

# Minnesota's Forest Resources 2017



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<http://www.dnr.state.mn.us/forestry/um/index.html>

# Minnesota's Forest Resources

## Revised 10/20

### Preface

This report is compiled annually by Minnesota DNR – Forestry Division, Resource Assessment Biometrician and Utilization & Marketing Program staff. The report is intended to answer frequently asked questions about Minnesota's forest resources such as: current conditions and trends in forest resources, and forest resource industrial use. Foresters, other natural resource managers, planners, forest industry, and forest policy makers will find items of interest in these pages.

We thank those who cooperated in providing and updating information for this report. They include many of Minnesota's wood product companies, USDA Forest Service Forest Inventory and Analysis (FIA) unit and Minnesota DNR staff (particularly Don Deckard, Bonnie DeLare Brian Schwingle, and Jon Drimel). All FIA summary data was obtained from FIADB version 1.8.0.00.

### Resource and Industry Highlights:

- Overall net growth for all species continued to outpace harvest levels. According to 2017 FIA figures, annual net growth of growing stock on timberland was approximately 5.68 million cords, with mortality of approximately 3.8 million cords.
- According to draft mill and fuelwood survey data, the volume of wood harvested and utilized by industry and fuelwood users was approximately 2.75 million cords (see page 5) which was down from previous years. The FIA volumes of net growth are still significantly above the current harvest levels providing a surplus of wood potentially available for additional harvest.
  - MN softwood harvest trends show a reduction in softwood species like balsam fir and tamarack, and an increased consumption of red pine compared to 2014.
  - MN hardwood harvest trends includes a slight increase in basswood. Red Oak harvest has decreased slightly from 2014, while white oak has increased from 2014.
  - Pulpwood harvest has decreased from 2015. More pulpwood imports than in the past from regional producers indicates an increased industry demand, for specific species of wood in the state.
  - The family owned timberlands acreage offers the greatest opportunity for increased timber harvest. Total pulpwood harvests from the family owned timberlands have decreased significantly since 2000.

Harvest levels: Total wood harvested and utilized from timberland by industry and fuelwood users in Minnesota was 2.75 million cords in 2017. ***Based on analysis of mill consumption (actual survey figures are not yet available), it appears that 2017/2018 harvest levels are within the 2.7 to 3.0 million cord range.***

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FIA data analysis and Report compiled by Scott Hillard, PhD, Forest Modeler.

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# Wood-Using Industry Overview



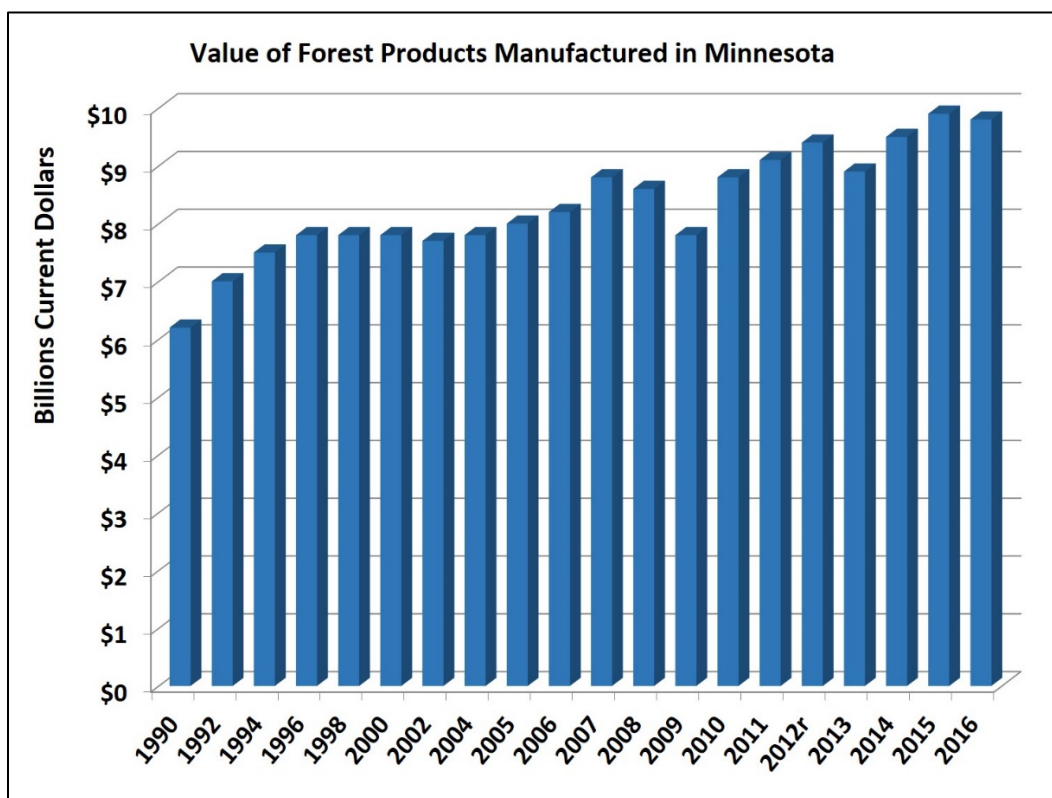
A brief overview of Minnesota's wood-using industry, including mill location and product information for many of the larger mills, and total industry economic impact.



## Minnesota's Forest Industry at a Glance <sup>1</sup>

### Economic Impact 2016

- \$9.8 billion direct value of shipments with \$17.8 billion total output effect.
- \$3.4 billion direct value added with \$8 billion total value added effect.
- 5th largest manufacturing sector in Minnesota by employment (#1 food products, #2 computers & electronics, #3 fabricated metal products, and #4 machinery).
- 30,500 direct jobs with 64,000 jobs total employment effect.
- \$1.6 billion in direct payroll with \$3.4 billion payroll effect.
- \$40 value added by primary manufacturing per \$1 stumpage value with \$24 remaining in-state.
- \$458 million total state and local tax receipts effect.



### 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.

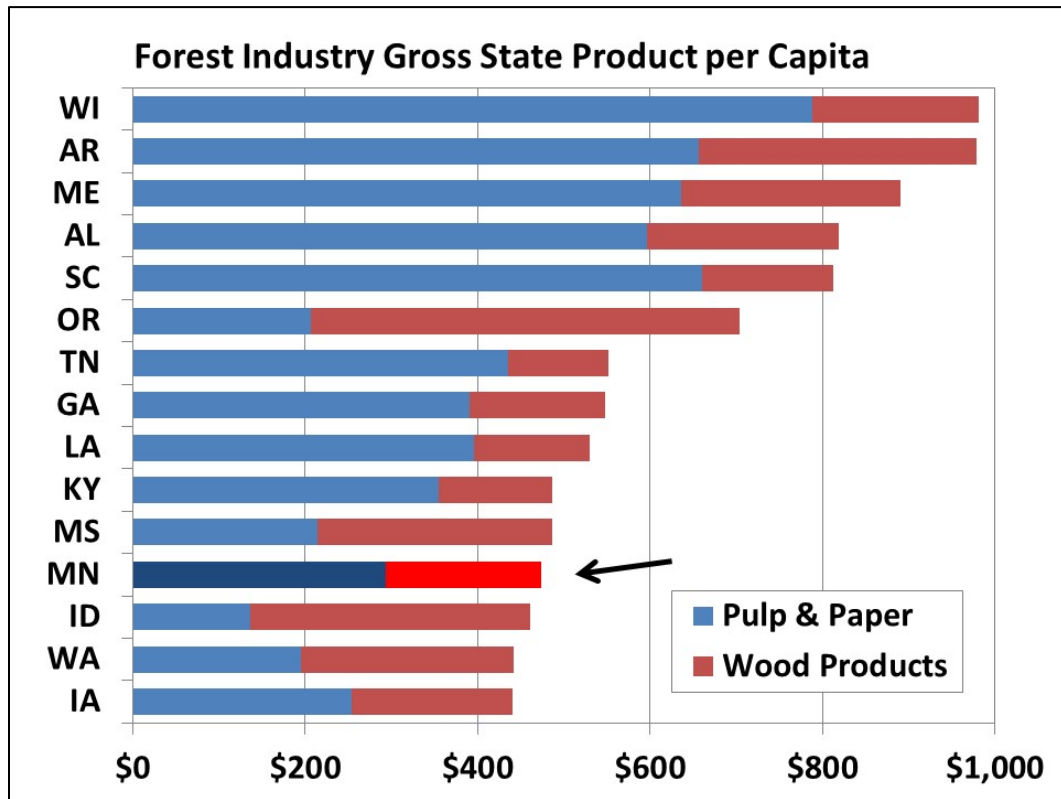
### Non-Traditional Industries Dependent on Minnesota's Forest Lands

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

<sup>1</sup> CY2016 data unless otherwise noted; compiled by Don Deckard, Ph.D., Forest Economist, Minnesota DNR.

### Value Added (Gross State Product) per Capita

**In 2016, Minnesota was ranked #12** nationally in forest products manufacturing with \$473 direct value added (Gross State Product) per capita. **In 2012, Minnesota was ranked #7** nationally in forest products manufacturing with \$524 direct value added (Gross State Product) per capita.



### Manufacturing Facilities as of January 2017 <sup>2</sup>

- 4 primary pulp & paper mills and 3 recycled pulp & paper mills
- 94 converted paper products plants
- 329 sawmills and wood products plants
- 328 wood kitchen cabinet and countertop manufacturers
- 62 wood furniture and custom architectural woodwork shops

### Volume of Timber Harvested

Annual harvest volume = 2.75 million cords including:

- Pulpwood = \*2.04 million cords (2016)
- Sawlog & Specialty Mills = \*284 million board feet (2017)
- Residential fuelwood = 108,000 cords live trees from timberland (2017/18)
- Commercial wood fuel = 39,700 cords ( draft 2017)

*\*Rounded number Source: 2017 draft USFS TPO Sawmill & DNR Survey*

<sup>2</sup> Source: MNDEED, Quarterly Census of Employment and Wages (QCEW), retrieved January 10, 2018.

## Minnesota Pulp and Paper – 2017

Firm	Wood Used	Product
UPM - Blandin Paper Mill Grand Rapids	Aspen, Balsam Fir, Basswood, Spruce	Lightweight coated publication papers
Packaging Corporation of America d.b.a. Boise White Paper, LLC International Falls	Aspen, Balm, Pine, Spruce, Balsam Fir, Birch, Tamarack, Maple	Office papers, label and release papers, base sheets, business and specialty printing grades
Verso Duluth	Balsam Fir, Spruce	Uncoated, lightweight supercalendered magazine and publication papers
SAPPI North America Cloquet		Coated freesheet fine printing and publication paper, market pulp
	Aspen, Maple, and minor amounts of birch and ash	Specialized cellulose
Recycling Mills		
Rock-Tenn Company St. Paul	Recycled paper and corrugated	Cardboard and corrugated boxes
Verso Recycled Fiber Mill Duluth	High grade office paper and computer paper	Market pulp
Liberty Paper Company Becker	Recycled paper and corrugated	Cardboard and corrugated boxes

## Minnesota Oriented Strand Board and Engineered Wood Products – 2017

Firm	Wood Used	Product
Louisiana-Pacific Two Harbors	Aspen, Balm, Birch	Engineered Siding Panel-OSB
Norbord Bemidji	Aspen, Balm, Birch, Maple, Pine	OSB

In October 2018 UPM Blandin announced permanent closure of their #5 paper machine line. This line produced lightweight coated magazine papers. The closure was completed by April 2018 and job loss was 150 employees. UPM mill in Grand Rapids has shut down three of their four paper machines since 2003. They continue to run one line the # 6 machine.

In April 2018 International Bildrite a mill producing fiberboard products including fiberboard sheathing, high density roof board, and sound deadening board closed its operations in International Falls MN. The mill had been in business for over 30 years. The job loss was 43 employees.

In 2018 Xcel terminated power purchase agreements with three wood biomass facilities under two entities the Laurention Energy Authority and Benson Power. The loss of these facilities use of wood biomass lead to significant changes in the wood energy markets in the state, being realized in 2018 and beyond. Wood biomass markets are discussed further on pg. 13 Wood Biomass Markets and Future Utilization.

For additional information about sawmills, specialty mills, pulp and paper mills, engineered wood products, shavings mills, and dry-kiln facilities in Minnesota go to the following website and click on the Minnesota Primary Forest Products Producer Directory link:

<http://www.dnr.state.mn.us/forestry/um>



## **Minnesota's Sawmills/Specialty Mills – 2017**

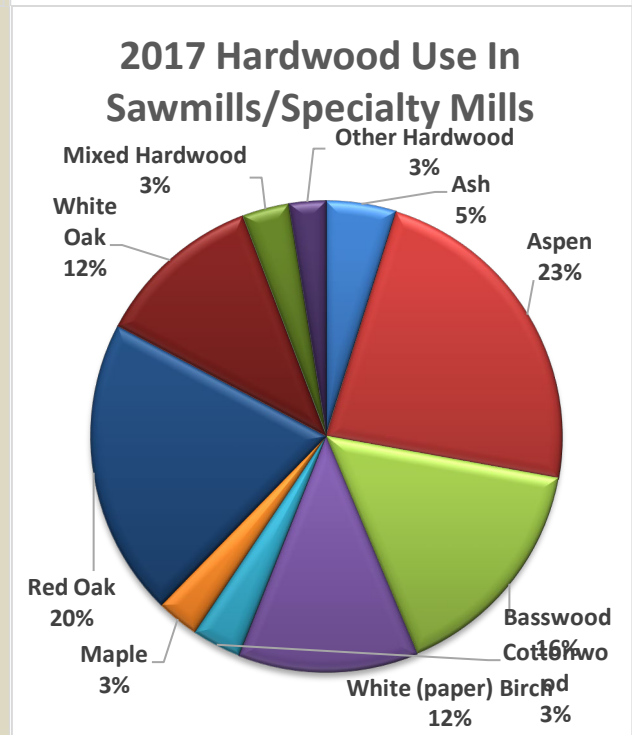
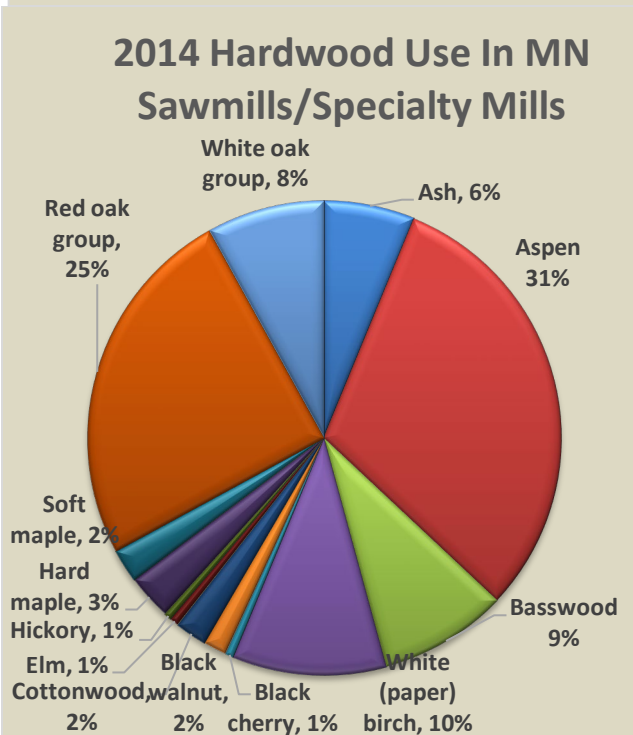
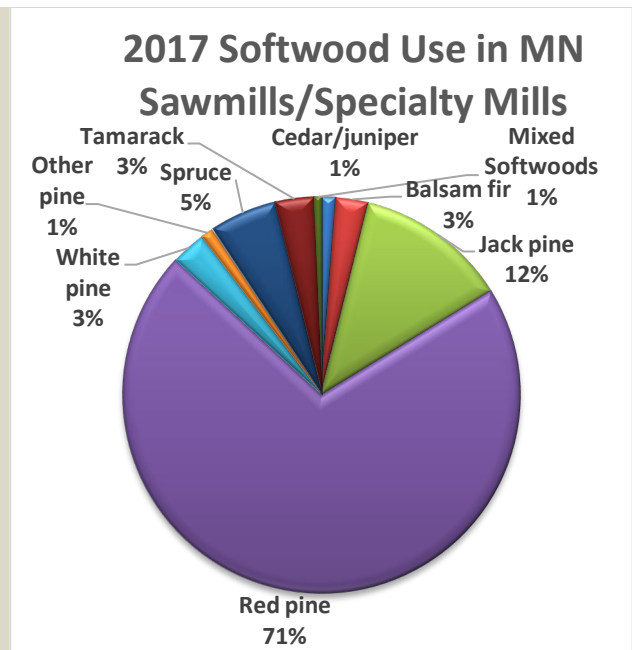
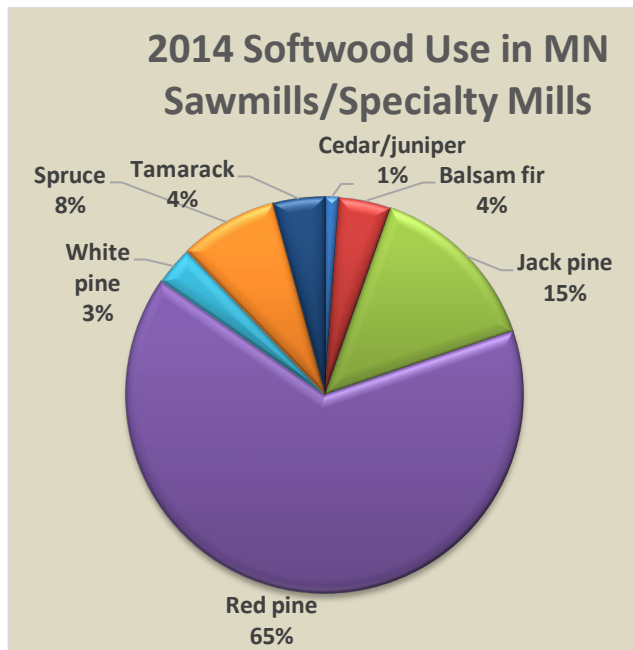
The sawmill sector is important to forestry and wood utilization because it creates market diversity. The approximately 568,100 cords produced annually is 21% of the statewide timber harvest and provides value-added markets for various species, sizes, and qualities of timber. In addition, sawmills provide products we all use, as well as providing significant employment and economic benefits for many rural communities.

Sawmills also have a complementary impact on other wood industry sectors. For example, some sawmills send residue chips to paper mills, benefitting both sectors. Also, the higher-value sawlog markets can help make logging residue economically accessible as woody biomass for energy. Finally, high value markets are important to landowners through harvest compensations, which help them, afford to engage in other management activities like creating wildlife habitat and improving their forests health.

There are over 200 sawmills in Minnesota, but most are small, portable bandsaw mills that account for a tiny fraction of wood use. In contrast, about 30 sawmill/specialty mills in Minnesota utilize more than 1 million board feet or 2,000 cords annually. In fact, the top 4 mills by production volume account for 60 percent of the total consumption, with one large softwood mill accounting for about 40 percent of the total

<b>Examples of Products Produced by MN Sawmills/Specialty Mills</b>		
<b>Firm</b>	<b>Wood Used</b>	<b>Product</b>
Cass Forest Products, Cass Lake	Aspen, Jack Pine, Red Pine, White Pine	Cants, lumber
Hawkins Sawmill, Isle	Mixed Hardwoods	Cants, lumber
Hedstrom Lumber Co, Grand Marais	Aspen, Jack Pine, Red Pine, White Pine, White Spruce	Lumber
Woodline Sawmill, Onamia	Aspen, Basswood, Jack Pine, Red Pine, Mxd. Pine	Shavings
Potlatch Corporation, Bemidji	Balsam Fir, Jack Pine, Red Pine, White Spruce	Lumber
Rajala Timber Co., Deer River	Black Ash, Aspen, Balsam Fir, Basswood, Paper Birch, Jack Pine, Red Pine, Black Spruce	Cants, lumber
Root River Hardwoods Inc., Preston	Basswood, Elm, Green Ash, Hickory, Hard Maple, Red Oak, White Ash, White Oak, Walnut	Cants, lumber, veneer logs
Savanna Pallets, McGregor	Black Ash, Aspen, Basswood, Paper Birch, Mixed Hardwoods, Red Oak, Pine	Boxes or crates, pallets/skids, hardwood lumber
Bell Lumber and Pole Inc., New Brighton	Red Pine	Telephone Poles
Lonza, Cohasset	Tamarack	Arabinogalactan extract used in food, beauty and health products
Pliny Post & Pole, McGrath	Red Pine	Poles/pilings and posts

Since 2001 sawmill consumption has declined statewide. A majority of the decline happened between the years 2001-2004. Softwood sawlog production has been more stable over the years and in the last few years has seen an increase in primarily Red Pine consumption. Hardwood sawlogs have seen increased use of Basswood and White Oak in the last few years. Species like Aspen, Maple and Spruce which can be preferred or utilized in pulp or sawlog markets tend to see the largest volume shifts between sectors over time.

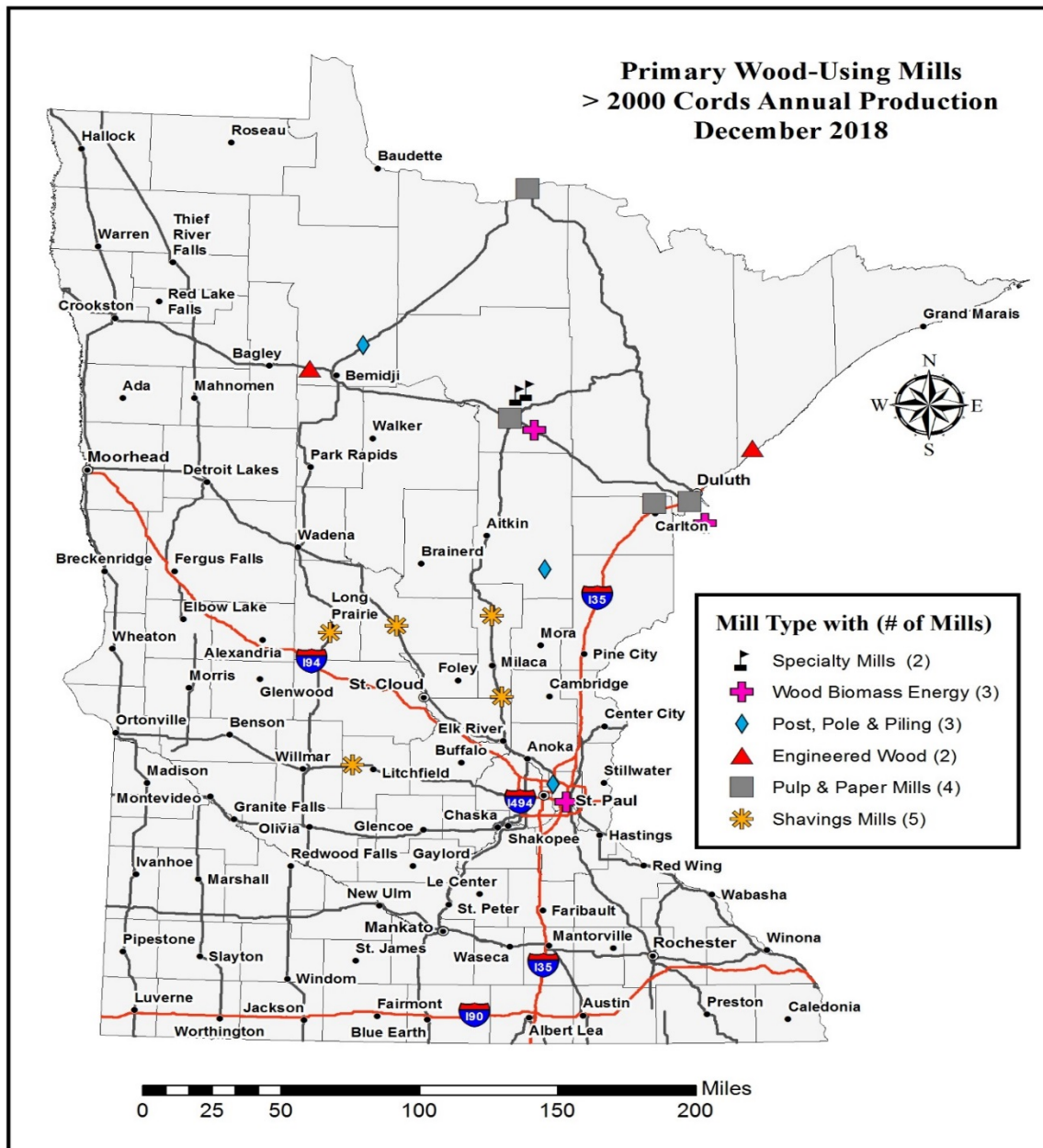


#### Minnesota Saw Log Roundwood production, (in cords)

*Saw logs	2007	2010	2014	2017 (Draft)
Softwoods	322,456	331,253	318,532	322,434
Hardwoods	216,316	190,633	197,823	211,851

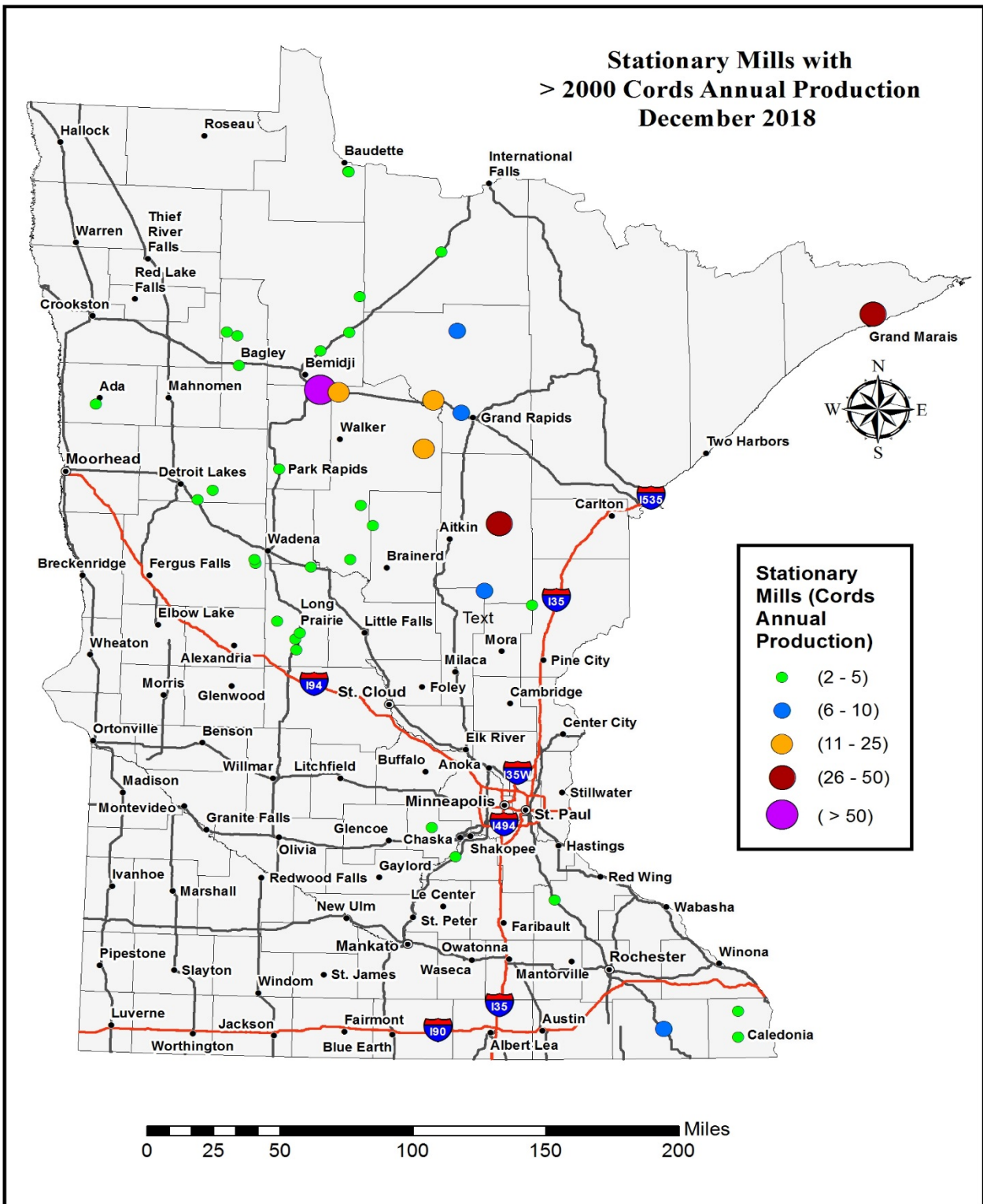
Total **538,772** **521,886** **516,355** **534,285**

\* 124 saw mills that reported less than 5 thousand cubic feet of receipts in 2010 were not surveyed for 2014 or subsequent years.\* Saw log production only not including other or specialty mill production



Locations of mills is an important factor in determining markets for wood. The map above shows the pulpwood consuming mills and other mills or specialty saw log wood consumers. The pulpwood mills utilize various species of wood material, with aspen pulpwood being the largest component. Wood energy facilities utilize the most species while other or specialty sawmills utilize the fewest, often only one species of wood.





The map above shows stationary sawmills. These mills utilize various species of wood material, with a ratio of 65 percent softwood and 35 percent hardwood in 2017.

## Woody Biomass Utilization & Future Wood Markets

Due to the changing demand for printing and writing paper products, a global marketplace, and the new normalized level of housing starts, Minnesota continues to experience changed demands for traditional forest products. This market change is a sustainable opportunity to use our local forest resources which are renewable and climate friendly alternatives to materials like steel and concrete and petroleum based fuels and chemicals. The resource is available for bio-based market development as well as to support, diversify and strengthen our traditional forest products industry. Trees can be used to make traditional wood products as well as create thermal energy, generate electricity and power, provide renewable chemicals and as liquid fuels.

Woody biomass comes in several forms and continues to be used as a source of renewable energy for both industrial and non-industrial applications in Minnesota. The forest products industry has been using biomass for heat or power or both for over thirty years. District and residential thermal heating remains an attractive option due to the volatile price of fossil fuels.

There are two main factors why small-diameter timber, and tops and limbs are not useful for most traditional forest products:

- 1) The high percentage of bark relative to wood fiber; bark fiber is not suitable for many products.
- 2) The higher cost and loss of efficiency in processing smaller-diameter material.

Small wood or biomass is a good fit for a number of other products and markets including:

Revegetation or Erosion Control Materials: Markets include products for the hydraulic seeding industry.

Special Forest Products (SFP): Markets include log furniture, craftwood, decorative material etc. These tend to be small volume, but high value niche markets.

Landscape Mulch/Animal bedding: Markets are available they can be more limited in rural forested regions of Minnesota, but are significant near metropolitan areas or areas in central and southern MN near the poultry and dairy industry.

Energy: Energy for heat or power production is by far the largest market for woody biomass in Minnesota.

Thermal Heating: Residential, commercial and district building heating.

Some Large Wood-Fired Energy Producers in Minnesota		
Company Name	City	Fuel
SAPPI	Cloquet	Mill residue, logging residue, roundwood
Minnesota Power	Duluth	Mill residue, logging residue, roundwood
St. Paul District Energy	St. Paul	Urban wood waste, roundwood, logging residue

*In addition to the list above, there are many small to medium wood processing companies that burn some or all of their wood waste for heat and/or process steam.*

The prospect of expanded woody biomass harvesting and processing has many potential benefits, including: reduced dependence on foreign energy sources, improved bottom lines for logging and processing operations, increased opportunities for forest management through timber stand improvement, pre-commercial thinning, sanitation or salvage operations, wildlife management through brush land clearing, invasive species control, and potential complementary value-added products for the forest products industry. In fact, increased utilization of wood for bioenergy can, on some sites, improve ease and success of regeneration. It can also reduce fuel loading and fire risk directly impacting the cost of fighting forest fire and forest reestablishment costs.

### **What is the Future for Underutilized Wood and Woody Biomass in MN?**

- National policies addressing the carbon neutrality of wood have made progress allowing for, the potential of future federal policy to increase renewable wood energy development and expand woody biomass utilization.
- In the 2017 MN Legislative session there was a repeal of the woody biomass mandate for Xcel Energy. This led to a loss of power purchase agreements, which stopped or greatly reduced wood biomass use at the impacted facilities. Woody biomass markets provide opportunities to manage forests for the diverse array of benefits they provide. Mill residue markets keep material from being landfilled. This repeal has led to a significant reduction in the amount of energy in MN coming from wood.
- Woody biomass can play an important role in Minnesota's clean energy economy by contributing to the energy markets for which other renewable energy sources are not as sustainable. Wood biomass is a renewable resource that can be used twenty-four hours a day year round on demand for industrial processes, heat, and torrefied wood production or to produce liquid fuels. Wood biomass supports more jobs through its continued operations when compared to other green energy sources.
- The DNR is interested in bioenergy for these main reasons: to mitigate climate change, as a conservation and habitat management tool, fire fuel load reduction, renewable resource economic opportunity and to maintain forest health and productivity.
- The development and sustainability of wood biomass markets depend on the price and availability of alternate energy sources, procurement and operation costs of biomass resources, state, federal and international renewable energy policies and markets.

