MINNESOTA'S FOREST RESOURCES 2020

DEPARTMENT OF NATURAL RESOURCES

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

Resource Assessment
438 Peterson Rd.
Grand Rapids, MN 55744

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mndnr.gov/forestry/um

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 about Minnesota's forest resources, such as current conditions and trends in forest resources and forest resource industrial use. Foresters, natural resource managers, planners, forest industry, and forest policy makers will find items of interest in these pages. This report uses the most recent version of multiple survey data sets.

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

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

All FIA summary data was obtained from FIA database version 1.9.0.02.

Forest resource highlights

- According to 2020 FIA data, Minnesota currently has approximately 17.7 million acres of forest land, from which 15.8 million are classified as "timberland" (Figure 1-2.)
- Privately owned forests make up almost half of Minnesota's timberlands (49%), followed by the state (23%) and county and local government (16%) (Figure 1-4.)
- Aspen is the largest forest type in Minnesota (30% of timberland). Oak (10%), northern hardwoods (10%), lowland hardwoods (9%), black spruce (9%), and tamarack (7%) also make up a large percentage of Minnesota forests (Figure 1-7).
- Overall, net growth (gross growth minus natural mortality) for all species continued to outpace harvest levels. According to 2020 FIA figures, annual net growth of growing stock on timberland was approximately 5.83 million cords after accounting for approximately 4.10 million cords of annual natural mortality (Figure 3-1).

Timber harvest highlights

In 2020, Minnesota industry and fuelwood users harvested and used approximately 2.8 million cords of wood.

Forest industry highlights

- Pulp and paper continue to be the dominant sector for utilization, with 55% of roundwood harvested in the state being used within this sector.
- Since 2008, utilization has held steady (with slight variations) after dropping from 2006 to 2007 due mainly to oriented strand board (OSB) mill closures.
- Aspen species utilization has also remained flat since 2008.
- There are several species which are largely underutilized, highlighting opportunity for continued sustainable growth.
- Ash and basswood show an increasing utilization trend within hardwoods with maple on the decline.
- Softwood species utilization remains relatively flat or decreasing. With the exception of red pine, which has increased dramatically over the last decade.

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FIA data analysis and report compiled by Irene De Pellegrin Llorente, Ph.D., forest modeler, Minnesota DNR.

Photo cover credit: Theresa Dobosenski

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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 2020 FIA data, Minnesota currently has approximately 15.8 million acres of forest land that is classified as "timberland." Timberland is forest land that is capable of producing a commercial crop of industrial wood and is not reserved from harvesting by policy or law.

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.

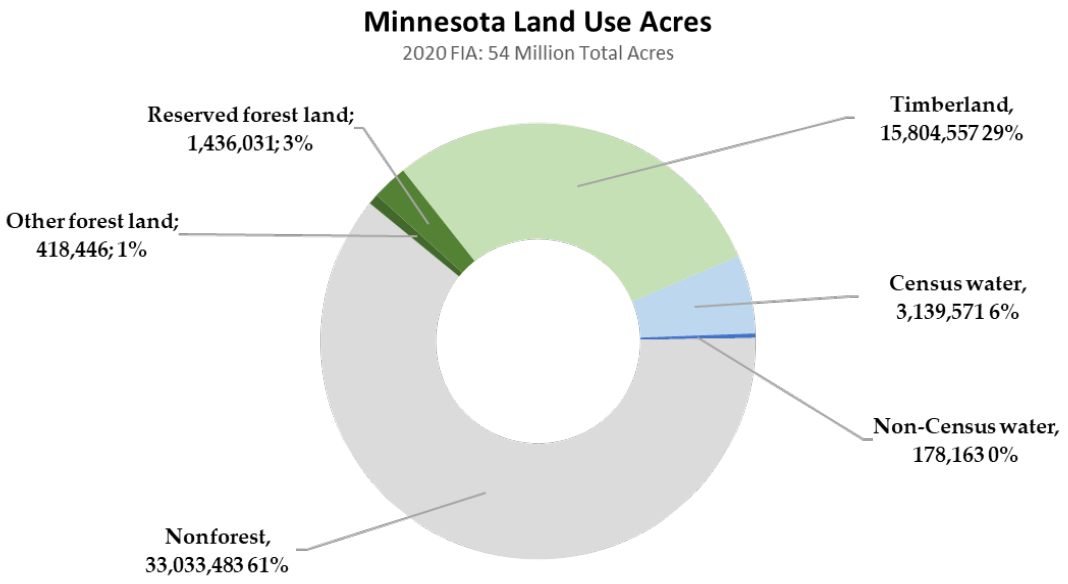


FIGURE 1-1: MINNESOTA LAND USE ACRES **Source:** U.S. Forest Service 2020 FIA database

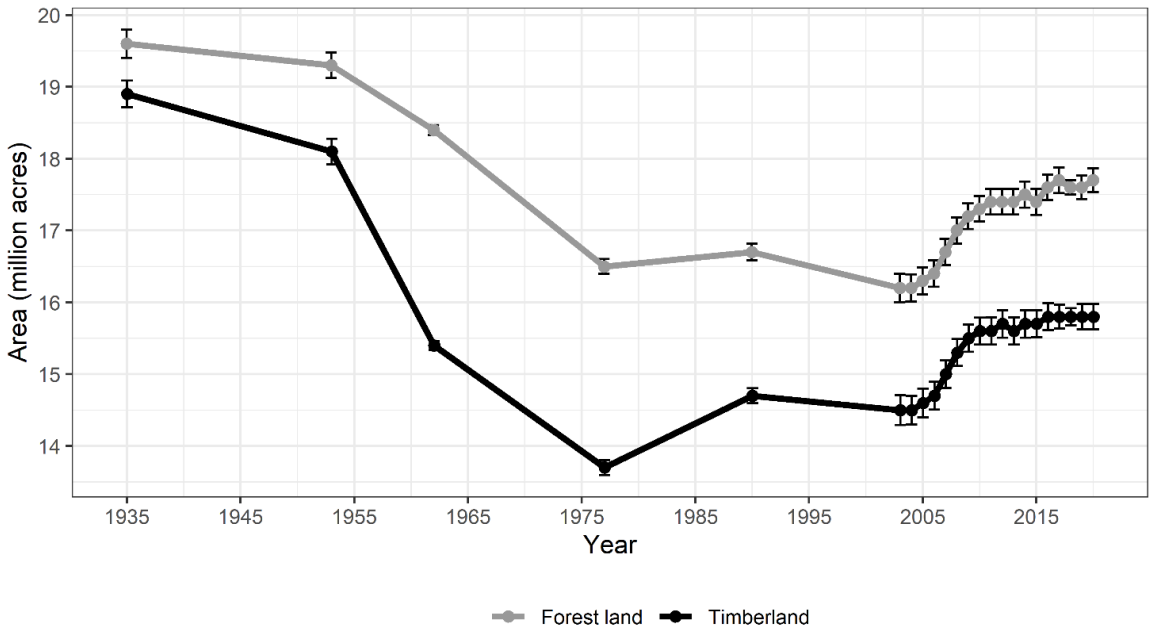


FIGURE 1-2: MINNESOTA LAND USE 1935-2019 **Source:** U.S. Forest Service 2020 FIA database. Black brackets represent 68% confidence interval) of the estimate.

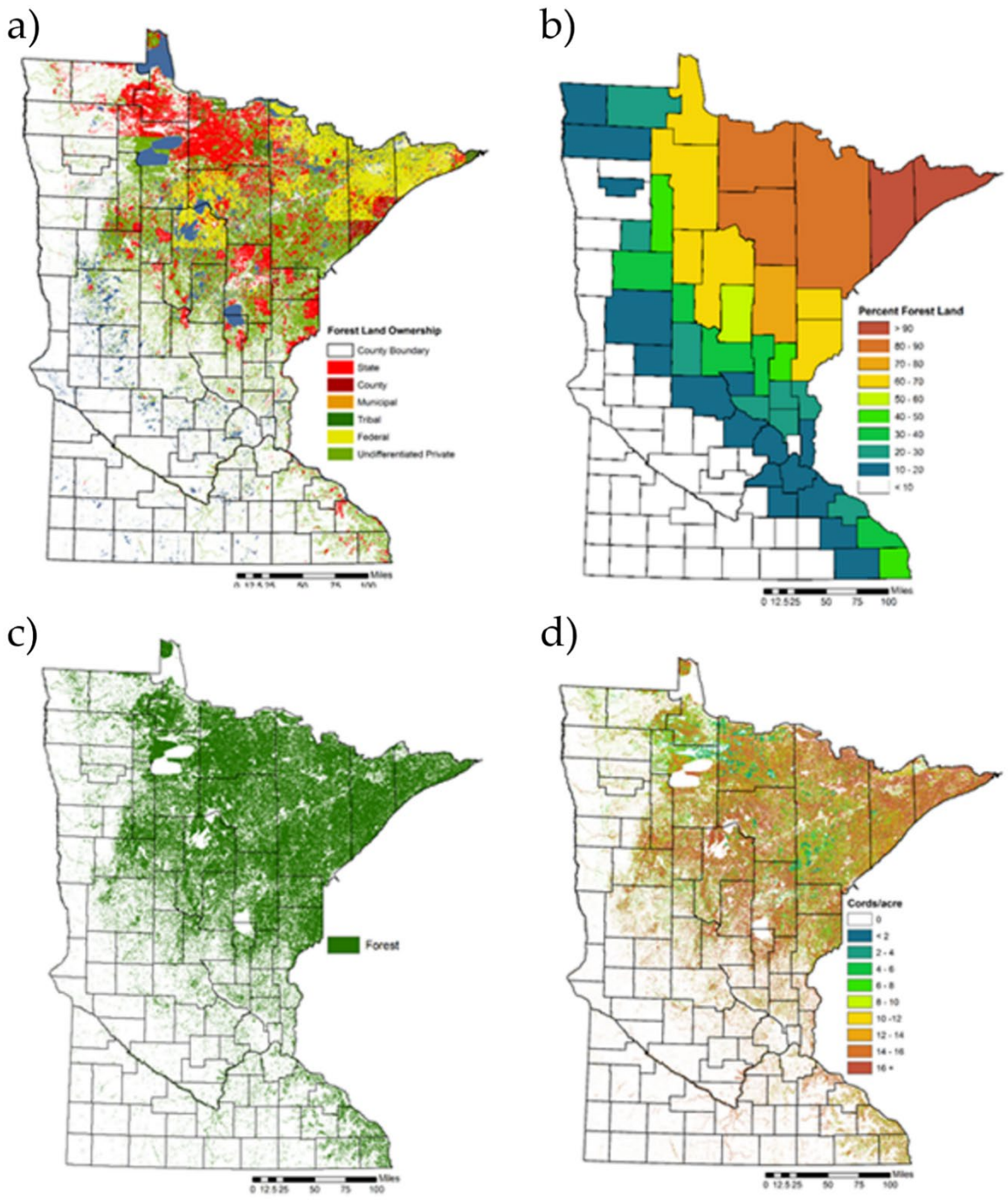


FIGURE 1-3: MINNESOTA AND USE MAPS a) Minnesota forest cover and ownership distribution, b) forest coverage percent by county, c) forest cover form the National Land Cover Database (NLCD), and d) estimated volume (cords/acre) for forest. **Source**: NLCD 2016, FIA 2018.

Generally, Minnesota's densest forest cover occurs in the northeastern portion of the state (Figure 1-3 c)). Forest cover decreases as one heads south, however, forest density increases in the southeastern corner of Winona, Fillmore, and Houston counties. Forest density can have a number of impacts on wildlife habitat, as well as forest resource productivity.

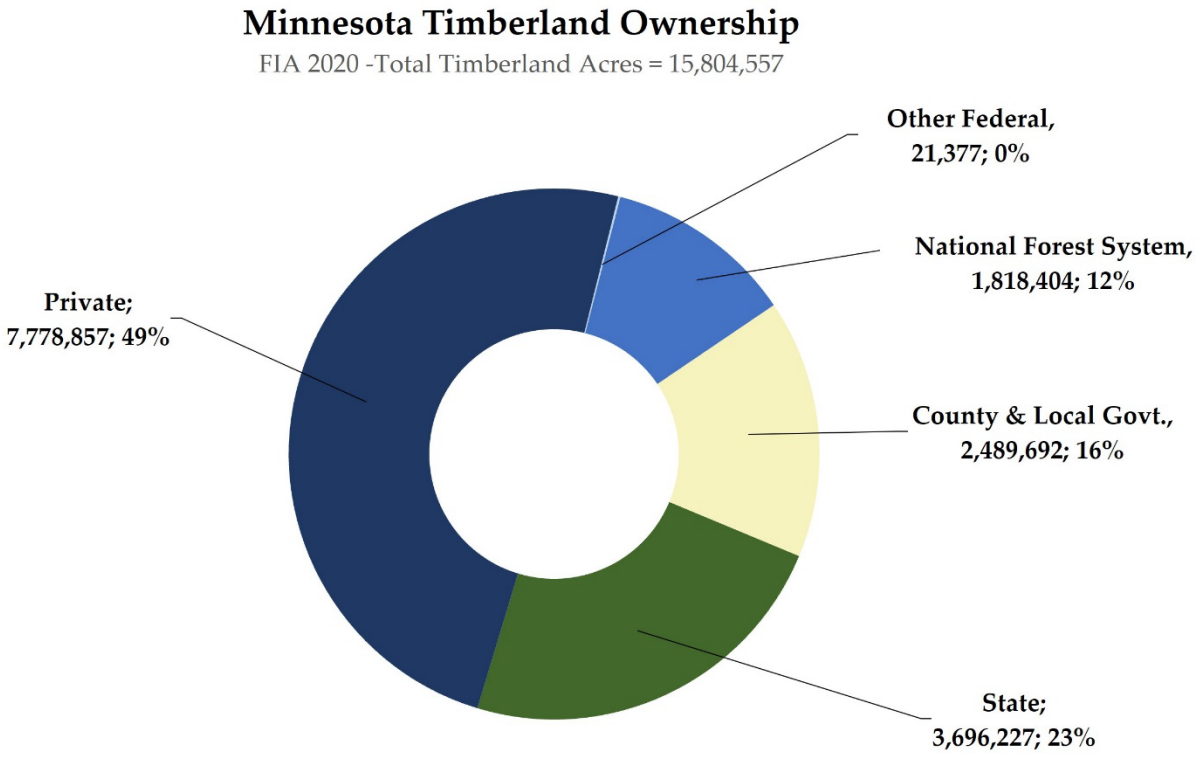


FIGURE 1-4: MINNESOTA TIMBERLAND OWNERSHIP **Source:** U.S. Forest Service 2020 FIA Database

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 and 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%) and may have varying management objectives compared to forests managed by government agencies. The Forest Inventory Analysis (FIA) database tracks some additional categories of private lands (see figure 1-5). For resolution at finer scales, please contact the FIA program's spatial services.

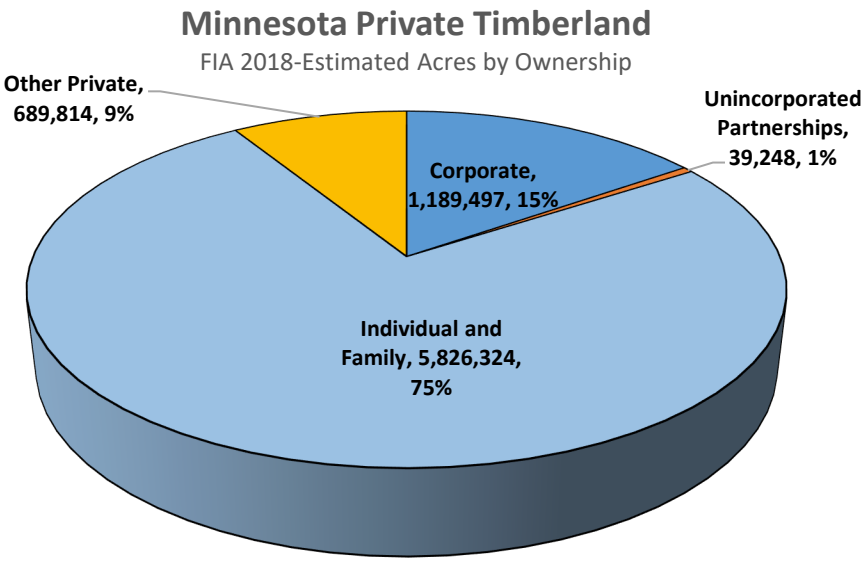


FIGURE 1-5: MINNESOTA PRIVATE TIMBERLAND ACRES. **Source:** U.S. Forest Service Spatial Services; 2018 FIA Database

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

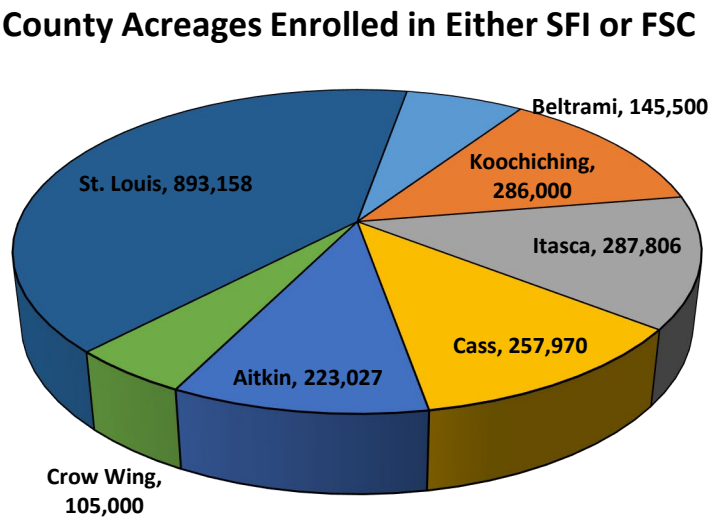


FIGURE 1-6: COUNTY ACREAGES ENROLLED IN EITHER SFI OR FSC **Source:** Minnesota DNR certification program 2018/2019. These are county acres as assessed by the MNDNR certification program

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

In addition to the county forests identified above, nearly 5 million acres of DNR administered forest lands are certified under SFI and FSC making MN DNR the largest single FSC-certified land manager in the United States. There are also over 600,000 acres of private forest lands certified under SFI, FSC, or the Programme for the Endorsement of Forest Certification Schemes (PEFC). In total, there are 7,852,878 acres of certified forest in the state.

Forest Type

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

Aspen is the largest forest or "cover" type in Minnesota. Oak, northern hardwoods, lowland hardwoods, black spruce, and tamarack also make up a large percentage of Minnesota forest (Figure 1-7).

Timberland in Minnesota has increased from approximately 15,599,930 acres in 2013 to approximately 15,804,557 acres in 2020. A number of factors play a part of this increase, such as agricultural land converting to forest. This is a dynamic process that depends on the different

economic drivers between agricultural or forestry land use. Improved assessment techniques also contribute to classifying former forest land as timberland.

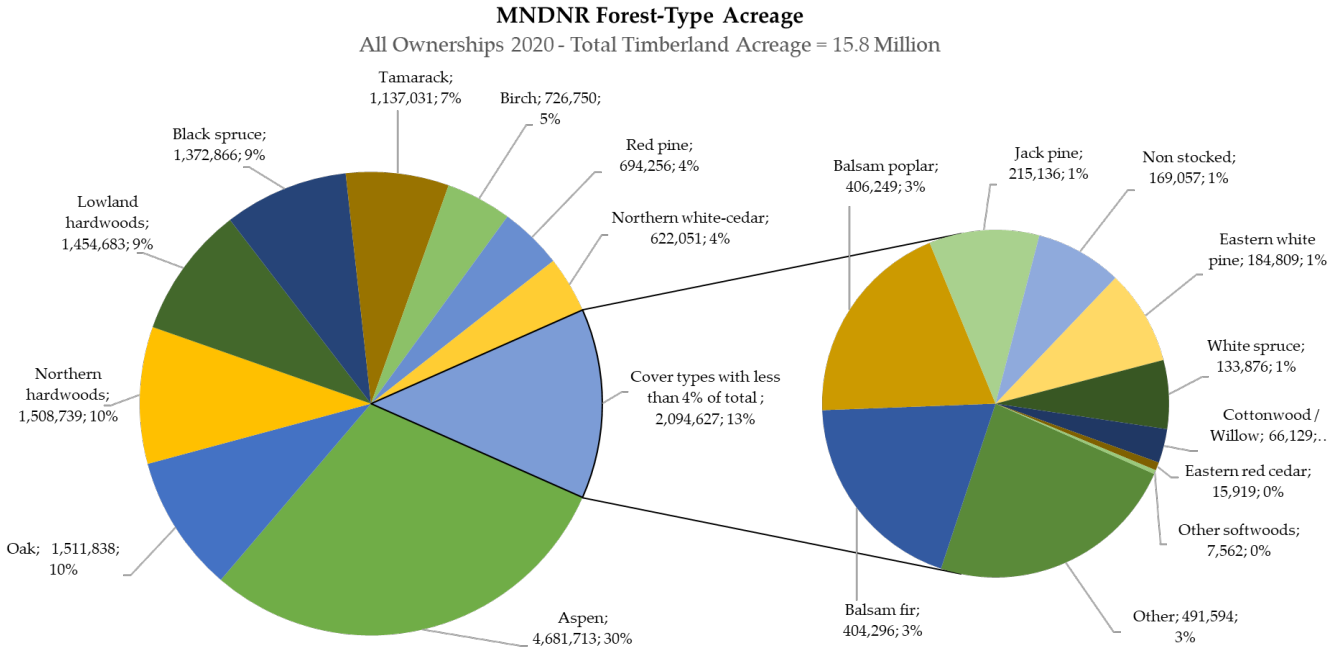


FIGURE 1-7: MINNESOTA DNR FOREST-TYPE ACREAGES **Source:** U.S. Forest Service 2020 FIA database

Chapter 2: Timber Harvest Overview

This chapter provides summary information on pulpwood timber harvest in 2019 and saw log harvest during 2020 in Minnesota by product category and estimation of contribution by timberland ownership.

All the information presented in this section has been created using the 2019 U.S. Forest Service Timber Product Output (TPO) pulpwood survey (draft), DNR 2020 Timber Product Output (TPO) sawmill survey (draft), the Minnesota Pollution Control Agency (MPCA) 2020/21 fuelwood survey, and the DNR 2020 Wood Energy Survey. 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

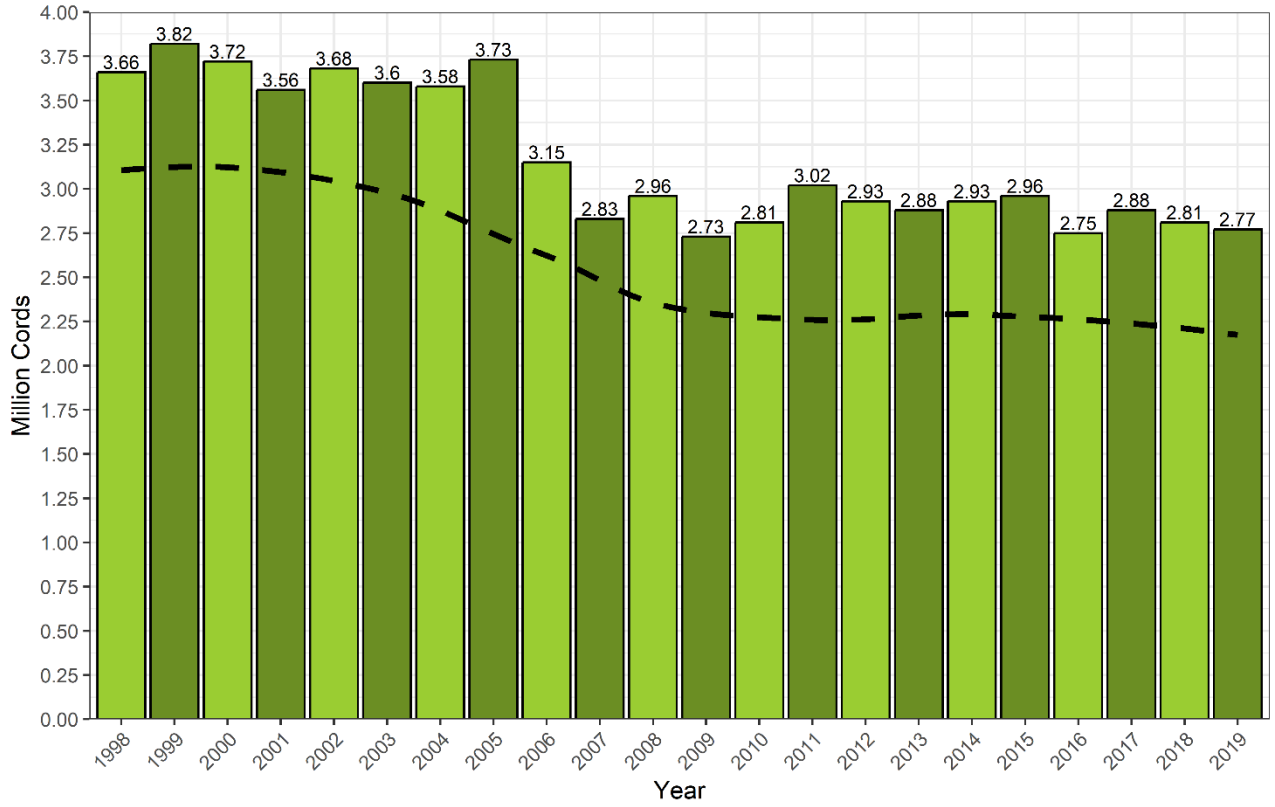


FIGURE 2- 1

FIGURE 2-1: TOTAL ROUND WOOD HARVEST FROM MINNESOTA TIMBERLANDS (1998-2019)
Source: 2019 Pulpwood (U.S. Forest Service, TPO survey, DRAFT), Sawtimber (TPO MN DNR survey DRAFT 2020) and fuelwood (MPCA and MN DNR surveys 2020). Dotted line shows trend in data.

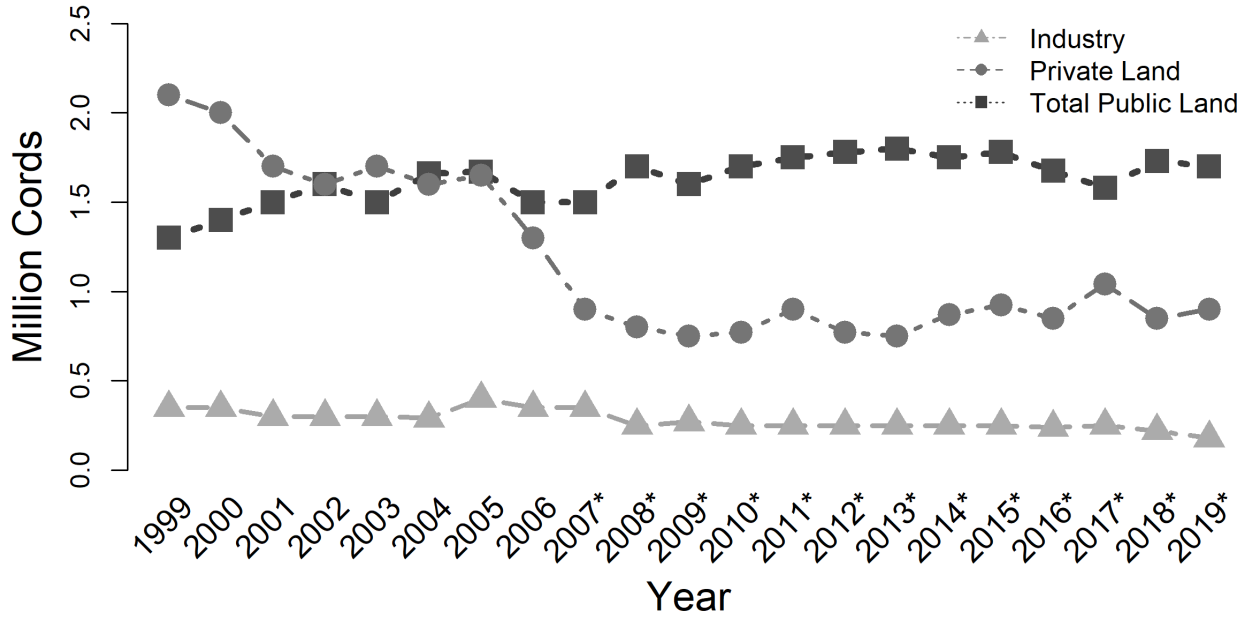


FIGURE 2-2: ESTIMATED VOLUME OF TIMBER SOLD AND HARVESTED IN MINNESOTA BY OWNERSHIP **Source**: Public Lands: Public Stumpage Price Review through 2006. Beginning in 2007, annual volume scale reports (harvested) are used for state and federal lands rather than volumes sold. Change necessary because public agencies re-offered and sold large volumes of wood.

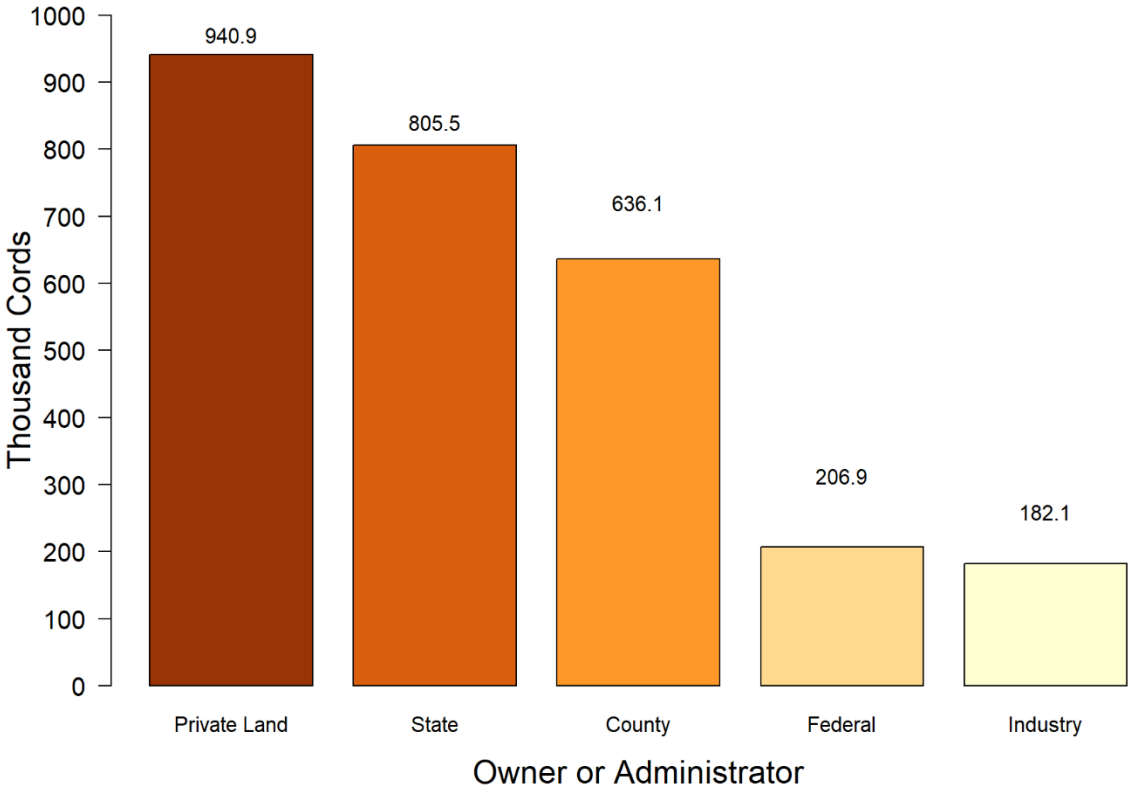


FIGURE 2-3: CONTRIBUTION TO ESTIMATED HARVEST IN MINNESOTA IN 2019

Sources:

- **State Lands**: Calendar year 2019 Harvest, DNR Timber sales scaled.
- **Federal**: Fiscal year 2019 harvest, Superior National Forest Timber Statistics, and Chippewa National Forest
- **County Lands:** Public Stumpage Price Review 2019 sold.
- **Industry Lands:** Minnesota Forest Industries survey of 2019 harvested volume.
- **Private Lands:** Calculated from total estimated harvest in 2019 minus state, county, national forest and BIA volume harvested, minus estimated industry volume harvested. Total harvest was down overall in 2019. State and counties produced the majority of public timber volume.

May not sum due to rounding

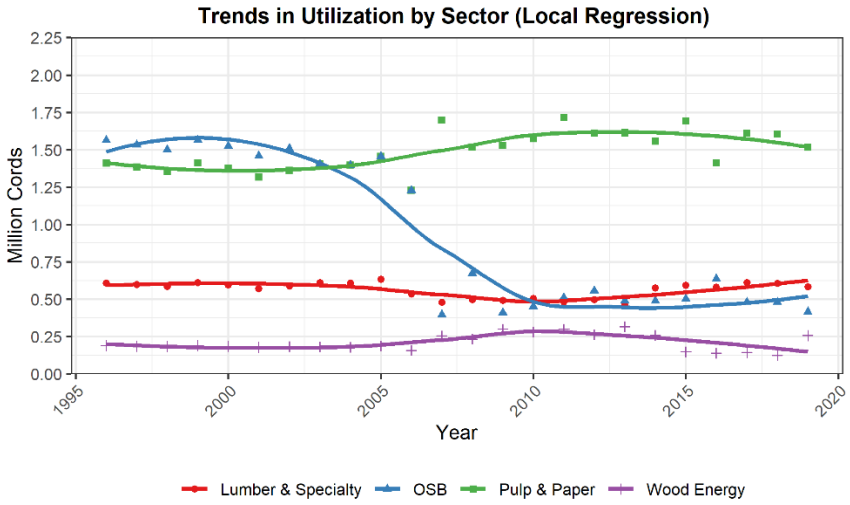


FIGURE 2-4: TRENDS IN UTILIZATION BY SECTOR Source: Wood use data from mill TPO surveys and fuelwood surveys conducted by the U.S. Forest Service, Northern Research Station and Minnesota DNR.

Figure 2-4 shows the trend in utilization by sectors. Pulp and paper continued its slight declining trend in 2020 while both OSB and lumber/specialty sectors are showing a slight upward trend. Wood energy produced from roundwood increased in 2020 but is still showing an overall downward trend. (Figure 2-4). Specialty products in Figures 2-4 and 2-5 include veneer, posts and poles, shavings, and landscape chips. Wood energy only includes commercial wood fuels. Trends in Figure 2-4 are fit using a local regression model.

