Balsam fir tree species: growth and harvest

The harvest volume of balsam fir species has steadily declined since 1994 (Figure 7). Paper industries use it to make high quality papers, prized for excellent fiber strengths. Hence, a large proportion of the harvested balsam fir volume is consumed by pulp and paper mills (Figure 9).

FIGURE 7. TOTAL VOLUME OF BALSAM FIR SPECIES HARVESTED, TIMBERLAND, 1994-2023, TPO

FIGURE 8. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BALSAM FIR, FIA
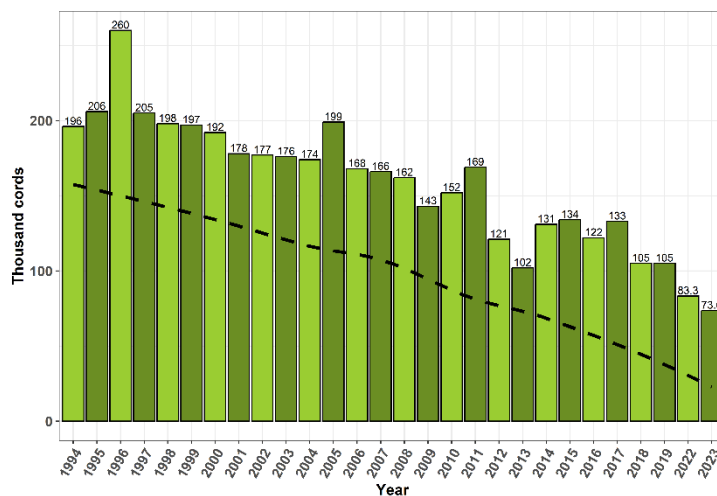
Some of the balsam fir volume is also used by the sawmill industry, mostly in making studs but also in small quantities for other types of lumber.

Figure 8 shows the average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of balsam fir on timberlands. The net growth has increased over time, but mortality has remained consistently high in each FIA cycle since 2003. Most of the harvest, mortality and growth is seen on private lands (Figure, 10). See Appendix A for explanations of these figures.

FIGURE 9. BALSAM FIR SPECIES HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO

FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY BY OWNERSHIP IN 2022, FIA
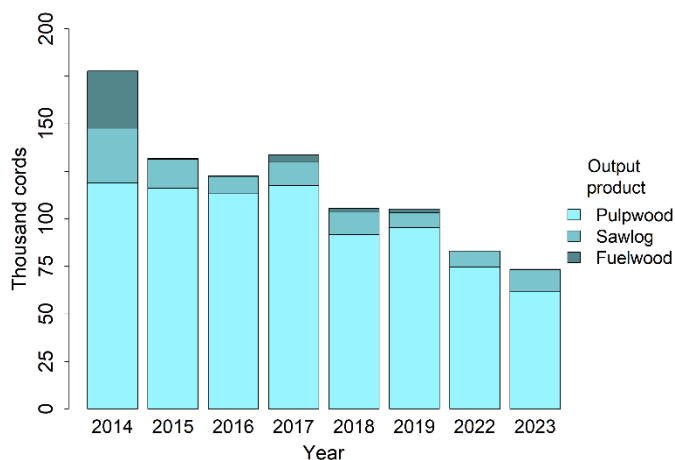
Opportunities:
• Average annual harvest is below annual net growth
• There may be opportunities to capture a portion of the mortality volume before additional losses occur.
• High quality fiber

Challenges:
• Spruce budworm can cause significant mortality in balsam fir and MN is currently in the peak of an outbreak cycle.

Tamarack forest cover type

Based on FIA 2022 estimates, the tamarack cover type has 1.14 million acres of timberland which is about 7.3% of the total timberland in Minnesota (Figure 2). Over half of it is on state land and 25% in private hands (Table 1).

