Minnesota's Forest Resources 2016

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

Minnesota's Forest Resources
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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, Minnesota DNR staff (particularly Don Deckard, Bonnie DeLare Brian Schwingle, Jess Hartshorn, and Jon Drimel), and the USDA Forest Service Forest Inventory and Analysis (FIA) unit. All FIA summary data was obtained from FIADB version 1.6.0.03a.

Resource and Industry Highlights:

- Overall net growth for all species continued to outpace harvest levels. According to 2016 FIA figures, annual net growth of growing stock on timberland was approximately 5.45 million cords, with mortality of approximately 4.61 million cords.
- According to draft 2014 mill and fuelwood survey data, the volume of wood harvested and utilized by industry and fuelwood users was approximately 2.88 million cords (see page 6) which was essentially unchanged from 2013. Hence, the FIA volumes of net growth are 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 spruce and red pine compared to 2013.
    - MN hardwood harvest trends includes a slight reduction in aspen with larger harvest reductions seen in maple & other hardwoods. Oak harvest has increased from 2013.
    - Pulpwood harvest has decreased by nearly 970,000 cords compared to 2005 levels. Less pulpwood imports than in the past from regional producers indicates a slowdown in industry demand, resulting in opportunities (and need) for additional utilization and management.
- 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 2.88 million cords in 2014. ***Based on analysis of mill consumption (actual survey figures are not yet available), it appears that 2015 harvest levels are within the 2.6 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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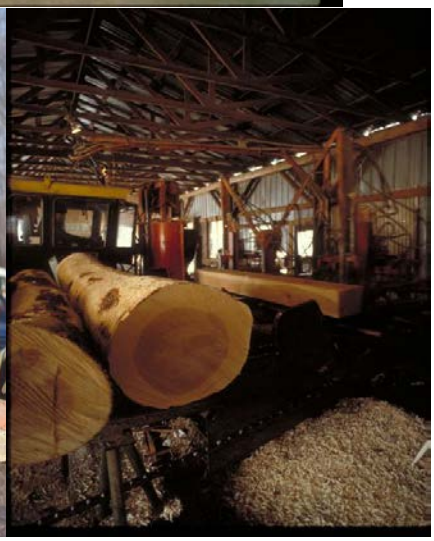
Wood-Using Industry Overview

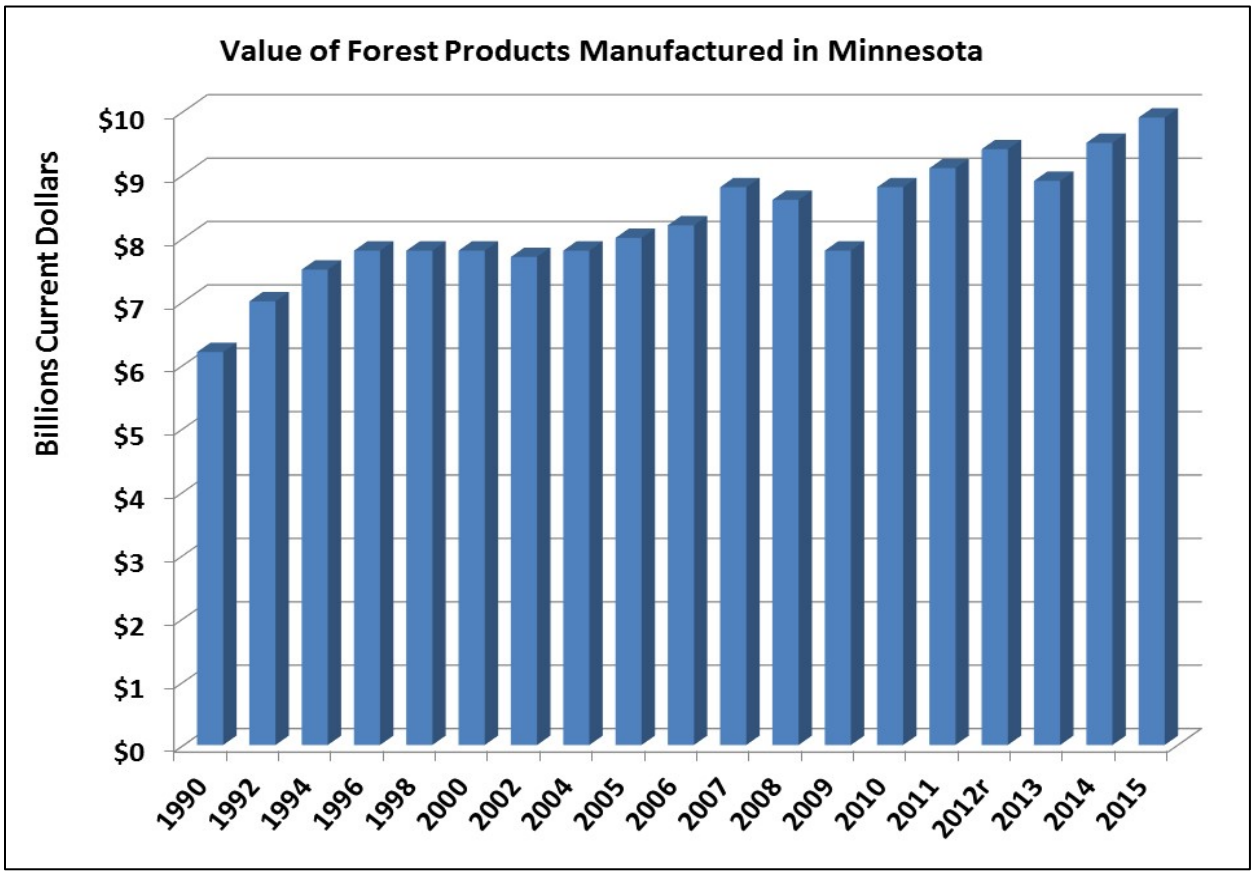


A brief overview of Minnesota's wood-using industry, including mill location and product information for many of the larger mills, and total industry economic impact.

Minnesota's Forest Industry at a Glance [1]

Economic Impact 2015

- $9.9 billion direct value of shipments with $17.8 billion total output effect.
- $3.5 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

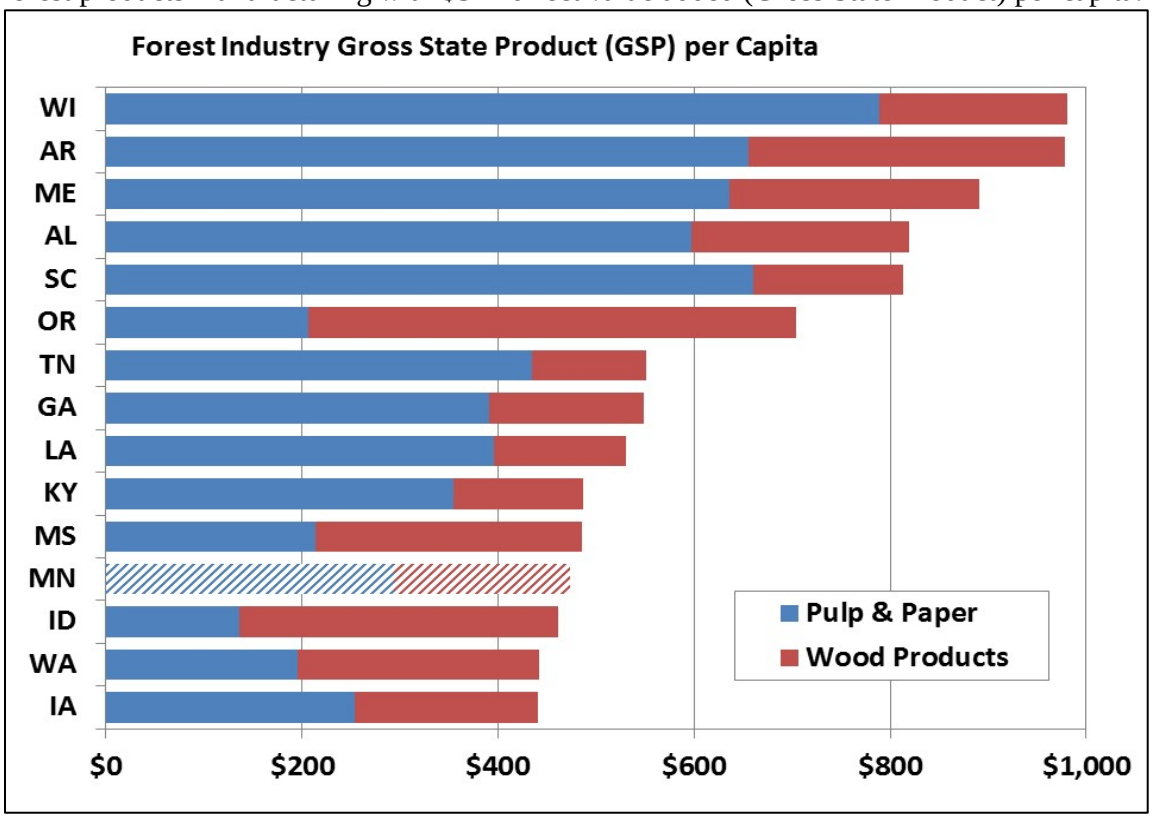
Pulp, paper, paperboard, engineered wood products, converted paper products, window & door components (MN # 2 in U.S.), kitchen cabinets and cabinet parts, store fixtures, wood office & residential furniture, pallets & crating, millwork, wood shavings for poultry industry, and wood biomass energy.

Non-Traditional Industries Dependent on Minnesota's Forest Lands

Balsam boughs for the 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.

[1] CY2015 data unless otherwise noted; compiled by Don Deckard, Ph.D., Forest Economist, Minnesota DNR.

Value Added (Gross State Product) per Capita
In 2015, Minnesota was ranked **twelvth** nationally in forest product manufacturing with $458 direct value added (Gross State Product) per capita. In 2012, Minnesota was ranked **seventh** nationally in forest products manufacturing with $524 direct value added (Gross State Product) per capita.



Manufacturing Facilities as of January 2016 [2]

- 4 primary pulp & paper mills and 3 recycled pulp & paper mills
- 100 converted paper products plants
- 325 sawmills and wood products plants
- 335 wood kitchen cabinet and countertop manufacturers
- 64 wood furniture and custom architectural woodwork shops

Volume of Timber Harvested
Annual harvest volume = 2. 88 million cords including:

- Pulpwood = *2.05 million cords (2014 draft)
- Sawlog & Specialty Mills = *282 million board feet (2014 draft) including the following specialty items:
  - Veneer (2014 draft) = 2.25 million board feet
  - ***Other (2014 draft) =58,392 cords
  - Posts & Poles (2014 draft) = 5,936 cords
- Residential fuelwood = 217,800 cords live trees from timberland (2014/15)
- Commercial wood fuel = 54,900 cords

Rounded number* **Source: *2014 draft USFS TPO Sawmill &DNR Survey*

*** Other includes excelsior/shavings, handles, cooperage and other miscellaneous products

[2] Source: MNDEED, Quarterly Census of Employment and Wages (QCEW), retrieved January 3, 2017.

Minnesota Pulp and Paper – 2016

Firm	Wood Used	Product
UPM - Blandin Paper Mill Grand Rapids	Aspen, Balsam Fir, Basswood, Spruce	Lightweight coated publication papers
Boise White Paper, LLC (PCA) 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 – 2016

Firm	Wood Used	Product
Louisiana-Pacific Two Harbors	Aspen, Balm, Birch	OSB – engineered siding panel
Norbord Bemidji	Aspen, Balm, Birch, Maple, Pine	OSB

Minnesota Hardboard and Specialty – 2016

Firm	Wood Used	Product
International Bildrite International Falls	Aspen, Balm and recycled paper	Sheathing

In 2017 Newell brands formerly Jarden Home Brands located in Cloquet MN announced closure of its Diamond brand match and toothpick facility. The facility had been in operation for more than a century. For additional information please see the spring 2017 edition of the Marketplace newsletter found at the MN DNR Utilization and Marketing website below.

For additional information about sawmills, 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 – 2016

The sawmill sector is very important to forestry because it creates market diversity. The approximately 563,400 cords used annually is about 20% 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.

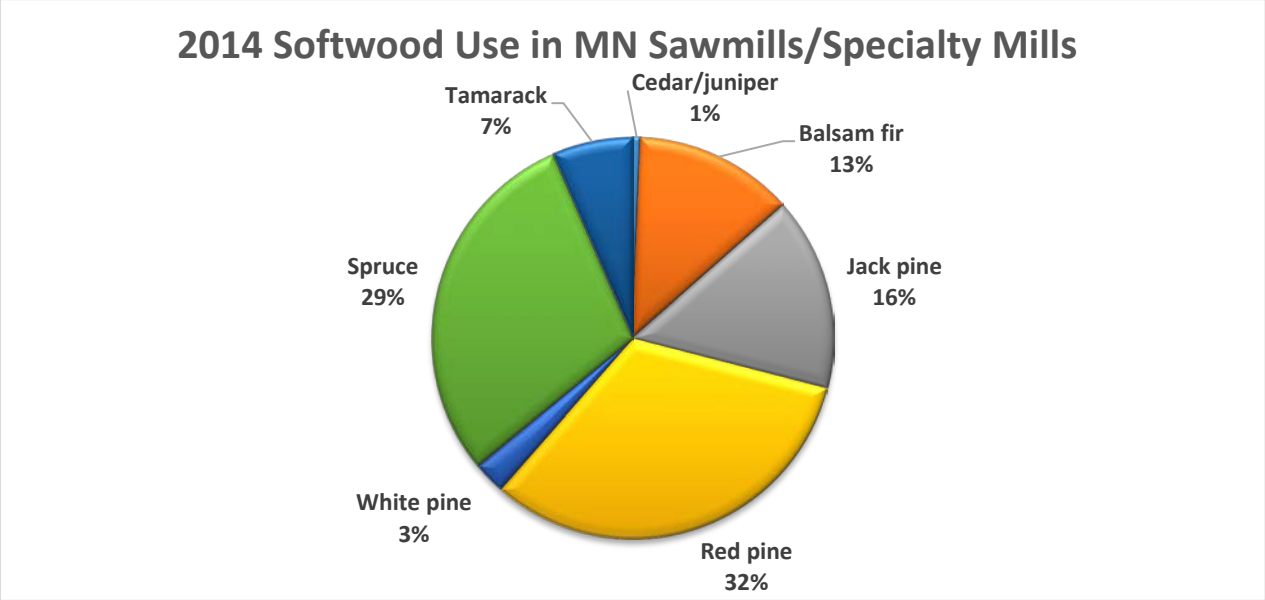
Sawmills can also have a complementary impact on other wood industry sectors. For example, some sawmills send residue chips to paper mills, benefitting both sectors. Also, the higher-value sawlog market can help make logging residue economically accessible as woody biomass for energy. Finally, high value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

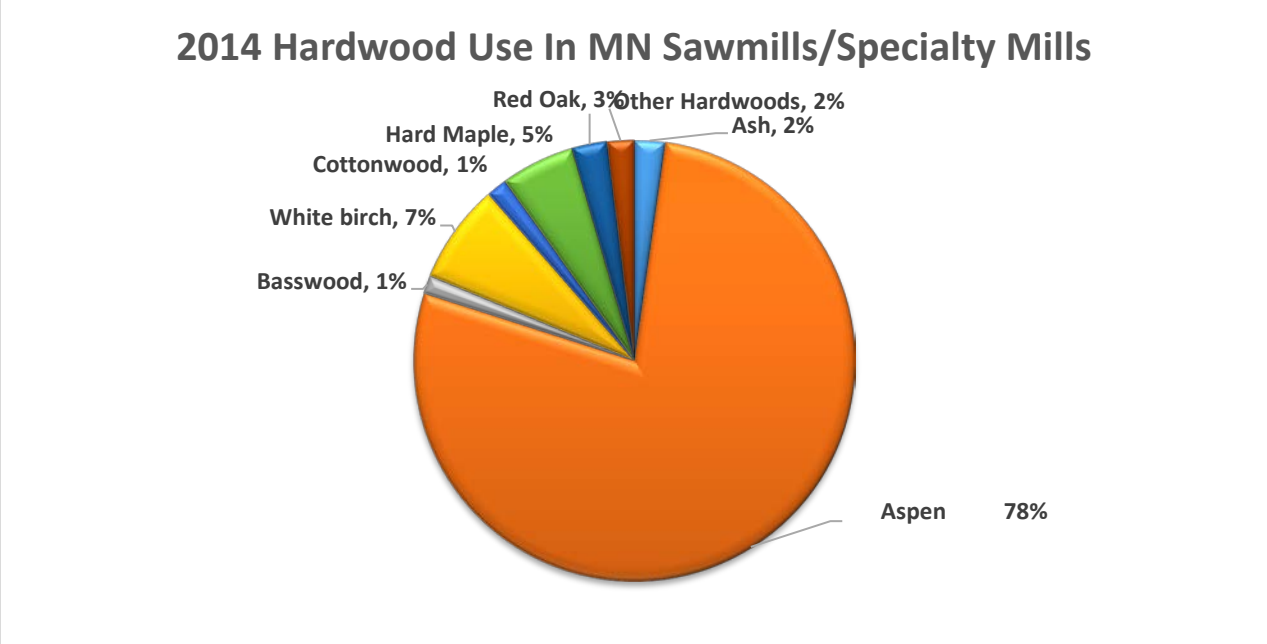
There are over 300 sawmills in Minnesota, but most are small, portable bandsaw mills that account for a tiny fraction of wood use. In contrast, about 40 larger sawmill/specialty mills in Minnesota utilize more than 1 million board feet or 2,000 cords annually. In fact, the top 12 mills by production volume account for 70 percent of the total consumption, with one large softwood mill accounting for about 40 percent of the total volume utilized by all sawmills/specialty mills.

Examples of Products Produced by MN Sawmills/Specialty Mills		
Firm	**Wood Used**	**Product**
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 Mill Co., Bigfork	Black Ash, Aspen, Basswood, Paper Birch, Hard Maple, Red Oak, White Oak, Red Pine, White Pine, White Spruce, Tamarack	Cants, lumber, veneer
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 other products
Pliny Post & Pole, McGrath	Red Pine	Poles/pilings and posts

Since 2001 sawmill consumption has declined statewide a total of (-24%). A majority of the decline (-17%) happened between the years 2001-2004. The years from 2004 to 2014 show only a (-7%) decline in consumption. The changes are located in hardwood and softwood capacity. Prior to the 2014 survey the large decrease was seen in hardwood sawlog consumption but between 2010 and 2014 sawmill surveys show hardwood saw log production across all species has seen an increase. In the converse softwood

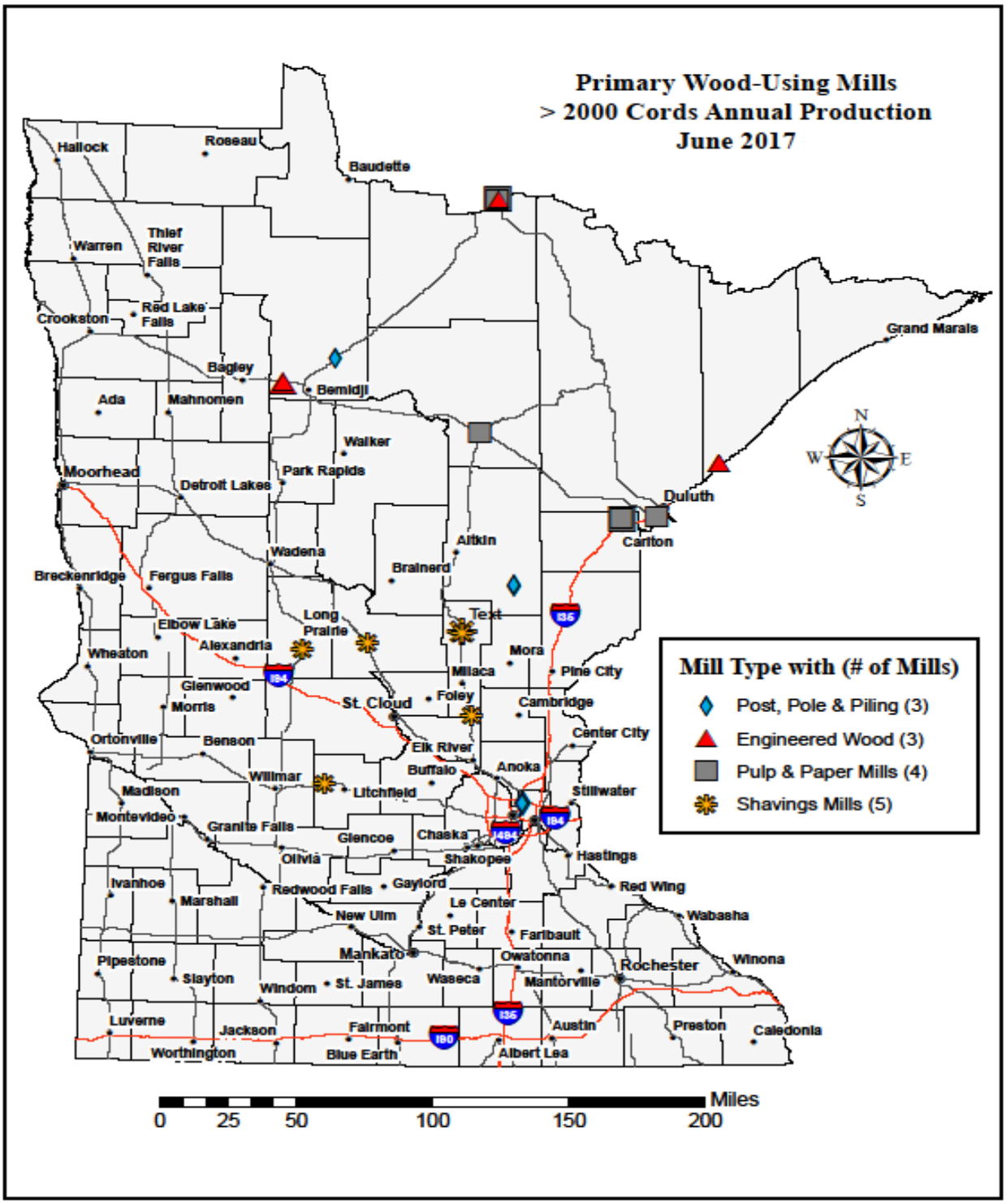
sawlog production has seen a decrease in total consumption (primarily balsam fir), but increased spruce and red pine consumption.



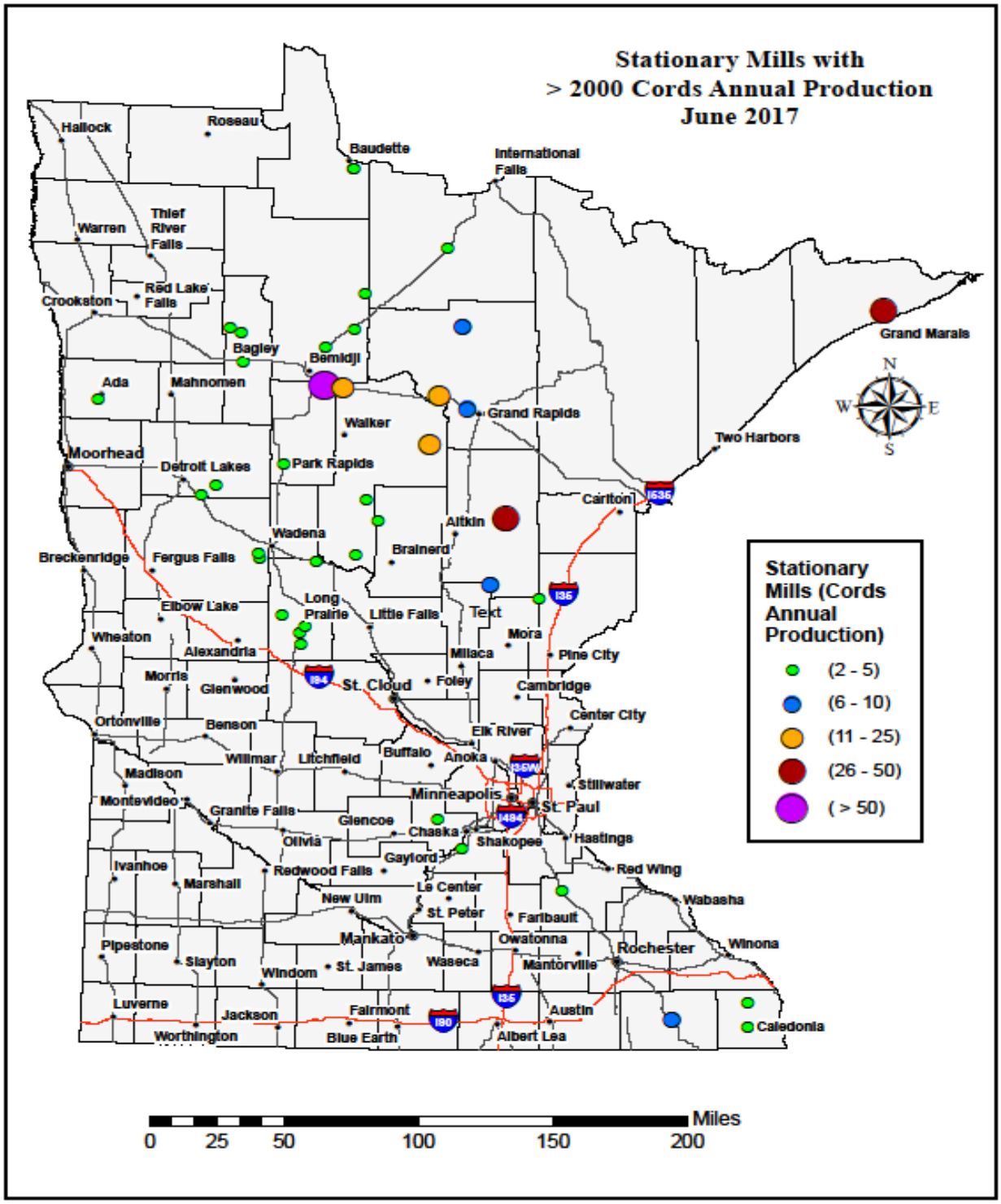


Minnesota Roundwood production, (in cords)

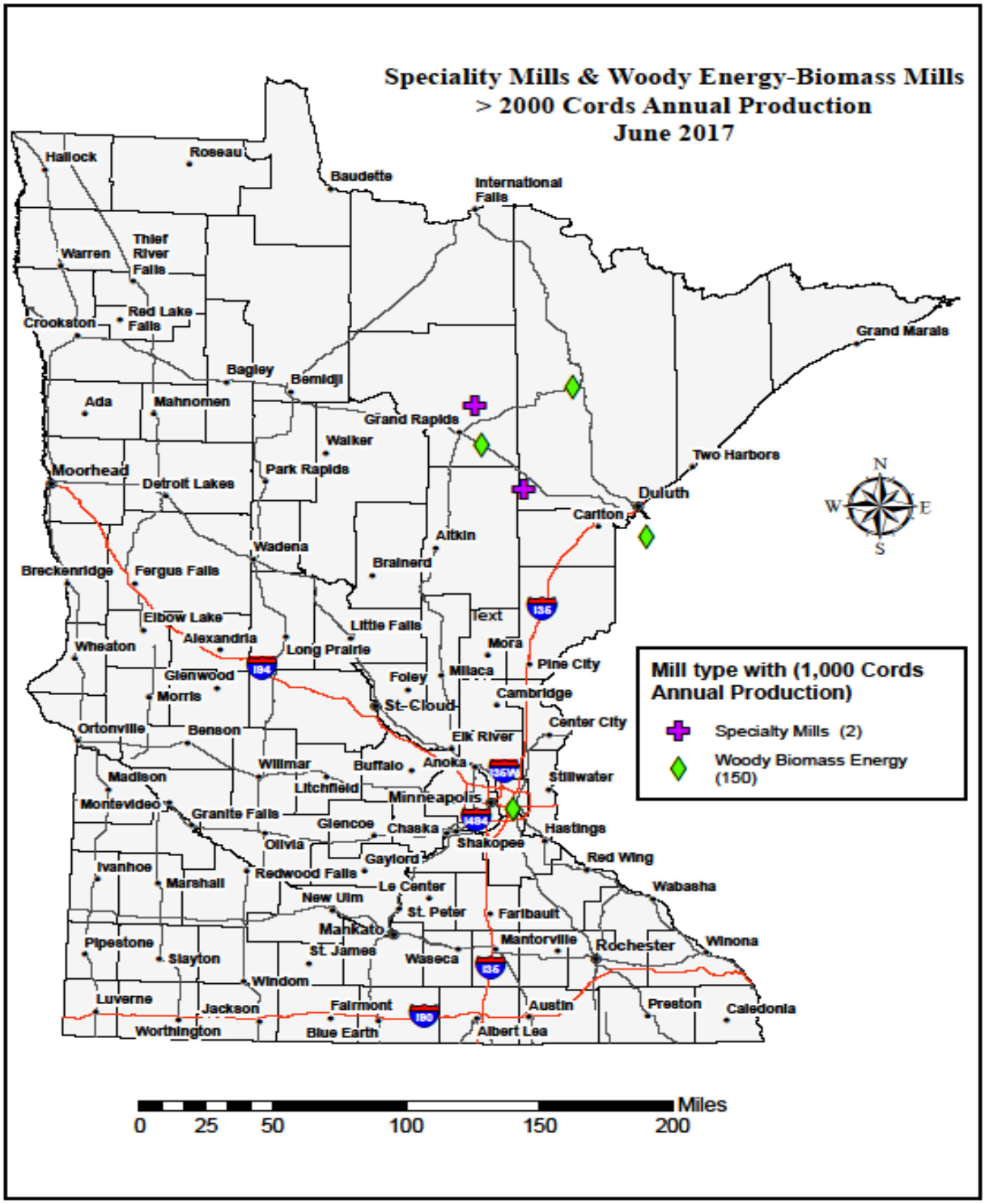
Saw logs	*2004*	*2007*	*2010*	*2014*
Softwoods	339,646	322,456	331,253	318,532
Hardwoods	214,316	216,316	190,633	198,620
Total	**553,962**	**538,772**	**521,886**	**517,152**



Locations of mills is an important factor in determining markets for wood. The map above shows the pulpwood consuming mills. These mills utilize various species of wood material, with aspen pulpwood being the largest component.



Locations of mills is an important factor in determining markets for wood. The map above shows stationary sawmills. These mills utilize various species of wood material, with a ratio of 60 percent softwood and 40 percent hardwood.



Locations of mills is an important factor in determining markets for wood. The map above shows wood energy facilities and specialty sawmills. Wood energy facilities utilize various species of wood material. Specialty mills utilize few or only a specific species of wood in their products.

Woody Biomass Utilization & Future Wood Markets

Due to the changing demand for paper products, a global marketplace, and the unstable recovery of the housing market, 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 petroleum based fuels and chemicals. The resource is available for bio-based market development as well as to support 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:
Engineered wood: The International Bildrite insulite mill in International Falls is an engineered wood product mill in Minnesota that utilizes bark-on chips.
Special Forest Products (SFP): Markets include log furniture, craftwood, etc. These tend to be small volume, but high value 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**
Minnesota Power	Grand Rapids	Mill residue, logging residue, roundwood
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 additional 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 changes addressing the carbon neutrality of wood have made significant progress in 2017. Potentially, future policy trends leading toward reduced greenhouse gas emissions and increased renewable energy development could expand woody biomass utilization.
- In the 2017 MN Legislative session there was a repeal of the woody biomass mandate for Xcel Energy. This repeal could become a loss of markets for low-grade forest products resulting in lost forest management opportunities. There will be negative effects to the industry supply chain including impacts to the logging workforce and existing manufacturing industry. Woody biomass markets provide opportunities to manage forests for the diverse array of benefits they provide. Mill residue markets keep material from being landfilled. If the repeal is successful it will significantly reduce the total amount of energy in MN coming from wood.
- Woody biomass can play an important role in Minnesota's energy system by contributing to a wide range of energy markets for which other renewable energy sources are not suitable. For example, biomass can be used twenty- four hours a day year round for industrial process heat, torrified wood production or to produce liquid fuels where wind and solar energy cannot.
- 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 and as an economic opportunity. 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: timber construction with cross laminated timber (CLT), glue laminated timber products (Glulam) or other engineered wood products, construction materials or bridges.
- Bio-char/Torrified 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 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 some 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 or household interior furnishing.

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,
2) Minnesota's Logger Education Program website (http://mlep.org/), and
3) MN Forest Resource Council website (http://mn.gov/frc/

Residential Fuelwood Consumption

The Minnesota Pollution Control Agency (MPCA) periodically conducts a statewide survey to find out how much wood is harvested and burned annually for heat or pleasure in Minnesota. This survey has been conducted in one form or another every few years since 1960. Historically, the survey was conducted by the Minnesota Department of Natural Resources (MDNR) and the US Forest Service. The survey data has been used by a variety of state and federal agencies as well as trade organizations to manage forests, to inform policy makers and scientists, and to assist the hearth and fireplace industry by examining trends in wood burning.

The MPCA conducted this latest survey in 2015 to gather additional information about wood combustion practices. Due to the levels of fine particles (PM2.5) in ambient air, it is important to have accurate information about the sources of this pollutant. While wood combustion is not the largest source of fine particle concentrations in the air, residential wood combustion is an important source of fine particle emissions. The survey provides an improved understanding of the residential wood burning in Minnesota, by type of equipment, by purpose for burning, by source of wood fuel, and by region of the state.