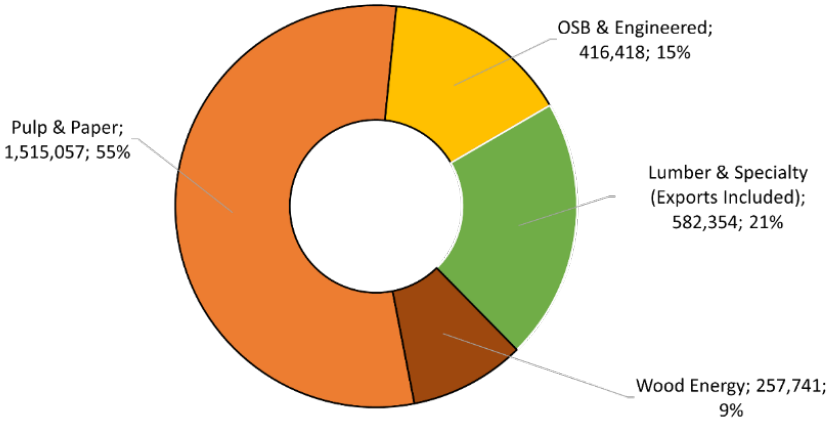


FIGURE 2-5: ESTIMATED FIBER PRODUCTION BY PRIMARY INDUSTRY SECTOR 2019 Source: TPO surveys conducted by U.S. Forest Service

TABLE 2-1: TOTAL WOOD HARVESTED FROM MINNESOTA AND UTILIZED BY INDUSTRY AND FUELWOOD USERS (BY SPECIES FROM TIMBERLAND) Source: U.S. Forest Service and Minnesota DNR Timber Product Output mill and wood energy surveys and Minnesota Pollution Control Agency residential fuelwood survey. Figures in chart may not total exactly due to rounding Pulpwood Timber Product Output survey 2019 (DRAFT); Sawtimber Timber Product Output survey 2020 (DRAFT); Residential Fuelwood 2020/21; Commercial Wood Fuels 2020

Species	Pulpwood[1]	Saw logs and Other[2]	Saw log Exports[3]	Residential Fuelwood[4]	Commercial Wood Uses[5]	Total
Aspen/ Balm	1,306,919	67,364	1,742	20,606	19,560	1,416,191
Paper Birch	88,401	19,272	1,402	11,448	944	121,467
Ash	35,356	19,904	636	27,474	690	84,060
Oak	512	53,290	14,050	70,975	325	139,152
Basswood	25,622	25,736	719	20,606	48	72,731
Maple	89,184	5,584	3,551	16,027	168	114,514
Cottonwood	---	5,248	1,082	---	---	6,330
Other Hardwoods	---	4,898	3,358	20,606	904	29,766
Hardwood Sub-Total	**1,545,994**	**201,296**	**26,539**	**187,742**	**22,639**	**1,984,210**
Pine	4	4,404	---	16,027	3,198	23,633
Red Pine	42,051	227,884	30,809	---	---	300,744
White Pine	3,616	8,298	580	---	---	12,494
Jack Pine	24,484	28,340	551	---	430	53,805
Pine Sub-Total	**70,155**	**268,926**	**31,940**	**16,027**	**3,628**	**390,676**
Spruce	186,171	23,924	2,077	---	288	212,460
Balsam Fir	95,499	7,750	6	---	1,942	105,197
Tamarack	33,657	8,590	---	---	132	42,379
White Cedar	---	9,992	---	---	---	9,992
Other Softwoods	---	1,290	---	---	158	1,448
Softwood Sub-Total	**315,327**	**51,546**	**2,083**	**0**	**2,520**	**371,476**
Mixed Species	---	24	---	25,185	---	25,209
Total	**1,931,476**	**521,792**	**60,562**	**228,954**	**28,787**	**2,771,571**

[1] Draft 2019
[2] Draft 2020
[3] 2017 Timber Product Output survey estimated exports
[4] Fuelwood removed from live trees on timberland.
[5] Estimates from MN DNR Wood Energy Survey

Pulpwood

Pulpwood consumption in the state is primarily by pulp and paper mills and engineered wood product manufacturers. Consumption declined dramatically in 2006 with the idling and eventual closer of 3 OSB mills in the state. Additional pulpwood consuming mill closures and machine shutdowns since that time have been largely offset by increases in existing mill consumption resulting in relatively stable pulpwood harvest numbers. Most imported pulpwood was aspen and maple from Wisconsin and Canada. The amount of pulpwood utilized continued to decline overall in 2019, relative to peak use in 2005.

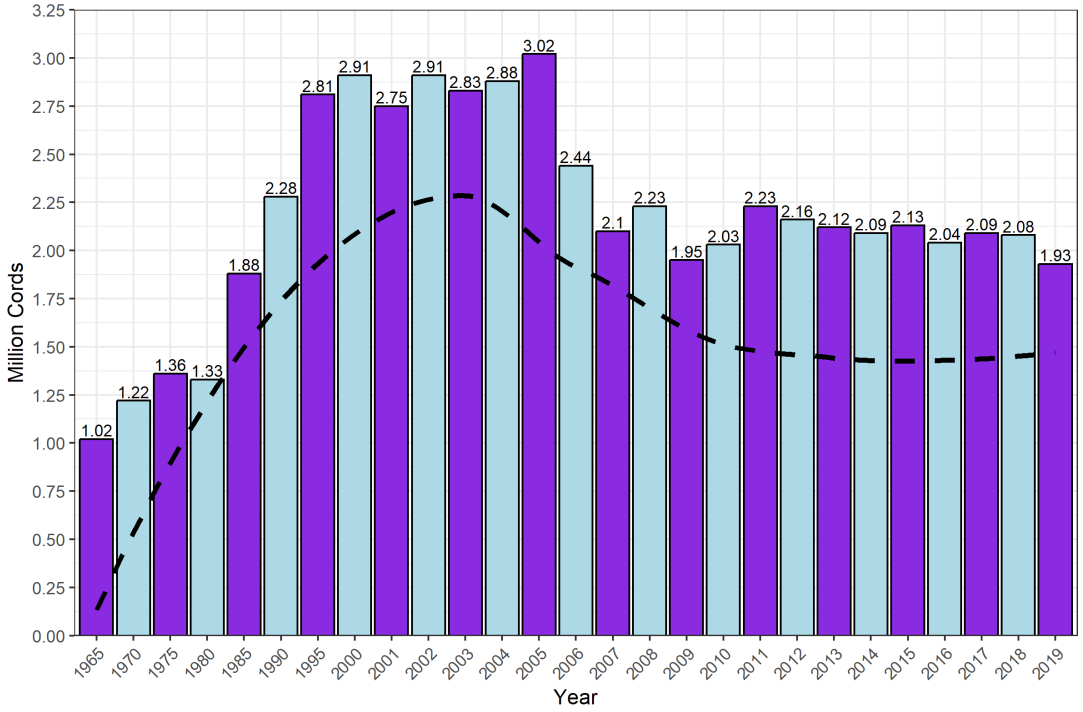


FIGURE 2-6: TOTAL PULPWOOD HARVEST FROM MINNESOTA TIMBERLANDS UTILIZED BY MILLS (1965-2019) **Source:** U.S. Forest Service TPO survey (includes roundwood and residues). DRAFT 2019. Dotted line represents the trend in pulpwood utilization using a local regression.

Beginning in 2000, Minnesota became a net importer of pulpwood with the completion of several mill expansions and total consumption increased. Imports declined in 2007 and have remained relatively stable since then. The dominant species imported in 2019 included aspen (87,775 cords), balsam fir (7,813 cords), and maple (198,295 cords).

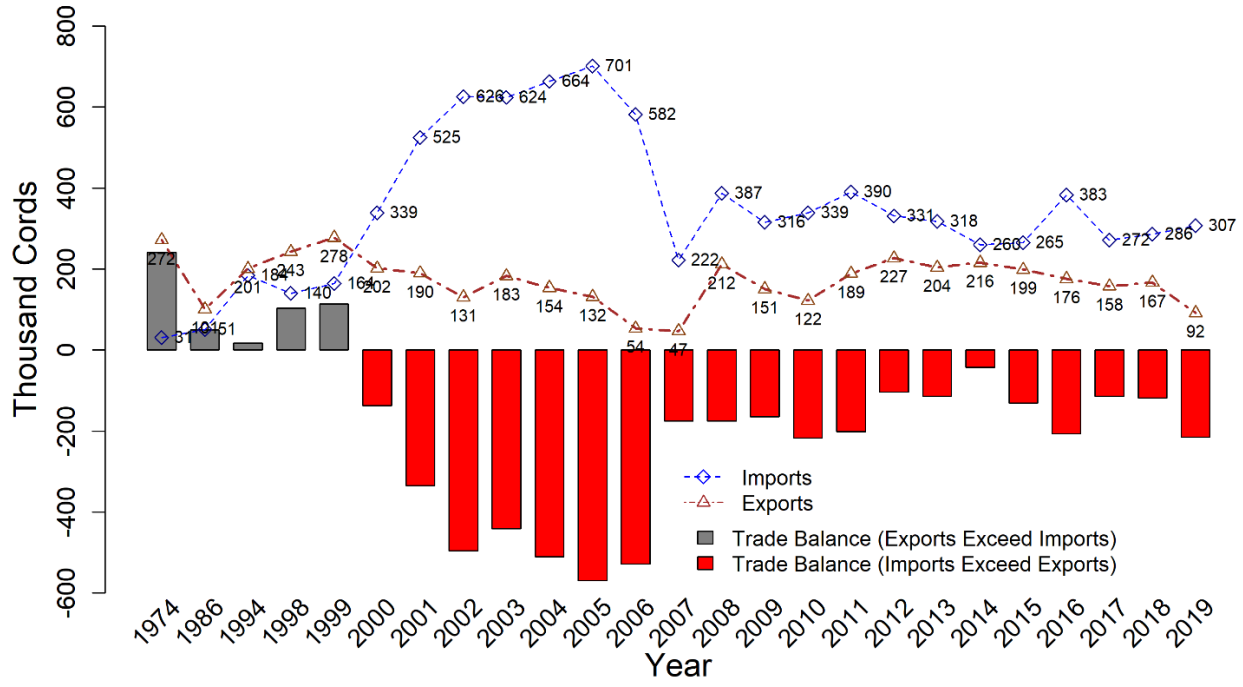


FIGURE 2-7: MINNESOTA IMPORTS AND EXPORTS OF PULPWOOD Source: U.S. Forest Service TPO survey of industrial wood-using industry.

TABLE 2-2: TOTAL PULPWOOD PRODUCED IN MINNESOTA BY SPECIES, INCLUDING EXPORTS (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
2018	1,351	92	104	93	69	42	83	250
2019	1,307	95	88	89	61	34	70	186

Pulpwood figures include cords of pulpwood exported to mostly Wisconsin, but also to Canada (Table 2-3)

TABLE 2-3. PULPWOOD EXPORTS, 2019 (CORDS)

	Canada	Wisconsin
Ash	---	5,006
Aspen	19,224	25,598
Balsam fir	---	3,773
Basswood	---	7,547
Jack pine	---	1,691
Maple	---	6,600
Read and white oak		512
Red pine	---	831
Spruce	---	215
Tamarack		1,456
White birch	---	18,953
White pine	---	409

Sawtimber

Sawtimber is often the highest value wood product that meets merchantability requirements. Typically, merchantable sawlogs must measure at least 8 feet in length and 8 inches in dimeter inside bark at the small end. However, an increasing number of sawmills can use smaller diameter material profitably.

Sawtimber consumption in 2015 was approximately 456,000 cords. This number steadily increased to a recent peak of approximately 653,000 cords in 2018. Since then, sawtimber consumption has declined to 606,000 cords in 2019 and 582,000 in 2020.

Relative to 2019, the use of aspen in sawmills in 2020 was stable while red pine and red oak saw slight declines. Red pine continues to make up the majority of round wood used by sawmills.

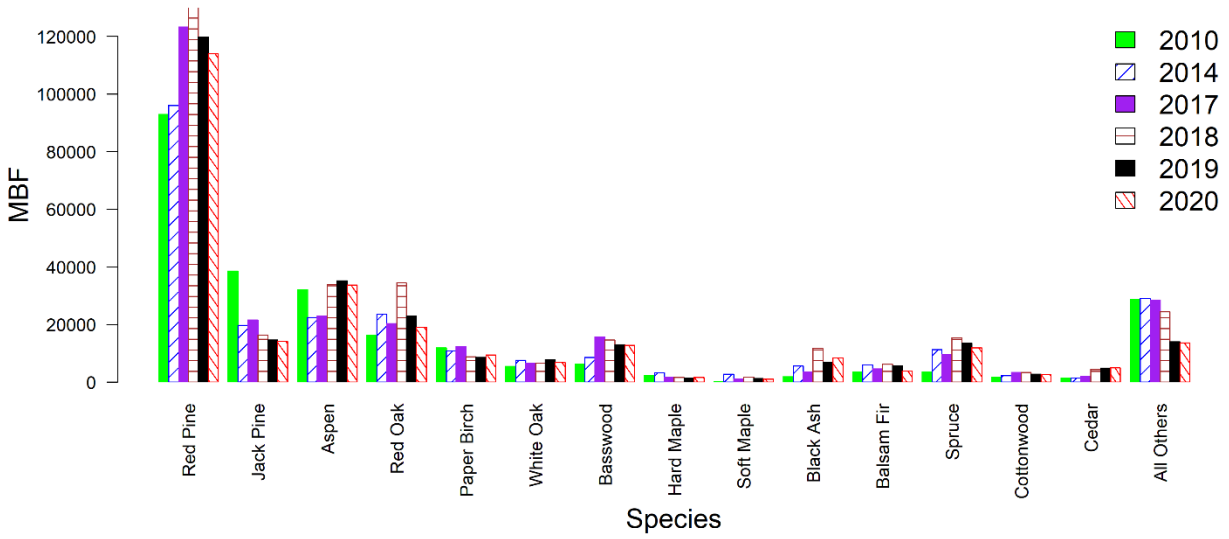


FIGURE 2-8: VOLUME HARVESTED FROM MINNESOTA TIMBERLAND AND UTILIZED BY SAWMILLS AND SPECIALTY MILLS **Source**: U.S. Forest Service TPO survey

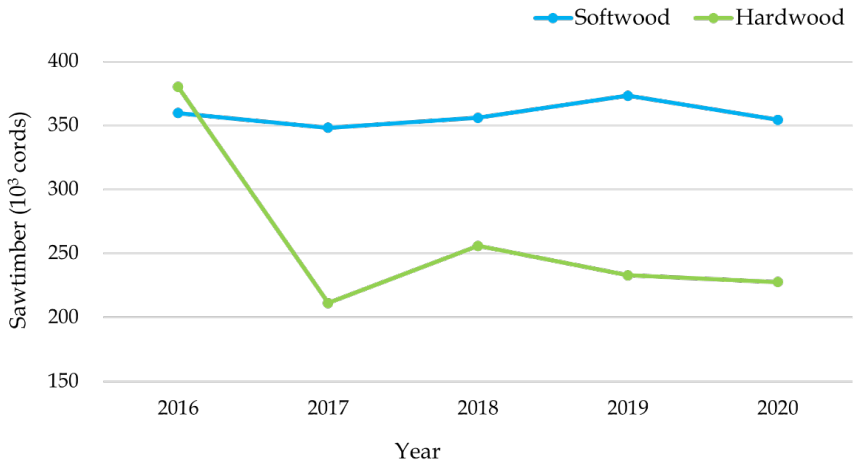


FIGURE 2-9: SAWTIMBER PRODUCTION IN MN (LAST FIVE YEARS) **Source**: U.S. Forest Service TPO survey

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

Utilization Trends

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

Trends in utilization are evaluated using localized regression models that show trends over time. Understanding recent and long-term trends helps to interpret the availability of a resource and gives stakeholders a tool to pinpoint issues and manage forest policy decisions.

Hardwoods

Since 2000, maple and ash species have shown increases in utilization, but maple has been on a downward trend since 2010. Oak species utilization is variable year to year but is demonstrating a slight upward trend since the more pronounced declines in the early 2000's. Basswood utilization is low but has shown an increase in recent years.

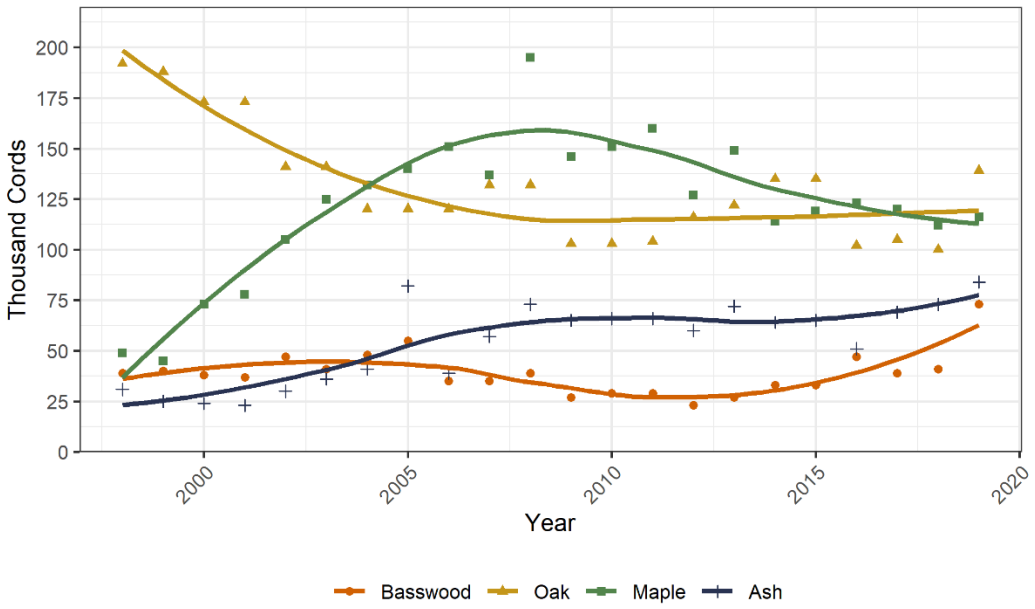


FIGURE 2-10: TRENDS IN HARDWOOD UTILIZATION (LOCALIZED REGRESSION) **Source:** U.S. Forest Service TPO draft survey data

Softwoods

Softwood species such as spruce have generally trended up, while balsam fir has trended downward. Long-term tamarack and white cedar utilization have remained relatively flat. In recent years white cedar has seen a slight increase in utilization (2019 vs 2017 estimates).

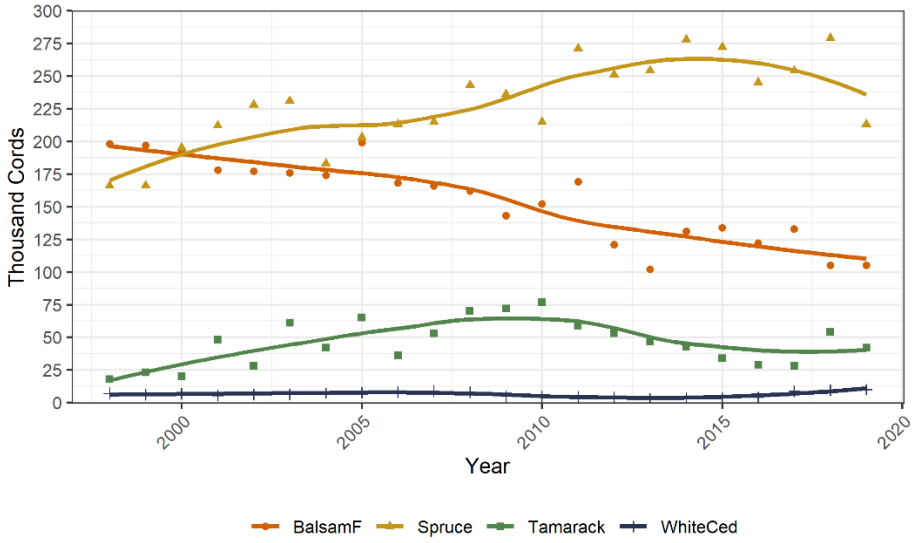


FIGURE 2-11: TRENDS IN SOFTWOOD UTILIZATION (LOCAL REGRESSION) **Source:** TPO draft survey data by U.S. Forest Service Northern Research Station and DNR.

Pines

Red pine utilization has increased substantially, while jack pine has seen significant declines. White pine utilization has remained flat.

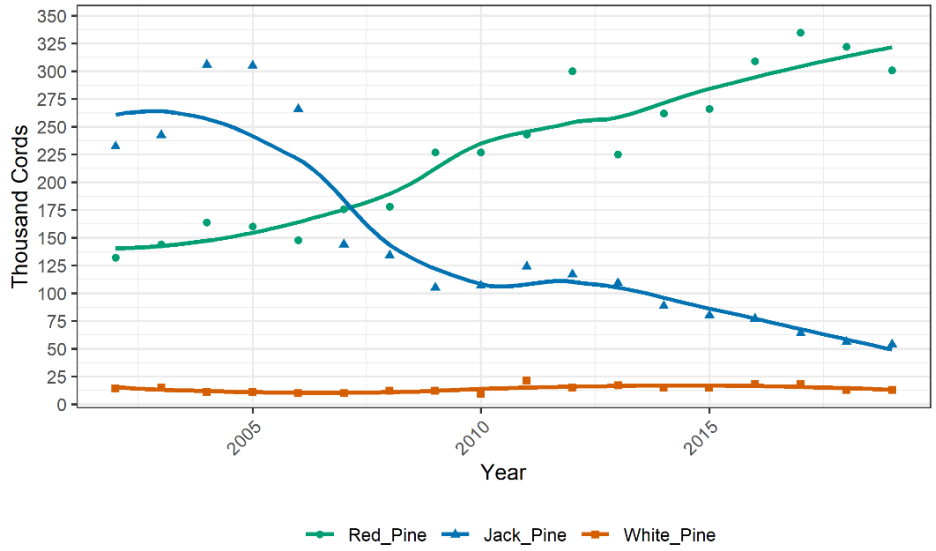


FIGURE 2-12: TRENDS IN PINE UTILIZATION (LOCAL REGRESSION) Source: Timber Product Output draft survey data by U.S. Forest Service Northern Research Station and DNR compiled in Minnesota Forest Resources Reports

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, which is typically included with aspen utilization figures. Compared to consumption levels 20 years ago, aspen has been decreasing in utilization but has remained stable for the last decade or so.

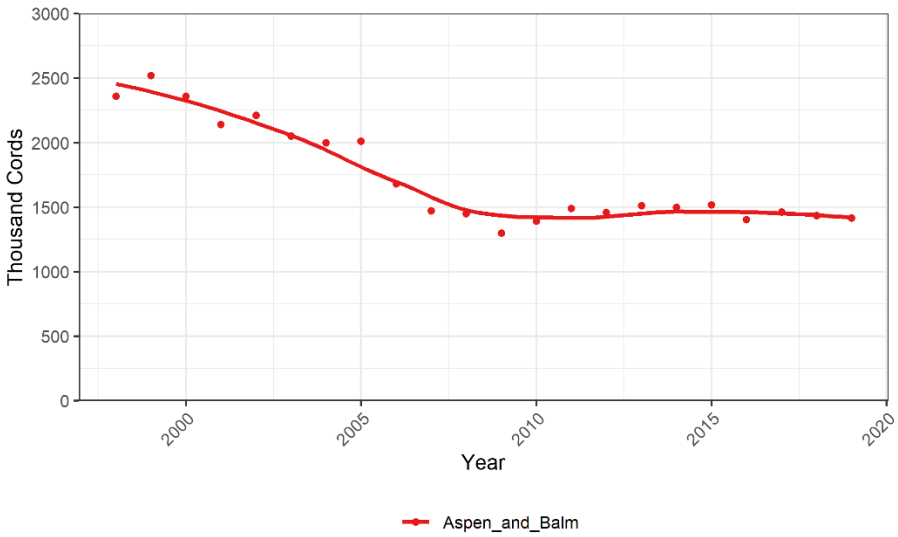


FIGURE 2-13: TRENDS IN ASPEN AND BALM OF GILEAD UTILIZATION (LOCALIZED REGRESSION)
Source: TPO draft survey data by U.S. Forest Service Northern Research Station and DNR

Chapter 3: Sustainable Review and Future Potential Opportunities

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

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

No best way or time exists to reach a target age-class structure. Planned and actual harvest levels may differ from long-term sustained yield estimates. Additionally, it is possible to increase future timber availability through intensified forest management resulting in fewer losses to mortality and improved timber productivity. Sustainable harvest estimates can also vary significantly because of differing assumptions used in deriving the estimates, such as rotation age, harvest accessibility and

availability, growth and yield, etc. An active forest management and harvesting program is key to sustaining habitat for diverse wildlife and maintaining a healthy forest.

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

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

The GEIS' main goal was to examine the impacts of timber harvesting and forest management on Minnesota's environment and on relevant sectors of the state's economy. Activities associated with timber harvesting and forest management could be related to logging, site preparation, reforestation, and forest road construction. The 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), reserved and unproductive forests. In 1990, the Minnesota Environmental Quality Board prescribed three levels of statewide timber harvesting activity to be assessed by the GEIS. These are referred to as the baseline, medium and high scenarios: a 4.0 million cords (the most recent statewide harvest level information available at the time of the study), a 4.9 million cords as an estimation of the harvest level by 1995 if the forest products industry expansions were to be fully materialized, and a 7 million cords as the estimated maximum sustainable annual volume of timber growth that would be available for harvest statewide in year 2000.

The modeling efforts on the GEIS study assessed the spatial and temporal distribution of the timber harvesting activities that needed to happen in these three scenarios and their environmental impacts over a 50-year planning horizon.

An important note to make is that these three statewide harvest scenarios are NOT the recommended harvest levels. Rather, they are harvest levels the study considered when assessing the potential impacts if those harvest levels were to occur.

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

The DNR concluded that an appropriate harvest level, taking into account the many goals of the department, would be 870,000 cords offered annually over the next 10 years. In addition, in the first five years of the plan (2020-2025), 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, annual volume offered is expected to drop back to 870,000 cords. This analysis will likely be reevaluated in 10 years.

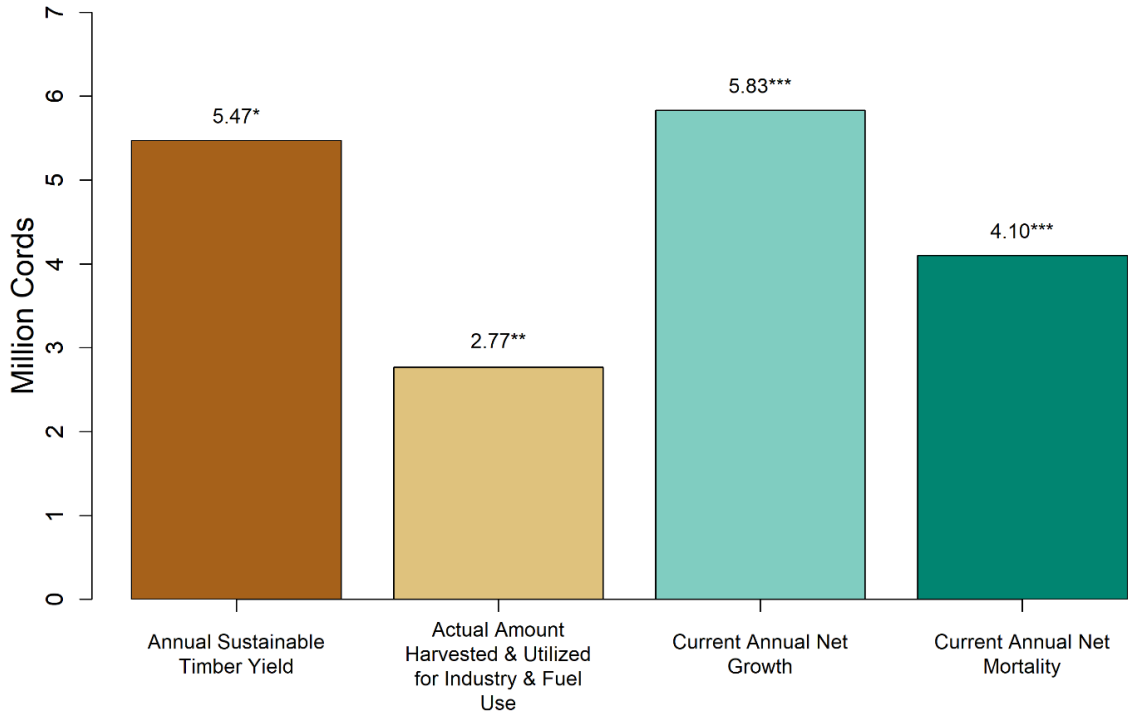


FIGURE 3-1: ANNUAL HARVEST COMPARED TO GEIS SUSTAINABLE HARVEST AND FIA GROWTH/MORTALITY METRICS. Source: Table accessed from Table 6.25, Technical Papers for Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota, December 1992.

Figure 3-1 includes data from 2019 U.S. Forest Service TPO pulpwood survey (*draft*), DNR 2020 TPO survey sawmill (*draft*) and 2020/21 fuelwood survey.

Includes data from U.S. Forest Service FIA 2020 database annual net growth and mortality on forest land (see Appendix A for definition of annual net growth and mortality).

Note: While complete capture of the average annual mortality is not realistic, capturing a portion of the approximately 4.10 million cords of mortality has the potential to increase net growth and sustainable harvest levels.

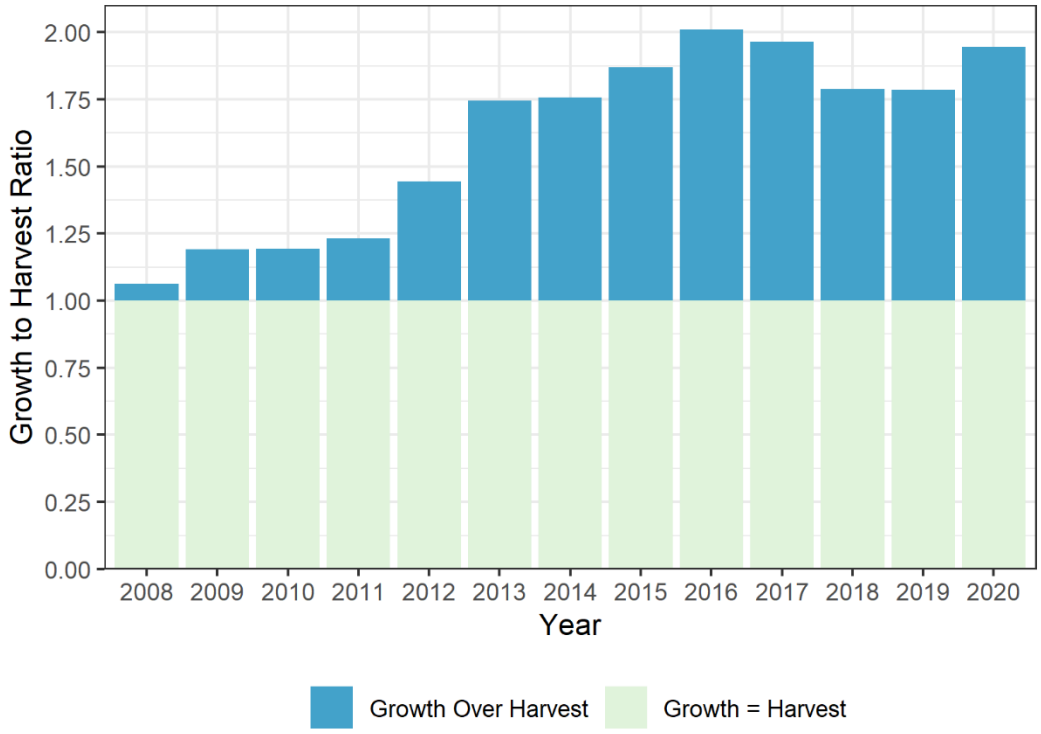


FIGURE 3-2: GROWTH TO HARVEST RATIO **Source:** FIA 2020

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.) A value of one means net growth and harvest are equal. Figures higher than 1 indicate 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.

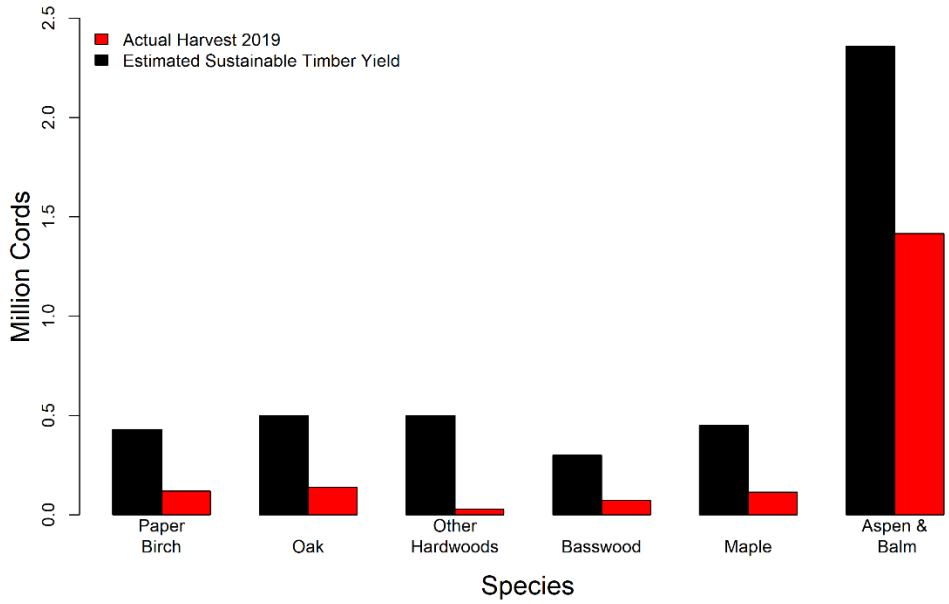


FIGURE 3-3: ESTIMATED LONG-TERM ANNUAL SUSTAINABLE TIMBER YIELD AND ACTUAL HARVEST OF SELECTED SPECIES **Source:** Harvest data 2019 U.S. Forest Service Timber Product Output pulpwood survey (*draft*), DNR 2020 Timber Product Output survey sawmill (*draft*) and MPCA 2020/21 fuelwood survey.

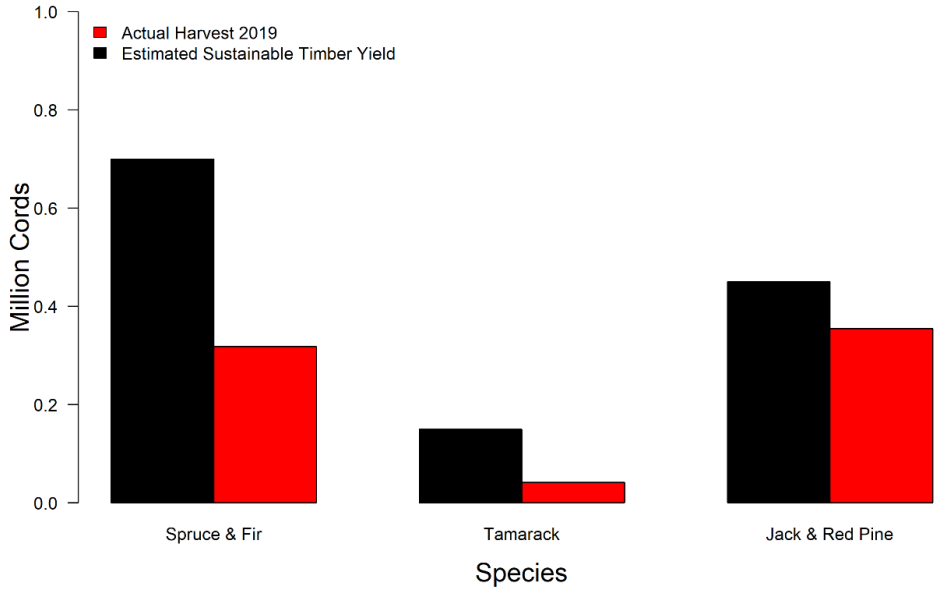


FIGURE 3-4: ESTIMATED LONG-TERM ANNUAL SUSTAINABLE TIMBER YIELD AND ACTUAL HARVEST OF SELECTED SPECIES **Source:** Harvest data 2019 U.S. Forest Service TPO pulpwood survey (*draft*), DNR 2020 TPO survey sawmill (*draft*) and MPCA 2020/21 fuelwood survey.

Sustainable timber yield for aspen and spruce-fir in the figures above are from the UPM-Blandin Thunderhawk Draft Environmental Impact Study (DEIS) analysis (Tables C-20 and C-21 average of high aspen A and B scenario model runs, 40-year planning horizon). Estimates from the Thunderhawk DEIS analyses focused on aspen-balsam poplar and spruce-fir product groups,

recognizing considerable detail regarding the mixed species nature of all cover types and projections of forest growth. Generally, the EIS estimates can serve as upper bound estimates of harvest levels sustainable at least until year 2040. These estimates assume that demand for other species will not limit aspen or spruce-fir harvesting from other cover types such as birch or northern hardwoods. However, the estimates omit potential volumes from additional investments in short-rotation intensive silviculture or potential volume increases resulting from investments in pre-commercial thinning. The estimates do consider allowable cut procedures used by public land management agencies.