TABLE 1. % AREA OF TIMBERLAND OF TAMARACK COVER TYPE BY OWNERSHIP, FIA 2022

	Area
All Federal	6%
State	51%
County/Municipality	18%
Private	25%

FIGURE 1. VOLUME OF TAMARACK COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2022
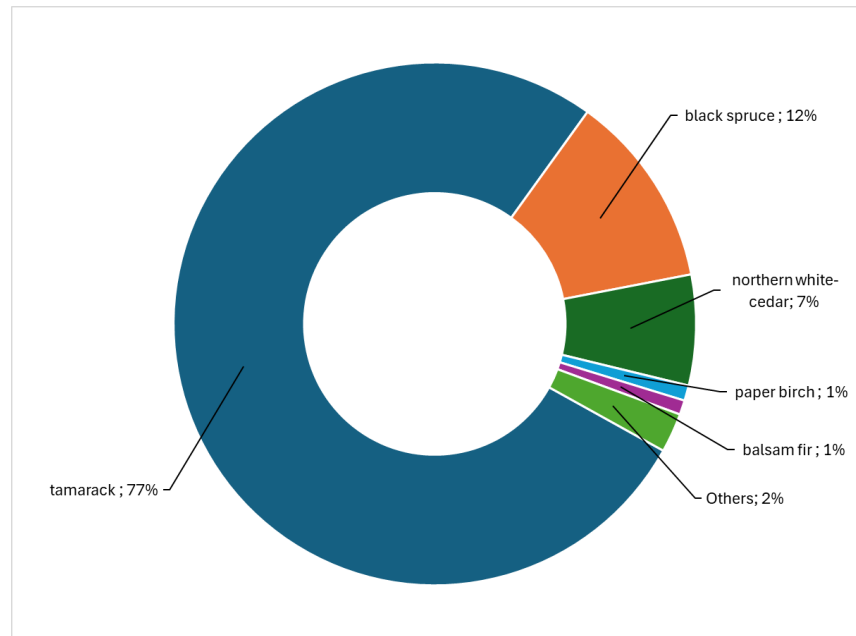
FIGURE 2. ACRES OF TAMARACK COVER TYPE ON TIMBERLAND, FIA
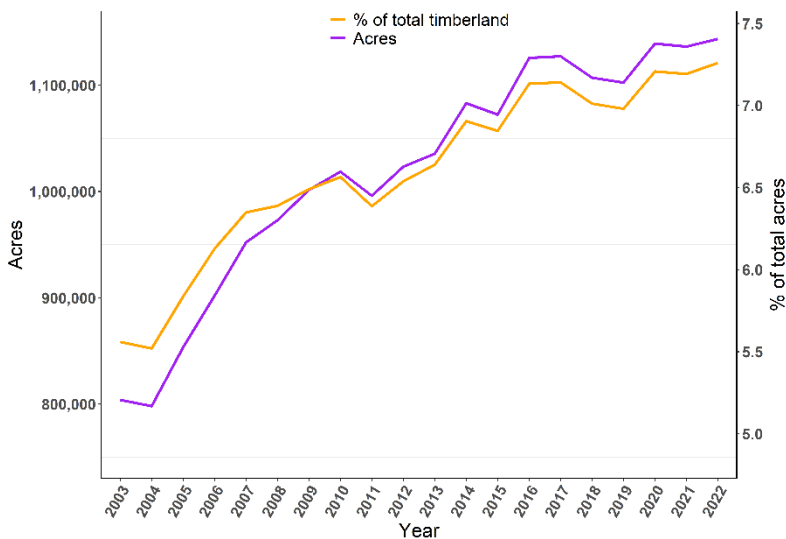
A dominant proportion (77%) of the total standing volume of tamarack cover type is constituted by tamarack species. This cover type is mixed with black spruce (12%), northern white-cedar (8%) and others (Figure 1). Based on FIA 2022 database, the acreage of tamarack cover type has increased since 2004, reaching its maximum of 1.14 million acres in 2022.