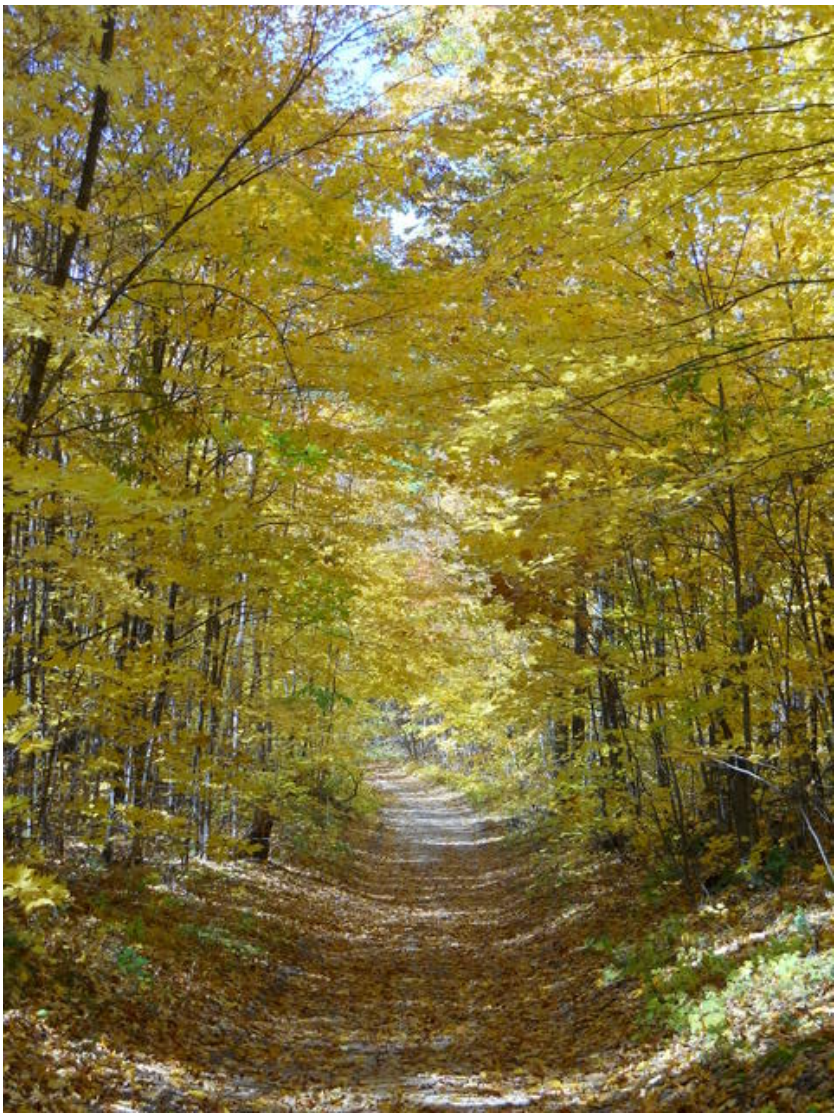
The general findings of the survey show that Minnesotans burned approximately 2.13 million cords of wood between April 1, 2014 and March 31, 2015. This suggests the amount of residential wood burning is on the rise. However, due to changes to improve the survey design and methodology, comparisons across surveys to identify trends should be done with caution.

The increase can be seen in both the estimated number of households burning wood, as well as the amount of wood burned by households. There were notable increases in the amount of wood burned in all types of equipment, though it appears that compared to the estimates from recent years in which most increases were from residential backyard burning, this time much of the increase was from burning for heat. This may be due, in part, to factors such as variations in weather and cost of propane across survey years.

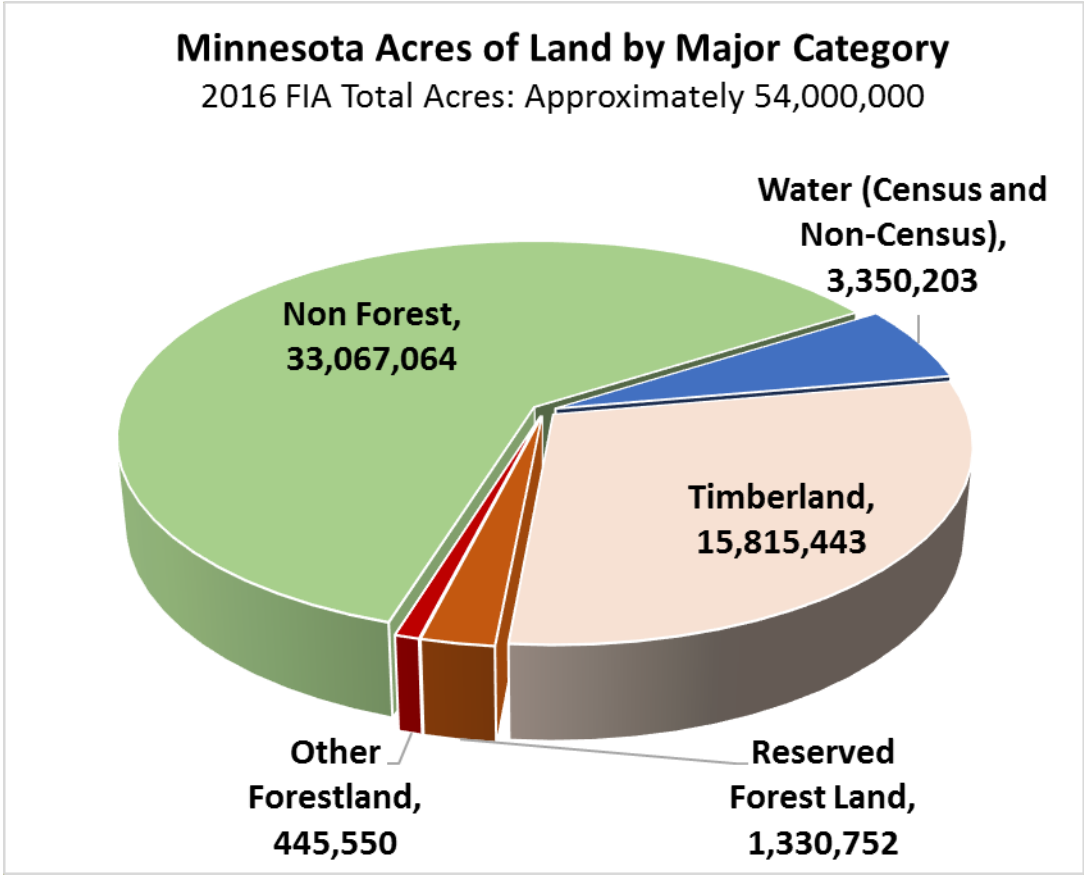
The forest resources data on timber harvests used in this annual report is focused on the utilization of live trees harvested from the state's timberlands; from all ownerships. The residential fuelwood survey collected the total volume of wood burned from all fuel types and sources including roundwood, slab wood, wood pellets, wax logs, and pallets. The fuelwood survey also collected data on harvest sources from live trees from forestlands, dead trees, cut trees and or tops and branches after a timber harvest, live or dead trees from pasture, croplands, and yards inside city limits or other non-forest lands. Using the findings from the 2014/2015 MPCA survey report, the total fuelwood consumption of 2,130,000 cords can be separated by fuel types and sources to determine the amount of fuelwood from live trees from timberlands.

Total residential fuelwood consumption:	2, 130,000 cords
Percent of roundwood/logs and split wood:	93.0 %
Percent of wood from live trees from forestland:	11.0 %
Calculated volume of cords from live trees:	217, 800* cords (*rounded number)

Forest Resources Overview

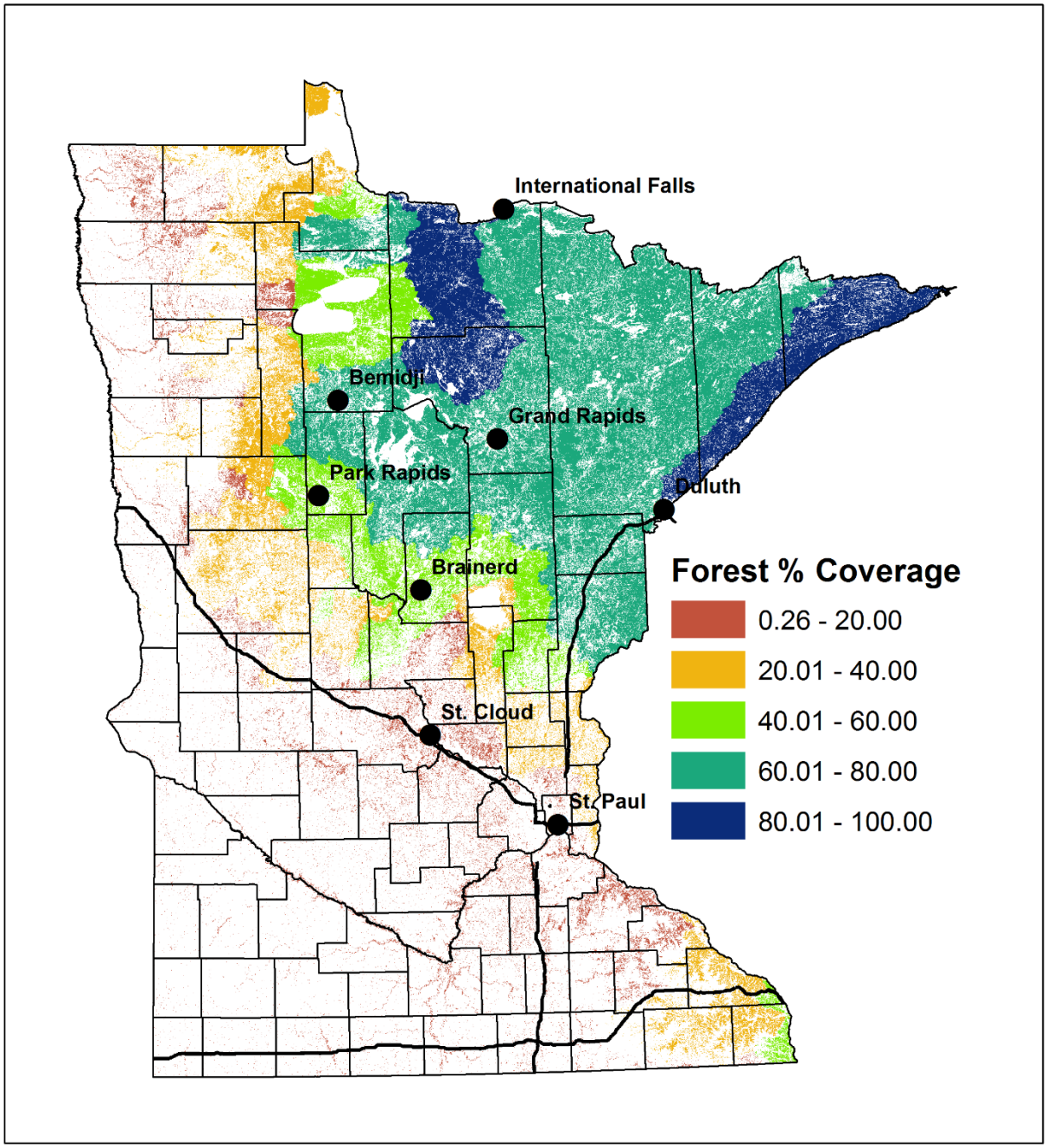


A brief overview of Minnesota's forest resources, including total forestland and timberland acreage, cover type percentages and an ownership breakdown for timberland.



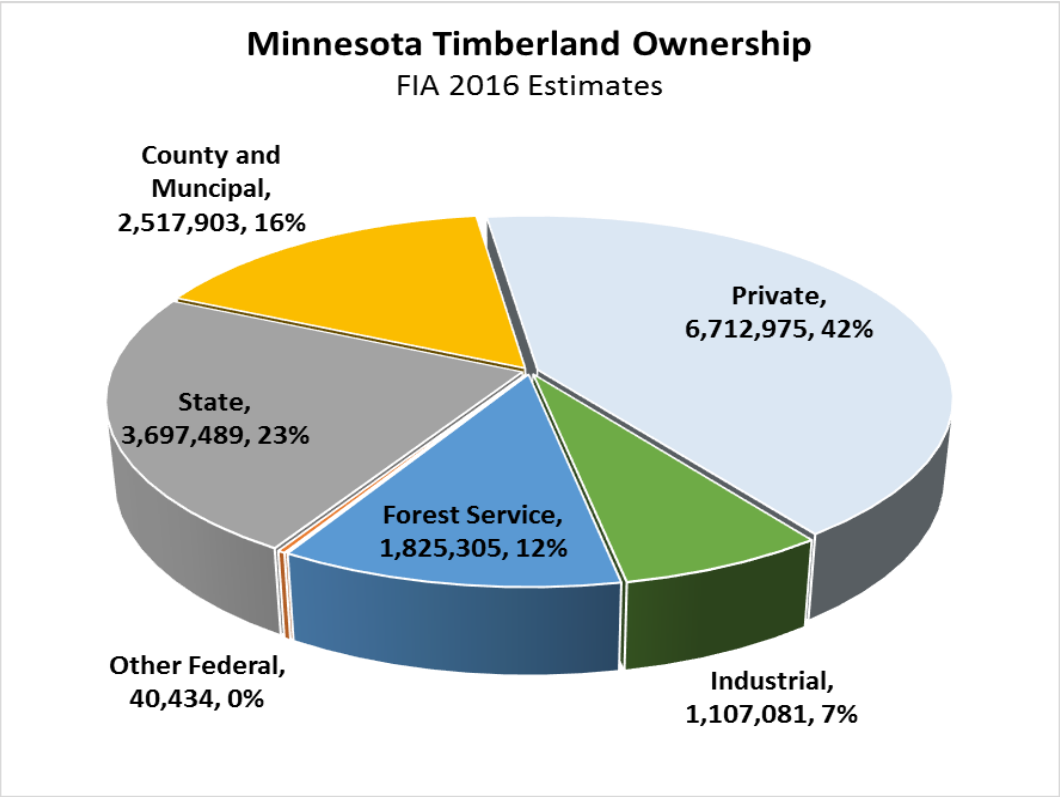
Source: USDA Forest Service 2016 FIA database

According to 2016 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 HUC8 watershed. **Source**: NLCD 2011

Generally around Minnesota the densist forest cover occurs within the northeastern portion of the state (refer to Map). On a watershed by watershed basis the most densly covered watersheds occur in Itasca, Koochiching, Lake, Cook, and St.Louis counties. Generally forest cover dcreases 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.

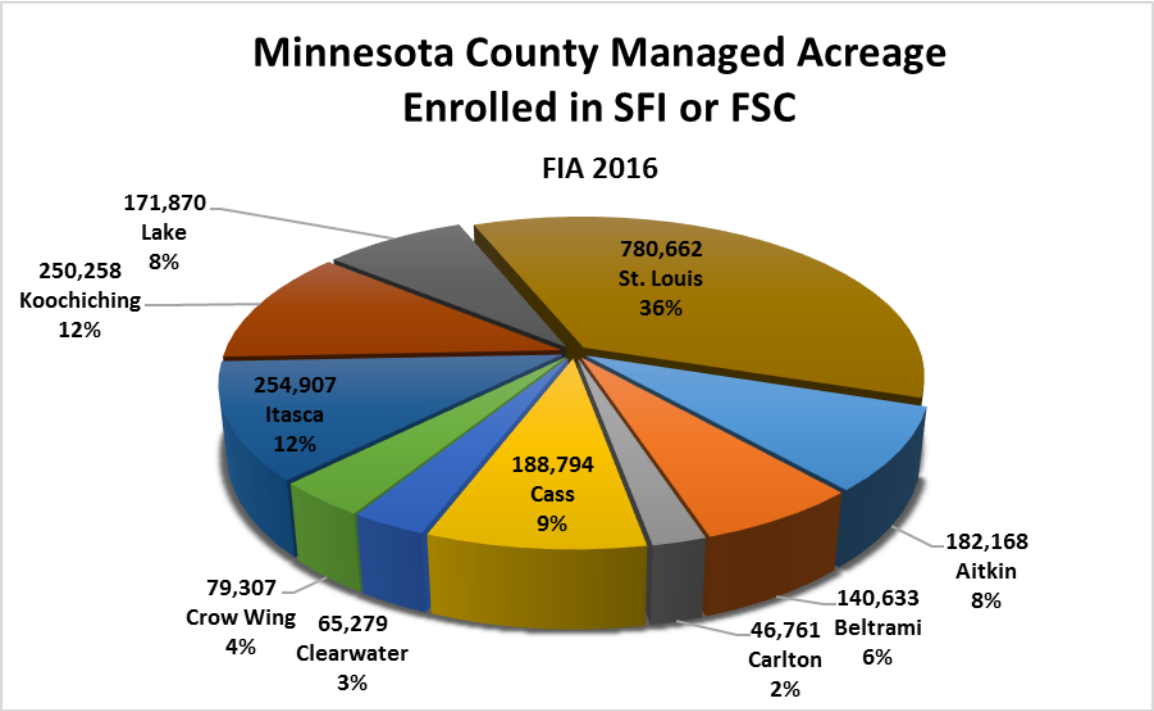


Source: USDA Forest Service 2016 FIA database

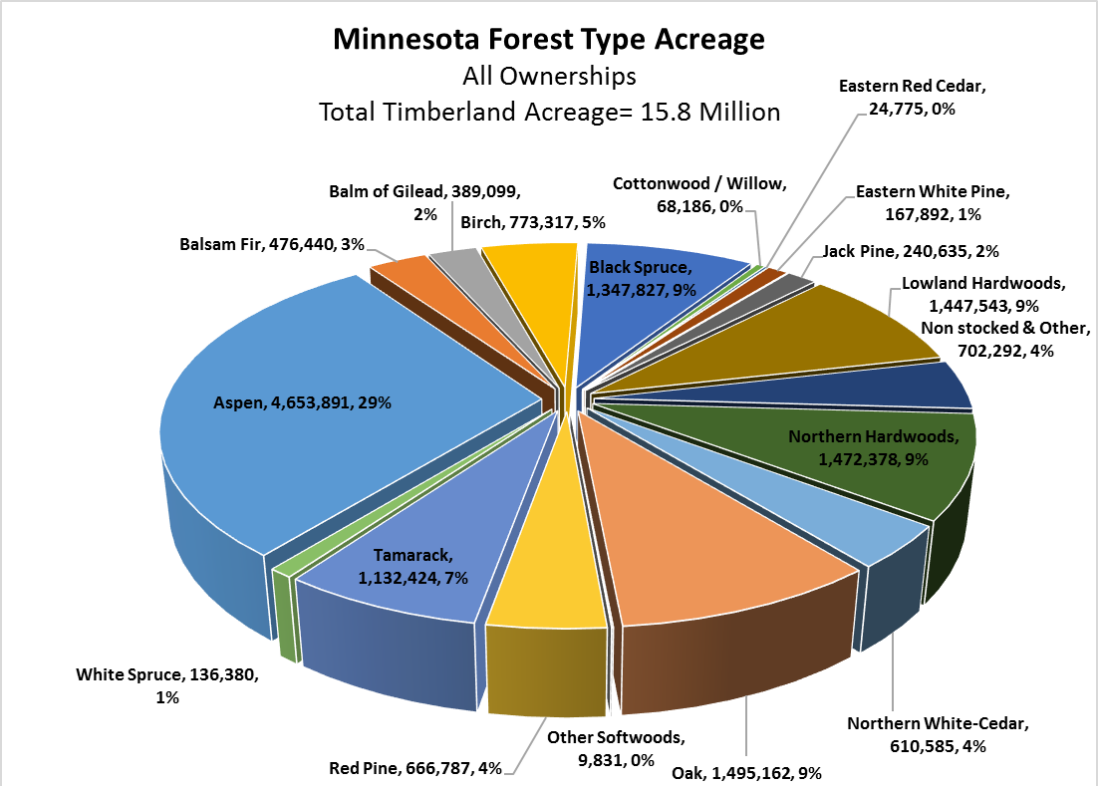
Ownership of timberland is an important factor in assessing many issues, including timber supply. Industry includes Real Estate Investment Trusts (e.g. Potlatch Corporation), Timberland Investment Management Organizations (e.g. Molpus Woodlands Group), and integrated timber companies such as UPM Blandin 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 organizations are liquidating their holdings.

Forest Type: A classification of forest land based on the species forming a majority 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 15,740,000 million acres in 2014 to approximately 15,815,000 in 2016. A number of factors could be at play in the increase of timberland within Minnesota. Possible Changes include: 1) FIA inventory data collection protocols, 2) 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.



Source: USDA Forest Service 2016 FIA database. Some counties have enrolled lands they administer under different sustainability agreements. The Sustainable Forestry Initiative (SFI) or the Forest Stewardship Council (FSC) are independent organizations that certify lands as being sustainably managed. The percentage indicates how much of the total forest within the county is administered by the county and is enrolled under SFI or FSC.



Source: USDA Forest Service 2016 FIA database

Area of Timberland in Minnesota by DNR Cover Type- 2016

Forest Type	Acres
Aspen	4,653,891
Oak	1,495,162
Northern Hardwoods	1,472,378
Lowland Hardwoods	1,447,543
Black Spruce	1,347,827
Tamarack	1,132,424
Birch	773,317
Non Stocked & Other	702,292
Red Pine	666,787
Northern White-Cedar	610,585
Balsam Fir	476,440
Balsam Poplar (Balm of Gilead)	389,099
Jack Pine	240,635
Eastern White Pine	167,892
White Spruce	136,380
Cottonwood / Willow	68,186
Eastern Red Cedar	24,775
Other Softwoods	9,831
Total	**15,815,443***

Source: USDA Forest Service-2016 FIA Database
**May not sum due to rounding*

Harvest Levels

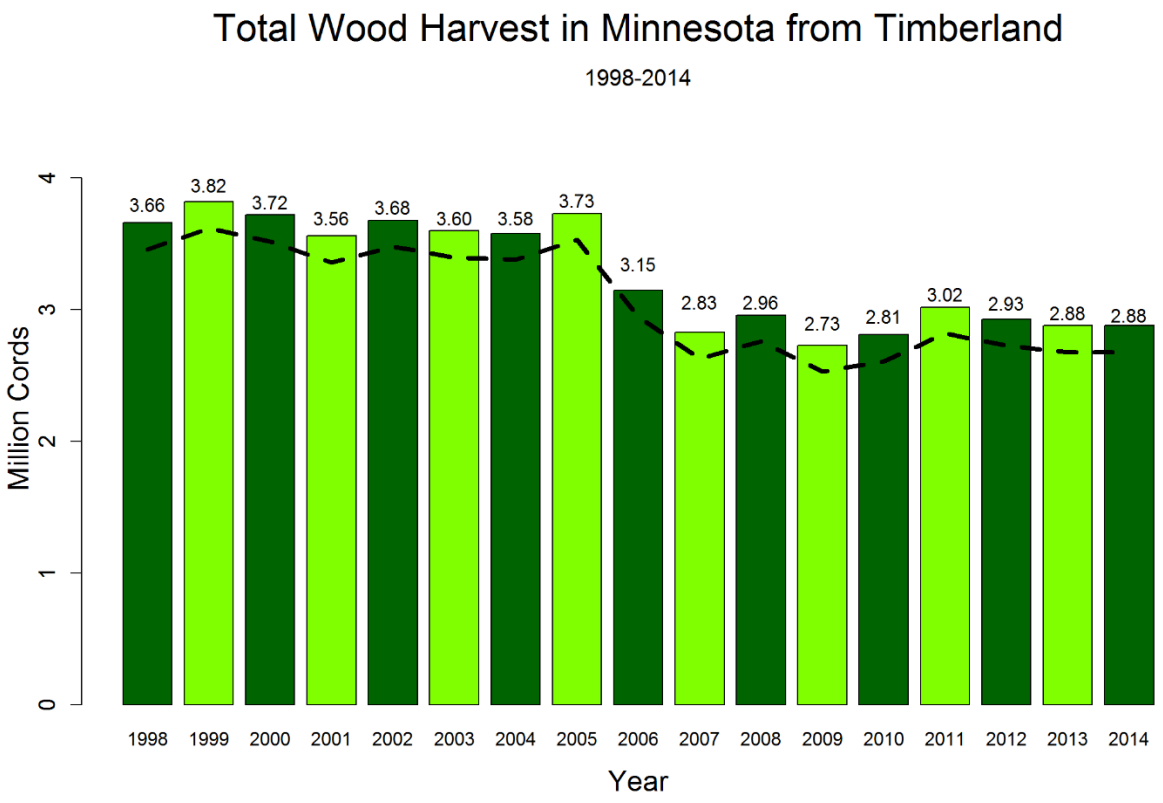
Information on 2014 timber harvest in Minnesota by product category and estimation of contribution by timberland ownership.

Total wood harvested and utilized by industry and fuelwood users in Minnesota (in thousand cords - by species – from timberland)
(Pulpwood 2014 (DRAFT); Sawtimber (DRAFT) 2014; Fuelwood 2014/15)

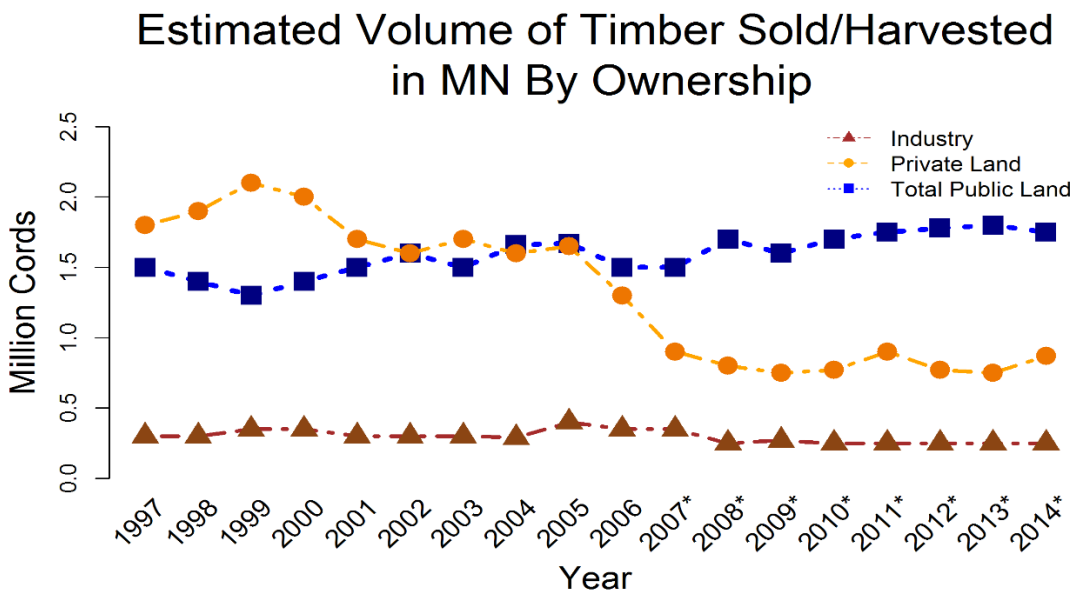
Species	*Pulpwood	*Sawlogs & Others	**Residential Fuelwood	*Commercial Wood Fuels	Total
Aspen/ Balm	1348.3	68.7	19.6	21.1	1457.7
Paper Birch	67.3	23.5	23.9	3.7	118.4
Ash	25.4	13.8	23.9	1.7	64.8
Oak	0.3	73.6	58.8	2.6	135.3
Basswood	3.9	19.6	4.4	0.2	28.1
Maple	84.5	13.2	13.1	4.1	114.9
Cottonwood	0.0	4.9	0.0	0.0	4.9
Other Hardwoods	27.6	8.1	10.9	2.2	48.7
Hardwood Sub-Total	**1557.3**	**225.4**	**154.6**	**35.6**	**1972.9**
Pine	--	--	15.3	14.7	--
Red Pine	48.2	214.8	0.0	0.0	263.6
White Pine	5.3	9.7	0.0	0.0	15.0
Jack Pine	78.9	50.7	0.0	0.0	129.6
Pine Sub-Total	132.4	275.2	15.3	14.7	437.6
Spruce	249.7	28.9	0.0	0.1	278.7
Balsam Fir	75.1	15.3	0.0	0.4	90.8
Tamarack	28.1	15.1	0.0	0.1	43.3
White Cedar	0.0	3.4	0.0	0.0	3.4
Other Softwoods	0.0	0.0	6.5	1.4	7.9
Softwood Sub-Total	**485.4**	**337.9**	**21.8**	**16.7**	**861.8**
Mixed Species	6.8	0.0	41.4	2.5	0.0
Total	**2049.5**	**563.3**	**217.8**	**54.8**	**2885.4**

Source: USFS and MN DNR mill surveys & residential fuelwood survey.
-*Figures in chart may not total exactly due to rounding*
*Draft **Fuelwood removed from live trees on timberland.

-Figures include cords of pulpwood exported to Wisconsin and Canada: Aspen: 35,086; Spruce: 51,786 (only WI); Red Pine: 12,494 (only WI); Maple: 13,271 (only WI); Jack Pine:10,829 (only WI); Birch: 30,019 (only WI); Ash: 5,261 (only WI); Basswood: 28 (only WI); White Pine: 1,668 (only WI); Red and White Oak: 292 (only WI); Elm: 2 (only WI); and total cords of sawlogs mainly exported to Wisconsin (and Iowa) and Canada of: 87,720 , most of which is Oak and Maple. Notably Aspen saw a drop in export from 82,655 in 2013 to 35,086 cords. Basswood export to WI decreased significantly from 4,805 cords to 28 in 2014.

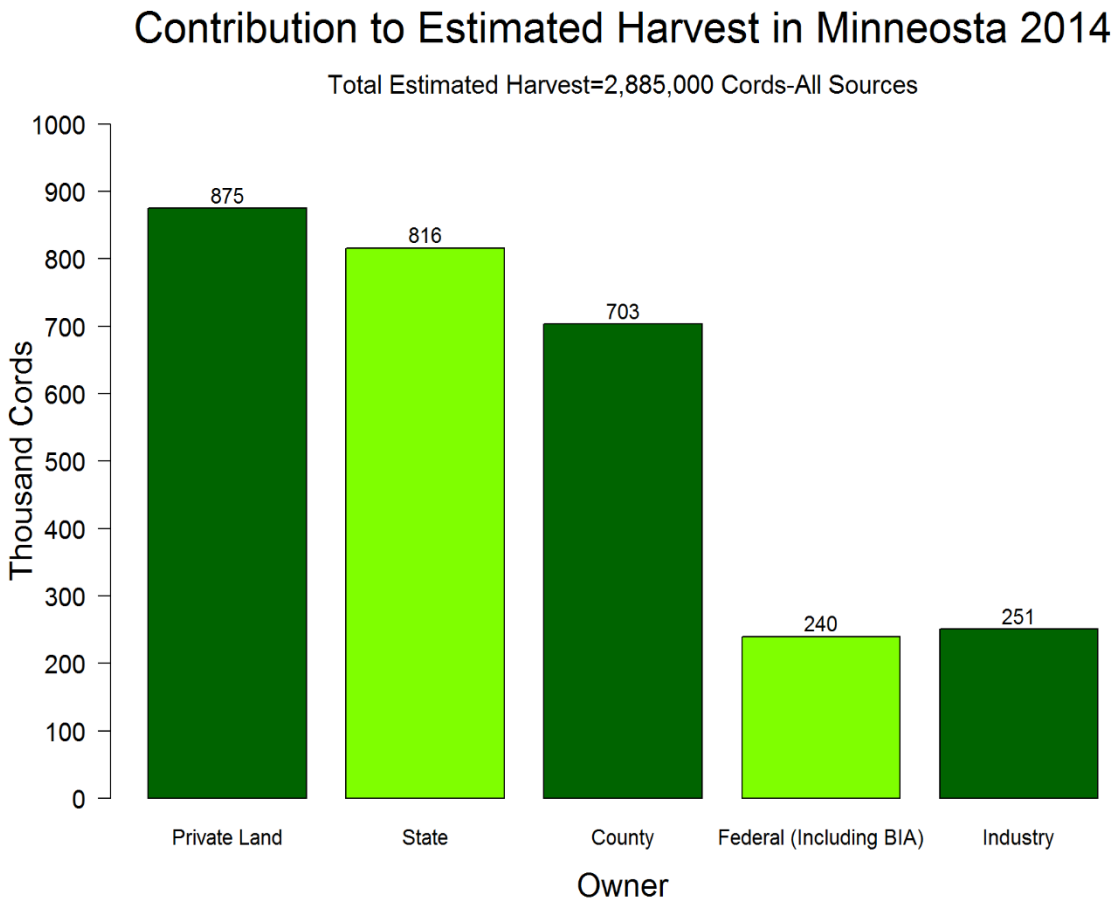


Source: Pulpwood (USFS, Northern Research Station), sawtimber and fuelwood (MN DNR surveys). Dashed line represents the trend.

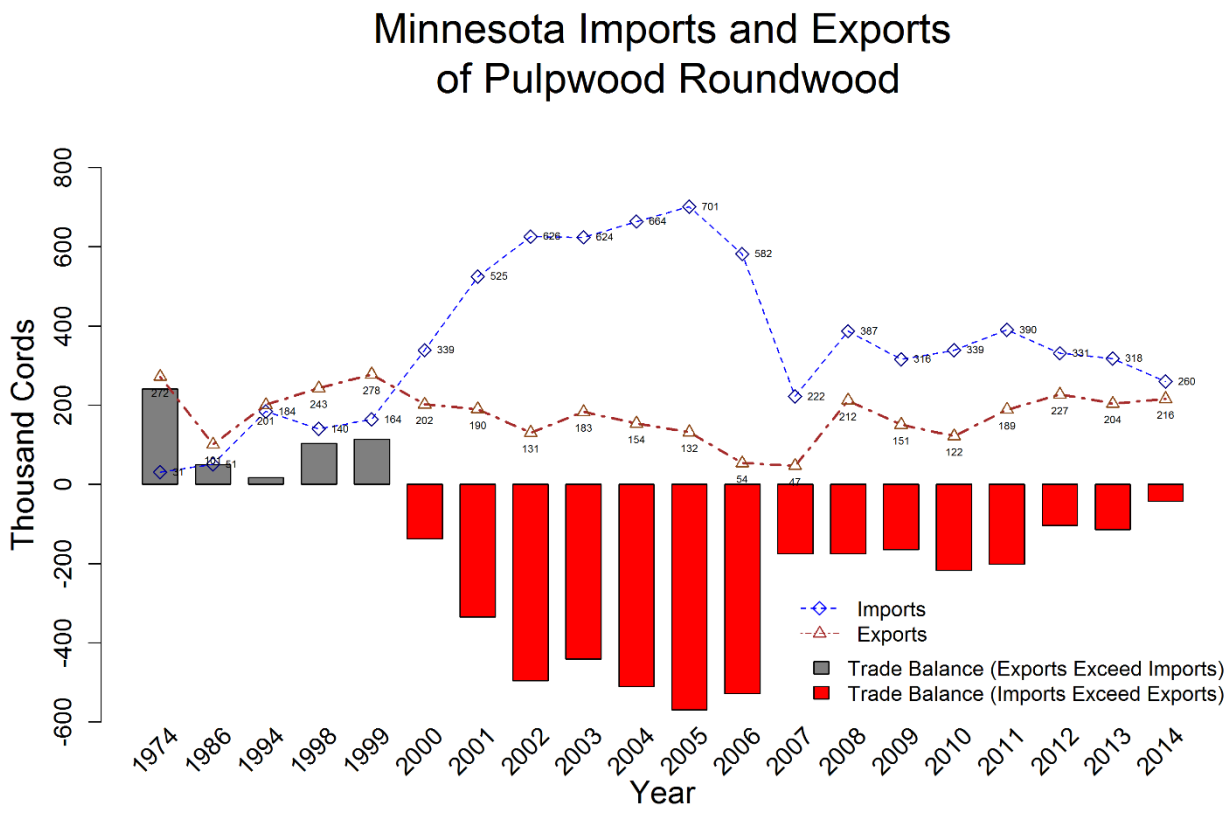


Source: Public Lands: Public Stumpage Price Review through 2006. ***Beginning with 2007, annual volume scale reports (harvested) are used for State and Federal lands rather than volumes sold. Change necessary due to large volumes of re-offered wood sold by public agencies in 2007.*** Industry Lands: Minnesota Forest Industries estimate of harvested volume from 2014. Private Lands = an estimate calculated as follows: Total estimated harvest

2014, minus 2014 public volume harvested (sold through 2006), minus 2014 estimated industry volume harvested. Molpus Woodlands Group (formerly Forest Capital Partners) timberlands contained in "Industry" totals.