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

Resource Opportunities and Challenges

Several different species of wood in Minnesota are currently underutilized based on the 1994 Minnesota's Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota (GEIS). The U.S. Forest Service's Forest Inventory and Analysis (FIA) data shows that Minnesota's forests grow nearly twice as much wood each year than 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 as forests. Forests act as climate mitigation tools on the landscape supporting renewable materials and closed carbon cycles. Closed carbon cycles decrease the amount of new carbon released in the atmosphere through fossil fuels extraction.

Certified Forests

There are a total of 7,852,878 acres of certified forest in the Minnesota. This includes nearly 5 million acres of DNR administered forest lands that are certified under SFI and FSC making MN DNR the largest single FSC-certified land manager in the United States. There are also over 2 million acres of county lands and over 600,000 acres of private forest lands certified under SFI, FSC, or the Programme for the Endorsement of Forest Certification Schemes (PEFC).

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, the vast majority 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 actually available for harvest. Localized wood basket analysis will help flesh out 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 occurs in the northern ½ of the state; with most of the spruce and balsam fir in the northeast ¼. Similar to hardwood species opportunities, the vast majority of potential for increased harvest in these softwood species exist on private lands.

Woody Biomass

Woody biomass is a large untapped resource in Minnesota. Woody biomass comes in different forms as manufacturing residues or in-woods chips. Manufacturing residues from sawmills continues to be available as a surplus. 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 decades. District and residential thermal heating remain a cost-effective option when compared to the historical volatile prices of fossil fuels. In-woods biomass consisting of tops, limbs, poorly formed, dead and diseased fiber remains underutilized.

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

- Reduced dependence on foreign energy sources
- 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
- Aesthetically pleasing treatment sites creating an 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 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 (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 Minnesota Department of Natural Resources 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

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

The pandemic impacted economic conditions across the world, including the forest products industry in Minnesota. The state's forest products sectors experienced varied impacts directly related to their product types, customers and end markets. The worst impacts were in the pulp and paper sector seen in the Verso mill closures in Wisconsin Rapids, Wis. and Duluth, Minn. The least impacts were in softwood lumber and engineered wood products primarily due to housing starts and renovation and remodel demand driven by consumers spending time at home. By 2021, the forest products industry was at full production. The demand for products was high in all segments 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.

Timberland managers, associations, private landowners, and public agencies need to work together to support existing and new wood manufacturers. Mill closures, layoffs, and downtime result in reduced forest management. Less forest management can negatively affect wildlife habitat, increase risk of forest fragmentation or development, increase risks to society (e.g. hazardous fuel loading, dead insect and disease infestation), and weaken economic benefits (e.g. rural jobs, rural tax base).

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 mill 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 forest land and converted forest land. Managed forests provide essential products society needs, ecosystem services such as air and water filtration, carbon sequestration, and carbon storage in harvested wood products.

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

New research and technology 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 2020[6]

The forest product industry provides:

- $9.7 billion direct value of shipments with $17.4 billion total output effect.
- $3.4 billion direct value added with $7.4 billion total value-added effect.
- 5th largest manufacturing sector in Minnesota by employment (#1 food products, #2 computers & electronics, #3 fabricated metal products, and #4 machinery).
- 30,045 direct jobs with 69,105 jobs total employment effect.
- $1.8 billion in direct labor income with $3.9 billion total labor income effect.
- $214 million direct state and local tax receipts with $494 million state and local tax receipts effect.

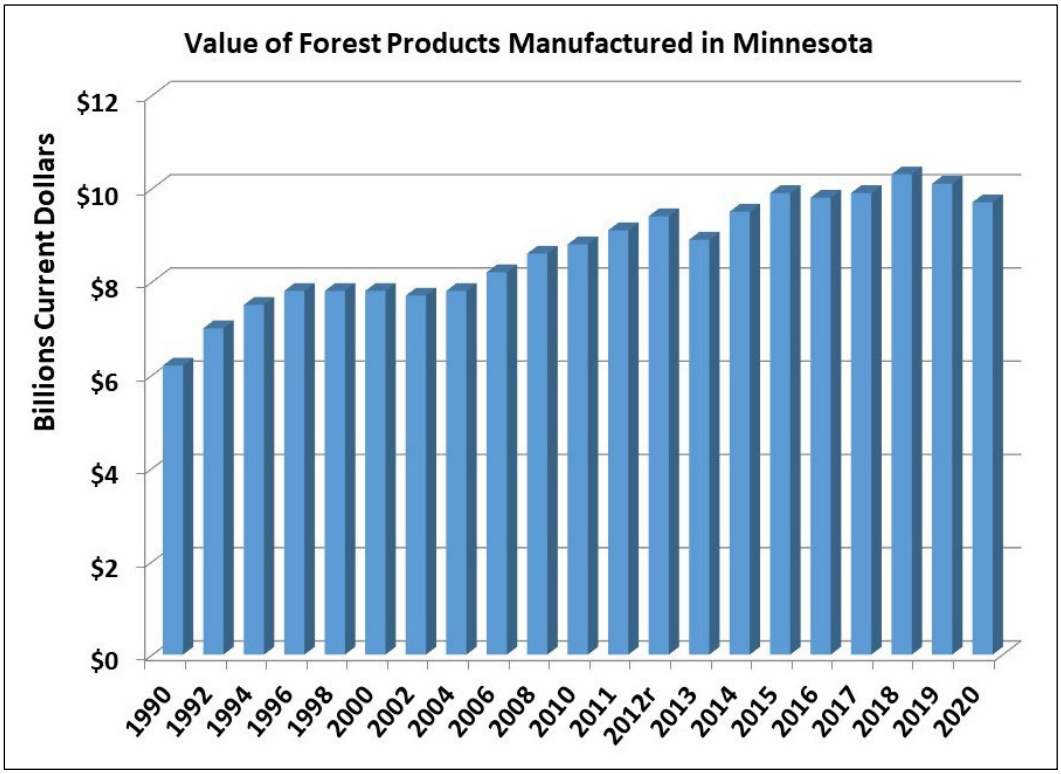


FIGURE 4-1: VALUE OF FOREST PRODUCTS MANUFACTURED IN MINNESOTA

Important Industrial Sectors

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

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

Non-Timber Industries Dependent on Minnesota's Forest Lands

Balsam boughs for the Christmas wreath industry with annual sales exceeding $20 million, decorative spruce tops, birch poles, 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 2019, Minnesota was ranked #14 nationally in forest products manufacturing with $536 direct value added (Gross State Product) per capita**.** In 2017, Minnesota ranked #12 nationally.

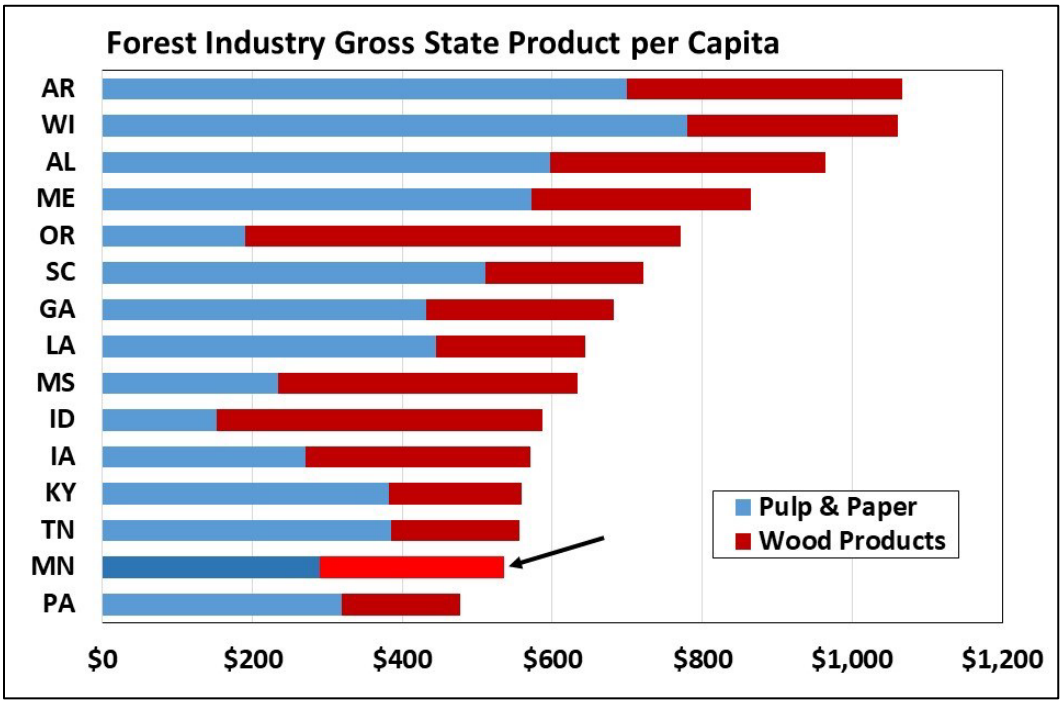


FIGURE 4-2: FOREST INDUSTRY GROSS STATE PRODUCT PER CAPITA

Manufacturing Facilities as of January 2020[7]

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

[7] Source: MNDEED, Quarterly Census of Employment and Wages (QCEW), retrieved February 2022.

Minnesota's Pulp, Paper, and Composite Wood Product Sector

The pulp, paper and composite sector is the dominant consumer of forest resources within Minnesota. These mills utilize various species of wood material, with aspen pulpwood being half the total volume consumed. In 2019 pulp, paper, and composite mills, consumed a ratio of 80 percent hardwood and 20 percent softwood.

Seventy percent of the roundwood consumed from Minnesota's forests supply this forest product sector. Many of these mills also consume residue chips from local sawmills.

TABLE 4-1: MINNESOTA PULP AND PAPER – 2020

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
Verso, Duluth (Idled in 2020 purchased by ST Paper 2023 and then Sofidel in 2024)	*Balsam Fir, Spruce (No longer producing virgin pulp.)*	*Uncoated, Lightweight Super Calendar Magazine and Publication Papers*
Sappi North America, Cloquet	Aspen, Maple, *Birch, *Ash, *Balm of Gilead	Coated Freesheet Fine Printing and Publication Paper, Market Pulp- Dissolving or Bleached Kraft
Recycling Mills		
Rock-Tenn Company, St. Paul	Recycled paper and corrugated	Cardboard and Corrugated Boxes
Verso Recycled Fiber Mill, Duluth (Idled 2020. Now, in 2024, owned by Sofidel)	*High grade office paper and computer paper*	*Market Pulp (Sofidel producing tissue.)*
Liberty Paper Company, Becker	Recycled paper and corrugated	Cardboard and Corrugated Boxes

TABLE 4-2: MINNESOTA ORIENTED STRAND BOARD AND ENGINEERED WOOD PRODUCTS - 2020

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

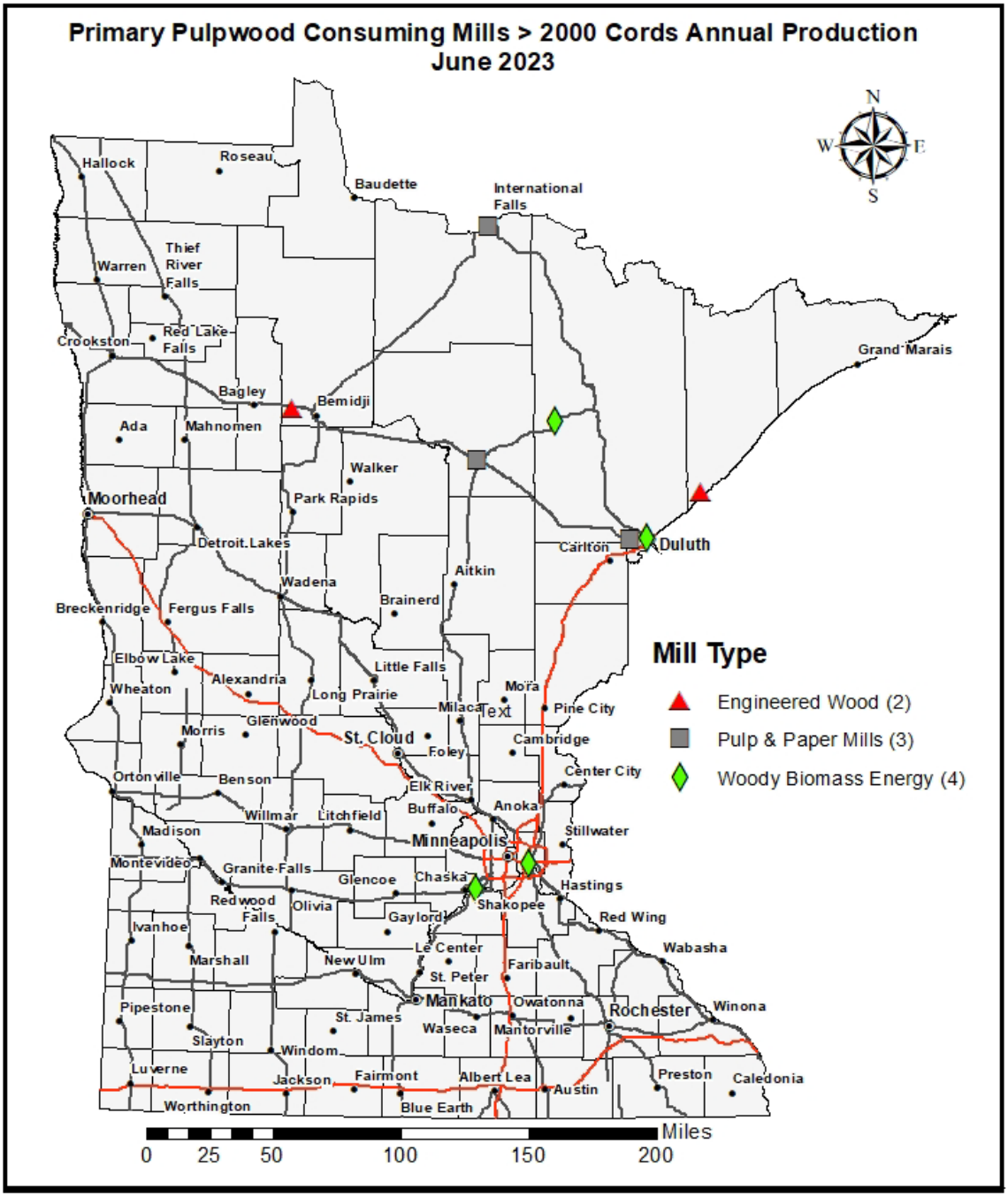


FIGURE 4-3: PRIMARY PULPWOOD-CONSUMING MILLS GREATER THAN 2,000 CORDS ANNUAL PRODUCTION, JUNE 2023

Minnesota's Sawmills and Specialty Mills Sector

Minnesota's sawmill and specialty mill sector is important to forest management, forest product utilization, and economic health of local communities. Mills are located throughout the state and produce wood products with local tree species. This sector creates market diversity and provides value-added markets for numerous species, sizes, and qualities of timber. Markets are important to landowners through harvest compensations, which help them engage in other management activities such as creating wildlife habitat and improving recreational opportunities and forest health. Sawmills and specialty mills provide products we all use and provide significant employment and economic benefits for many rural communities. Minnesota's sawmills and specialty mills use 21% of timber harvested annually in Minnesota, or approximately 582,000 cords.

Sawmills affect other wood industry sectors. For example, some sawmills send residue chips to paper mills, benefitting both sectors. Higher-value sawlog markets help make logging and mill residues available as woody biomass for energy. Sawmill byproducts or residues supply animal bedding and landscape mulch markets. Marketing byproducts or residues 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 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 even though the numbers of sawmills remained steady. Wood availability during this time, especially aspen, was challenged by a competitive marketplace. The market changed after several pulpwood consuming facilities closed.

Softwood sawlog manufacturing has been stable over the years and recently has seen an increase in red pine, balsam fir and spruce consumption. Hardwood sawlog manufacturing has increased in basswood, ash, white, and bur oak. Aspen, maple and spruce, which are preferred by pulpwood mills and utilized in the sawmill sector, tend to see the largest volume shifts between the pulpwood mill and sawmill sectors annually.

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

TABLE 4-3: EXAMPLES OF PRODUCTS PRODUCED BY MINNESOTA SAWMILLS AND SPECIALTY MILLS – 2020

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

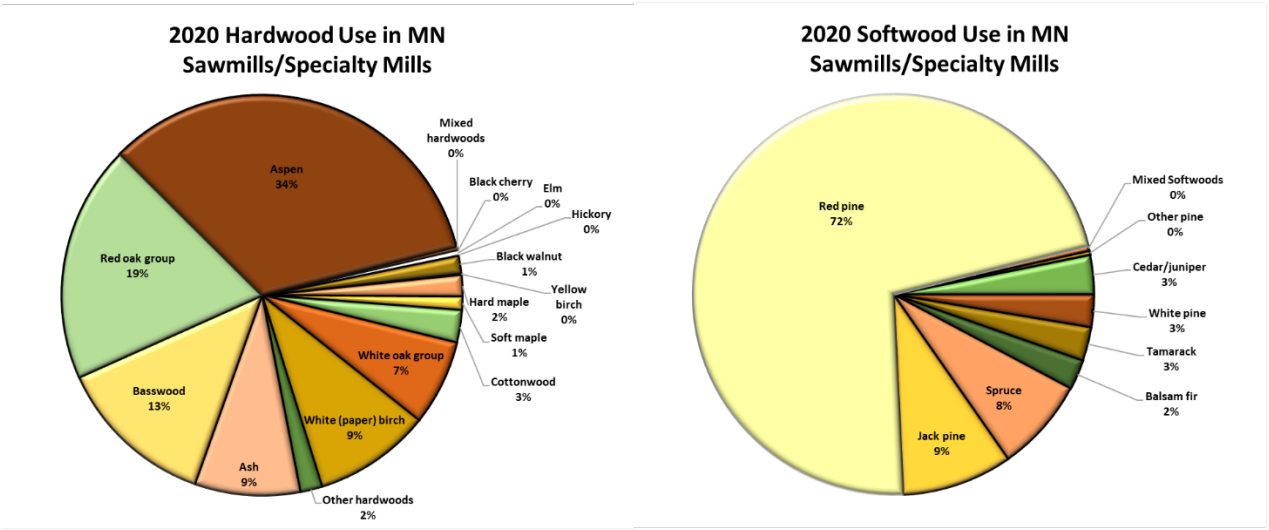


FIGURE 4-4: 2020 HARDWOOD AND SOFTWOOD USE IN SAWMILLS AND SPECIALTY MILLS

Figure 4-5 shows sawmills, post, pole and piling mills, shavings mills and specialty mills listed in the primary producer directory. These mills utilize various species of wood material, with a ratio of 61% softwood and 39% hardwood in 2020.

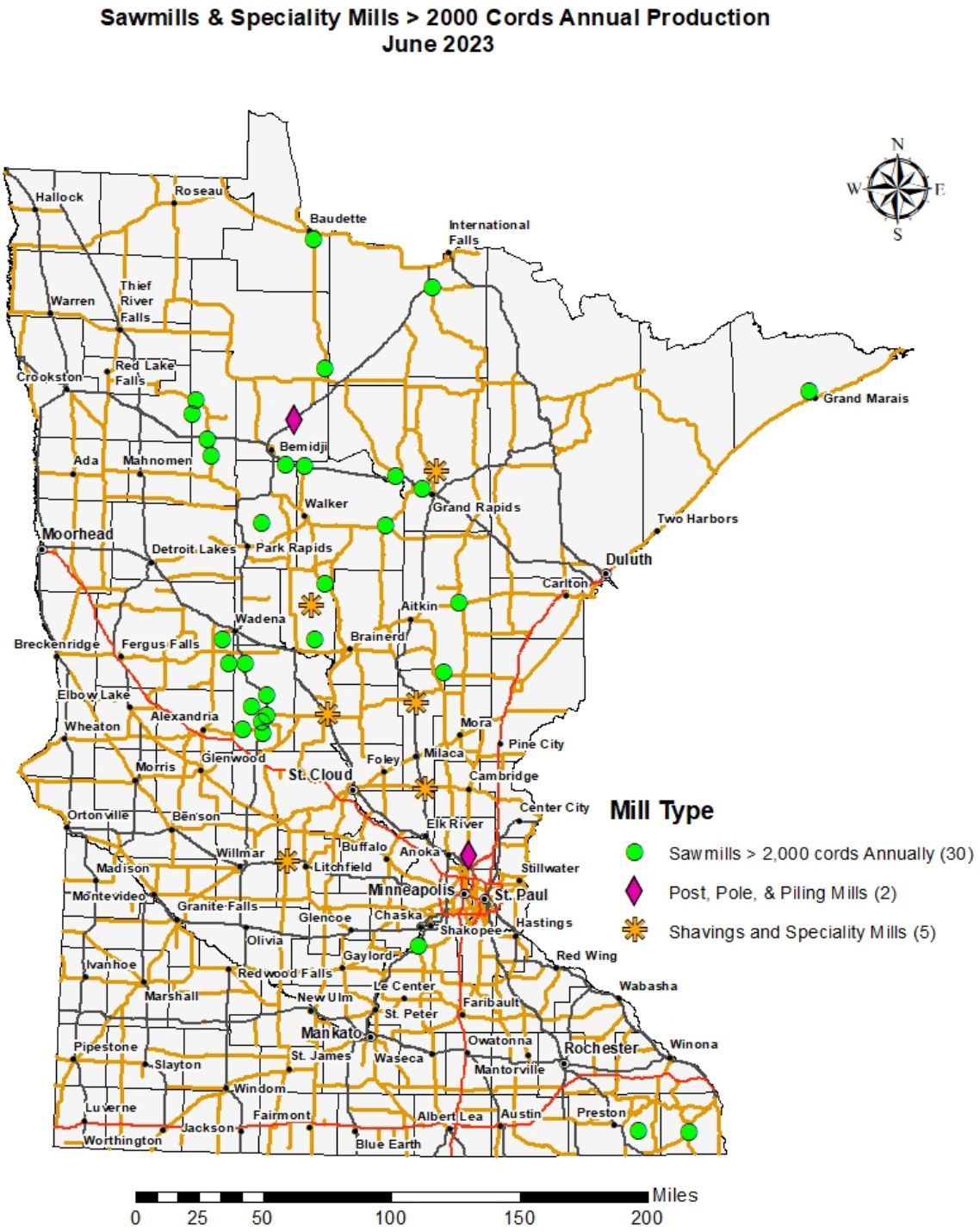


FIGURE 4-5: SAW AND SPECIALTY MILLS GREATER THAN 2,000 CORDS ANNUAL PRODUCTION, JUNE 2023

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 when approximately 2.7 million green tons were consumed. Biomass energy production fluctuated since then with a gradual trend downward until 2018.

Legislation in 2017 led to the closure of 3 biomass energy facilities which caused a significant reduction in logging residue consumption. From 2018 to 2020, total biomass utilization has remained flat.

There is substantial room for additional woody biomass consumption. The state is currently only utilizing approximately 30% of what is potentially available as logging residue and urban wood waste. There is also additional opportunity to utilize biomass from tree species and forests currently experiencing heavy mortality due to forest insect infestations in portions of the state (ash, tamarack, and balsam fir).

TABLE 4-4: COMMERCIAL BIOMASS ENERGY – 2020

Total estimated woody biomass consumption	1,380,000 green tons
Percent from mill residues	68%
Percent from urban tree and industrial wood waste	22% (approx. 131,700 cords)
Percent roundwood from timberlands	5% (approx. 28,800 cords)
Percent from logging residue (tops & limbs)	5%

Residential Fuelwood Sector

Since 1960, the Minnesota Pollution Control Agency (MPCA), with assistance from the Minnesota Department of Natural Resources (MDNR) and the U.S. Forest Service, periodically conducts a statewide survey to find out how much wood is harvested and burned annually for heat or pleasure in Minnesota. A variety of state, federal agencies and trade organizations use the survey data to track firewood consumption, inform policy makers and scientists, and assist the hearth and fireplace

industry by examining trends in wood burning. However, use caution when comparing across survey years to identify trends as survey questions and format have changed over the years. The 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 the state's timberlands from all ownerships. The residential fuelwood survey collected the total volume of wood burned from all fuel types and sources including roundwood, slab wood, wood pellets, wax logs, and pallets. The fuelwood survey also collected data on harvest sources from dead trees, cut trees and or tops and branches after a timber harvest, live or dead trees from pasture, croplands, and yards inside city limits or other non-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 4-5: 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 and the Christmas wreath industry typically exceeds $20 million in annual sales. Other 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 in 2020

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

Verso Announces Necessary Actions to Offset Unprecedented Market Decline Due to COVID 19

In June 2020, the Verso Corporation announced they would indefinitely idle paper mills in Duluth Minnesota, and Wisconsin Rapids, Wisconsin to reposition the company for future success.

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

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

Maverick Wood Products Makes New Investments

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

Nelson Wood Shims Expands

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

ST Paper invests in an Andritz-supplied tissue machine (TM) at Duluth

August 11, 2021 (tissueworldmagazine.com)—America's ST Paper has invested in an Andritz-supplied PrimeLineTM W 2000 high-speed tissue machine at its plant in Duluth, Minnesota. Start-up is planned for the end of 2022 and the machine has a design speed of 2,000m/min and a working width of 5.65m. It will produce a range of bath, napkin and towel grades. ST Paper acquired Verso Corporation's idled Duluth, Minnesota mill in May 2021 with the intention to converting the mill's production from specialty paper grades to tissue. The company has already converted two fine paper machines into tissue machines at its Franklin, Virginia facility.

Timberlyne acquires Cass Forest Products

April 28, 2022 (timberlyne.com release)—On April 27, Timberlyne acquired Cass Forest Products located in Cass Lake, Minnesota. The new name for the Cass Lake operations will be Timberlyne Wood Products. The process started in October 2021 when the CEO of Timberlyne asked if the mill was for sale. Six months later, the process is complete. There was a period of time in March that the sale looked questionable due to the stipulations noted in the purchase agreements. After the lawyers stepped aside, there was an agreement. Aitkin Hardwoods name will remain the same. Timberlyne Group now has six established locations: headquarters and production facility in Wayne, NE; office and production facility

in Boerne, TX; commercial sales office in Elkhorn, NE; mill operations in Kelliher, MN and Cass Lake, MN; and custom lumber and millwork facility in Aitkin, MN. Timberlyne has thousands of customers across the United States and beyond with custom wood barns, timber homes, and commercial structures. Together we design, manufacture, and ship pre-designed as well as custom designed timber frames as a package to help our customers experience the beauty, sustainability, and strength of wood.

Idled Minn. biomass power plant back in service

February 22, 2022 (businessnorth.com)—Hibbing Public Utilities is all fired up about burning wood. Every day, Shermer Logging of Gheen, Minn., delivers about 16 semi-trailers of wood chips to the municipally owned utility. The wood chips are fed into a wood-burning boiler system that had been idle at the utility for several years. Energy from the boiler produces steam and electricity to the utility's 4,500 customers. The 126-year-old steam and electrical generating facility on the north edge of downtown re-started the biomass boiler in December. Re-firing the wood-fired boiler is a major change in how the utility is doing business. The boiler system had been idle since the Laurentian Energy Authority (LEA), including a similar wood-burning facility in Virginia, was shuttered under a deal with Xcel Energy. The two Iron Range utilities had been burning wood chips since 2007 under a legislative agreement that allowed Xcel Energy to store more nuclear waste at its two nuclear facilities in Minnesota in exchange for buying more renewable power. However, when Xcel later said it was cheaper to burn natural gas than wood, the Laurentian Energy Authority facilities were shuttered under a buyout agreement with Xcel.

Wood pellets flowing from Caledonia, MN sawmill

May 11, 2022 (The Caledonia Argus)—Staggemeyer Stave Company is trying something completely different. The Houston County business has produced top-quality white oak staves for making whiskey and wine aging barrels for well over 50 years. And now, a new product from the mill may be coming to a cookout near you. White oak barbeque pellets and mixed hardwood fuel (heating) pellets are shipping from the mill. The barbeque pellets are 20-pound bags with 40 pound bags available in the future. The heating pellets are sold in 40-pound bags. Various distributors (including hardware stores) have expressed interest in the products. It is the only straight white oak barbeque pellet available in the marketplace. Most people use some oak or hickory for their barbeque pellet but, a lot of times it's 60 or 70 percent red oak. And red oak and white oak are completely different woods.

Viking new high-speed nailing machine working well at Savanna Pallets Inc., McGregor, Minnesota

July 1, 2022 (palletenterprise.com) One of the most trusted names and longest standing suppliers in the U.S. pallet sector, Viking Engineering & Development is on the move. A leading supplier of stringer-pallet nailing machines is moving into a new, larger facility to better service customers and meet equipment demand. Viking has launched a new online training service called Viking University. And its new high-speed nailing machine, the Voyager, has impressed Savanna Pallets in McGregor, Minnesota with its production and performance.

The first Voyager was installed at Savanna Pallets Inc. in July 2021. Chad Raushel, operations manager for Savanna Pallets Inc., recalled, "Viking had showed us the new machine they were developing. Given Viking's proximity to our plant and how many pallets we want to produce, they suggested the Voyager would be a good fit. We ran it for a week, and Viking sent its engineering team to evaluate and make some adjustments. That process continued for a while until we settled into a regular production routine.

Now, we are getting 2,200-2,400 pallets in a typical shift, depending on pallet type. We have even hit 2,900 in a shift, that's our record to this point."

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.

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.

Aspen and Balm of Gilead forest cover type

Aspen and Balm together are the predominant cover type in Minnesota's forests (5.08 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 oak.

FIGURE 1. VOLUME OF ASPEN COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2020

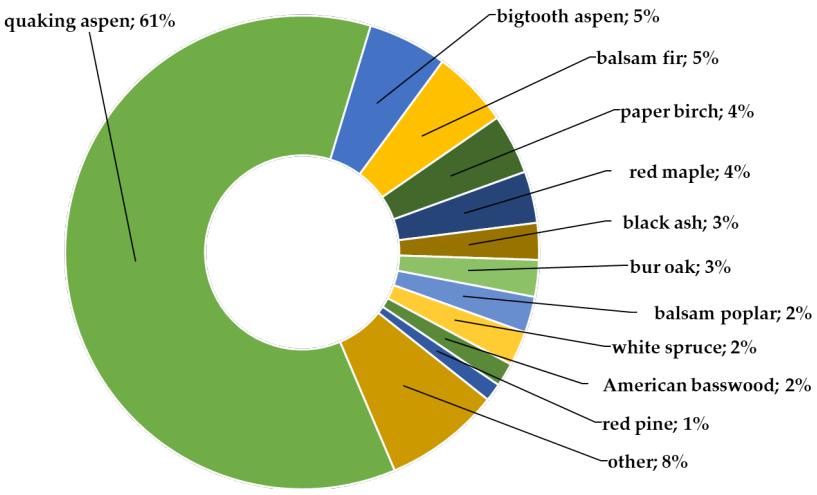
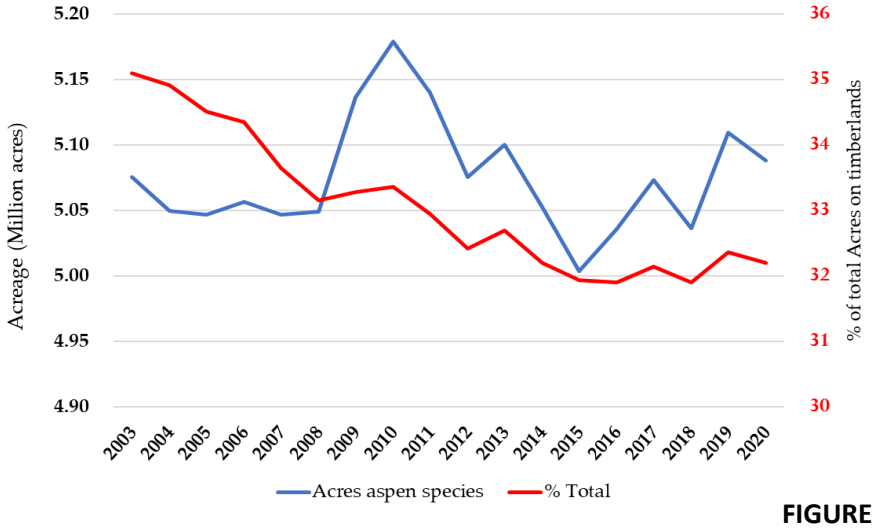


TABLE 1. % AREA OF ASPEN AND BALM COVER TYPE IN TIMBERLAND BY OWNERSHIP, FIA 2020

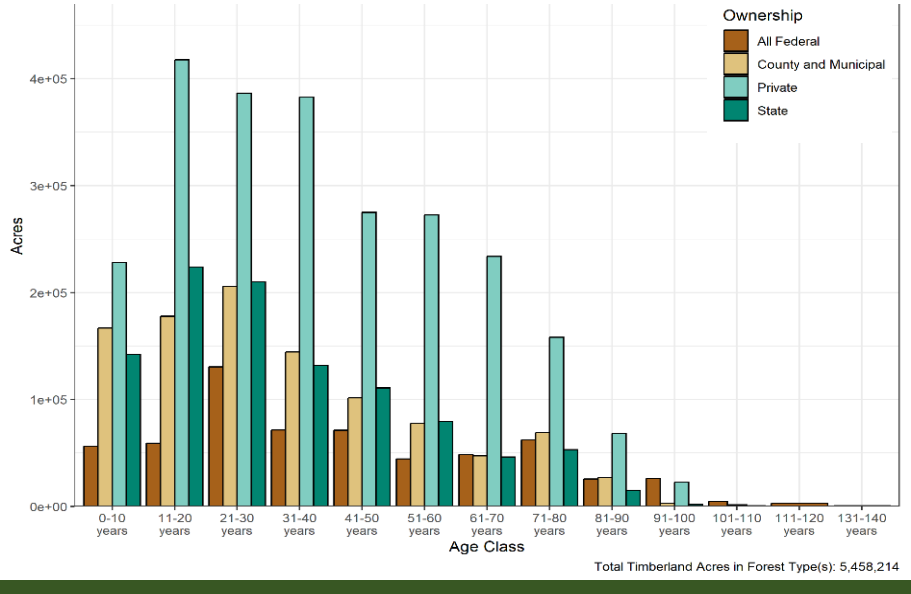
	Area
All Federal	12%
State	20%
County/Municipality	20%
Private	48%

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.

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP ASPEN AND BALM OF GILEAD, FIA 2020



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.

Aspen and Balm of Gilead species: presence

Aspen species (quaking and bigtooth aspen and balsam poplar) are the predominant tree species in Minnesota's forests (Figure 4). Based on FIA 2020 data, the current merchantable volume of aspen species represent 22.6% of the total merchantable volume in Minnesota.