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP OF TAMARACK, FIA 2022
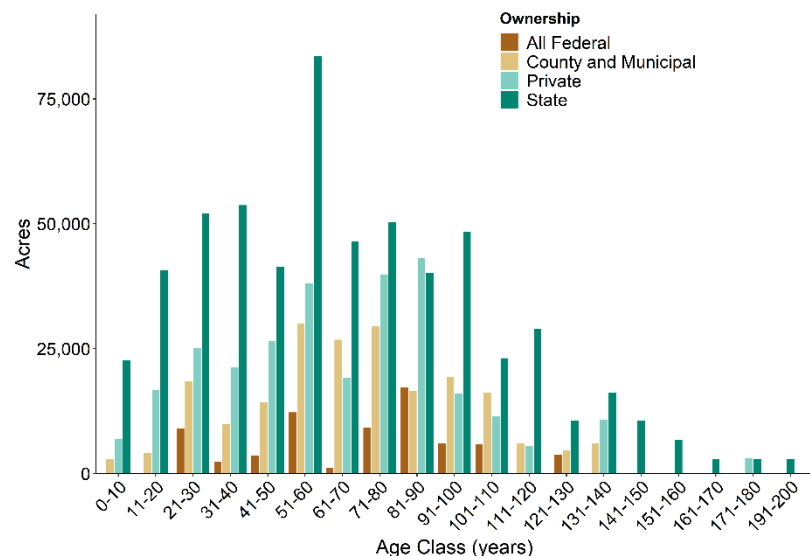
The age-class distribution of the tamarack cover type acreage by ownership reveals that most of the stands are younger than 100 years.

Tamarack tree species: presence

FIGURE 4. VOLUME OF TAMARACK SPECIES (2003-2022), FIA

Based on FIA 2022 data, tamarack species volume represents around 3.3% of the total merchantable volume in Minnesota's timberlands (Figure 4). The highest proportion of tamarack volume occurs in diameter classes below 11 inches (Figure 5).

FIGURE 5. VOLUME OF TAMARACK SPECIES BY DIAMETER CLASS (1990-2022), FIA
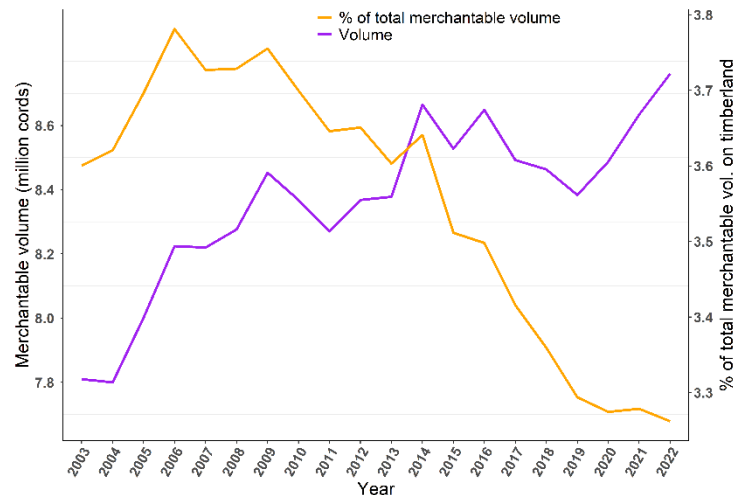
TABLE 2. % MERCHANTABLE VOLUME OF TAMARACK ON TIMBERLAND BY OWNERSHIP, FIA 2022

	Volume
All Federal	8%
State	47%
County/Municipality	16%
Private	29%

More than 46% of tamarack volume is present on state lands (Table2) and 66% of the volume is found in the tamarack cover type. Tamarack volume is also found in other cover types such as black spruce (15%) and white cedar (8%), Table 3.