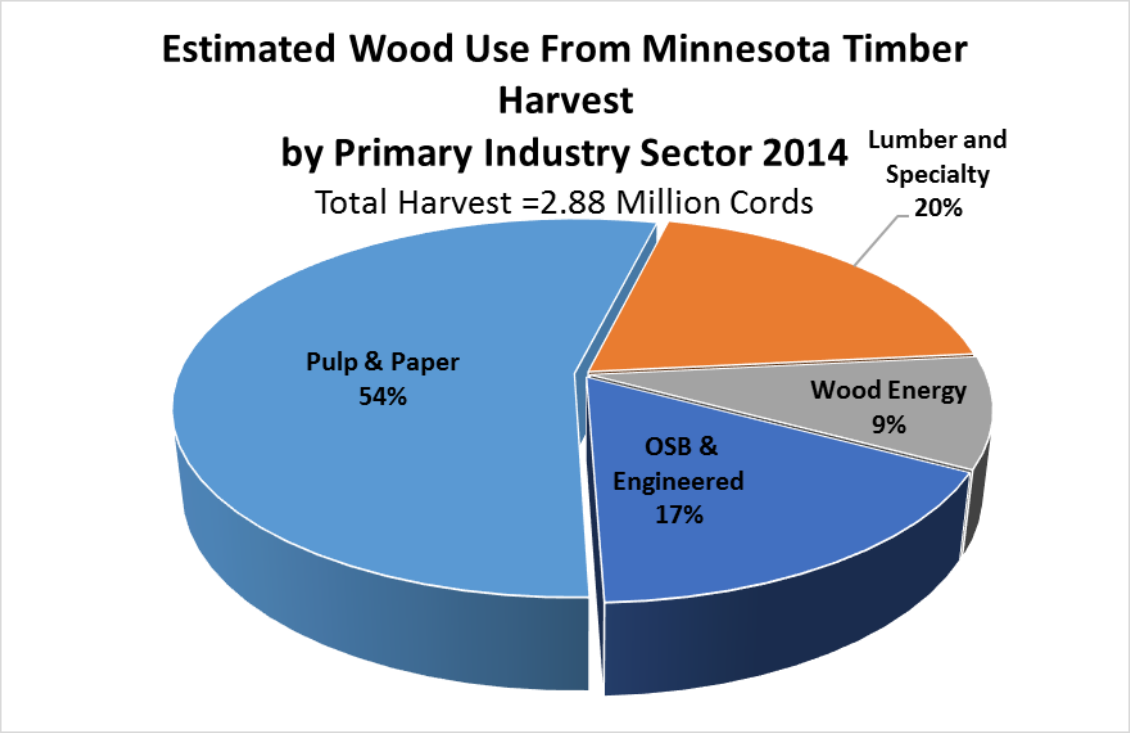
Source: State Lands: FY 2014 Harvest, DNR Timber Sales Annual Report. Federal: FY 2014 Harvest, Superior National Forest Timber Statistics, and Chippewa National Forest Timber Statistics; BIA: Public Stumpage Price Review 2014 sold. County Lands: Public Stumpage Price Review 2014 sold. Industry Lands: Minnesota Forest Industries survey of 2014 harvested volume. Molpus Woodlands Group (formerly Forest Capital Partners) timberlands included in Industry totals. Private Lands = an estimated figure as follows: Total estimated harvest 2014, minus state, county, National Forest and BIA volume harvested, minus estimated industry volume harvested. Harvest stayed very similar to 2013 with only a slight overall decrease of approximately 20,000 cords.



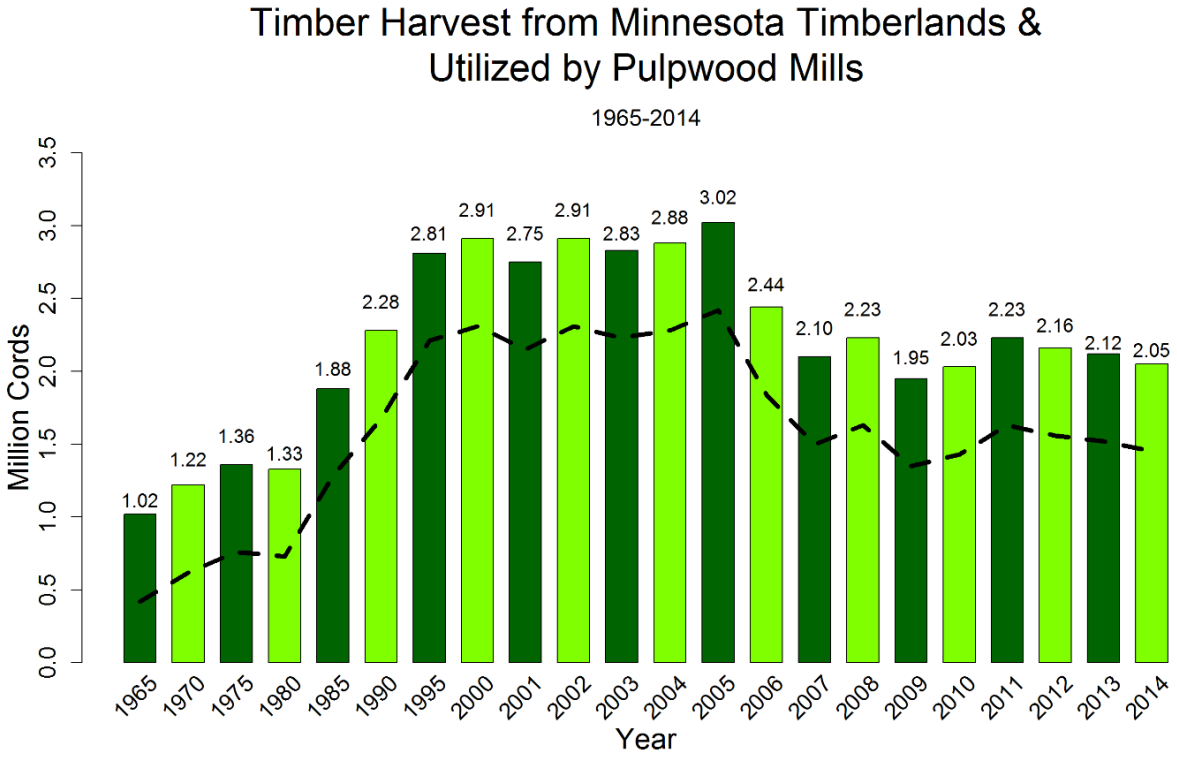
Source: USFS, Northern Research Station survey of industrial wood using industry.

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 (72,309 cords), Balsam Fir (17,205 cords), and Maple (163,432 cords). Imports in 2014 were largely from Wisconsin (204,928 cords), with fair amounts from Michigan (49,275 cords) and Canada (18,825). Exports in 2014 were mainly to Wisconsin and Canadian mills. Minnesota remained a net importer in 2014 mainly from Wisconsin, but also Canada and Michigan.

Minnesota imported approximately 49,275 cords of pulp and roundwood from Michigan, 191,020 cords from WI, and 18,825 cords from Canada. Total exports from Minnesota were approximately 182,000 cords to Wisconsin and 34,000 cords to Canada. Spruce (51,786 cords), Jack Pine (10,829 cords), and Red Pine (12,494 cords) made up the majority of softwood, while Paper Birch (30,019 cords) and Aspen (35,086 cords) made up the majority of hardwoods. 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.

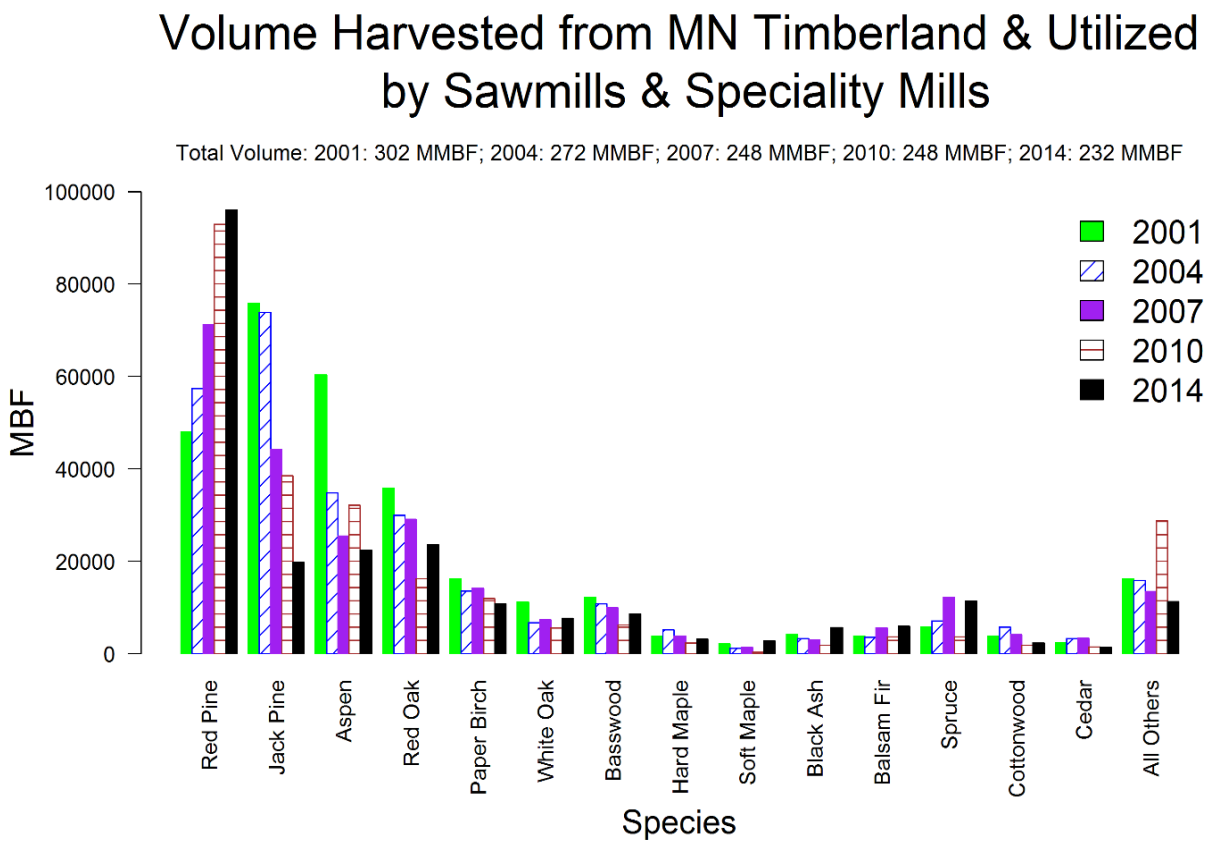


Source: Wood use data from mill and fuelwood surveys conducted by USDA Forest Service, Northern Research Station and MN DNR. Specialty products include veneer, posts and poles, shavings and landscape chips.



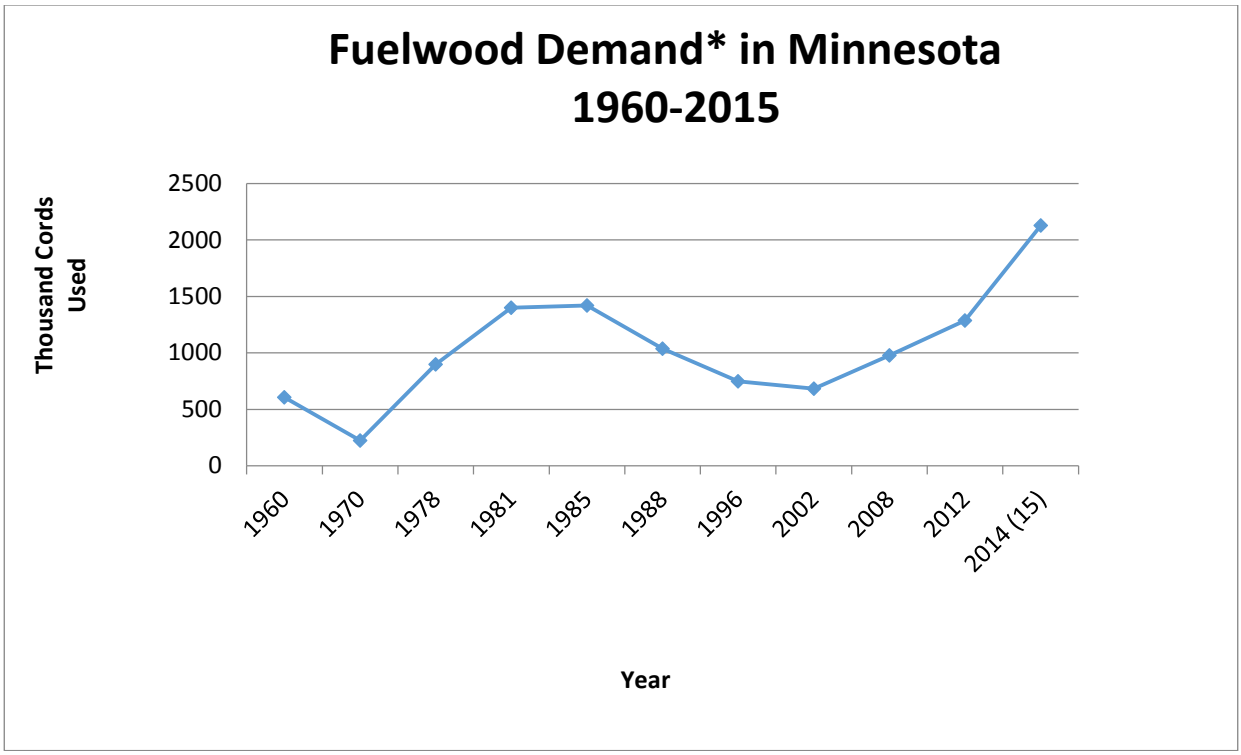
Source: USFS, Northern Research Station surveys. Dashed line represents the trend.

Pulpwood utilization includes the pulp and paper mills, engineered wood manufacturers and specialty mills. 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 2014, relative to the peak utilization in 2005.



Source: MN DNR 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 2014, Jack pine, aspen use dropped off most significantly in the sawmill sector; while hardwood such as oaks, basswood, maple, and ash have seen a slight increase in 2014. Spruce has seen an increase but red pine continues to make up the majority of board feet in use by sawmills.



Source: MN fuelwood surveys

Note: Changes over time should be interpreted with caution due to changes in the survey design, methodology, response rate, equipment included, wood bundle volume, and conversion rates for different types of wood. Dates shown on the x-axis are the year the survey was administered.

Residential fuelwood is a relatively small portion of total timber harvest.
It is important to note that only a portion of 2.13 million cords of total residential fuelwood demand comes from live trees on timberland. About 217,800 cords of residential fuelwood came from live trees on timberland in 2014/2015. The remainder is from pasture land or cropland, urban tree waste, land and power line clearing, and dead trees.

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).

<u>* A note to readers</u>: 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.

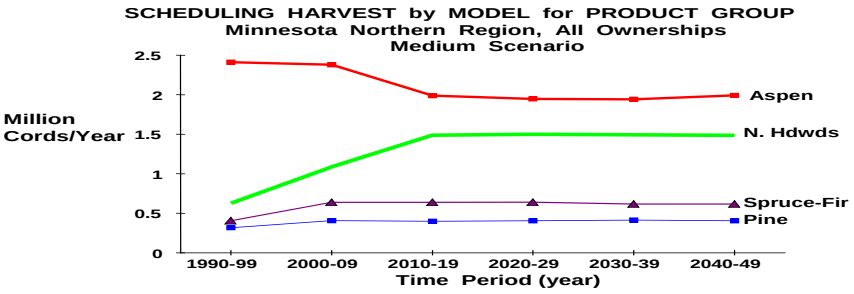
DNR sustainable harvest estimates use the full, five-year panel of 2005 FIA inventory data. Estimates are adjusted downward (as appropriate by ownership) for potential timber supply restrictions that can apply to timberlands such as riparian, old growth, leave tree and extended rotation. Rotation ages 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 estimations procedures and assumptions. Future changes to procedures may be made as new information becomes available. The UPM Thunderhawk Environmental Impact Statement analysis figures are used for aspen and spruce-fir product groups, as the EIS focused on these product groups. The Thunderhawk EIS analysis was led by Drs. Howard Hoganson and Tom Burk of the University of Minnesota's Department of Forest Resources.

In December 2016 the Minnesota DNR at the request of Governor Mark Dayton, began a sustainable timber harvest analysis (STHA) project to reevaluate the sustainable harvest levels within DNR administered lands. While the original question concerned the long term sustainability of 1 million cords annually, the project is investigating scenarios that include 1 million cords, as well as what is a sustainable harvest level (above or below 1 million). The project is being undertaken by an interdisciplinary DNR project team and includes a third party contractor, Mason Bruce & Girard (MB&G) a timber consulting firm based out of Portland, OR, who was chosen after a competitive bidding process. This project is in its early phases, however it has a phase I and phase II structure. Phase I has involved MB&G collecting all the relevant data, particularly the DNR's forest inventory data as well as growth and yield tables for available SFRMP sections, and generating base models and investigating assumptions. Phase II will involve testing model assumptions, and incorporating non-timber values into the model framework, to account for other forest values beyond timber production. There is ongoing involvement of a stakeholder advisory group, which is being contacted regularly for comment, meetings, and project updates. A final report is expected to be complete by March 1, 2018. You can keep up to date on the project by visiting the project website.



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.

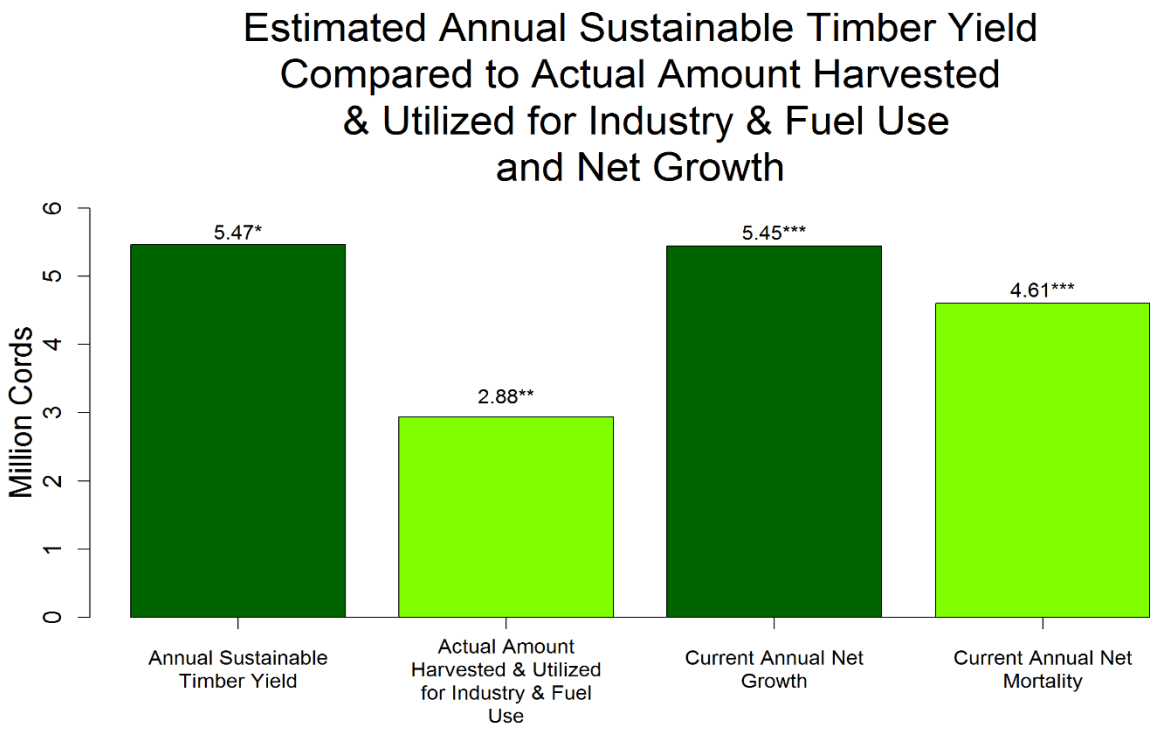
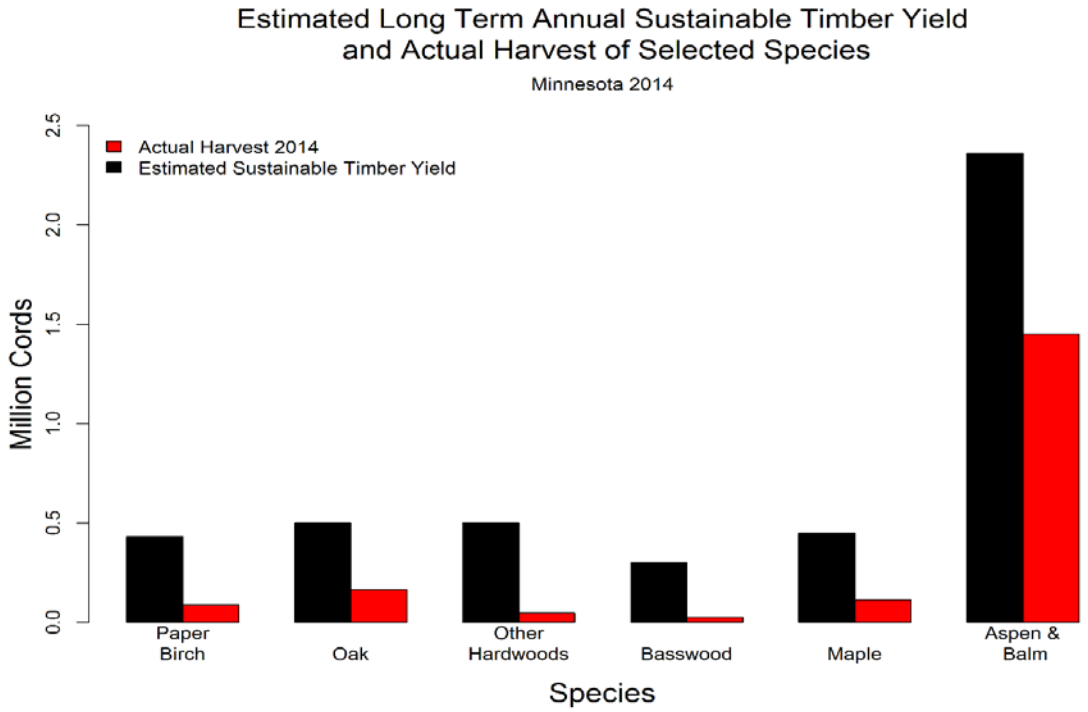
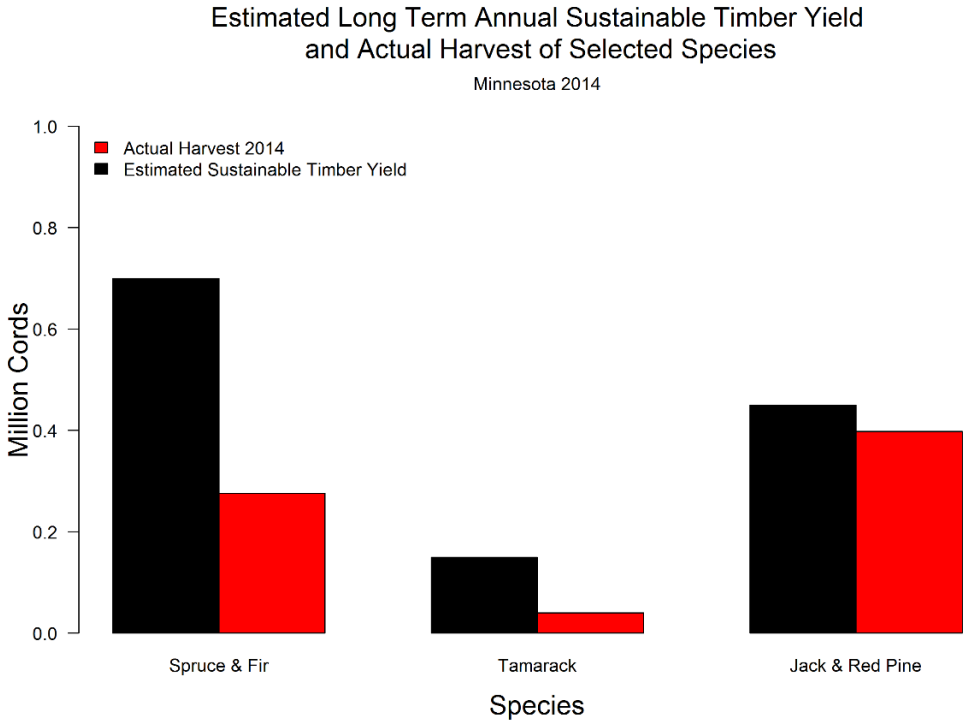


*Table 6.25, GEIS, High Long-Term Sustainable Level, Timber Productivity Tech. Paper, Dec. '92.
** 2014 (DRAFT) NRS pulpwood survey, 2014 DNR sawmill survey, 2014/15 fuelwood survey. For Harvest comparisons to Net Growth, it is necessary to add annual "growing stock" logging residue of approximately 275,000 cords to this figure.
***USFS FIA 2016 database.
Note: While complete capture is not realistic, capture of a portion of annual mortality of approximately 4.61 million cords has the potential to increase net growth and sustainable harvest levels.



Source: Harvest data 2014 USFS pulpwood survey, DNR 2014 sawmill & 2014/15 fuelwood survey. Sustainable timber yield data source as per the notes below.



Source: Harvest data 2014 USFS pulpwood survey, DNR 2014 sawmill & 2014/15 fuelwood survey. Sustainable timber yield data source as per the notes below.

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.

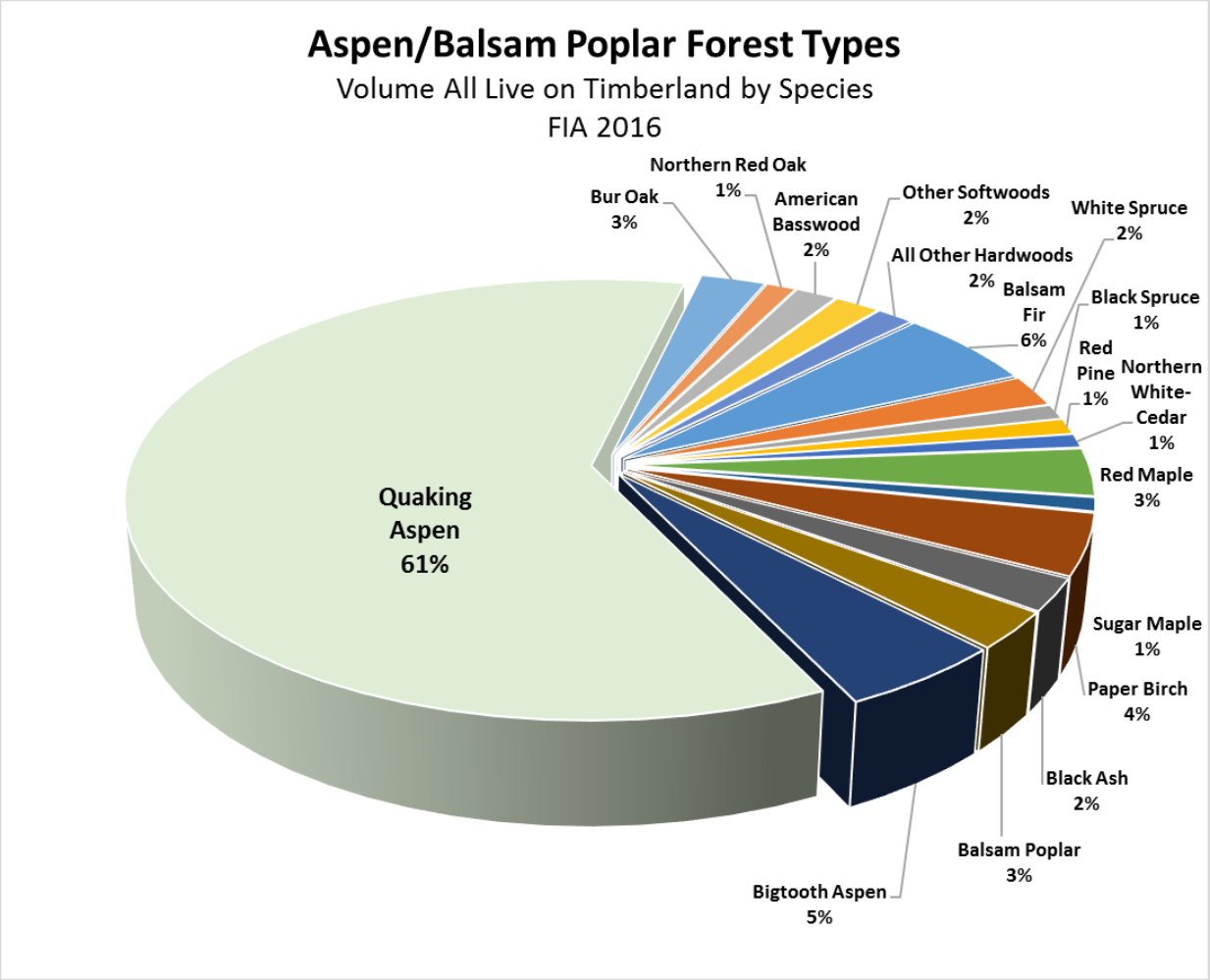
Wood Supply and Demand Information for Important Cover Types and Species

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

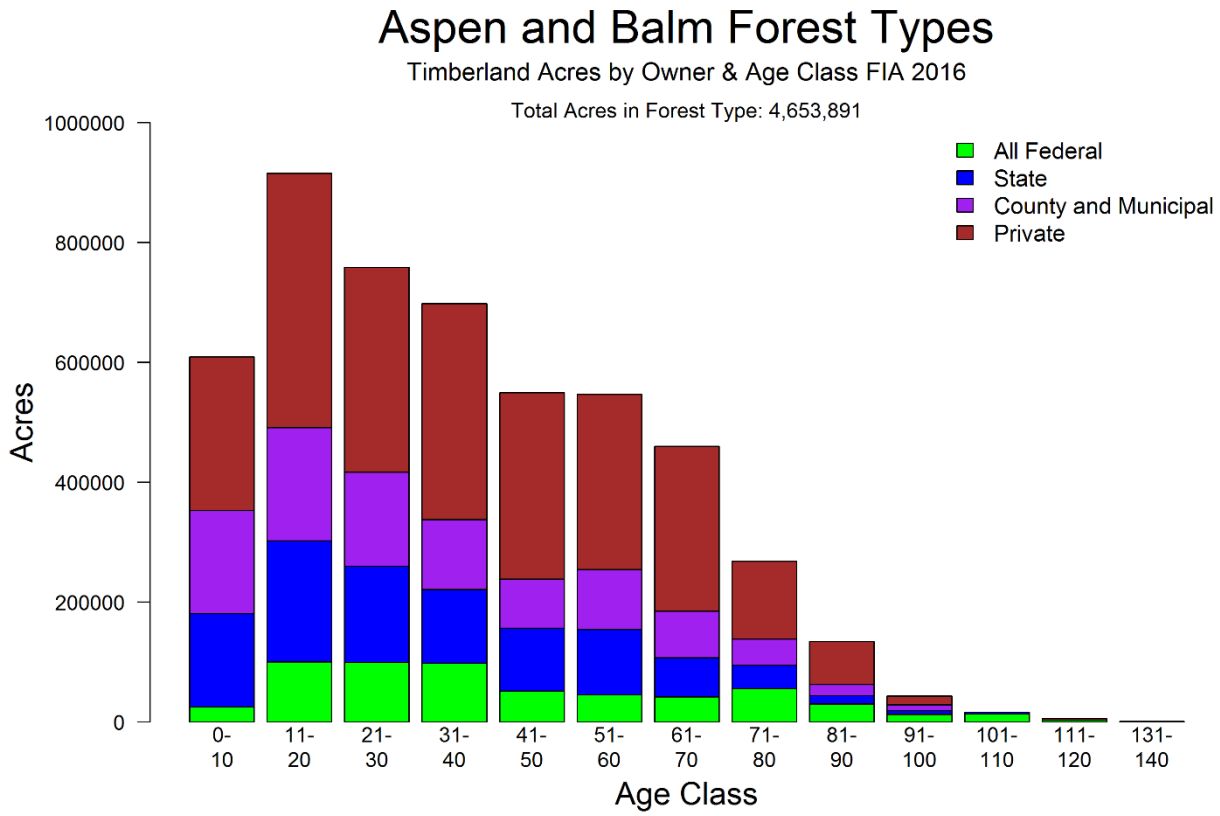
Minnesota's Aspen/Balm of Gilead Resource

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.