### **What are some potential opportunities for future wood markets?**

- Building: mass timber construction with cross laminated timber (CLT), glue laminated timber (Glulam) or other traditional or emerging engineered wood products.
- Bio-char/Torrefied Wood/Thermally Modified Wood: used in water filtration as an absorbent material, a soil amendment, as a substitute for coal, as an exterior building product. Wood modification treatments using heat improves wood properties.
- The structural properties of wood: primarily cellulose products such as cellulosic insulation, or wood plastic composites, nano-materials to increase strength and sturdiness of a variety of materials such as packing materials or as fibers used in textiles.
- Chemical products: chemical sugars used in plastics or biofuels, clean lignin fiber or bio based adhesives that can be an alternative to petroleum-based resins and bio-oil products.
- Combined heat and power (CHP) applications: this could include thermal cooling as well as heating and electrical power generation.
- Jet fuel/Transportation Bio Fuels: the same concepts as fossil-based carbon fuel technology with production process and efficiency's to be refined and commercialized.
- Additional or Increasing "traditional" consumer wood products: products that are evolving or increasing market share to reflect new consumer demands. Examples; recycled fiber products, clothing or cosmetics, food additive products, and new residential construction products like siding or decking.

Guidelines, policies, and educational resources have been created in Minnesota to manage our forest resources sustainably and promote best practices including:

1) Forest Management and Biomass Harvesting Guidelines

[http://www.frc.state.mn.us/initiatives\\_sitelevel\\_management.html](http://www.frc.state.mn.us/initiatives_sitelevel_management.html),

2) Minnesota's Logger Education Program website (<http://mlep.org/>), and

3) MN Forest Resource Council website (<http://mn.gov/frc/>)



## Residential Fuelwood Consumption



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

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

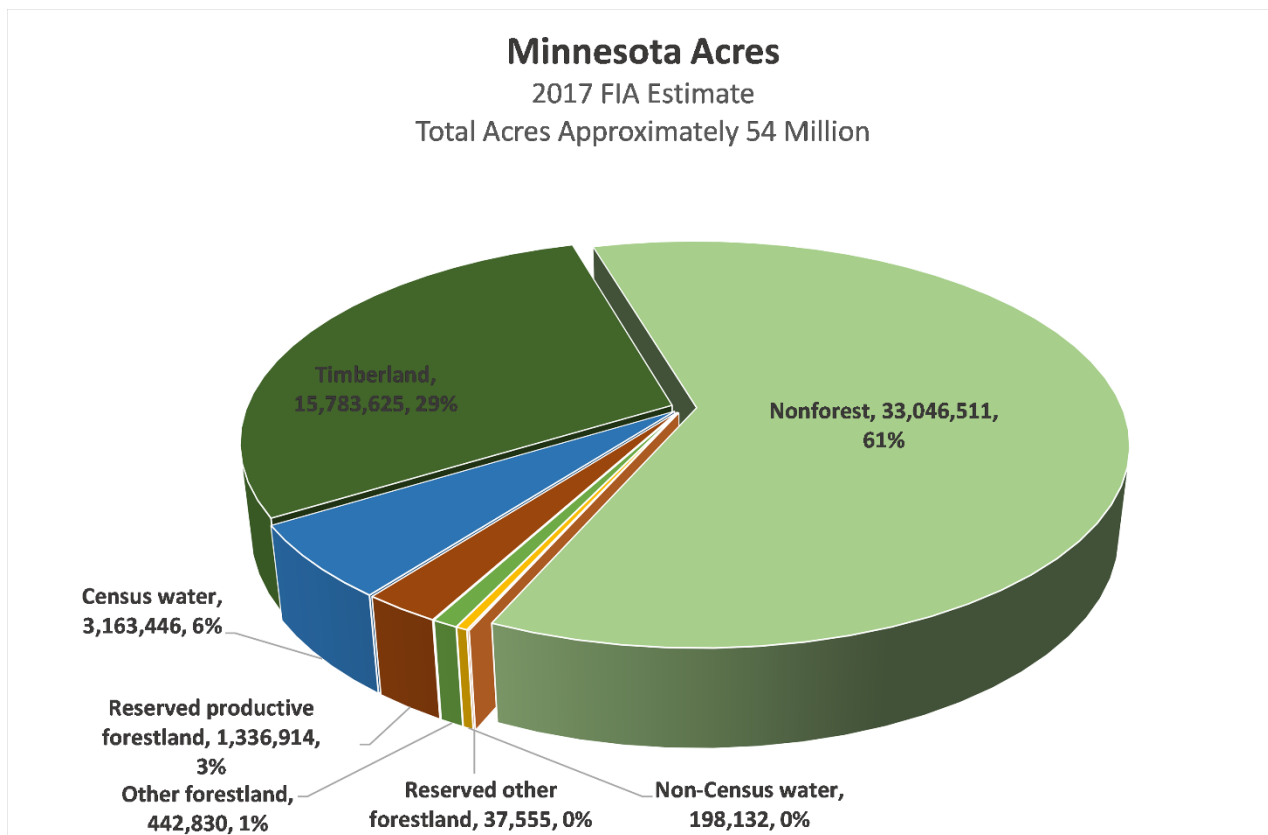
### FUELWOOD

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

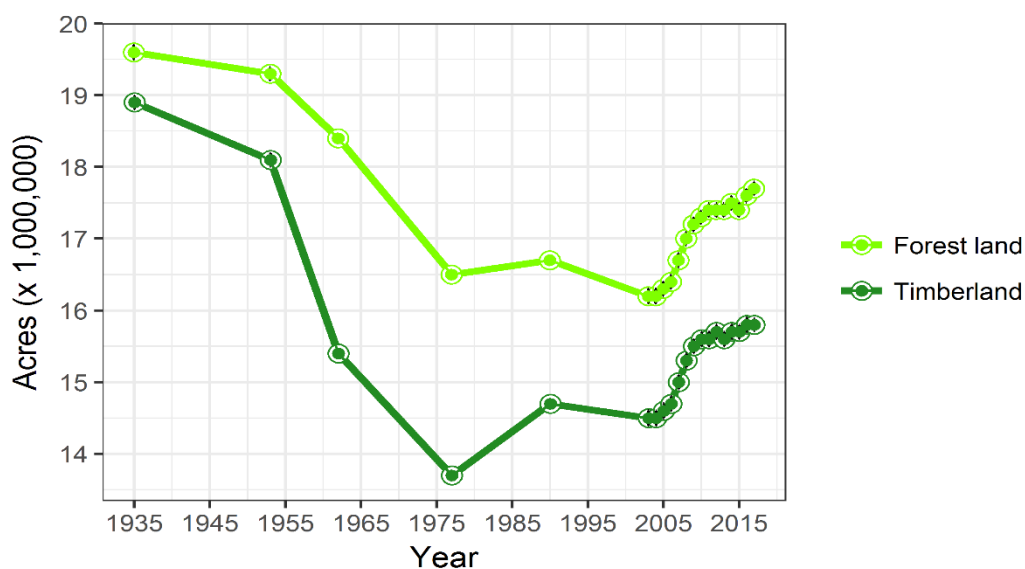
# Forest Resources Overview



**A brief overview of Minnesota's forest resources, including total forestland and timberland acreage, cover type percentages and an ownership breakdown for timberland.**



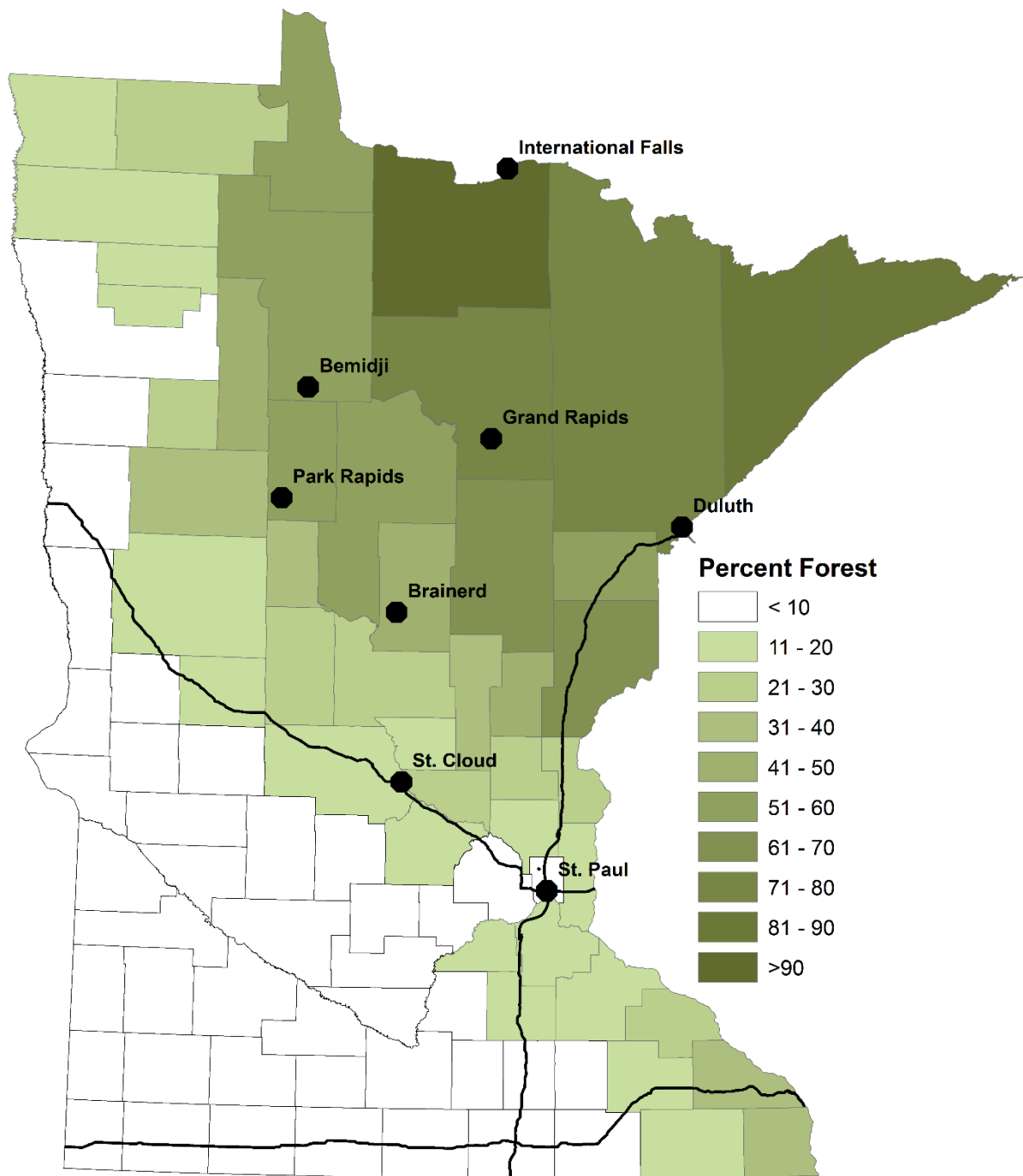
**Source:** USDA Forest Service 2017 FIA database



**Source:** USDA Forest Service 2017 FIA database

According to 2017 FIA data, Minnesota currently has about 15.8 million acres of forest land that is classified as “timberland”. Timberland is forest land that is productive enough to produce a commercial crop of trees and is not reserved from harvesting by policy or law. Reserved forestland is land reserved from harvest by policy or law, including designated wilderness areas like the Boundary Waters Canoe Area

(BWCA), old growth reserves, and others. Other forestland is mostly forested land of very low productivity for tree growth, such that it is incapable of producing a commercial crop of trees.



**Map:** Minnesota percent forest coverage by county. **Source:** FIA 2017

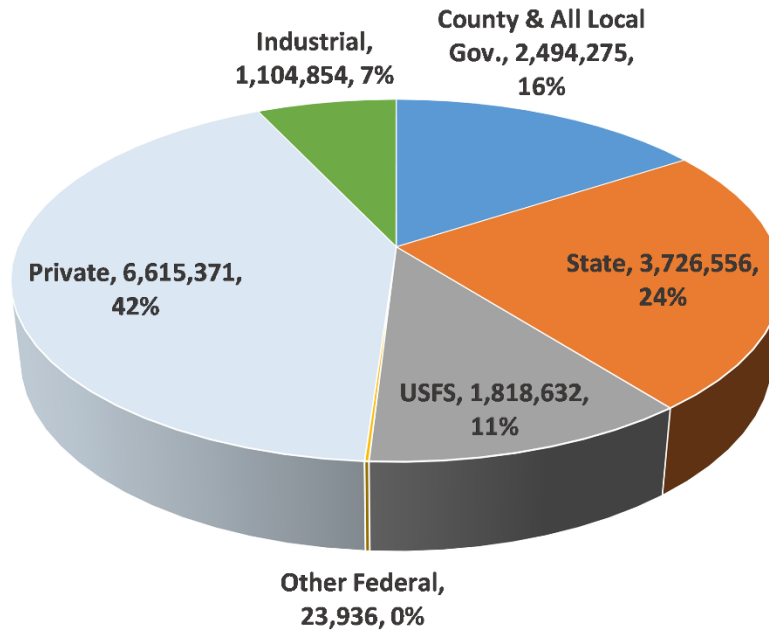
Generally around Minnesota the densist forest cover occurs within the north eastern portion of the state (refer to Map). Generally forest cover decreases as one heads south, however the density of forests increases in the south eastern corner in Winona, Fillmore, and Houston counties. Forest density can have a number of consequences for wildlife habitat, as well as forest resource availability.



## Minnesota Timberland Ownership

FIA 2017 Estimate

Total Timberland=15,783,625

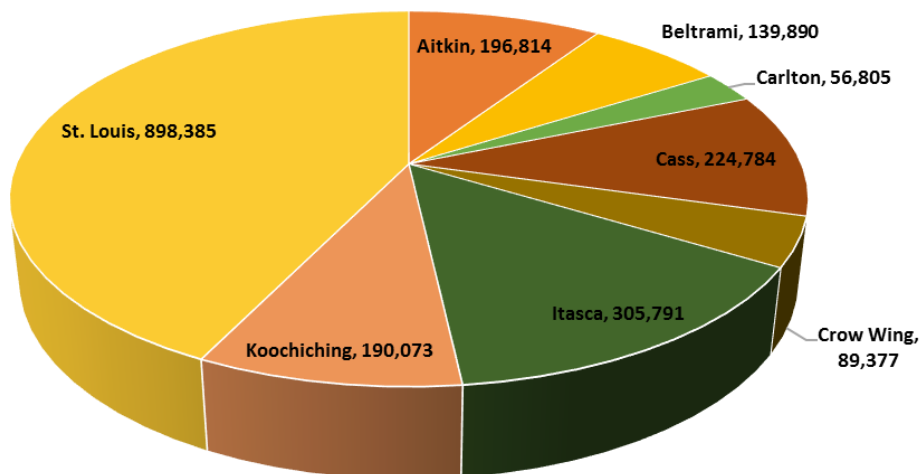


Source: USDA Forest Service 2017 FIA Database; update 10/20

Ownership of timberland is an important factor in assessing many issues, including timber supply. Industry includes Real Estate Investment Trusts (e.g. Potlatch Corporation), Timberland Investment Management Organizations (e.g. Molpus Woodlands Group), and integrated timber companies such as UPM Blandin and Rajala Timber Company. FIA does not differentiate between private industrial and private non-industrial lands. Industrial lands are estimated at approximately 7-8% in Minnesota. Though this figure may change in the future as some timber companies are liquidating their holdings.

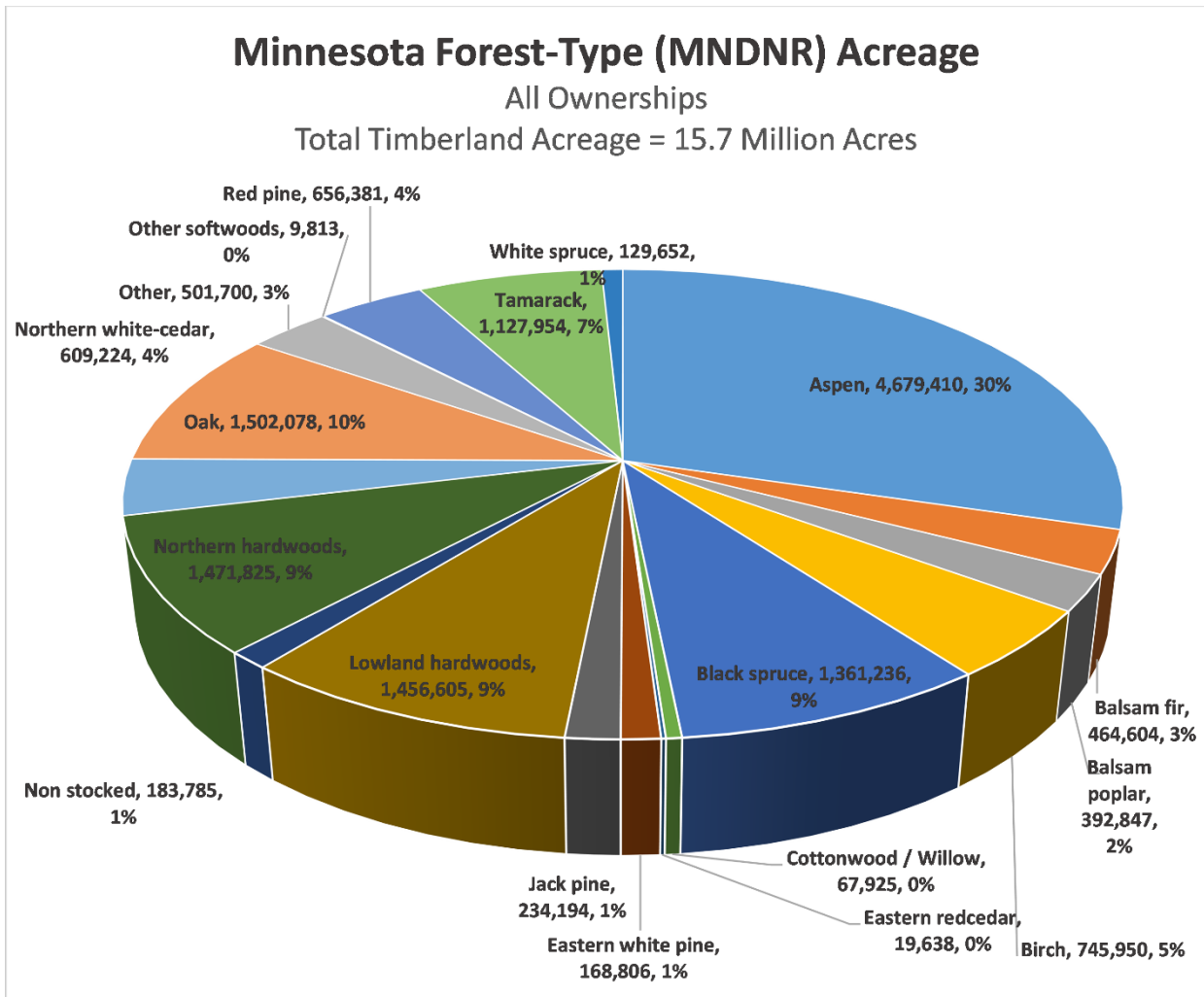
## County Acreage Within Minnesota, Enrolled in SFI or FSC

FIA 2017-Timberland Acres, Total=2,101,919



Source: USDA Forest Service 2017 FIA database

Some counties have enrolled their lands under different sustainability agreements. The sustainable forestry initiative (SFI) or the forest stewardship council (FSC) are the organizations that certify lands as being managed to their specifications. Estimates of how many acres are enrolled come from FIA. The percentage indicates how much of the total forest within the county is administered by the county.



Source: USDA Forest Service 2017 FIA database

**Forest Type:** A classification of forest land based on the species forming a plurality of live tree stocking. It is worth noting that aspen is by far the largest forest or “cover” type in Minnesota. Oak, northern hardwoods, black spruce and tamarack also make up a large percentage of Minnesota forests. The timberland in Minnesota has increased from approximately 15,815,000 million acres in 2016 to approximately 15,981,000 in 2017. A number of factors could be at play in the increase of timberland within Minnesota. Land conversion often takes place as agricultural land is reclaimed by forest. This is a dynamic process though that may reverse with fortunes in the agricultural or timber industry sector.

**Area of Timberland in Minnesota by DNR Cover Type - 2017**

<b>Forest Type</b>	<b>Acres</b>
Aspen	4,679,410
Balsam fir	464,604
Balsam poplar (Balm of Gilead)	392,847
Birch	745,950
Black spruce	1,361,236
Cottonwood / Willow	67,925
Eastern red cedar	19,638
Eastern white pine	168,806
Jack pine	234,194
Lowland hardwoods	1,456,605
Non stocked	183,785
Northern hardwoods	1,471,825
Northern white-cedar	609,224
Oak	1,502,078
Other	501,700
Other softwoods	9,813
Red pine	656,381
Tamarack	1,127,954
White spruce	129,652
<b>Total</b>	<b>15,783,625*</b>

**Source:** USDA Forest service-2017 FIA Database, update 10/20; \* May not sum due to rounding

# Harvest Levels



**Information on 2016/17 timber harvest in Minnesota by product category and estimation of contribution by timberland ownership.**



**Total wood harvested and utilized by industry and fuelwood users in Minnesota  
(in thousand cords - by species – from timberland)**

Pulpwood 2016 (DRAFT); Sawtimber 2017 (DRAFT\*\*); Residential Fuelwood 2017/18; Commercial Wood Fuels 2017 (DRAFT\*)

Species	*Pulpwood	*Sawlogs & other	Estimated Sawlog Exports (based on 2017 TPO)	**Residential Fuelwood	*Commercial Wood Fuels	Total
Aspen/ Balm	1,336.9	46.0	0.1	5.4	14.0	1,402.3
Paper Birch	97.2	24.6	0.4	10.8	3.9	136.9
Ash	29.6	9.6	0.2	9.7	1.9	51.0
Oak	0.6	63.7	12.1	23.7	2.2	102.3
Basswood	12.1	31.6	0.4	3.2	0.1	47.4
Maple^	^102.3	5.9	1.1	9.7	4.0	123.0
Cottonwood	0.0	6.7	1.3			8.0
Other Hardwoods	1.2	5.1	2.5	11.8	1.9	22.7
<b>Hardwood Sub-Total</b>	<b>1,580.3</b>	<b>193.2</b>	<b>18.1</b>	<b>74.5</b>	<b>28.0</b>	<b>1,894.1</b>
Pine	0.4	3.5		11.8	7.4	23.1
Red Pine	61.9	246.6	1.1			309.6
White Pine	8.7	10.0				18.7
Jack Pine	33.8	43.3			0.1	77.2
<b>Pine Sub-Total</b>	<b>104.8</b>	<b>303.4</b>	<b>1.1</b>	<b>11.8</b>	<b>7.5</b>	<b>428.7</b>
Spruce	226.0	19.6			0.2	245.8
Balsam Fir	113.1	9.2			0.3	122.6
Tamarack	18.0	10.9			0.1	29.0
White Cedar		4.0				4.0
Other Softwoods				4.3	1.2	5.4
<b>Softwood Sub-Total</b>	<b>357.3</b>	<b>43.7</b>	<b>0</b>	<b>4.3</b>	<b>1.7</b>	<b>407.0</b>
Mixed Species	1.2	8.6		17.2	2.5	29.5
<b>Total</b>	<b>2,043.7</b>	<b>548.9</b>	<b>19.2</b>	<b>108.0</b>	<b>39.7</b>	<b>2,759.5</b>

**Source:** USFS and MN DNR mill surveys & residential fuelwood survey.

*-Figures in chart may not total exactly due to rounding*

\*\*Draft Sawmill does include estimated wood produced in MN and exported to region Sawmills (used 19,284 cords based on 2017 actual numbers)

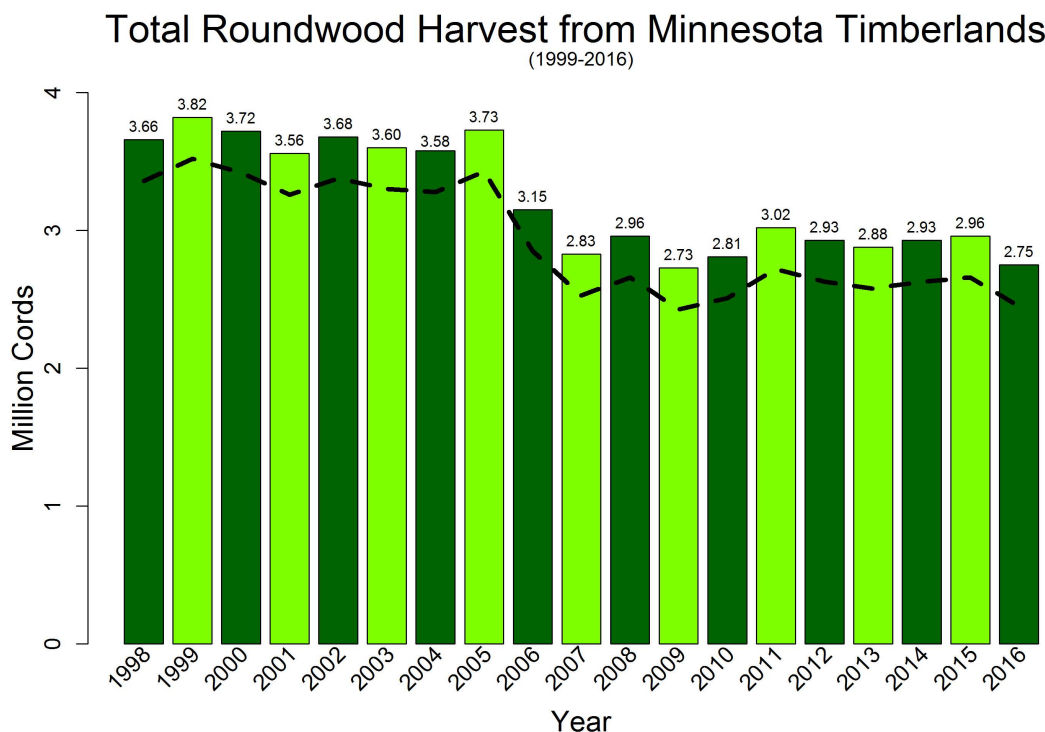
\*\*Fuelwood removed from live trees on timberland.

\*Draft

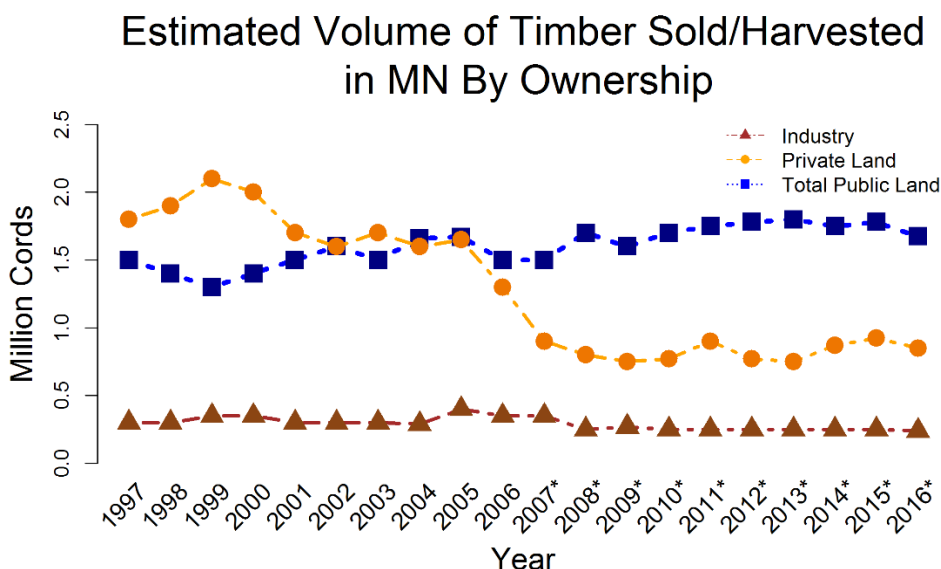
^ Maple pulpwood number in table is half the production volume reported in draft 2016 TPO data, plus exports.

-Figures include cords of pulpwood exported to Wisconsin and Canada: Aspen: 49,698; Spruce: 51,755 (only WI); Red Pine: 9,211 (only WI); Maple: 13,271 (only WI); Jack Pine: 10,244 (only WI); Birch: 30,019 (only WI); Ash: 5,261 (only WI); Basswood: 2,751 (only WI); White Pine: 2,023 (only WI); Red and White Oak: 697 (only WI). Commercial fuelwood use in 2017 dropped by approximately 15K relative to 2014/15 numbers. Pulp use in 2016

decreased relative to 2014 estimates by approximately 55,600 cords. We estimate 2017 sawlog exports, based on the TPO 2017 (Production –Receipts) numbers, were approximately 19,284 cords, mostly hardwoods to Wisconsin.

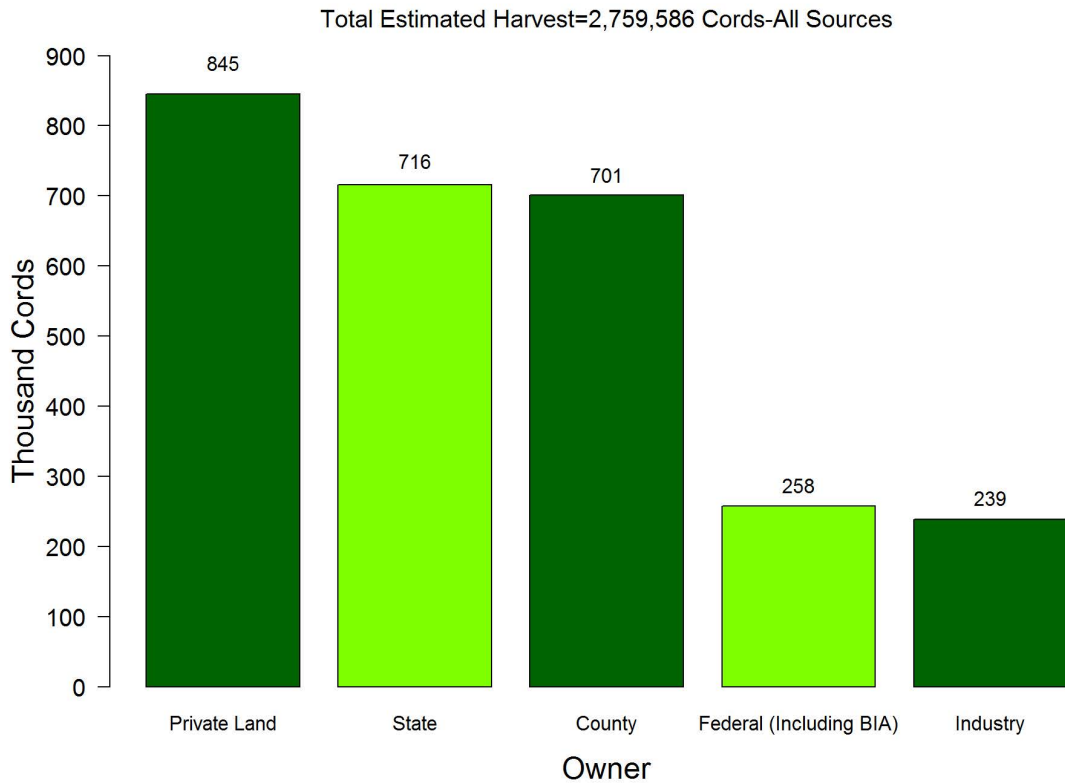


**Source:** 2016 Pulpwood (USFS, Northern Research Station, DRAFT), sawtimber + sawtimber exports (DRAFT 2017 and TPO estimate 2017)\* and fuelwood (MN DNR surveys, DRAFT 2017).