FIGURE 4. VOLUME OF ASPEN AND BALM OF GILEAD SPECIES (2003-2020), FIA

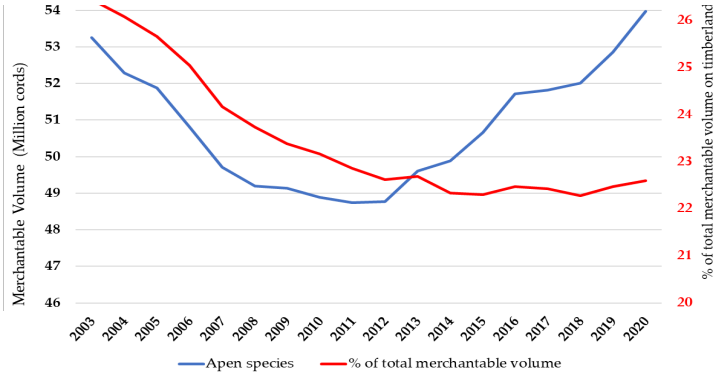


FIGURE 5. VOLUME OF ASPEN AND BALM OF GILEAD SPECIES BY DIAMETER CLASS (2003-2020), FIA

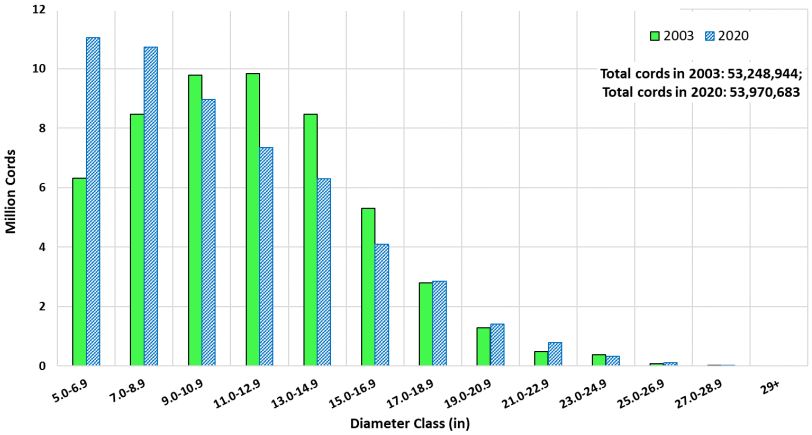


TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF ASPEN AND BALM OF GILEAD BY OWNERSHIP, FIA 2020

	Volume
All Federal	15%
State	17%
County/Municipality	19%
Private	49%

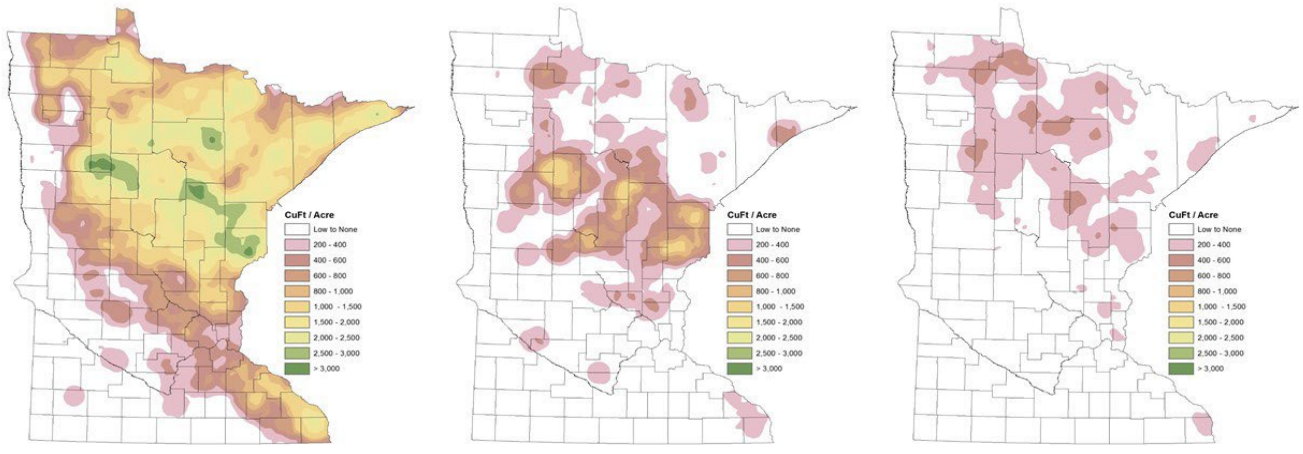
Almost 50% of their volume can be found in private lands (Table 2). Their presence is a significant component in many other upland cover types. 21% of the volume of aspen species is found in cover types other than aspen (Table 3).

TABLE 3. % OF PRESENCE ASPEN AND BALM OF GILEAD TREE SPECIES BY FOREST COVER TYPES, FIA 2020

	Aspen	Balsam poplar	Birch	Lowland hardwoods	Northern Hardwoods	Oak	Other*	Red pine
% of total Volume of aspen species	74	5	3	2	5	5	4	2

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

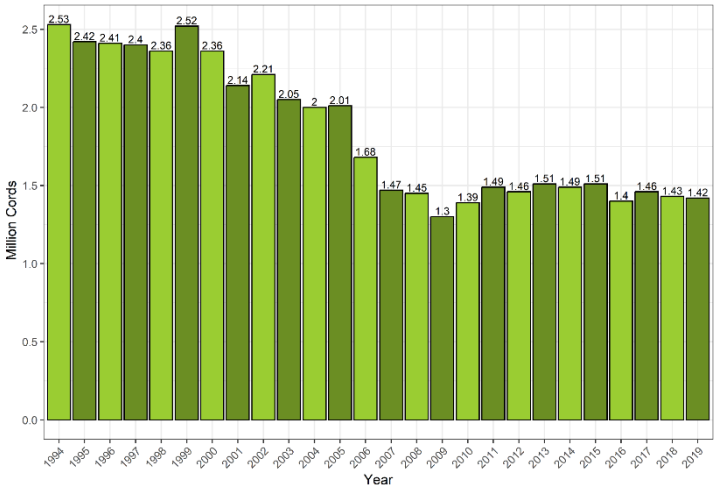
FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF QUAKING ASPEN, BIGTOOTH ASPEN AND BALSAM POPLAR RESPECTIVELY, FIA 2017



Aspen and Balm of Gilead species: growth and harvest

Aspen species are relatively short-lived, fast growing tree species that requires 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 (1994-2019), TPO



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). Figure 9 shows the volume harvested of aspen species is predominantly pulpwood.

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

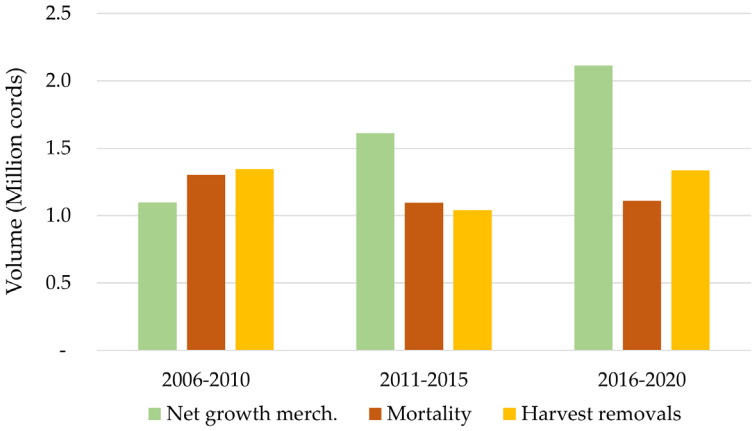


Figure 8 shows the average annual net growth (gross growth minus mortality), mortality (non-harvest related mortality), and harvest removals of merchantable volume on timberlands. The net growth to harvest removals ratio has increased in the last 5 years. In 2016-2020, federal and private timberland have the highest average net growth to harvest ratio compared to state and county timberlands (Figure 10). See Appendix A for further explanation of these figures.

FIGURE 9. ASPEN HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO 2019

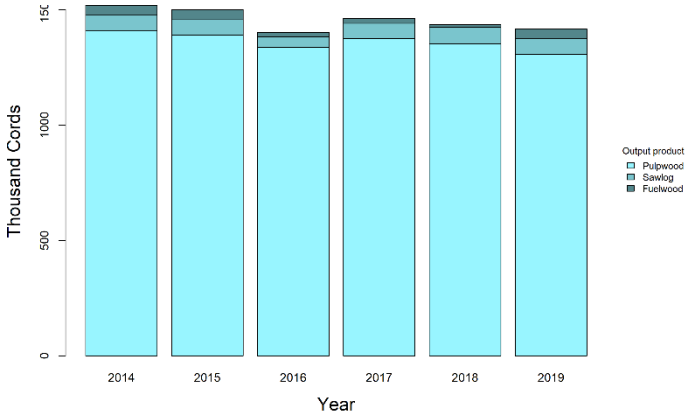
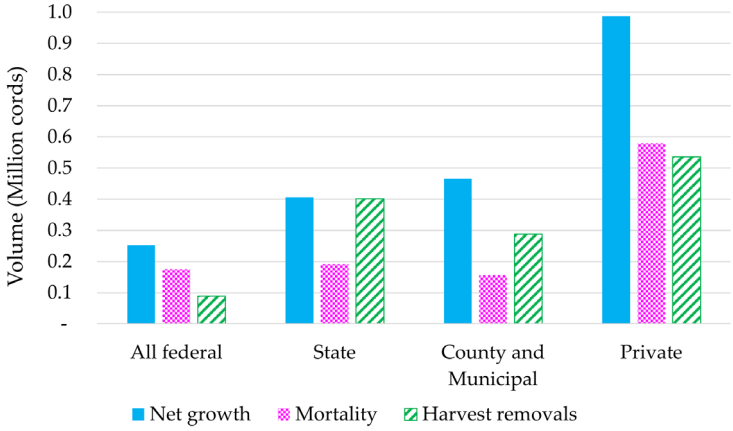


FIGURE 10. AVERAGE ANNUAL NET GROWTH, MORTALITY, AND HARVEST REMOVALS BY OWNERSHIP IN 2016-2020, FIA



Opportunities:

- Large acreage of 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 (24% and 18% respectively). Predominant secondary species include red maple, bur oak, quaking aspen, and northern red oak (Figure 1). Based on FIA 2020 data, the area of timberland of the northern hardwoods cover type is 1.5 million acres (Figure 2).

TABLE 1. % AREA NORTHERN HARDWOODS COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2020

	Area
All Federal	10%
State	13%
County/Municipality	15%
Private	62%

FIGURE 1. VOLUME OF NORTHERN HARDWOODS COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2020

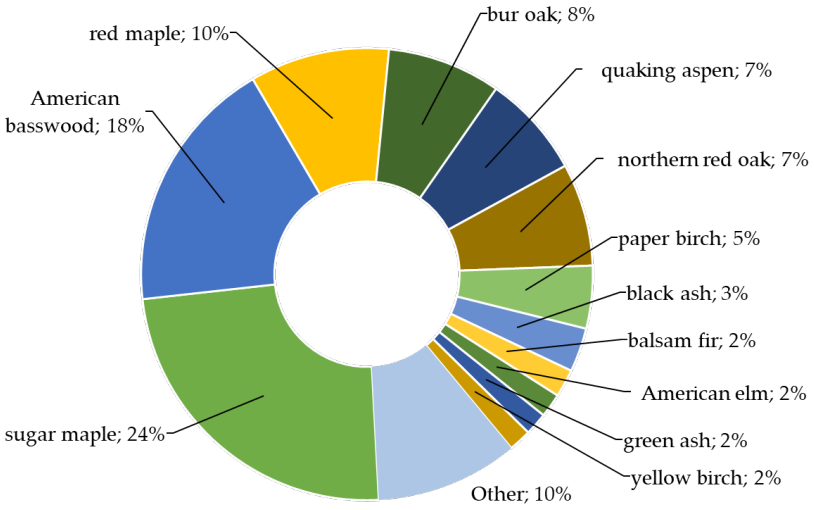
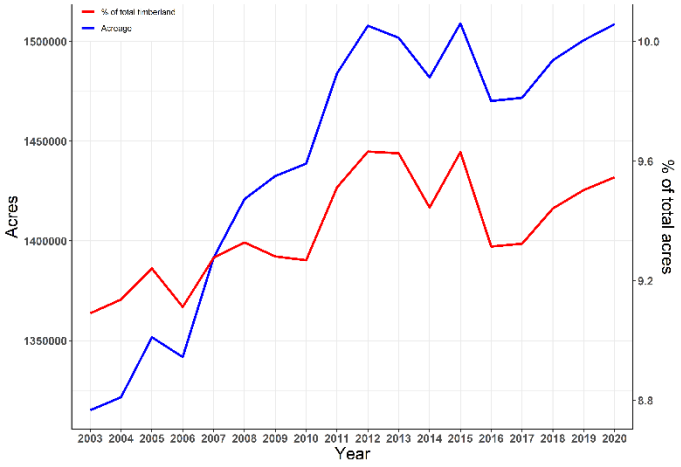


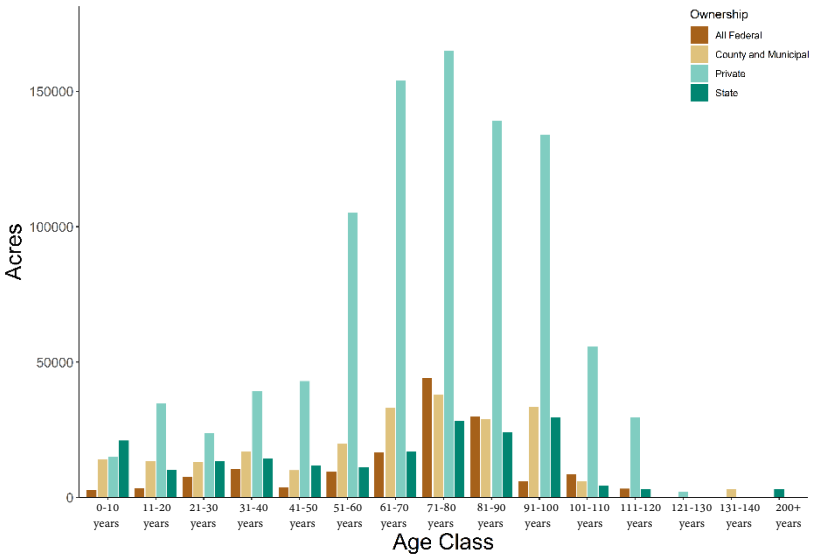
FIGURE 2. ACRES OF NORTHERN HARDWOODS COVER TYPE ON TIMBERLAND, FIA



Over sixty percent of the area of northern hardwoods timberland is on private land, with a lower presence on state and federal land (Table 1). The estimated acres of timberland have increased in the past 15 years, reaching in 2020 similar acreage than in 2012 and 2015 (Figure 2).

The northern hardwood cover type has a unimodal age-class distribution with a higher presence of late middle-aged stands (61-100 years old). For reference, the average even-aged rotation age for this cover type is 80 years. The majority of the acres of northern hardwood cover type is on private land, and its distribution is centered between 50 and 110 years old (Figure 3).

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP NORTHERN HARDWOODS, FIA 2020



Maple and basswood species: presence

Based on FIA 2020 data, the estimated merchantable volume of sugar and red maple and basswood species represents around 11% of all the estimated merchantable volume in Minnesota (Figure 4), around 26 Million cords in 2020. The estimated volume of these species are dominated by smaller diameter trees (Figure 5).

FIGURE 4. VOLUME MAPLE AND BASSWOOD SPECIES (2003-2020), FIA

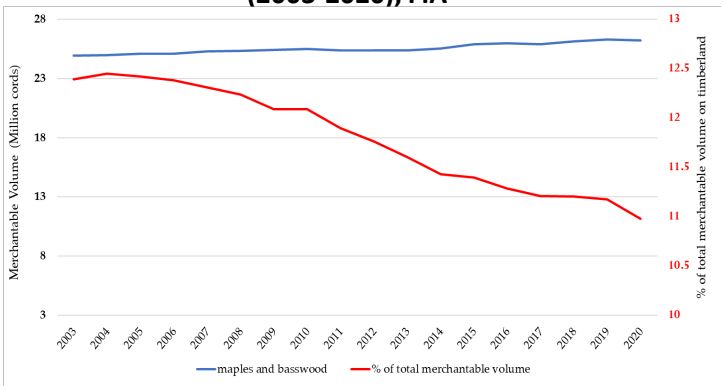


FIGURE 5. VOLUME OF RED AND SUGAR MAPLE AND AMERICAN BASSWOOD SPECIES BY DIAMETER CLASS (2003-2020), FIA

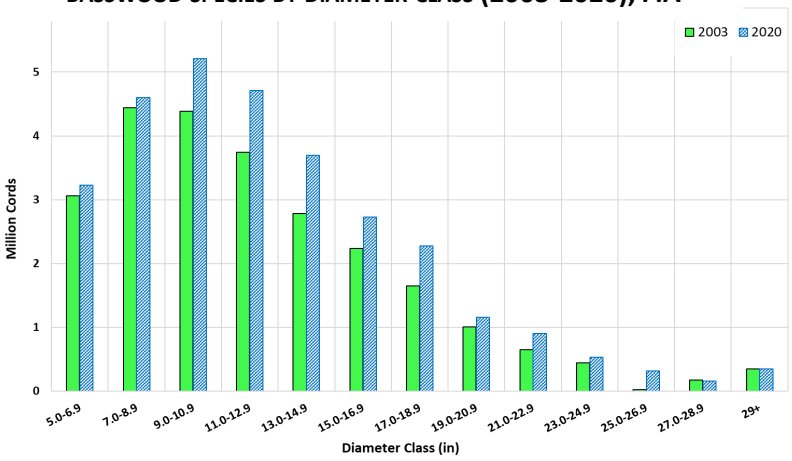


TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF RED AND SUGAR MAPLE/AMERICAN BASSWOOD BY OWNERSHIP, FIA 2020

	Volume
All Federal	13/7%
State	13/10%
County/Municipality	17/11%
Private	57/72%

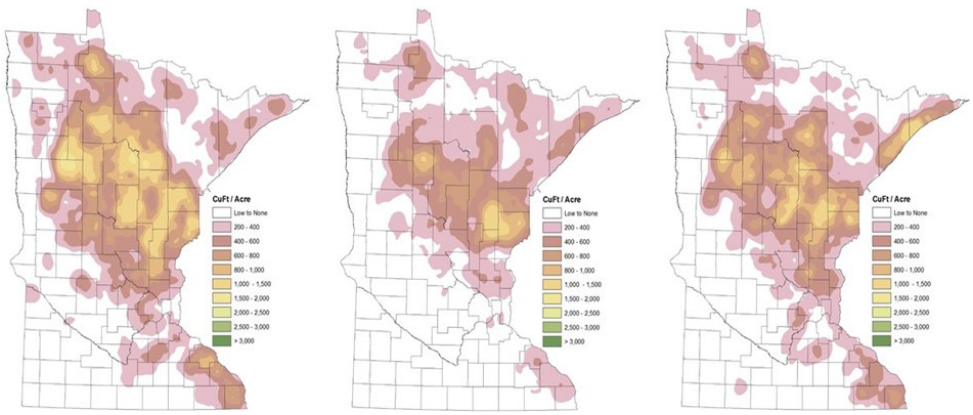
TABLE 3. % OF VOLUME OF SUGAR AND RED MAPLE AND AMERICAN BASSWOOD TREE SPECIES ON DIFFERENT FOREST COVER TYPES, FIA 2020

	Northern Hardwoods	Oak	Aspen	Birch	Lowland hardwoods	Other*
% of total Volume of sugar/red maple species	84/39%	6/15%	6/25%	1/7%	-/6%	3/8%
% of total Volume of American basswood species	45%	39%	7%	-	5%	4%

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

The majority of their volume can be found in private and county lands (Table 2). Their presence is a significant component in many other cover types, mostly in northern hardwoods. Over 50% of the American basswood species is found is found in alternative cover types, such as oak, aspen, and lowland hardwoods (Table 3).

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF AMERICAN BASSWOOD, RED MAPLE, AND SUGAR MAPLE RESPECTIVELY, FIA 2017



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 and sizes, markets for some hardwoods have changed in recent years as pulp and paper mills have increased the use of maple and other hardwoods. In the case of maple species, the total volume harvested has remained constant during the last five years (Figure 7).

FIGURE 7. VOLUME OF MAPLE SPECIES HARVESTED FROM TIMBERLAND (1998-2019), TPO

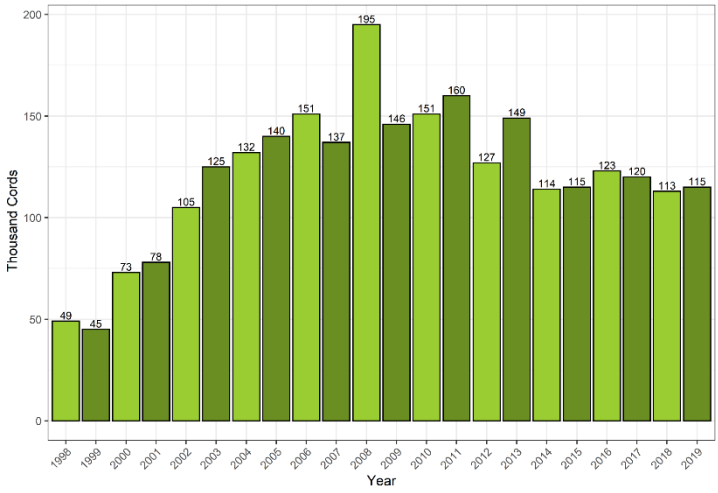


Figure 9 shows the volume harvested of maple species by output product, pulpwood being the main product. Some is also used by the sawmill industry, but a higher proportion is used as fuelwood.

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

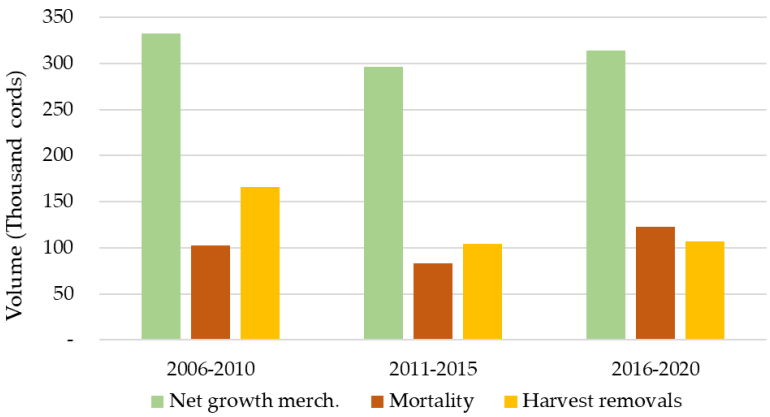


Figure 8 shows the average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of merchantable volume on timberlands of maple species. Based on FIA, the estimated mortality has increased in the last 5 years while the harvest removals has substantially decreased since 2006-2010. In 2016-2020, private timberland presents the highest annual average values of net growth, mortality and harvest removals. See Appendix A for further explanation of these figures.

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

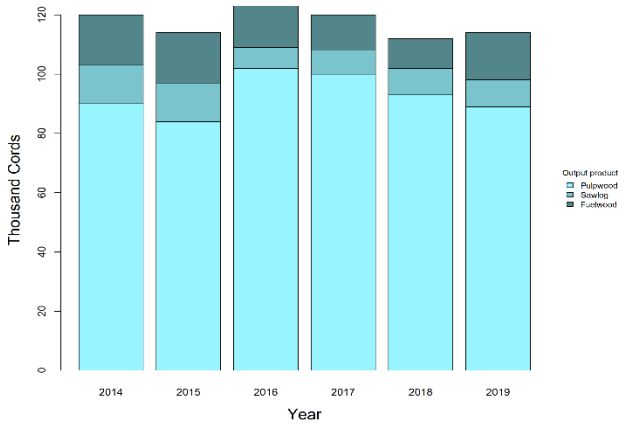
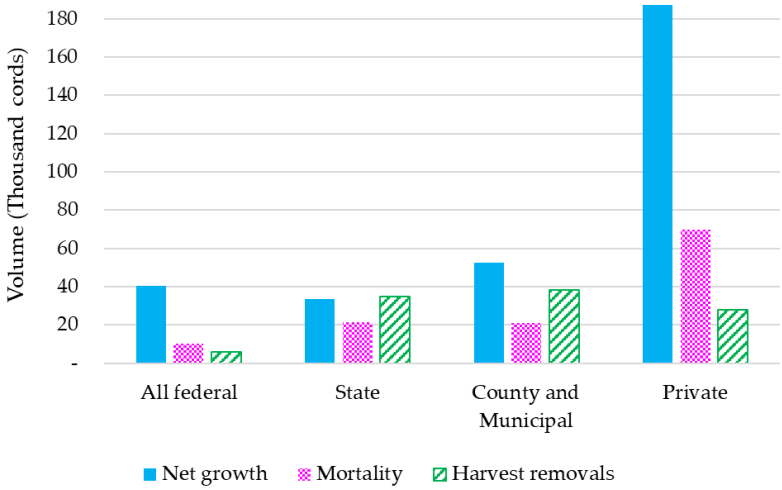


FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF MAPLE SPECIES BY OWNERSHIP, 2016-2020, FIA



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 volume of basswood species harvested in 2019 has drastically increased (Figure 11), with an increase in both pulpwood and fuelwood products (Figure 13).

FIGURE 11. VOLUME OF BASSWOOD SPECIES HARVESTED FROM TIMBERLAND (1994-2019), TPO

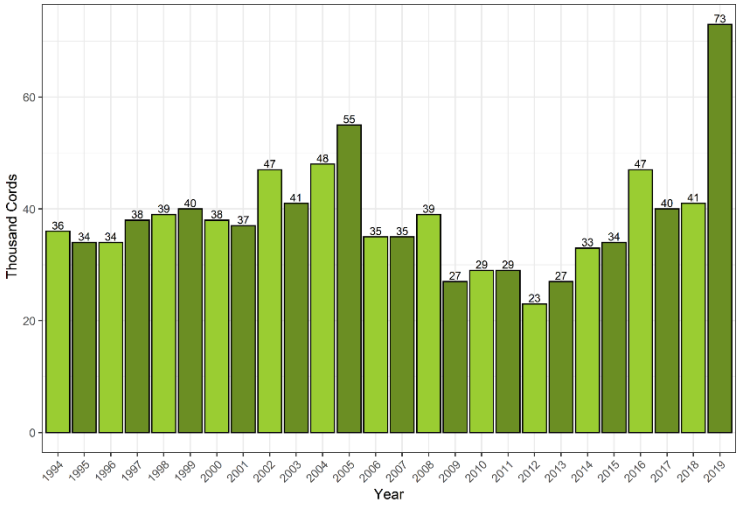


FIGURE 12. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BASSWOOD SPECIES, FIA

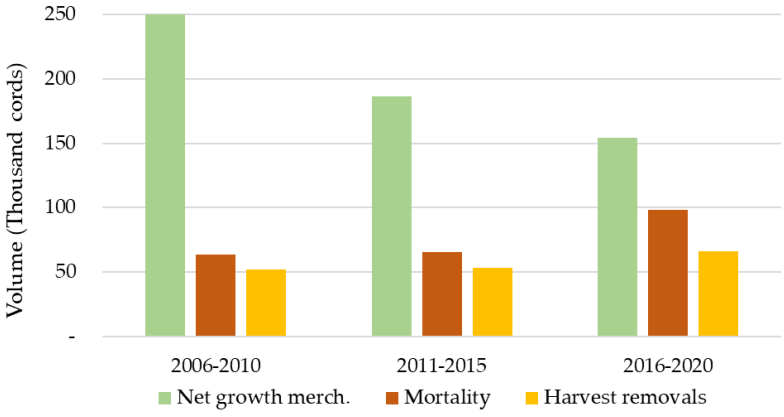
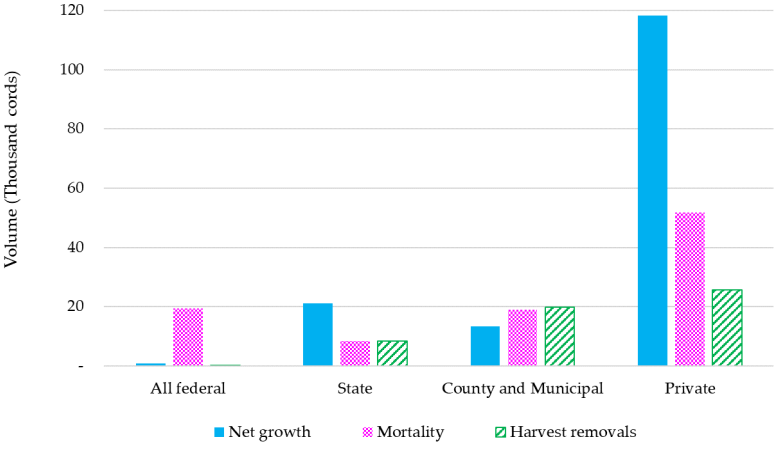


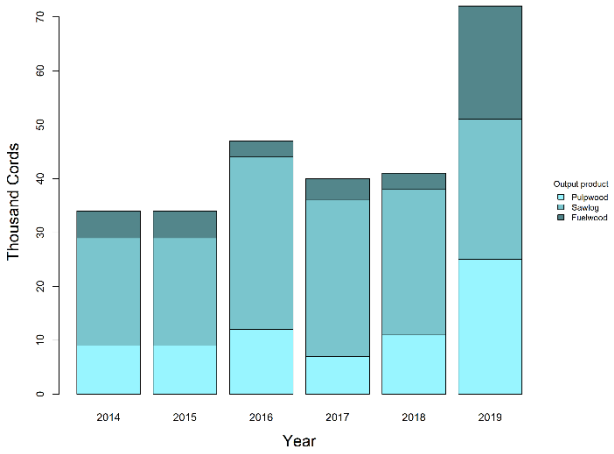
Figure 12 shows the average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of merchantable volume on timberlands. Based on FIA, the estimated annual average mortality has increased in the last 5 years while the net growth has experienced a decrease. In 2016-2020, 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.

FIGURE 14. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BASSWOOD SPECIES BY OWNERSHIP, 2016-2020, FIA



Basswood is capable of producing a large percentage of high-quality saw log and veneer material on good sites in Minnesota. Figure 13 shows the volume harvested of basswood species by output product, showing an even split across output products in 2019.

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



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 0.73 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 2020

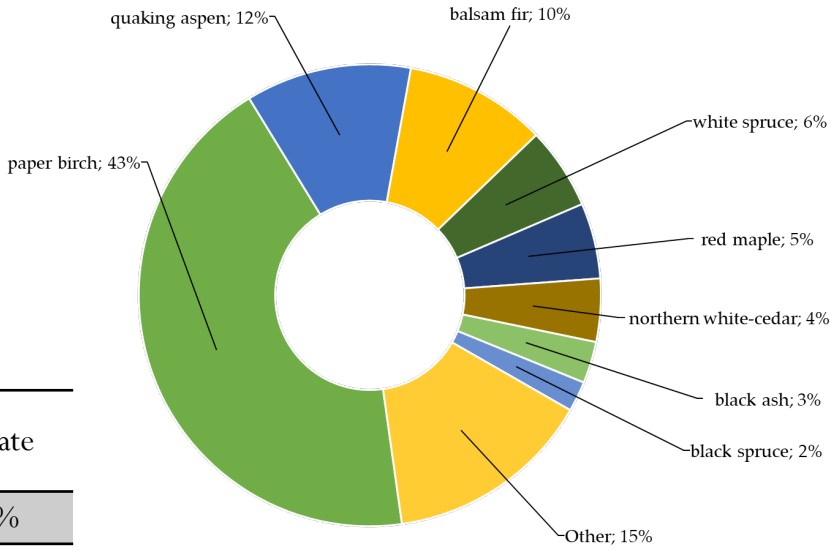
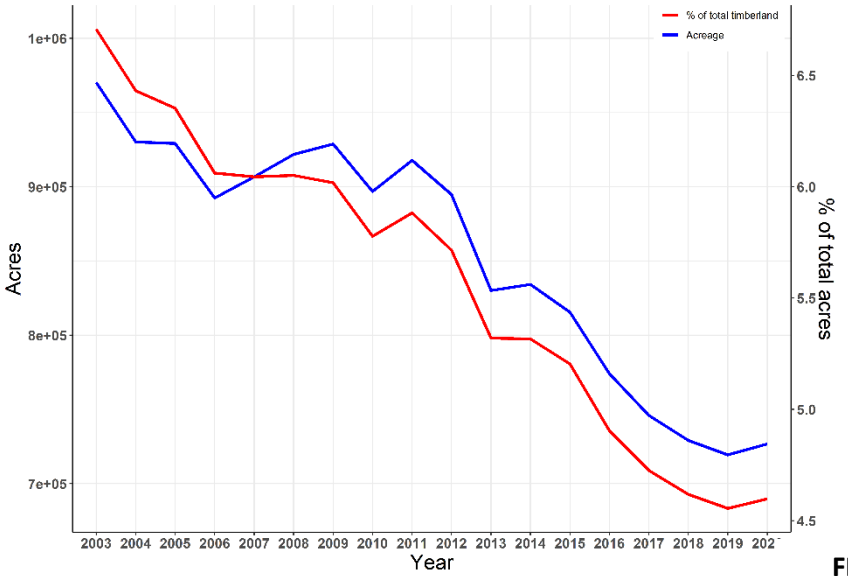


TABLE 1. % AREA OF BIRCH COVER TYPE IN TIMBERLAND BY OWNERSHIP, FIA 2020

	All Federal	State	County/ Municipality	Private
Area	27%	16%	15%	42%

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

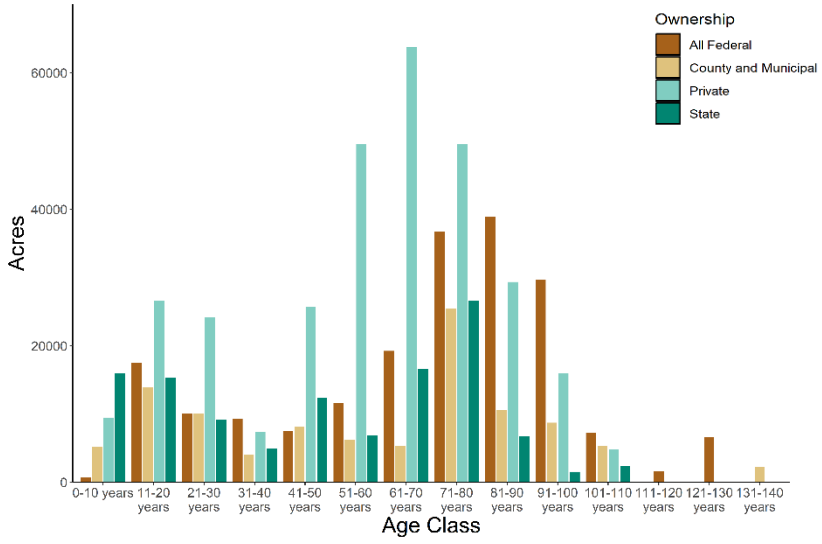


Acres of birch cover type have decreased since 2003 (Figure 2) because of serious mortality trends of paper birch species associated with age, insects, and stress caused by increased number and severity of weather fluctuations.

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 2020 follows a bimodal distribution across all the ownerships (Figure 3), with a higher cluster skewed to the older ages.

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP BIRCH COVER TYPE, FIA 2020



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 2020 data, the current merchantable volume of paper birch tree species represent less than 5% of the total merchantable volume in Minnesota (Figure 4).