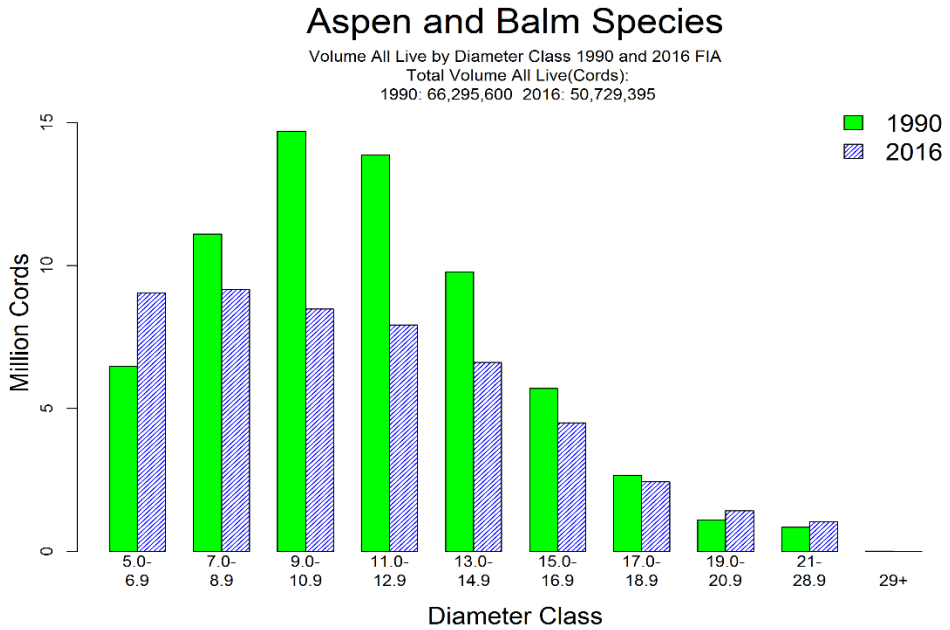


Source: 2016 FIA database provided by USFS, Northern Research Station



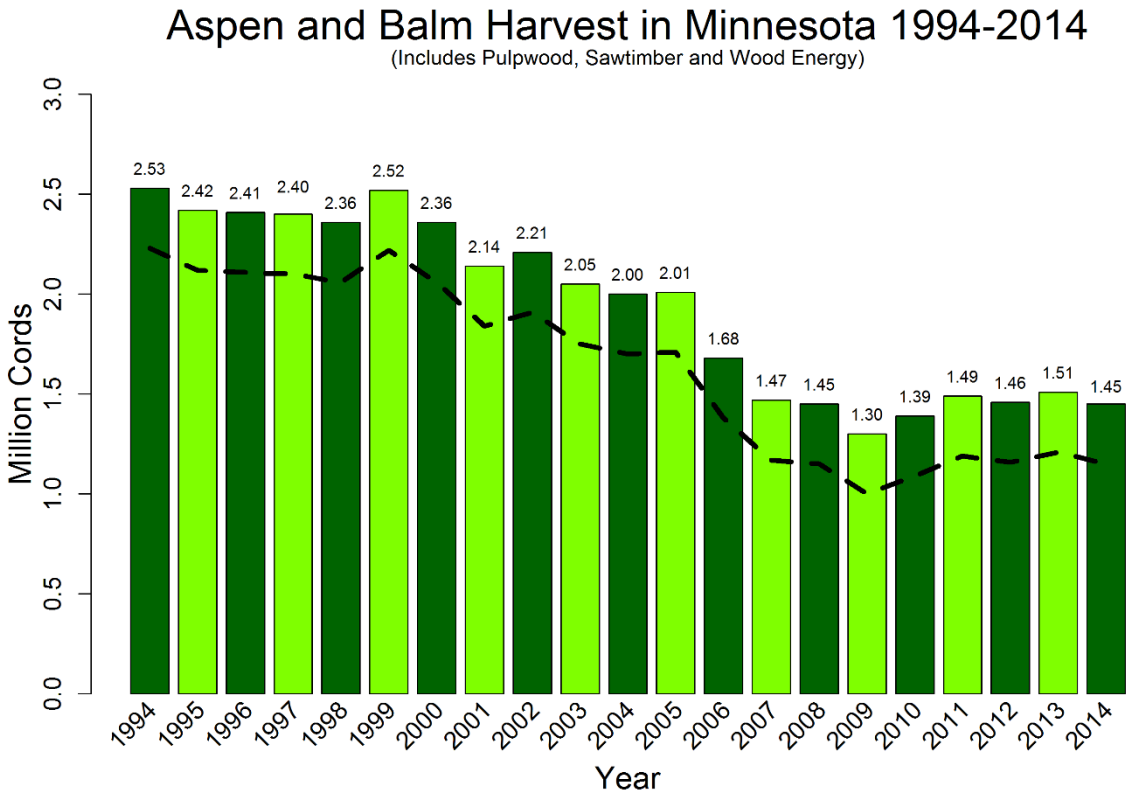
Source: 2015 FIA database provided by USFS, Northern Research Station

There is a significant amount of the aspen resource found on private lands. The 2016 FIA inventory indicates a much more even age-class distribution than the 1990 inventory.



Source: FIA 2016 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: Harvest data compiled by USFS, Northern Research Station & DNR. Dashed line represents the trend.

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 2016 USFS FIA database, estimated average net annual growth of aspen & balm growing stock: 1,815,425 cords, estimated average annual mortality of aspen & balm growing stock 1,072,883 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

2014 Harvest……... ……...**1,457,697**

- Minnesota Pulpwood Industries ……...……...……..1,313,204
- Pulpwood Export (To Canada and Wisconsin)……..…….....35,086
- Sawlogs & Other……..……...68,699
- Fuelwood (from live trees on timberland)…..…….…….....40,700

Source: NRS & DNR Surveys, the amount utilized by industry is higher due to imports from WI and Canada

Resource Opportunities:

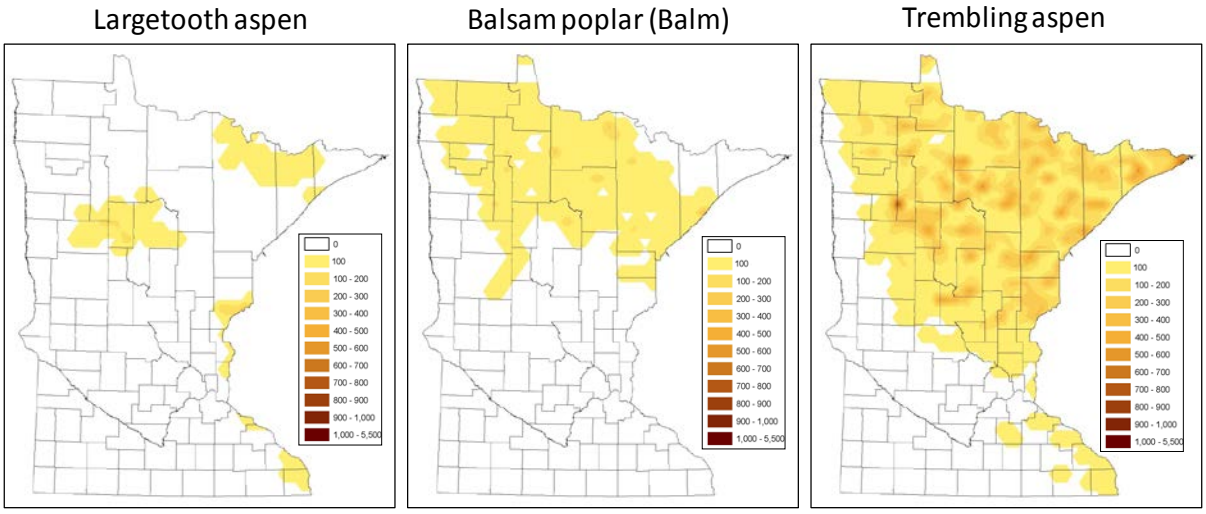
- The recent reduction in aspen harvest levels has resulted in a situation where current harvest levels are well below long-term sustainable levels.
- In stands where, aspen-birch decline is occurring harvest could avoid additional volume losses due to top kill and mortality.

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.

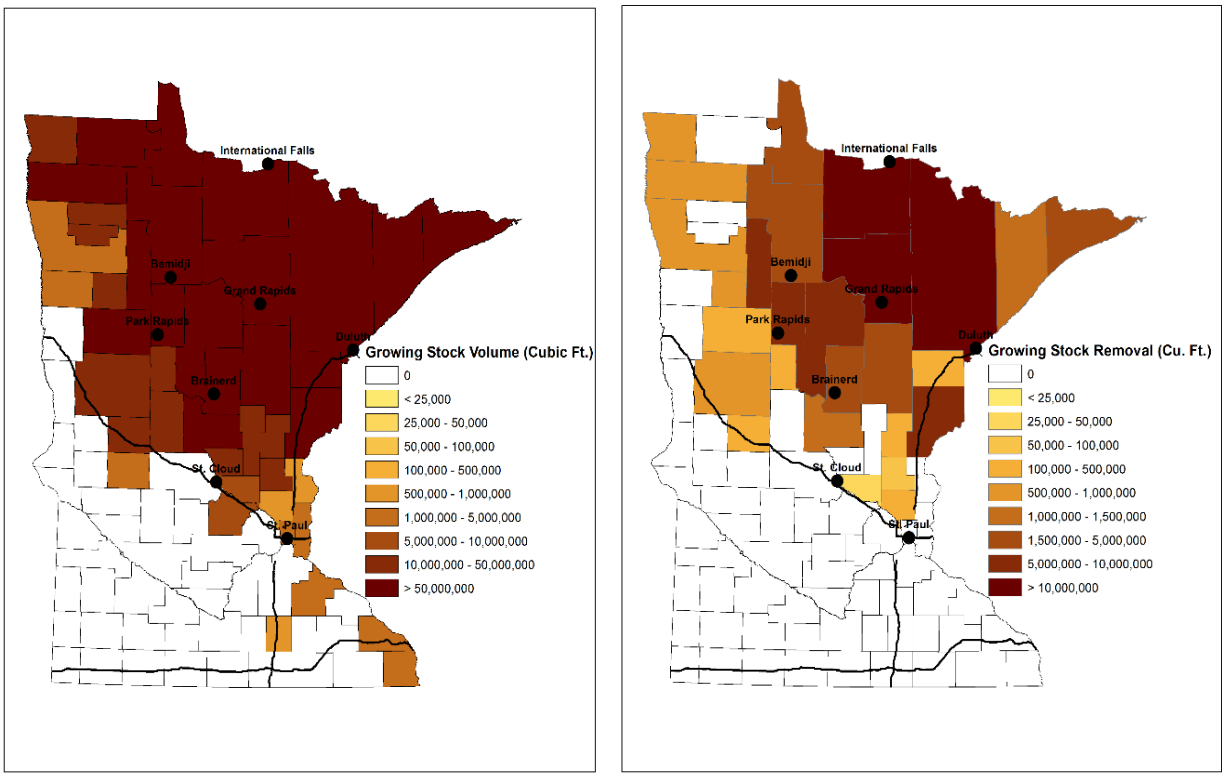
The table below shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top DOB) by percent of basal area per acre that is "Aspen" (quaking, bigtooth, and balm) ON FIA PLOTS. This table shows that Aspen and Balm forest types can differ significantly and provides 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 of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. These maps don'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: 2010 FIA database provided by USFS, Northern Research Station

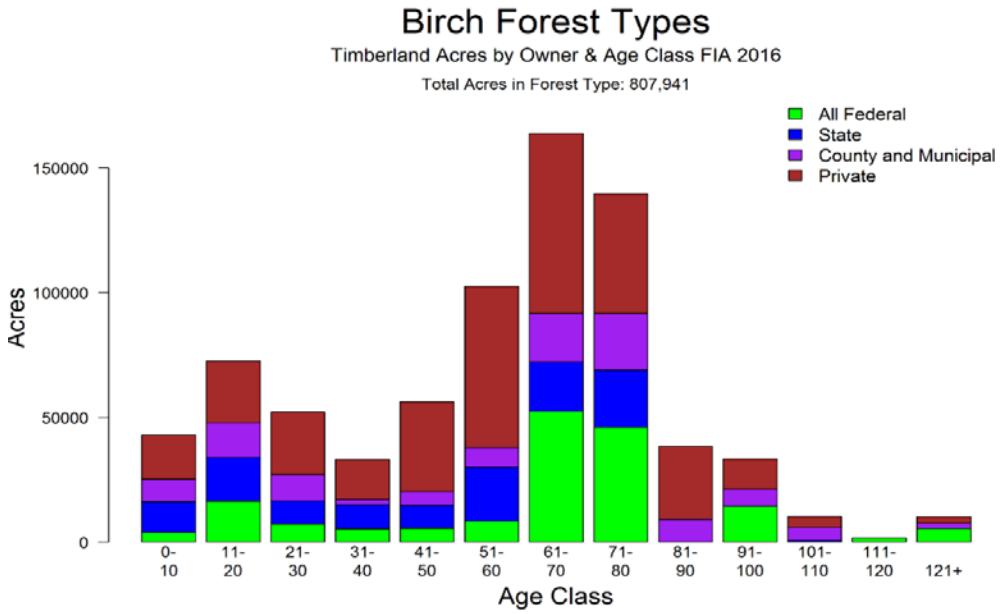


Growing stock (left) and growing stock removal (right) volumes on timberland for Aspen/Balm forest type by county.

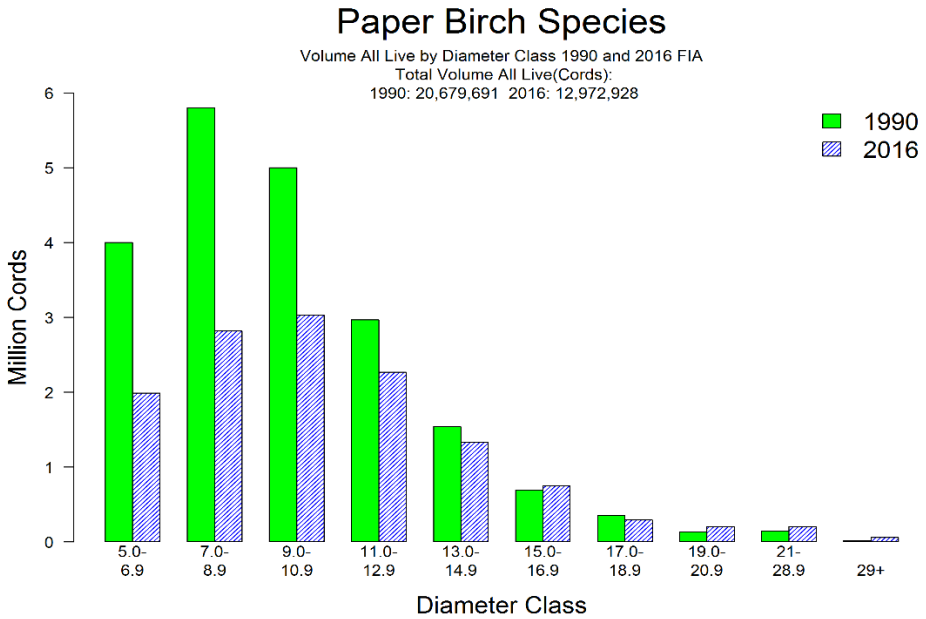
Source: FIA database 2016

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.

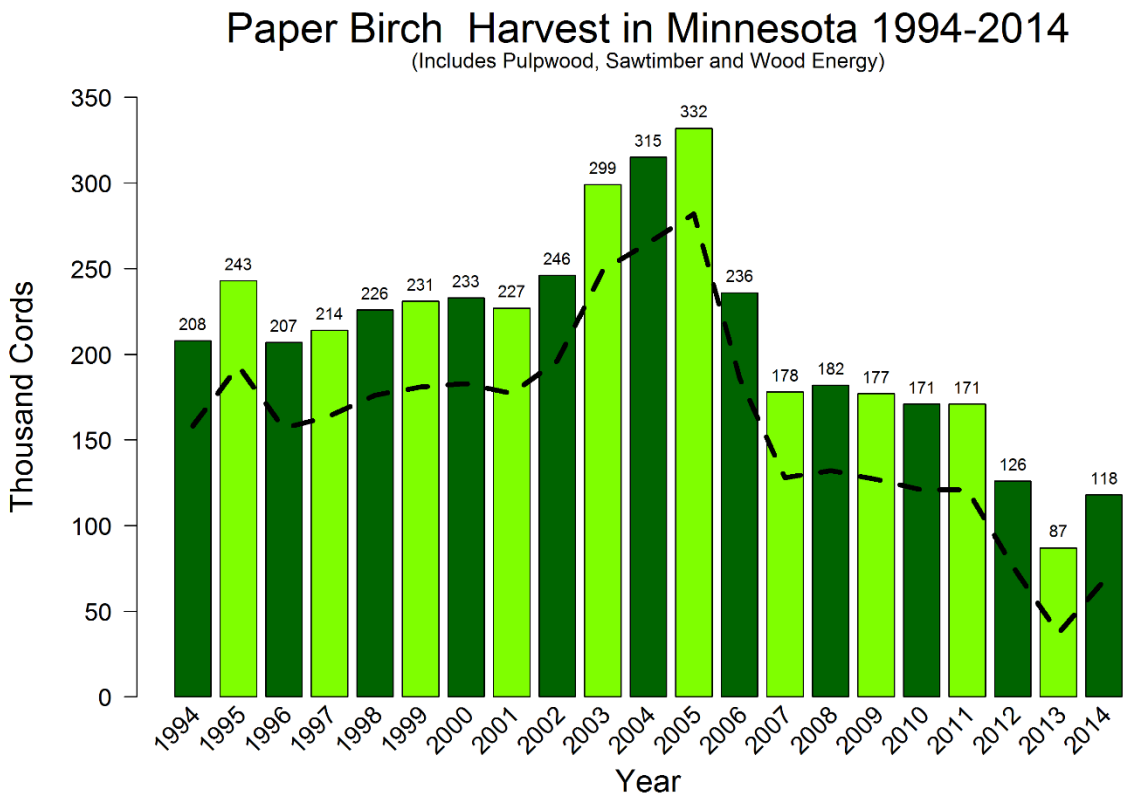


Source: 2016 FIA database provided by USFS, Northern Research Station



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: Harvest data compiled by USFS, Northern Research Station & DNR. Dashed line represents the trend.

DNR estimated long-term annual sustainable harvest level: 371,500 cords/year. Estimated average net annual growth of paper birch growing stock: 69,154 cords, and estimated average annual mortality of birch growing stock: 244,808 cords, based on 2016 FIA data.

Current Demand for Birch from Minnesota Timberlands

	Cords
2014 Harvest	**118,411**
• Minnesota Pulpwood Industries	37,294
• Pulpwood Export (To Wisconsin)	30,019
• Sawlogs & Other	23,486
• Fuelwood (from growing stock)	27,612

Source: NRS & DNR Surveys

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.
- In stands where, aspen-birch decline is occurring harvest could avoid additional volume losses due to top kill and mortality.

Resource Issues:

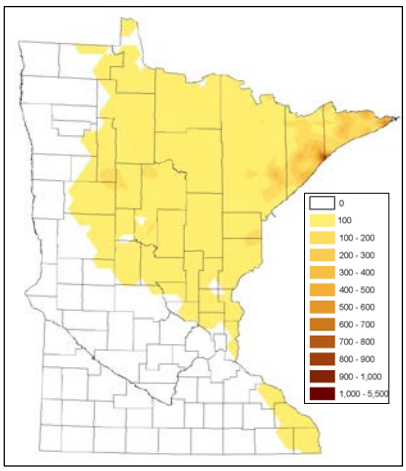
- There is a need to improve ability to consistently regenerate birch stands.
- Wood quality can be highly variable; from high valued to significant rot in some older birch.
- A major age class imbalance, with significant volumes of older birch.
- Birch volume is declining due to mortality from age, 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.

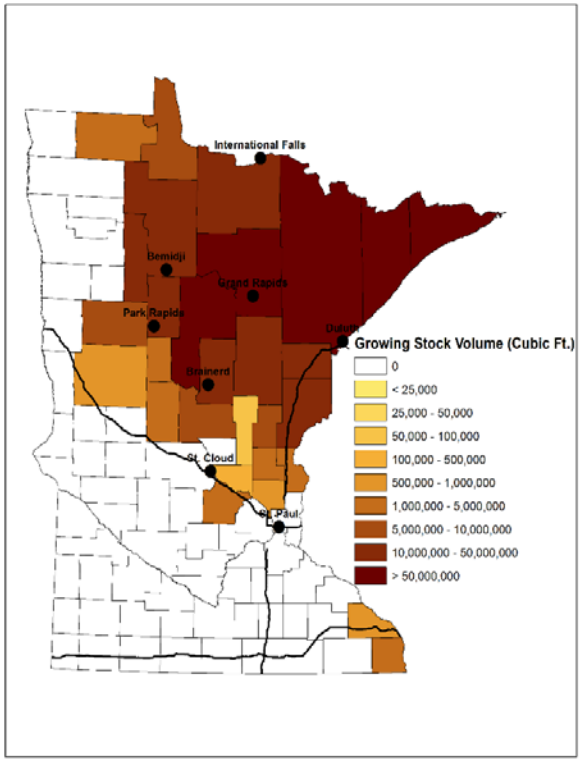
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	148,737	11.7	10.7	4.6	6	2.7	1.7	1.3	6	16.2	16	2.3	0.9	2	5.3	7.1	3.2
25-50%	415,660	12	3.1	4.5	4.2	1.5	1.1	1.6	3	16	35.7	0.8	0.6	0.8	5.9	5.2	2.4
50-75%	186,733	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%	44,695	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

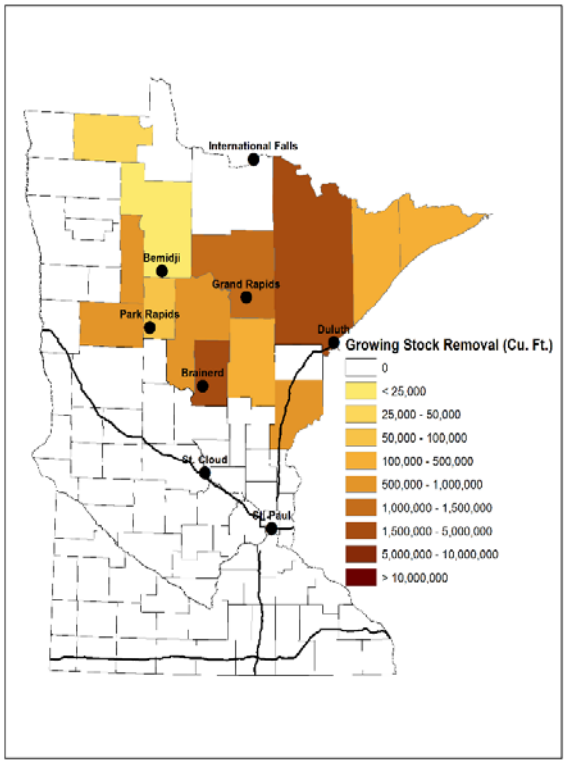
Predicted spatial distribution of paper birch CUBIC FOOT volume of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees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

Paper birch



Source: 2010 FIA database provided by USFS, Northern Research Station



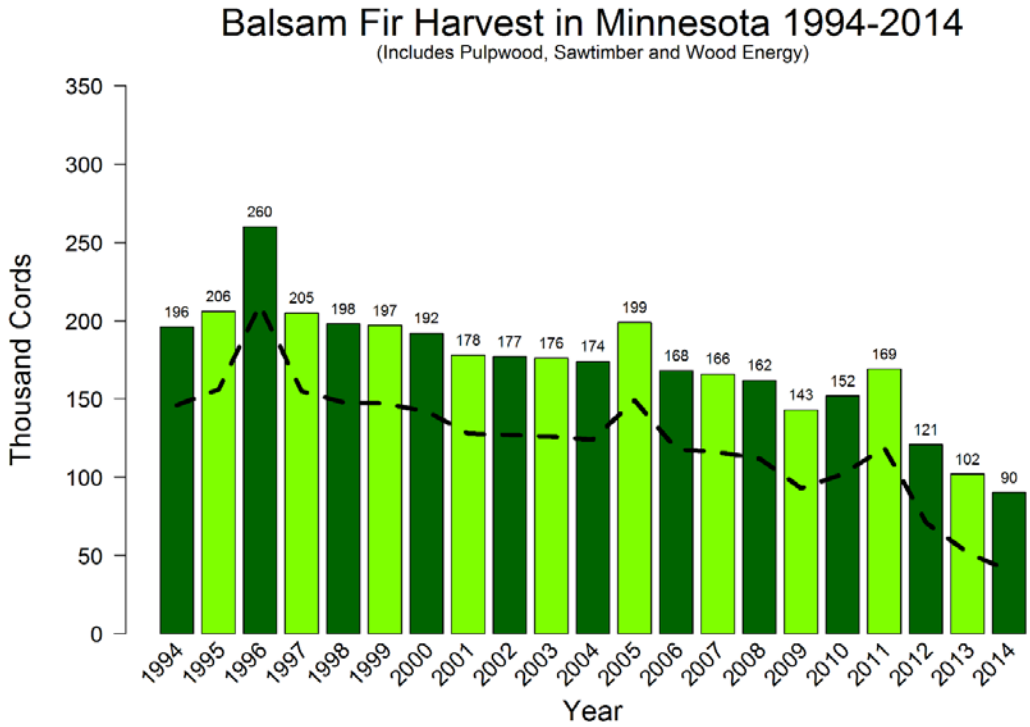


Growing stock (left) and growing stock removal (right) volumes on timberland for Birch forest type by county.

Source: FIA database 2016

Minnesota's Balsam Fir Resource

Based on 2016 FIA data, estimated average net annual growth of balsam fir growing stock: 237,439 cords; estimated average annual mortality of balsam fir growing stock: 320,805 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: Harvest data compiled by USFS, Northern Research Station & DNR. Dashed line represents the trend.

Current Demand for Balsam Fir from Minnesota Timberlands

	Cords
2014 Harvest	**90,812**
• Minnesota Pulpwood Industries	75,131
• Pulpwood Export (To Wisconsin)	0
• Sawlogs & Other	15,325
• Fuelwood (from growing stock)	356

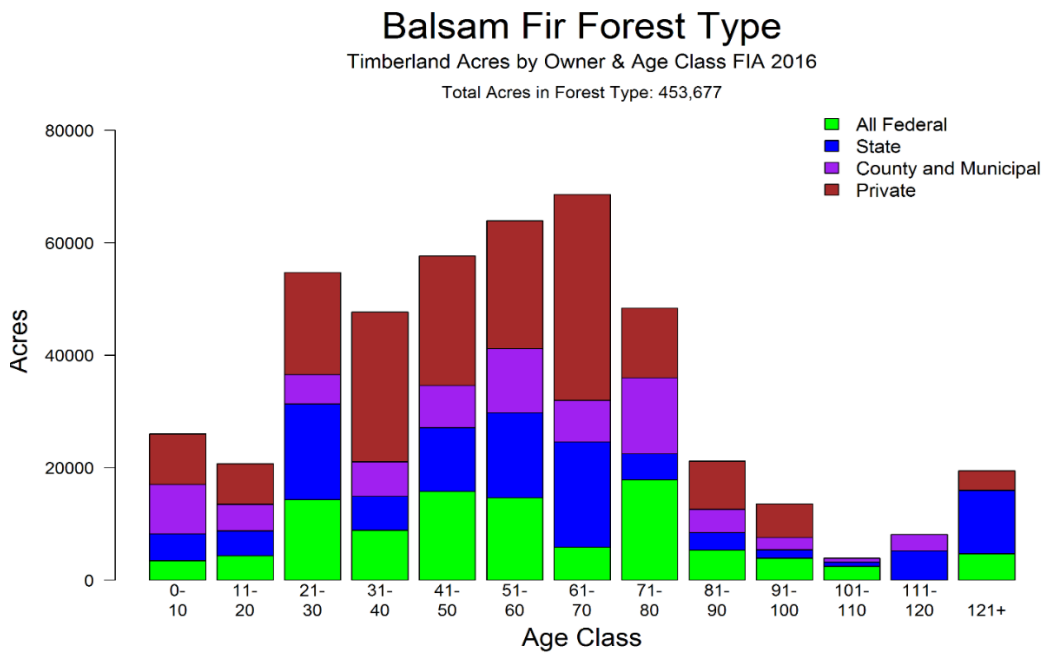
Source: NRS & DNR Surveys

Resource Opportunities

- 2011 harvest was 168,600 cords and reduced to 101,900 cords in 2013, and has declined further to 91,000 cords in 2014 due to reduced pulp markets.
- High-quality balsam fir has excellent qualities for pulp & paper and stud manufacture.
- Pre-salvage operations of fir and white spruce should be occurring now, primarily in Lake and eastern St. Louis counties, since spruce budworm populations have affected spruce/fir forests in that locale for several consecutive years. Expect a short-term, local increase in supply.
- Balsam fir is currently utilized at well below its estimated sustainable harvest. In 2014 the difference between harvest (spruce and fir) and sustainable harvest (spruce and fir) was approximately 400,000 cords.

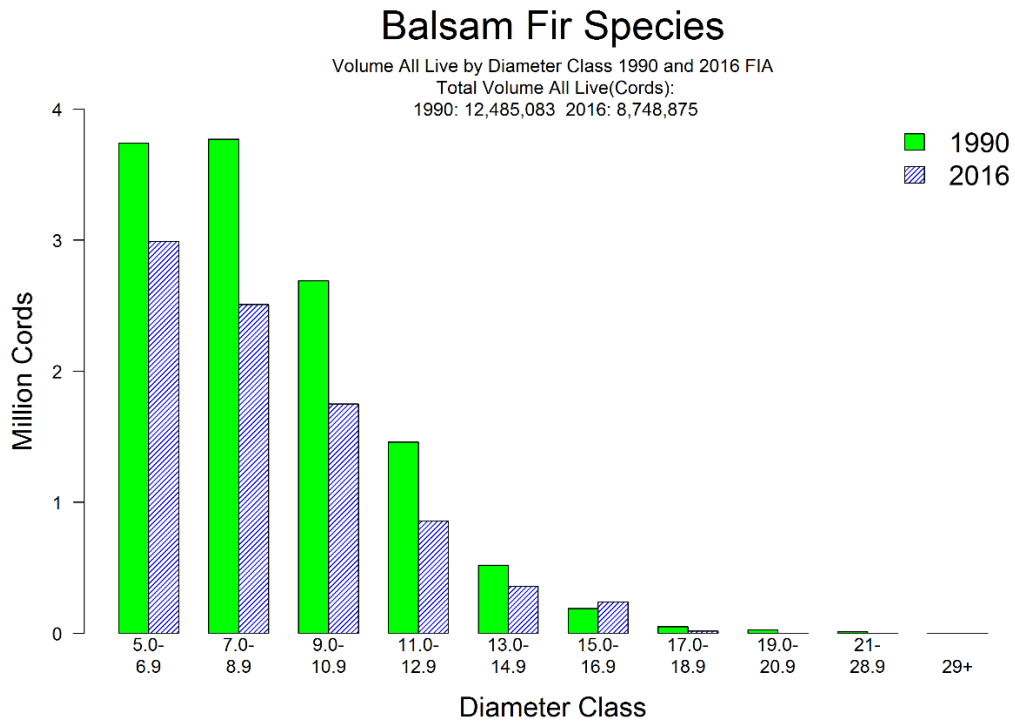
Resource Issues:

- 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 classes of the Balsam Fir type are imbalanced.
- 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: 2016 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).



Source: FIA database provided by USFS, Northern Research Station

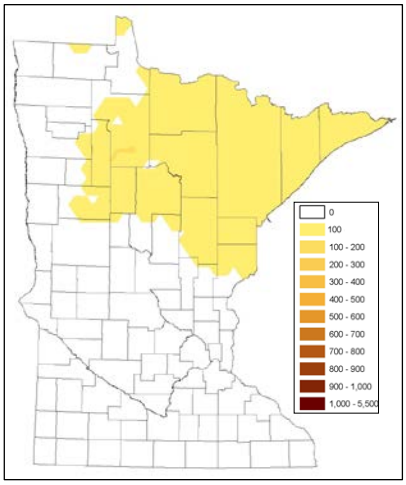
Much of the balsam fir volume in Minnesota (roughly 51%) is found mixed in with the aspen/balm and birch cover types, and is therefore tied to aspen and birch harvest. Total balsam fir volume has dropped significantly since 1990.

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.

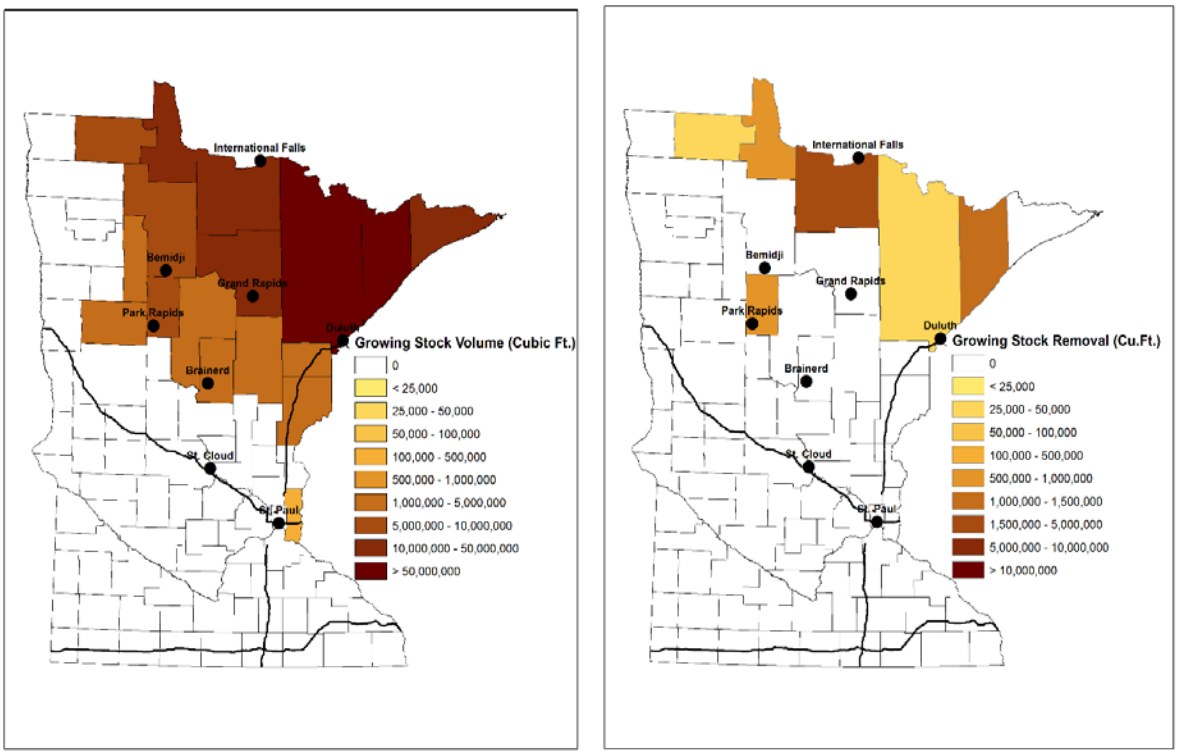
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	41,389	3.6	23	8.7	23.2	3	0	5.7	10.9	12.55	5.2	2.2	0	0.2	0.9	0.2	0
25-50%	134,317	18	8.2	7.2	18	1.3	3.6	4.5	8.9	12.8	8.3	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 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



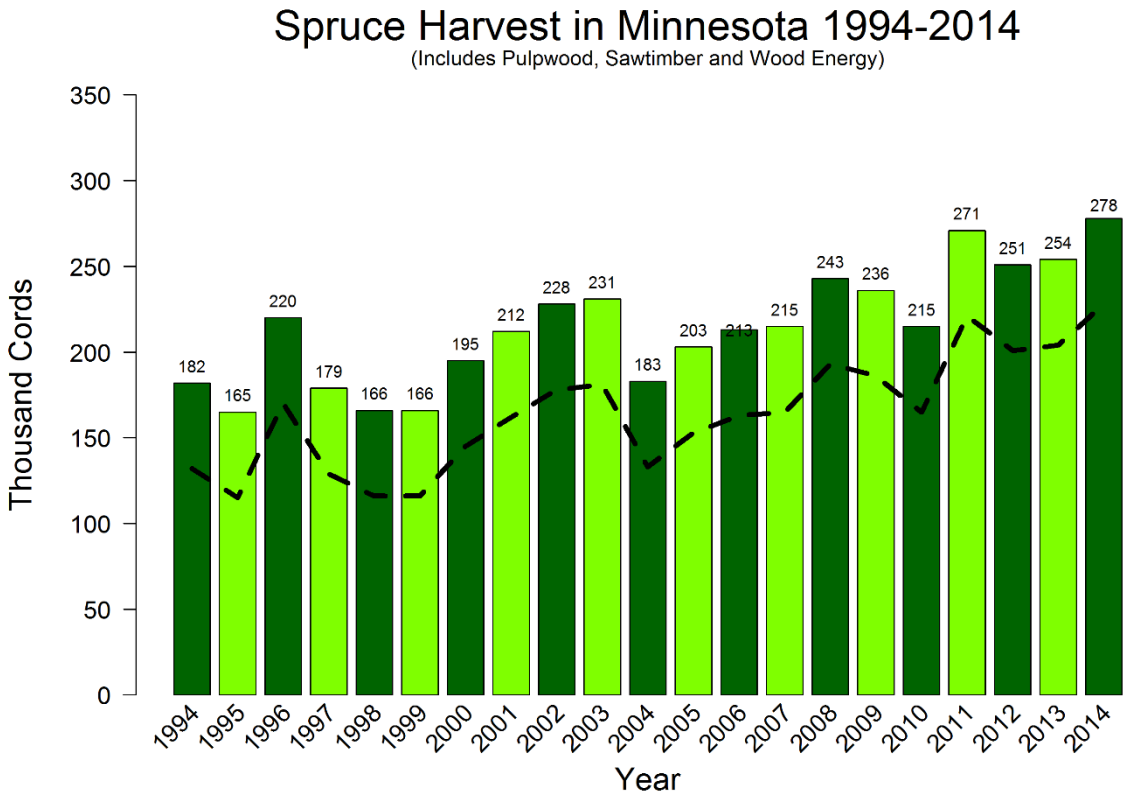
Source: 2010 FIA database provided by USFS, Northern Research Station



Growing stock (left) and growing stock removal (right) volumes on timberland for Balsam Fir forest type by county.