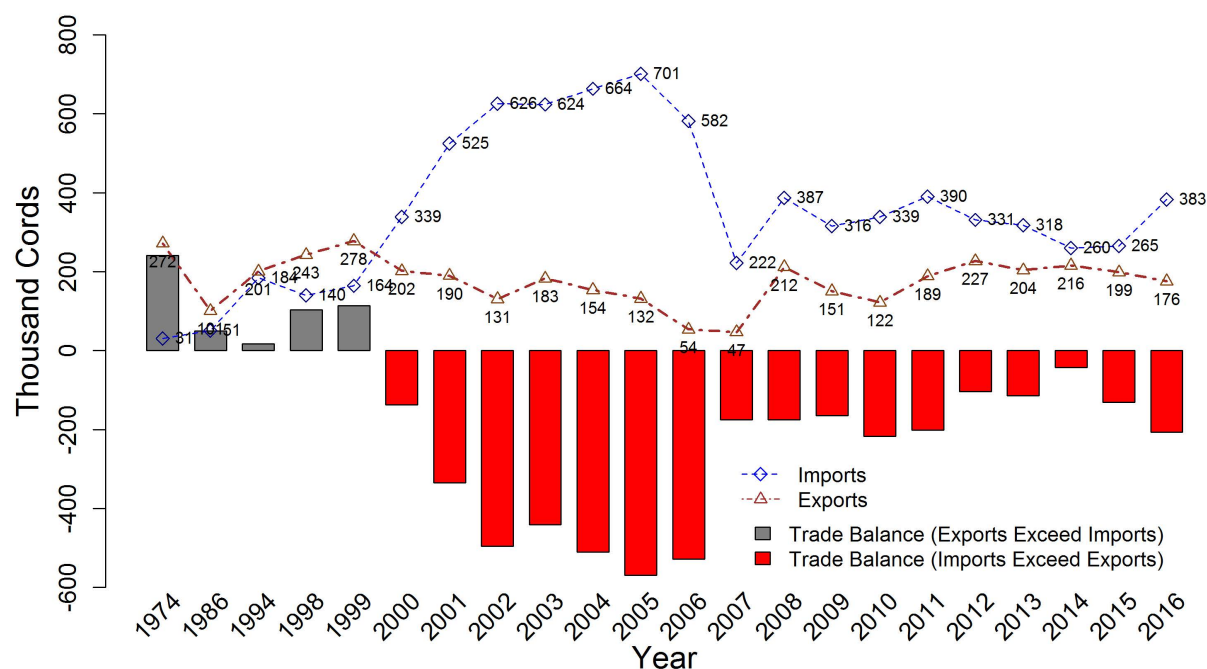
**Source:** Public Lands: Public Stumpage Price Review through 2006. *Beginning with 2007, annual volume scale reports (harvested) are used for State and Federal lands rather than volumes sold. Change necessary due to large volumes of re-offered wood sold by public agencies in 2007.* Industry Lands: Minnesota Forest Industries estimate of harvested volume from 2016. Private Lands = an estimate calculated as follows: Total estimated harvest 2016, minus 2016 public volume harvested (sold through 2006), minus 2016 estimated industry volume harvested. Molpus Woodlands Group (formerly Forest Capital Partners) timberlands contained in “Industry” totals.

## Contribution to Estimated Harvest in Minnesota 2016



**Source:** State Lands: FY 2016 Harvest, DNR Timber Sales Annual Report (scaled). Federal: FY 2016 Harvest, Superior National Forest Timber Statistics, and Chippewa National Forest Timber Statistics; BIA: Public Stumpage Price Review 2016 sold. County Lands: Public Stumpage Price Review 2016 sold. Industry Lands: Minnesota Forest Industries survey of 2016 harvested volume. Molpus Woodlands Group (formerly Forest Capital Partners) timberlands included in Industry totals. Private Lands = an estimated figure as follows: Total estimated harvest 2016, minus state, county, National Forest and BIA volume harvested, minus estimated industry volume harvested. Total harvest was down in 2016, compared to 2014.

## Minnesota Imports and Exports of Pulpwood Roundwood



**Source:** USFS, Northern Research Station survey of industrial wood using industry. Based on Draft 2016 pulpwood data, does not include sawtimber. In 2016, estimated imports were approximately 383,000 cords, while exports were approximately 176,000 cords.

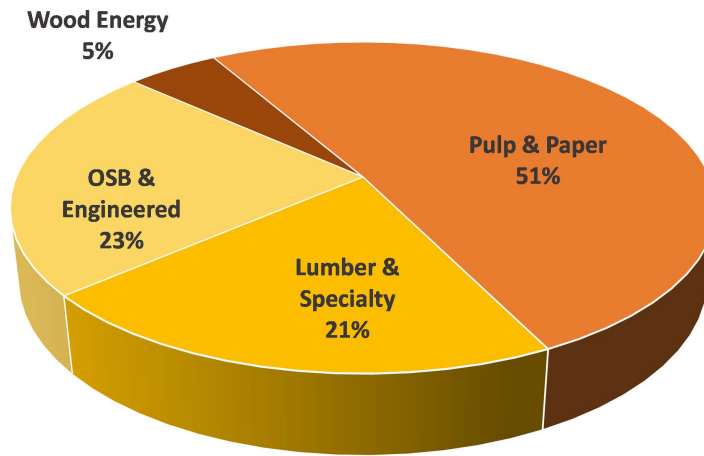
Minnesota became a net importer of wood starting in 2000, due to a number of mill expansions completed during the 2000-2001 time period. Near border mill locations and specific species requirements continue to induce procurement activities outside of Minnesota's borders in order to meet their raw material needs, especially for aspen (134,465 cords), balsam fir (13,199 cords), and maple (221,840 cords). Imports in 2016 were largely from Wisconsin (226,700 cords), Michigan (151,493 cords), and Canada (5,309). Exports in 2016 were mainly to Wisconsin and Canada mills totaling 176,681 cords. In 2016 Minnesota remained a net importer, mainly from Wisconsin. The graph (above) shows the import and export trends. The trade balance is calculated as exports-imports. Since 2000 Minnesota has had a negative trade balance with neighboring states and Canada.



## Estimated Wood Use From MN Timber Harvest by Primary Industry Sector

(2016 Pulp and 2017 Sawtimber)

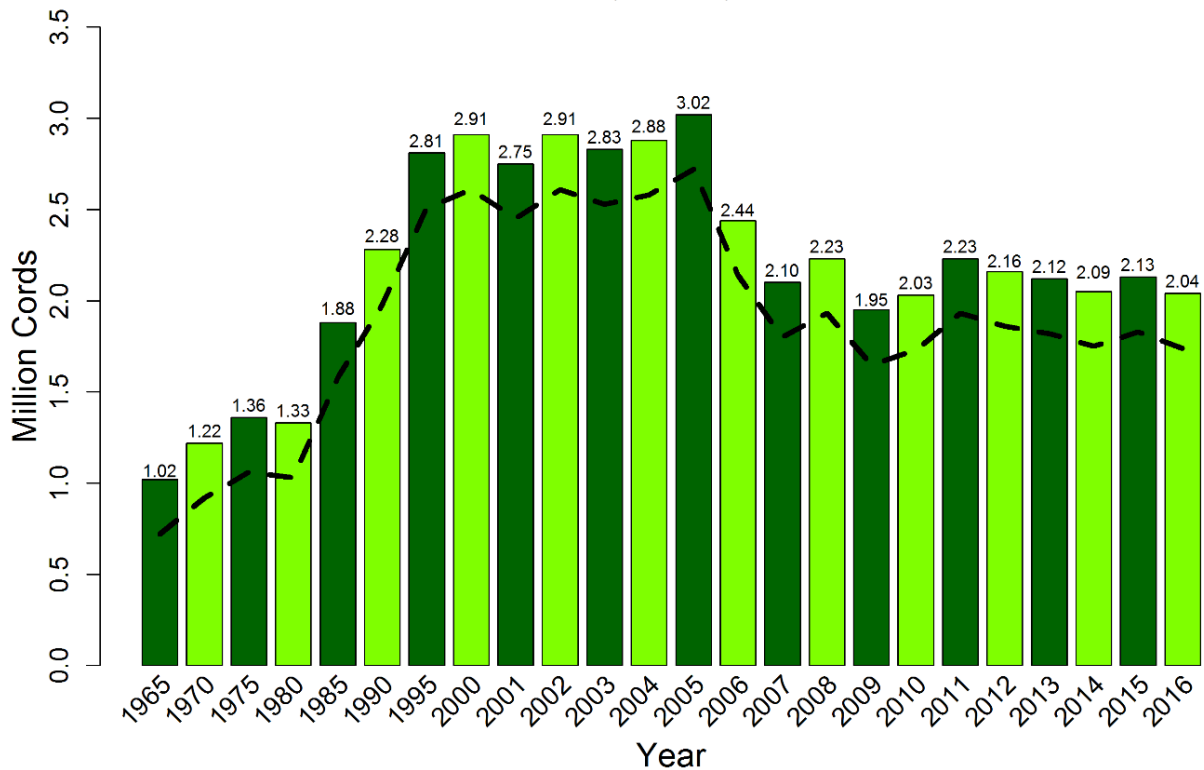
Total Estimated Harvest = 2.75 Million Cords



**Source:** Wood use data from mill and fuelwood surveys conducted by USDA Forest Service, Northern Research Station and MN DNR. Specialty products include veneer, posts and poles, shavings and landscape chips.

## Timber Harvest from Minnesota Timberlands & Utilized by Pulpwood Mills

(1965-2016)

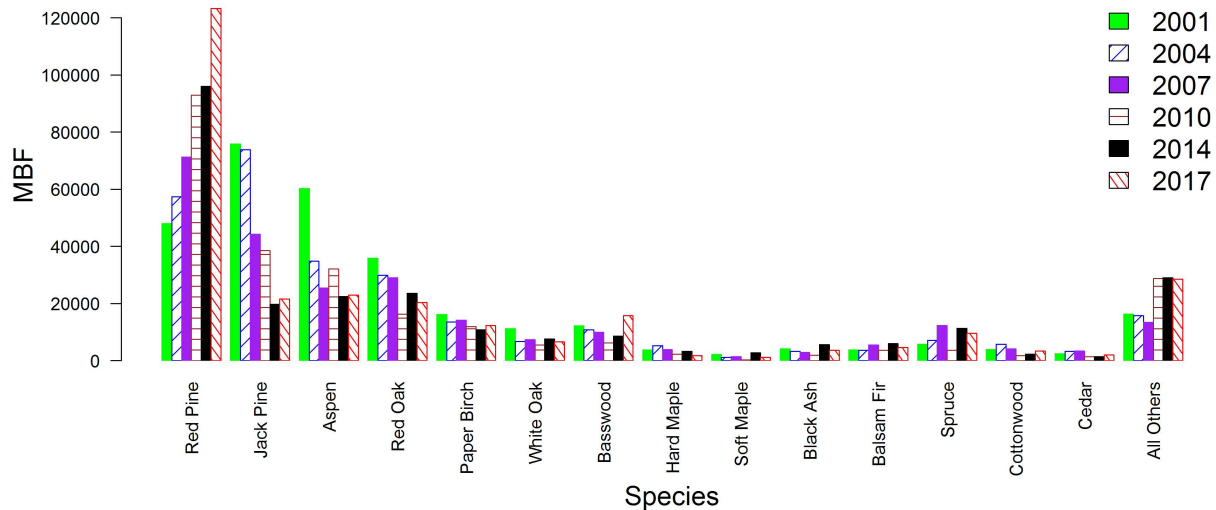


**Source:** NRS & DNR DRAFT survey results

Pulpwood utilization includes the pulp and paper mills and wood composite manufacturers. Key reasons for the harvest leveling off in the early to mid-2000s, during a period of increasing primary industry demand and use, was limitations on specific species utilization, the lack of additional private timberland harvests and an increase in imports. Most of the imported pulpwood was aspen and maple from Wisconsin and Canada. The amount of pulpwood utilized has continued to decline in 2016, relative to the peak utilization in 2005.

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

Total Volume: 2001: 302 MMBF; 2004: 272 MMBF; 2007: 248 MMBF; 2010: 248 MMBF; 2014: 281 MMBF; 2017: 284 MMBF



**Source:** MN DNR (2017) sawmill and specialty mill survey and USFS, Northern Research Station surveys.

Sawtimber is often the highest value product for wood that meets merchantability requirements. Generally speaking, a log needs to be at least 8 feet in length and 8 inches minimum diameter inside bark at the small end in order to be of merchantable sawlog size, however, there are an increasing number of sawmills that can utilize smaller diameter material profitably. Sawmill capacity dropped from 2001 through 2010, and appears to have remained fairly stable since 2014. Basswood was the only hardwood species to see a significant increase relative to 2014. Red pine has continued to make up the majority of board feet in use by sawmills.

# Sustainable Harvest



## Levels



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

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

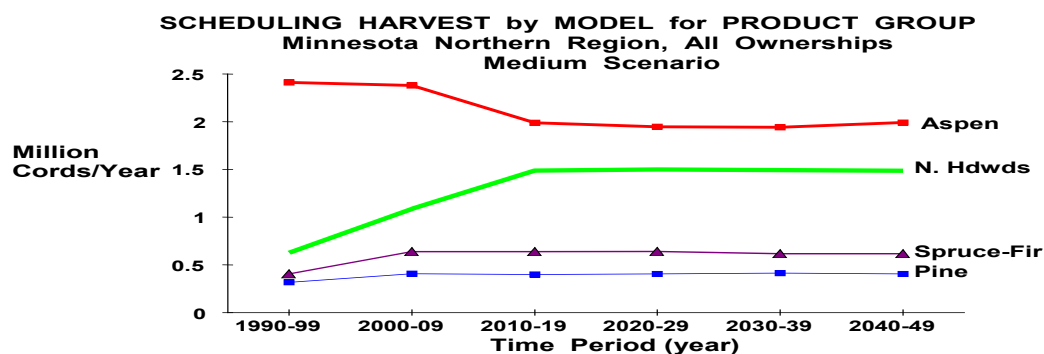
There is no one best way or time period to reach a target age class structure. Transition harvests may at some time be either lower or higher than long-term sustained yield estimates. Additionally, it is important to note that it is possible to raise future timber availability through intensified forest management resulting in fewer losses to mortality and improved timber productivity. Sustainable harvest estimates can also vary significantly because of differing assumptions used in deriving the estimates, such as rotation age, harvest restrictions, growth and yield, etc. An active forest management and harvesting program is also key to sustaining habitat for diverse wildlife.

For the above reasons, it is important to view the levels as helpful benchmarks that are only one part of the picture in determining long-term sustainability of our forest resources. They should not be viewed as absolute targets.

DNR sustainable harvest estimates use the full, five-year panel of 2005 FIA inventory data. Estimates are adjusted downward (as appropriate by ownership) for potential timber supply restrictions that can apply to timberlands such as riparian, old growth, leave tree and extended rotation. Rotation ages used to determine the estimates are based on average rotation ages used in the DNR's Subsection Forest Resource Management Plans (SFRMP).

It is important to note that DNR sustainable harvest level estimates are averages over an entire rotation. Generally therefore, for cover types with age-class imbalances resulting from large acreages in older classes, current timber availability may be *above* long-term sustainable estimates. This is due to a need to manage many old stands on timberlands before their health, habitat value and available timber volume deteriorates. For cover types with young age-class imbalances such as red pine, current timber availability may be *below* long-term sustainable estimates. Finally, as more of the forest area is managed, productivity is likely to increase...as it has for a number of decades.

DNR is committed to providing excellent analysis, and will therefore periodically review sustainable harvest estimation procedures and assumptions. Future changes to procedure may be made as new



Source : GEIS table 6.8 medium scenario, 2nd run ( p210 of M.P. & F. Reso. Base, 12/1992 )  
 Assumptions used : Ownership constraints (riparian lands & old growth forests, etc.)

The year 1994 saw the completion of Minnesota's Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota (GEIS). This study was commissioned by the Minnesota Environmental Quality Board in response to a citizen petition. The GEIS assessed how three levels of statewide timber harvesting activity relate to Minnesota's environmental, economic and social resources. Base, Medium and High harvesting scenarios were looked at: 4 million cords annually, 4.9 million cords annually, and 7 million cords annually. Each scenario was projected over a 50 year planning horizon. The GEIS did not recommend these as levels of harvest to follow, nor should their development and analysis be considered a plan. Rather, they are levels the GEIS study analyzed, in order to determine impacts.

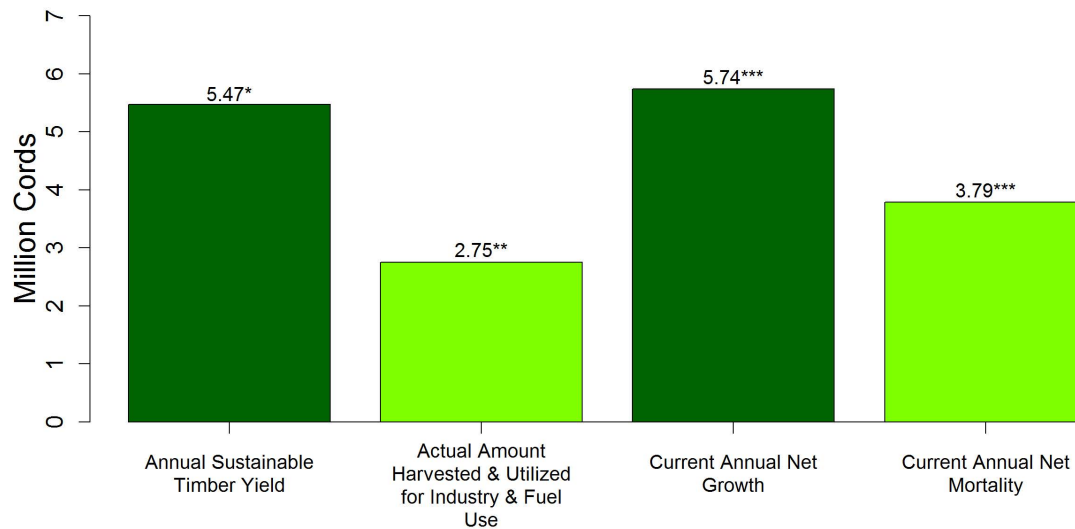
In March 2018 the DNR completed its Sustainable Timber Harvest Analysis (STHA). This project was not a replication of the Thunderhawk study, the STHA was meant to apply only to DNR administered lands capable of producing timber. Modeling was conducted by Mason Bruce & Girard, a forestry consulting firm based in Portland, OR. This effort was conducted over a year and half, involved the three divisions concerned with forest management (Forestry, Fish and Wildlife, and Ecological & Water Resources), and was evaluated and approved by the commissioner's office. The DNR concluded that an appropriate harvest level, taking into account the myriad goals of the department, would be 870,000 cords offered annually over the next 10 years. In addition to this, an Ash and Tamarack initiative was included to encourage more harvest of these two species, offering approximately 15,000 additional cords of Tamarack and Ash each in the next 5 years. Net harvest levels were adjusted to 900,000 cords in years 1-5, dropping to 870,000 cords in years 5-10. This effort will likely be reevaluated in 10 years.

MN DNR Sustainable Timber Harvest Analysis, 10 year annual cord targets for DNR administered lands only.

Tree Species or Cover-type	FY2019 - FY2029 Target Offered Volume (Cords)
Ash	25,000 - 40,000
Aspen and Balm of Gilead	360,000 - 400,000
Balsam Fir	30,000 - 40,000
Mixed Hardwoods	110,000 - 120,000
Birch	30,000
Spruce	105,000 - 115,000
Pine	110,000 - 120,000
White Cedar	2,000
Tamarack	30,000 - 40,000
<b>Approximate Annual Offer (Cords)</b>	<b>870,000</b>



# Estimated Annual Sustainable Timber Yield Compared to Actual Amount Harvested & Utilized for Industry & Fuel Use and Net Growth



\*Table 6.25, GEIS, High Long-Term Sustainable Level, Timber Productivity Tech. Paper, Dec. '92.

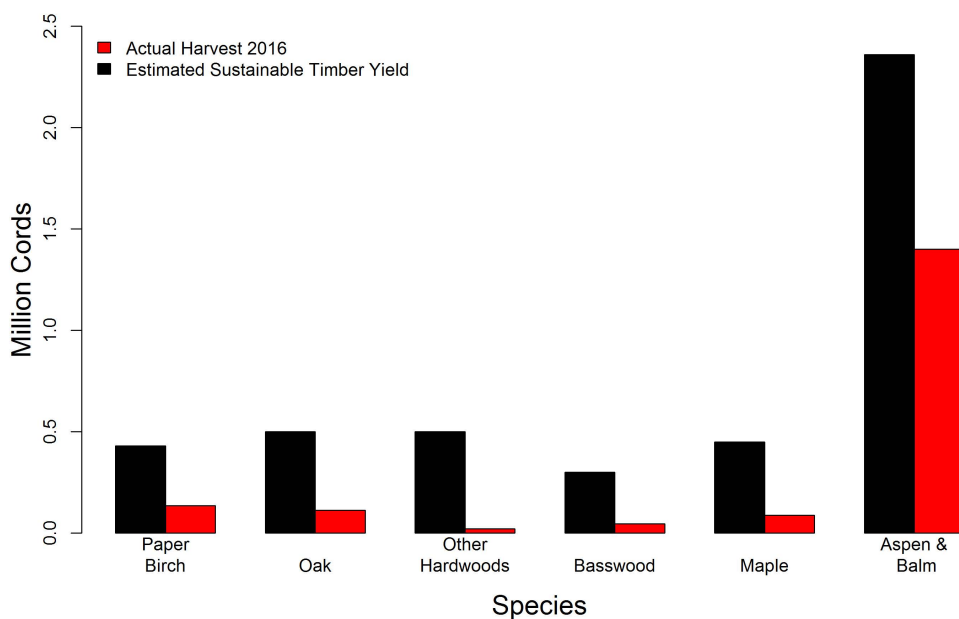
\*\* 2016 NRS pulpwood survey, 2017 DNR sawmill survey, 2014/15 fuelwood survey. For Harvest comparisons to Net Growth, it is necessary to add annual “growing stock” logging residue of approximately 275,000 cords to this figure.

\*\*\*USFS FIA 2017 database.

**Note:** While complete capture is not realistic, capture of a portion of annual mortality of approximately 3.79 million cords has the potential to increase net growth and sustainable harvest levels.

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

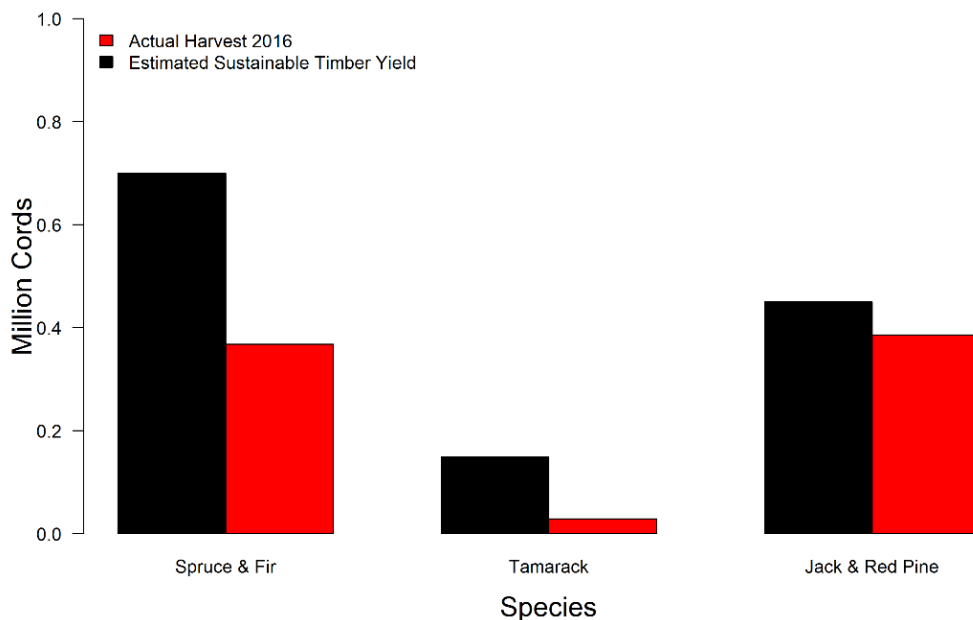
Minnesota 2016



**Source:** Harvest data 2016 USFS pulpwood survey, DNR 2017 sawmill (DRAFT) & 2017 fuelwood survey (DRAFT). Sustainable timber yield data source as per the notes below.

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

Minnesota 2016



**Source:** Harvest data 2016 USFS pulpwood survey (DRAFT), DNR 2017 sawmill (DRAFT) & 2017 fuelwood survey (DRAFT).

**NOTES:**

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

**-Sustainable timber yield levels for birch, oak, basswood, maple and other hardwoods, tamarack and jack and red pine in the figures above are based on DNR method of calculating long-term sustainable harvest levels**, which consists of area regulation for cover types typically managed as even-aged, and volume regulation for types typically managed as many-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.

# Wood Supply and Demand Information for Important Cover Types and Species

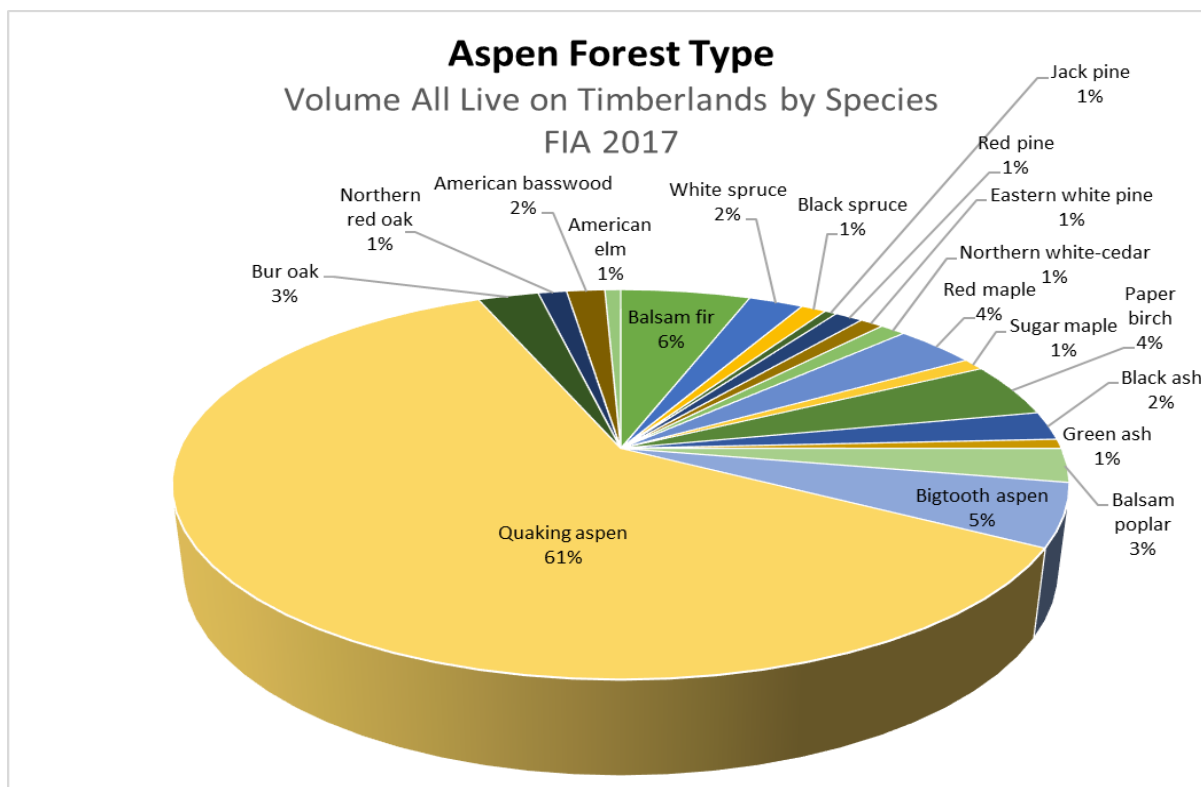


Forest resource and harvest level information for Minnesota's most significant cover types and tree species.

## Minnesota's Aspen/Balm of Gilead Resource

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

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



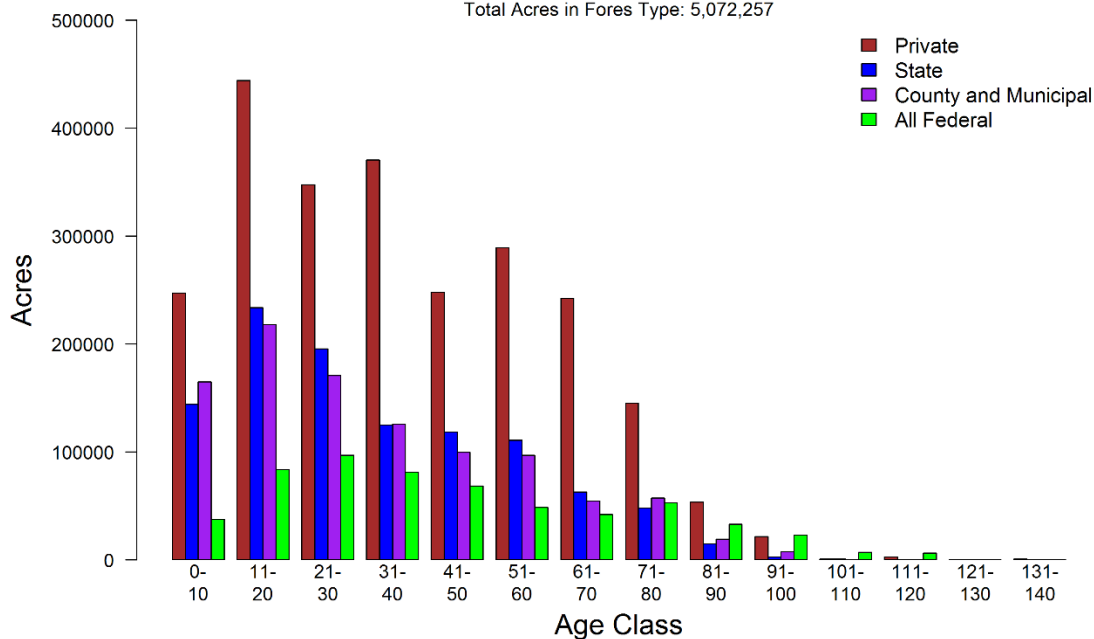
**Source:** 2017 FIA database provided by USFS, Northern Research Station



## Aspen and Balm Forest Types

Timberland Acres by Owner & Age Class FIA 2017

Total Acres in Fores Type: 5,072,257



Source: 2017 FIA database provided by USFS, Northern Research Station

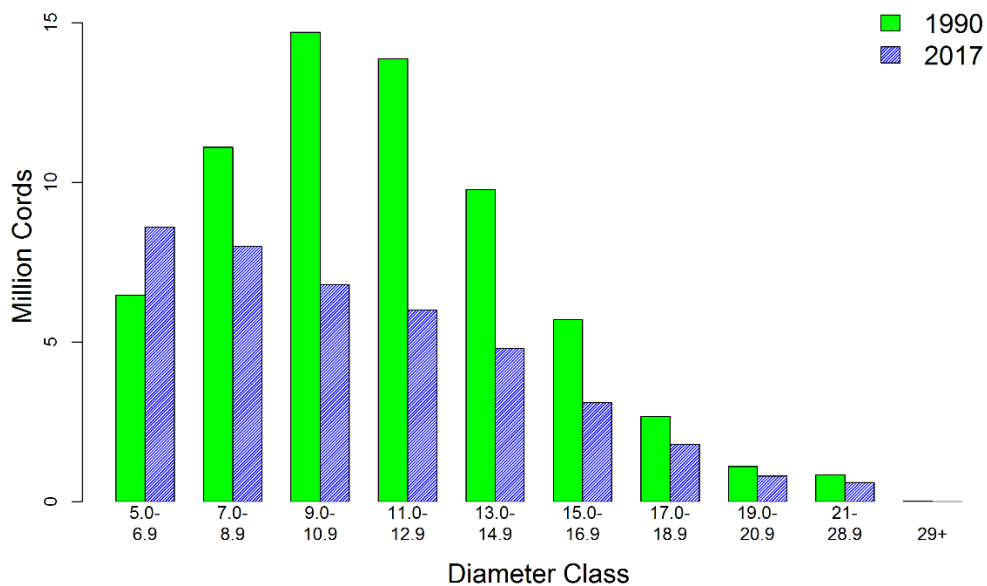
The bulk of the aspen resource is found on private lands. The 2017 FIA inventory indicates a much more even age-class distribution than the 1990 inventory.