FIGURE 4. MERCHANTABLE VOLUME OF PAPER BIRCH SPECIES (2003-2020), FIA

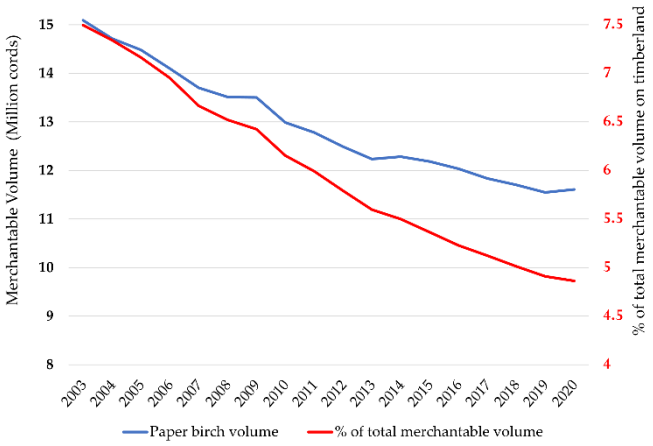


FIGURE 5. VOLUME OF PAPER BIRCH SPECIES BY DIAMETER CLASS (2003-2020), FIA

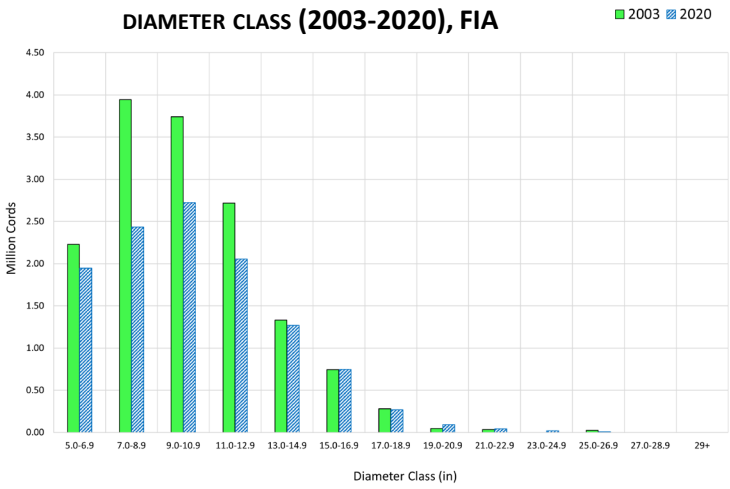


TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF PAPER BIRCH BY OWNERSHIP, FIA 2020

	Volume
All Federal	26%
State	14%
County/Municipality	16%
Private	44%

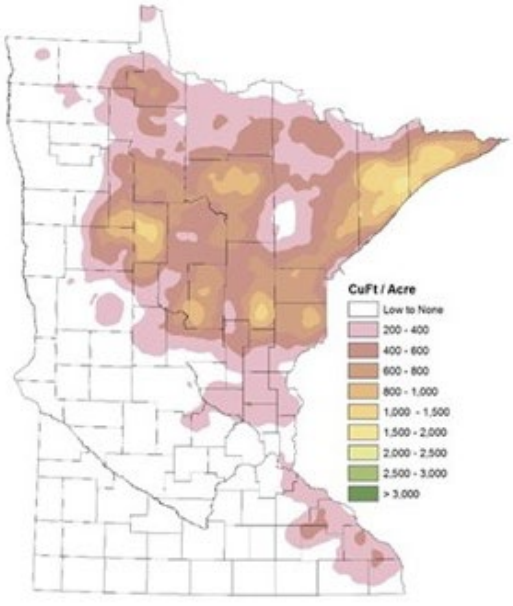
The current merchantable volume of paper birch has decreased since 2003 (Figure 4). Almost half of the volume of paper birch species can be found on private lands (Table 2).
Only 37% of the total paper birch volume in the state is found in the birch cover type while 63% of the total birch volume is found in other cover types (Table 3).

TABLE 3. % OF PRESENCE PAPER BIRCH SPECIES BY FOREST COVER TYPES, FIA 2020

	% of total Volume of paper birch
Birch	37%
Aspen	20%
Northern Hardwoods	12%
Northern white cedar	5%
Red pine	5%
Oak	5%
Other	16%

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

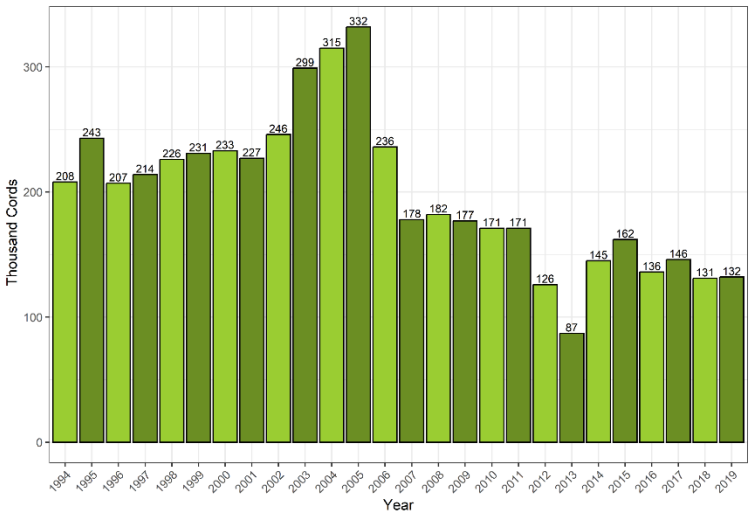
FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF PAPER BIRCH *(BETULA PAPYRIFERA)*, FIA 2017



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 also decreased in the past 5 years compared to the 2006-2010 FIA cycle, but mortality remains high (Figure 8). Average annual net growth has increased during the last 5 years compared to 2006-2010.

FIGURE 7. TOTAL VOLUME OF PAPER BIRCH HARVESTED FROM TIMBERLAND (1994-2020), TPO



The volume harvested of paper birch species 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 8. AVERAGE ANNUAL NET GROWTH, MORTALITY, AND HARVEST REMOVALS, FIA

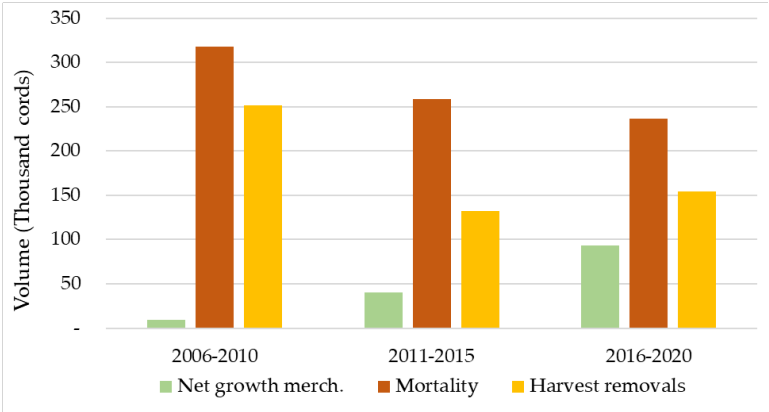


Figure 8 shows the average annual net growth (gross growth minus mortality), mortality (non-harvest related mortality), and harvest removals of merchantable volume on timberlands. In 2016-2020, private timberlands have suffered the highest average annual mortality of paper birch. County and municipal lands have had the highest average annual harvest (Figure 10). See Appendix A for further explanation of these figures.

FIGURE 9. PAPER BIRCH HARVEST BY OUTPUT PRODUCT (ALL OWNERSHIPS), TPO 2020

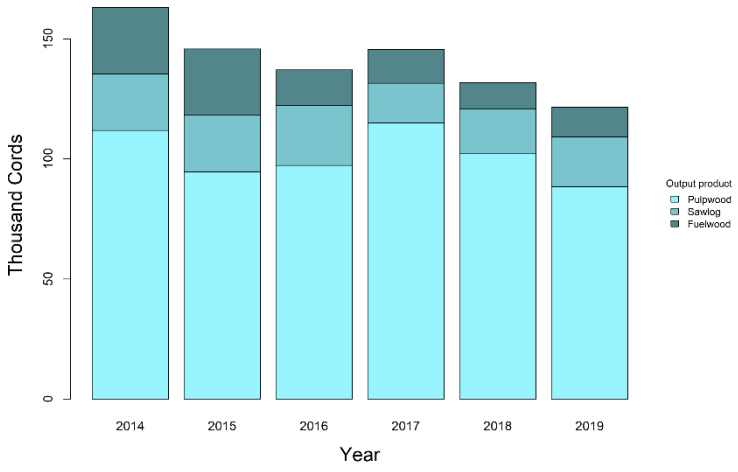
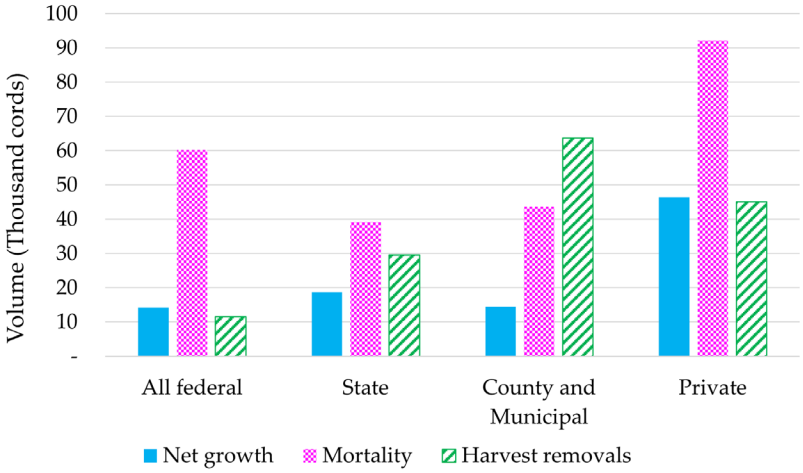


FIGURE 10. AVERAGE ANNUAL NET GROWTH, MORTALITY, AND HARVEST REMOVALS BY OWNERSHIP IN 2016-2020, FIA



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 and species in much of Minnesota. Oaks provide acorns and dens for many wildlife species. The oak cover type consists of a wide mixture of species, being bur and northern red oak 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 2020

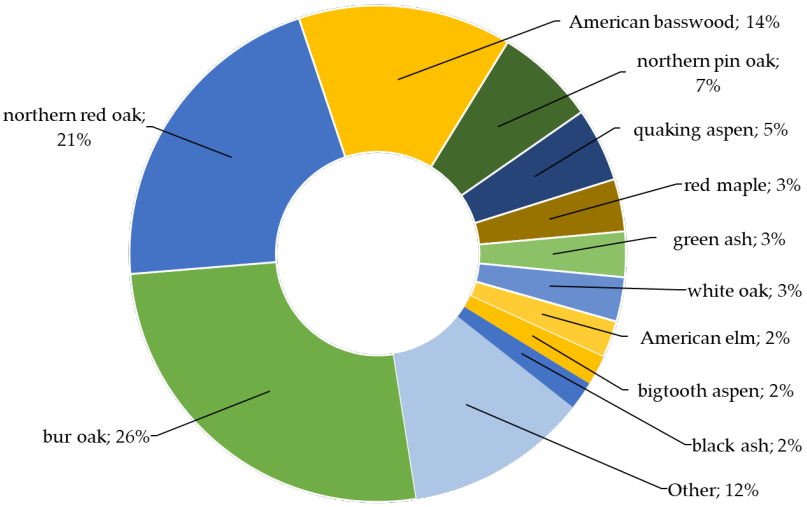
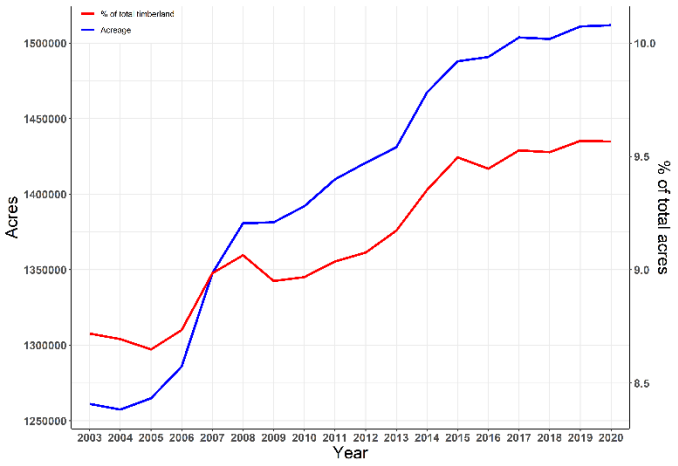


TABLE 1. % AREA OF OAK COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2020

	Area
All Federal	2%
State	11%
County/Municipality	7%
Private	80%

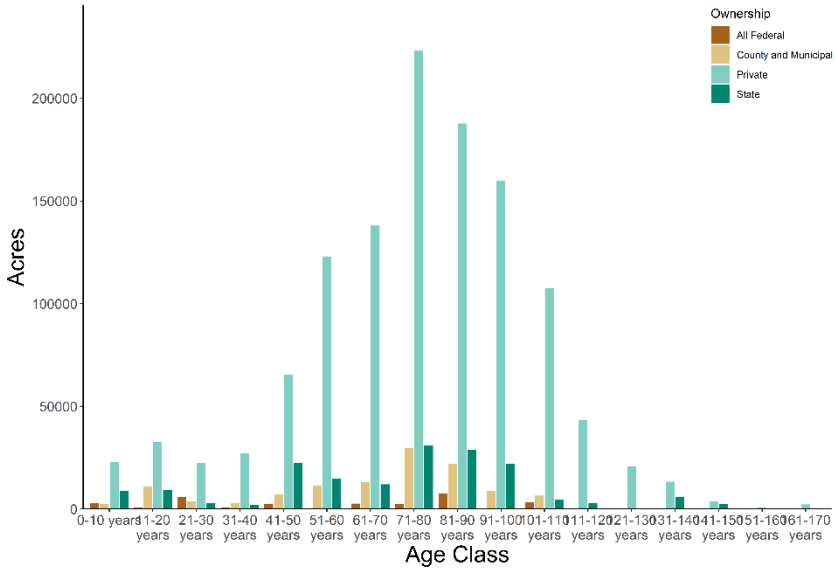
FIGURE 2. ACRES OF OAK COVER TYPE ON TIMBERLAND, FIA



Based on FIA data, the estimated area of timberland of the oak cover type has increasing since 2003, with a current acreage of 1.51 million (Figure 2). 80% of that area is in private hands, 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. Estimated area of timberland in private lands also presents an increased acreage of 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 2020



Bur and Northern red oak species: presence

Based on FIA data, the estimated merchantable volume of bur and northern red oak species has increased since 2003, representing over 10.7% of the total merchantable volume in Minnesota in 2020 (Figure 4). The majority of the volume of oak species is considered to be in smaller diameter class (<12.9 inches), Figure 5.

FIGURE 4. MERCHANTABLE VOLUME OF OAK SPECIES (2003-2020). FIA

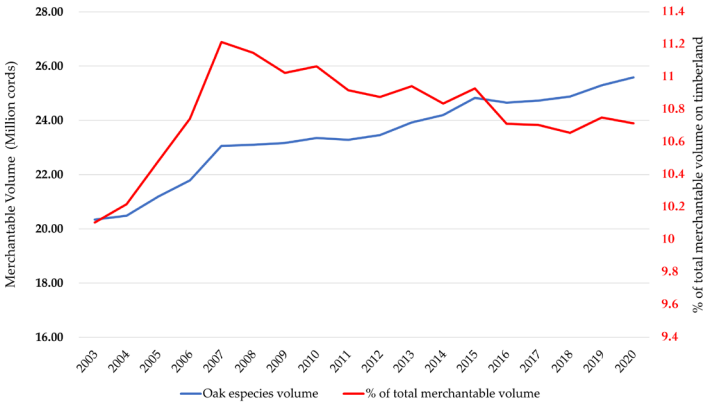


FIGURE 5. VOLUME OF BUT AND N. RED OAK SPECIES BY DIAMETER CLASS (2003-2020), FIA

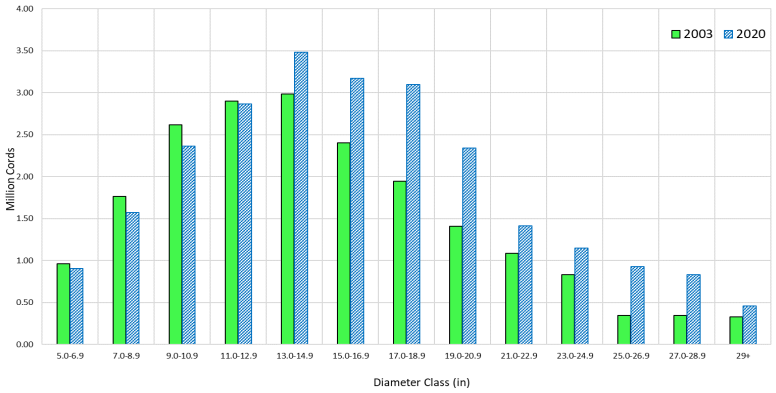


TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF BUR/N. RED OAK BY OWNERSHIP, FIA 2020

	Volume
All Federal	2/3%
State	9/15%
County/Municipality	7/11%
Private	82/71%

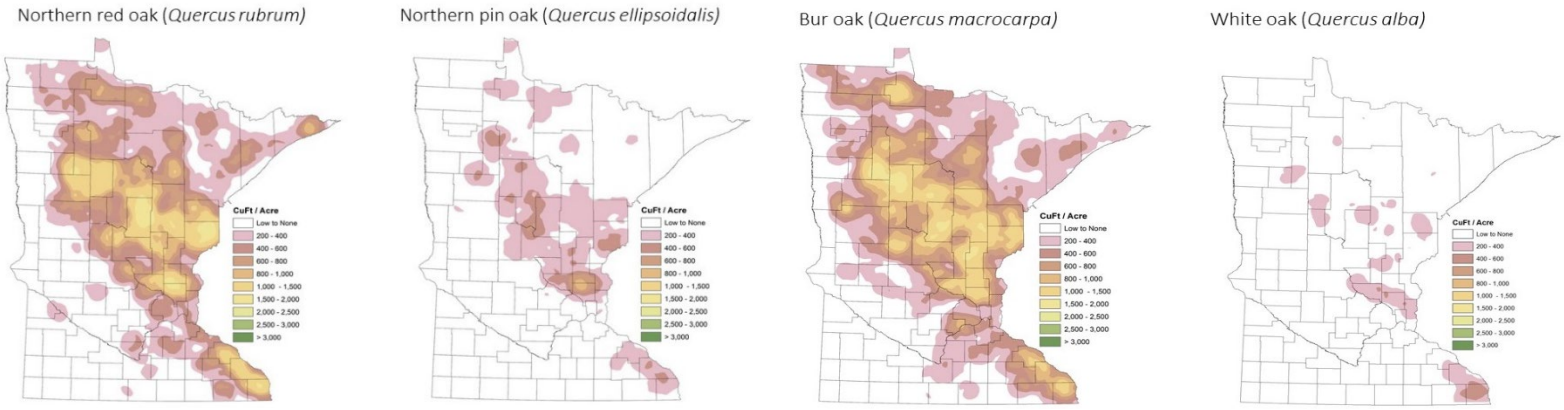
TABLE 3. % OF PRESENCE BUR AND NORTHERN RED OAK TREE SPECIES BY FOREST COVER TYPES, FIA 2020

	Oak	Northern hardwoods	Aspen	Lowland Hardwoods	Eastern white pine	Other*
% of total volume of bur oak	64	17	10	4	-	5
% of total volume of N. red oak	70	22	6	-	1	1

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

Over 80% (70%) of the bur (N. red) oak volume can be found in private lands (Table 2). The bur N. red oak presence is a significant component in many other cover types. More than 35% (30%) of the volume of bur (N. red) oak species 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. It is the largest hardwood species by volume produced by many sawmills, especially those in the southern two-thirds of the state, but the volume harvested of oak species has not changed in the last ten years (Figure 7).

FIGURE 7. VOLUME OF OAK SPECIES HARVESTED FROM TIMBERLAND (1995-2019), TPO

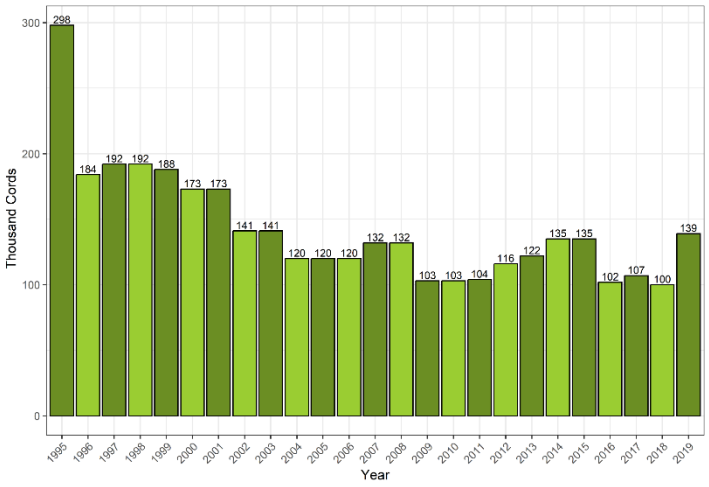


Figure 9 shows the estimated volume harvested of oak species by output product. Oak is primarily used as sawlogs and fuelwood. The lower amounts of oak fuelwood consumed in 2016-2018 likely just reflects the variability of the residential fuelwood survey data and not an actual decline in fuelwood use those years.

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

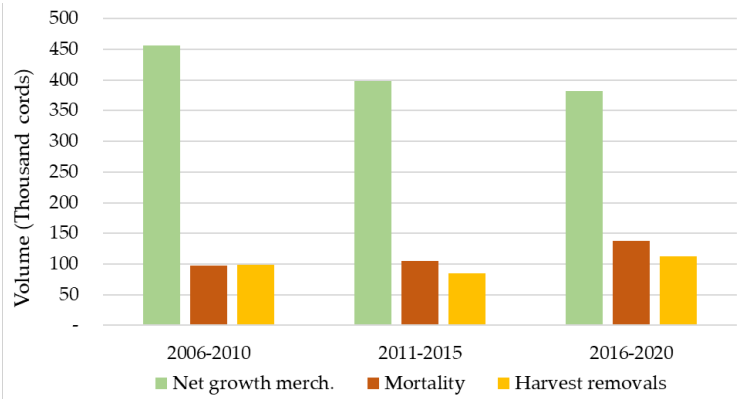


Figure 8 shows the average annual net growth (gross growth minus mortality), harvest removals, and mortality (non-harvest related mortality) of merchantable volume on timberlands. The estimated average annual net growth has decreased in the last 10 years, and the estimated mortality and estimated harvest removals has increased in the last decade. In 2016-2020, 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

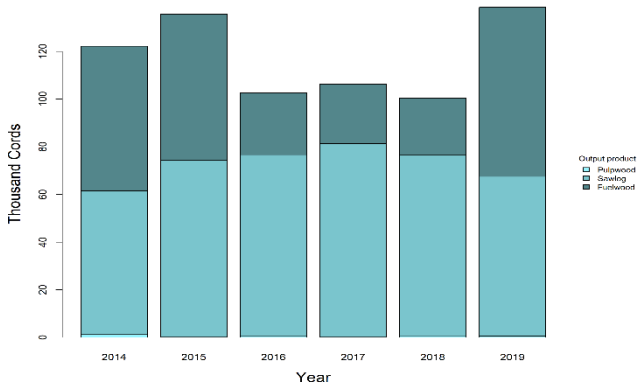
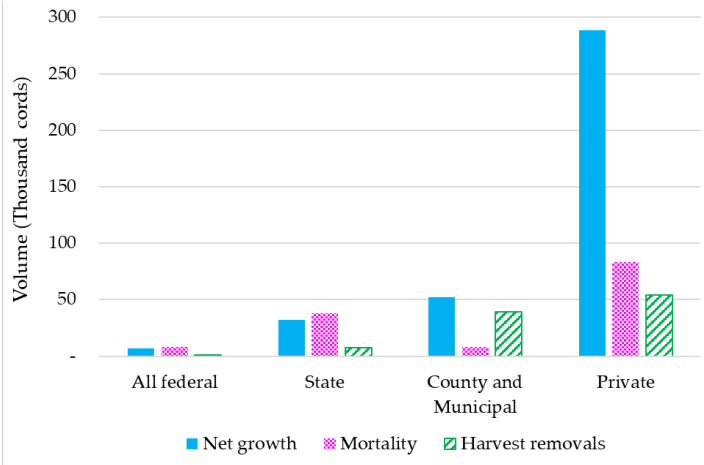


FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BUR AND N. RED OAK SPECIES BY OWNERSHIP, 2016-2020, FIA



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

FIGURE 1. VOLUME OF LOWLAND HARDWOODS COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2020

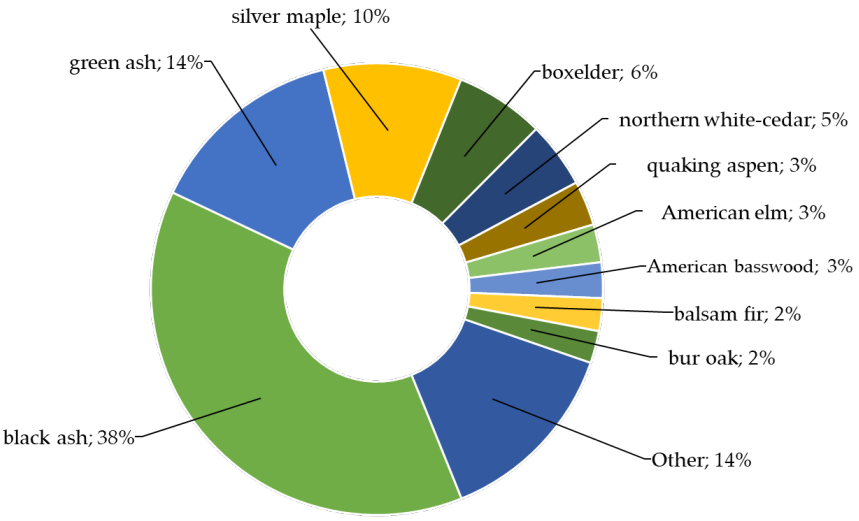
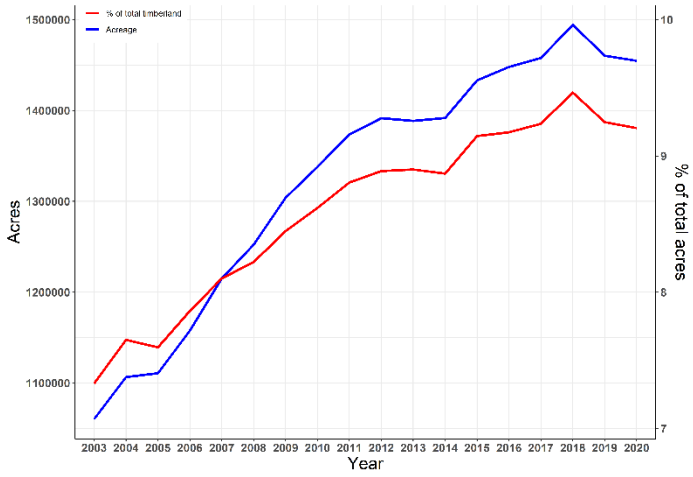


TABLE 1. % AREA OF LOWLAND HARDWOODS COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2020

	Area
All Federal	5%
State	15%
County/Municipality	15%
Private	65%

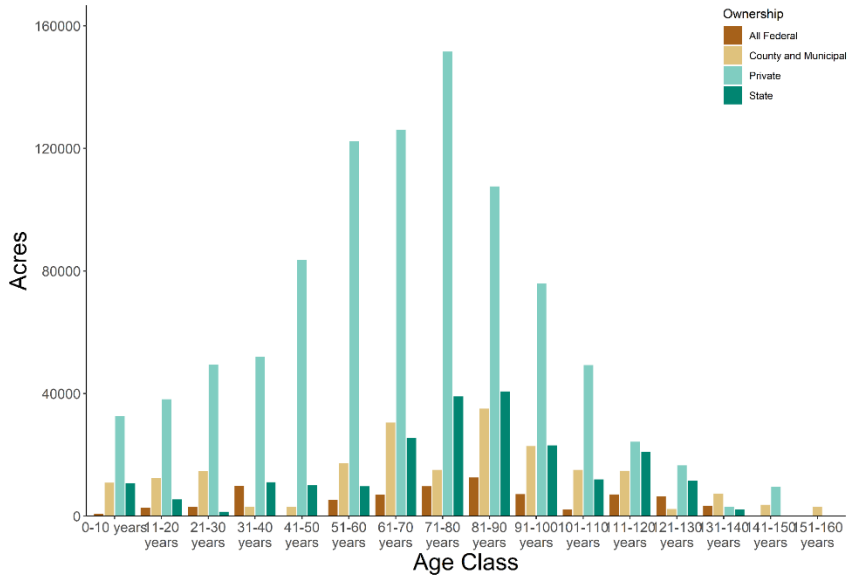
FIGURE 2. ACRES OF LOWLAND HARDWOODS COVER TYPE ON TIMBERLAND, FIA



Based on FIA data, the estimated area of timberland of the lowland hardwoods cover type has increasing since 2003, with a current acreage of 1.45 million (Figure 2). 65% of that area is in private hands, 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). A common rotation age for black ash is 90 years. Estimated area of timberland in private lands also presents an increase 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 2020



Black and green ash species: presence

Based on FIA data, the estimated merchantable volume of black and green species has increased since 2003, representing over 8.5% of the total merchantable volume in Minnesota in 2020 (Figure 4). The majority of the volume of black and green ash species is considered to be in smaller diameter class (<12.9 inches), Figure 5.

FIGURE 4. MERCHANTABLE VOLUME OF BLACK AND GREEN ASH SPECIES (2003-2020), FIA

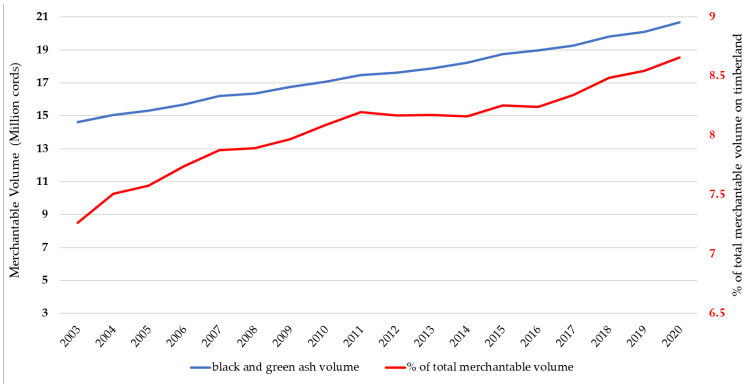


FIGURE 5. VOLUME OF BLACK AND GREEN ASH SPECIES BY DIAMETER CLASS (2003-2020), FIA

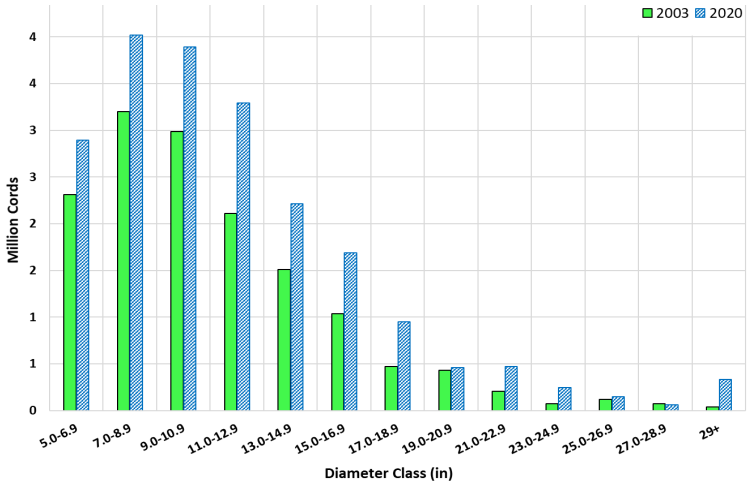


TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF BLACK/GREEN ASH BY OWNERSHIP, FIA 2020

	Volume
All Federal	8/1%
State	20/7%
County/Municipality	18/9%
Private	54/83%

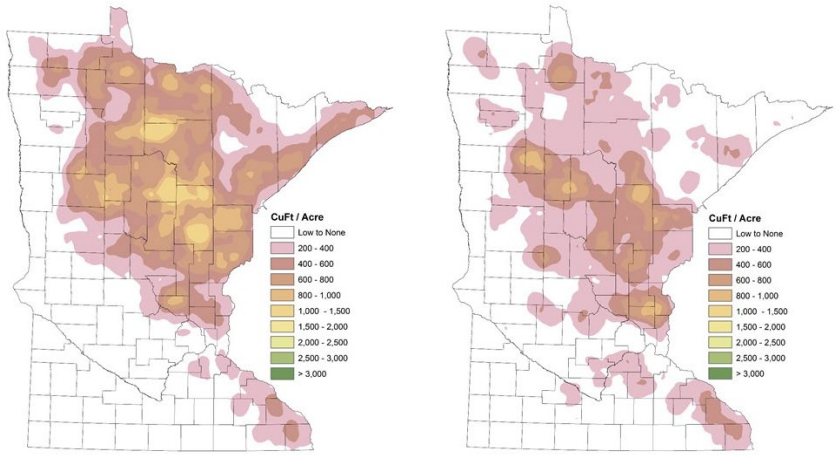
TABLE 3. % OF PRESENCE BLACK AND GREEN ASH TREE SPECIES BY FOREST COVER TYPES, FIA 2020

	Lowland hardwoods	Aspen	Northern hardwoods	Oak	Birch	Other*
% of total volume of black ash	68	11	7	5	2	7
% of total volume of green ash	47	7	7	14	<1	24

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

Over 50% (80%) of the black (green) ash volume can be found in private lands (Table2). The black and green ash presence is a significant component in many other cover types. More than 30% (50%) of the volume of black (ash) species 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 volume harvested 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. The DNR is currently offering additional ash volume on state lands over the next few years to manage forest health concerns.

FIGURE 7. VOLUME OF BLACK AND GREEN ASH SPECIES HARVESTED FROM TIMBERLAND (1997-2019), TPO

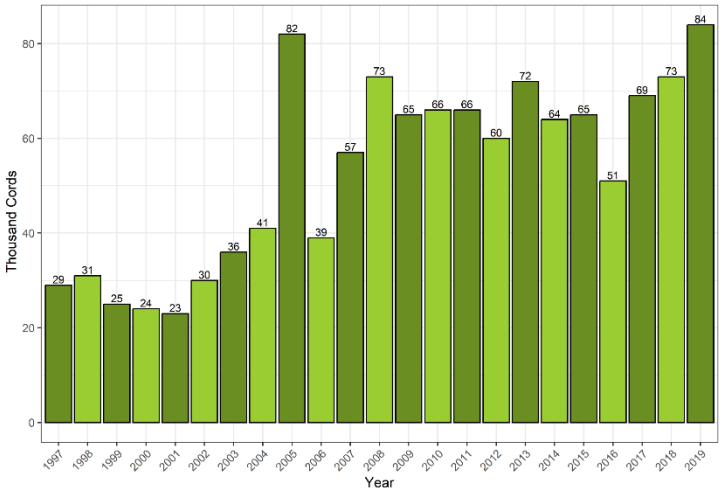


Figure 9 shows the estimated volume harvested of black and green ash species by output product. Based on FIA 2019, the ash pulpwood has decreased but the sawlog and firewood harvest has increased, increasing estimates of volume harvested to 84 thousand cords.

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

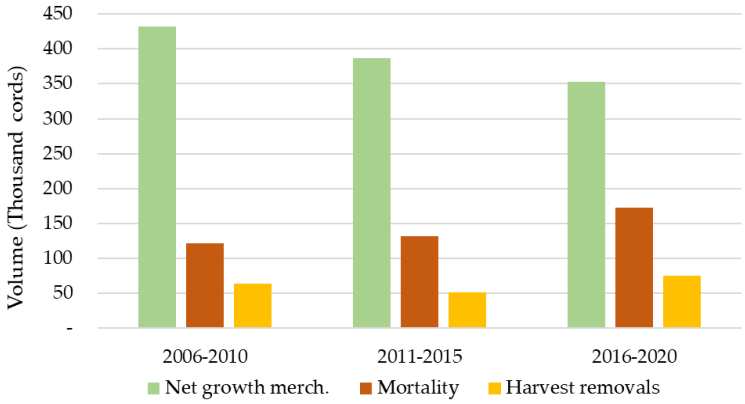


Figure 8 shows the average annual net growth (gross growth minus mortality), harvest removals, and mortality (non-harvest related mortality) of merchantable volume on timberlands. The estimated average annual net growth has decrease in the last 10 years, and the estimated mortality and estimated harvest removals has increased in the last decade. In 2016-2020, private timberlands have the highest average annual net growth, mortality and harvest removal compared to state, county and federal timberlands (Figure 10).