TABLE 3. % DISTRIBUTION OF TAMARACK SPECIES BY FOREST COVER TYPES, FIA 2022

	% of total Volume of tamarack
Tamarack	66%
Black spruce	15%
Northern white cedar	8%
Lowland hardwoods	3%
Aspen	3%
Other	5%

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF TAMARACK SPECIES, FIA 2017
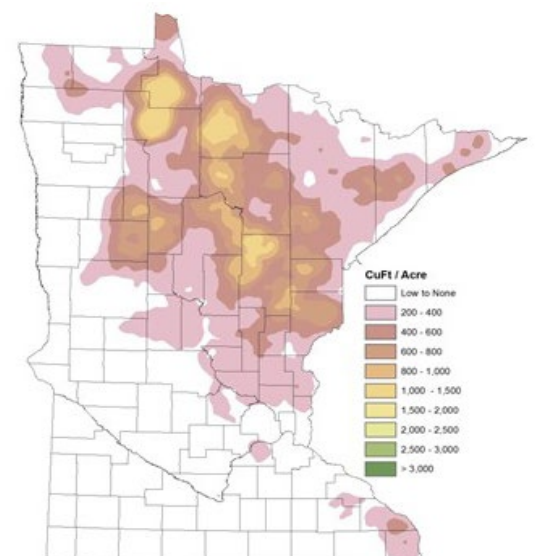
Tamarack tree species: growth and harvest

The harvest volume of tamarack species has decreased since 2010 (Figure 7); significant mortality levels have been occurring for the last 20 years. Eastern larch beetles are killing trees, mostly in older stands and especially in Koochiching, Beltrami, Lake of the Woods, and Roseau counties (Figure 8).

FIGURE 7. TOTAL HARVESTED VOLUME OF TAMARACK SPECIES FROM TIMBERLAND (1994-2023), TPO

FIGURE 8. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY, FIA

Figure 8 shows the average annual net growth (gross growth minus mortality), harvest removals, and mortality (non-harvest related mortality) of merchantable volume on timberlands. In 2018-2022, state and private timberlands suffered the most with a large volume of average annual mortality. Private and federal lands also showed negative average annual net growths (Figure 10). See Appendix A for further explanations of these figures.

FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY BY OWNERSHIP IN 2018-2022, FIA

In the past, tamarack had been reported as mixed softwood; volume swings are largely due to mill reporting and changes in pulp mill consumption. Tamarack markets also include biochemical extraction, OSB, and industrial lumber (pallets). In recent years, biomass energy facilities had begun to use more tamarack, but those markets have been drastically reduced. (Figure 9).

FIGURE 9. TAMARACK HARVEST LEVEL BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO
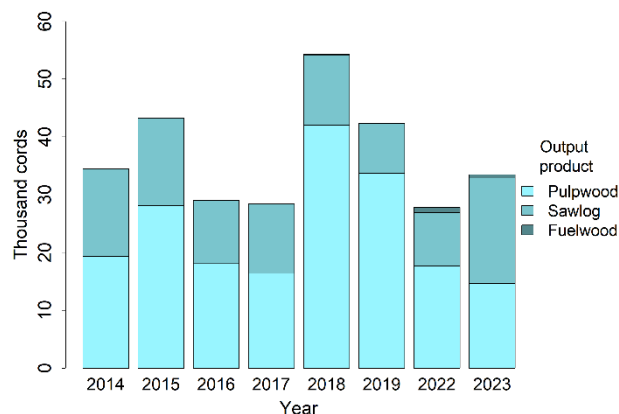
Opportunities:
• There may be opportunities to capture a portion of the mortality volume on state and private lands before additional losses occur.

Challenges:
• Eastern larch beetle has caused significant mortality in Minnesota tamarack forests since 2000.

Chapter 6 - Timber Price Information

Average prices received for stumpage sold by public land agencies: 2013-23

Average prices in Tables 6-1, 6-2 and 6-3 are based on those reported by Minnesota counties (Aitkin, Becker, Beltrami, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Itasca, Koochiching, Lake, Pine, and St. Louis), the Chippewa and Superior National Forests, the Bureau of Indian Affairs, and the 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 are 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 6-1: Pulpwood prices ($ per cord).