## Aspen and Balm Species

Volume All Live by Diameter Class 1990 and 2017 FIA

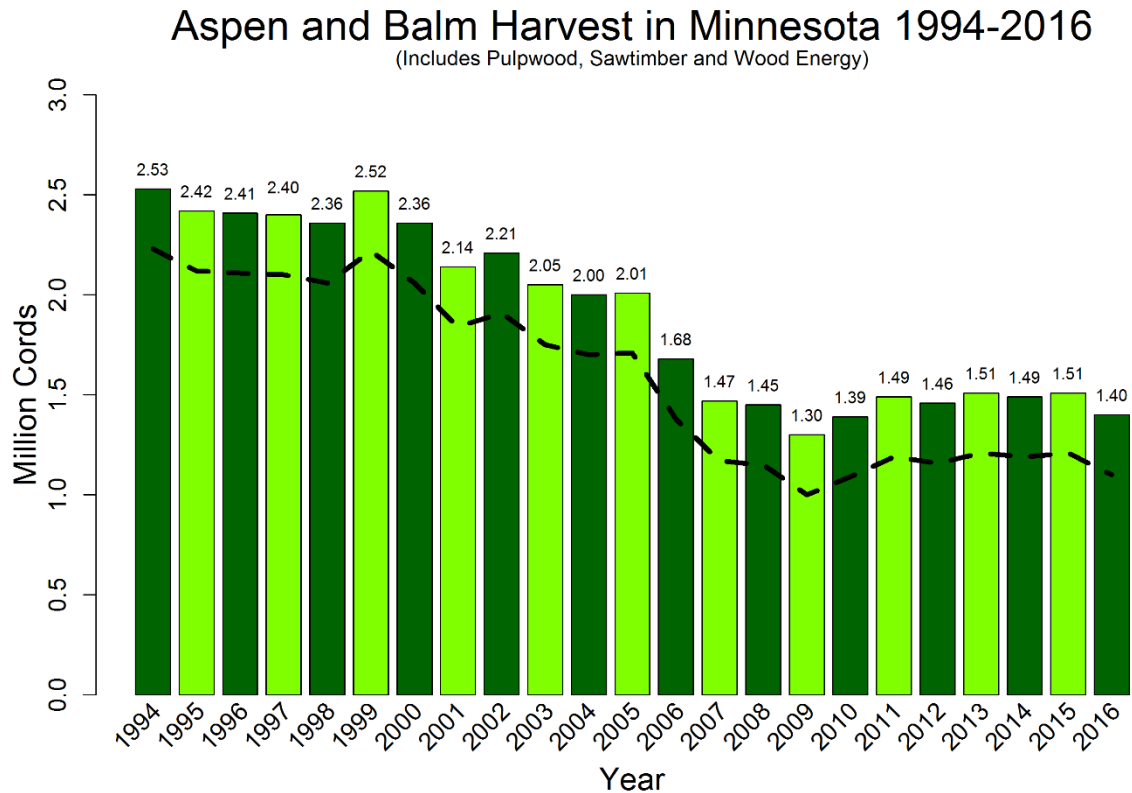
Total Volume All Live(Cords):

1990: 66,295,600 2017: 40,493,742



Source: FIA 2017 database provided by USFS, Northern Research Station

Total FIA aspen and balm of gilead (balm) volume has gone down since 1990 as significant acreages have been harvested and managed. For at least the next 10 years, more of the available aspen is likely to be found in stands that average less volume than past harvests, which is difficult on efficiency of loggers and mills. However, it is important to note that beginning in 10 years or so and then accelerating over time, more high-volume aspen stands will begin to reach harvest age.



**Source:** NRS & DNR DRAFT survey results.

Annual long-term allowable harvest= 2.358 million cords based on Table C-20 UPM-Thunderhawk DEIS, average of high aspen A&B scenarios, 40 year planning horizon.

Based on the 2017 USFS FIA database, estimated average net annual growth of aspen & balm growing stock: 1,834,115 cords, estimated average annual mortality of aspen & balm growing stock 1,279,362 cords.

Several factors caused the reduction in aspen and balm harvest from its peak in 1999, including:

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

## Current Demand for Aspen/Balm of Gilead from Minnesota Timberlands

	Cords
2016 Harvest.....	1,402,464
<ul style="list-style-type: none"> <li>Minnesota Pulpwood Industries .....</li> <li>Pulpwood Export (To Canada and Wisconsin).....</li> <li>Sawlogs (with est. Exports) &amp; Other (DRAFT).....</li> <li>Fuelwood (from live trees on timberland).....</li> </ul>	1,287,259 49,698 46,107 19,400

**Source:** NRS & DNR Draft survey results. The amount utilized by industry is higher due to imports from WI and Canada

### Resource Opportunities:

- The recent reduction in aspen harvest levels has resulted in a situation where current harvest levels are well below long-term sustainable levels.
- Last year, aspen-birch decline occurred on 39,000 acres, most of which were newly declining areas relative to the previous year. These stands should be harvested to avoid additional volume losses due to top kill and mortality.

### Resource Issues:

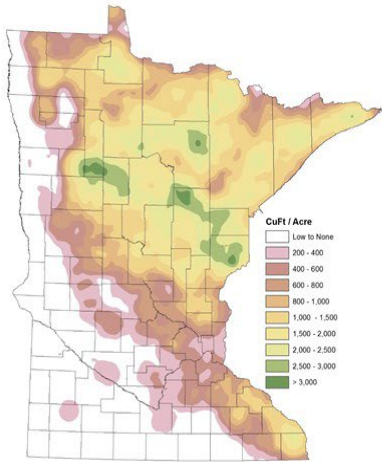
- Readers should note that a great deal of the resource is in private hands, so managing it will require greater efforts in private landowner incentives and assistance.
- Parts of NE Minnesota are under gypsy moth quarantine. Loggers and mills should contact MN Department of Agriculture to learn about compliance agreements.

The table below shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top DOB) by percent of basal area per acre that is “Aspen” (quaking, bigtooth, and balm) ON FIA PLOTS. This table shows that Aspen and Balm forest types can differ significantly and provides some idea of what other species can be harvested within these forest types. This is FIA Aspen and Balm Forest Types. Acres Statewide provides some idea of the relative nature of different percent species compositions within a particular forest type. Only FIA plots age 20 and older were included.

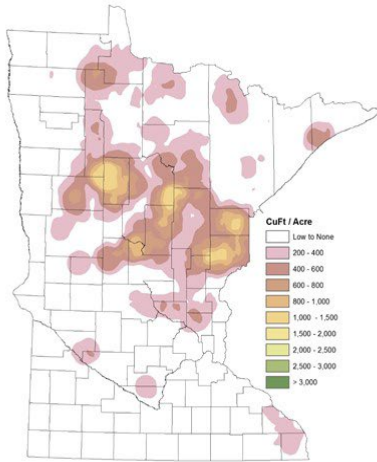
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	112,992	21.9	3.5	5.4	3	8.8	1.7	0	0.7	13.7	10.9	1	0.5	3.5	4.7	7	6.9
25-50%	848,930	14	1.6	4	2.9	1.7	0.9	1.3	1.5	38.6	8.8	4.8	1.7	1.2	6	5.7	4.3
50-75%	1,134,810	6.5	0.5	2.2	1	1.3	0.9	0.5	0.6	59.4	5.8	5.6	1.2	1.4	4.7	3.5	4.3
> 75%	1,571,297	1.7	0.1	0.6	0.2	0.5	0.1	0.1	0.1	77.4	1.2	12.5	0.2	0.8	0.9	1.7	1.5

Predicted spatial distribution of aspen and balm CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

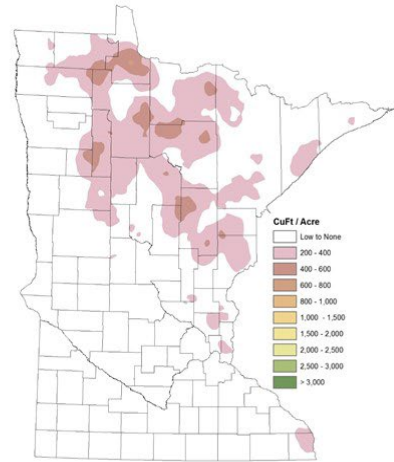
Quaking aspen (*Populus tremuloides*)



Bigtooth aspen (*Populus grandidentata*)



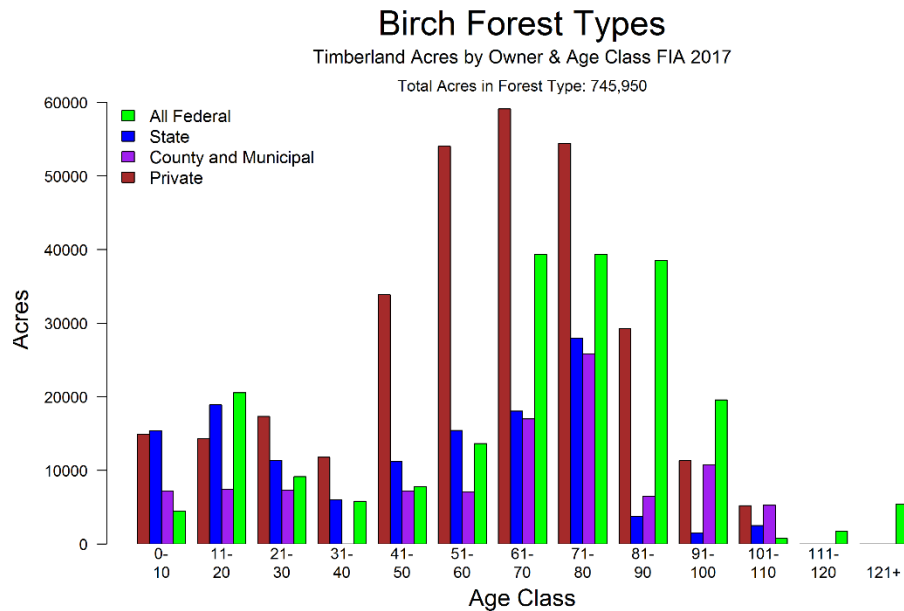
Balsam poplar (*Populus balsamifera*)



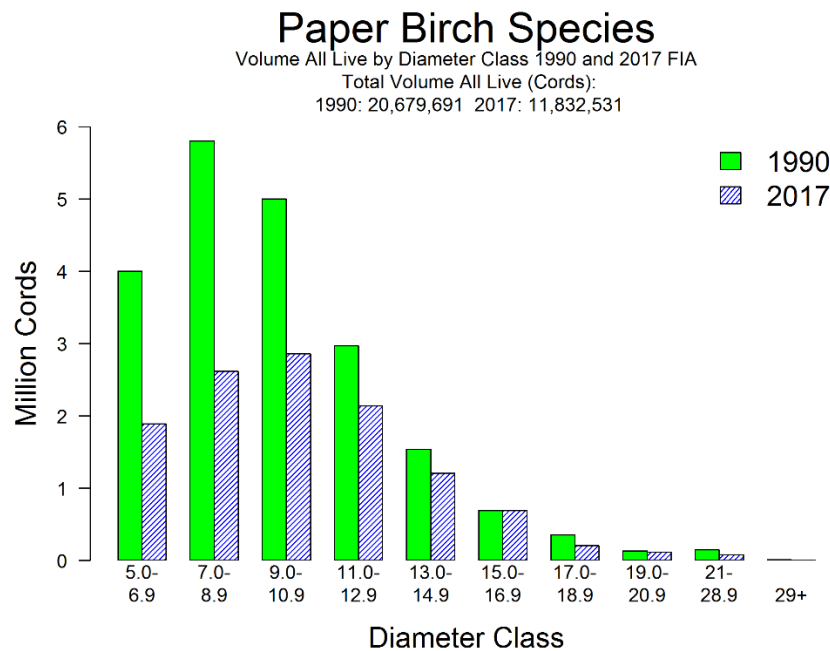
**Source:** 2017 FIA database provided by USFS, Northern Research Station

# Minnesota's Birch Resource

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



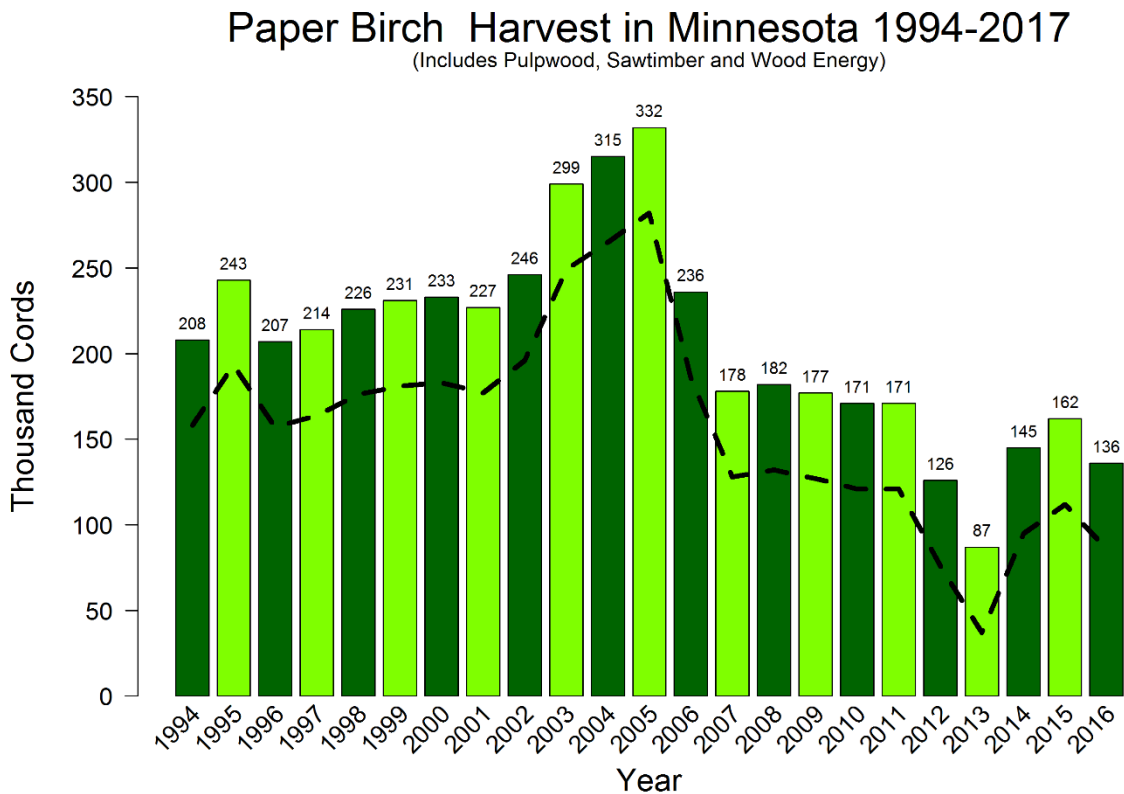
Source: 2017 FIA database provided by USFS, Northern Research Station



Source: FIA database provided by USFS, Northern Research Station



Total volume of paper birch has declined since 1990, due largely to serious mortality trends associated with an aging resource and stress caused by periodic drought.



Source: NRS & DNR DRAFT survey results

DNR estimated long-term annual sustainable harvest level: 371,500 cords/year. Estimated average net annual growth of paper birch growing stock: 23,993 cords, and estimated average annual mortality of birch growing stock: 336,699 cords, based on 2017 FIA data.

## Current Demand for Birch from Minnesota Timberlands

	Cords
2016 Harvest.....	136,962
<ul style="list-style-type: none"> <li>Minnesota Pulpwood Industries.....</li> <li>Pulpwood Export (To Wisconsin).....</li> <li>Sawlogs &amp; Other .....</li> <li>Fuelwood (from growing stock).....</li> </ul>	67,278 30,019 24,964 14,700

Source: NRS & DNR DRAFT survey results.

### Resource Opportunities:

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

- Birch in northeastern Minnesota is “fleck-free” (fleck is a common appearance defect in birch), so larger, high-quality stems are a fit for veneer markets.
- Last year, aspen-birch decline occurred on 39,000 acres, most of which were newly declining areas relative to the previous year. These stands should be harvested to avoid additional volume losses due to top kill and mortality.

#### Resource Issues:

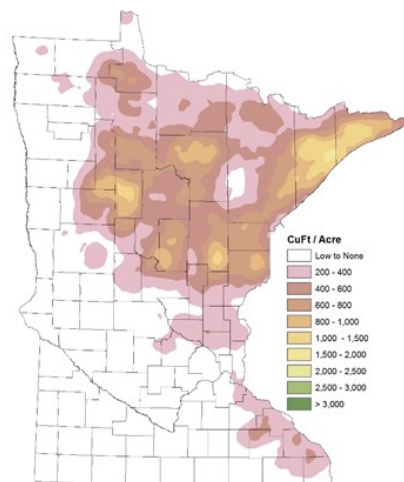
- There is a need to improve ability to consistently regenerate birch stands.
- Wood quality can be highly variable; from high valued to significant rot in some older birch.
- A major age class imbalance, with significant volumes of older birch.
- Birch volume is declining due to mortality from age,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

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

Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	148737	11.7	10.7	4.6	6	2.7	1.7	1.3	6	16.2	16	2.3	0.9	2	5.3	7.1	3.2
25-50%	415660	12	3.1	4.5	4.2	1.5	1.1	1.6	3	16	35.7	0.8	0.6	0.8	5.9	5.2	2.4
50-75%	186733	8.3	1.9	3.7	1.9	0.9	0.7	0.4	0.4	8	60.8	0.7	0.6	0.8	4.1	3.5	2.7
> 75%	44695	7.8	3.2	2.1	0	0	0	0	0	5.2	73.9	0.9	1.2	2.3	0.2	2.1	1.1

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

Paper birch (*Betula papyrifera*)



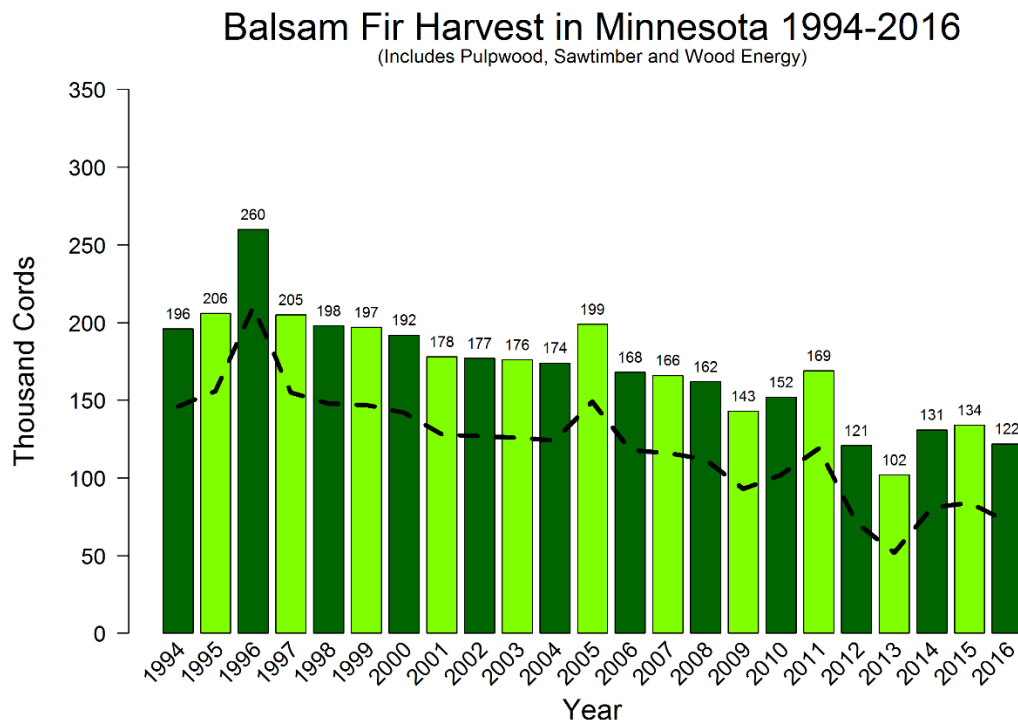
Source: 2017 FIA database provided by USFS, Northern Research Station

## Minnesota's Balsam Fir Resource

Based on 2017 FIA data, estimated average net annual growth of balsam fir growing stock: 235,812 cords; estimated average annual mortality of balsam fir growing stock: 343,565 cords.

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

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



Source: NRS & DNR DRAFT survey results.

### Current Demand for Balsam Fir from Minnesota Timberlands

	Cords
2016 Harvest.....	122,636
<ul style="list-style-type: none"> <li>Minnesota Pulpwood Industries.....</li> <li>Pulpwood Export (To Wisconsin).....</li> <li>Sawlogs &amp; Other.....</li> <li>Fuelwood (from growing stock).....</li> </ul>	113,130 0 9,206 300

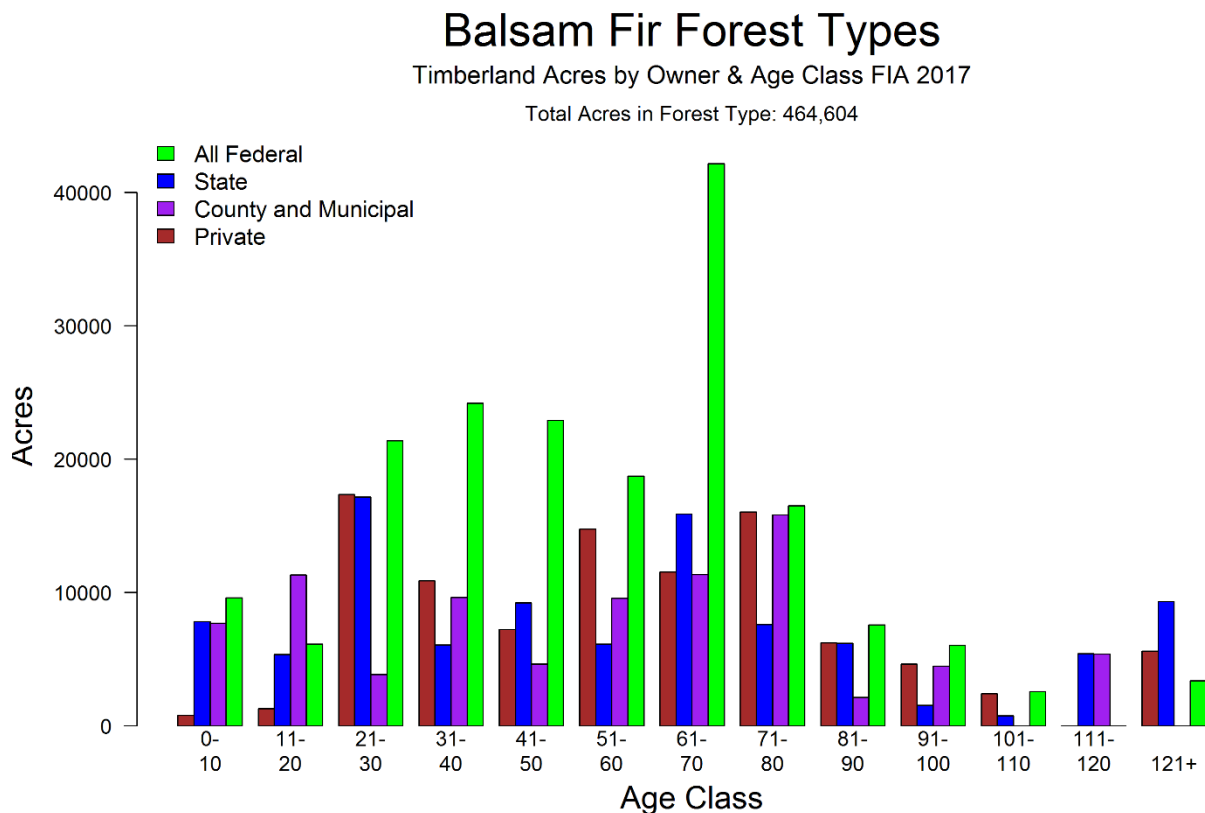
Source: NRS & DNR DRAFT survey results.

## Resource Opportunities

- 2011 harvest was 168,600 cords and reduced to 101,900 cords in 2013, but has rebounded some in 2016 to 122,636 cords.
- High-quality balsam fir has excellent qualities for pulp & paper and stud manufacture.
- Pre-salvage and salvage operations of fir and white spruce should be occurring now, primarily in western Lake and eastern St. Louis counties, since spruce budworm populations have affected spruce/fir forests in that locale for approximately three years. Expect a short-term, local increase in supply.

## Resource Issues:

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

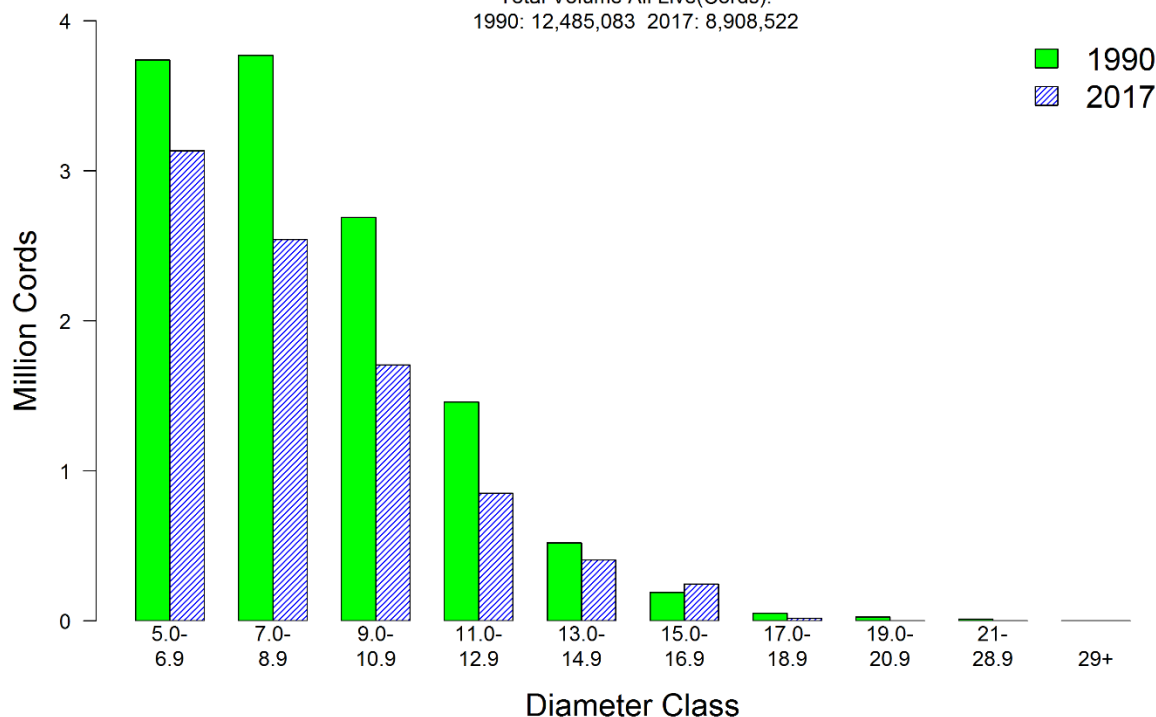


**Source:** 2017 FIA database provided by USFS, Northern Research Station

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

# Balsam Fir Species

Volume All Live by Diameter Class 1990 and 2017 FIA  
Total Volume All Live(Cords):  
1990: 12,485,083 2017: 8,908,522



Source: FIA database provided by USFS, Northern Research Station

Much of the balsam fir volume in Minnesota (roughly 51%) is found mixed in with the aspen/balm and birch cover types, and is therefore tied to aspen and birch harvest. Total balsam fir volume has dropped significantly since 1990.

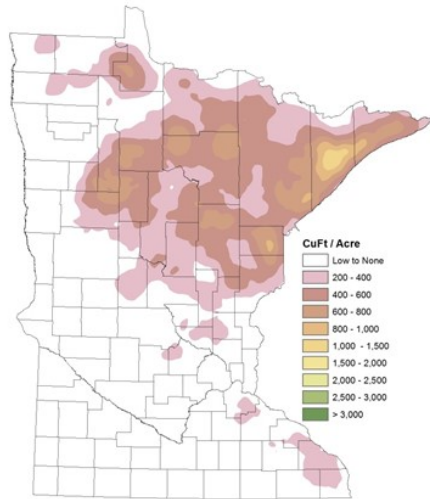
The table below shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top DOB) by percent of basal area per acre that is balsam fir ON FIA PLOTS. This table shows that a Balsam fir forest type can differ significantly and provides some idea of what other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

Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
<25%	41,389	3.6	23	8.7	23.2	3	0	5.7	10.9	12.55	5.2	2.2	0	0.2	0.9	0.2	0
25-50%	134,317	18	8.2	7.2	18	1.3	3.6	4.5	8.9	12.8	8.3	2.2	0	0	0.6	2.5	1.1
50-75%	130,688	41.5	5.8	6.2	10.5	0.2	2.3	1.1	6	9.8	9.5	1.9	0	0.2	2.7	13.1	0.2
>75%	24,169	77.5	0	4.3	0	0	0	0	0	7	4.3	1	0	0	5.1	0.9	0

Predicted spatial distribution of balsam fir CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.

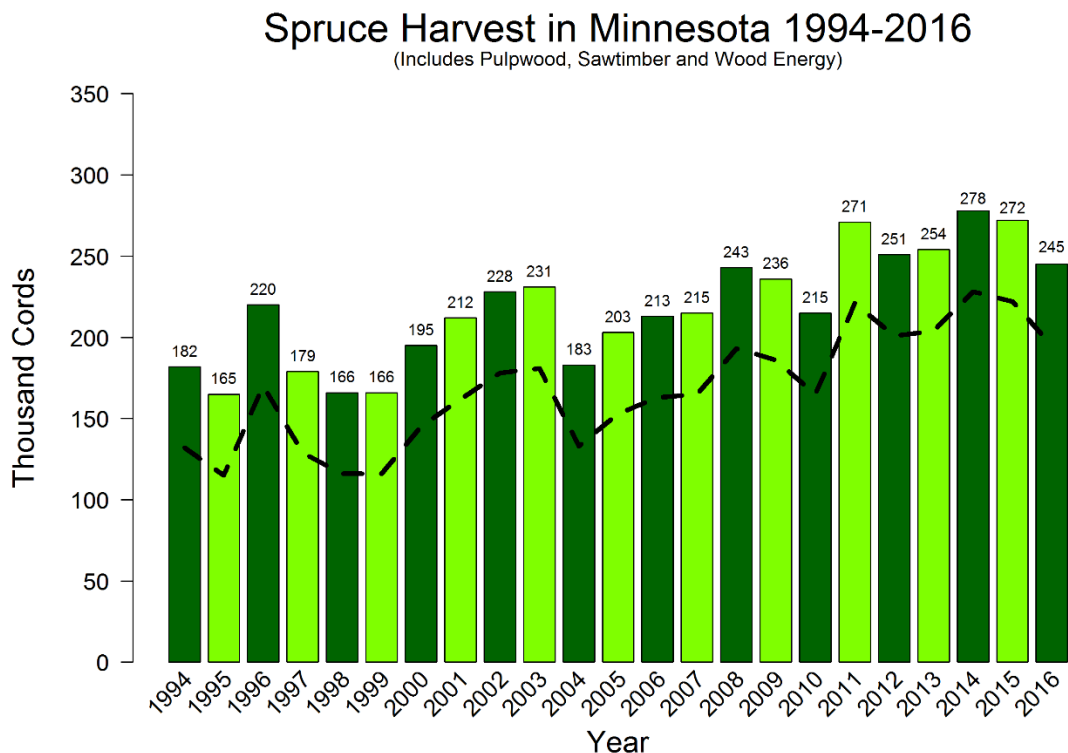


Balsam fir (*Abies balsamea*)



**Source:** 2017 FIA database provided by USFS, Northern Research Station

# Minnesota's Spruce Resource



Source: NRS & DNR DRAFT survey results.

Spruce-fir estimated annual sustainable harvest level 705,500 cords/year based on Table C-20 UPM-Thunderhawk DEIS, average of high aspen A&B scenarios, 40 year planning horizon. Based on the 2017 FIA database, estimated average net annual growth of spruce growing stock: 380,400 cords, estimated average annual mortality of spruce growing stock: 213,862 cords.

## Current Demand for Spruce from Minnesota Timberlands

	Cords
2016 Harvest.....	245,892
<ul style="list-style-type: none"> <li>Minnesota Pulpwood Industries.....</li> <li>Pulpwood Export (To Wisconsin).....</li> <li>Sawlogs (with est. Exports) &amp; Other (DRAFT).....</li> </ul>	174,336 51,755 19,600

Source: NRS & DNR DRAFT survey results.