Source: FIA database 2016

Minnesota's Spruce Resource



Source: Harvest data compiled by USFS, Northern Research Station & DNR. Dashed line represents the trend.

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 2016 FIA database, estimated average net annual growth of spruce growing stock: 326,261 cords, estimated average annual mortality of spruce growing stock: 119,155 cords.

Current Demand for Spruce from Minnesota Timberlands

	Cords
2014 Harvest	**278,736**
• Minnesota Pulpwood Industries	197,924
• Pulpwood Export (To Wisconsin)	51,786
• Sawlogs & Other	28,933

Source: NRS & DNR Surveys

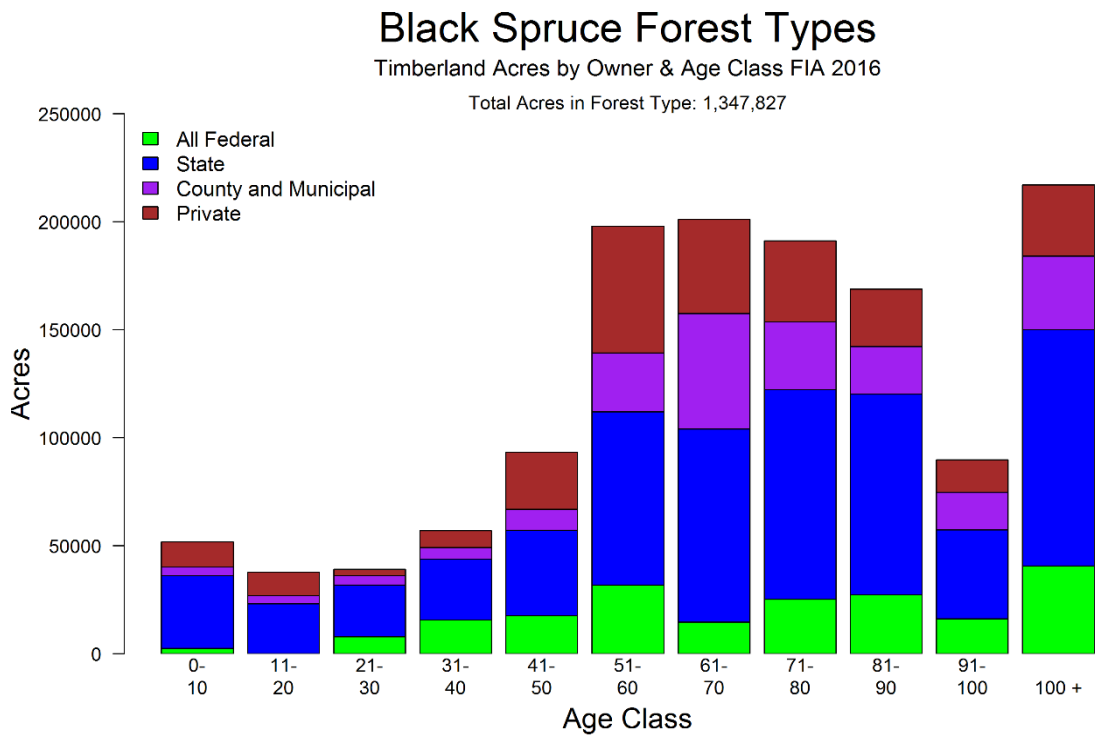
Resource Opportunities

- 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.
- The current utilization is below sustainable harvest by approximately 400,000 cords.
- 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 operations of fir and white spruce should be occurring now, primarily in Lake and eastern St. Louis counties, since spruce budworm populations have affected spruce/fir forests in that locale for several consecutive years. Expect a short-term, local increase in supply.

Resource Issues:

- Many stands have 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

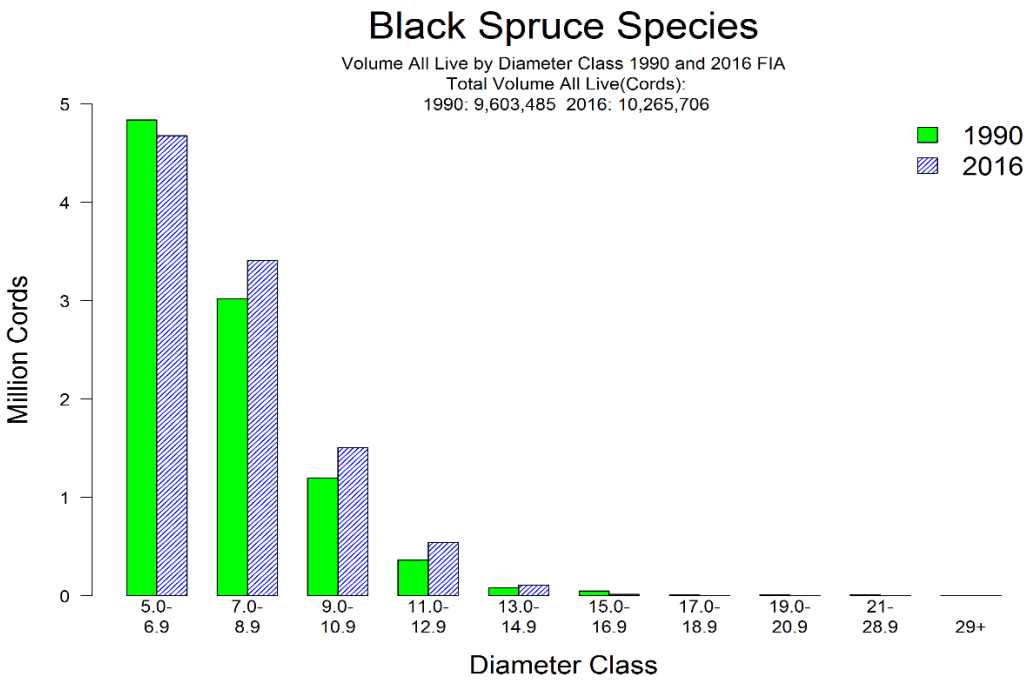


Source: 2016 FIA database provided by USFS, Northern Research Station

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.

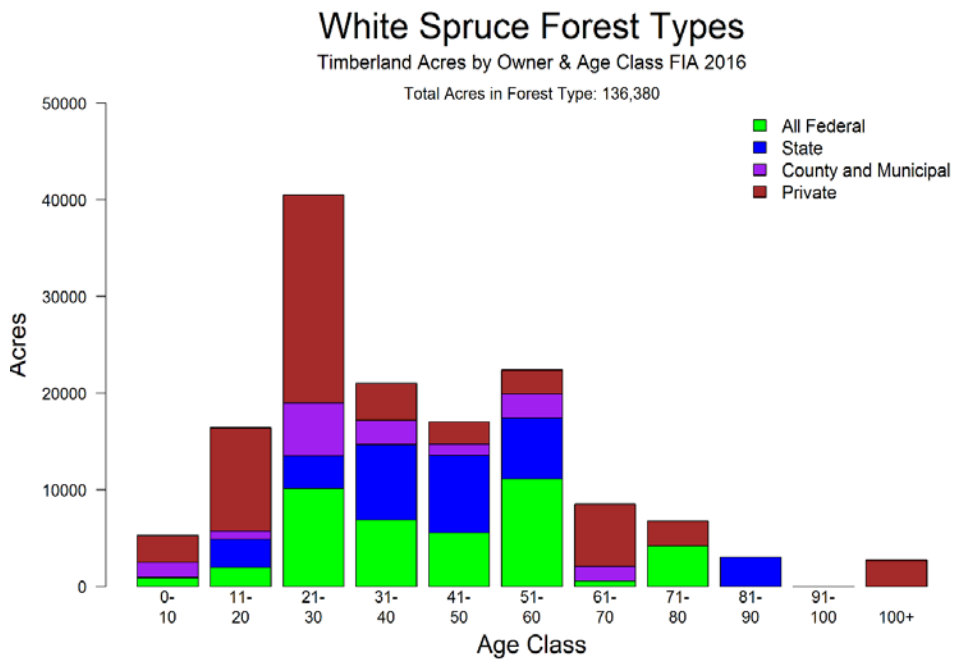
The State of Minnesota is by far the largest owner of black spruce cover type acres, but counties, private owners and our two national forests all have significant acreage.

The vast majority of black <u>and</u> 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 is also used in making OSB.



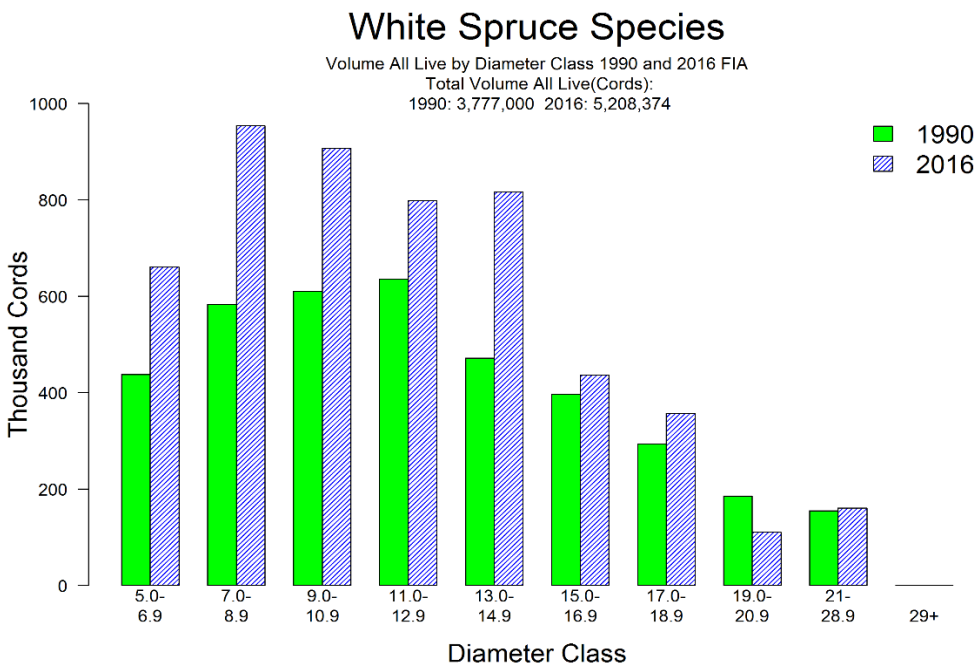
Source: FIA database provided by USFS, Northern Research Station

White Spruce



Source: 2016 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.



Source: 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.

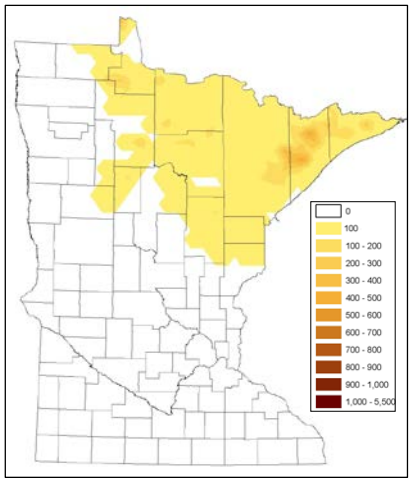
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	5,286	45.4	0	14.7	0	0	0	0	8.4	24.8	1.9	2	0	2.7	0	0	0
25-50%	15,571	13.8	1.8	39.9	4.8	3.5	4.7	0	6.4	7.7	10.9	0	0	4.7	0	0.4	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.

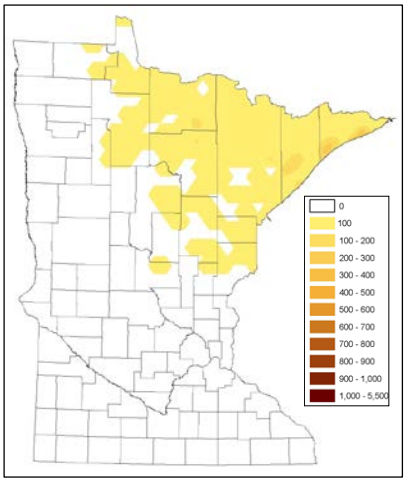
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	587	12.9	0	22	21.4	0	0	0	0	26.1	17.6	0	0	0	0	0	0
25-50%	8,576	14.3	0	53	1.3	0	3.6	2.7	7.1	12.3	4	0	0	0	1.9	0	0
50-75%	27,418	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 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.

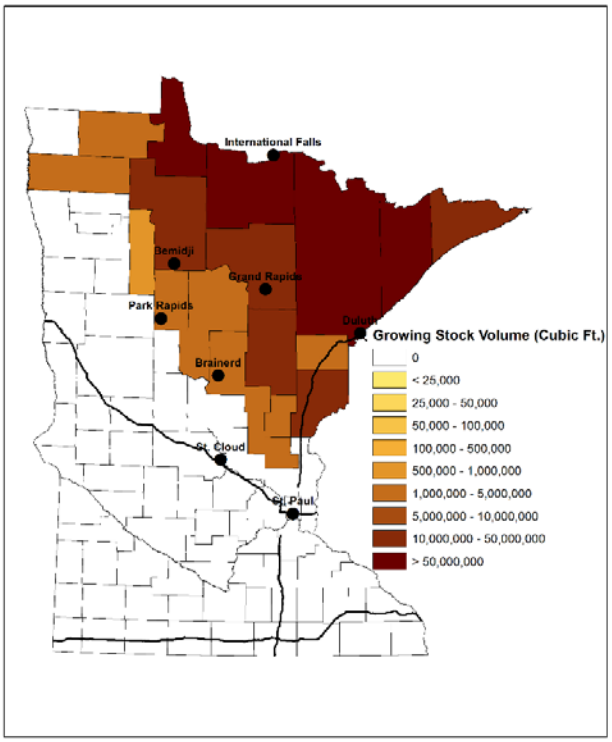
Black spruce

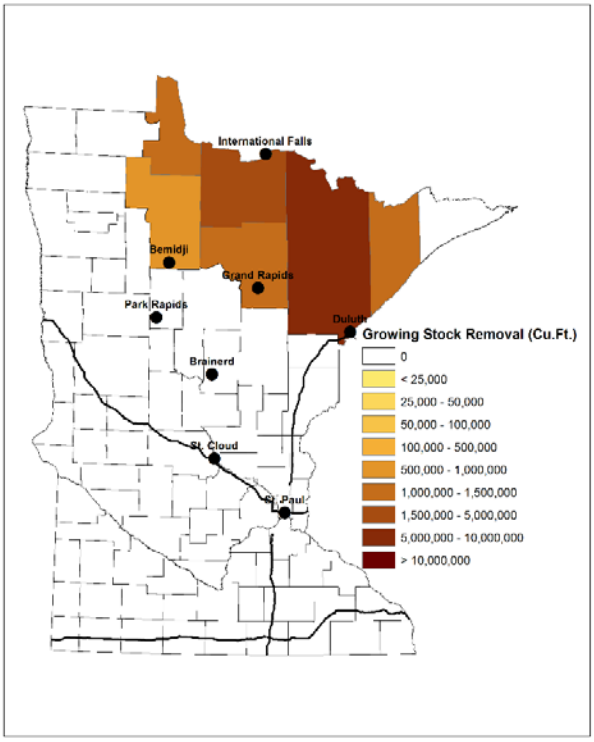


White spruce



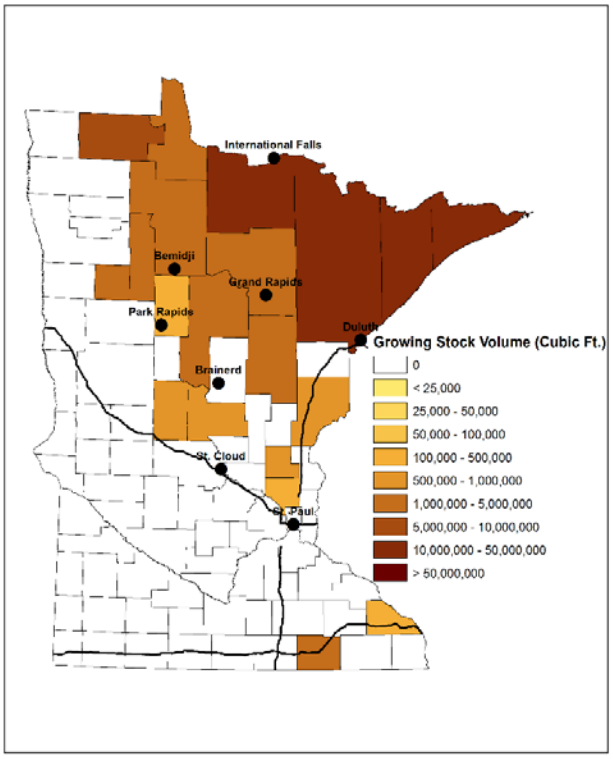
Source: 2010 FIA database provided by USFS, Northern Research Station

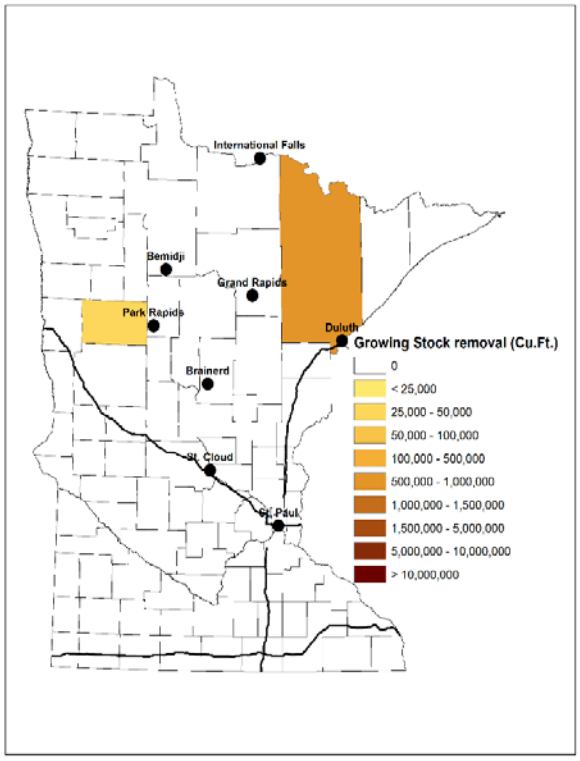




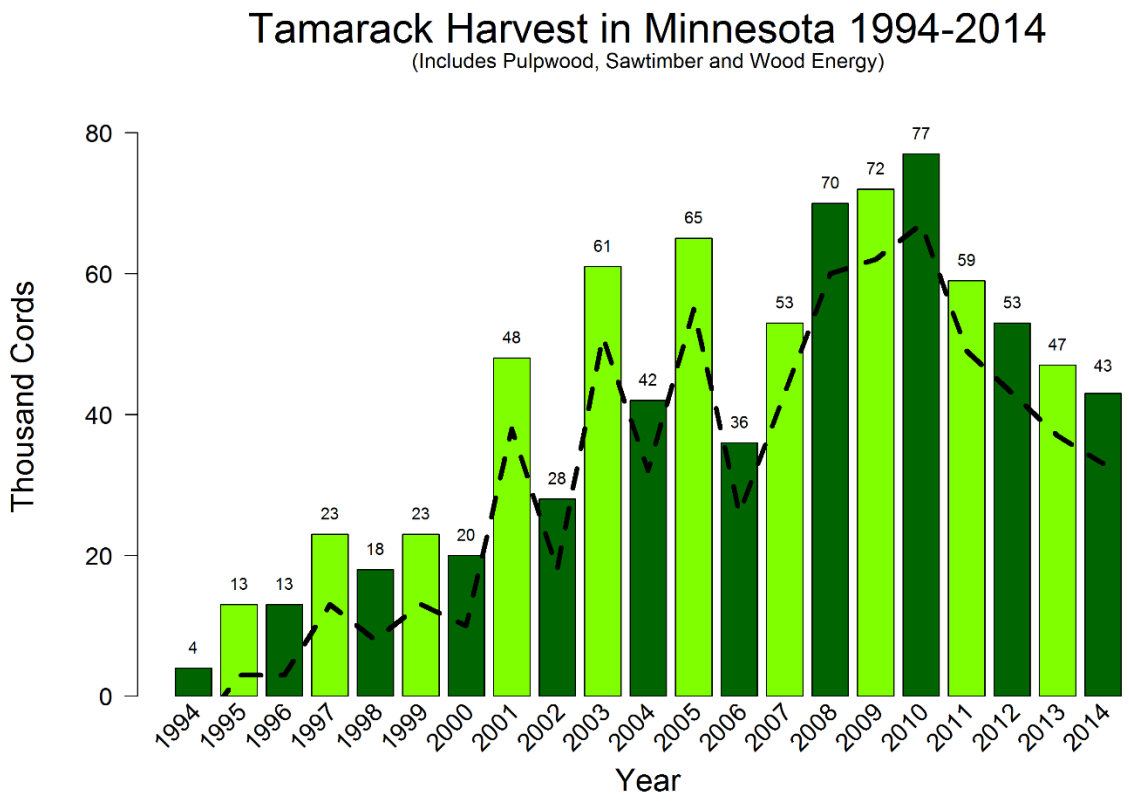
Growing stock (left) and growing stock removal (right) volumes on timberland for Black Spruce forest type by county. Below (left) growing stock and (right) growing stock removal volumes for White Spruce forest type by county.

Source: FIA database 2016





Minnesota's Tamarack Resource



Source: Harvest data compiled by USFS, Northern Research Station & DNR. Dashed line represents the trend.

DNR estimated long-term annual sustainable harvest level = 114,800 cords/year. Based on the 2016 FIA database, estimated average net annual growth of tamarack growing stock: 148,055 cords, estimated average annual mortality of tamarack growing stock: 191,443 cords.

Current Demand for Tamarack from Minnesota Timberlands

	Cords
2014 Harvest……	**43,315**

- Minnesota Pulpwood Industries……....28,127
- Sawlogs & Other……...15,098

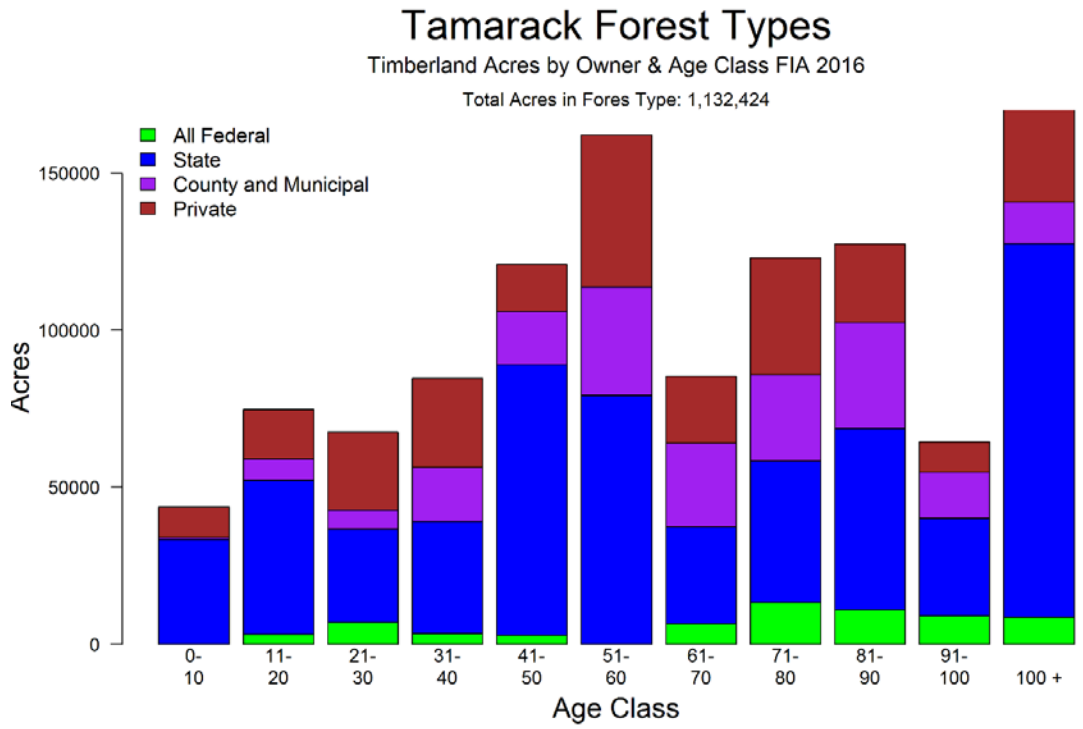
Source: NRS & DNR Surveys.

Resource Opportunities:

- Harvest is below long-term sustainable levels.
- An eastern larch beetle outbreak has killed over 50% of mature trees on at least 103,700 acres since it started in 2000. About 280,000 acres have been impacted to some degree by eastern larch beetle.
- Lots of standing dead/dying tamarack available now.

Resource Issues:

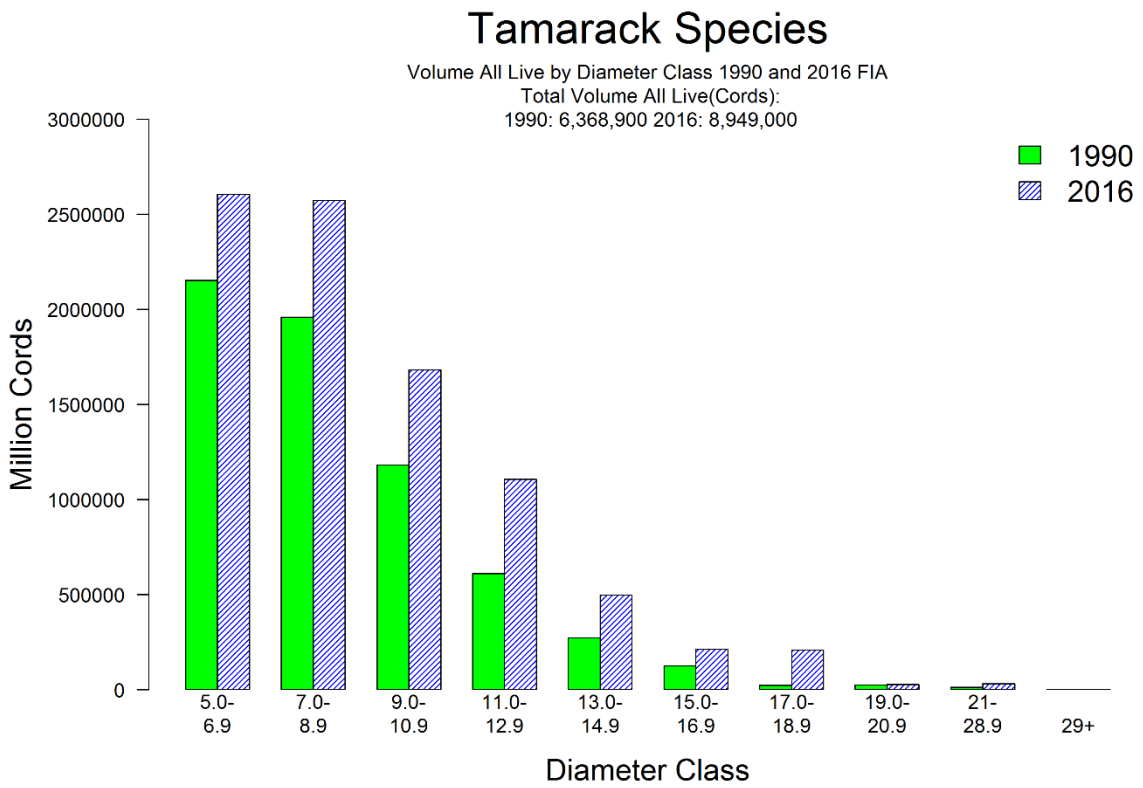
- Many stands have low volumes.
- Serious mortality levels are being experienced statewide, but especially in Koochiching, Beltrami, Lake of the Woods and Roseau counties. The mortality is from eastern larch beetle and is occurring in pole-sized and sawtimber-sized stands.
- Winter access only.
- Inconsistent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



Source: 2016 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 Kraft pulp, Arabinogalactan extraction and to a limited extent, engineered wood products. Recently, biomass energy facilities have begun to use more tamarack. Markets for tamarack have therefore improved somewhat since the 1990s, and stumpage prices still remain quite low.



Source: FIA database provided by USFS, Northern Research Station

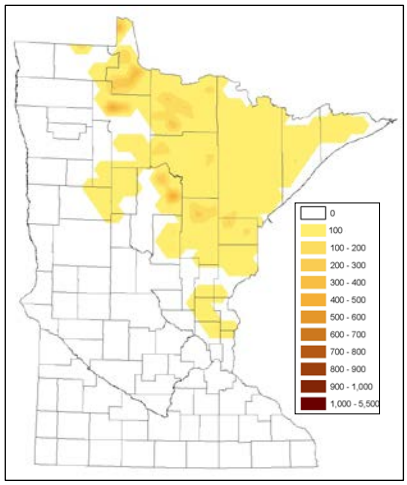
Total volume of tamarack has risen substantially since 1990.

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 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.

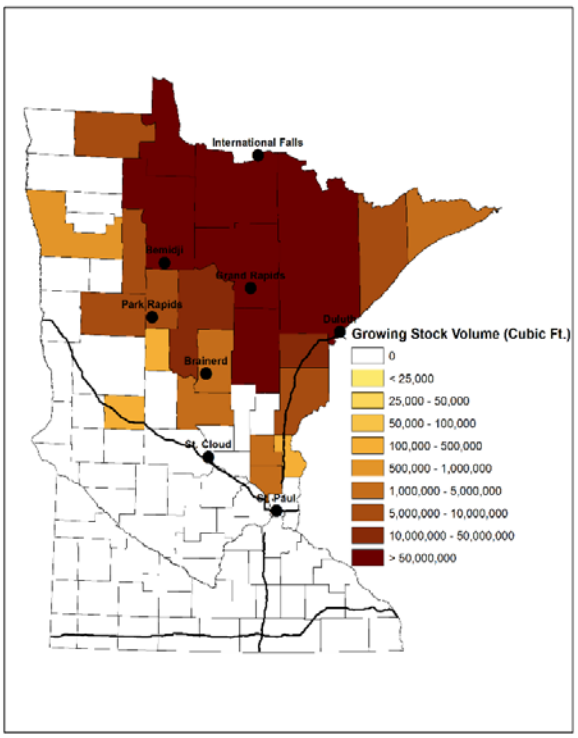
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	31,462	10.32	11.8	0	26.1	0	0	5.4	20.1	0.9	14.1	2	0	0	0	9.2	0
25-50%	156,723	2.9	52.7	1	24.8	0.7	2.1	1	11.3	0.8	1.8	0.2	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

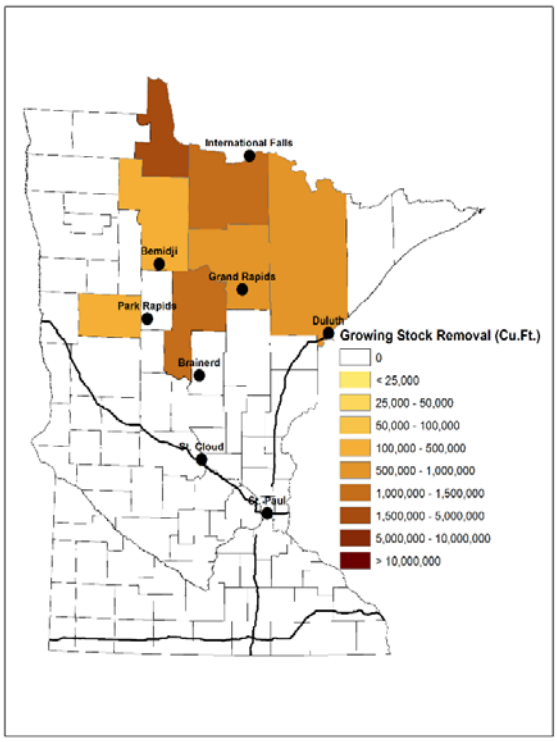
Predicted spatial distribution of tamarack CUBIC FOOT volume of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of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

Tamarack



Source: 2010 FIA database provided by USFS.