Species	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Aspen	24.99	30.62	36.08	34.26	34.33	32.09	28.55	30.07	30.73	33.00	34.55
Balm	20.56	24.8	27.68	24.29	30.56	25.55	25.59	23.60	26.25	25.31	30.80
Birch	8.44	9.89	12.02	13.77	11.33	10.65	10.14	8.92	8.82	9.76	10.20
Ash	6.62	6.82	6	8.07	6.69	7.19	6.32	5.94	6.75	7.46	8.07
Oak	15.44	13.1	14.63	17	16.61	20.61	17.19	13.14	15.02	14.19	19.09
Basswood	9.16	8.82	12.51	8.26	8.49	7.87	8.17	7.34	7.67	10.57	10.67
Mixed/Other Hardwoods	10.59	12.44	11.45	8.06	14.38	6.8	8.9	11.05	8.90	12.84	5.48
Balsam Fir	9.86	10.62	14.18	14.76	16.71	14.64	13.28	9.90	6.68	9.34	6.83
W. Spruce	17.57	16.55	19.09	17.25	23	20.9	19.88	14.48	13.22	12.20	10.67
B. Spruce	19.22	16.8	22.63	24.87	24.9	23.11	23.55	20.84	17.38	19.99	14.05
Tamarack	5.05	5.4	7.81	6.26	7.81	5.45	5.35	5.53	5.94	5.34	6.08
W. Cedar	7.86	5.3	6.41	6.8	5.2	5.47	4.97	5.72	5.39	5.48	6.13
Jack Pine	13.5	13.41	15.66	14.2	16	15.02	19.32	17.82	7.51	14.88	2.89
Red Pine	15.5	12.44	18.59	11.84	12.3	10.87	6.85	10.00	9.52	18.13	5.61
White Pine	13.01	16.56	12.78	15.91	8.44	7.31	9.87	5.57	5.99	10.65	5.29
Maple	9.91	9.82	10.13	12.31	10.47	11.26	10.19	10.38	9.96	11.68	10.95
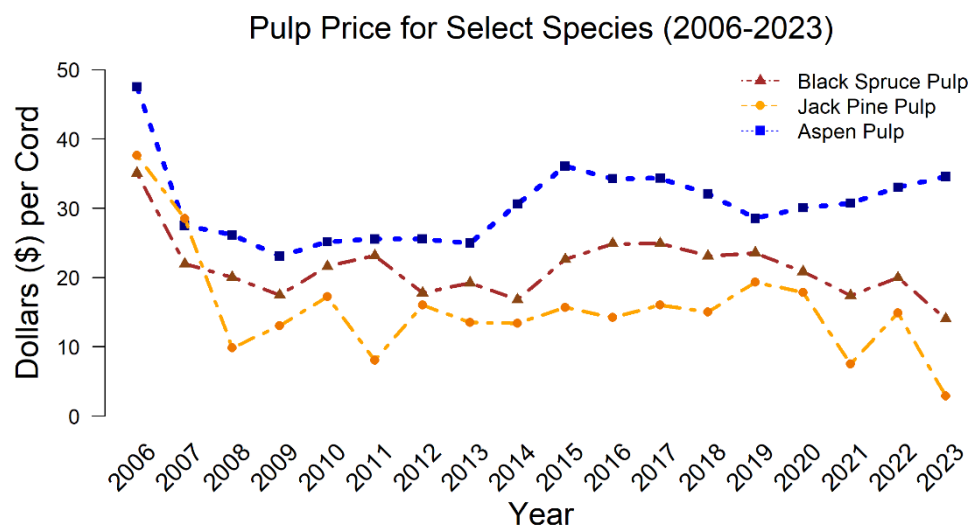
Figure 6-1: Pulp Price for Select Species (2006-2022). Source: DNR 2023 Minnesota Public Agencies Stumpage Price Review and Price Indices.