### Resource Opportunities

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

#### Resource Issues:

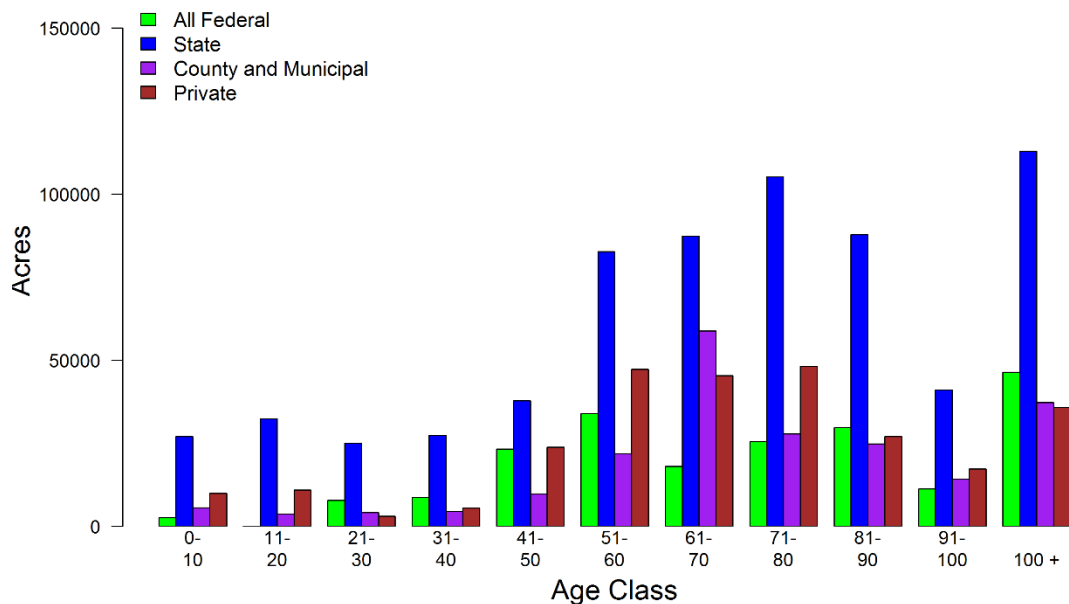
- Many stands have very low volume/acre of spruce. Volume could impact the ability to manage some stands.
- Since black spruce is normally found on lowland sites it's primarily only accessible during frozen conditions.
- Spruce budworm has caused top kill and mortality on white spruce, including plantations.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

## Black Spruce

### Black Spruce Forest Types

Timberland Acres by Owner & Age Class FIA 2017

Total Acres in Forest Type: 1,361,236

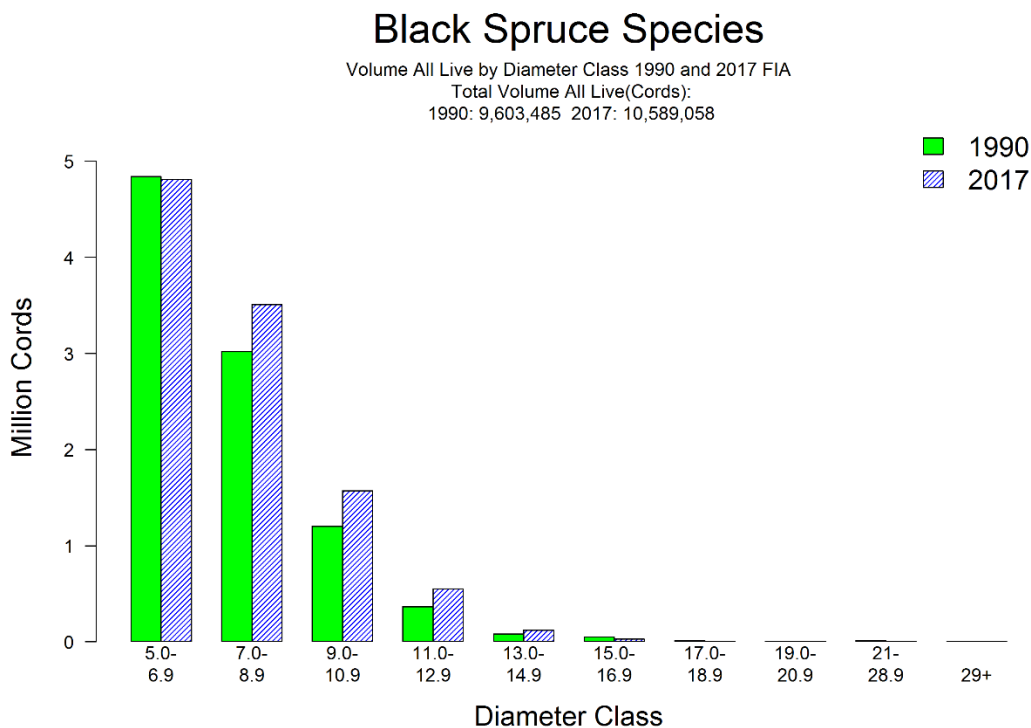


Source: 2017 FIA database provided by USFS, Northern Research Station

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

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

The vast majority of black and white spruce in Minnesota (over 93%) is used in the making of high quality paper, where it is prized for its excellent fiber qualities. Some is also used by the sawmill industry, mostly in making studs but also in small quantities for other types of lumber. A very small amount of spruce can be used in making OSB.



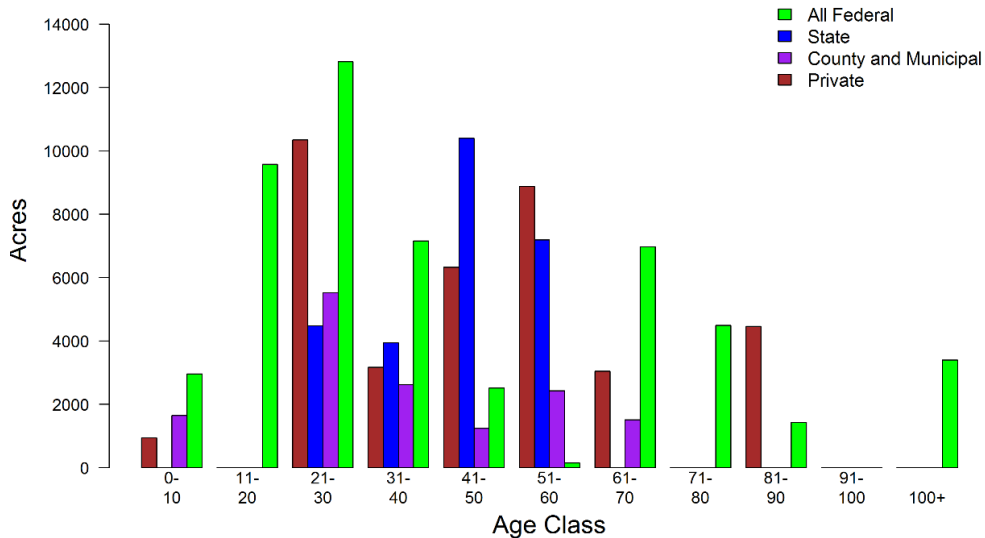
**Source:** 2017 FIA database provided by USFS, Northern Research Station

# White Spruce

## White Spruce Forest Types

Timberland Acres by Owner & Age Class FIA 2017

Total Acres in Forest Type: 129,652



**Source:** 2017 FIA database provided by USFS, Northern Research Station

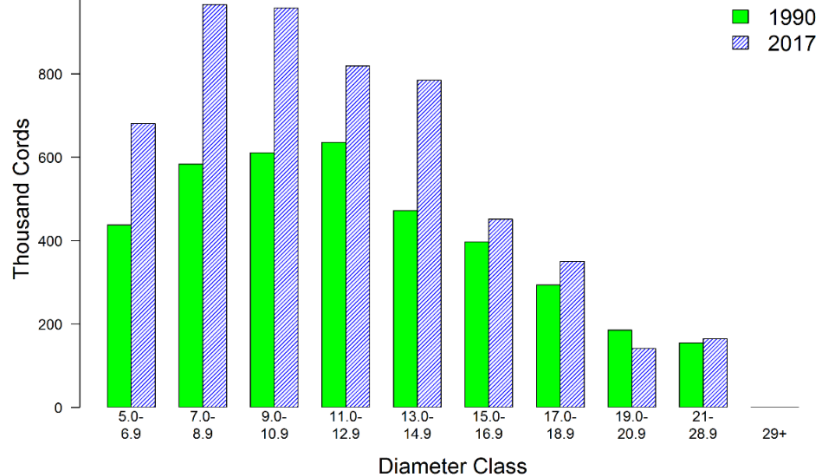
White spruce is a relatively young resource. The cover type is dominated by stands below the age of 50, many of which are in the form of plantations. Many of these stands likely require a first (e.g. ages 25 to 40) or second thinning (e.g. ages 35-50). Recommended rotation ages can range from 40 to 90 years, depending on site productivity and condition (again, some stands managed as extended rotation are held beyond these ages). White spruce is located most often on upland sites, where in natural stands it is commonly found mixed in as a component in aspen, birch, balsam fir & pretty much all upland cover types. A great deal of white spruce volume exists as a component in mixed stands of other upland cover types.

## White Spruce Species

Volume All Live by Diameter Class 1990 and 2017 FIA

Total Volume All Live(Cords):

1990: 3,777,000 2017: 5,316,880



**Source:** 2017 FIA database provided by USFS, Northern Research Station



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

**Black Spruce - Only FIA plots age 35 and older were included.**

Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	38,727	18.6	36.8	0.9	6.5	14.1	5.5	2.2	2.7	4.2	7.5	0.5	0	0	0.5	0	0
25-50%	103,866	9.3	30.1	0.3	36.7	3	0.1	2.5	7.7	6.9	3.2	0.1	0	0	0.1	0	0
50-75%	281,516	2.2	29.4	0.7	58.2	2.1	0	0.5	2.4	1.6	2.2	0.1	0	0	0.4	0.3	0
> 75%	805,985	0.8	13.8	0.3	82.8	0.4	0.2	0.4	0.4	0.5	0.3	0	0	0	0	0	0

**White Spruce Natural - Only FIA plots age 20 and older were included.**

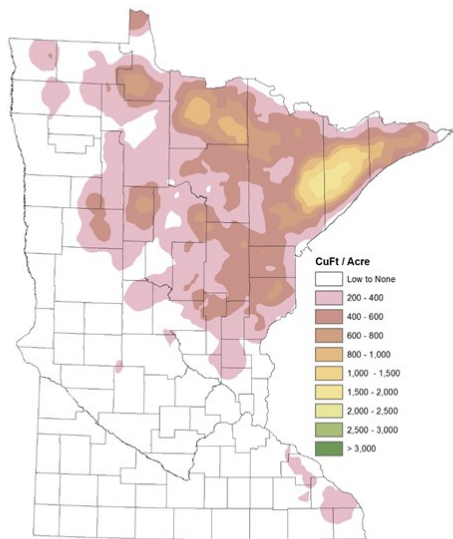
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	5,286	45.4	0	14.7	0	0	0	0	8.4	24.8	1.9	2	0	2.7	0	0	0
25-50%	15,571	13.8	1.8	39.9	4.8	3.5	4.7	0	6.4	7.7	10.9	0	0	4.7	0	0.4	0
50-75%	10,758	9.9	0	72.3	0.4	0	3.6	0	0	3.6	4	0	0.1	1.5	1.2	2.7	0
> 75%	20,806	2.1	0	92.5	1.2	0	0	0	0	2.7	0.5	0.1	0	1	0	0	0

**White Spruce Planted - Only FIA plots age 20 and older were included.**

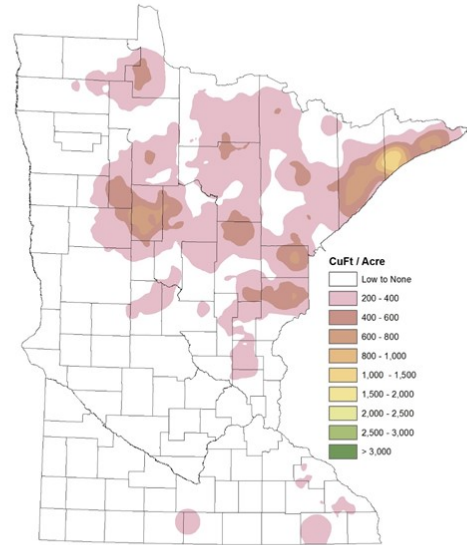
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	587	12.9	0	22	21.4	0	0	0	0	26.1	17.6	0	0	0	0	0	0
25-50%	8,576	14.3	0	53	1.3	0	3.6	2.7	7.1	12.3	4	0	0	0	1.9	0	0
50-75%	27,418	8.8	1.5	72.5	0.5	0	0	0	0	4.5	2	0.9	1.3	0.2	1.6	0.9	4.3
> 75%	28,177	2	0	93.2	0.1	0	0	0	0	3.1	0.7	0	0	0	0	0	0

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

Black spruce (*Picea mariana*)



White spruce (*Picea glauca*)

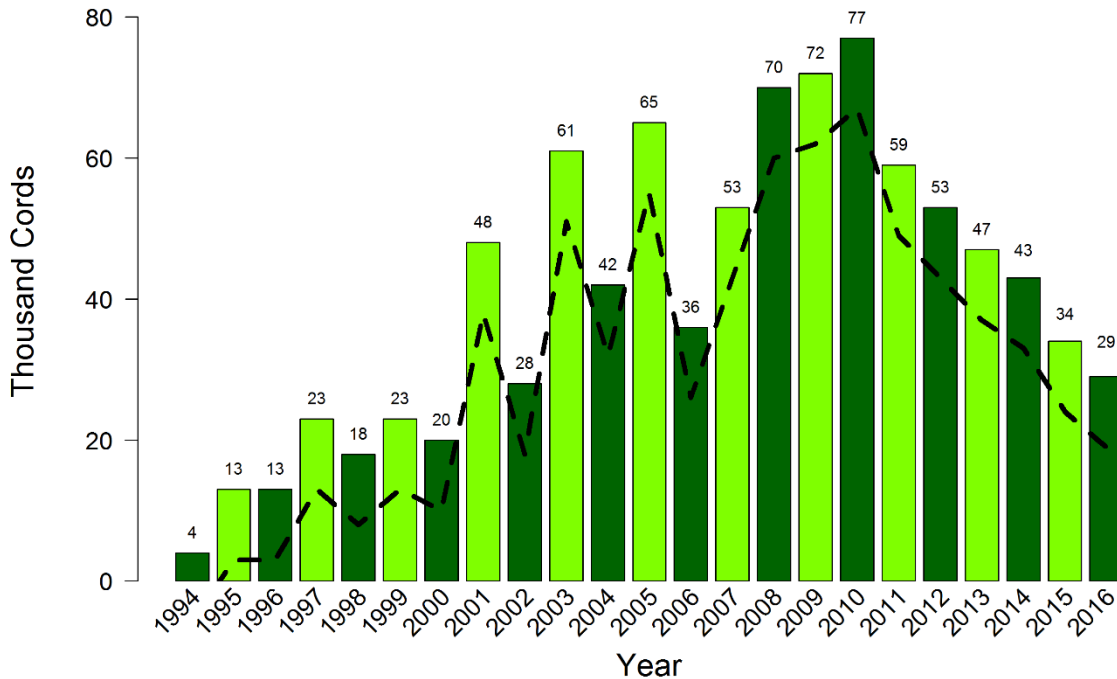


**Source:** 2017 FIA database provided by USFS, Northern Research Station

# Minnesota's Tamarack Resource

## Tamarack Harvest in Minnesota 1994-2016

(Includes Pulpwood, Sawtimber and Wood Energy)



Source: NRS & DNR DRAFT survey results.

DNR estimated long-term annual sustainable harvest level = 114,800 cords/year. Based on the 2017 FIA database, estimated average net annual growth of tamarack growing stock: 85,293 cords, estimated average annual mortality of tamarack growing stock: 289,613 cords.

## Current Demand for Tamarack from Minnesota Timberlands

	Cords
2016 Harvest.....	29,093
<ul style="list-style-type: none"> <li>Minnesota Pulpwood Industries.....</li> <li>Sawlogs &amp; Other .....</li> </ul>	18,093 11,000

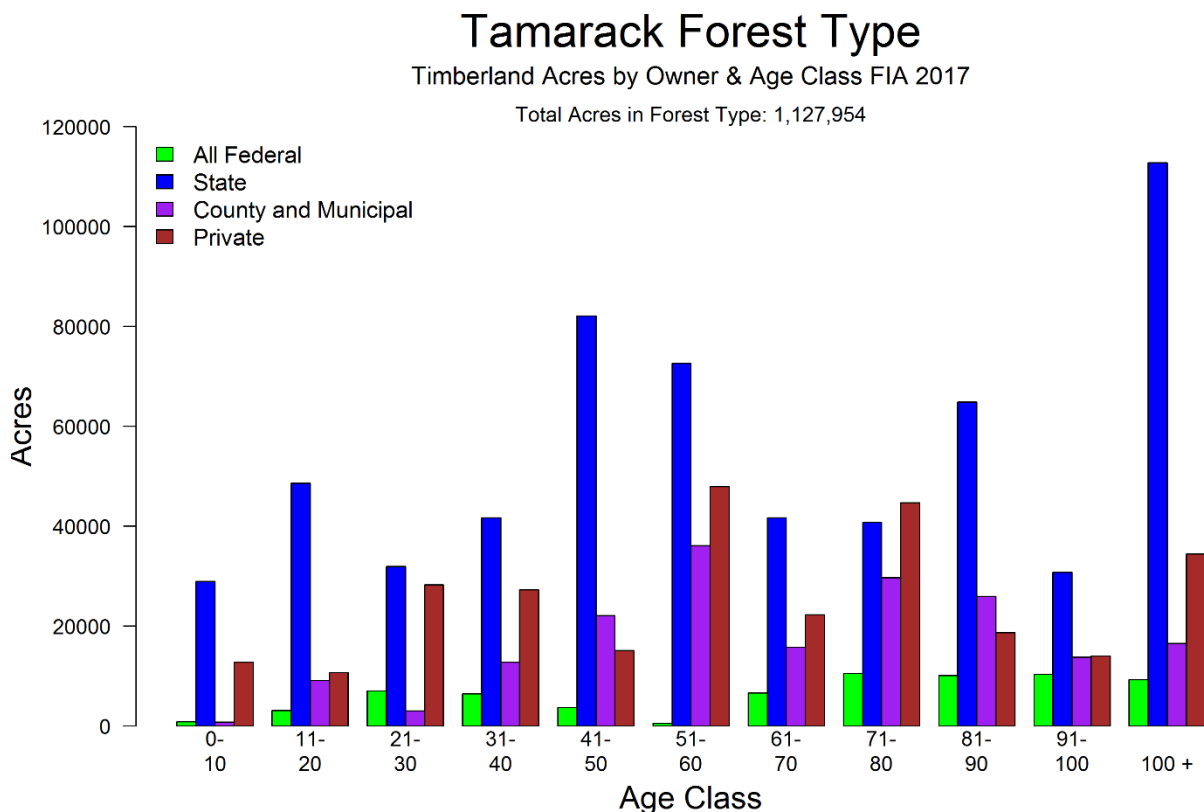
Source: NRS & DNR DRAFT survey results.

### Resource Opportunities:

- Harvest is below long-term sustainable levels. Reaching a 10 year low in 2016 estimated harvest.
- An eastern larch beetle outbreak has killed over 50% of mature trees on at least 103,178 acres since it started in 2000. At least 233,402 acres have been impacted to some degree by eastern larch beetle.
- Lots of standing dead tamarack available now. Long-term outlook indicates a potential future shortage of this cover type.

### Resource Issues:

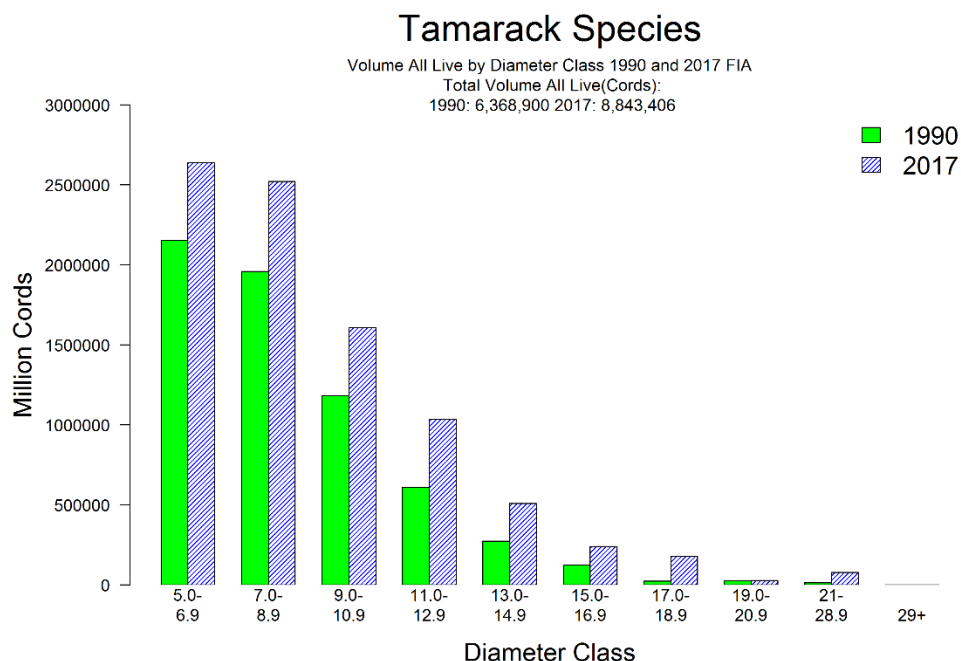
- Many stands have low volumes.
- Serious mortality levels are being experienced statewide, but especially in Koochiching, Beltrami, Lake of the Woods and Roseau counties that are caused by eastern larch beetle and are occurring in older stands.
- Winter access only.
- Inconsistent and varying levels of marketability.
- Additional market development potential.
- Markets include woody biomass energy, biochemical extraction and industrial lumber (pallets).



**Source:** 2017 FIA database provided by USFS, Northern Research Station

Tamarack is dominated by “middle-aged” stands, but there is a fair amount of very old tamarack (average rotation age= 90). The State of Minnesota owns close to 54% of the tamarack cover type acreage.

Tamarack is used primarily in the manufacture of, Arabinogalactan extraction and to a limited extent, engineered wood products. In the recent past, biomass energy facilities had begun to utilize more tamarack, but those markets have been drastically reduced. Markets for tamarack had been somewhat improved since the 1990s, but with the loss of biomass markets the future is uncertain and consumption has declined dramatically since 2014. Stumpage prices still remain quite low.



**Source:** 2017 FIA database provided by USFS, Northern Research Station

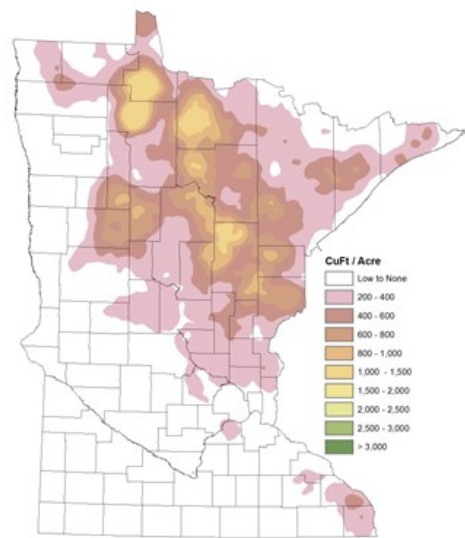
Total volume of tamarack has risen substantially since 1990. Insect and disease issues have risen substantially since 1990 as well.

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

Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	31,462	10.32	11.8	0	26.1	0	0	5.4	20.1	0.9	14.1	2	0	0	0	9.2	0
25-50%	156,723	2.9	52.7	1	24.8	0.7	2.1	1	11.3	0.8	1.8	0.2	0	0	0	0.5	0
50-75%	222,331	0.2	70.7	0	21.6	0.3	0	0.2	4.5	0.3	0.7	0.1	0	0	0.4	0.5	0.3
> 75%	483,596	0	95.1	0	3.7	0	0	0	0.5	0.2	0.2	0	0	0	0	0.1	0

**Predicted spatial distribution of tamarack CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.**

Tamarack (*Larix laricina*)

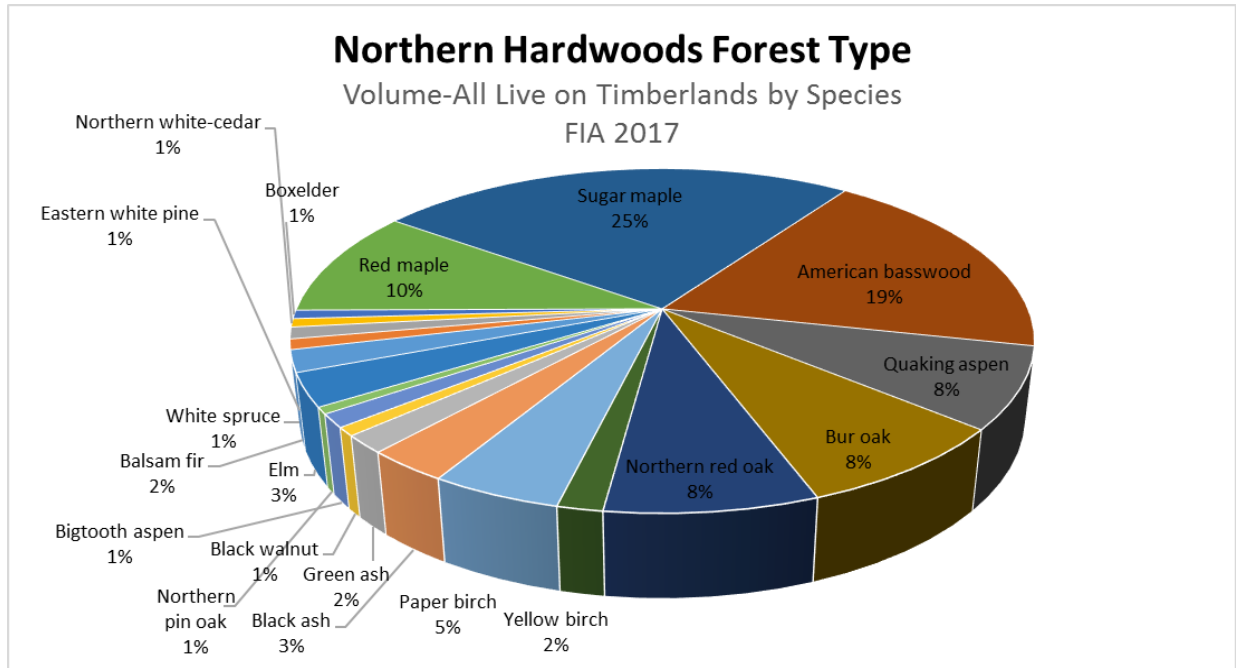


**Source:** 2017 FIA database provided by USFS



## Minnesota's Northern Hardwoods Resource

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

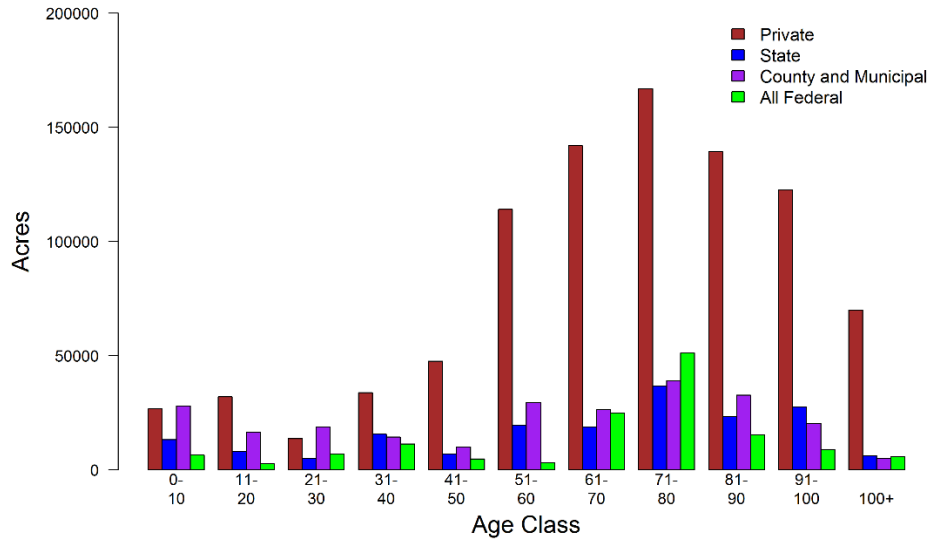


**Source:** 2017 FIA database provided by USFS, Northern Research Station

The northern hardwoods cover type is dominated by late “middle aged” stands (average rotation age = 80), many of which are in need of thinning in order to promote optimal growth and forest health. Northern hardwoods are often managed through periodic “thinning” harvests (or partial cuts), although clearcutting can be an appropriate tool in some situations, especially in sites with a poorly performing over story or over mature trees (comprising 50-60% of the stand). The northern hardwoods cover type is owned largely by private landowners. Continuing and improved availability and use of forest management technical assistance to private landowners is therefore a critical issue for this type. Our northern hardwoods cover type has been something of a “neglected” resource for many years. This has largely been due to a history of poor markets for many hardwood species and sizes in much of the state. The market situation for some hardwoods has changed drastically in recent years, however. Minnesota pulp and paper has increased the use of maple and to a limited extent other hardwoods.

## Northern Hardwood Forest Type

Timberland Acres by Owner & Age Class FIA 2017  
Total Acres in Forest Type: 1,471,825

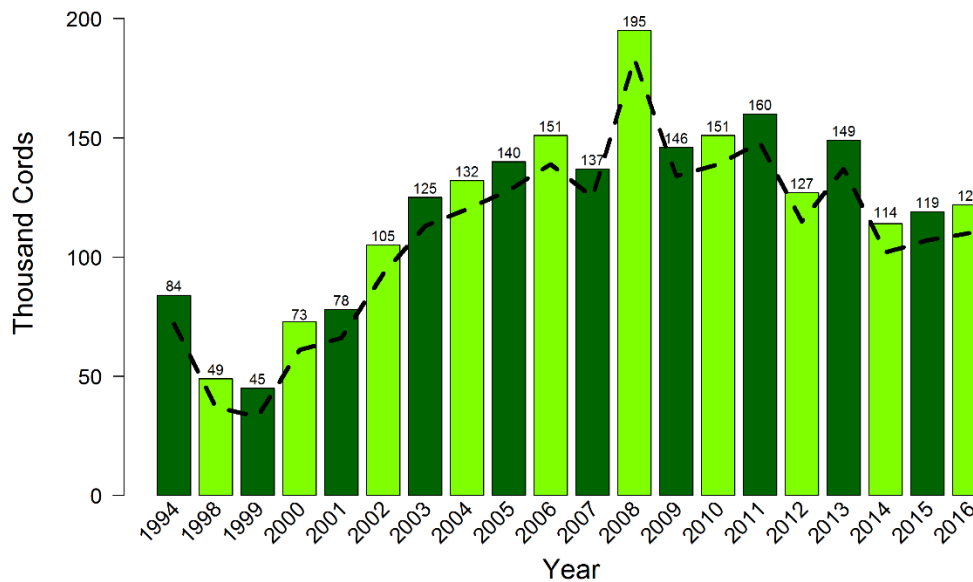


Source: 2017 FIA database provided by USFS, Northern Research Station

## Maple

### Maple Harvest in Minnesota 1994, 1998-2016

(Includes Pulpwood, Sawtimber and Wood Energy)



Source: NRS & DNR DRAFT survey results.

DNR estimated long-term annual sustainable harvest level = 429,600 cords. Based on the 2017 FIA database, estimated average annual net growth for maple growing stock in Minnesota is 374,437 cords, estimated average annual mortality of maple growing stock is 208,059 cords.