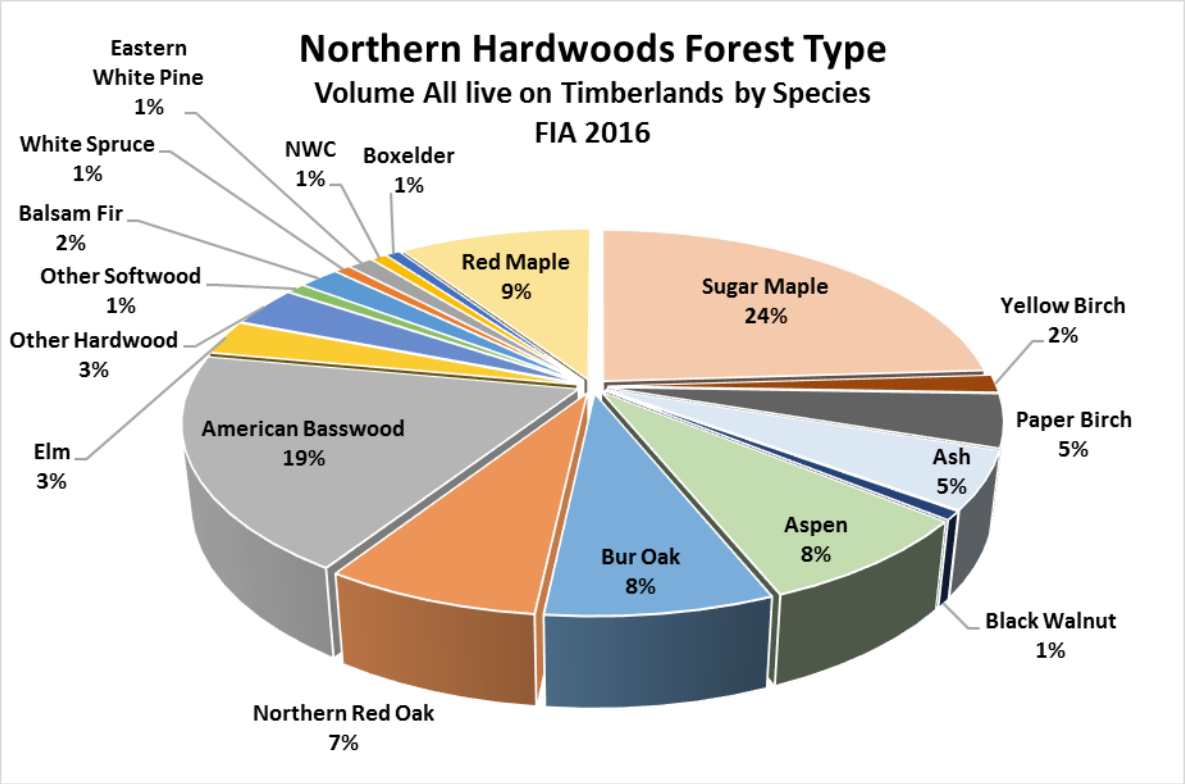


Growing stock (left) and growing stock removal (right) volumes on timberland for Tamarack forest type by county.

Source: FIA database 2016

Minnesota's Northern Hardwoods Resource

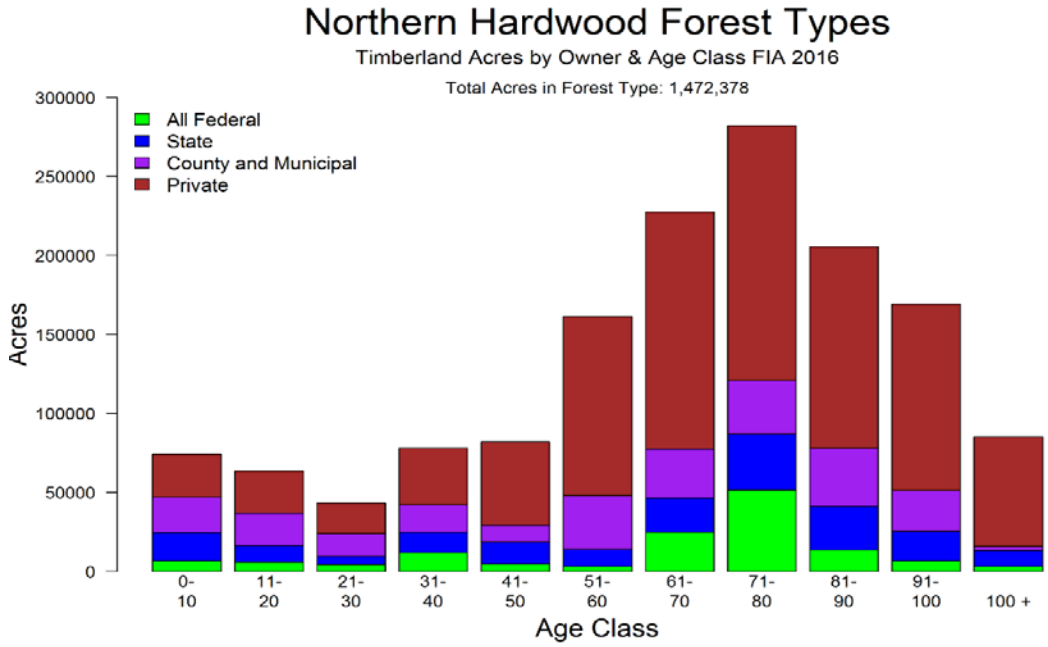
The northern hardwoods cover type is an assortment of a wide group of species. The dominant species are the shade tolerant sugar maple and basswood. There are also significant oak, red maple, aspen, and birch volumes as well in this cover type.



Source: 2016 FIA database provided by USFS, Northern Research Station (NWC=Northern White Cedar)

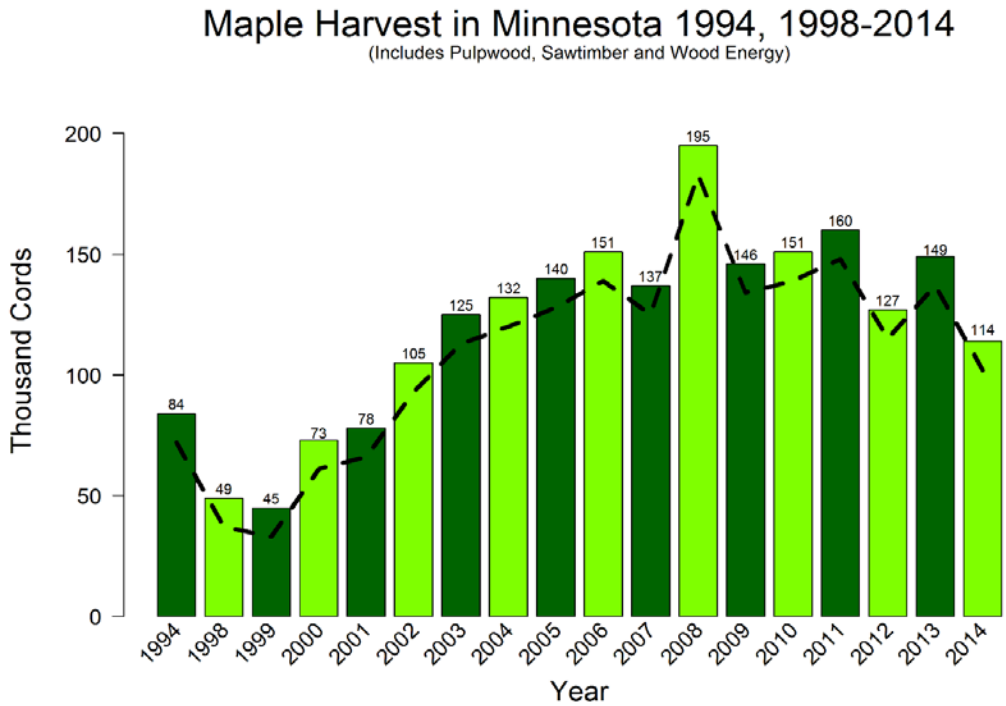
The northern hardwoods cover type is dominated by late "middle aged" stands (average rotation age = 80), many of which are in need of thinning in order to promote optimal growth and forest health. Northern hardwoods are often managed through periodic "thinning" harvests (or partial cuts), although clearcutting 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 experienced challenges for many years. These challenges are 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. Some Minnesota pulp and paper

and engineered wood product manufacturers have increased the use of maple and other hardwoods. In the long-term emerald ash borer will reduce the ash component in the northern hardwood resource.



Source: 2016 FIA database provided by USFS, Northern Research Station

Maple



Source: Harvest data compiled by USFS, Northern Research Station & DNR. Dashed line represents the trend.

DNR estimated long-term annual sustainable harvest level = 429,600 cords. Based on the 2016 FIA database, estimated average annual net growth for maple growing stock in Minnesota is 298,007 cords, estimated average annual mortality of maple growing stock is 102,344 cords.

Current Demand for Maple from Minnesota Timberlands

	Cords
2014 Harvest……..…...	**114,888**

- Minnesota Pulpwood Industries…….……...……71,197
- Pulpwood Export (To Wisconsin)..…….....13,271
- Sawlogs & Other……....13,255
- Fuelwood……...…….17,165

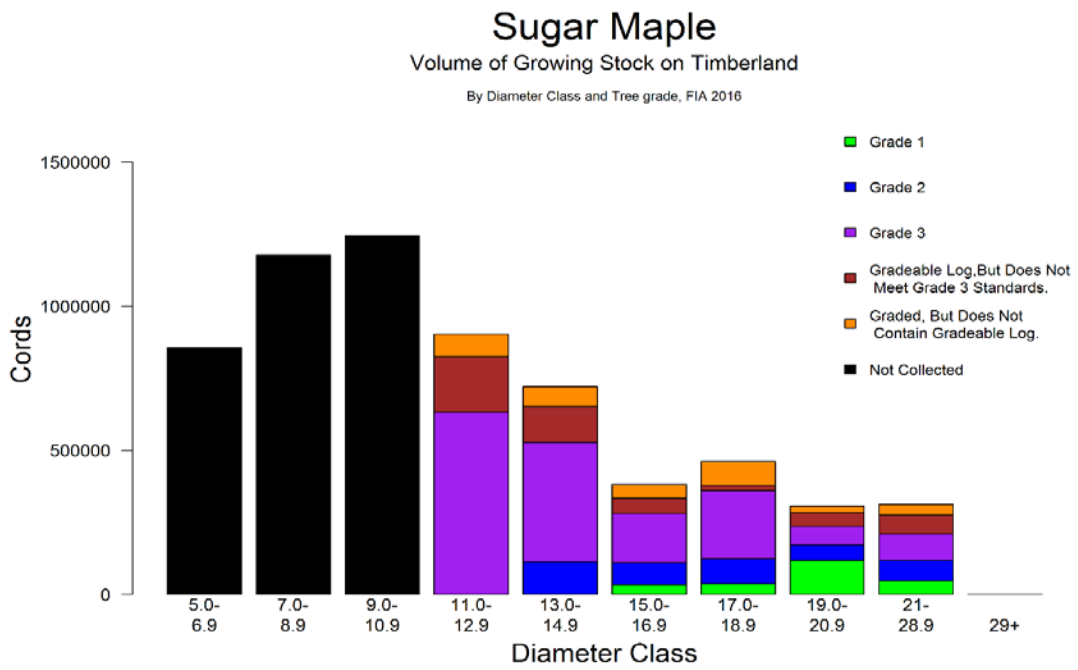
Source: NRS & DNR Surveys.

Resource Opportunities:

- Harvest is well below long-term sustainable levels. In 2014 harvest was 114,888 cords, approximately 315,000 cords below 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:

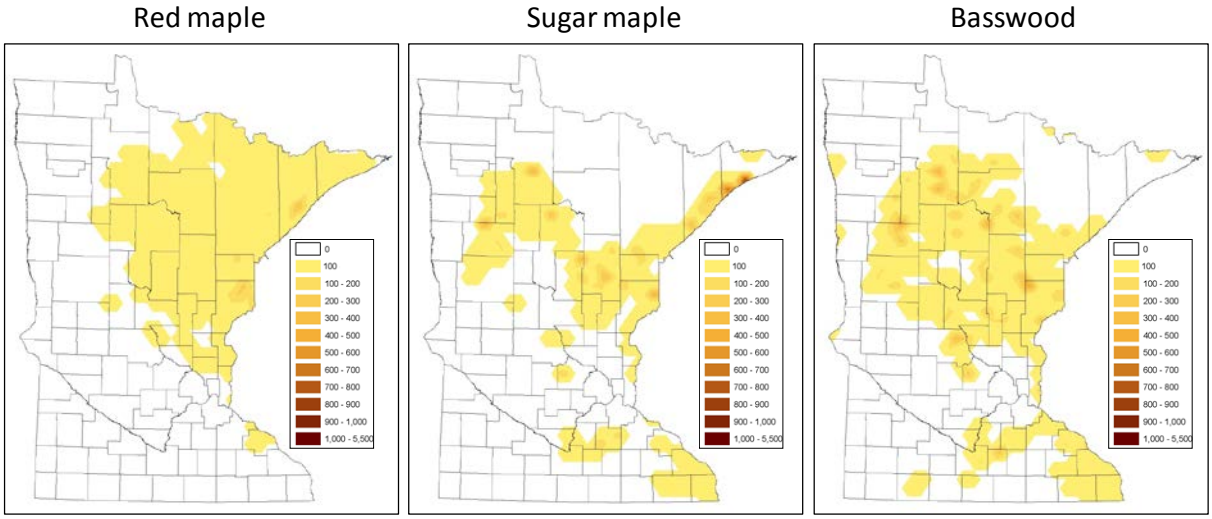
- Much of the maple resource is in private ownership. Different logging equipment and intensity of management required in multiple-entry management (i.e., partial cutting, uneven-aged management).
- Parts of NE Minnesota are under gypsy moth quarantine. Loggers and mills should contact MN Department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



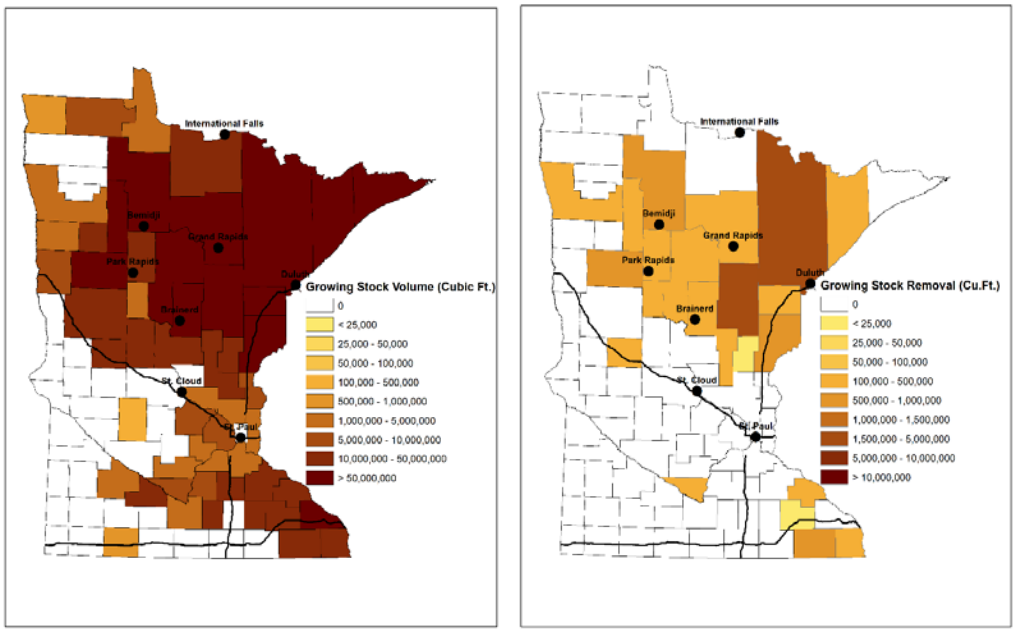
Source: 2016 FIA database provided by USFS, Northern Research Station
Note: Tree grade 1 = highest quality in the USFS tree grading system.

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 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.

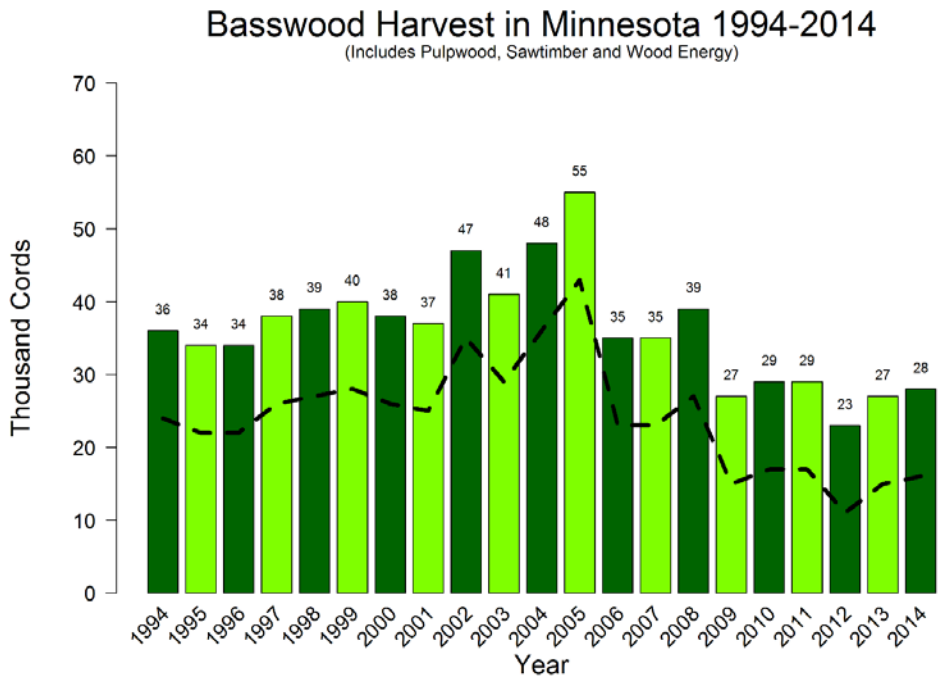


Source: 2010 FIA database provided by USFS, Northern Research Station



Growing stock (left) and growing stock removal (right) volumes on timberland for Northern Hardwood forest type by county.
Source: FIA database 2016

Basswood



Source: Harvest data compiled by USFS, Northern Research Station & DNR. Dashed line represents the trend.

DNR estimated long-term annual sustainable harvest level = 280,300 cords. Based on the 2016 FIA database, estimated net annual basswood growth: 189,894 cords, estimated annual mortality is 67,533 based on 2016 FIA estimates.

Current Demand for Basswood from Minnesota Timberlands

	Cords
2014 Harvest……..……..**28,670**	
• Minnesota Pulpwood Industries…….….……..1,932	
• Pulpwood Export (To Wisconsin)..…….…….……..28	
• Sawlogs & Other…….17,774	
• Fuelwood……..….4,600	

Source: NRS & DNR Surveys.

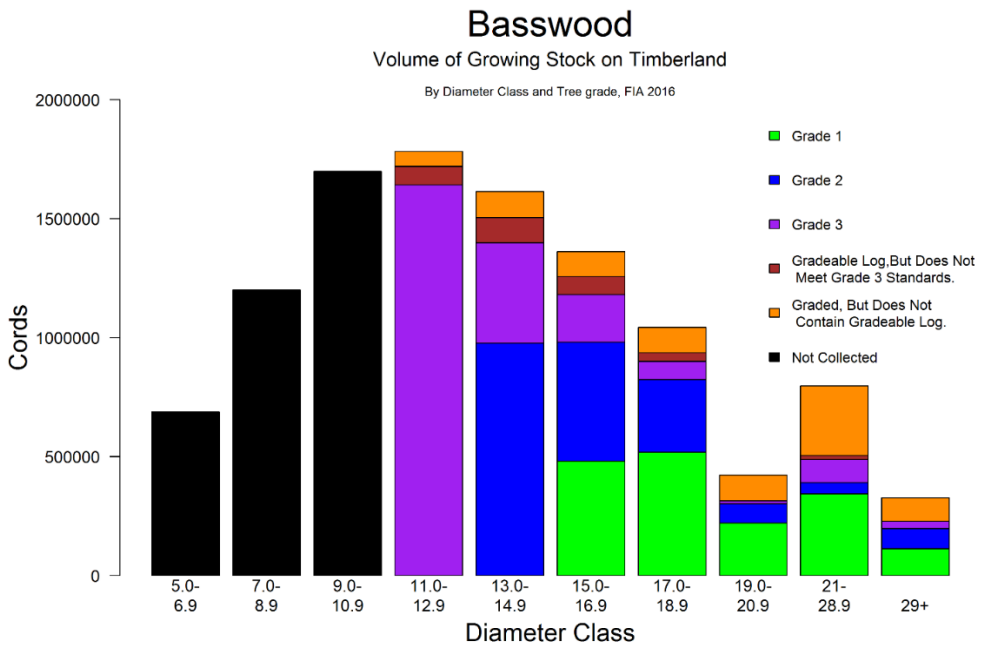
Resource Opportunities

- Harvest is well below long-term sustainable levels. In 2014 harvest was 28,670 cords, approximately 251,000 cords below 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

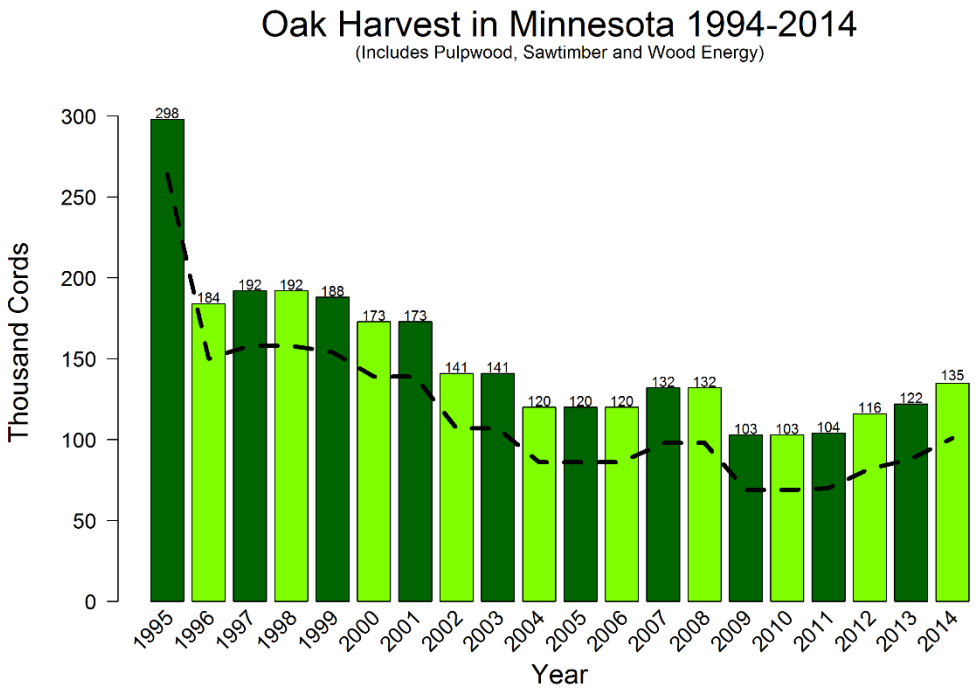
- Much of the basswood resource is in private ownership.
- Potential for harvest of high-quality stems as "pulpwood" on productive sites prior to their reaching sawlog size on private lands. Important to get quality material to higher-value markets.
- Different logging equipment and intensity of management 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: 2016 FIA database provided by USFS, Northern Research Station.
Note: Tree grade 1 = highest quality in the USFS tree grading system

Minnesota's Oak Resource



Source: Harvest data compiled by USFS, Northern Research Station & DNR. Dashed line represents the trend.

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
2014 Harvest…….……...	**135,341**

- Minnesota Pulpwood Industries……..……...0
- Pulpwood Export (To Wisconsin)..……..……....…….292
- Sawlogs & Other…….……..73,637
- Fuelwood…….…..61,412

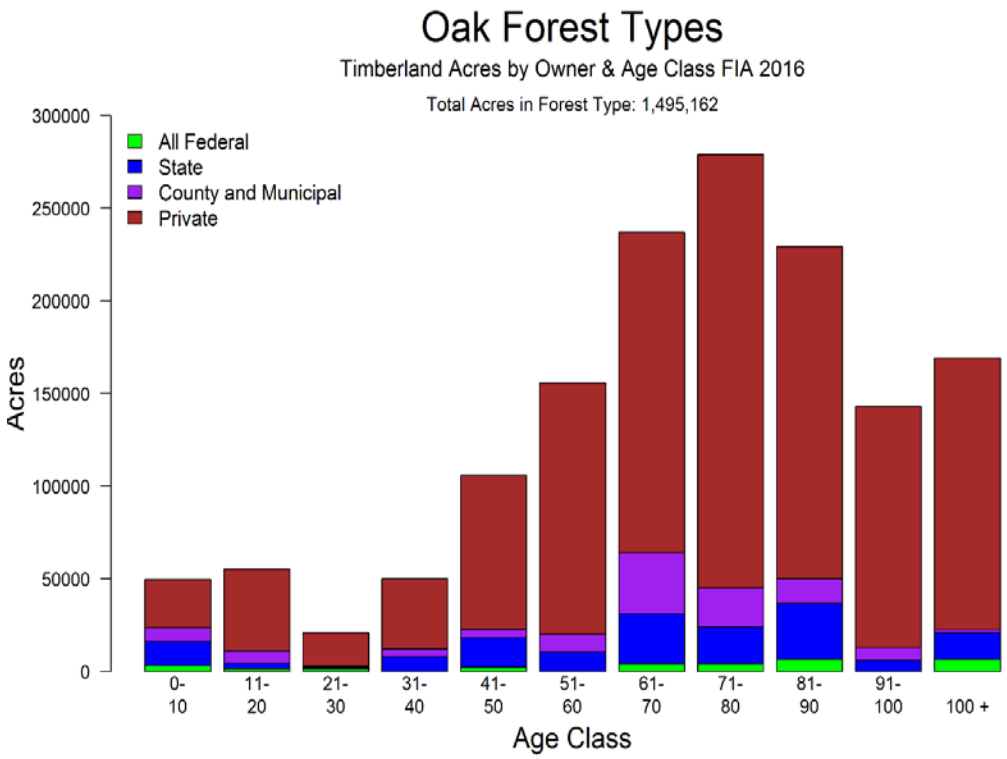
Source: NRS & DNR Surveys.

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.
- Oak is underutilized, sustainable harvest is estimated at approximately 500,000 cords annually, and in 2014 harvest was 334,000 cords below sustainable harvest levels.

Resource Issues:

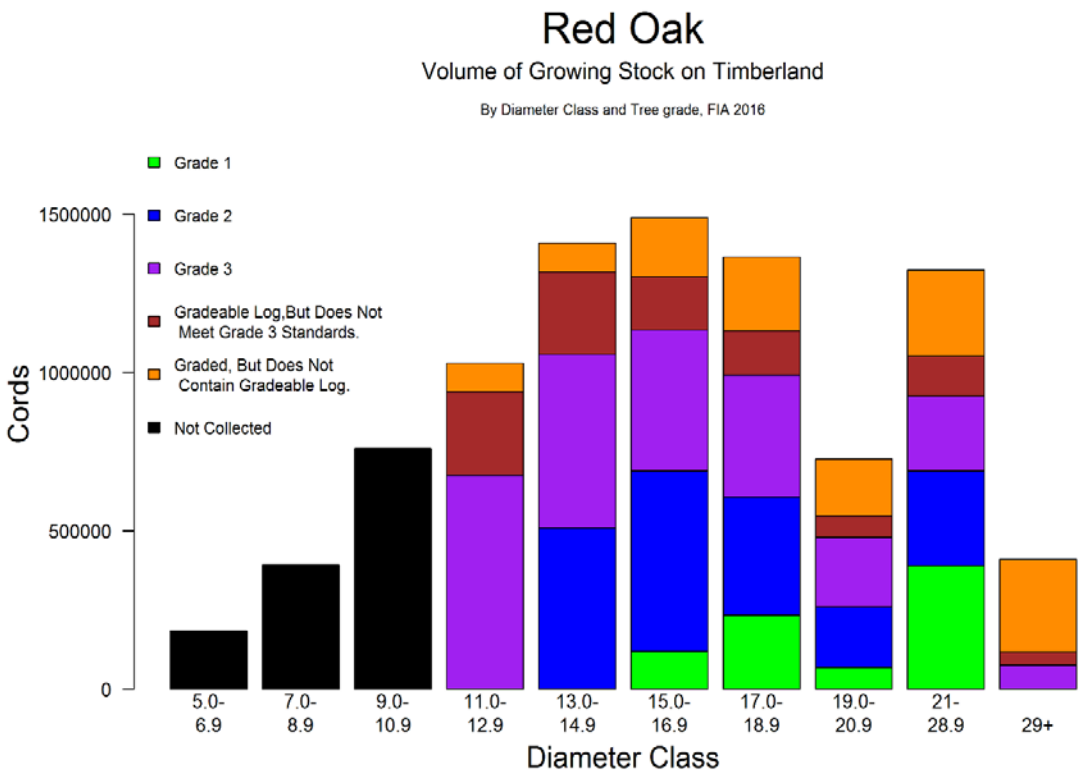
- High quality red oak sawlog resource continues to decline.
- Gypsy moth is making its way slowly into Minnesota. It will increase the mortality rate of the oak resource where forests are primarily comprised of oak and are on shallow or sandy soils. We are still many years away from this initial impact.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



Source: 2016 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 volume species 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 2016 FIA data, estimated net annual oak growth: 626,032 cords; estimated annual oak mortality: 300,368 cords. Some high quality sawlog and veneer red oak is grown on good sites in Minnesota. Oak is generally well distributed, but high value red oak is primarily found around central and southern Minnesota. White oak occurs in only a few areas of south eastern Minnesota.

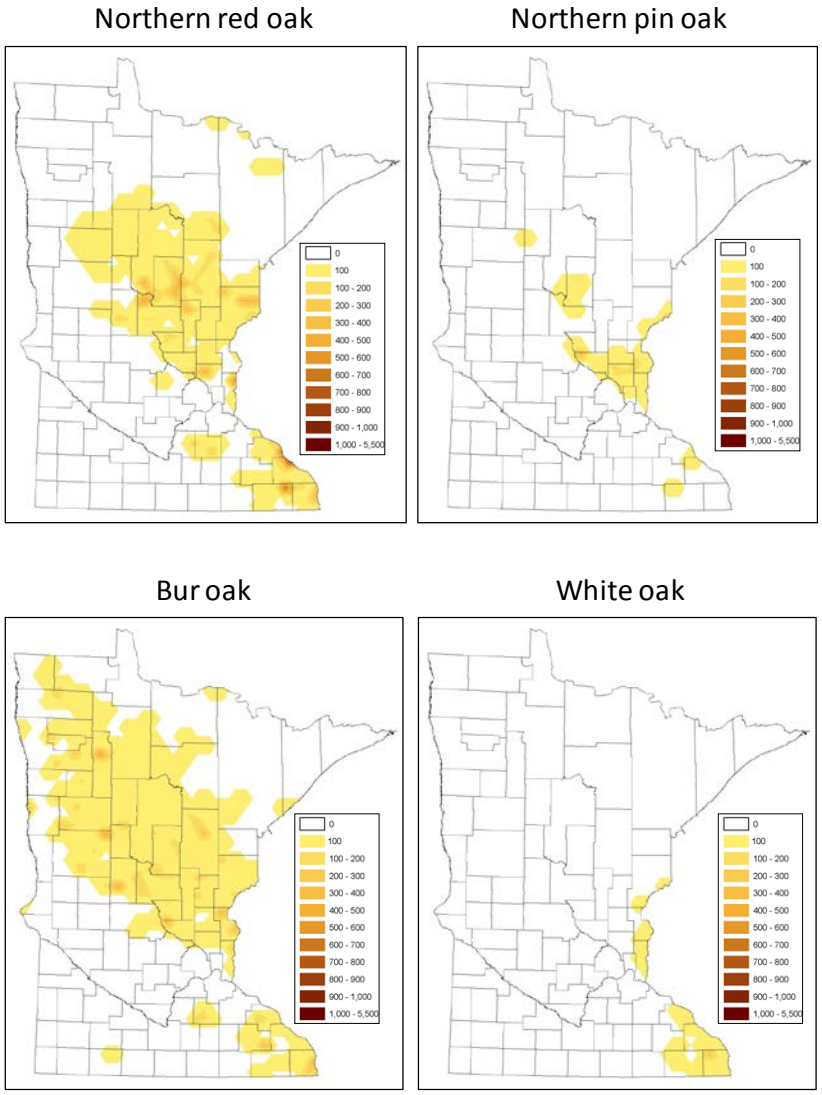


Source: 2016 FIA database provided by USFS, Northern Research Station (includes black oak, northern pin oak, and northern red oak).
Note: Tree grade 1 = highest quality in the USFS tree grading system

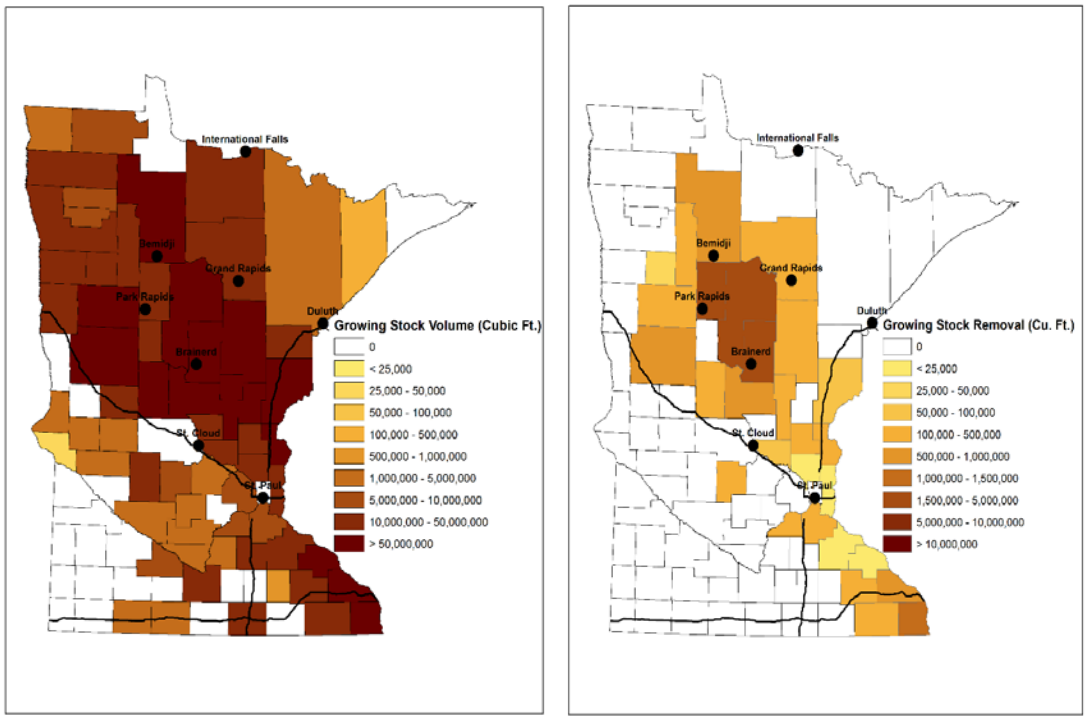
The table below shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top DOB) by percent of basal area per acre that is Oak ON FIA PLOTS. This table shows that an Oak forest type can differ significantly and provides some idea of what other species can 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 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.