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In 2023, across all species and as reported on public lands, 17,797.6 tons of biomass were sold for bioenergy consumption with an average price of $0.65 per ton. For more information on this topic visit the biomass sector section on this document.

Table 6-2: Prices of pulp and bolts Combined ($ per cord).

Species	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Aspen	0	36.16	44.24	46.49	39.24	56.73	0	37.54	0	37.68	37.72
Balm	0	0	0	66.8	0	0	0	31.82	42.60	34.54	33.21
Birch	15.17	15.31	17.98	18.11	20.35	16.76	16.9	18.74	17.28	16.76	15.84
Ash	15.81	11.59	14.66	12.55	13.47	12.06	10.56	11.37	10.32	11.15	9.66
Oak	22.2	23.62	27.01	31.71	28.72	28.57	27.63	29.31	29.63	27.49	29.06
Basswood	13.78	12.03	14.52	16.62	15.91	13.56	11.84	13.05	12.89	16.56	13.82
Mixed/Other Hardwoods	14.32	16.02	15.67	17.15	16.77	16.57	14.38	12.37	16.13	10.92	30.20
Balsam Fir	16.65	17.93	23.97	24.73	21.7	24.03	21.19	18.46	12.03	9.86	11.30
W. Spruce	25.48	29.57	25.73	27.63	32.82	26.99	27.22	26.4	19.62	28.11	24.03
B. Spruce	24.65	27.9	30.48	41.36	27.87	27.1	27.82	0	28.23	32.19	25.77
Tamarack	12.75	15.54	13.87	0	15.31	9.82	7.9	10.4	7.27	10.03	9.54
W. Cedar	0	13.04	0	12.07	12.75	8.77	9.18	21.25	10.77	16.02	9.08
Jack Pine	27.31	32.06	30.88	34.03	32.19	28.63	27.73	25.61	24.78	30.30	28.96
Red Pine	40.48	43.09	43.78	37.71	39.73	40.3	38.64	36.93	39.81	46.97	46.08
White Pine	36.9	24.95	39.21	28.7	16.68	26.62	30.16	29.77	33.24	36.96	42.27
Maple	13.76	13.57	18.11	17.82	16.19	16.21	16.78	13.84	16.22	15.29	14.12

Table 6-3: Sawtimber prices ($ per thousand board feet).