## Current Demand for Maple from Minnesota Timberlands

	Cords
2016 Harvest.....	123,000
<ul style="list-style-type: none"> <li>Minnesota Pulpwood Industries.....</li> <li>Pulpwood Export (To Wisconsin) .....</li> <li>Sawlogs (&amp; est. Exports) &amp; Other... ..</li> <li>Fuelwood.....</li> </ul>	89,013 13,271 6,980 13,720

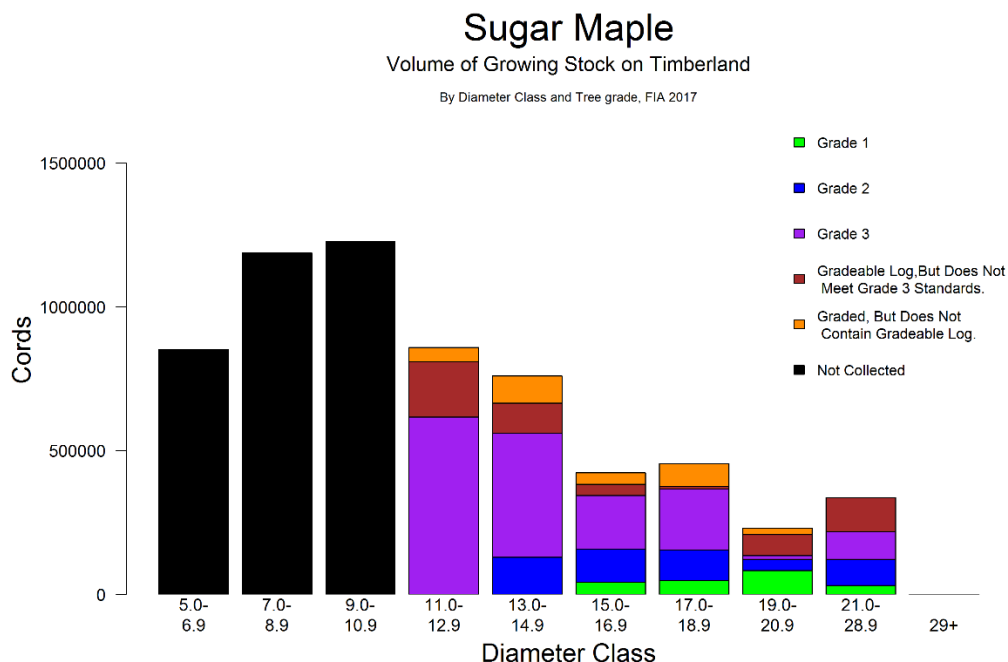
Source: NRS & DNR DRAFT survey results.

### Resource Opportunities:

- Harvest is well below long-term sustainable levels.
- Investments in appropriate harvesting equipment can improve ability to manage this resource.
- Increased management could create higher grade maple products, and improve marketing and utilization.

### Resource Issues:

- Much of the maple resource is in private ownership. Different logging equipment and intensity of management required in multiple-entry management (i.e., partial cutting, uneven-aged management).
- Parts of NE Minnesota are under gypsy moth quarantine. Logger and mills should contact MN Department of Agriculture to learn about compliance agreements.



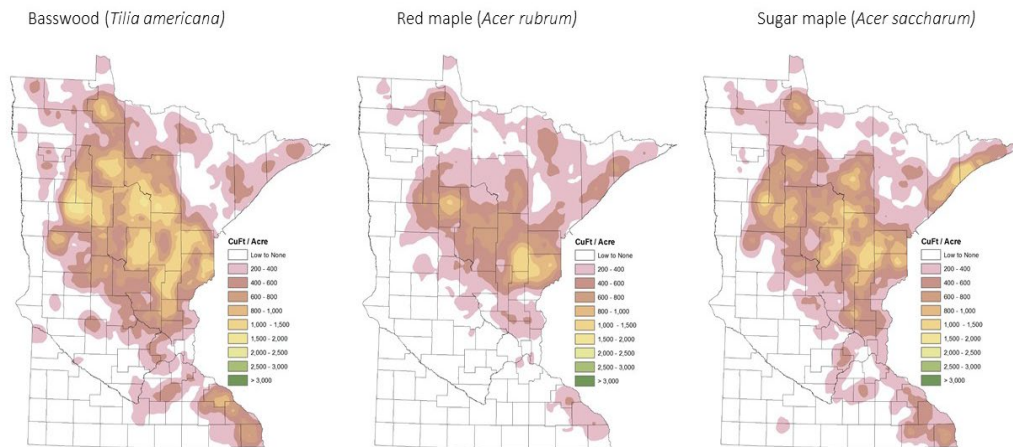
Source: 2017 FIA database provided by USFS, Northern Research Station

Note: Tree grade 1 = highest quality in the USFS tree grading system.

Minnesota's maple resource is made up of 4 species: sugar maple, red maple, silver maple and black maple.

Sugar maple in much of Minnesota tends to be of fairly low sawlog quality, due to relatively small size and poor form. We are on the western edge of its natural growing range. However, some higher quality sugar maple is grown in southeastern Minnesota.

**Predicted spatial distribution of red maple, sugar maple, and basswood CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.**

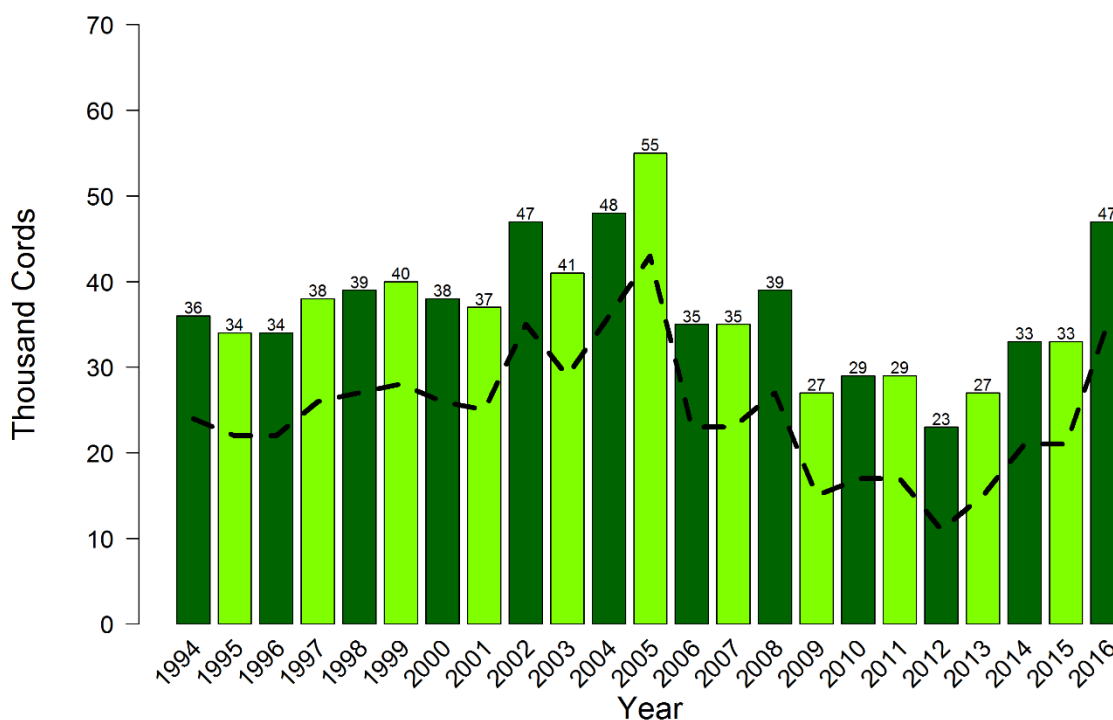


**Source:** 2017 FIA database provided by USFS, Northern Research Station

# **Basswood**

## **Basswood Harvest in Minnesota 1994-2016**

(Includes Pulpwood, Sawtimber and Wood Energy)



Source: NRS & DNR DRAFT survey results.

DNR estimated long-term annual sustainable harvest level = 280,300 cords. Based on the 2017 FIA database, estimated net annual basswood growth: 184,016 cords, estimated annual mortality is currently estimated at 102,393 cords.

## **Current Demand for Basswood from Minnesota Timberlands**

	Cords
2016 Harvest.....	47,455
• Minnesota Pulpwood Industries.....	9,401
• Pulpwood Export (To Wisconsin) .....	2,751
• Sawlogs & Other*.....	31,963
• Fuelwood*.....	3,340

Source: NRS & DNR DRAFT survey results.

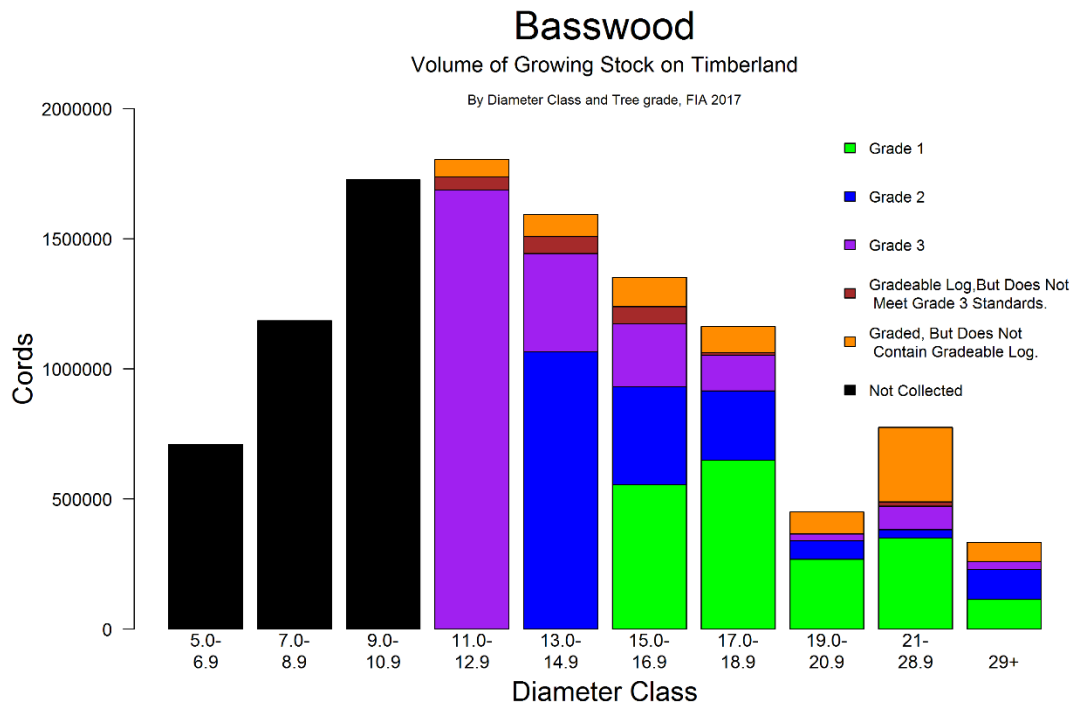
### **Resource Opportunities**

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

## Resource Issues

- Much of the basswood resource is in private ownership.
- Potential for harvest of high-quality stems as “pulpwood” on productive sites prior to their reaching sawlog size on private lands. Important to get quality material to higher-value markets.
- Different logging equipment and intensity of management required in multiple-entry management (i.e., partial cutting, uneven-aged management).
- Parts of NE Minnesota are under gypsy moth quarantine. Loggers and mills should contact MN Department of Agriculture to learn about compliance agreements.

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



**Source:** 2017 FIA database provided by USFS, Northern Research Station.

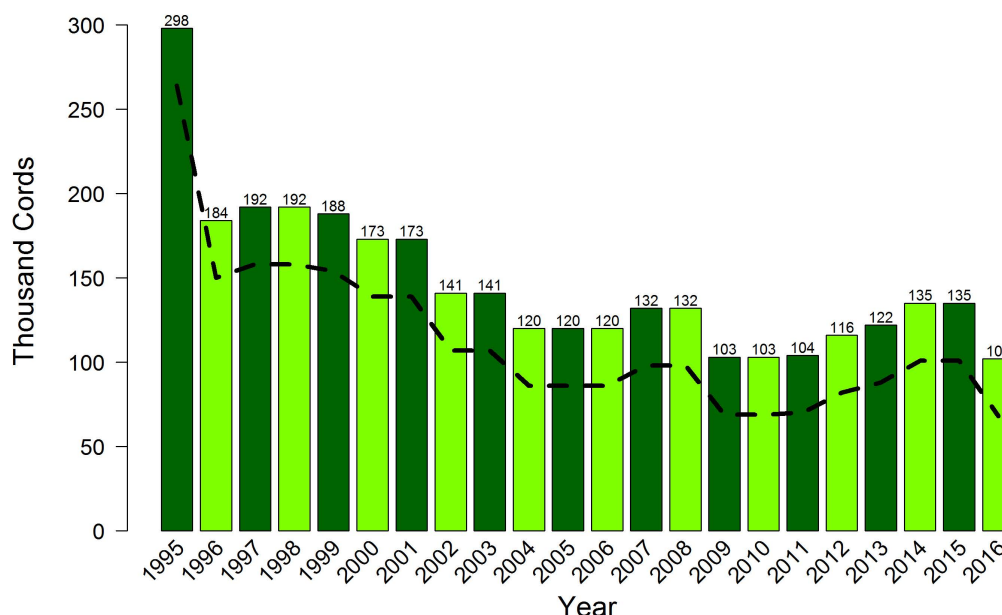
**Note:** Tree grade 1 = highest quality in the USFS tree grading system



# Minnesota's Oak Resource

## Oak Harvest in Minnesota 1994-2016

(Includes Pulpwood, Sawtimber and Wood Energy)



Source: NRS & DNR DRAFT survey results.

The oak cover type is dominated by late “middle aged” stands (average rotation age = 80 to 100).  
The oak resource is largely owned by private landowners.

## Current Demand for Oak from Minnesota Timberlands

	Cords
2016 Harvest.....	102,387
• Minnesota Pulpwood Industries.....	0
• Pulpwood Export (To Wisconsin).....	627
• Sawlogs & Other*.....	75,800
• Fuelwood*.....	25,960

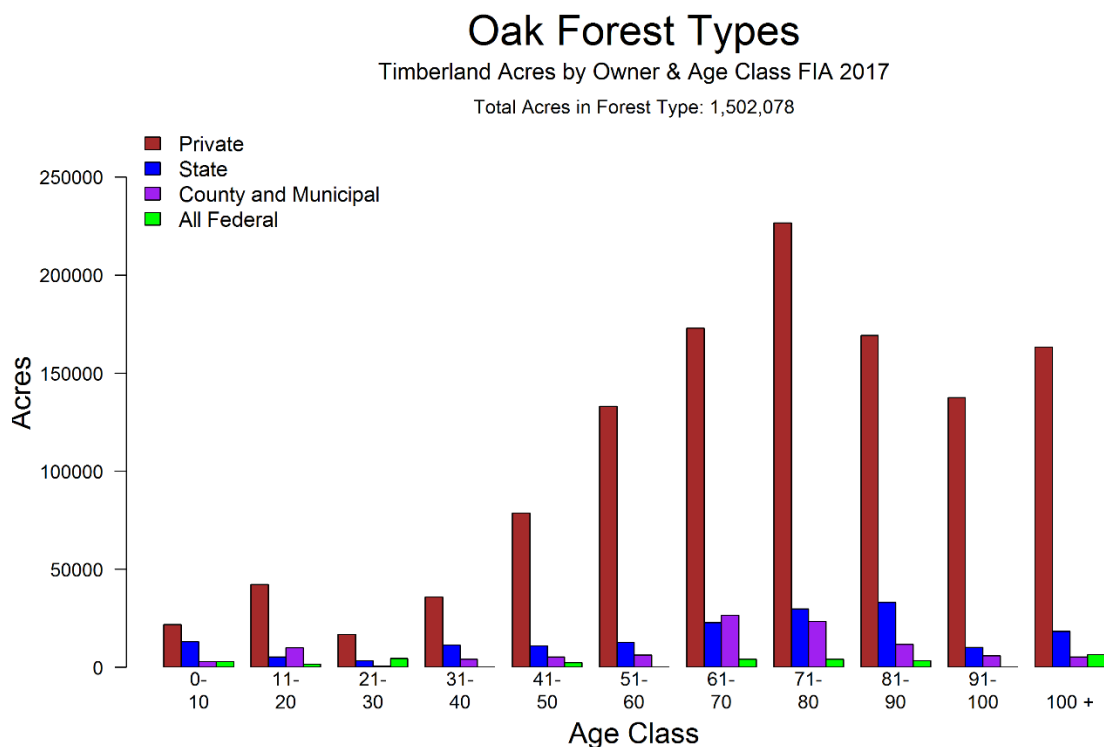
Source: NRS & DNR Surveys. \*DRAFT estimates from recent surveys

### Resource Opportunities:

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

### Resource Issues:

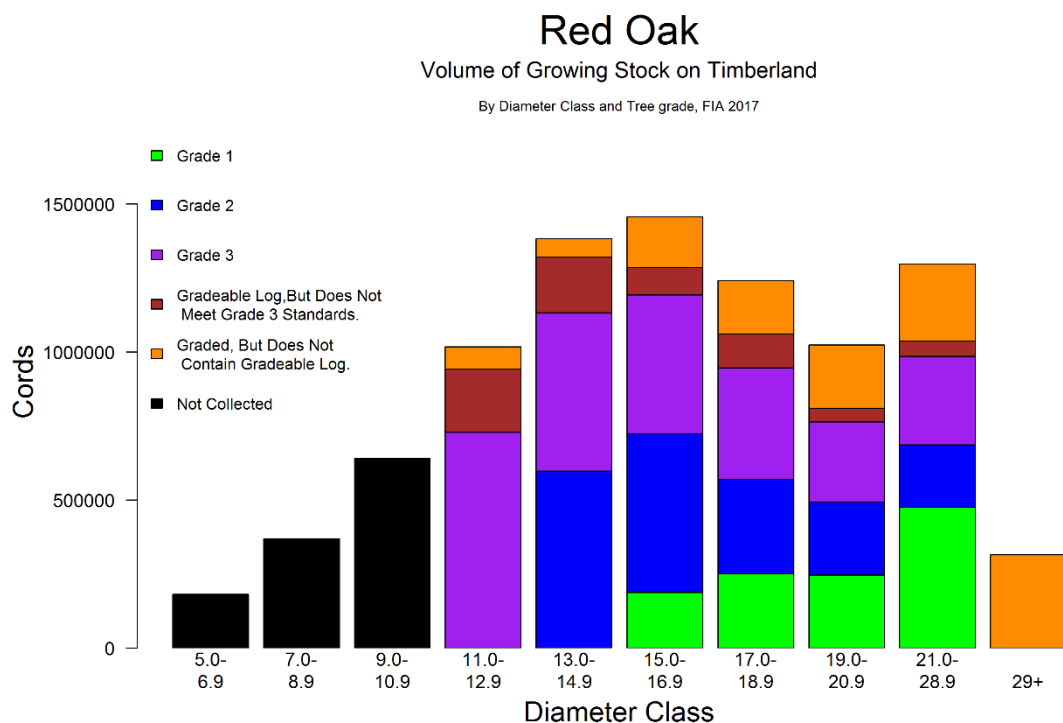
- High quality red oak sawlog resource continues to decline.
- Gypsy moth is making its way into Minnesota. It will likely have a negative impact on the oak resource where forests are primarily comprised of oak and are on shallow or sandy soils. We are still many years away from this initial impact.
- Oak wilt is a preventable disease that is continuing to be found further north in Minnesota. Controlling oak wilt is possible but costly.
- Where oak dominates stands, avoid harvesting during and after severe droughts or defoliation events.



**Source:** 2017 FIA database provided by USFS, Northern Research Station

Oak is a tremendously important cover type and species in a large portion of Minnesota. Many wildlife species commonly use acorns as part of their diet, and oaks also can provide excellent den opportunities. Additionally, it is the largest hardwood species by volume produced by many sawmills, especially those in the southern 2/3 of the state.

DNR estimated long-term annual sustainable harvest level for oak = 499,300 cords. Based on 2017 FIA data, estimated net annual oak growth: 560,730 cords, a 9% decrease compared to 2016 on Timberlands, white oak had a net growth of 16,659 cords, red oak was 238,027 cords; estimated annual oak mortality: 259,966 cords, a 55% increase over 2016 estimates. White oak annual mortality was 4,520 cords, and red oak was 111,404 cords



**Source:** 2017 FIA database provided by USFS, Northern Research Station (includes black oak, northern pin oak, and northern red oak).

**Note:** Tree grade 1 = highest quality in the USFS tree grading system

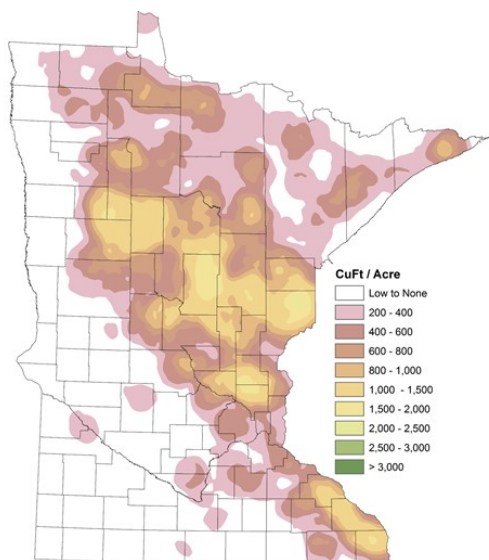
Some high quality sawlog and veneer red oak is grown on good sites in Minnesota.

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

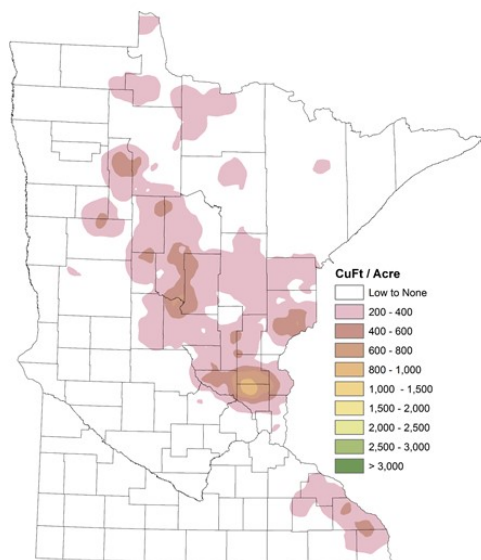
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	336,261	0.4	0.4	0	0	0.3	1.4	0.5	0.1	11.8	3.9	0.8	34.2	7.5	4.4	7.4	9.4
25-50%	333,073	0.2	0	1	0	0.7	0.5	1.2	0	12.2	5.1	0.2	12.7	3.2	6.8	5.5	43.4
50-75%	397,706	0.2	0	0.1	0	0.5	0.2	0	0	8.9	2.6	0.1	4	3.2	3.5	2.5	68.4
> 75%	289,061	0.1	0	0.1	0	0.5	0	0	0	1.7	0.8	0	0.6	0.9	1	1	91.4

**Predicted spatial distribution of northern red oak and northern pin oak (red oak family) and bur oak and white oak (white oak) CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.**

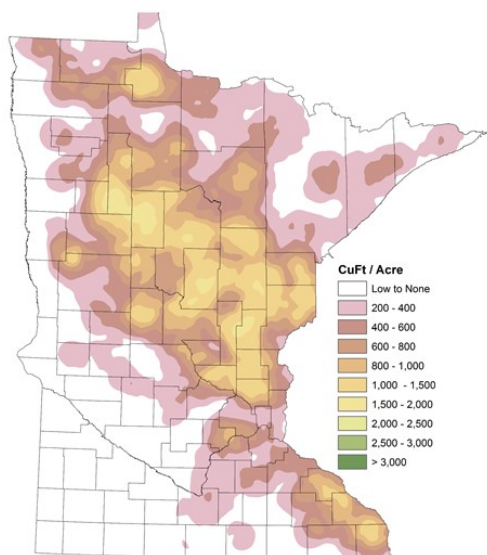
Northern red oak (*Quercus rubrum*)



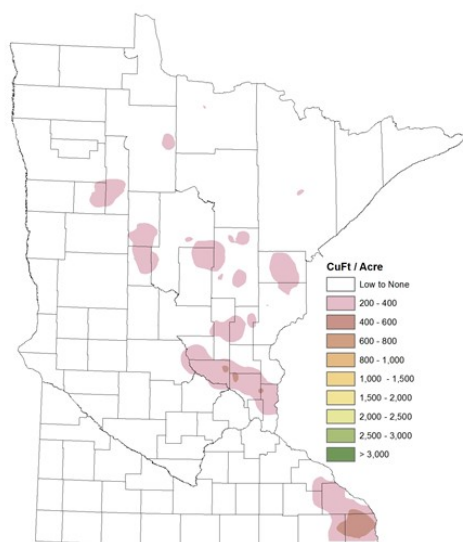
Northern pin oak (*Quercus ellipsoidalis*)



Bur oak (*Quercus macrocarpa*)

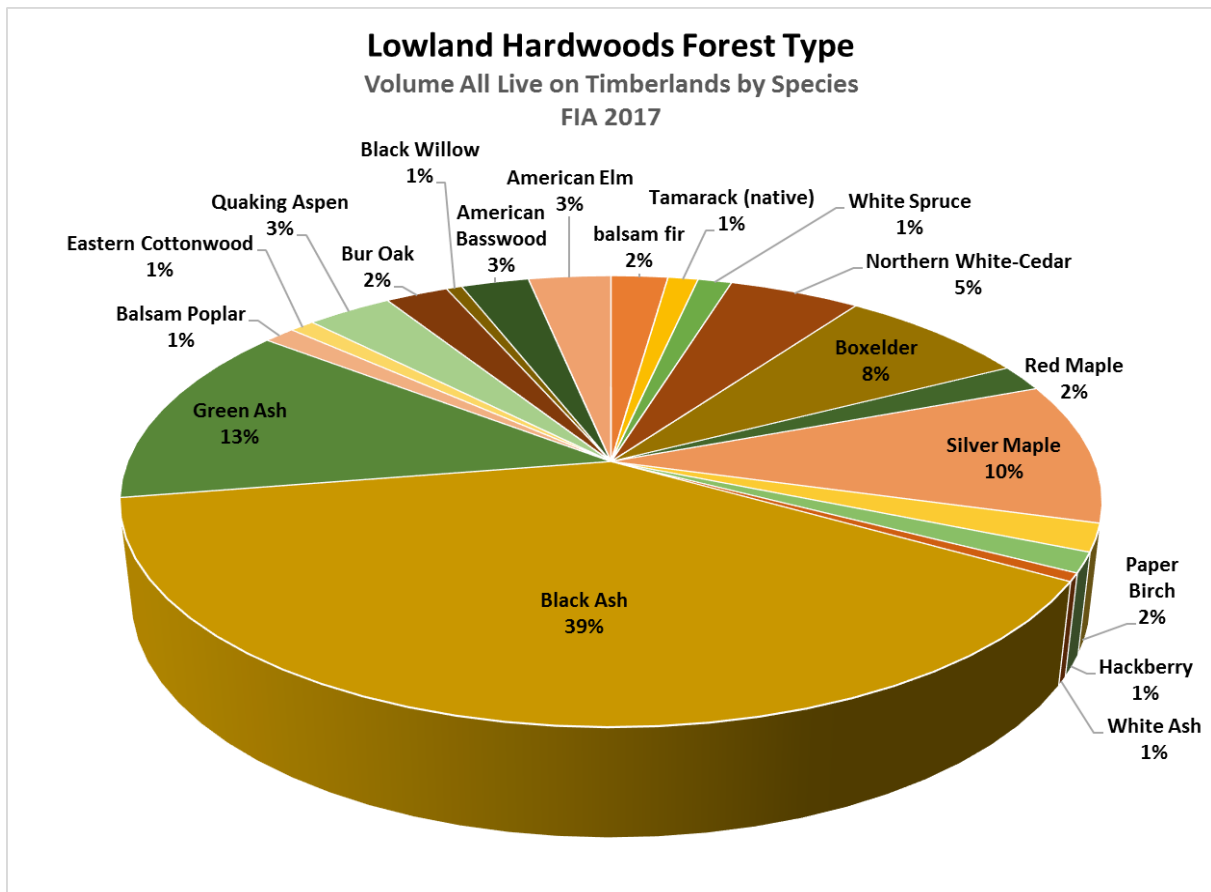


White oak (*Quercus alba*)



**Source:** 2017 FIA database provided by USFS, Northern Research Station

## Minnesota's Lowland Hardwoods Resource



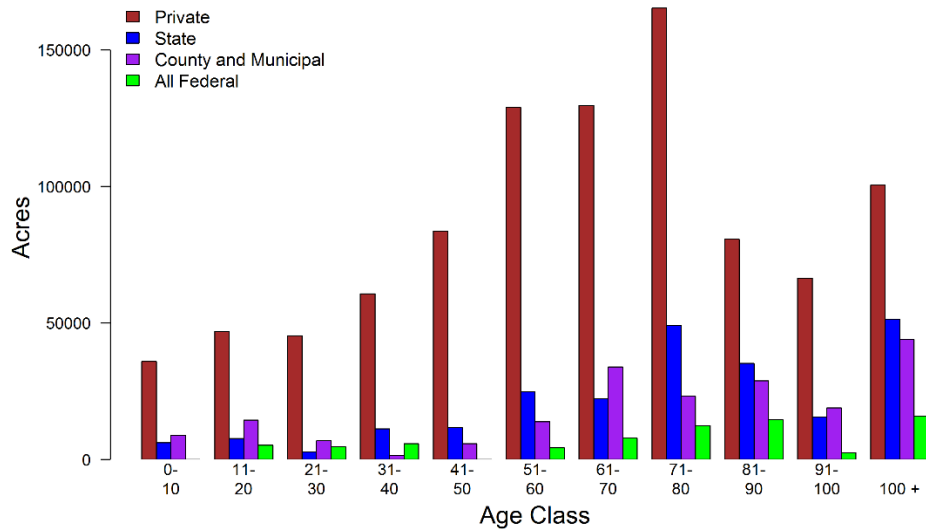
**Source:** 2017 FIA database provided by USFS, Northern Research Station

The lowland hardwoods cover type is made up of a variety of species. Most prevalent are black ash, green ash, silver maple, and boxelder.

## Lowland Hardwood Forest Types

Timberland Acres by Owner & Age Class FIA 2017

Total Acres in Forest Type: 1,456,605



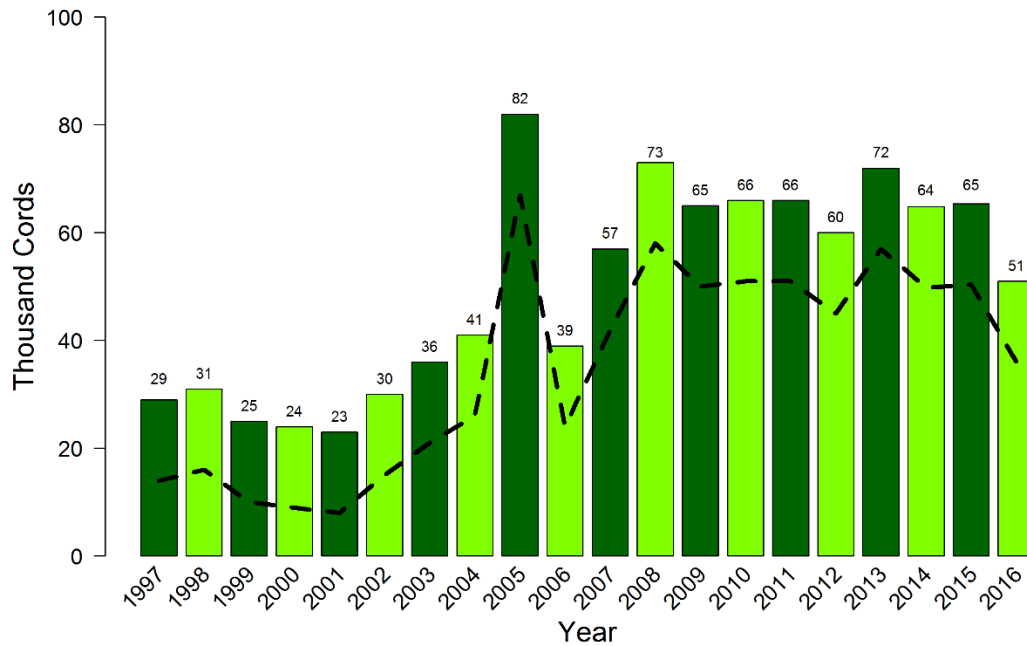
Source: 2017 FIA database provided by USFS, Northern Research Station

The lowland hardwood cover type is dominated by late “middle age” stands. A common rotation age for black ash is 90 years.