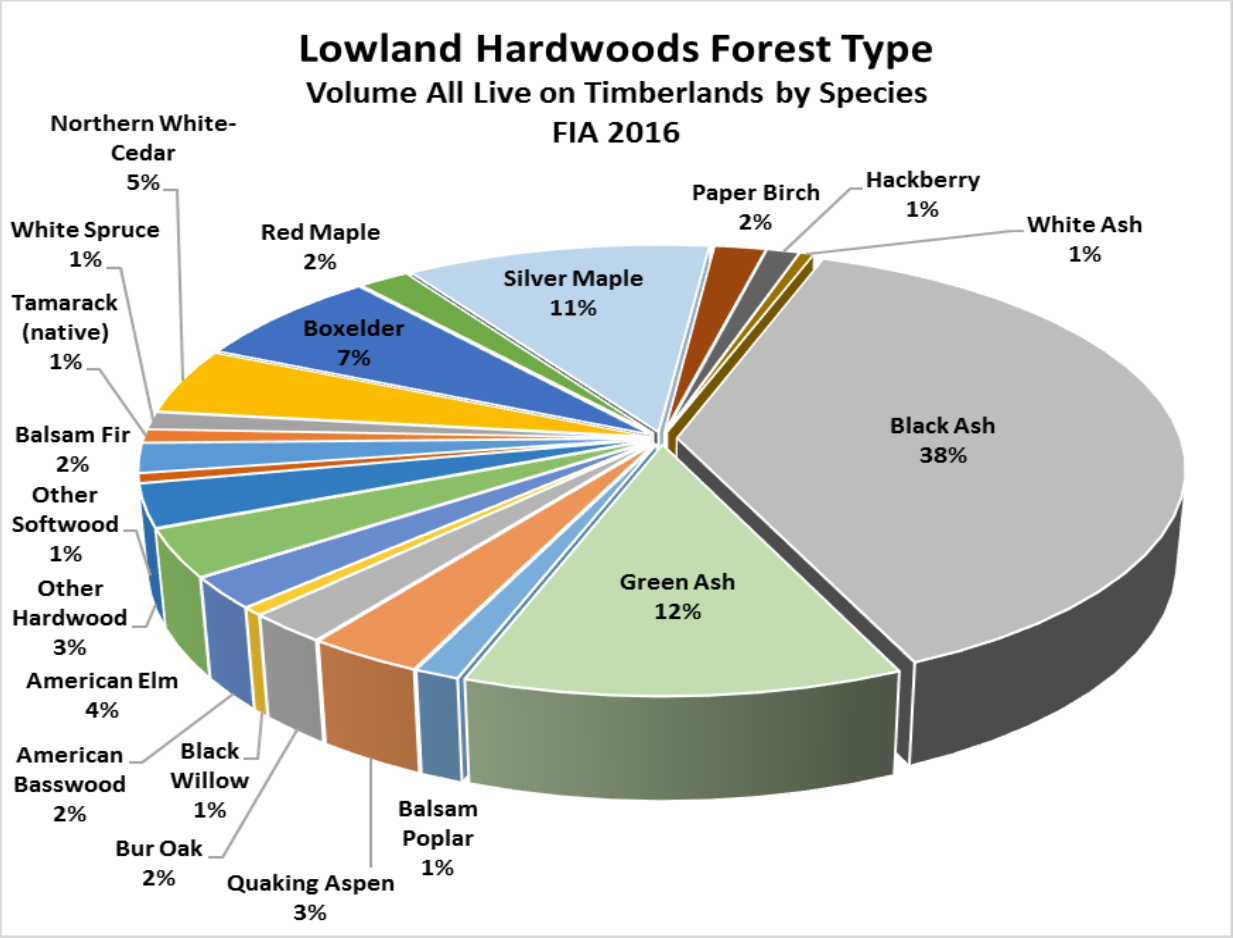
Source: 2010 FIA database provided by USFS, Northern Research Station



Growing stock (left) and growing stock removal (right) volumes on timberland for Oak forest type by county.

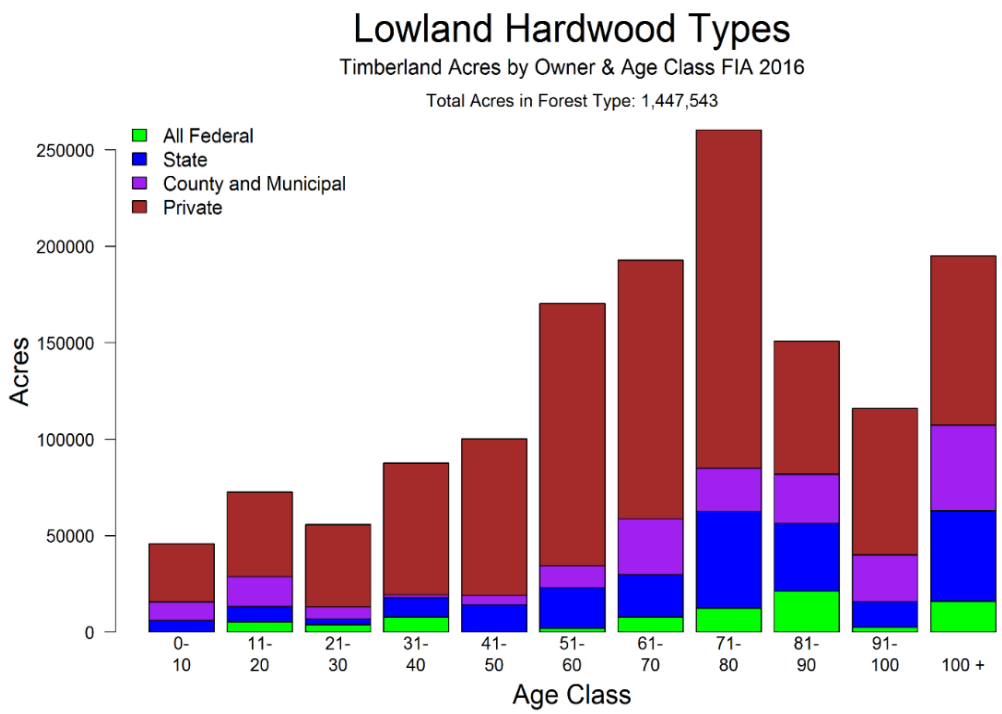
Source: FIA database 2016

Minnesota's Lowland Hardwoods Resource



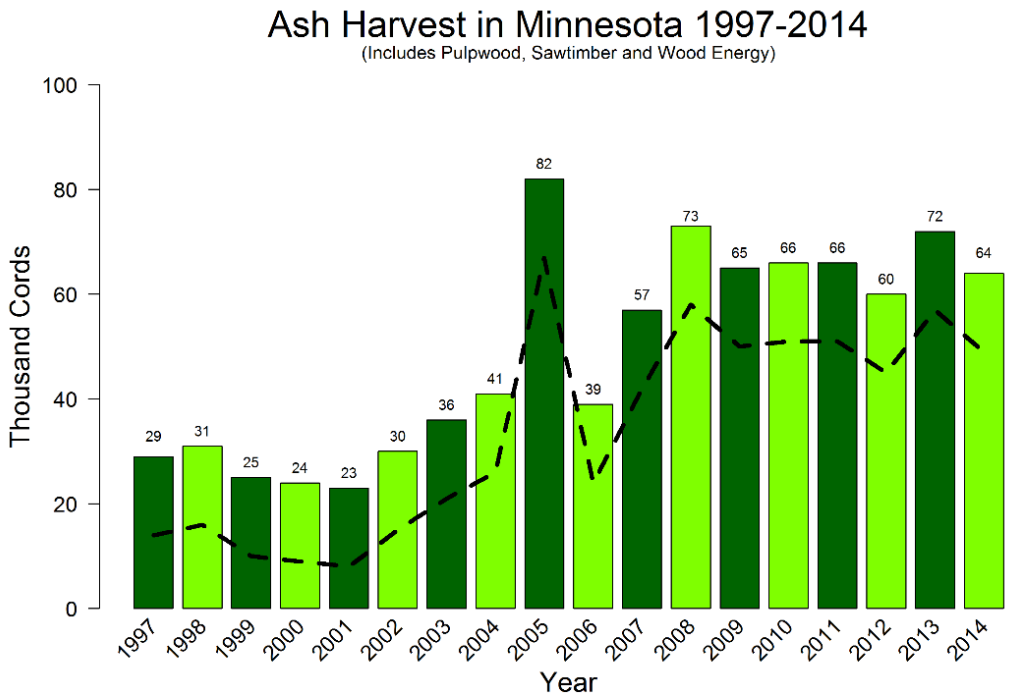
Source: 2016 FIA database provided by USFS, Northern Research Station.

The lowland hardwoods cover type is made up of a variety of species. Most prevalent are black ash, green ash, silver maple, and boxelder. Northern white cedar is the most common softwood. Most stands are only harvest accessible in the winter. The lowland hardwood cover type is dominated by late "middle age" stands. A common rotation age for black ash is 90 years. This cover type will change dramatically in the coming decades depending on the severity of the emerald ash borer infestation.



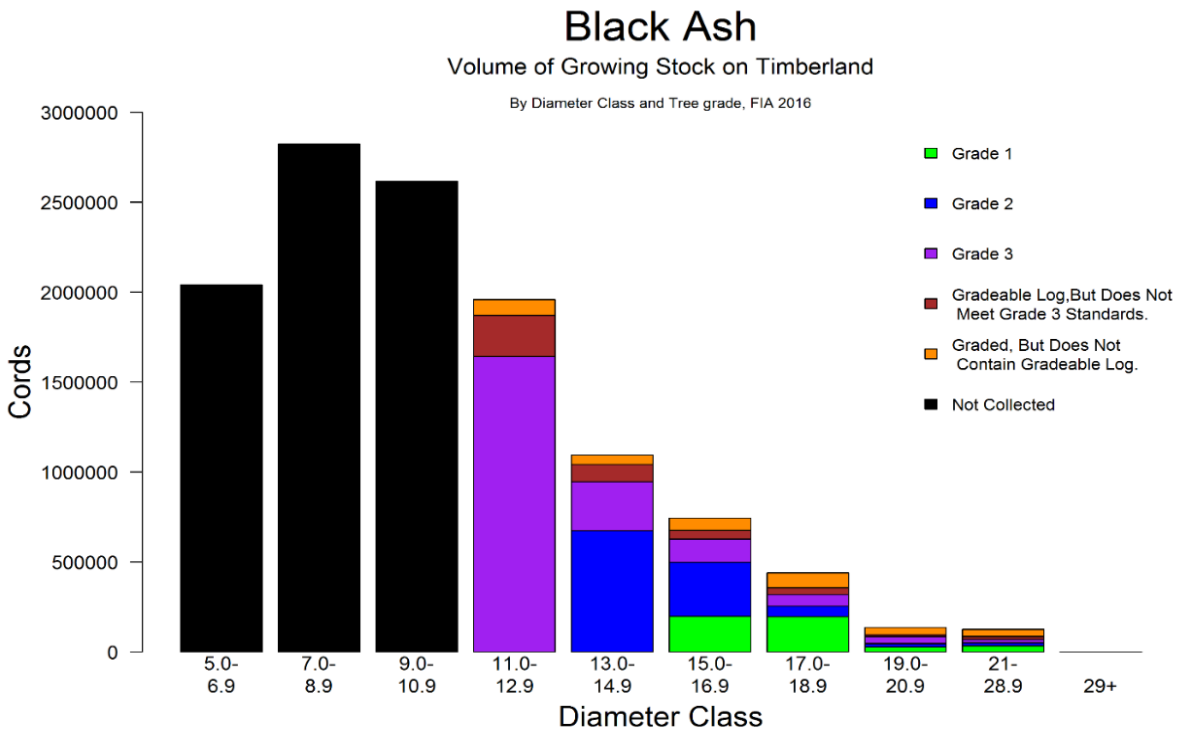
Source: 2016 FIA database provided by USFS, Northern Research Station

Minnesota's Ash Resource



Source: Harvest data compiled by USFS, Northern Research Station & DNR. Dashed line represents the trend.

Ash has not historically had a consistent pulpwood market although several mills have increased the use of ash in recent years. DNR estimated long-term annual sustainable harvest level for ash = 353,600 cords. Based on 2016 FIA data, estimated net annual ash growth: 427,122 cords; estimated annual mortality: 126,487 cords.



Source: 2016 FIA database provided by USFS, Northern Research Station
Note: Tree grade 1 = highest quality in the USFS tree grading system

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

2014 Harvest……..... **64,842**

- Minnesota Pulpwood Industries…….. 20,141
- Pulpwood Export (To Wisconsin)…...……...…….. 5,261
- Sawlogs & Other (including fuel)…….……...39,440

Source: NRS & DNR Surveys.

Resource Opportunities

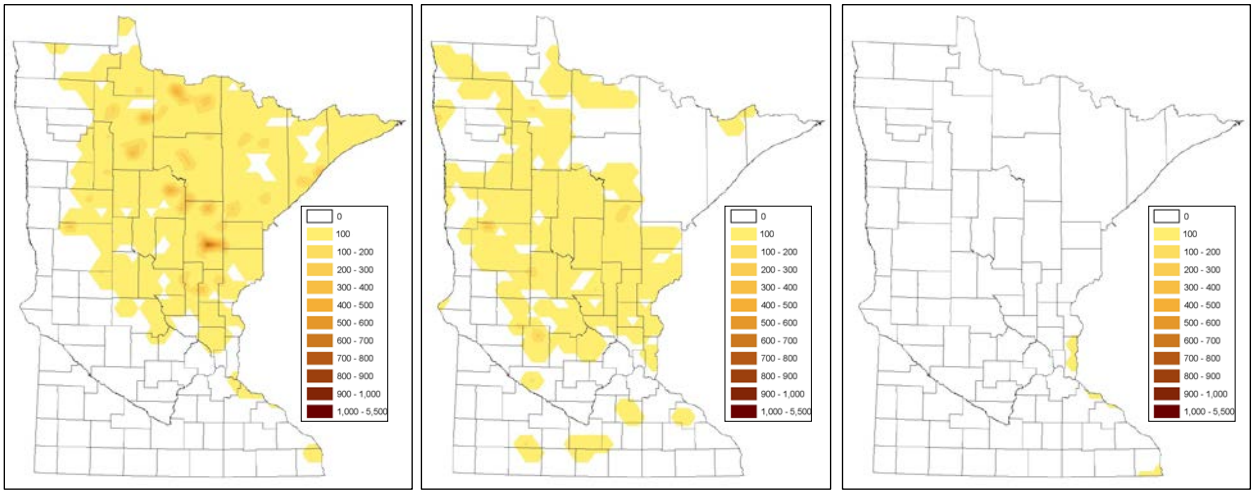
- Harvest is well below long-term sustainable levels .In 2014 harvest was approximately 288,000 cords below sustainable levels.
- Winter harvest season predominately.
- Before emerald ash borer moves in, it's the best time to log and merchandize ash.
- We are expecting significant mortality across the entire ash range indicating the supply of ash is expected to continue increasing in the early- to mid-term.

Resource Issues

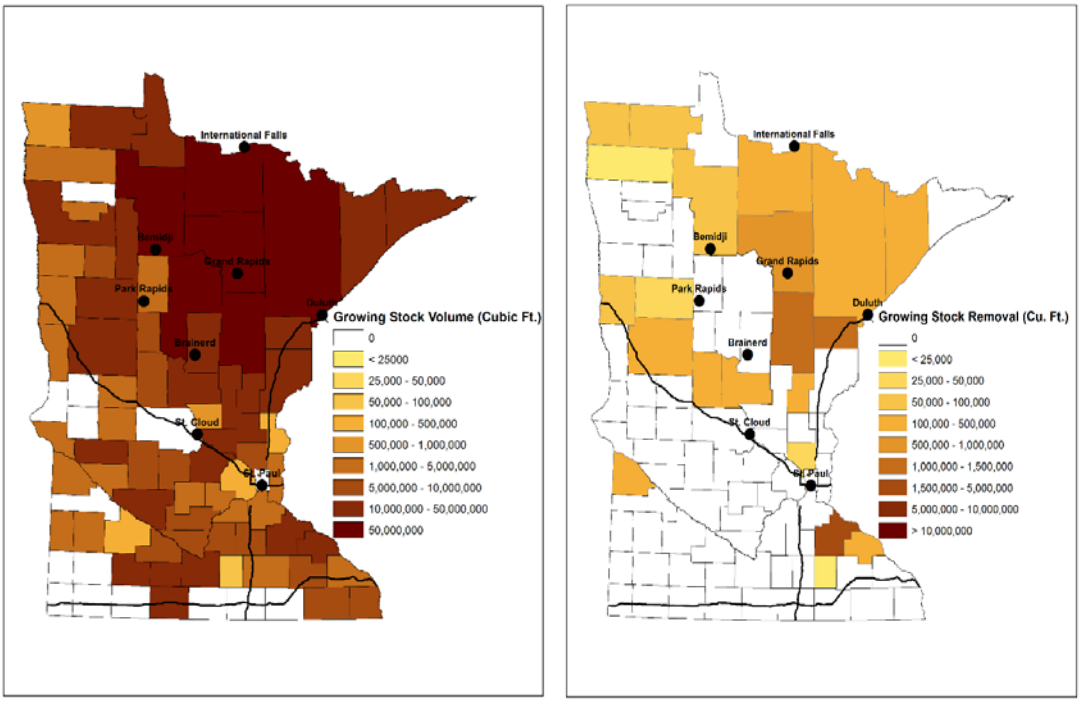
- Serious health concerns in black ash.
- Sorting high quality ash for highest value markets.
- Invasive emerald ash borer found in Minnesota.
- Several counties are under emerald ash borer quarantine. Loggers and mills should contact MN Department of Agriculture to obtain information about compliance 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, green ash, and white ash CUBIC FOOT volume 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 | Green ash | White ash



Source: 2010 FIA database provided by USFS, Northern Research Station

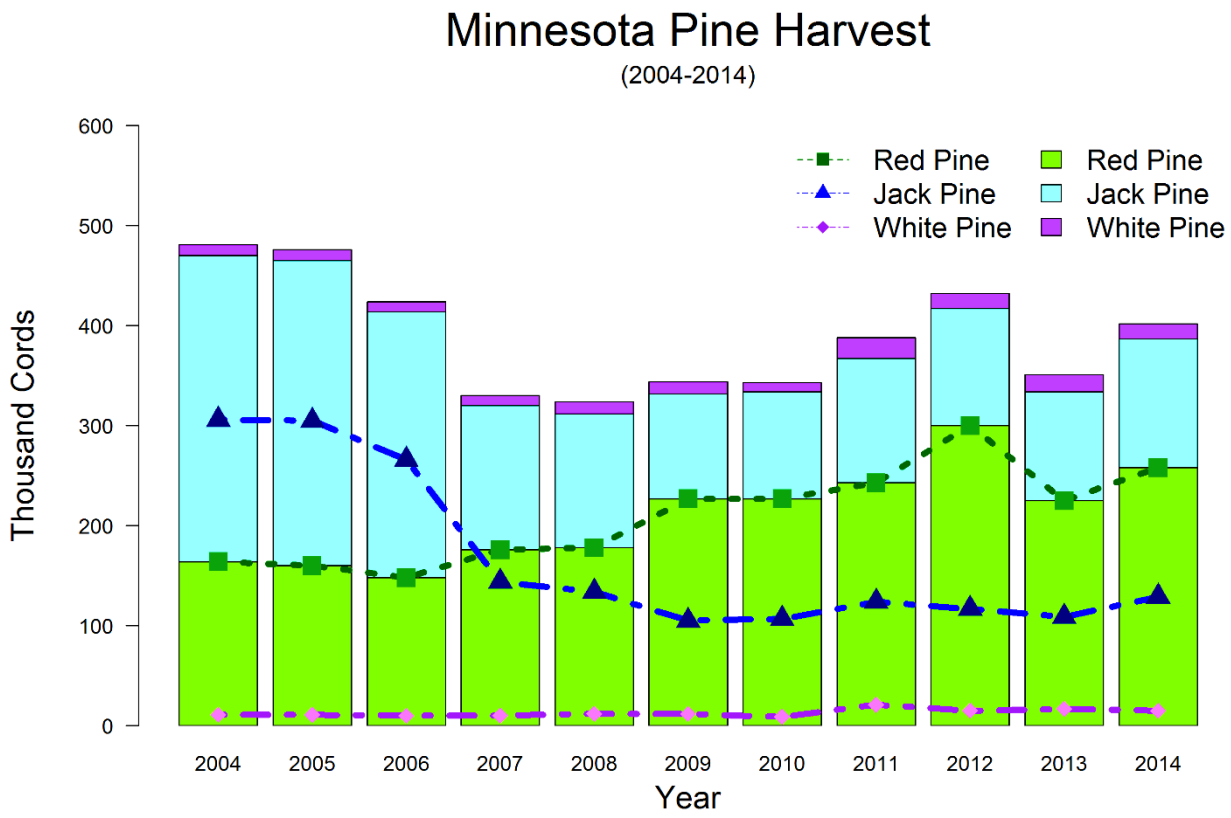


Growing stock (left) and growing stock removal (right) volumes on timberland for Lowland Hardwood forest type by county.

Source: FIA database 2016

Minnesota's Pine Resource

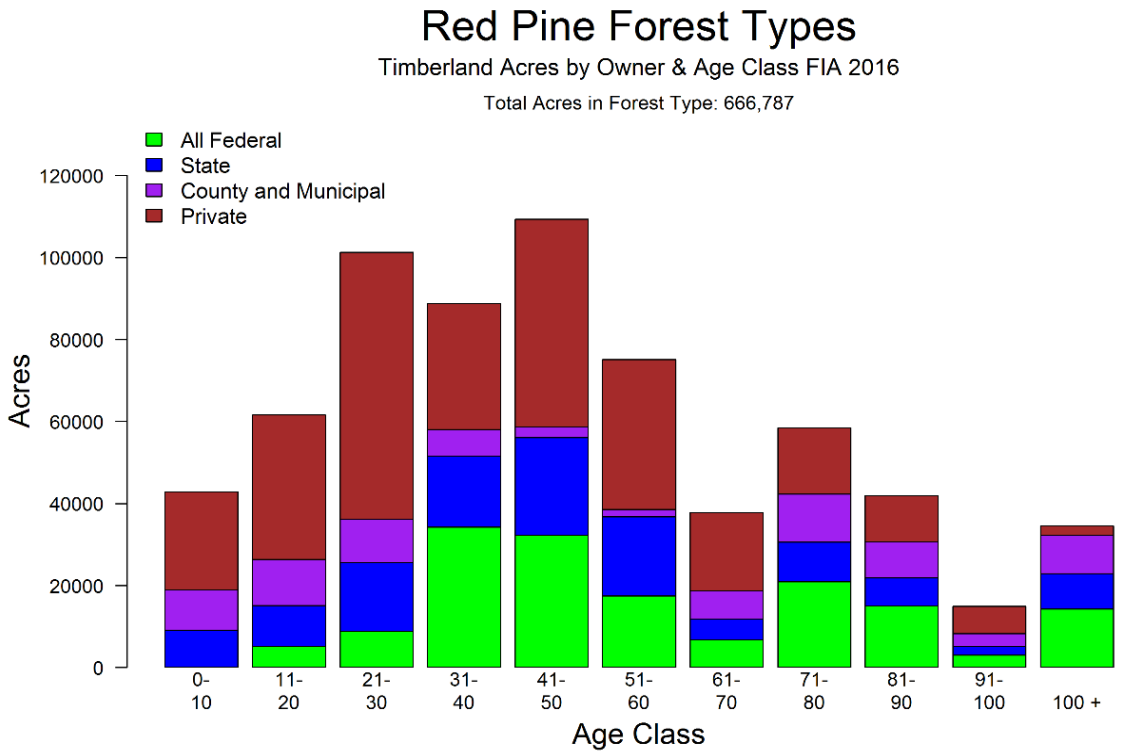
Minnesota has a substantial and regionally important pine resource, which is dominated by red pine, jack pine, and to a lesser extent white pine. Red pine in particular is a very important sawtimber species, which occurs primarily in northern Minnesota. Much of the pine resource (red and jack pine) is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



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 2004-2014.

Over the past decade white pine contribution to total harvest has remained relatively steady, while 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, decline in jack pine acres replanted and a general decline in operating mills. Red pine harvest increases have mainly been driven by demand for saw timber.

Red Pine



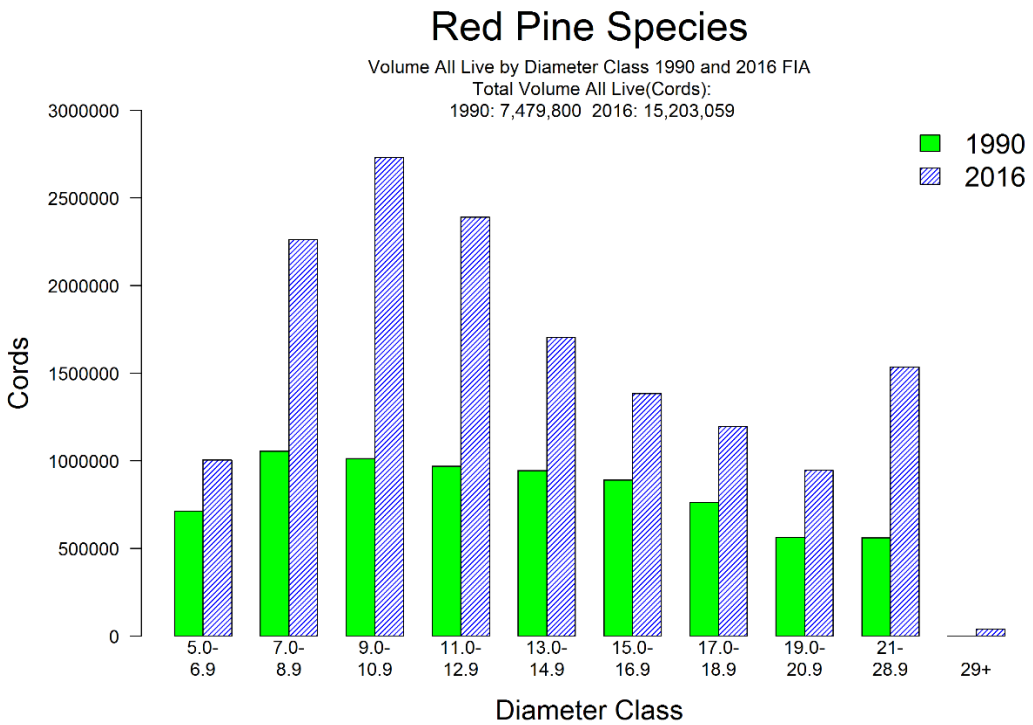
Source: 2016 FIA database provided by USFS, Northern Research Station

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.

Current Demand for Red Pine from Minnesota Timberlands

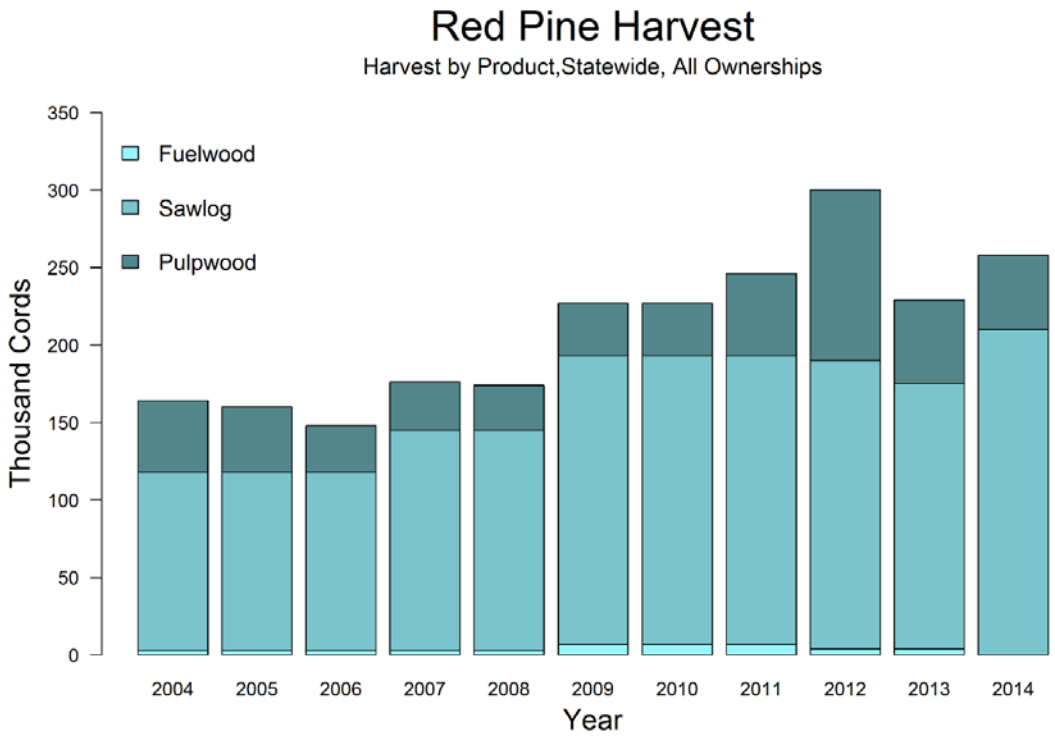
	Cords
2014 Harvest…….....	**262,970**
• Minnesota Pulpwood Industries……	35,692
• Pulpwood Export (To Wisconsin)…...……...……..12,494	
• Sawlogs & Other…….……....214,783	

Source: NRS & DNR Surveys.



Source: FIA database provided by USFS, Northern Research Station

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



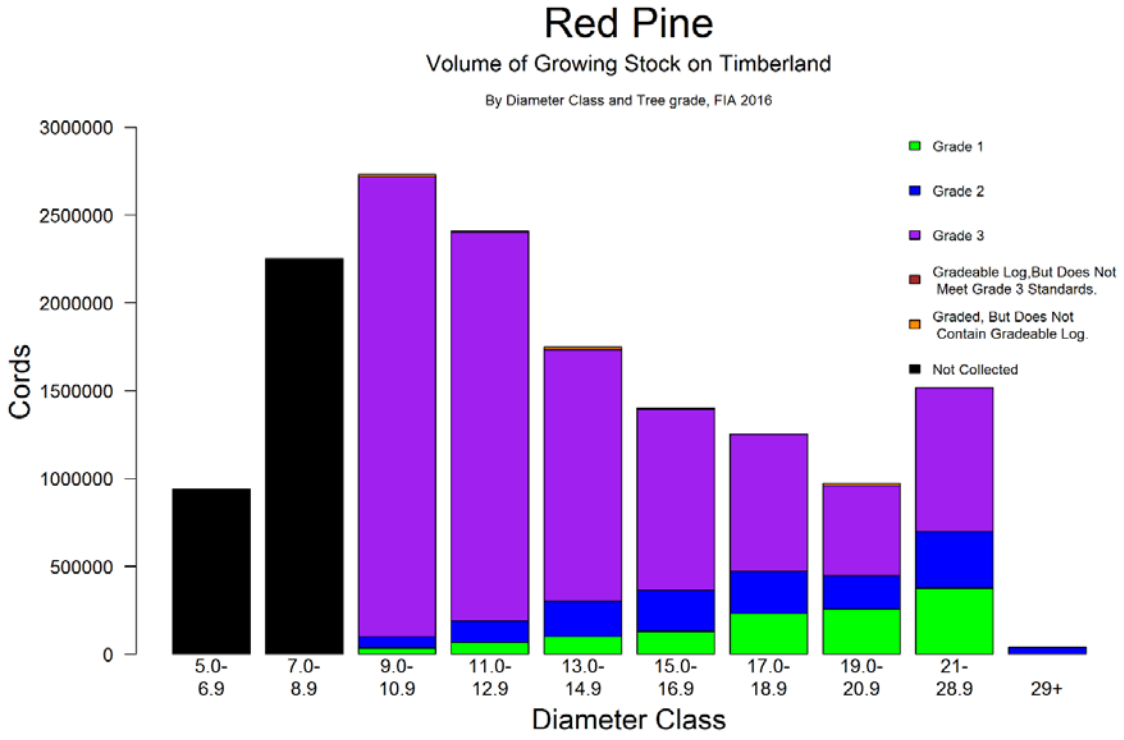
Source: Harvest data compiled by USFS, Northern Research Station & DNR

DNR estimated long-term annual all-ownership sustainable harvest level is approximately 345,000 cords*. Based on 2016 FIA data, average net annual growth of red pine growing stock: 599,053 cords; average annual mortality: 98,184 cords. Red Pine is being utilized much closer to sustainable levels compared to other species.

**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. In many cases a more aggressive thinning regime would benefit the cover type, particularly before crown crowding and self-pruning occurs.
- 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 two years after severe drought minimizing 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: 2016 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

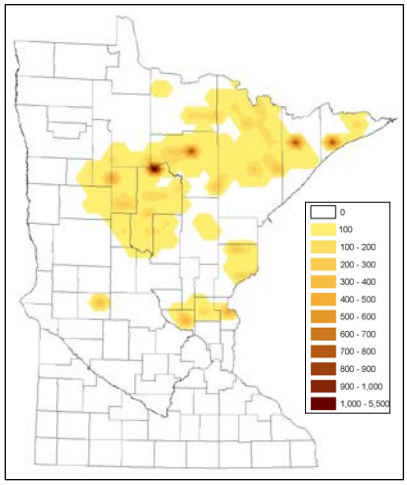
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	85,045	0.9	0	2.7	0.9	40.1	8	3.5	0.4	23.7	6.7	0	0	0.3	3	0.3	9.1
25-50%	75,373	1.8	0	3.2	0.8	5.1	49.9	9.7	0	15.5	7.7	0	0.3	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

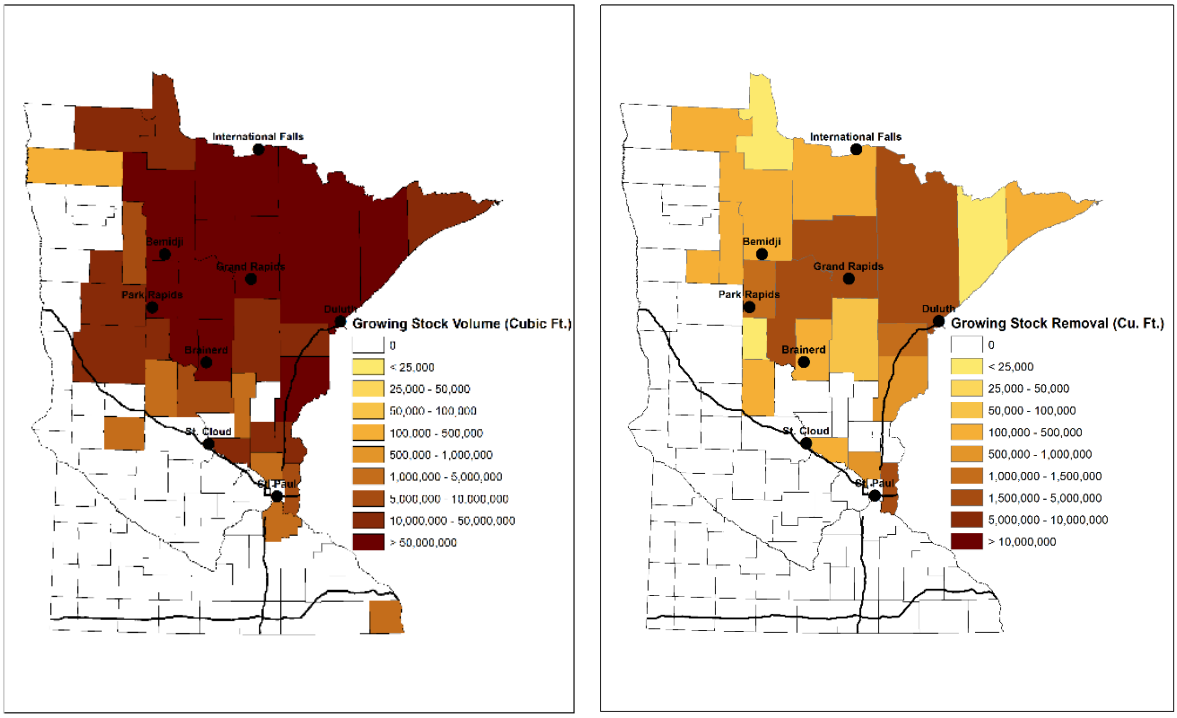
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	4,283	26.8	0	0	0	45.8	4.4	0	0	23	0	0	0	0	0	0	0
25-50%	22,563	2.6	0	0.4	1	1.1	52.3	7.4	0	14.2	7.3	0	0.6	0.2	8.6	0.1	1.8
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 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.