| Species	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Aspen	53.12	0	0	0	0	0	72	0	0	0	33.60
Balm	0	0	0	0	0	0	0	0	0	0	0
Birch	36.97	47.04	42.84	45.24	0	61.23	53.33	51.69	80.54	97.38	53.44
Ash	34.06	73.41	54.17	97.67	72.2	196.37	149.81	61.14	89.96	31.32	55.03
Elm	41.41	42.19	42.5	42.54	39.77	54.75	54.07	72.91	43.99	54.38	29.05
Oak	274.5	411.3	265.5	299.03	195.16	194.63	213.2	161.13	108.64	209.85	145.48
Basswood	54.44	68.87	59.24	80.4	104.38	69.55	59.18	75.34	76.32	84.19	55.85
Mixed/Other Hardwoods	28.56	65.4	47.87	47.04	50.28	47.3	78.78	67.78	72.59	51.25	94.28
Balsam Fir	66.51	0	0	0	0	0	0	0	0	0	0
W. Spruce	87.57	61.12	74.68	73.59	67.58	76.14	83.77	82.53	96.89	59.63	25.32
B. Spruce	0	0	0	0	0	0	0	78.32	0	82.60	25.62
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	112	89.56	0	118.77	139.76	109.56	109.34	105.86	103.91	29.91	15.89
Red Pine	127.1	148.3	177.2	133.22	142.72	144.41	143.27	128.1	149.11	166.15	145.56
White Pine	112.8	121.3	88.92	117.5	82.28	127.44	100.32	109.9	109.09	104.12	94.18
Maple	70.92	406.7	126.7	168.5	153.04	95.21	0	94.29	110.28	93.32	76.02
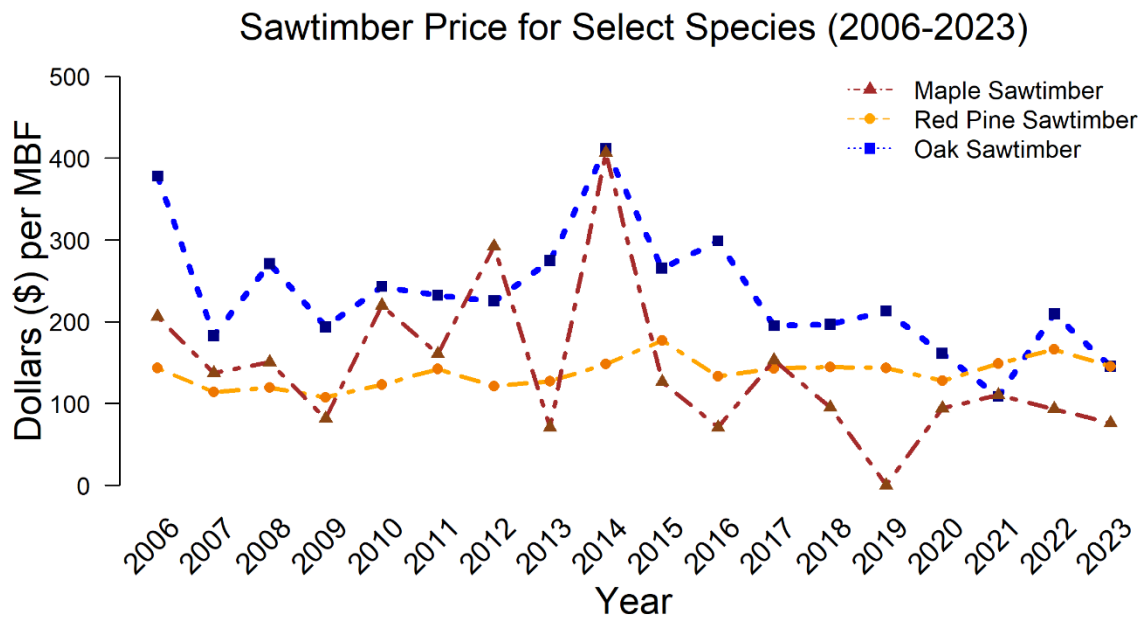
Figure 6-2: Sawtimber Prices for Select Species. Source: DNR 2023 Minnesota Public Agencies Stumpage Price Review and Price Indices.

Glossary

BIA – Bureau of Indian Affairs

Cover Type – A classification of forest land, 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 defects.

FIA – Forest Inventory and Analysis. It is the national annual inventory program of the USDA USFS in which permanent sample plots are measured on the ground where its distribution follows random locations within regular hexagonal grids such that each 6000-acre hexagon has up to three plots in it. Under an older periodic system before 1999, all existing FIA plots were measured during the same year; the periodic field measurements were last completed in 1977 and 1990. The annual system beginning in 1999 measures one-fifth (20%) of all plots within a state each year, such annual collection of plots are called a "panel". Hence, all existing plots are measured during a five-year "cycle."

Five complete cycle of FIA data as listed below are available in Minnesota:

- 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)
- Cycle 16 (panels of 2019, 2020, 2021, 2022, and 2023)

We are currently in Cycle 17 (panel 2024, 2025 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 forest land 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 USFS is located in St. Paul, Minnesota. USFS staff, in cooperation with state DNR, accomplish the FIA inventory and Timber Product Output surveys.

NIPF – Non-Industrial Private Forest land. Forest land 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 – Forest land 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 USFS is a part of the USDA.

USFS – United States Forest Service. An agency within USDA responsible for managing many kinds of public land, including national forests.