## Minnesota’s Ash Resource

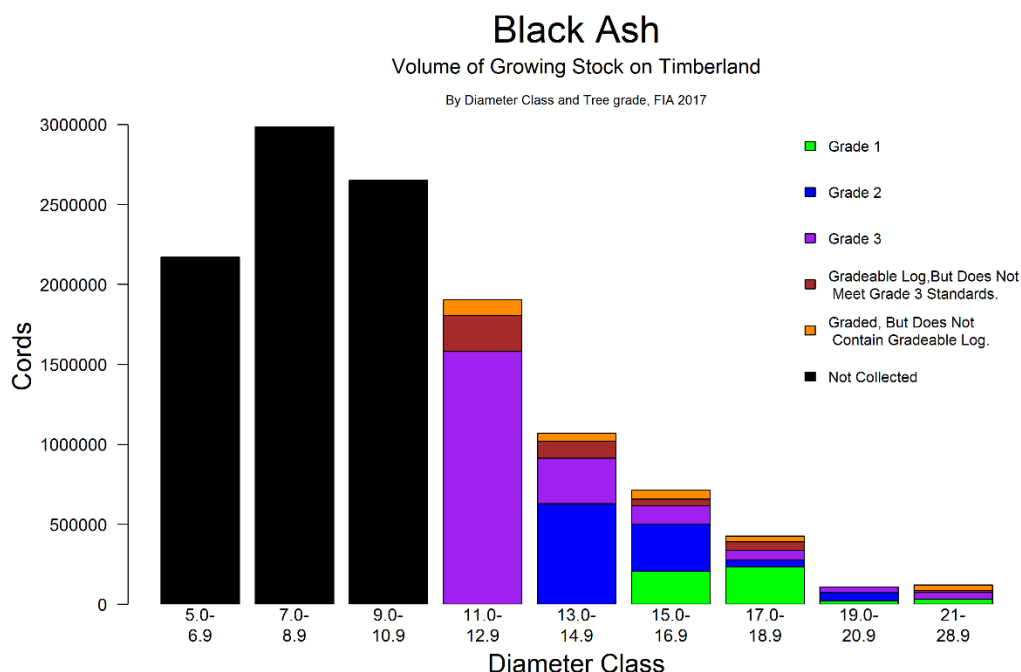
### Ash Harvest in Minnesota 1997-2016

(Includes Pulpwood, Sawtimber and Wood Energy)



Source: NRS & DNR DRAFT survey results.





**Source:** 2017 FIA database provided by USFS, Northern Research Station

**Note:** Tree grade 1 = highest quality in the USFS tree grading system

Ash has not historically had a consistent pulpwood market although several mills have increased the use of ash in recent years. DNR state lands only, estimated long-term annual sustainable harvest level, based on the STHA analysis, for ash is between 25,000 - 40,000 cords annually, though the DNR is offering additional ash in the next 5 years due to forest health concerns. Based on 2017 FIA data, estimated net annual ash growth: 471,637 cords; estimated annual mortality: 161,299 cords.

Of the ash species found in Minnesota (black, green and white), black ash has by far the largest volume. Minnesota's ash resource is dominated by smaller diameter material. This has an impact on processing opportunities: specifically, much of the ash resource is a good fit for pulpwood mills. A modest amount of high quality sawlog and veneer ash is grown in Minnesota.

## Current Demand for Ash from Minnesota Timberlands

	Cords
2016 Harvest.....	51,098
<ul style="list-style-type: none"> <li>Minnesota Pulpwood Industries.....</li> <li>Pulpwood Export (To Wisconsin).....</li> <li>Sawlogs (including est. exports).....</li> <li>Fuelwood.....</li> </ul>	24,423 5,261 9,793 11,620

**Source:** NRS & DNR DRAFT survey results.

## Resource Opportunities

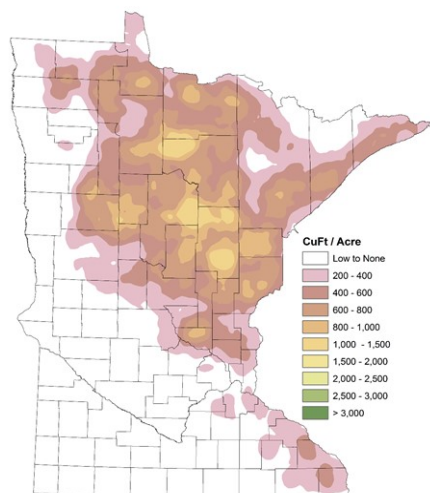
- Harvest is well below long-term sustainable levels.
- Winter harvest season predominately.
- Before emerald ash borer moves in, is the best time to log and merchandize ash.
- We are expecting significant mortality wherever emerald ash borer occurs and hence the supply of ash to keep increasing in the early- to mid-term.

## Resource Issues

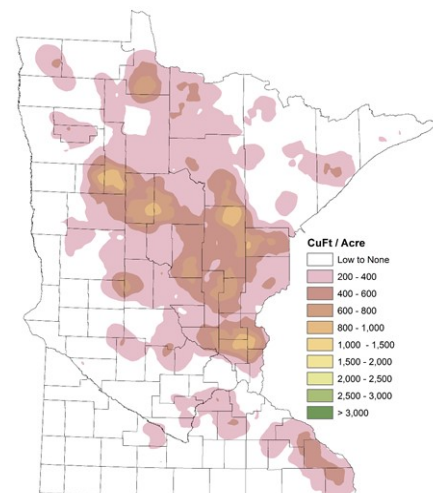
- Serious health concerns in black ash.
- Sorting high quality ash for highest value markets.
- Invasive emerald ash borer found in Minnesota.
- Several counties are under emerald ash borer quarantine. Loggers and mills should contact MN Department of Agriculture to obtain information about compliance agreements for moving ash products and hardwood firewood.
- Dutch elm disease continues to take its toll on elms > 5"dbh, making elms an unlikely replacement species for black ash in the short and mid-term.

**Predicted spatial distribution of black ash and green ash. CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.**

Black ash (*Fraxinus nigra*)



Green ash (*Fraxinus pennsylvanica*)



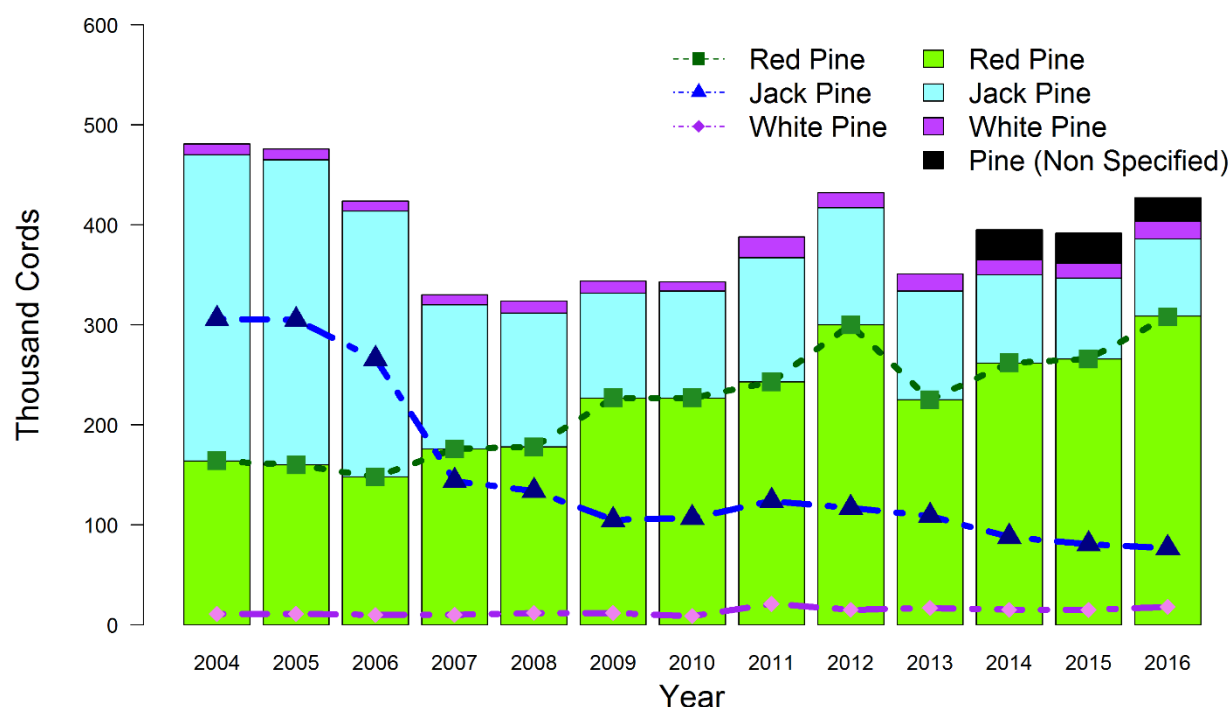
Source: 2017 FIA database provided by USFS, Northern Research Station

# Minnesota's Pine Resource

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

## Minnesota Pine Harvest

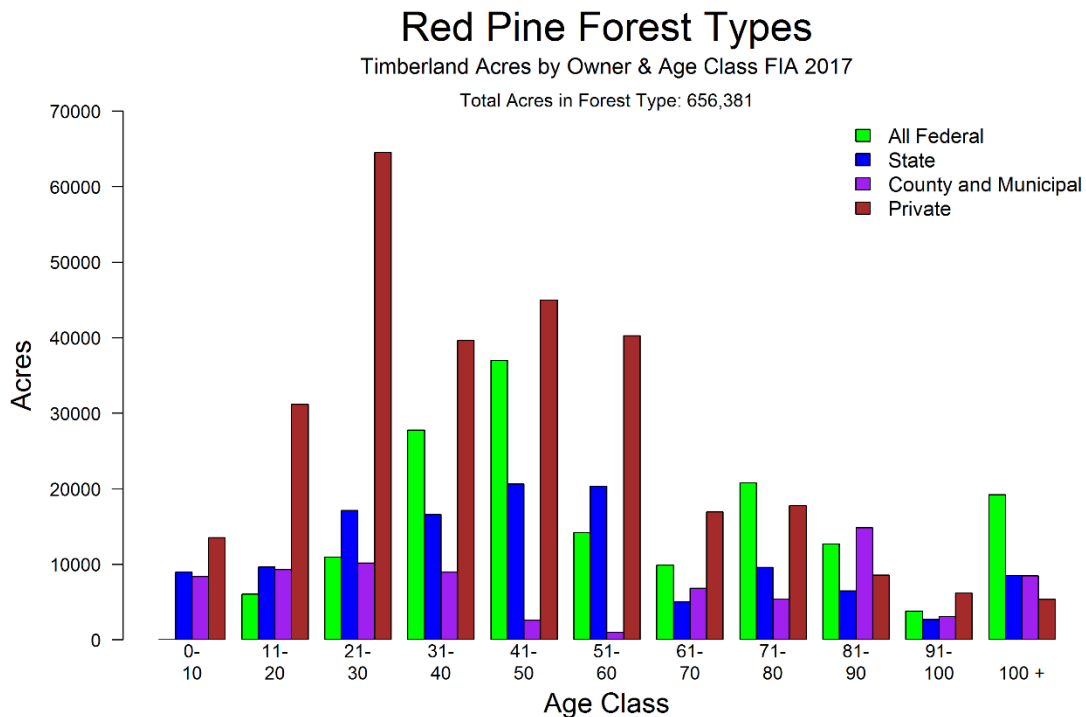
(2004-2016)



**Source:** Harvest data compiled by USFS, Northern Research Station & MN-DNR. Bars represent pine species contribution to total harvest, lines represent actual harvest numbers from 2004-2016 for specified species. Non-specified pine species typically contribute to commercial and residential fuelwood.

Over the past decade white pine contribution to total harvest has remained relatively steady, jack pine saw a major decline starting in 2007, which has persisted to the present day. Red pine has seen a gradual increase as jack pine use has decreased. The decline in jack pine use can be contributed to disease outbreaks such as budworm and decline in operating mills generally. Red pine harvest increases have mainly been driven by demand for saw timber. Recently demand for red pine small diameter pulpwood has fluctuated.

# Red Pine



Source: 2017 FIA database provided by USFS, Northern Research Station

## Current Demand for Red Pine from Minnesota Timberlands

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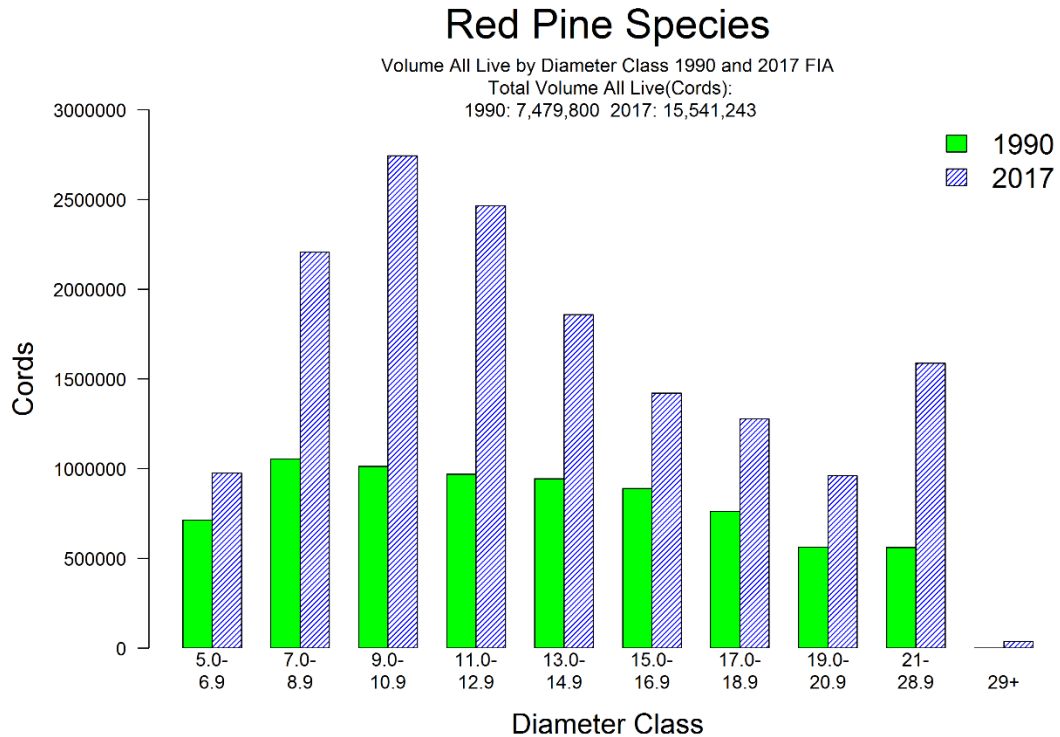
**Cords**

2016 Harvest..... **309,595**

- Minnesota Pulpwood Industries.....52,692
- Pulpwood Export (To Wisconsin)..... 9,211
- Sawlogs (& est. exports & Other\*)..... 247,692

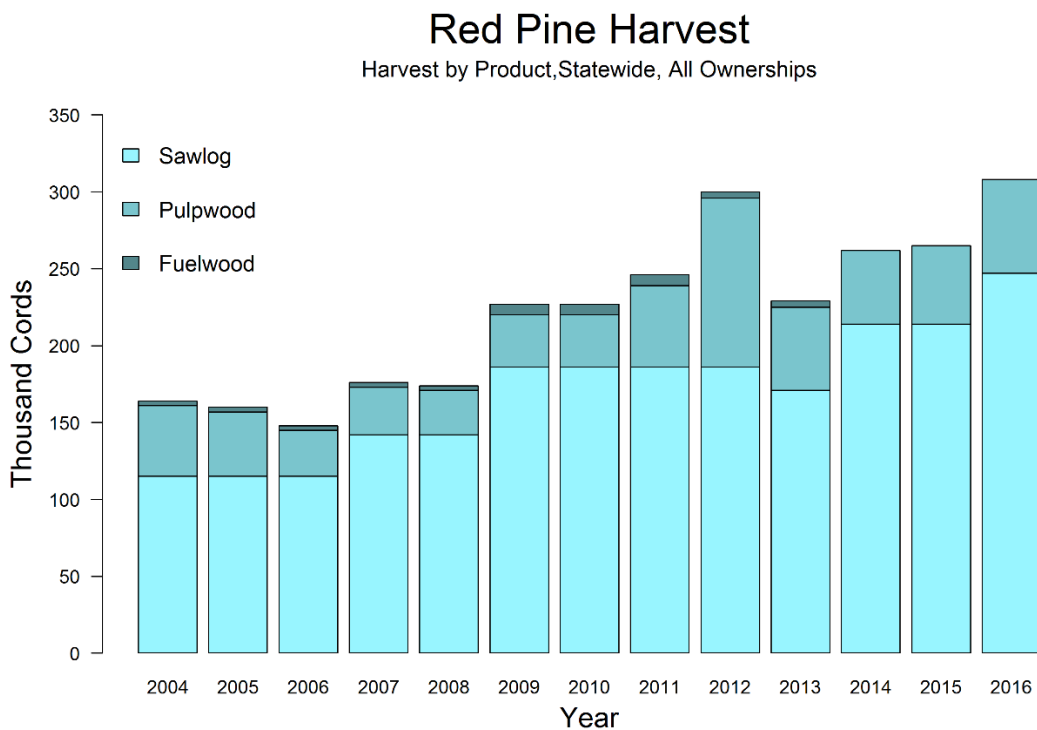
Source: NRS & DNR DRAFT survey results.

Red pine is a type dominated by young age classes, much of which is in the form of plantations in need of periodic thinning. Much of the resource is owned by the federal government and private landowners.



**Source:** 2017 FIA database provided by USFS, Northern Research Station

Volume of red pine has increased greatly since 1990 as many plantations have reached merchantable sizes.



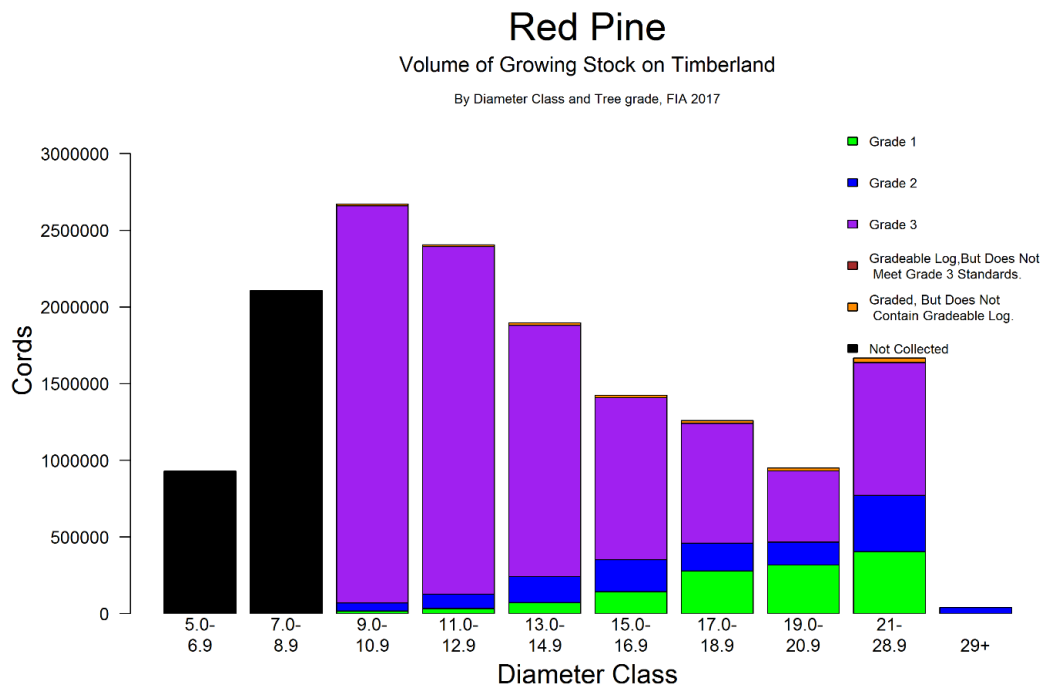
**Source:** NRS & DNR DRAFT survey results.

DNR estimated long-term annual all-ownership sustainable harvest level is approximately 345,000 cords\*. Based on 2017 FIA data, average net annual growth of red pine growing stock: 551,143 cords; average annual mortality: 42,658 cords.

\* Short-term sustainable level of 345,000 cords will continue to rise for at least 30 years as the cover type ages and available volume for thinning increases. Also: intensified thinning present an additional opportunity to raise sustainable levels by providing added stand growth.

## Resource Opportunities

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



**Source:** 2017 FIA database provided by USFS, Northern Research Station

**Note:** Tree grade 1 = highest quality in the USFS tree grading system

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

## Red Pine Natural

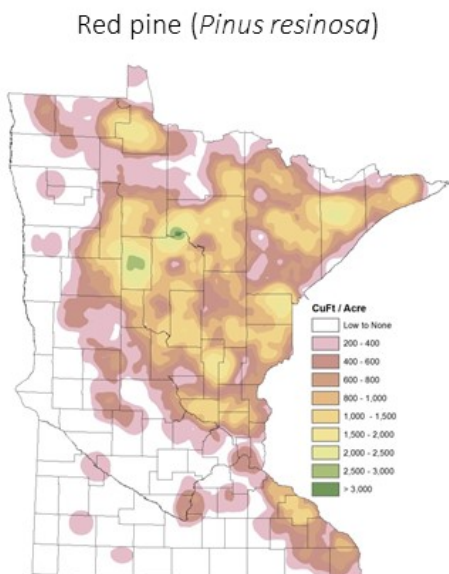


Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	85,045	0.9	0	2.7	0.9	40.1	8	3.5	0.4	23.7	6.7	0	0	0.3	3	0.3	9.1
25-50%	75,373	1.8	0	3.2	0.8	5.1	49.9	9.7	0	15.5	7.7	0	0.3	0	2	0	3.9
50-75%	66,204	4	0	0.9	0.4	6.1	70	6.8	0	4.7	3.4	0	0	0	1.4	0	1.5
> 75%	44,638	0.9	0	0.5	0.1	0.9	93.8	1.7	0	0.7	0.8	0.2	0	0	0.2	0	0.2

### Red Pine Planted

Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	4,283	26.8	0	0	0	45.8	4.4	0	0	23	0	0	0	0	0	0	0
25-50%	22,563	2.6	0	0.4	1	1.1	52.3	7.4	0	14.2	7.3	0	0.6	0.2	8.6	0.1	1.8
50-75%	98,344	2	0	3.9	1.1	5.6	70.4	4.9	0.3	6.3	2.4	0.9	0	0	0.5	0	1.5
> 75%	167,633	0.7	0	0.5	0.1	1.7	94.4	0.1	0	1.7	0.3	0.1	0	0.1	0	0	0.1

**Predicted spatial distribution of red pine CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.**



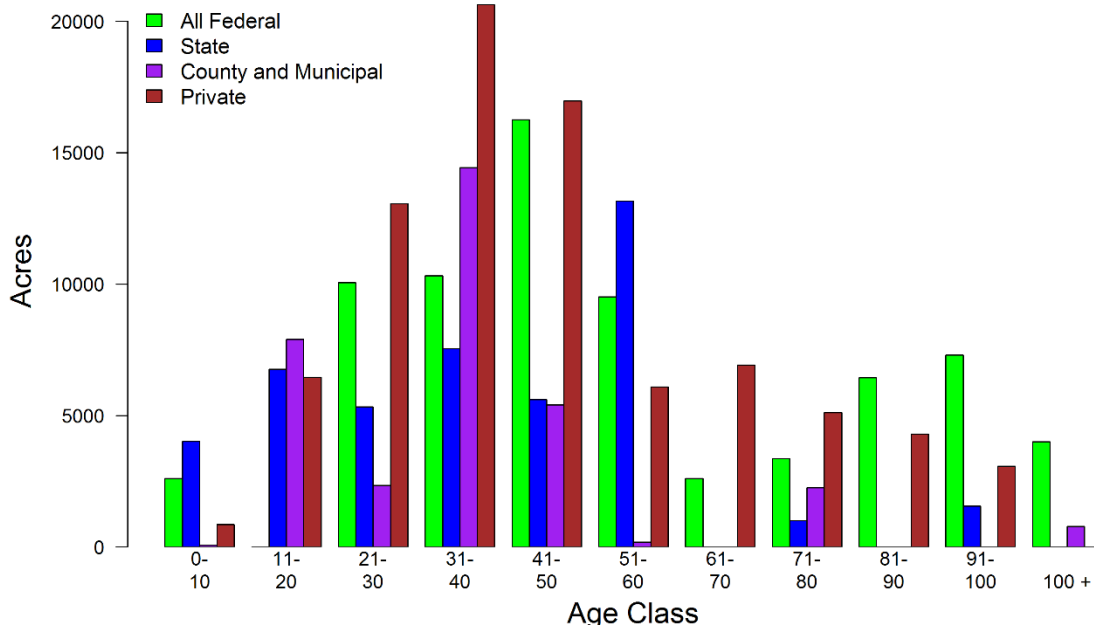
**Source:** 2017 FIA database provided by USFS, Northern Research Station

# Jack Pine

## Jack Pine Forest Types

Timberland Acres by Owner & Age Class FIA 2017

Total Acres in Forest Type: 234,194



Source: 2017 FIA database provided by USFS, Northern Research Station

## Current Demand for Jack Pine from Minnesota Timberlands

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Cords

2016 Harvest..... 77,216

- Minnesota Pulpwood Industries..... 23,571
- Pulpwood Export (To Wisconsin)..... 10,245
- Sawlogs & Other\*..... 43,400

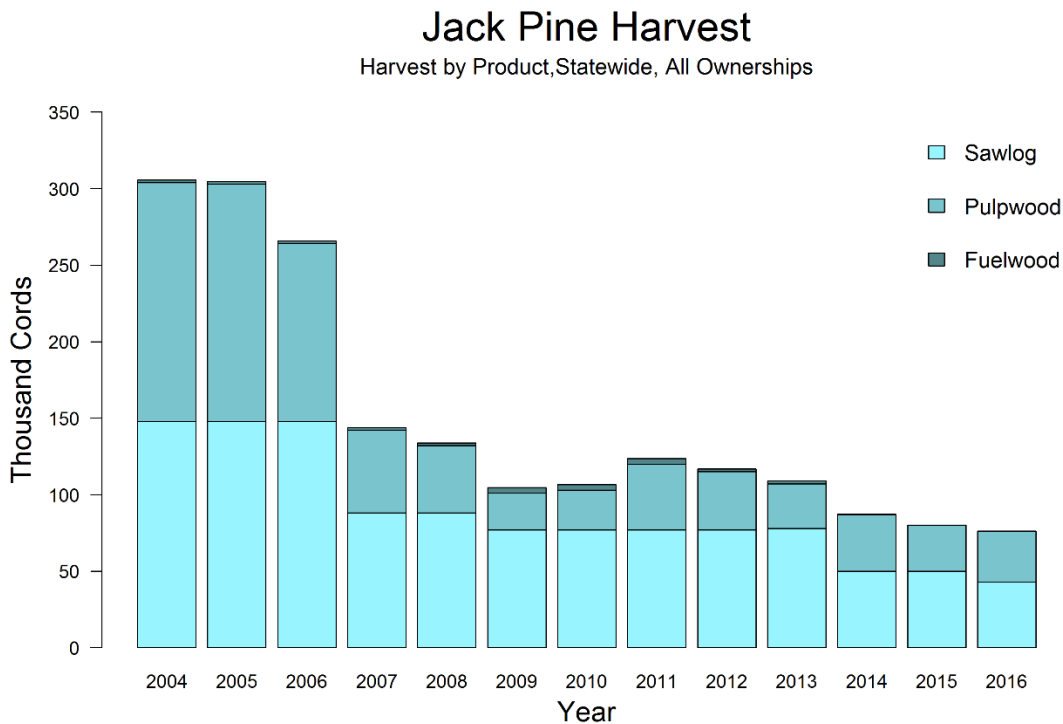
Source: NRS & DNR DRAFT survey results.

Ownership of the jack pine resource is well-distributed between the major ownership groups. Private landowners control the largest total acreage, but the federal government has by far the largest resource as a proportion of its total ownership. The jack pine cover type is heavily weighted to the 21 to 60 year age classes. Many stands over age 50 are in need of management at the present time. Periodic jack pine budworm outbreaks occur in older stands, which can result in heavy mortality and increased fire risk.

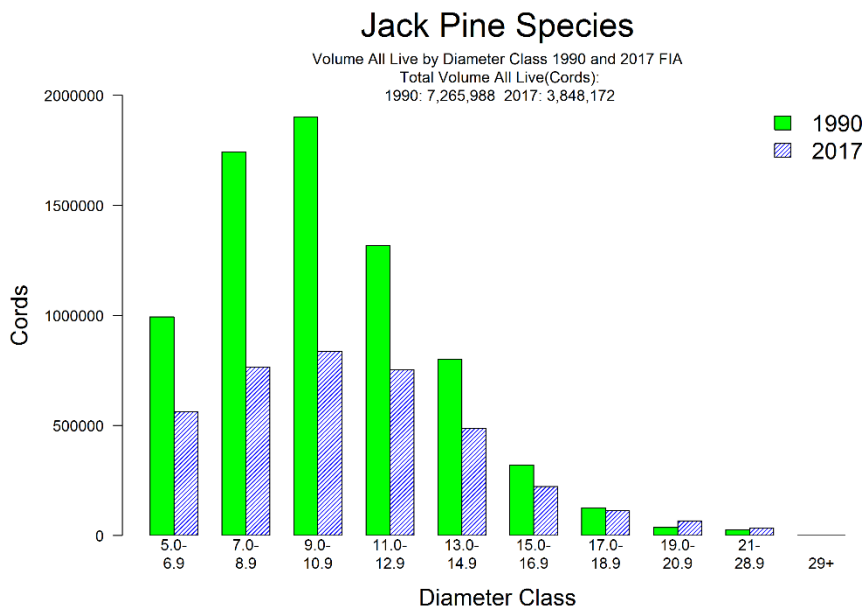
The accelerated harvest rates of the mid-2000s were necessary and prudent for forest health management purposes, but they were not sustainable for the long term. Jack pine harvest levels recently began a downward trend, but may be leveling off. The volume “slack” caused by the reduction in jack pine can be made up with increased thinning of the young red pine resource. Periodic outbreaks of jack pine

budworm in west-central counties cause mortality; the current outbreak started in 2015. It will last through about 2019 and make more jack pine available.

Based on 2017 USFS FIA data, average net annual growth of jack pine growing stock: 70,655 cords; average annual mortality of jack pine growing stock: 76,750 cords.



**Source:** NRS & DNR DRAFT survey results.



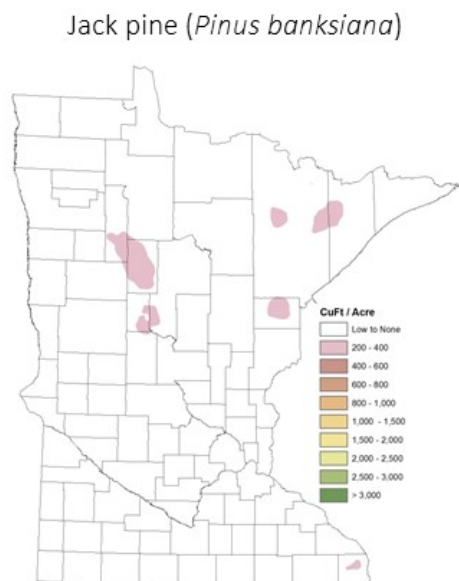
**Source:** 2017 FIA database provided by USFS, Northern Research Station.

Jack pine total volume of all live has declined from 7,266,000 cords in 1990 to 3,848,172 cords in 2017 – a 52% decrease relative to 1990 estimates. The vast majority of jack pine volume is found in trees with diameters smaller than 15 inches.

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

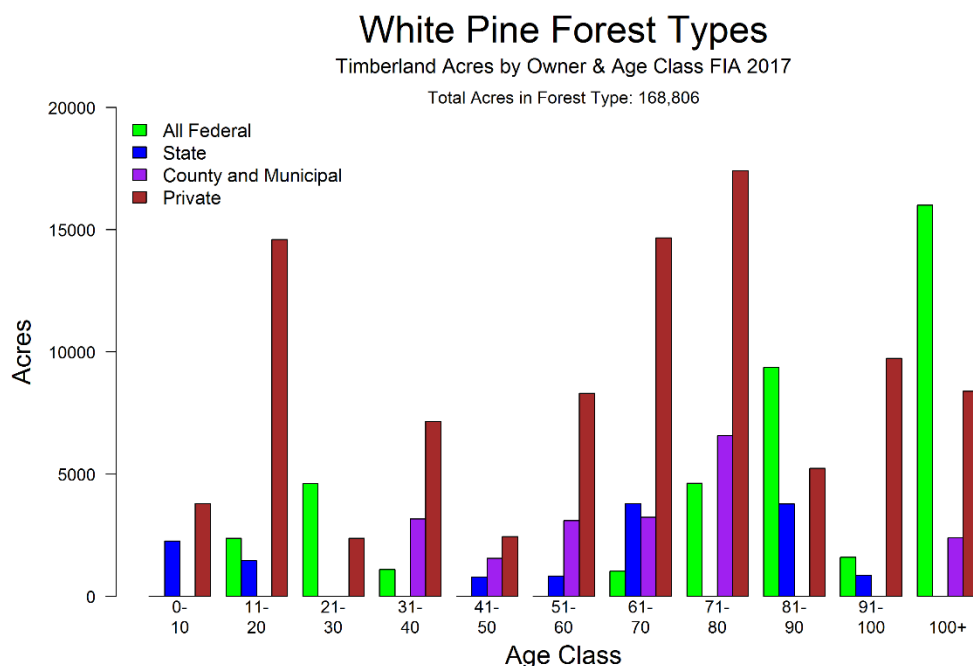
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	12,046	8	0	0	0	8.2	24.9	6.6	0	24.8	2.2	0.1	0	0	0	0	24.5
25-50%	65,913	9.1	0	3.5	12.6	43.3	11.8	3.2	0	8.9	5.2	0.8	0	0	0.6	0.1	0.2
50-75%	67,021	4.5	1.3	1.5	3.8	68.5	5.2	3.2	0	6.7	3.9	0	0	0.5	0.1	0.6	0.1
> 75%	70,995	2.7	0.1	0.4	1.9	89.2	1.8	0	0	3.4	0.2	0	0	0	0	0	0.3

Predicted spatial distribution of jack pine CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.