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

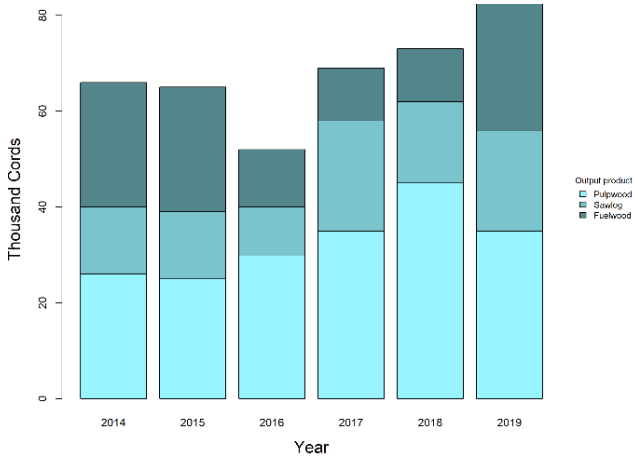
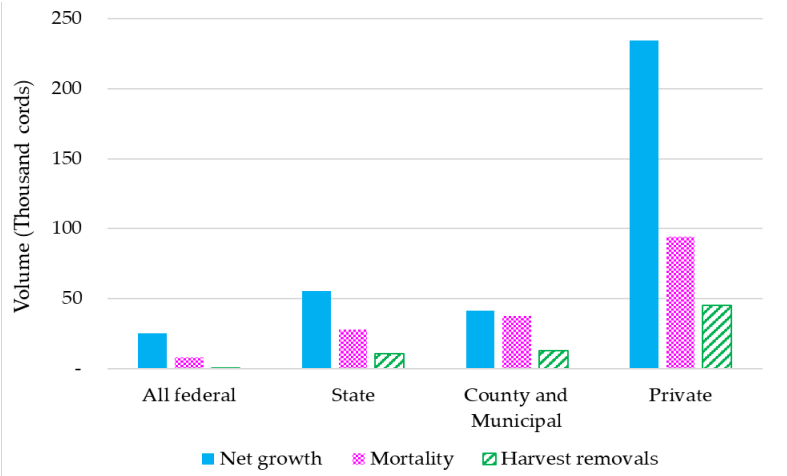


FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BLACK AND GREEN ASH SPECIES BY OWNERSHIP, 2016-2020, FIA



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.

Red pine forest cover type

Based on FIA 2020 data, the area of timberland of the red pine cover type is 694 thousand acres (Figure 2). This cover type consists of a wide mixture of species, red pine being the most abundant one (74%). Predominant secondary species include quaking aspen, eastern white pine, jack pine and paper birch (Figure 1).

FIGURE 1. VOLUME OF RED PINE COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2020

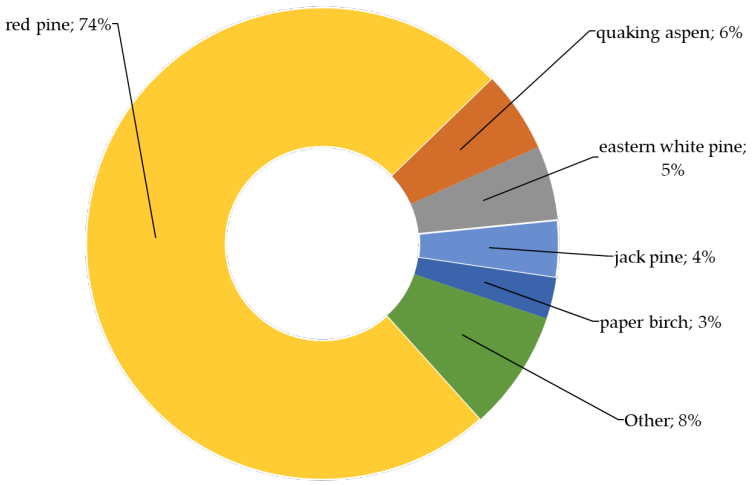
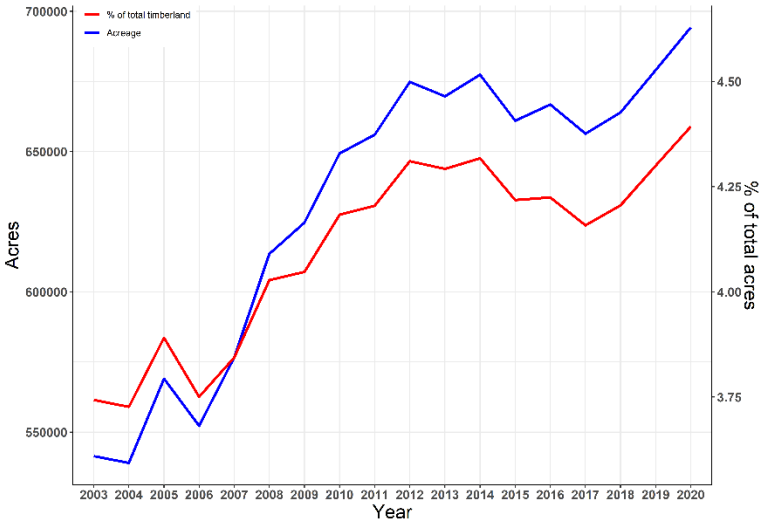


TABLE 1. % AREA OF RED PINE COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2020

	Area
All Federal	24%
State	18%
County/Municipality	15%
Private	43%

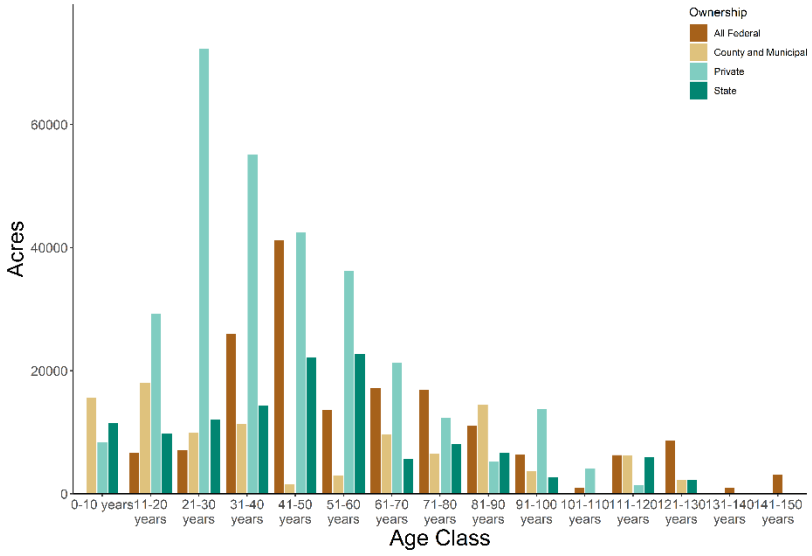
FIGURE 2. ACRES OF RED PINE COVER TYPE ON TIMBERLAND, FIA



Over 40% of the area of timberland is on private land, with a lower presence on federal, county/municipality, and state land (Table 1). The acres of timberland have increased in the past 5 years and overall since 2003, with the maximum acres of timberland since 2003 being 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 (highest 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 2020



Red pine species: presence

Volume of red pine has increased greatly since 2003 as many plantations have reached merchantable sizes. Red pine species represents around 7% of the total estimated merchantable volume in Minnesota (Figure 4). That volume is mostly found in private and federal land, with a lower presence in federal, state, and county/municipality land (Table 2).

FIGURE 4. MERCHANTABLE VOLUME RED PINE SPECIES (2003-2020), FIA

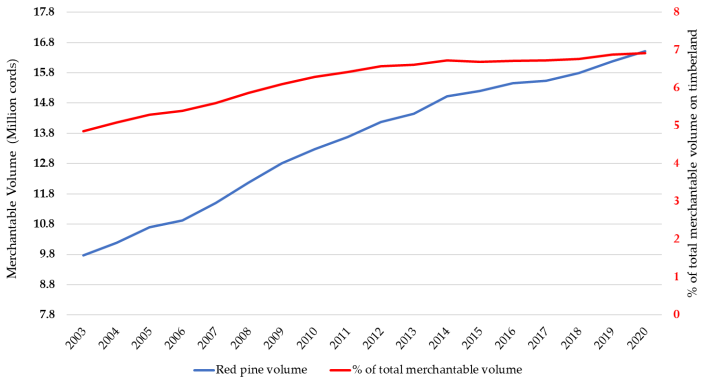


FIGURE 5. MERCHANTABLE VOLUME OF RED PINE SPECIES BY DIAMETER CLASS (2003-2020), FIA

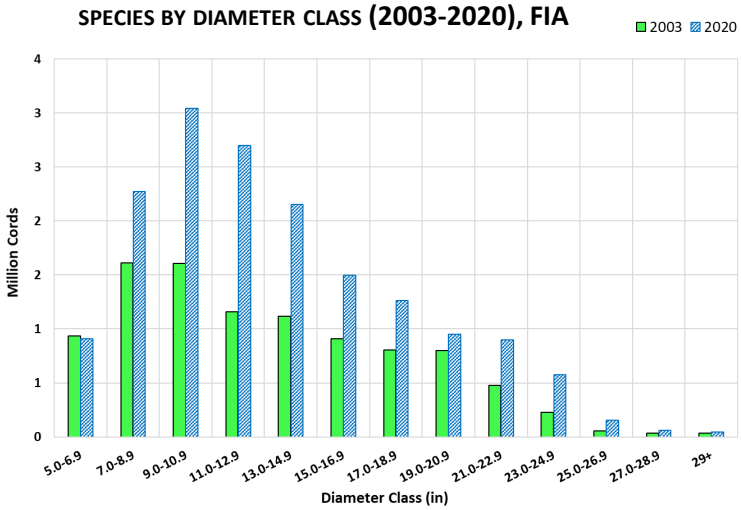


TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF RED PINE BY OWNERSHIP, FIA 2020

	Volume
All Federal	28%
State	18%
County/Municipality	11%
Private	43%

TABLE 3. % OF VOLUME OF RED PINE TREE SPECIES ON DIFFERENT FOREST COVER TYPES, FIA 2020

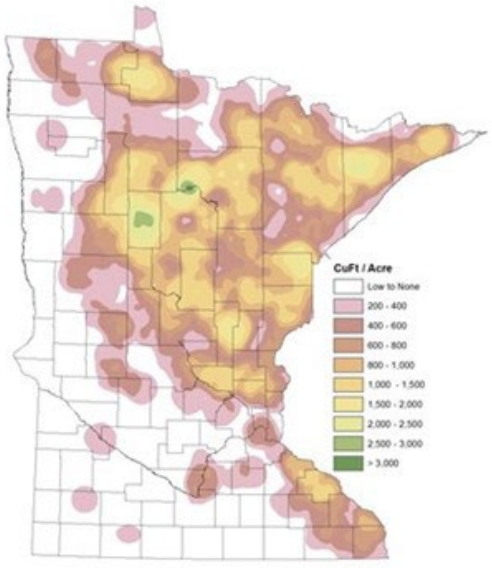
	Red pine	Aspen	Eastern white pine	Jack pine	Oak	Other*
% of total Volume of red pine species	87.5%	4.3%	2.6%	1.7%	1%	2.8%

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

The majority of red pine volume is in trees with diameters less than 15 inches (Figure 5).

Only about 13% of the volume of red pine species in the state is found in alternative cover types, other than red pine, such as aspen or eastern white pine (Table 3).

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF RED PINE , FIA 2017



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. A rising demand for saw timber has driven increased red pine harvests in the past four years (Figure 7). Demand for red pine small-diameter pulpwood fluctuates (Figure 9).

FIGURE 7. VOLUME OF RED PINE SPECIES HARVESTED FROM TIMBERLAND (2004-2019), TPO

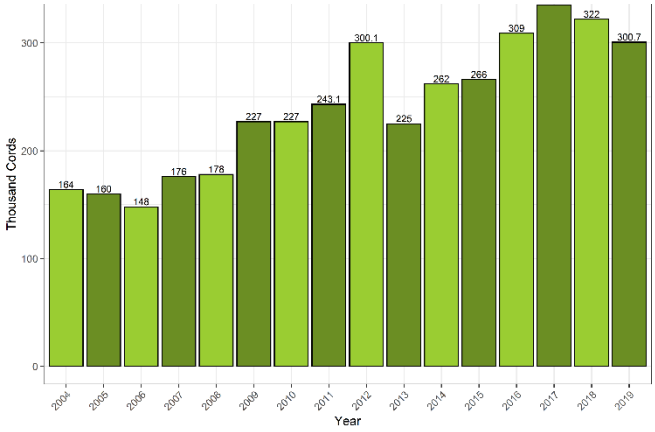
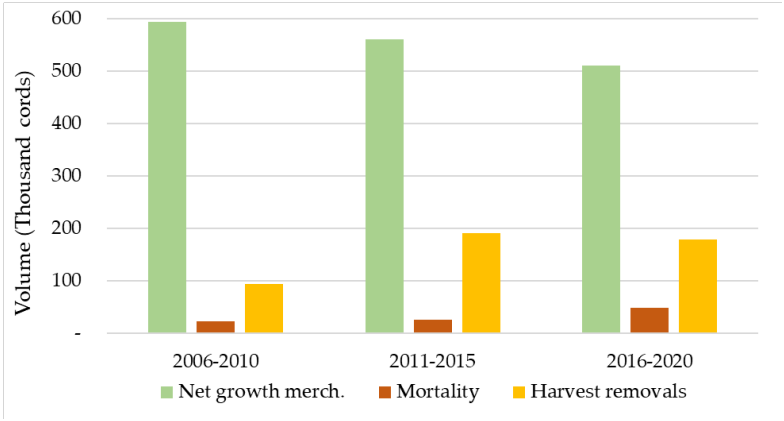


Figure 8 shows the estimated average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of merchantable volume on timberlands since 2006. The net growth of red pine species has decreased during this period of time and mortality and harvest removals have increased.

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



In 2016-2020, red pine species in private timberlands present the highest net growth and mortality estimates. State lands have had the highest average annual harvest removals (Figure 10).
See Appendix A for further explanation of these figures.

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

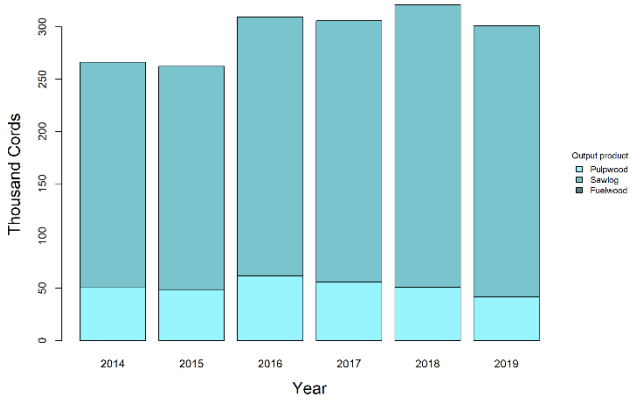
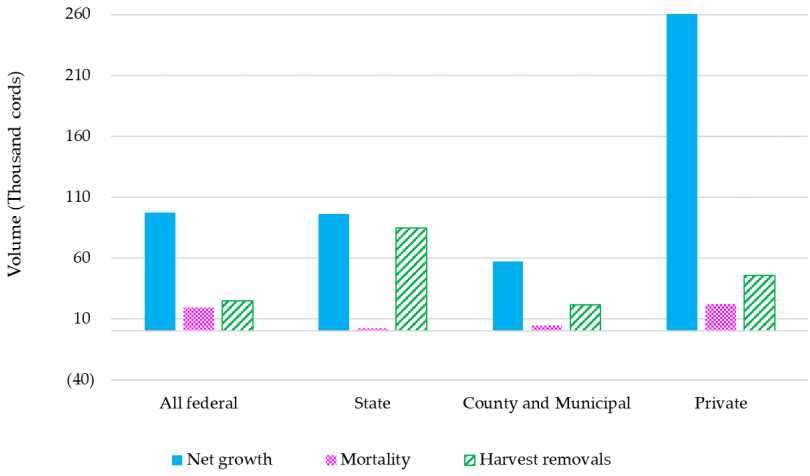


FIGURE 10. ESTIMATED AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY BY OWNERSHIP, 2016-2020, FIA



Opportunities:

- Average annual harvest is well below annual net growth.
- Many red pine acres are nearing or at management age.
- 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 2020 data, the area of timberland of the jack pine cover type is 215 thousand acres (Figure 2), the lowest in the past 20 years. This cover type consists of a wide mixture of species, being jack pine the most abundant one (61%). 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 2020

	Area
All Federal	32 %
State	19 %
County/Municipality	8 %
Private	41 %

FIGURE 1. VOLUME OF JACK PINE COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2020

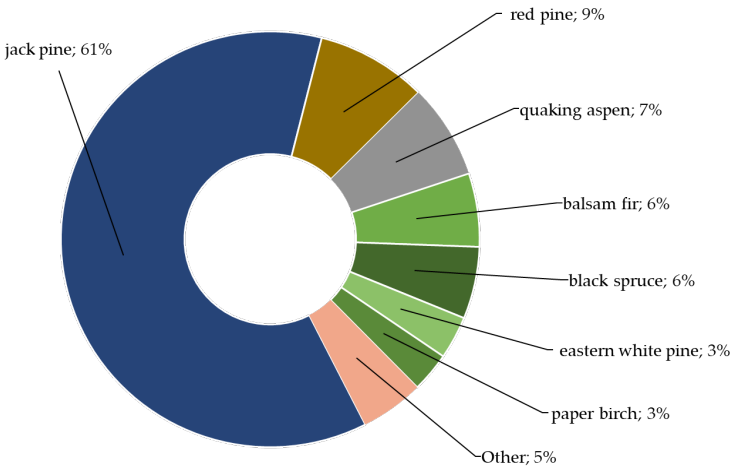
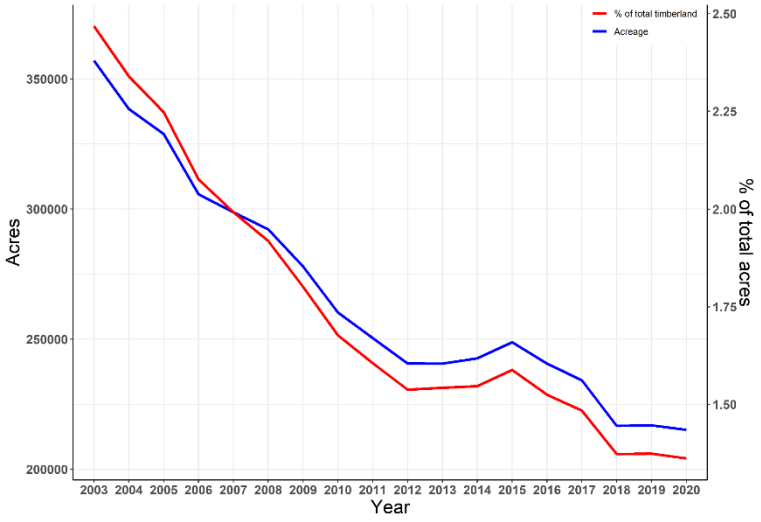


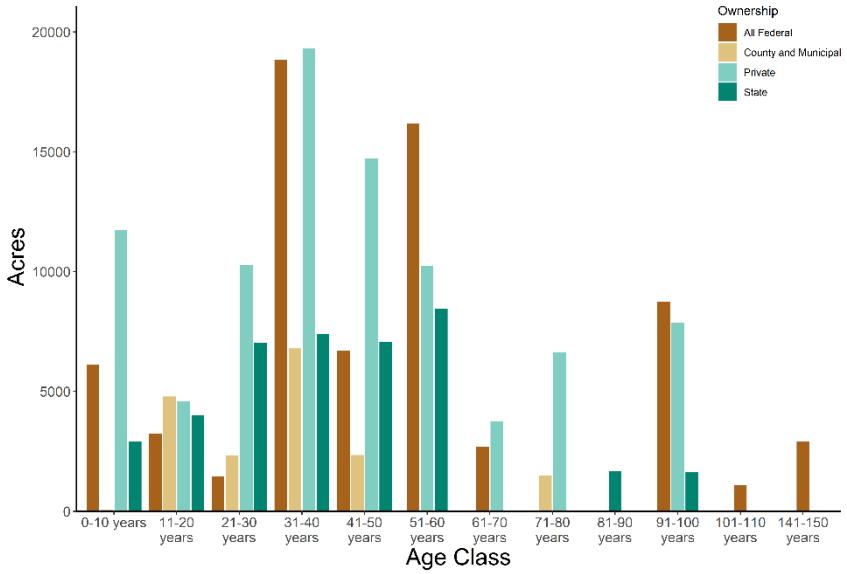
FIGURE 2. ACRES OF JACK PINE COVER TYPE ON TIMBERLAND, FIA



Private landowners control the largest total acreage (over 40% of the area of timberland), but the federal government controls by far the most acres compared to its total ownership (Table 1). The acres of timberland have decreased since 2003 (Figure 2). The decline in jack pine is caused by disease outbreaks such as budworm and 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 (greater of 90 years old) on the landscape (Figure 3).

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP OF JACK PINE, FIA 2020



Jack pine species: presence

The estimated jack pine merchantable volume began a major decline starting in 2005 and continues to decline today. It currently represents 1.5% of the total merchantable volume in Minnesota (Figure 4). This decline in jack pine volume is mainly caused by disease outbreaks.

FIGURE 4. VOLUME JACK PINE SPECIES (2003-2020), FIA

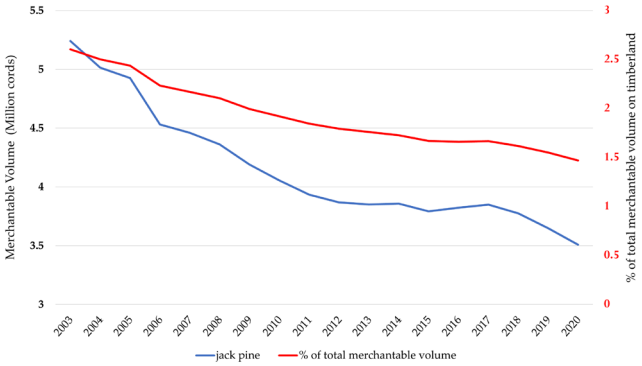


FIGURE 5. VOLUME OF JACK PINE SPECIES BY DIAMETER CLASS (2003-2020), FIA

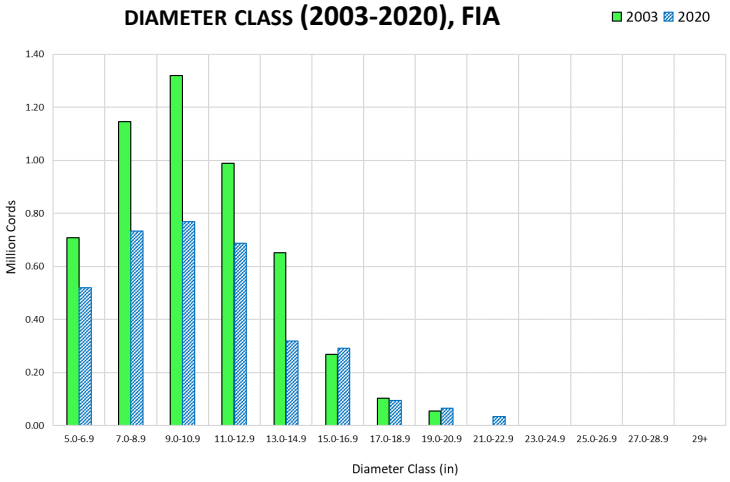


TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF JACK PINE BY OWNERSHIP, FIA 2020

	Volume
All Federal	32%
State	18%
County/Municipality	11%
Private	39%

TABLE 3. % OF VOLUME OF JACK PINE TREE SPECIES ON DIFFERENT FOREST COVER TYPES, FIA 2020

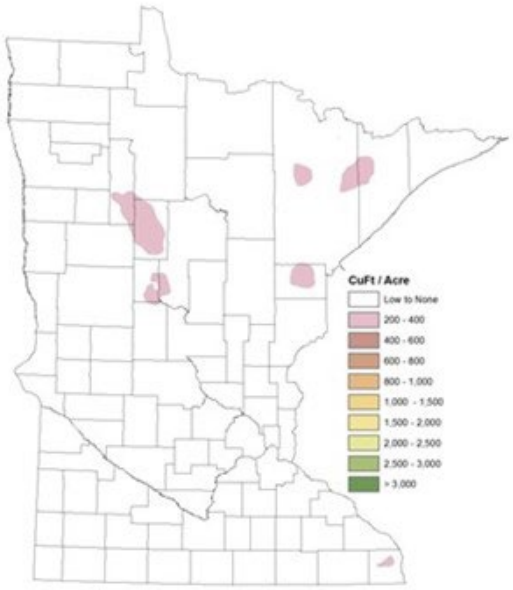
	Jack pine	Red pine	Aspen	Black spruce	Balsam fir	Birch	Other*
% of total Volume of black spruce species	58%	22%	8%	3%	3%	2%	5%

*Other includes forest cover types with less than 2% of the volume

The vast majority of jack pine volume are trees with diameters smaller than 15 inches (Figure 5). Almost 40% of its merchantable volume can be found in private lands, with a high presence in federal land (Table2).

Their presence is a significant component in many other upland cover types. More than 40% of the volume of jack pine species 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

The 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 decrease in the last decade (Figure 7) but may be leveling off. Thinning young red pine can replace the slack in jack pine harvest volume.

FIGURE 7. VOLUME OF JACK PINE SPECIES HARVESTED FROM TIMBERLAND (1994-2019), TPO

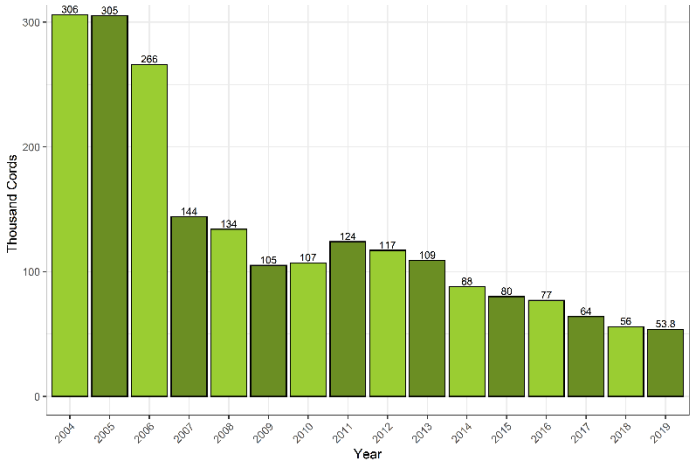
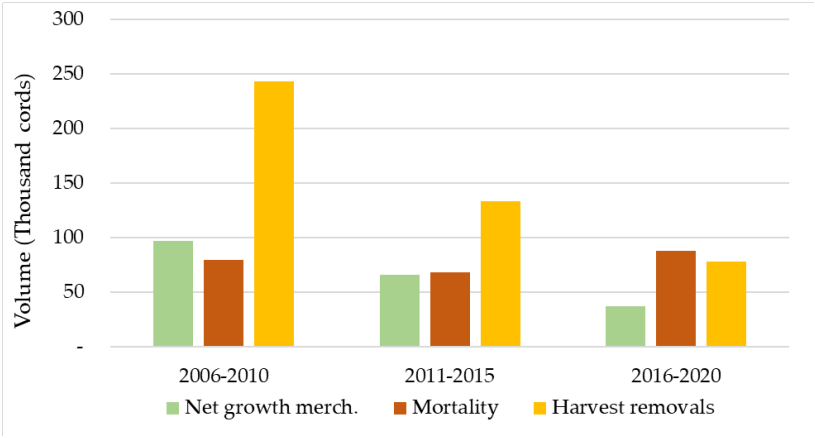


FIGURE 8. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND NON-HARVEST RELATED MORTALITY, FIA



Mortality of jack pine species has increased in the past decade and the net growth as steadily decreased (Figure 8). Periodic jack pine budworm outbreaks occur in older stands, which can result in heavy mortality and increased fire risk. The current outbreak started in west-central counties in 2015, lasted through 2019, and made more jack pine available.

In 2016-2020, jack pine species in private timberlands present the highest average annual mortality estimates. Federal lands have had the highest average annual harvest removals as well as the highest estimated values of average annual net growth (Figure 10).

See Appendix A for further explanation of these figures.

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

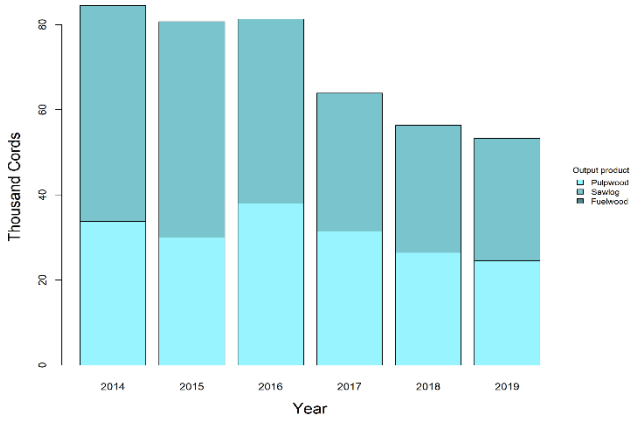
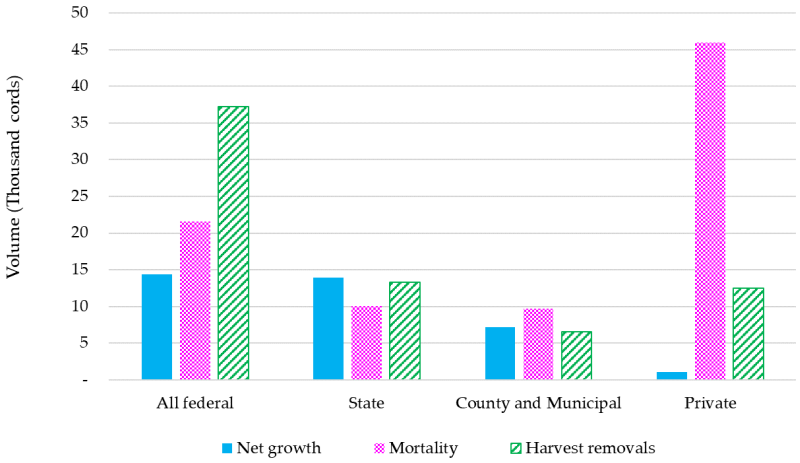


FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY BY OWNERSHIP, 2016-2020, FIA



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 2020 data, the area of timberland of the white pine cover type is 185 thousand acres (Figure 2). This cover type consists of a wide mixture of species, with eastern white pine being the most abundant (73%). Predominant secondary species include red pine, quaking aspen, and paper birch (Figure 1).

FIGURE 1. VOLUME OF WHITE PINE COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2020

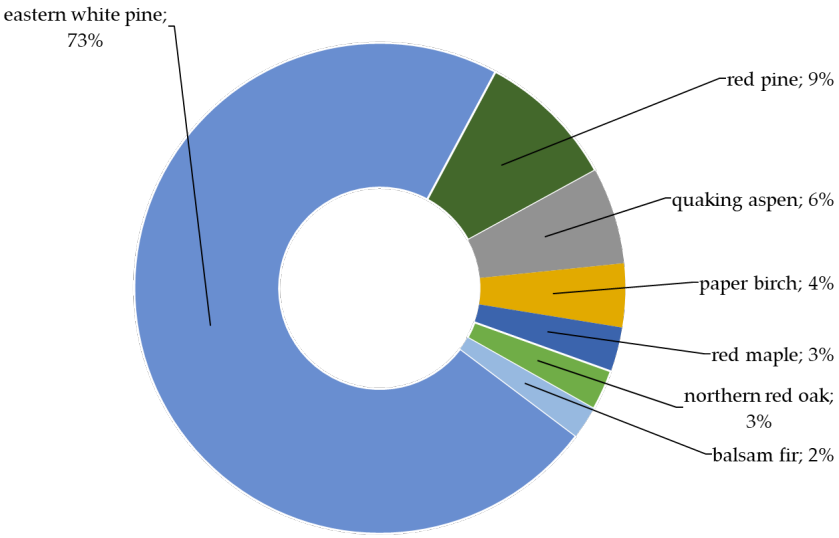
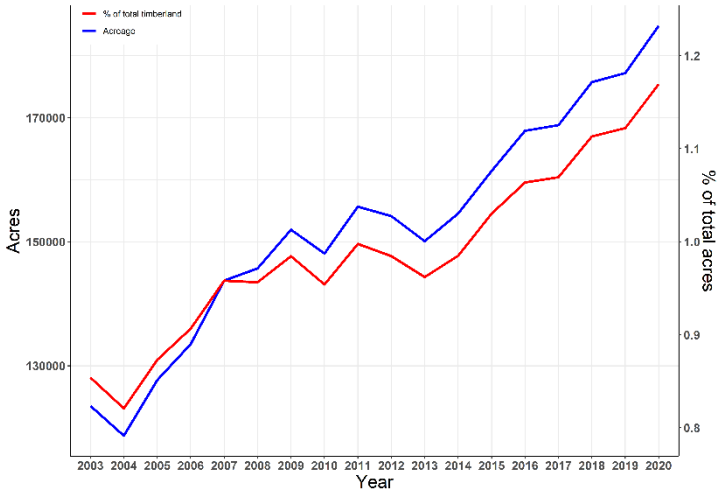


TABLE 1. % AREA OF WHITE PINE COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2020

	Area
All Federal	25%
State	12%
County/Municipality	11%
Private	52%

FIGURE 2. ACRES OF WHITE PINE COVER TYPE ON TIMBERLAND, FIA



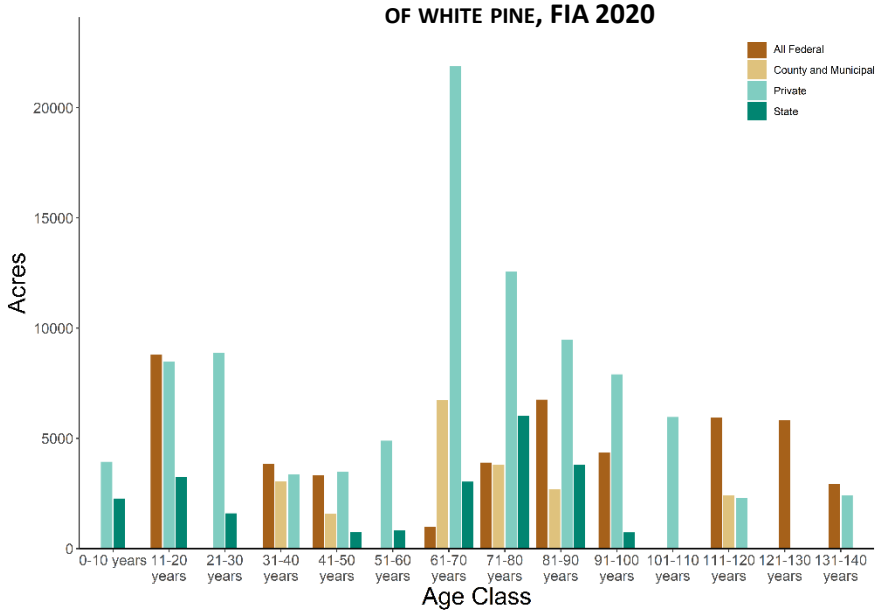
The acres of timberland of eastern white pine cover type have increased since 2003 (Figure 2).

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

The majority of the acreage on private land is between 60 and 110 years old (Figure 3).

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP OF WHITE PINE, FIA 2020



Eastern white pine species: presence

The merchantable volume of white pine species has increased substantially since the 2003 inventory (Figure 4). Based on FIA 2020 data, the current merchantable volume of white pine species represents over 2.5% of the total merchantable volume in Minnesota.