Conversion Factors

Conversion factors used to prepare this report:

1 cord = 500 board feet

1 cord = 79 cubic feet

1 cord = 2.3 green tons (for mixed species biomass)

Appendix A: Definitions of gross growth, net growth, ingrowth, mortality, and removals

Gross growth: The annual increase in volume of trees with 5.0 inches and larger d.b.h. in absence of harvest removals and mortality. Gross growth includes survivor growth, ingrowth, growth on ingrowth, growth on removals before removal, and growth on mortality prior to death.

Ingrowth: the number or net volume of trees that grow large enough during a specified year to qualify as saplings, pole-timber, or sawtimber.

Harvest removals: the net volume of growing-stock trees removed from the inventory by harvesting or other silviculture related operations.

Mortality: Number or sound-wood volume of live trees dying from natural causes and not utilized, during a specified period.

Net annual growth: The average annual net increase in the volume of trees during the period between inventories. Components include the increment in net volume of trees at the beginning of the specific year surviving to its end, plus the net volume of trees reaching the minimum size class during the year, minus the volume of trees that died during the year, and minus the net volume of trees that became cull trees during the year.

Net volume: gross volume less deductions for defects affecting use for timber products.

Other removals: the net volume of growing-stock trees removed from the inventory by cultural operations, such as land clearing or changes in land use.

For example, net growth is gross growth minus mortality. Harvest volume may be above or below net growth volume. During the period of 2006-2010 (Figure A-1), the average annual harvest removal volume exceeded the average annual net growth. In contrast, the average annual net growth from 2016-2020 exceeded the average annual harvest, indicating more volume was added than harvested during that period.
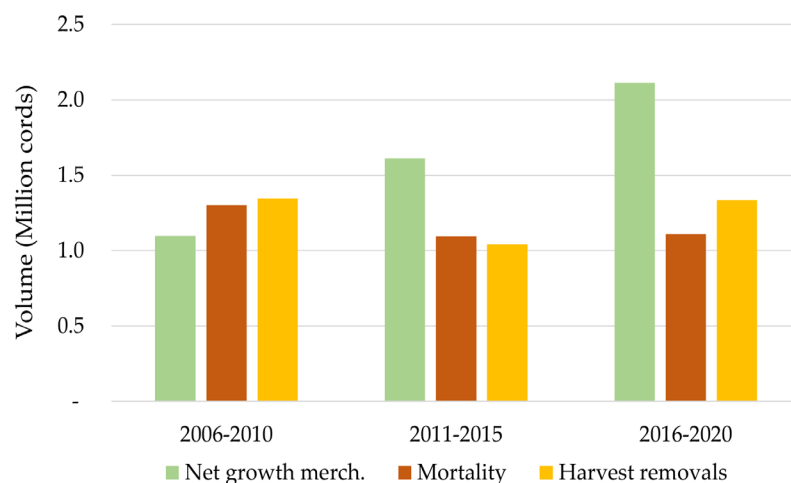

Figure A-1: The average annual harvest removal volume exceeded the average annual net growth during the period of 2006-2010 (Source: FIA).

Appendix B: List of scientific names of the most common tree species in Minnesota

American basswood: *Tilia americana*

Balm of Gilead/balsam poplar: *Populus balsamifera*

Balsam fir: *Abies balsamea*

Bigtooth aspen: *Populus grandidentata*

Black ash: *Fraxinus nigra*

Black spruce: *Picea mariana*

Bur oak: *Quercus macrocarpa*

Eastern white pine: *Pinus strobus*

Green ash: *Fraxinus pennsylvanica*

Jack pine: *Pinus banksiana*

Northern red oak: *Quercus rubra*

Paper birch: *Betula papyrifera*

Quaking aspen: *Populus tremuloides*

Red maple: *Acer rubrum*

Red pine: *Pinus resinosa*

Sugar maple: *Acer saccharum*

Tamarack: *Larix laricina*

White spruce: *Picea glauca*