Source: 2017 FIA database provided by USFS, Northern Research Station

# White Pine



Source: 2017 FIA database provided by USFS, Northern Research Station

## Current Demand for White Pine from Minnesota Timberlands

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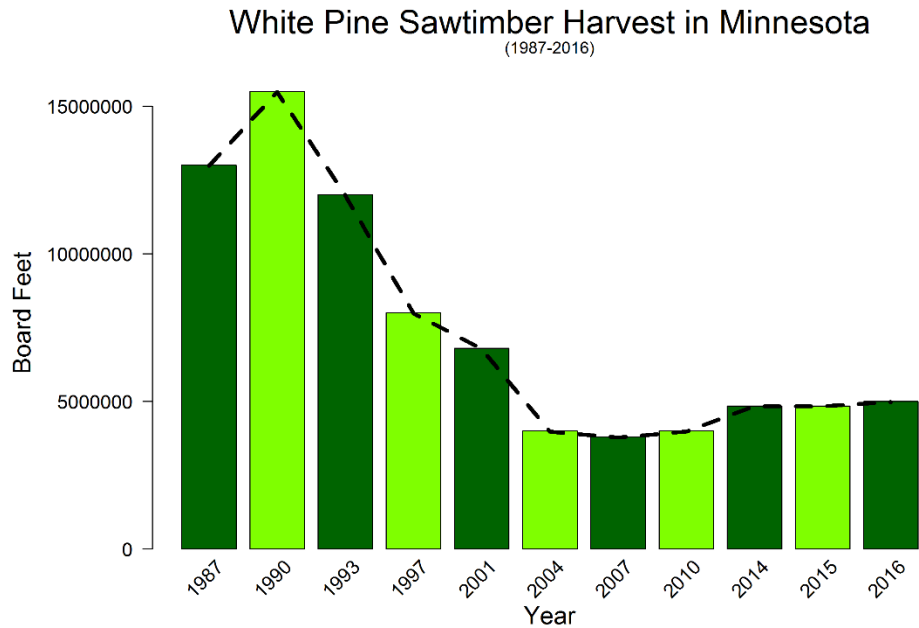
**Cords**

2016 Harvest..... **18,738**

- Minnesota Pulpwood Industries..... 6,715
- Pulpwood Export (To Wisconsin)..... 2,023
- Sawlogs & Other\*..... 10,000

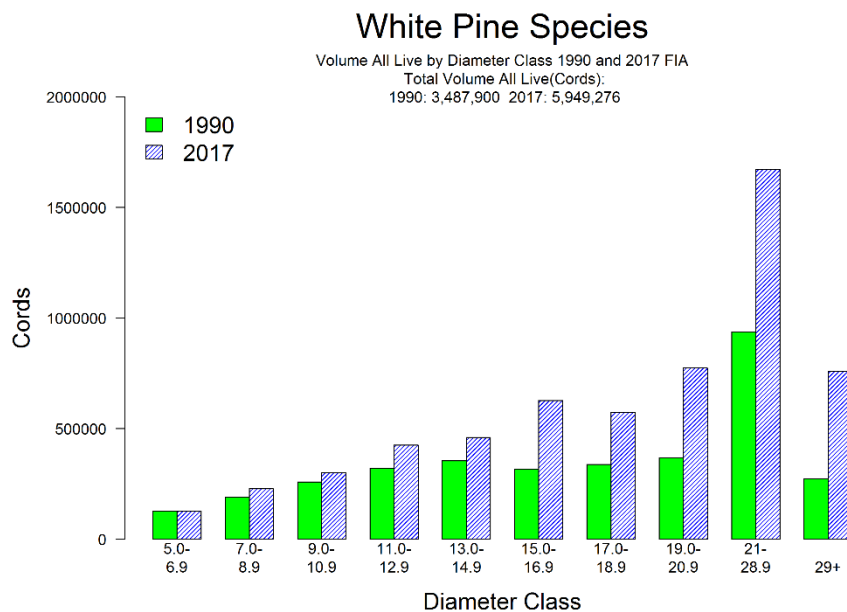
Source: NRS & DNR DRAFT survey results.

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

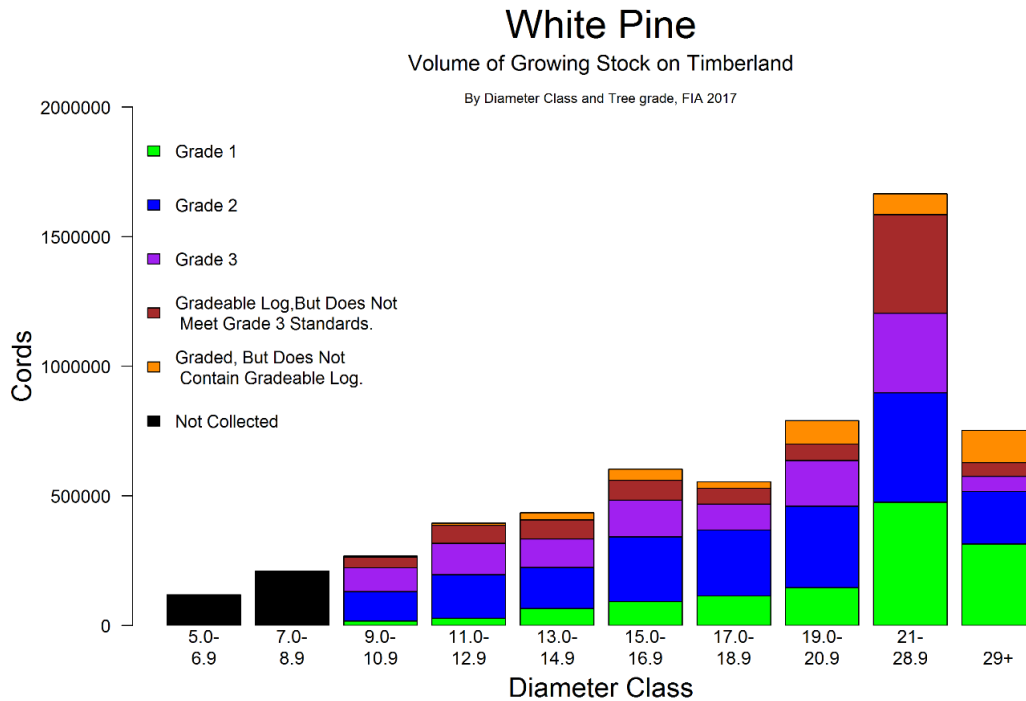


**Source:** NRS & DNR DRAFT survey results.

Most white pine volume occurs in the white pine, red pine, aspen and northern hardwoods cover types. The vast majority of white pine volume is in trees with diameters greater than 15 inches. Volume has increased substantially since the 1990 inventory. Based on 2017 FIA data, average net annual growth of white pine growing stock: 186,264 cords; average annual mortality: 41,993 cords. While the inventory has increased the harvest of white pine for sawtimber has decreased. Changes in climate may reduce white pine blister rust in parts of the state leading to more white pine in the long term.



**Source:** FIA 2017 database provided by USFS, Northern Research Station



**Source:** 2017 FIA database provided by USFS, Northern Research Station

**Note:** Tree grade 1 = highest quality in the USFS tree grading system

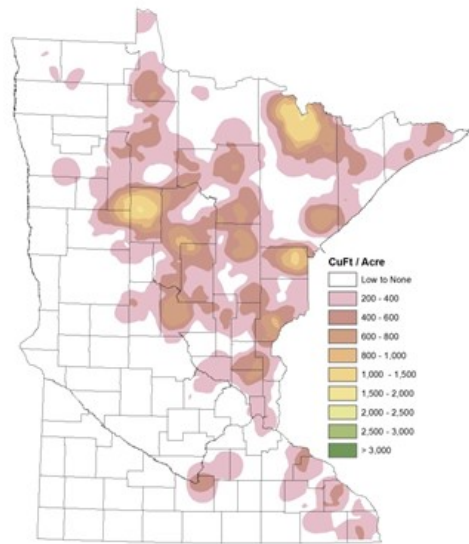
The table below shows **AVERAGE** percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top DOB) by percent of basal area per acre that is White Pine ON FIA PLOTS. This table shows that a White pine forest type can differ significantly and provides some idea of what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

Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	10,781	7.2	0	8.9	0	0.3	24.5	20.1	0	3.9	4.8	0.9	0	0.2	3.5	4.2	21.3
25-50%	72,059	1.3	0.5	1.7	1.4	5.8	11.4	47.6	0	11.4	4.9	0.2	1.4	0	3.2	0.4	7.8
50-75%	49,493	2.2	0.4	4.1	0.5	1	8	67.9	0	3.4	3.5	0	0.2	0	3.1	0.1	3.9
> 75%	12,996	14.3	0	0.4	2.3	0	0.4	81.9	0	0.4	0.2	0	0	0.1	0	0	0.2

**Predicted spatial distribution of eastern white pine CUBIC FOOT volume per acre of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of a certain species are dense enough to represent a large enough volume warranting depiction.**



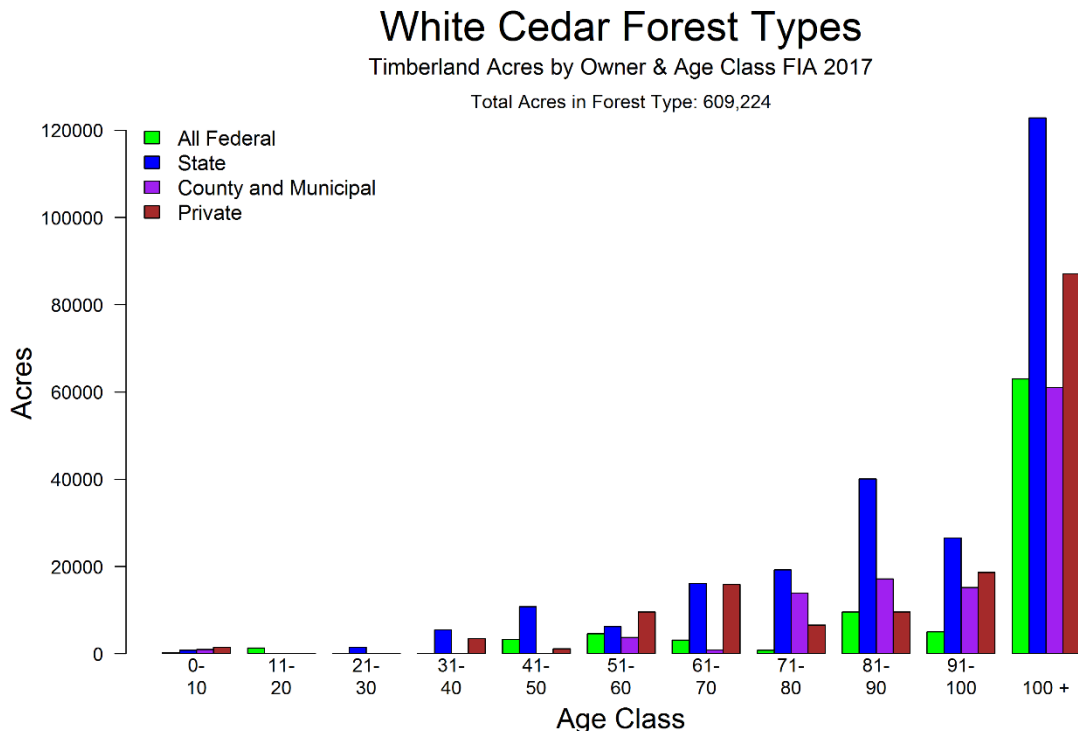
White pine (*Pinus strobus*)



**Source:** 2017 FIA database provided by USFS, Northern Research Station

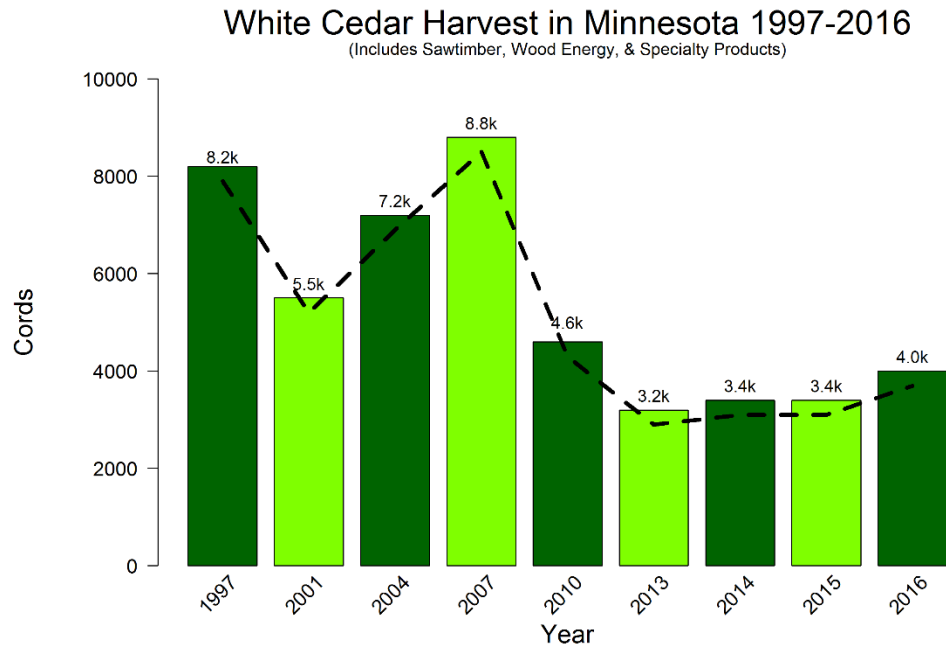
## Minnesota's White Cedar Resource

Northern white cedar is a slow-growing, long-lived conifer. The white cedar cover type in Minnesota is located largely in the northeastern 1/3 of the state and is made up of a variety of species. Cover type volume is dominated by white cedar, but includes spruce, tamarack, birch, balsam fir, ash and several other minor species. Significant volumes of cedar can also be found mixed with other lowland cover types and it also exists as a minor component of some upland cover types. Cedar is significant because it provides critical habitat for white-tailed deer and for many rare plant species including the threatened ram's head orchid, and because it is a potentially valuable timber resource.



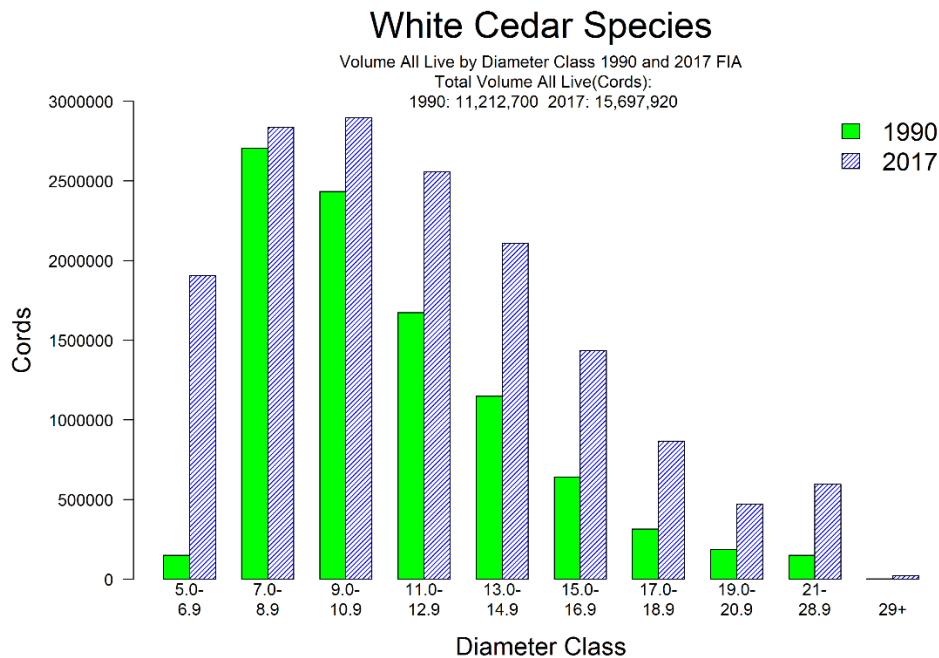
**Source:** 2017 FIA database provided by USFS, Northern Research Station

White cedar is generally an old resource, and it is getting older: around 440,344 cover type acres exist in stands over age 100, an increase from the 327,000 cover type acres over age 100 in 2016. Currently around 8,611 cover type acres are below age 30, or approximately 1.25% of the cover type acres. Much of the white cedar resource exists on very wet sites, many of which have low productivity and slow growth. High amounts of heart rot are common in older stands on wet sites. Much of the volume of white cedar is contained in material below 13 inches in diameter.



**Source:** NRS & DNR DRAFT survey results.

With no pulpwood market for cedar, the small amount of utilization is entirely for sawtimber, specialty products and a small amount of fuelwood. Net annual growth for white cedar growing stock is approximately 263,506 cords, and average annual mortality is approximately 62,459 cords, according to the 2017 FIA inventory. Annual harvest has been below 5,000 cords since 2010, there is a great deal of potential in the resource for more utilization and management, if regeneration issues can be solved.



**Source:** 2017 FIA database provided by USFS, Northern Research Station

# Current Demand for White Cedar from Minnesota Timberlands

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Cords

2016 Harvest..... 4,000

- Minnesota Pulpwood Industries..... 0
- Pulpwood Export (To Wisconsin)..... 0
- Sawlogs & Other..... 4,000

Source: NRS & DNR DRAFT survey results.

## Resource Opportunities:

- Cedar can be a great fit for some value-added products due to its natural decay resistance.
- Product markets include post & poles, railings and rough lumber.

## Resource Issues

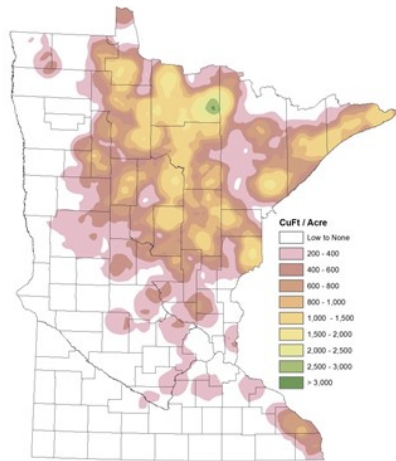
- White cedar has been somewhat of a “neglected” resource for many years. Probably the single biggest reason for this is an inability to consistently regenerate it on many sites. Cedar is in need of greater research efforts in regeneration techniques.
- Use of white cedar for industrial products in MN is very modest. There is no pulpwood market for cedar. The modest amount of utilization in Minnesota is essentially entirely for sawtimber, specialty products and a small amount for fuelwood.
- Cedar has tremendous importance for wildlife habitat and ecological diversity.
- Cedar is very long-lived, and can be difficult to regenerate naturally.

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

Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
<25%	3,361	7	0	0	0	0	0	0	11.9	42.2	0	7.8	0	25.3	0	5.8	0
25-50%	82,759	6.6	10.3	1.9	11.2	0	0	1.9	46.2	4.6	10.1	1.7	0	0	1.2	2.7	0
50-75%	253,045	5.3	8.01	1.5	5.5	0	8	0.6	67.6	2	4.5	0.9	0	0.1	0.1	3	0
>75%	253,418	2.1	3.4	0.2	2.6	0	0.2	0	87.4	0.2	1.9	0.4	0	0	0	1.2	0

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

Northern white cedar (*Thuja occidentalis*)



**Source:** 2017 FIA database provided by USFS, Northern Research Station

# Timber Price Information



**Average Prices Received by Product for Stumpage Sold by Public Land Agencies in Minnesota: 2006-2017**

## Average Prices Received for Stumpage Sold by Public Land Agencies in Minnesota: 2006-2017

Notes:

- Average prices based on those reported by Minnesota Counties (Aitkin, Becker, Beltrami, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Itasca, Koochiching, Lake, Pine, St. Louis, and Wadena), USDA Chippewa and Superior National Forests, USDI Bureau of Indian Affairs, and Minnesota DNR- Division of Forestry. Agency specific prices are available on the DNR website, in the annual “[Minnesota Public Stumpage Price Review](#)”.
- Reporting agencies have different fiscal years and different 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. For recent timber auction results, readers can go to the DNR website and view the “[DNR Timber Sales Calendar and Archive](#)”

**Table 1. Pulpwood (\$ per cord)**

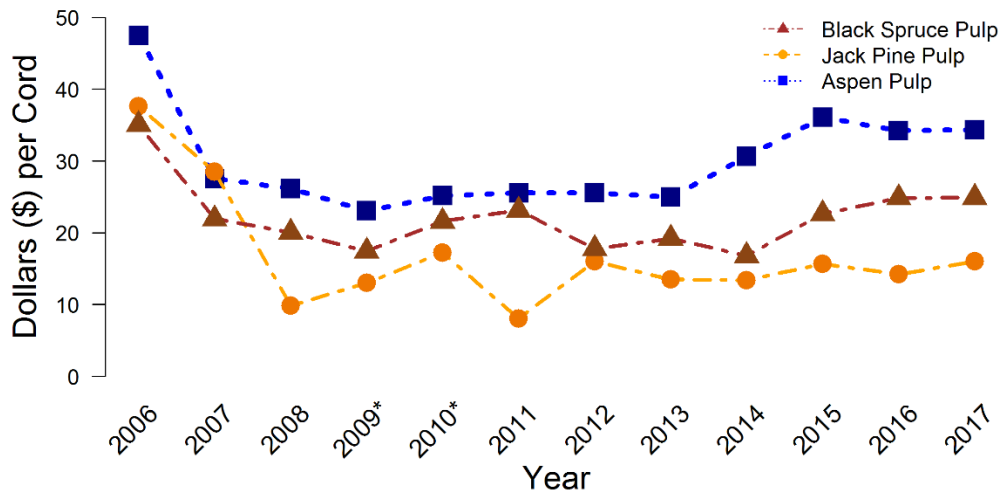
Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Aspen	47.52	27.52	26.14	23.07	25.16	25.55	25.58	24.99	30.62	36.08	34.26	34.33
Balm	38.85	23.7	21.18	20.83	21.22	20.01	22.77	20.56	24.8	27.68	24.29	30.56
Birch	14.76	9.68	9.06	9.17	8.48	9.41	9.31	8.44	9.89	12.02	13.77	11.33
Ash	8.22	7.65	6.86	8.73	6.97	7.41	6.26	6.62	6.82	6	8.07	6.69
Oak	18.27	16.23	8.39	15.32	13.41	11.29	11.69	15.44	13.1	14.63	17	6.05
Basswood	8.06	10.98	7.41	8.1	7.5	7.58	6.61	9.16	8.82	12.51	8.26	8.49
Mixed/Other Hardwoods	14.65	12.55	9.96	11.78	12.29	10.58	10.24	10.59	12.44	11.45	8.06	14.38
Balsam Fir	30.59	18.36	15.98	14.67	16.1	17.91	14.19	9.86	10.62	14.18	14.76	16.71
W. Spruce	35.06*	21.94	18.69*	17.44*	21.58*	17.91	15.12	17.57	16.55	19.09	17.25	23.00
B. Spruce	35.06*	0.76	20.05			23.14	17.77	19.22	16.8	22.63	24.87	24.90
Tamarack	5.96	5.4	4.61	5.01	5.03	5.51	6.2	5.05	5.4	7.81	6.26	7.81
W. Cedar	9.26	9.35	4.1	5.44	6.19	8.21	5.12	7.86	5.3	6.41	6.8	5.20
Jack Pine	37.62	28.5	9.87	13.02	17.21	8.06	16.03	13.5	13.41	15.66	14.2	16.00
Red Pine	35.59	27.15	11.99	16.22	9.08	19.25	10.27	15.5	12.44	18.59	11.84	12.30
White Pine	35.59	27.15	-	-	-	5.37	10.81	13.01	16.56	12.78	15.91	8.44
Maple	7.98	7.91	8.86	8.06	9.21	8.99	8.18	9.91	9.82	10.13	12.31	10.47

\* Spruce Species

- Insufficient data



## Pulp Price for Select Species (2006-2017)



**Source:** DNR public price stumpage reports

In 2017, across all species and as reported on public lands, a total of 52,790.2 tons of biomass was sold for bioenergy consumption with an average price of \$1.02 per ton.

**Table 2. Pulp and Bolts in Combination\* (\$ per cord)**

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Aspen	0	32.74	0	36.79	0	0	0	0	36.16	44.24	46.49	39.24
Balm	0	27.55	0	0	0	0	0	0	0	0	66.8	0
Birch	14.72	0	0	13.01	14.48	15.54	14.24	15.17	15.31	17.98	18.11	20.35
Ash	28.43	15	0	10.1	17.41	18.23	18.39	15.81	11.59	14.66	12.55	13.47
Oak	55.62	26.1	0	21.25	21.49	19.95	20.45	22.2	23.62	27.01	31.71	28.72
Basswood	41.34	16.61	0	11.62	13.15	10.7	11.58	13.78	12.03	14.52	16.62	15.91
Mixed/Other Hardwoods	28.75	0	0	0	0	18.75	17.3	14.32	16.02	15.67	17.15	16.77
Balsam Fir	0	0	0	21.91	23.44	20.39	20.78	16.65	17.93	23.97	24.73	21.70
W. Spruce	0**	0	0**	23.37**	26.54**	24.99	24	25.48	29.57	25.73	27.63	32.82
B. Spruce	0**	0	0			0	26.91	24.65	27.9	30.48	41.36	27.87
Tamarack	0	0	0	0	0	0	16.57	12.75	15.54	13.87	0	15.31
W. Cedar	0	0	0	11.65	0	0	0	0	13.04	0	12.07	12.75
Jack Pine	55.6	57.2	0	25.41	28.34	28.03	29.84	27.31	32.06	30.88	34.03	32.19
Red Pine	48.41	36.68	0	29.32	31.04	36.29	32.01	40.48	43.09	43.78	37.71	39.73
White Pine	48.41	-	-	-	-	37.95	27.51	36.9	24.95	39.21	28.7	16.68
Maple	10.43	0	0	16.59	17.41	13.86	12.94	13.76	13.57	18.11	17.82	16.19

\* A bolt is defined as short log, usually 100" in length, with a specific minimum top diameter.

\*\* Spruce Species

- Insufficient data

**Table 3. Sawtimber (\$ per Thousand Board feet (MBF)))\***

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Aspen	43.96	41.33	43.64	51.11	33.67	52.11	53.48	53.12	0	0	0	0
Balm	0	0	0	0	0	0	0	0	0	0	0	0
Birch	52.06	27.24	32.04	19.82	38.92	42.15	35.7	36.97	47.04	42.84	45.24	0
Ash	61.41	38.21	42.41	51.89	56.27	58.09	36.12	34.06	73.41	54.17	97.67	72.20
Elm	--	85.22	60.08	53.99	45.08	60.43	42.45	41.41	42.19	42.5	42.54	39.77
Oak**	378.03	182.8	\$271.04	193.6	243.1	232.2	225.4	274.5	411.3	265.5	299.03	195.16
Basswood	124.73	97.73	97.33	66.24	63.47	66.11	55.87	54.44	68.87	59.24	80.40	104.38
Mixed/Other Hardwoods	209.61	52.91	52.86	37.72	29.8	48.31	36.88	28.56	65.4	47.87	47.04	50.28
Balsam Fir	0	76.47	72.75	58.34	0	0	0	66.51	0	0	0	0
W. Spruce	113.02	96.41	81.57	87.05†	102.15†	64.23	83.12	87.57	61.12	74.68	73.59	67.58
B. Spruce	113.02	0	0			0	0	0	0	0	0	0
Tamarack	0	0	0	0	0	0	0	0	0	0	0	0
W. Cedar	153.14	16.2	0	0	0	0	0	0	0	0	0	0
Jack Pine	124.11	115.2	109.95	106.2	0	145.76	139	112	89.56	0	118.77	139.76
Red Pine	143.45	114	119.51	107.4	123.4	142.33	121.5	127.1	148.3	177.2	133.22	142.72
White Pine	143.45	114	-	-	-	82.55	106.7	112.8	121.3	88.92	117.50	82.28
Maple	206.45	137.2	150.62	81.48	219.8	160.78	292.1	70.92	406.7	126.7	168.50	153.04

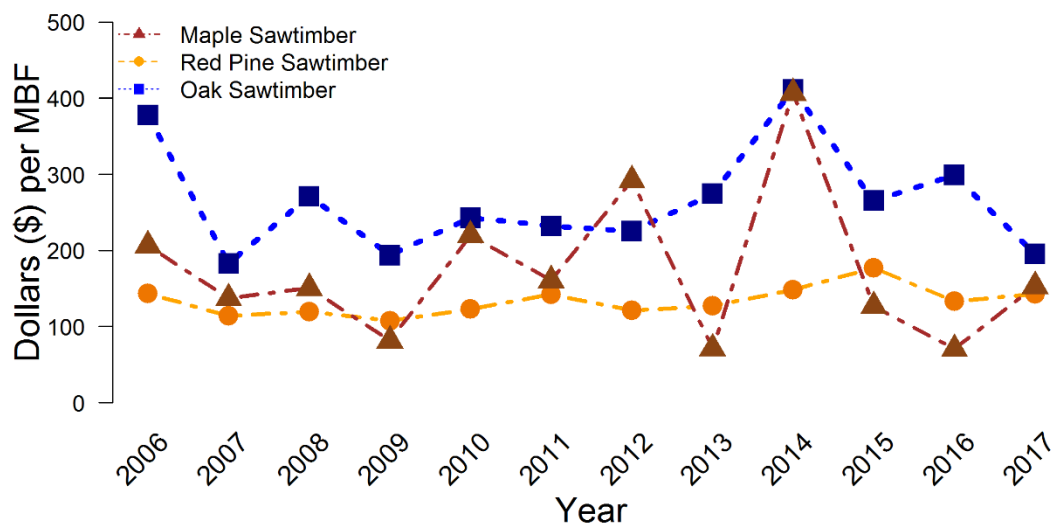
\* Includes Veneer for certain hardwood species

\*\* Primarily from public Lands in Southeastern Minnesota

† Spruce species

- Insufficient data

## Sawtimber Price for Select Species (2006-2017)



Source: DNR public price stumpage reports

# 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 defect.

**FIA** – Forest Inventory & Analysis. In this inventory, permanent plots are remeasured. Under an older system, where all existing FIA plots were measured during the same year, field remeasurements were last completed in 1977 and 1990. A new system is now used. Rather than measuring all plots during one year, basically 20% of all plots are remeasured annually, referred to as a panel. Hence, all existing plots are remeasured during a five-year period, referred to as a cycle. Three 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), we are currently in Cycle 15 (panels of 2014, 2015, and 2016 have been completed thus far). FIA is a cooperative effort between the USDA Forest Service and Minnesota DNR.

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 and changes over time for non-industrial private woodlands and is the only way to get comprehensive data 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 & 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. This is where the FIA unit of the USFS is located. These are the folks that, in cooperation with state DNR, accomplish the FIA inventory and Timber Product Output surveys. Without them, very little of the information in this document would be available.

**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, and 5. Wood energy. These primary products are often inputs into “secondary” or “value-added” products.

**Pulpwood** – Wood that is harvested and used by primary mills that make products from reconstituted wood fiber. In addition to wood pulp, 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, one important requirement is that at least 90% of its taxable income must be distributed to shareholders in the form of dividends. A REIT structure is advantageous for many reasons, a large one is that earnings are considered capital gains which are taxed at a maximum rate of 15%, as opposed to corporate income tax rates such as 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 the 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.

## **Glossary (Continued)**

**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. Although these organizations generally possess large amounts of acreage, they differ from REITs and vertically-integrated timberland-owning companies in that they hold timberlands for the financial value of the land and timber rather than as a source of raw material for company-owned mills.

**USDA** – United States Department of Agriculture.

**USFS** – United States Department of Agriculture - Forest Service.

## **Conversion Factors**

**Conversion factors used in the preparation of this report:**

**1 cord = 500 board feet**

**1 cord = 79 cubic feet**