FIGURE 4. VOLUME EASTERN WHITE PINE SPECIES (2003-2020), FIA

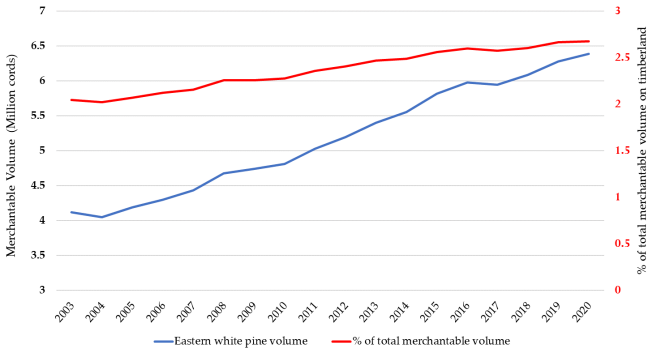


FIGURE 5. VOLUME OF EASTERN WHITE PINE SPECIES BY DIAMETER CLASS (2003-2020), FIA

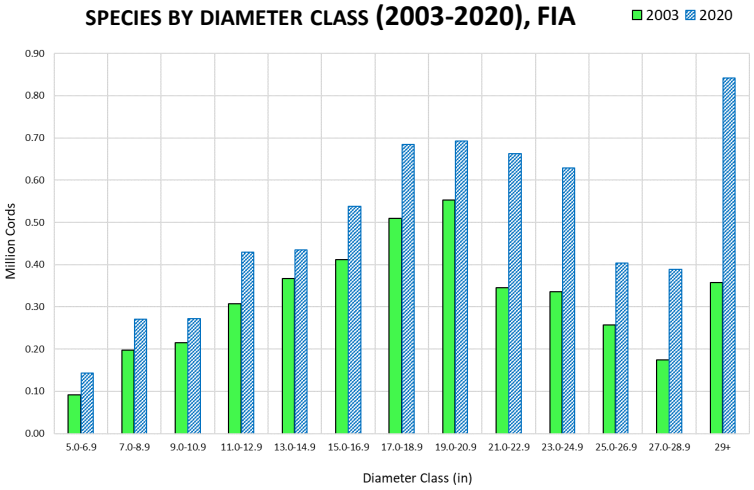


TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF EASTERN WHITE PINE BY OWNERSHIP, FIA 2020

	Volume
All Federal	24%
State	11%
County/Municipality	15%
Private	50%

TABLE 3. % OF VOLUME OF EASTERN WHITE PINE TREE SPECIES ON DIFFERENT FOREST COVER TYPES, FIA 2020

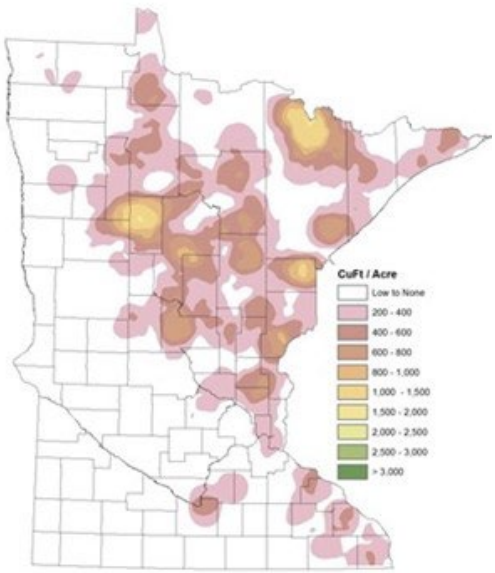
	Eastern white pine	Red pine	Aspen	Northern hardwoods	Balsam fir	Other*
% of total Volume of eastern white pine species	53%	16%	9%	6%	3%	13%

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

The vast majority of white pine volume is in trees with diameters greater than 15 inches (Figure 5). Almost 50% of the volume can be found in private lands and around a quarter of it in federal land (Table 2).

Their presence is a significant component in many other upland cover types. Almost 50% of the volume of white pine species is found in alternative cover types, such as red pine, aspen, northern hardwood and balsam fir (Table 3).

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF EASTERN WHITE PINE , FIA 2017



Eastern white pine species: growth and harvest

Over the past decade, white pine contribution to total harvest has remained relatively steady (Figure 7). The amount of saw timber and pulpwood produced from white pine species has fluctuated since 2014 (Figure 9).

FIGURE 7. VOLUME OF EASTERN WHITE PINE SPECIES HARVESTED FROM TIMBERLAND (2004-2019), TPO

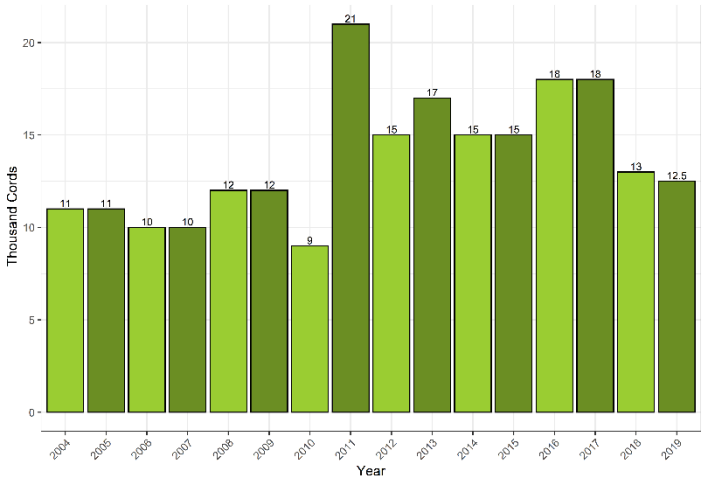
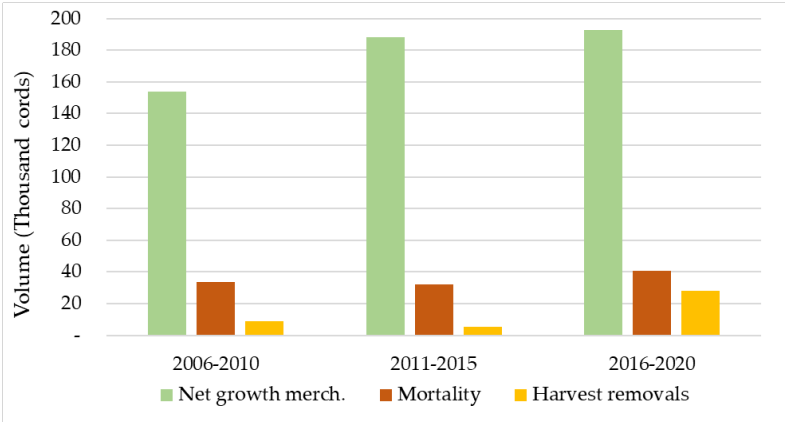


Figure 8 shows the estimated average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of merchantable volume on timberlands since 2006. The net growth, mortality and harvest removals of white pine species has increased in the past five years.

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



In 2016-2020, white pine species in private timberlands present the highest net growth estimates. County/municipality lands have had the highest average annual harvest removals. The highest estimated values of mortality are found on federal land (Figure 10).
See Appendix A for further explanation of these figures.

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

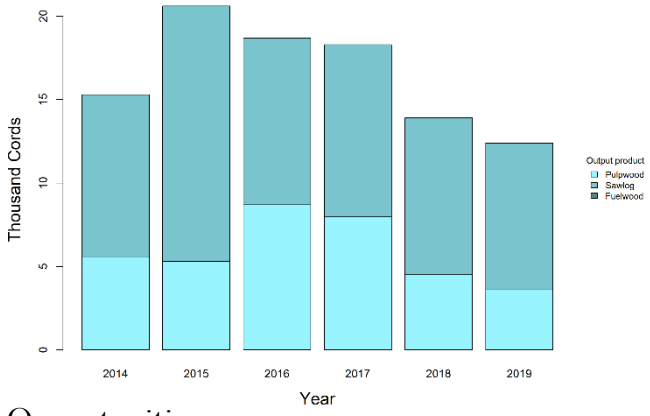
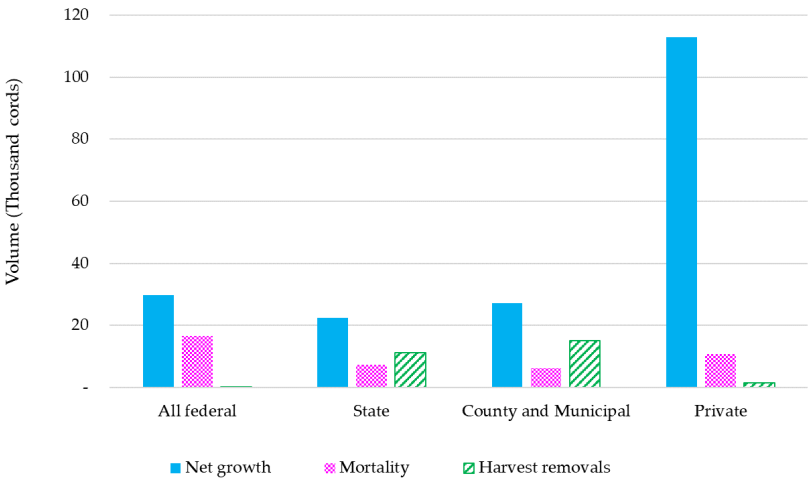


FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY BY OWNERSHIP, 2016-2020, FIA



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 2020 data, the area of timberland of the black spruce cover type is 1.4 million acres (Figure 2). This cover type consists of a wide mixture of species, with black spruce being the most abundant (74%). Predominant secondary species include tamarack, northern white-cedar, balsam fir, and quaking aspen (Figure 1).

FIGURE 1. VOLUME OF BLACK SPRUCE COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2020

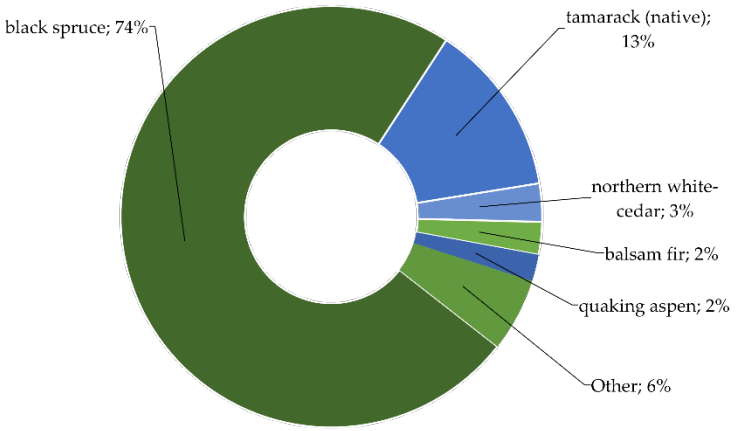
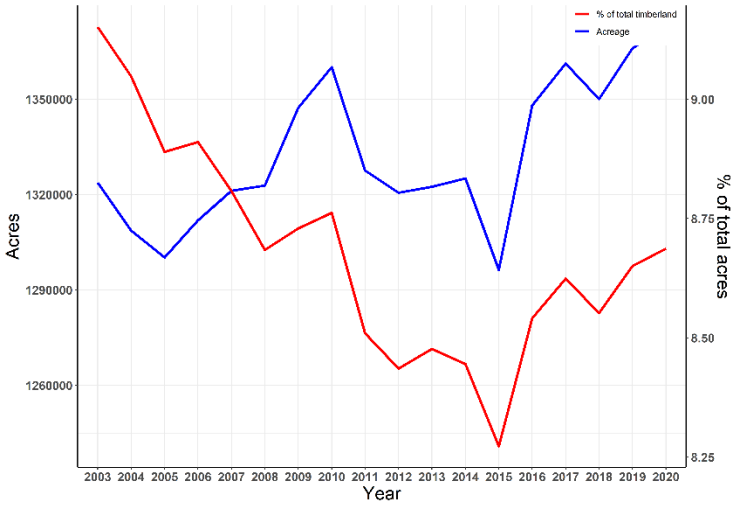


TABLE 1. % AREA OF BLACK SPRUCE COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2020

	Area
All Federal	14%
State	52%
County/Municipality	15%
Private	19%

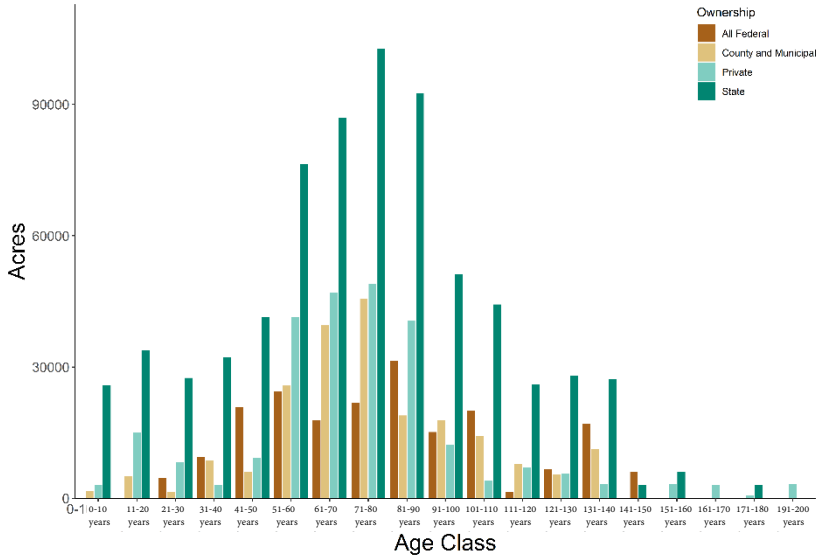
FIGURE 2. ACRES OF BLACK SPRUCE COVER TYPE ON TIMBERLAND, FIA



Over half of the area of timberland is on state land, with a lower presence on private, county, and federal land (Table 1). The estimated acres of timberland have fluctuated in the past 15 years, reaching the highest coverage in 2020 (Figure 2).

The black spruce cover type has a unimodal age-class distribution with a higher presence of stands 71-80 years old. A high portion of the acres of timberland are older than 50 years old. The majority of the black spruce cover type on state land is between 50 and 90 years old (Figure 3).

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP BLACK SPRUCE, FIA 2020



White spruce forest cover type

Based on FIA 2020 data, the area of timberland of the white spruce cover type is 134 thousand acres (Figure 5). White spruce is located most often on upland sites. In natural stands, it is commonly found mixed in with balsam fir, quaking aspen, red pine, and paper birch (Figure 4).

TABLE 2. % AREA OF WHITE SPRUCE COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2020

	Area
All Federal	26%
State	18%
County/Municipality	13%
Private	43%

FIGURE 4. VOLUME OF WHITE SPRUCE COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2020

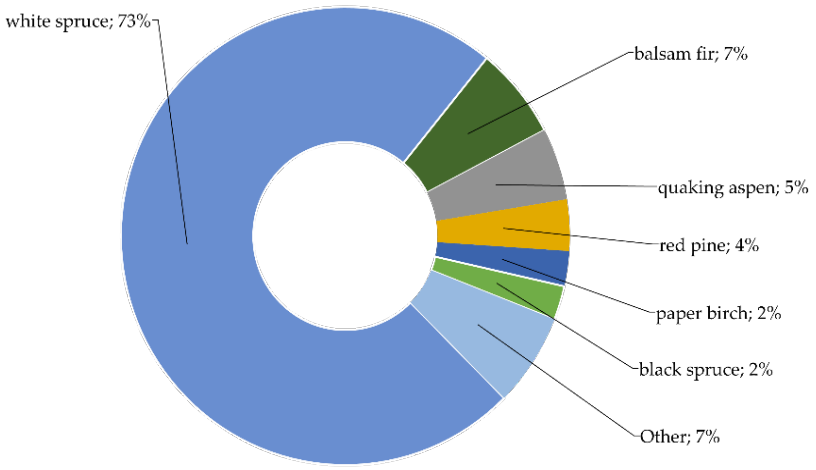
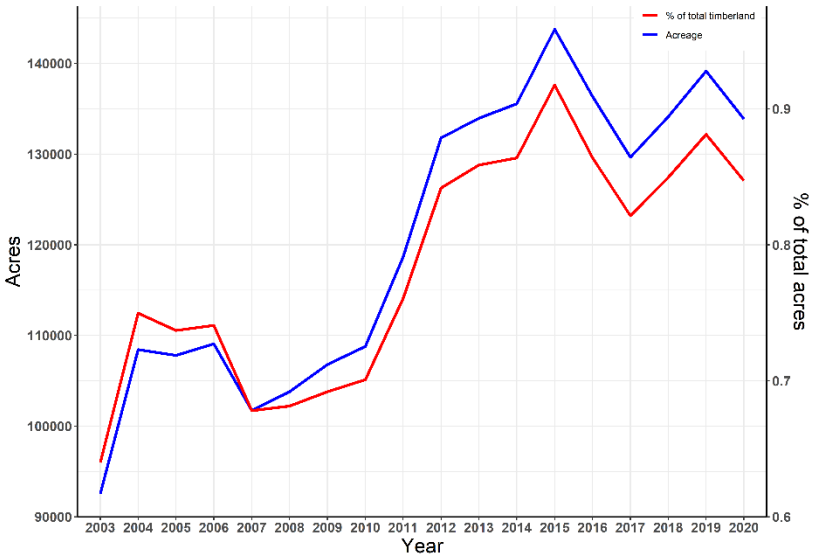


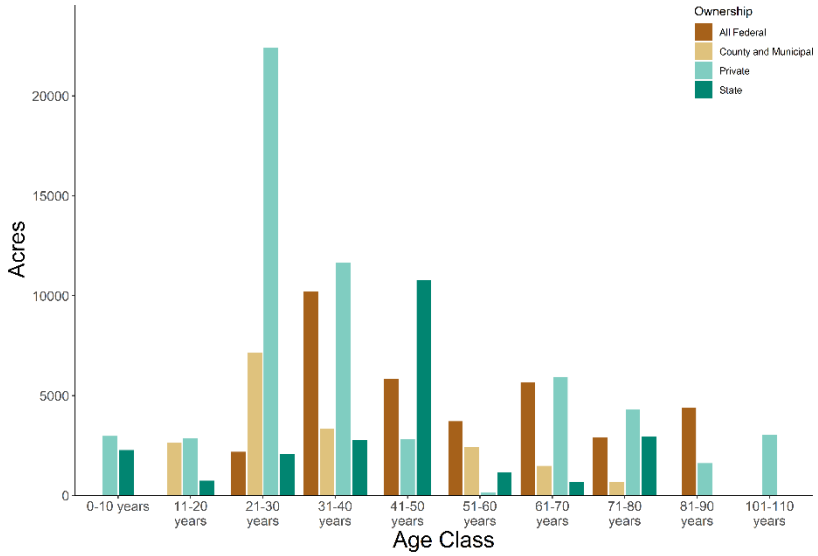
FIGURE 5. ACRES OF WHITE SPRUCE COVER TYPE ON TIMBERLAND, FIA



The area of timberland of the white spruce forest type has increased since 2003, with some fluctuations in the past 5 years (Figure 5). This can be due to the recent use of white spruce species and the increase of white spruce plantations.

Over 40% of the timberland of white spruce is on private land, with a lower proportion in federal, state, and county/municipality land (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 ACRES BY OWNERSHIP OF WHITE SPRUCE, FIA 2020



Black and white spruce species: presence

Based on FIA 2020 data, the estimated merchantable volume of black and white spruce species represents around 4.4% of all the estimated merchantable volume in Minnesota (Figure 7). The estimated volume of black spruce species are dominated by small diameter trees.

FIGURE 7. VOLUME BLACK AND WHITE SPRUCE SPECIES (2003-2020), FIA

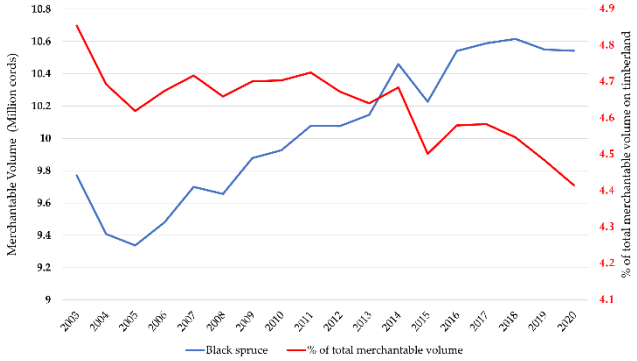


FIGURE 8. VOLUME OF BLACK AND WHITE SPRUCE SPECIES BY DIAMETER CLASS (2003-2020), FIA

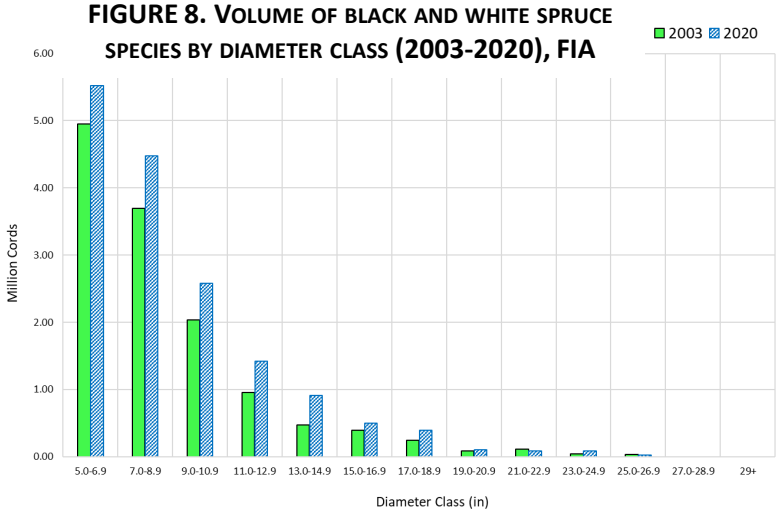


TABLE 3. % MERCHANTABLE VOLUME IN TIMBERLAND OF BLACK/WHITE SPRUCE BY OWNERSHIP, FIA 2020

	Volume
All Federal	24%/31%
State	35%/16%
County/Municipality	16%/15%
Private	25%/38%

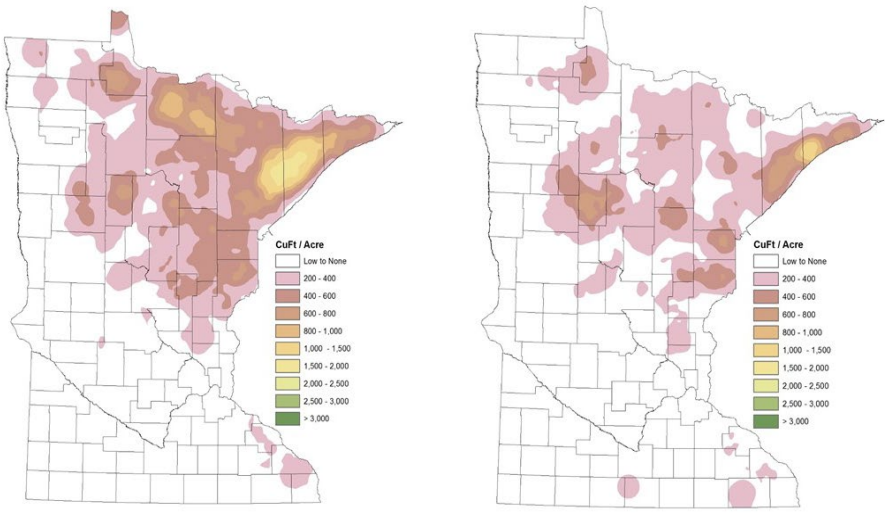
TABLE 4. % OF VOLUME OF BLACK AND WHITE SPRUCE TREE SPECIES ON DIFFERENT FOREST COVER TYPES, FIA 2020

	Black spruce	Tamarack	Balsam fir	Aspen	White spruce	Birch	Lowland hardwoods	Other*
% of total Volume of black spruce species	69%	9%	5%	5%	-	-	-	12%
% of total Volume of white spruce species	-	-	7%	25%	31%	10%	5%	22%

*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 their volume can be found in state lands (black spruce) or private lands (white spruce), Table 3. Their presence is a significant component in many other upland cover types. 31% (69%) of the volume of black (white) spruce species is found in alternative cover types, other than black (white) spruce cover type (Table 4).



Black and white spruce species: growth and harvest

Spruce is also a species of great industrial use in pulp and paper mills. The majority of black spruce in Minnesota is used to make high quality paper, prized for its excellent fiber qualities.. Many of the white spruce stands likely require a first (e.g. ages 25 to 40) or second thinning (e.g. ages 35-50).

FIGURE 11. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BLACK AND WHITE SPRUCE, FIA

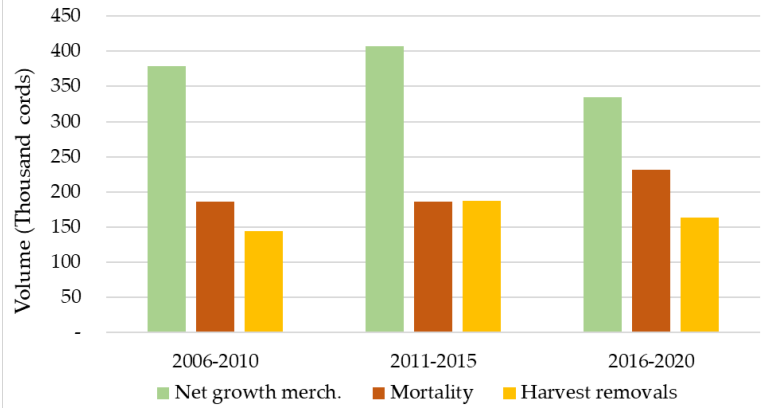


Figure 11 shows the average annual net growth (gross growth minus mortality), harvest removals, and non-harvest related mortality of merchantable volume on timberlands. Based on FIA, the estimated mortality has increased in the last 5 years while the net growth has decreased. In 2016-2020, state and private timberland present the highest annual average values of net growth, mortality and harvest removals. See See Appendix A for further explanation of these figures.

FIGURE 13. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY OF BLACK AND WHITE SPRUCE BY OWNERSHIP, 2016-2020, FIA

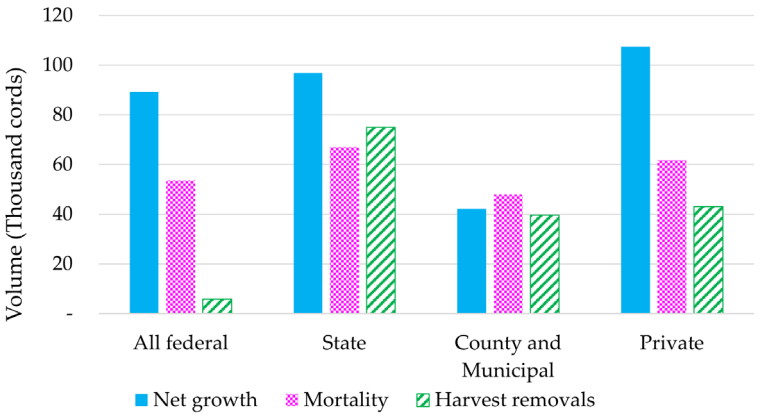
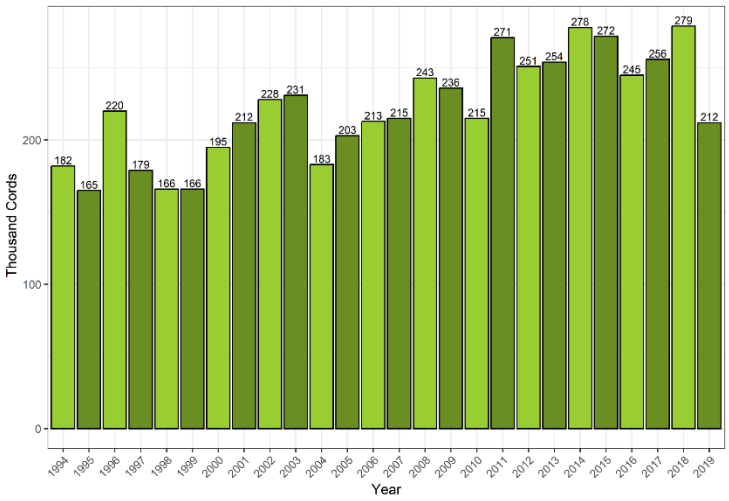
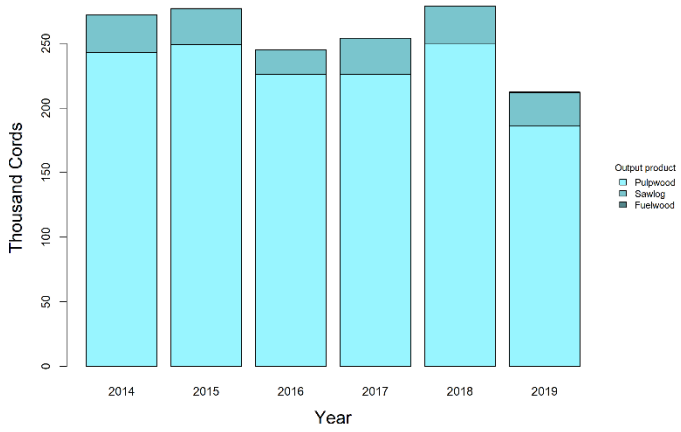


FIGURE 10. VOLUME OF WHITE AND BLACK SPRUCE SPECIES HARVESTED FROM TIMBERLAND (1994-2019), TPO



The volume harvested of black and white species has increased since 1994 (Figure 10). Figure 12 shows the volume harvested of black and white spruce species by output product, pulpwood being the main output product. Some is also used by the sawmill industry, mostly in making studs but also in small quantities for other types of 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 2020 FIA data, the estimated area of timberland of balsam fir cover type is over 400 thousand acres (Figure 2). It consists of a wide mixture of species, mainly balsam fir species. Predominant secondary species include black spruce, quaking aspen, paper birch, and northern white-cedar (Figure 1).

FIGURE 1. VOLUME OF BALSAM FIR COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2020

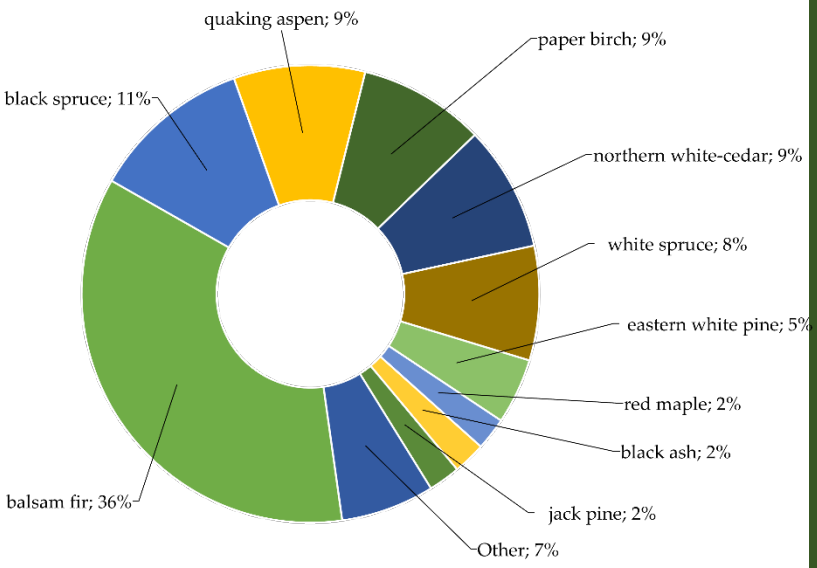
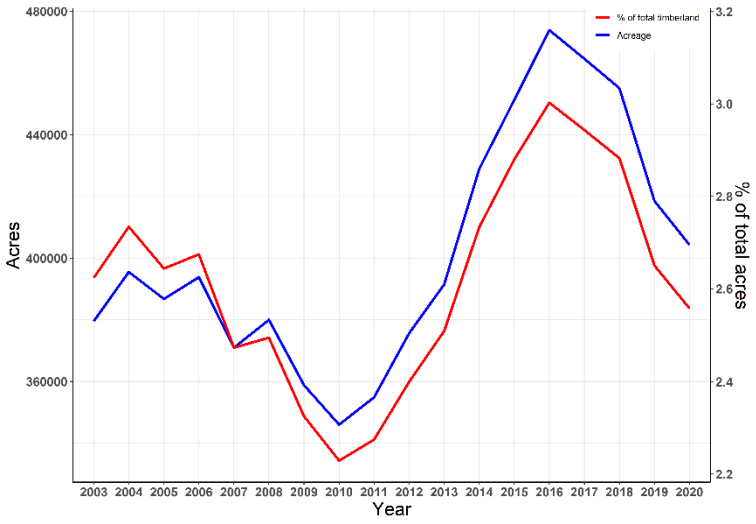


TABLE 1. % AREA OF BALSAM FIR COVER TYPE ON TIMBERLAND BY OWNERSHIP, FIA 2020

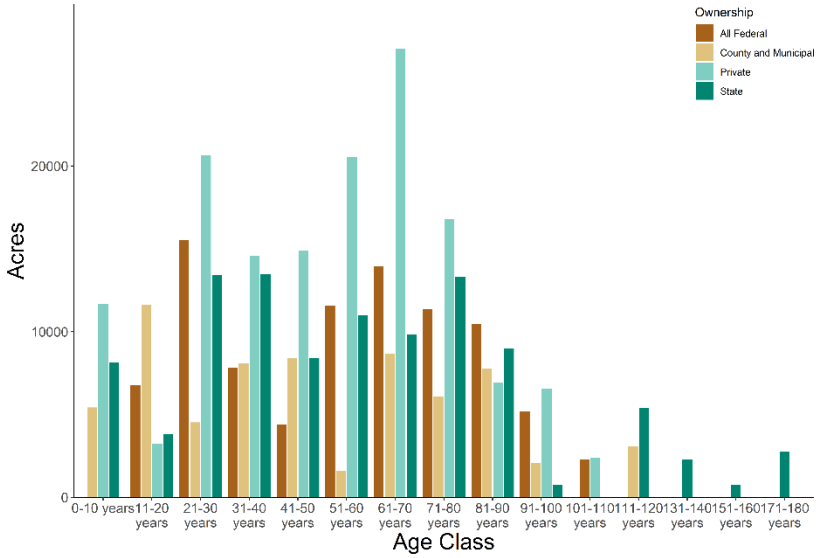
	Area
All Federal	22%
State	25%
County/Municipality	17%
Private	36%

FIGURE 2. ACRES OF BALSAM FIR COVER TYPE ON TIMBERLAND, FIA



A higher percentage of the acres of balsam fir timberland are in private land, with an even split across the rest of the ownerships (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 2020



Balsam fir cover type is dominated by stands at and above 40 years (Figure 3), making this a relatively old resource for such a short-lived species. Recommended rotation ages can vary with stand productivity and site condition, with 50 years a common average.

Balsam fir tree species: presence

The estimated annual merchantable volume of balsam fir species has increased since 2008, it represents around 3.6% of the total merchantable volume in Minnesota (Figure 4). Based on FIA 2020, the estimated merchantable volume is dominated by small diameter classes (Figure 5).

FIGURE 4. MERCHANTABLE VOLUME OF BALSAM FIR SPECIES (2003-2020), FIA

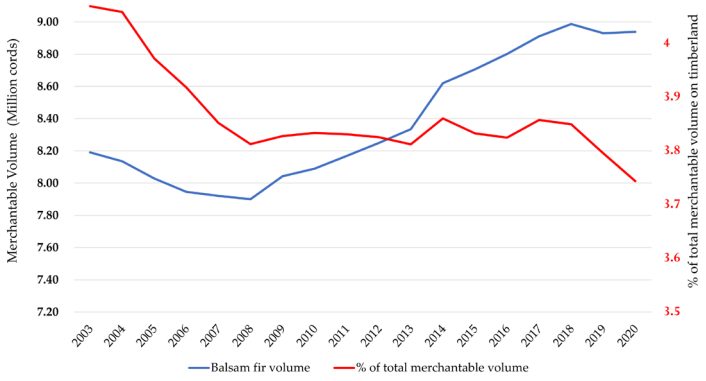


FIGURE 5. VOLUME OF BALSAM FIR SPECIES BY DIAMETER CLASS (2003-2020), FIA

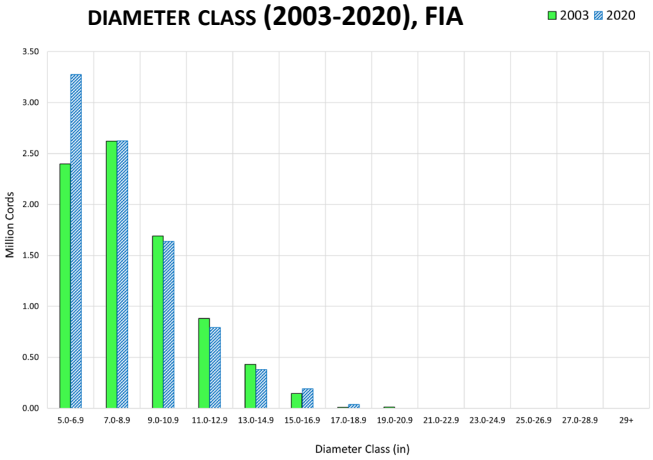


TABLE 2. % MERCHANTABLE VOLUME ON TIMBERLAND OF BALSAM FIR BY OWNERSHIP, FIA 2020

	Volume
All Federal	23%
State	17%
County/Municipality	18%
Private	42%

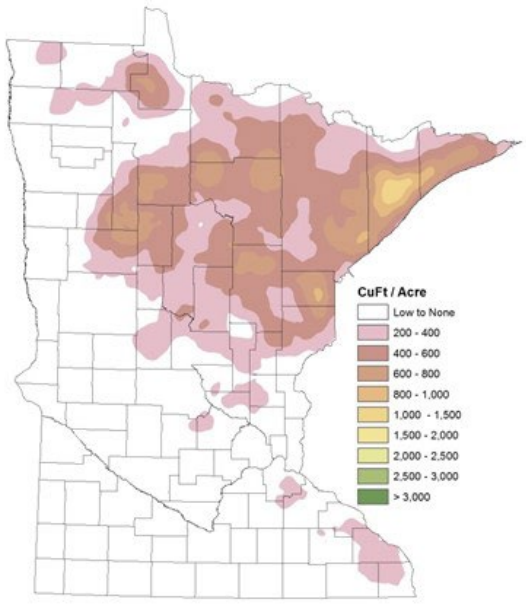
Over 40% of the total merchantable volume of balsam fir species is on private lands (Table 2). Only 28% of balsam fir volume in the state is found within the balsam fir cover type. Most (52%) of balsam fir volume occurs in the aspen cover type. It can also be found in other cover types such as birch, northern hardwoods, and lowland hardwoods (Table 3).

TABLE 3. % OF PRESENCE OF BALSAM FIR SPECIES ON OTHER FOREST COVER TYPES, FIA 2020

	% of total Volume of balsam fir species
Aspen	52%
Balsam fir	28%
Birch	17%
Northern Hardwoods	11%
Lowland Hardwoods	10%
Northern white-cedar	8%
Red pine	5%
Other	22%

*Other includes forest cover types with less than 6% of the volume

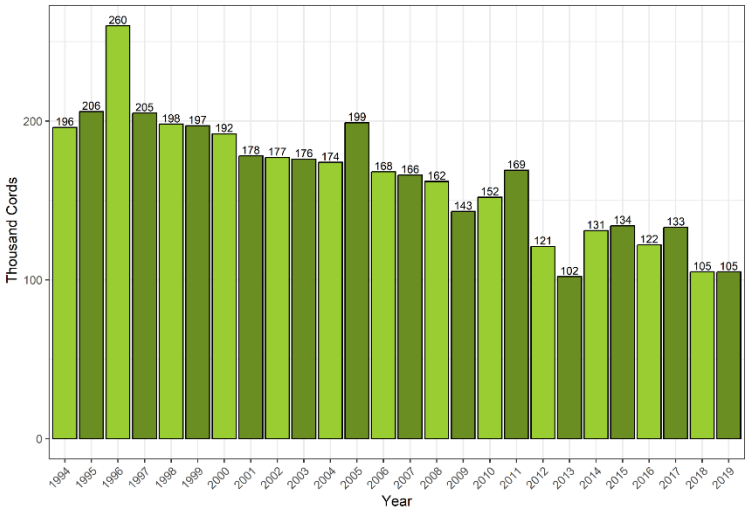
FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF BALSAM FIR *(ABIES BALSAMEA)*, FIA 2017



Balsam fir tree species: growth and harvest

The volume harvested of balsam fir species has steadily declined since 1994 (Figure 7). Industry uses it to make high quality paper prized for excellent fiber qualities, therefore a high percentage of the volume of balsam fir species harvested is for pulpwood production (Figure 9).

FIGURE 7. TOTAL VOLUME OF BALSAM FIR SPECIES HARVESTED, TIMBERLAND, 1994-2019, TPO



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

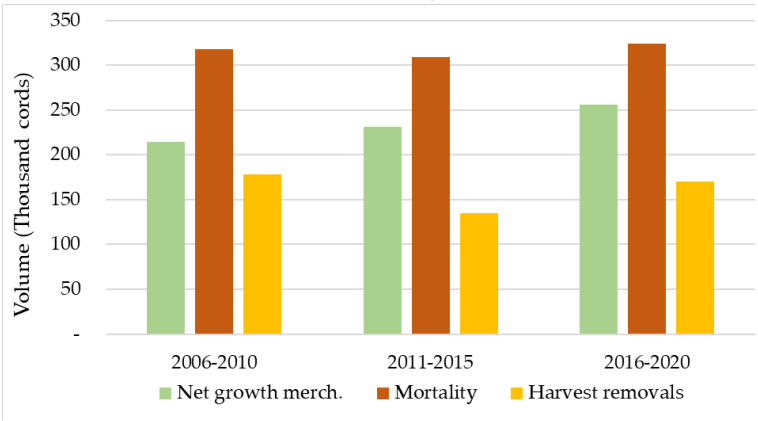


Figure 8 shows the average annual net growth (gross growth minus mortality), harvest removals, and mortality (non-harvest related mortality) of merchantable volume on timberlands. The net growth has increased in the past 15 years, but mortality of balsam fir has remained on the same level during that period. See Appendix A for further explanation of these figures.

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

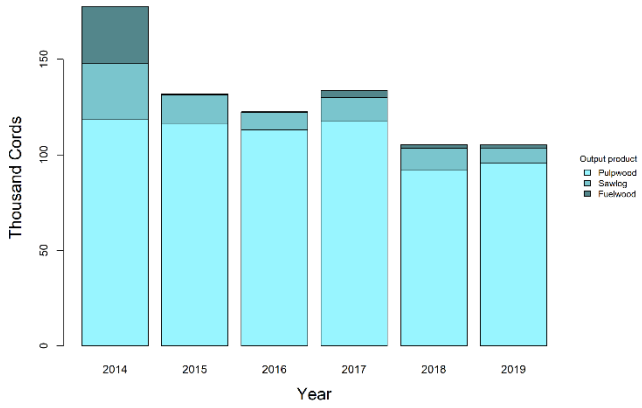
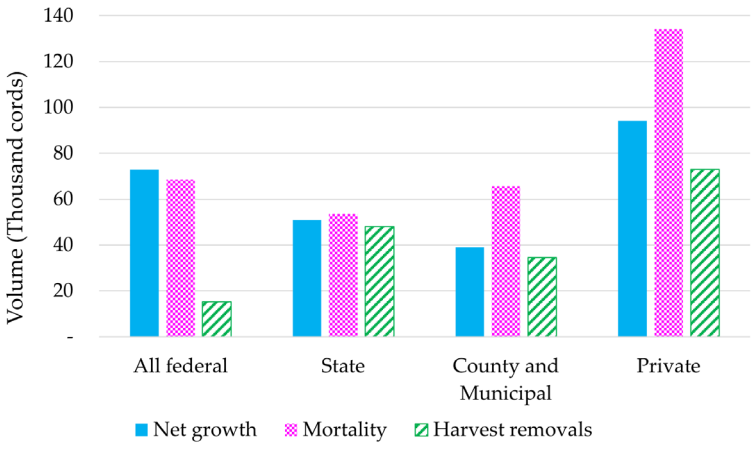


FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY BY OWNERSHIP IN 2020, FIA



Opportunities:

- Average annual harvest is below annual net growth
- There may be opportunities to capture a portion of the mortality volume before 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 2020 estimates, there is 1.1 million acres of timberland of tamarack cover type, corresponding to over 7% 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 2020

	Area
All Federal	7%
State	52%
County/Municipality	16%
Private	25%

FIGURE 1. VOLUME OF TAMARACK COVER TYPE ON TIMBERLAND BY SPECIES, FIA 2020

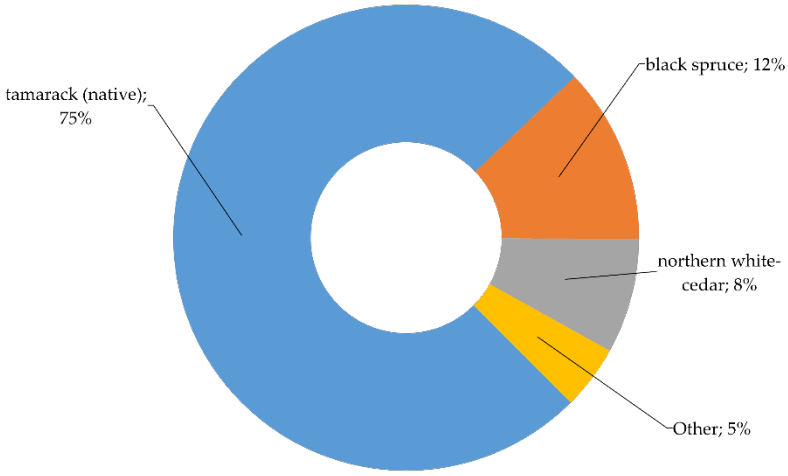
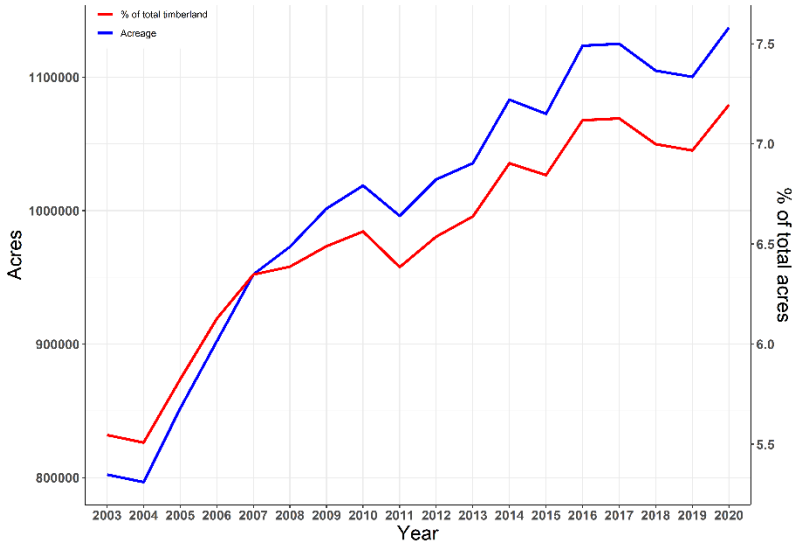


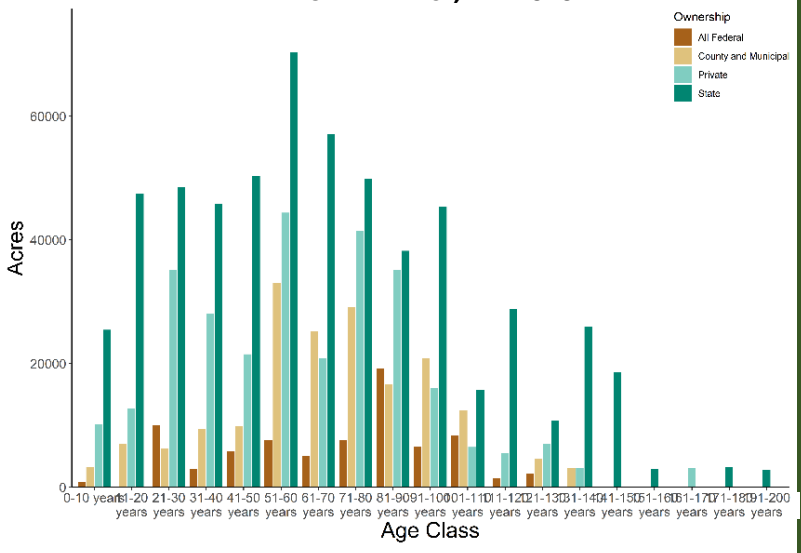
FIGURE 2. ACRES OF TAMARACK COVER TYPE ON TIMBERLAND, FIA



The estimated volume of tamarack cover type consists mainly of tamarack native species (75% of the volume), mixed with black spruce (12%) and northern white-cedar (8%) (Figure 1). Based on FIA, the estimated acreage of tamarack cover type has increased since 2004, reaching its maximum of 1.1 million acres in 2020.

The 2020 age-class distribution of tamarack cover type acreage by ownership shows that the highest proportion of this acreage is younger than 100 years and can be found on state land.

FIGURE 3. AGE CLASS DISTRIBUTION OF ACRES BY OWNERSHIP OF TAMARACK, FIA 2020



Tamarack tree species: presence

Based on FIA 2020 data, tamarack species volume represents around 3.6% of the total merchantable volume in Minnesota's forests (Figure 4). The highest proportion of the volume of the tamarack species in Minnesota is dominated by small diameter classes (Figure 5).

FIGURE 4. VOLUME OF TAMARACK SPECIES (2003-2020), FIA

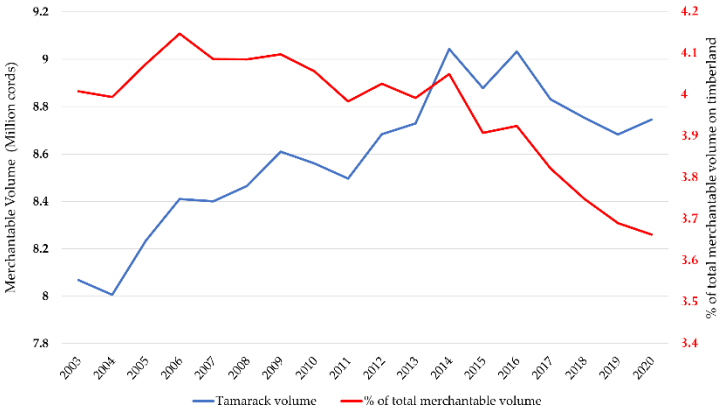


FIGURE 5. VOLUME OF TAMARACK SPECIES BY DIAMETER CLASS (2003-2020), FIA

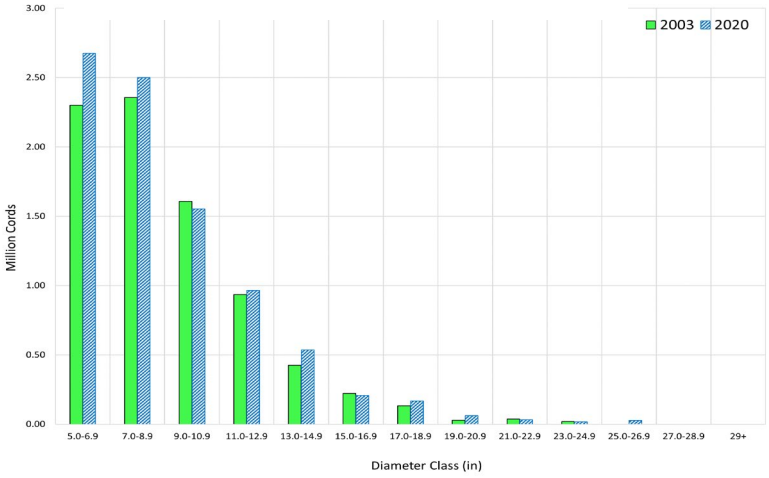


TABLE 2. % MERCHANTABLE VOLUME IN TIMBERLAND OF TAMARACK BY OWNERSHIP, FIA 2020

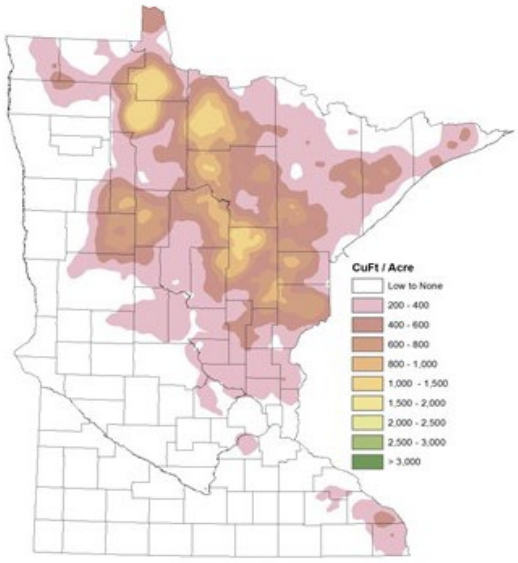
	Volume
All Federal	8%
State	47%
County/Municipality	16%
Private	29%

Almost 50% of its volume can be found on state lands (Table2). 67% of tamarack 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. % OF PRESENCE TAMARACK SPECIES BY FOREST COVER TYPES, FIA 2020

	% of total Volume of tamarack
Tamarack	67%
Black spruce	15%
Northern white cedar	8%
Lowland hardwoods	3%
Aspen	2%
Other	5%

FIGURE 6. SPATIAL DISTRIBUTION OF VOLUME OF TAMARACK SPECIES, FIA 2017



Tamarack tree species: growth and harvest

Harvest of tamarack species have decreased since 2013 (Figure 7). Significant mortality levels are being experienced statewide. Eastern larch beetles are killing trees, mostly in older stands and especially in Koochiching, Beltrami, Lake of the Woods, and Roseau counties (Figure 8).

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

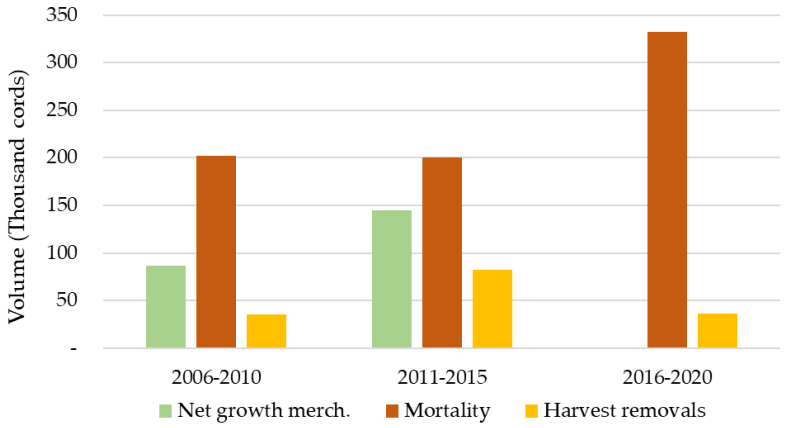


Figure 8 shows the average annual net growth (gross growth minus mortality), harvest removals, and mortality (non-harvest related mortality) of merchantable volume on timberlands. In 2016-2020, state and private timberlands have suffered the highest average annual mortality. Private and federal lands also present negative average annual net growth estimates (Figure 10). See Appendix A for further explanation of these figures.

FIGURE 10. AVERAGE ANNUAL NET GROWTH, REMOVALS, AND MORTALITY BY OWNERSHIP IN 2016-2020, FIA

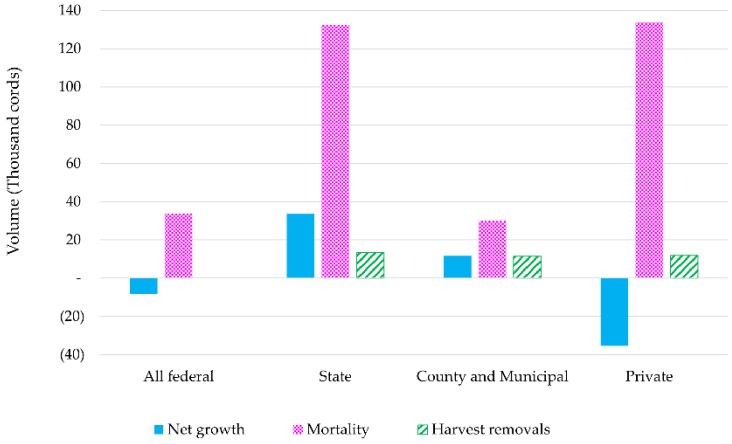
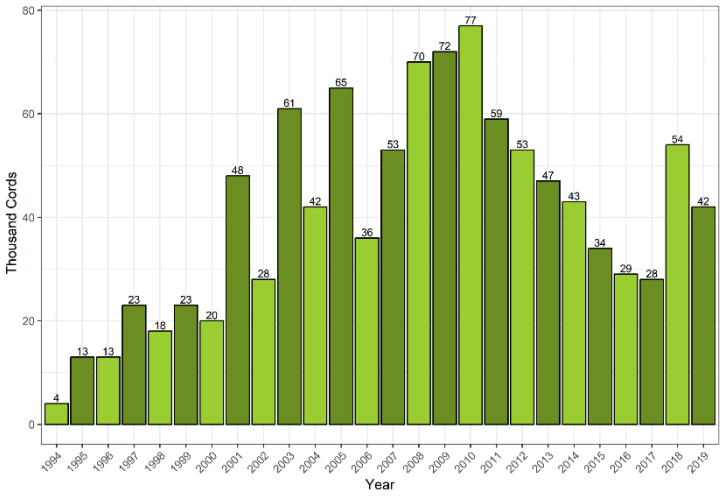
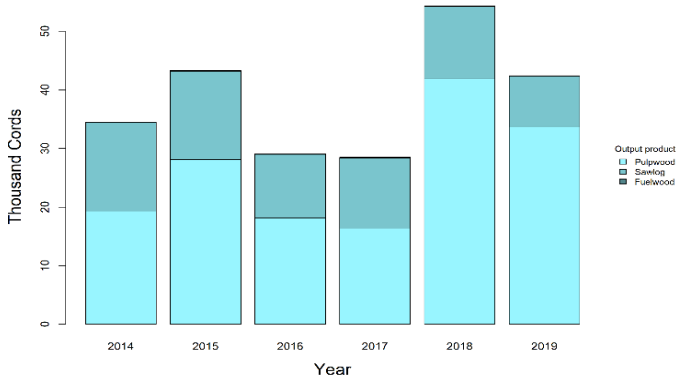


FIGURE 7. TOTAL TAMARACK SPECIES HARVESTED FORM TIMBERLAND (1994-2019), TPO



In the past, tamarack had been reported as mixed softwood; volume swings are largely due to mill reporting and change in pulpwood mill consumption. Tamarack markets 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 losses occur.

Challenges:

- Eastern larch beetle can cause significant mortality in tamarack and has been impacting forests in MN since 2000

Chapter 6: Timber Price Information

Average Prices Received by Product for Stumpage Sold by Public Land Agencies in Minnesota in the last 10 years (2011 to 2020.)

Average Prices Received for Stumpage Sold by Public Land Agencies in Minnesota: 2011-2020

Average prices 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 Minnesota DNR – Division of Forestry. The annual Minnesota Public Stumpage Price Review shows agency-specific prices.

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

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

TABLE 6-1: PULPWOOD PRICES ($ PER CORD)

Species	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Aspen	25.55	25.58	24.99	30.62	36.08	34.26	34.33	32.09	28.55	30.07
Balm	20.01	22.77	20.56	24.8	27.68	24.29	30.56	25.55	25.59	23.60
Birch	9.41	9.31	8.44	9.89	12.02	13.77	11.33	10.65	10.14	8.92
Ash	7.41	6.26	6.62	6.82	6	8.07	6.69	7.19	6.32	5.94
Oak	11.29	11.69	15.44	13.1	14.63	17	16.61	20.61	17.19	13.14
Basswood	7.58	6.61	9.16	8.82	12.51	8.26	8.49	7.87	8.17	7.34
Mixed/Other Hardwoods	10.58	10.24	10.59	12.44	11.45	8.06	14.38	6.80	8.9	11.05
Balsam Fir	17.91	14.19	9.86	10.62	14.18	14.76	16.71	14.64	13.28	9.90
W. Spruce	17.91	15.12	17.57	16.55	19.09	17.25	23.00	20.90	19.88	14.48
B. Spruce	23.14	17.77	19.22	16.8	22.63	24.87	24.90	23.11	23.55	20.84
Tamarack	5.51	6.2	5.05	5.4	7.81	6.26	7.81	5.45	5.35	5.53
W. Cedar	8.21	5.12	7.86	5.3	6.41	6.8	5.20	5.47	4.97	5.72
Jack Pine	8.06	16.03	13.5	13.41	15.66	14.2	16.00	15.02	19.32	17.82
Red Pine	19.25	10.27	15.5	12.44	18.59	11.84	12.30	10.87	6.85	10.00
White Pine	5.37	10.81	13.01	16.56	12.78	15.91	8.44	7.31	9.87	5.57
Maple	8.99	8.18	9.91	9.82	10.13	12.31	10.47	11.26	10.19	10.38

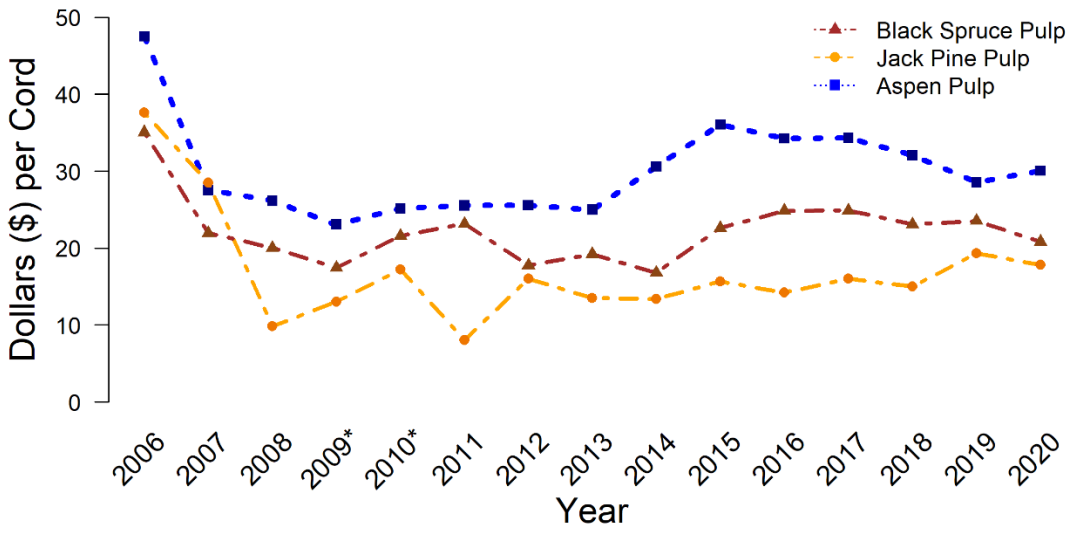


FIGURE 6-1: PULP PRICE FOR SELECT SPECIES (2006-2020) **Source:** DNR 2020 Minnesota Public Agencies Stumpage Price Review and Price Indices

In 2020, across all species and as reported on public lands, 17,133.4 tons of biomass was sold for bioenergy consumption with an average price of $0.79 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	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Aspen	0	0	0	36.16	44.24	46.49	39.24	56.73	0	37.54
Balm	0	0	0	0	0	66.8	0	0	0	31.82
Birch	15.54	14.24	15.17	15.31	17.98	18.11	20.35	16.76	16.90	18.74
Ash	18.23	18.39	15.81	11.59	14.66	12.55	13.47	12.06	10.56	11.37
Oak	19.95	20.45	22.2	23.62	27.01	31.71	28.72	28.57	27.63	29.31
Basswood	10.7	11.58	13.78	12.03	14.52	16.62	15.91	13.56	11.84	13.05
Mixed/Other Hardwoods	18.75	17.3	14.32	16.02	15.67	17.15	16.77	16.57	14.38	12.37
Balsam Fir	20.39	20.78	16.65	17.93	23.97	24.73	21.70	24.03	21.19	18.46
W. Spruce	24.99	24	25.48	29.57	25.73	27.63	32.82	26.99	27.22	26.40
B. Spruce	0	26.91	24.65	27.9	30.48	41.36	27.87	27.10	27.82	0
Tamarack	0	16.57	12.75	15.54	13.87	0	15.31	9.82	7.90	10.40
W. Cedar	0	0	0	13.04	0	12.07	12.75	8.77	9.18	21.25
Jack Pine	28.03	29.84	27.31	32.06	30.88	34.03	32.19	28.63	27.73	25.61
Red Pine	36.29	32.01	40.48	43.09	43.78	37.71	39.73	40.30	38.64	36.93
White Pine	37.95	27.51	36.9	24.95	39.21	28.7	16.68	26.62	30.16	29.77
Maple	13.86	12.94	13.76	13.57	18.11	17.82	16.19	16.21	16.78	13.84

TABLE 6-3: SAWTIMBER PRICES ($ PER THOUSAND BOARD FEET)

Species	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Aspen	52.11	53.48	53.12	0	0	0	0	0	72.00	0
Balm	0	0	0	0	0	0	0	0	0	0
Birch	42.15	35.7	36.97	47.04	42.84	45.24	0	61.23	53.33	51.69
Ash	58.09	36.12	34.06	73.41	54.17	97.67	72.20	196.37	149.81	61.14
Elm	60.43	42.45	41.41	42.19	42.5	42.54	39.77	54.75	54.07	72.91
Oak[8]	232.2	225.4	274.5	411.3	265.5	299.03	195.16	194.63	213.20	161.13
Basswood	66.11	55.87	54.44	68.87	59.24	80.40	104.38	69.55	59.18	75.34
Mixed/Other Hardwoods	48.31	36.88	28.56	65.4	47.87	47.04	50.28	47.30	78.78	67.78
Balsam Fir	0	0	66.51	0	0	0	0	0	0	0
W. Spruce	64.23	83.12	87.57	61.12	74.68	73.59	67.58	76.14	83.77	82.53
B. Spruce	0	0	0	0	0	0	0	0	0	78.32
Tamarack	0	0	0	0	0	0	0	0	0	0
W. Cedar	0	0	0	0	0	0	0	0	0	0
Jack Pine	145.76	139	112	89.56	0	118.77	139.76	109.56	109.34	105.86
Red Pine	142.33	121.5	127.1	148.3	177.2	133.22	142.72	144.41	143.27	128.10
White Pine	82.55	106.7	112.8	121.3	88.92	117.50	82.28	127.44	100.32	109.90
Maple	160.78	292.1	70.92	406.7	126.7	168.50	153.04	95.21	0	94.29

[8] Primarily for lands in southeastern Minnesota

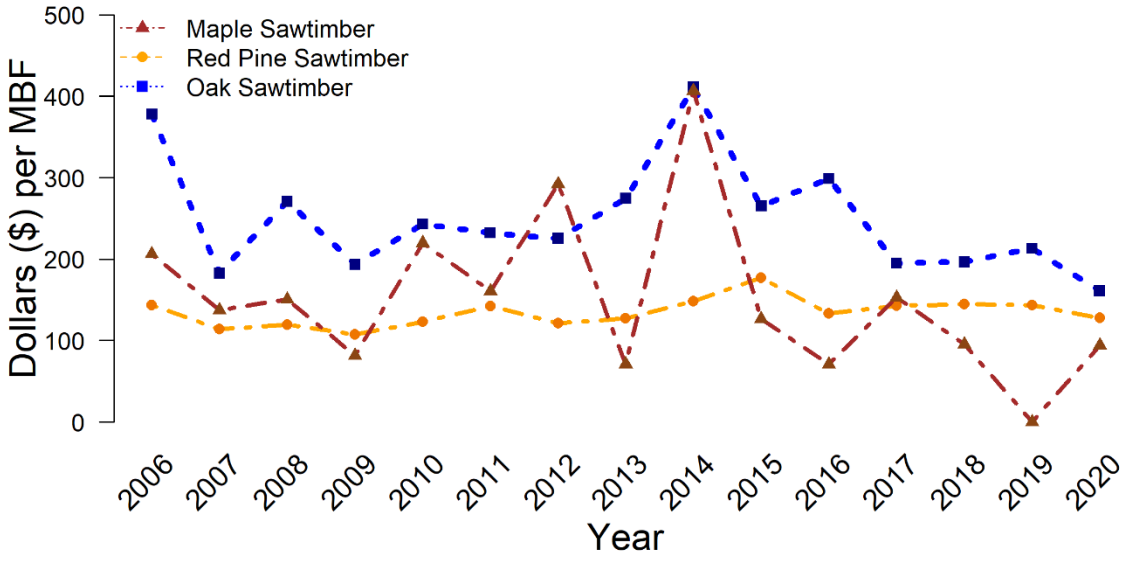


FIGURE 6-2: SAWTIMBER PRICES FOR SELECT SPECIES **Source:** DNR 2020 Minnesota Public Agencies Stumpage Price Review and Price Indices

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

Four complete cycles have been completed:

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

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

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

Forest Type – A classification of 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 U.S. Forest Service is located in St. Paul, Minnesota. U.S. Forest Service staff, in cooperation with state DNR, accomplish the FIA inventory and Timber Product Output surveys.

NIPF – Non-Industrial Private 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 U.S. Forest Service is a part of the USDA.

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: definition of gross growth, net growth, ingrowth, mortality, and removals

Gross growth: The annual increase in volume of trees 5.0 inches d.b.h. and larger in absence of cutting 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.

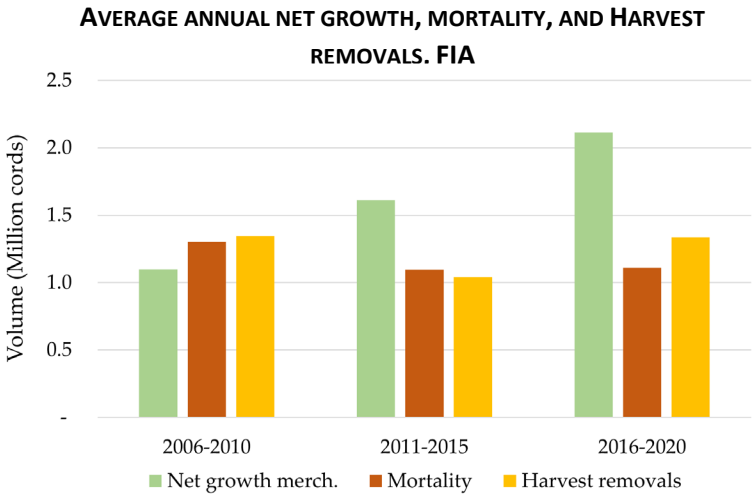
Mortality: Number or sound-wood volume of live trees dying from natural causes and not utilized, during a specified period.

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 rot, sweep, or other defect 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 has already had mortality removed so, a rough approximation of gross growth would be to add net growth and mortality together. Harvested volumes are not removed when calculating net growth. You can see in the figure below; the average annual harvest removal volume exceeded the average annual net growth during the period of 2006-2010. In contrast, from 2016-2020, the average annual net growth exceeded the average annual harvest meaning more volume was added to the timberlands than was harvested during this time period.



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*