Red pine



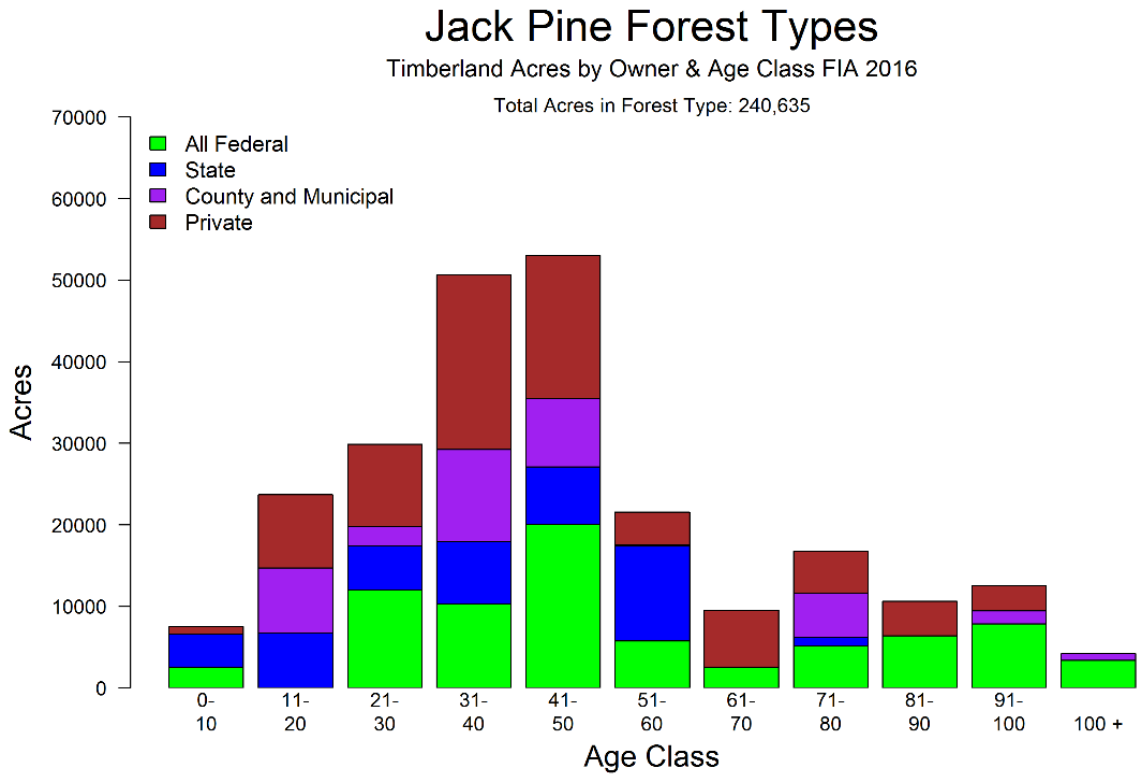
Source: 2010 FIA database provided by USFS, Northern Research Station



Growing stock (left) and growing stock removal (right) volumes on timberland for Red Pine forest type by county.

Source: FIA database 2016

Jack Pine



Source: 2016 FIA database provided by USFS, Northern Research Station

Current Demand for Jack Pine from Minnesota Timberlands

	Cords
2014 Harvest…….....	**129,589**
• Minnesota Pulpwood Industries……	68,073
• Pulpwood Export (To Wisconsin)…...……...……..	10,829
• Sawlogs & Other…….…….....	50,684

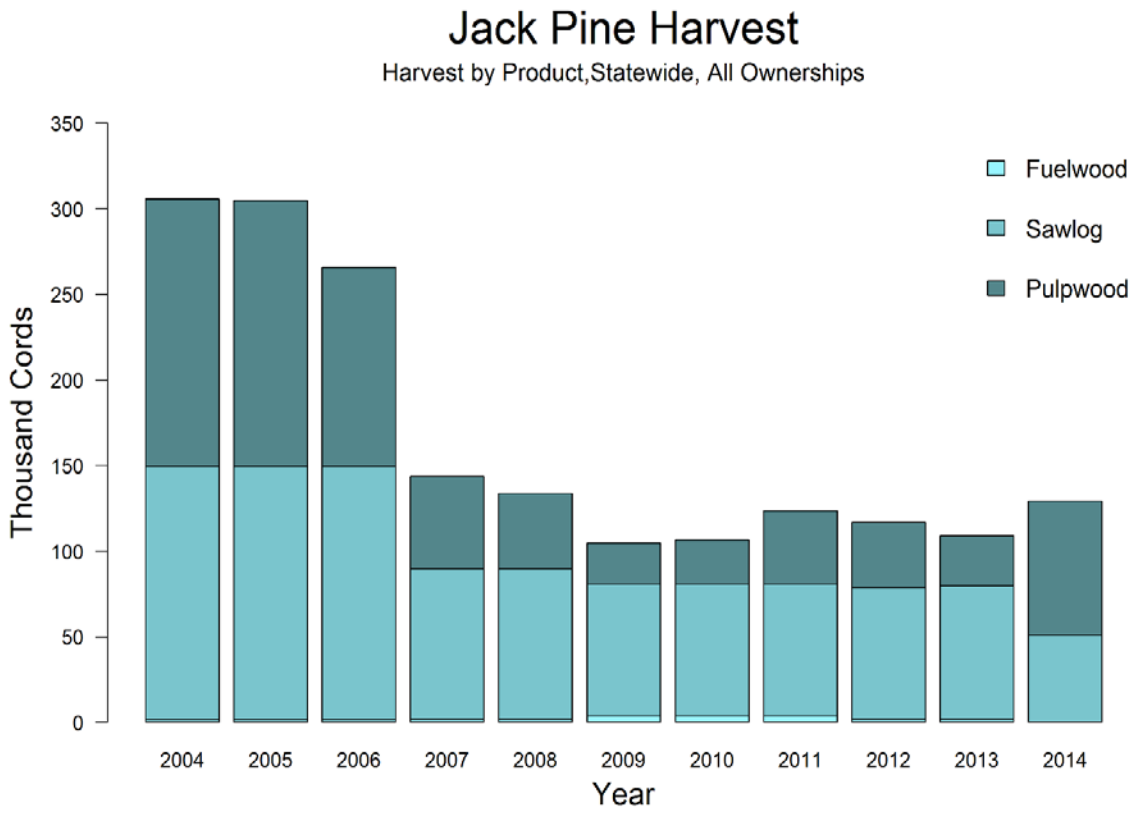
Source: NRS & DNR Surveys.

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

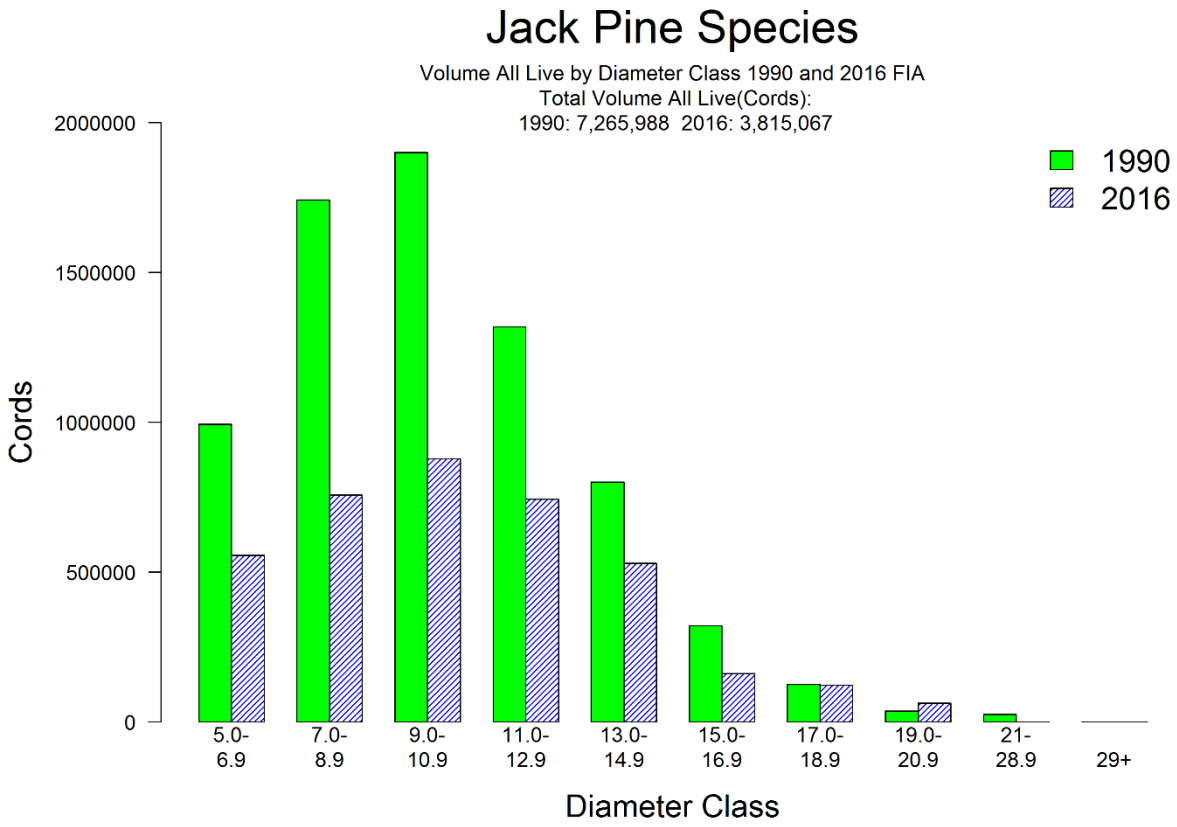
at the present time. Periodic jack pine budworm outbreaks occur in older stands, which can result in heavy mortality, and further increase risk of fire in this fire prone cover type.

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 and has made additional jack pine volume available.

Based on 2016 USFS FIA data, average net annual growth of jack pine growing stock: 67,369 cords; average annual mortality of jack pine growing stock: 48,165 cords.



Source: Harvest data (2004-2014) compiled by USFS, Northern Research Station & DNR



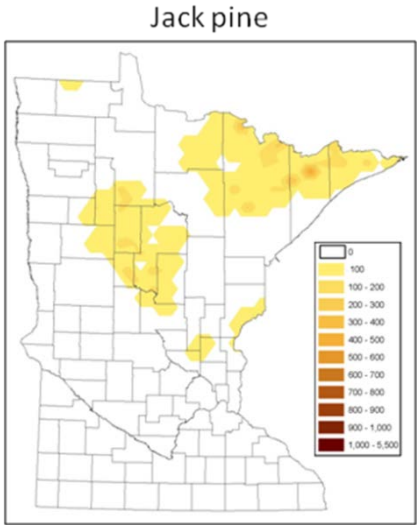
Source: FIA database provided by USFS, Northern Research Station

Jack pine total volume of all live has declined from 7,266,000 cords in 1990 to 3,815,067 cords in 2016 – a 47% decrease. The vast majority of jack pine volume is found in trees with diameters smaller than 15 inches.

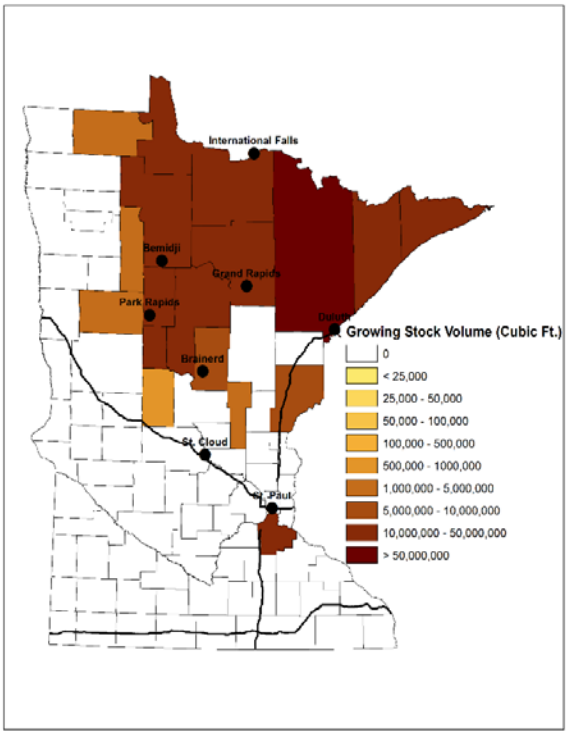
The table below shows AVERAGE percent species compositions by merchantable volume (5 inch dbh and greater to a 4 inch top DOB) by percent of basal area per acre that is Jack Pine ON FIA PLOTS. This table shows that a Jack pine forest type can differ significantly and provides some idea of what other 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.

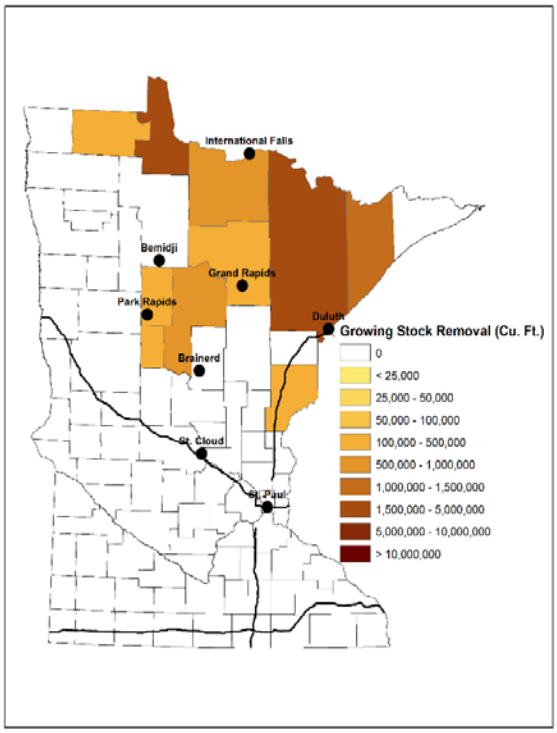
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	12,046	8	0	0	0	8.2	24.9	6.6	0	24.8	2.2	0.1	0	0	0	0	24.5
25-50%	65,913	9.1	0	3.5	12.6	43.3	11.8	3.2	0	8.9	5.2	0.8	0	0	0.6	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 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: 2010 FIA database provided by USFS, Northern Research Station

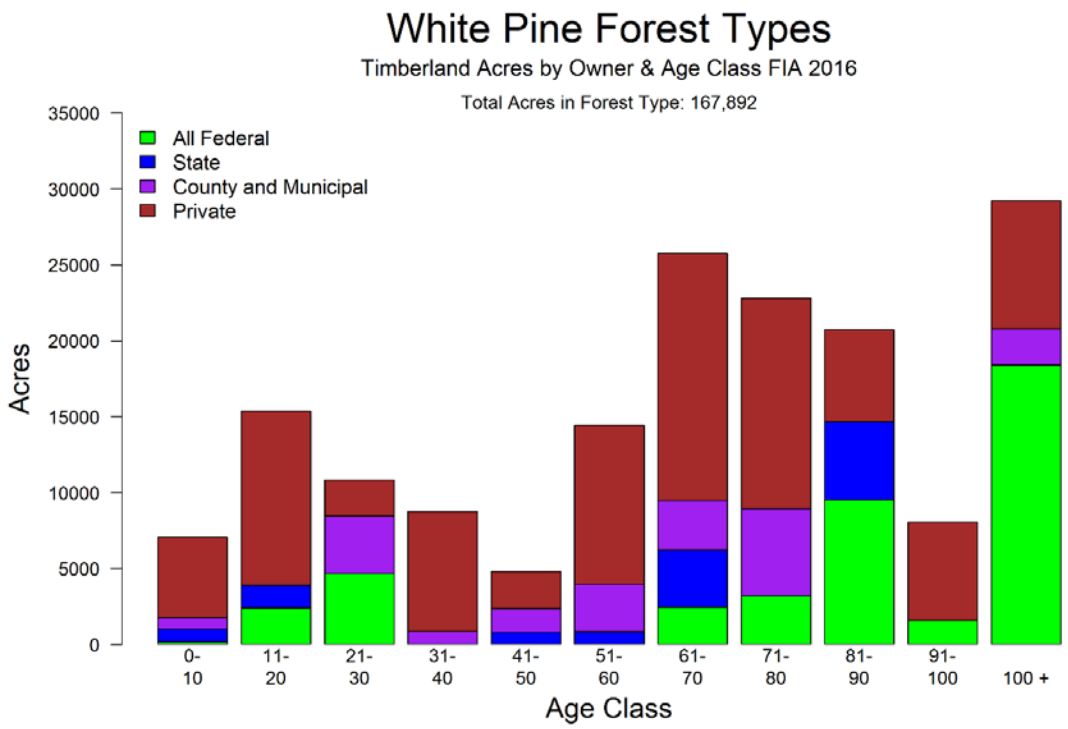




Growing stock (left) and growing stock removal (right) volumes on timberland for Jack Pine forest type by county.

Source: FIA database 2016

White Pine



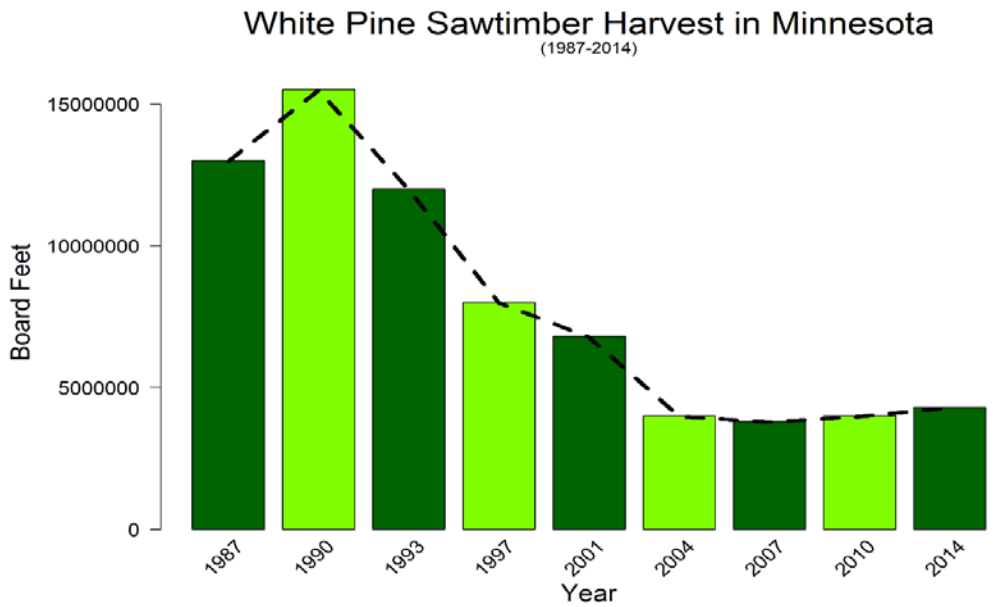
Source: 2016 FIA database provided by USFS, Northern Research Station

Current Demand for White Pine from Minnesota Timberlands

	Cords
2014 Harvest…….....	**15,023**
• Minnesota Pulpwood Industries…….	3,654
• Pulpwood Export (To Wisconsin)…...……...……...	1,668
• Sawlogs & Other…….…….....	9,701

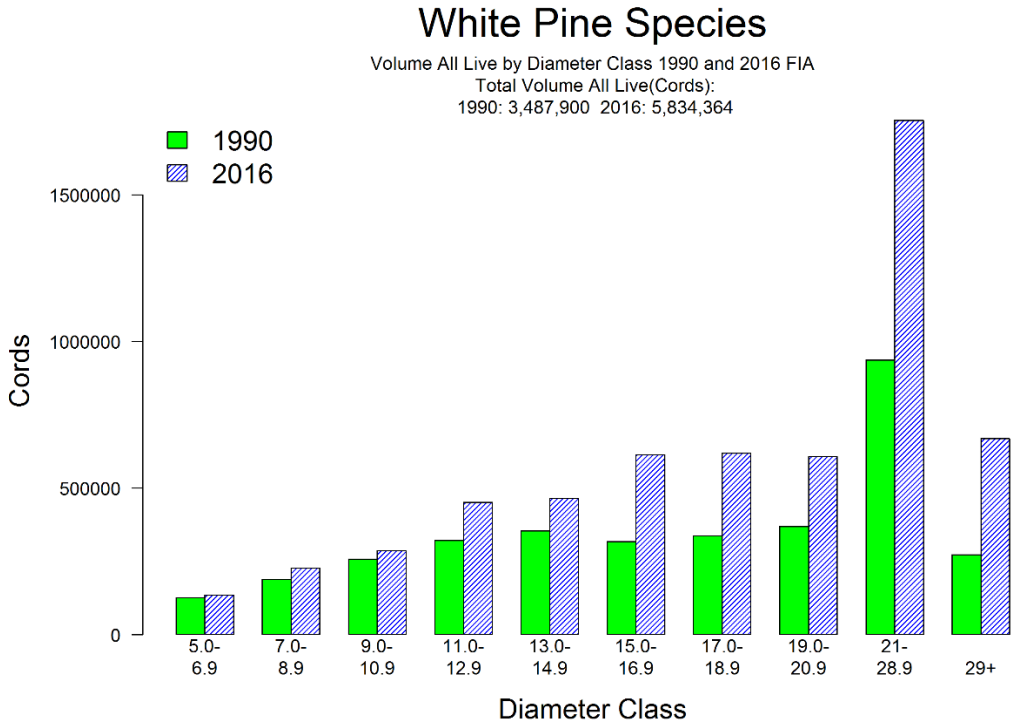
Source: NRS & DNR Surveys.

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.

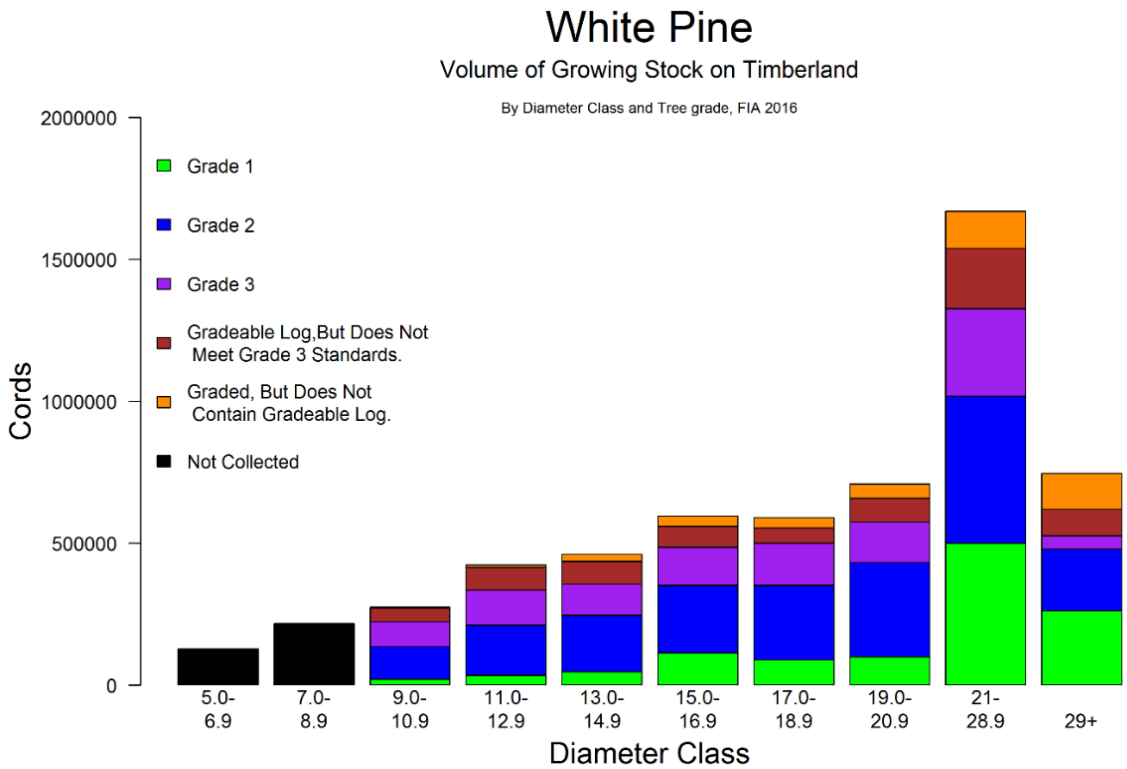


Source: MN DNR sawmill surveys, Dashed line represents the trend

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 2016 FIA data, average net annual growth of white pine growing stock: 183,518 cords; average annual mortality: 29,859 cords. While the inventory has increased the harvest of white pine for sawtimber has decreased.



Source: FIA database provided by USFS, Northern Research Station



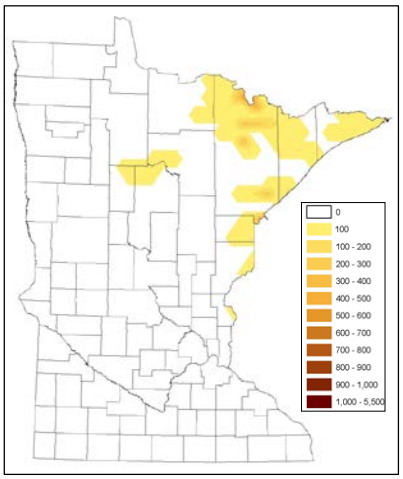
Source: 2016 FIA database provided by USFS, Northern Research Station
Note: Tree grade 1 = highest quality in the USFS tree grading system

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.

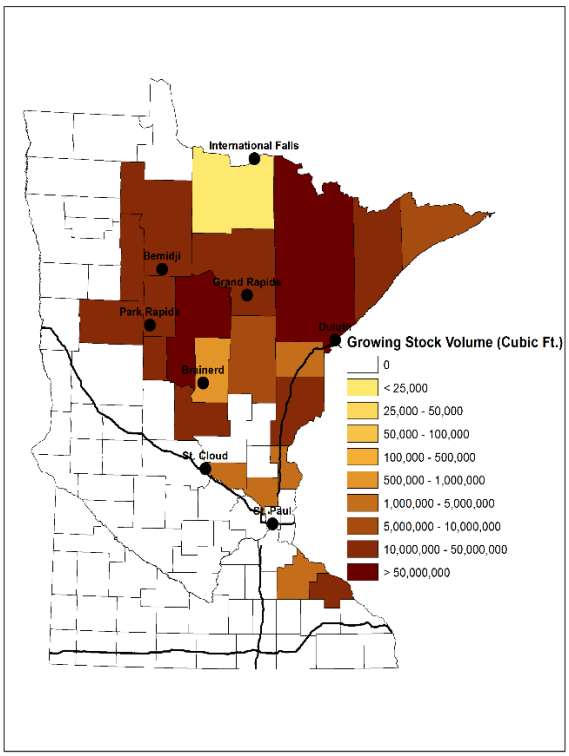
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	10,781	7.2	0	8.9	0	0.3	24.5	20.1	0	3.9	4.8	0.9	0	0.2	3.5	4.2	21.3
25-50%	72,059	1.3	0.5	1.7	1.4	5.8	11.4	47.6	0	11.4	4.9	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

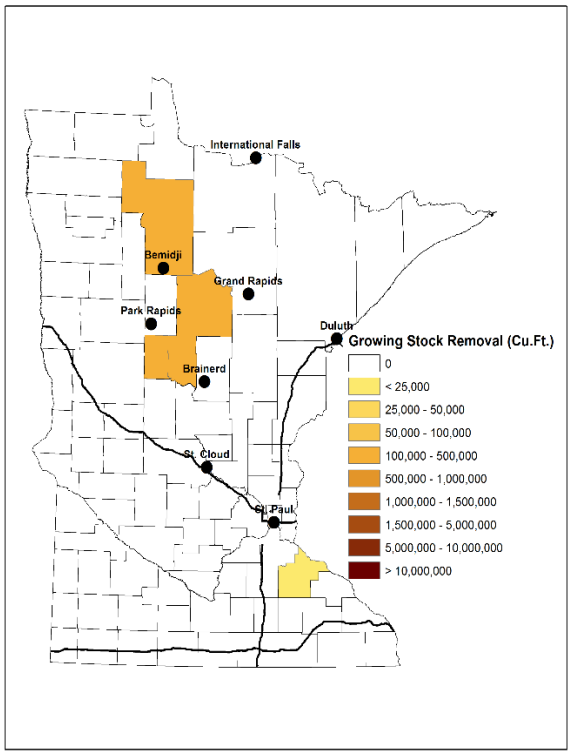
Predicted spatial distribution of eastern white pine CUBIC FOOT volume of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual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

Eastern white pine



Source: 2010 FIA database provided by USFS, Northern Research Station



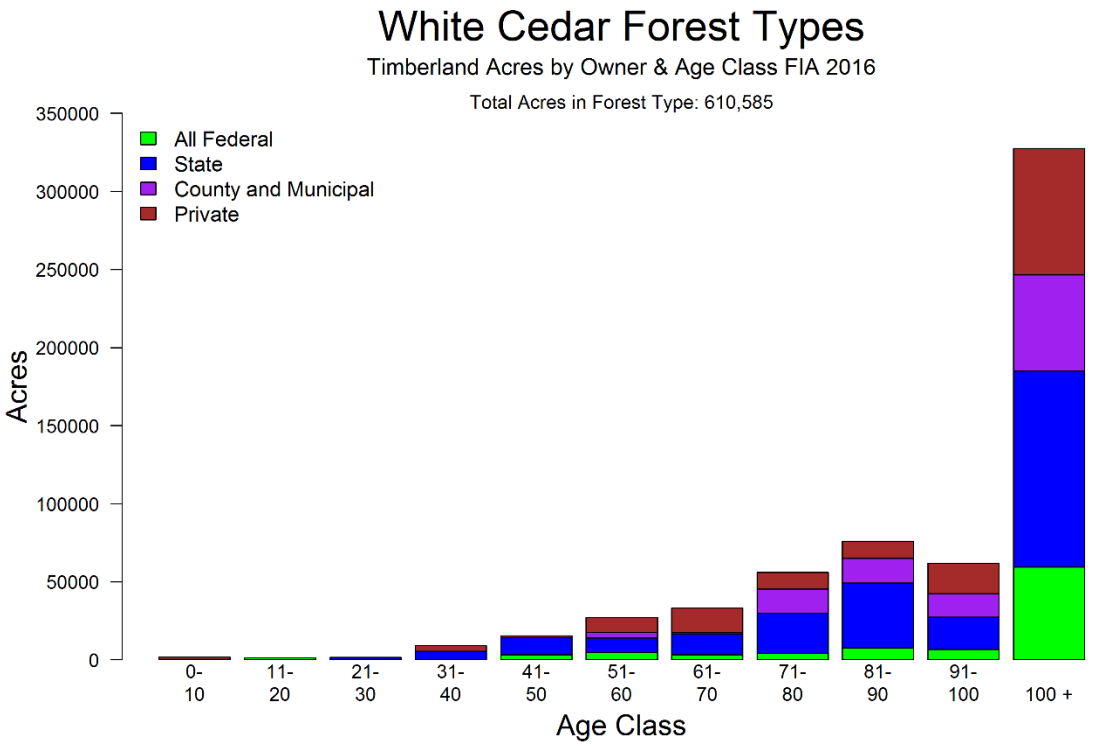


Growing stock (left) and growing stock removal (right) volumes on timberland for White Pine forest type by county.

Source: FIA database 2016

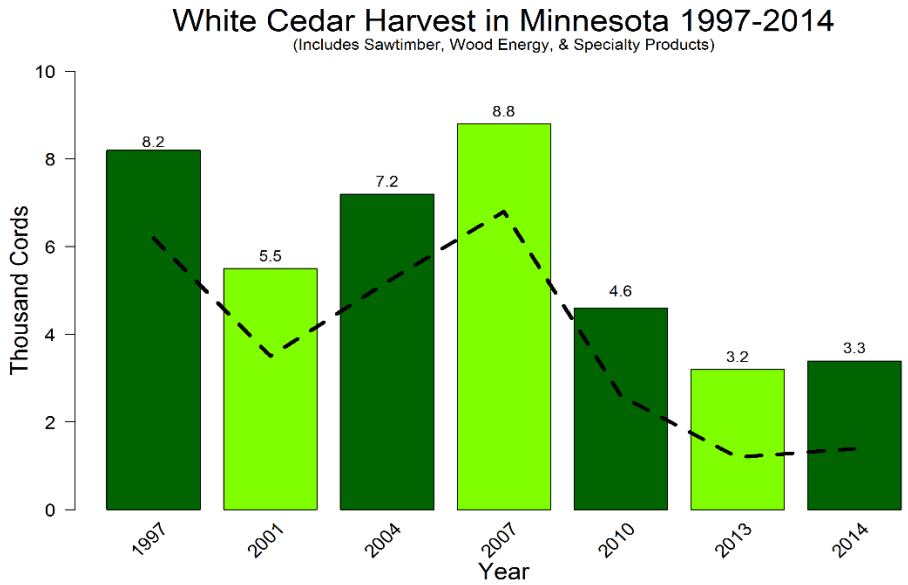
Minnesota's White Cedar Resource

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 is a potentially valuable timber resource which is greatly underutilized compared to the amount of acres available.



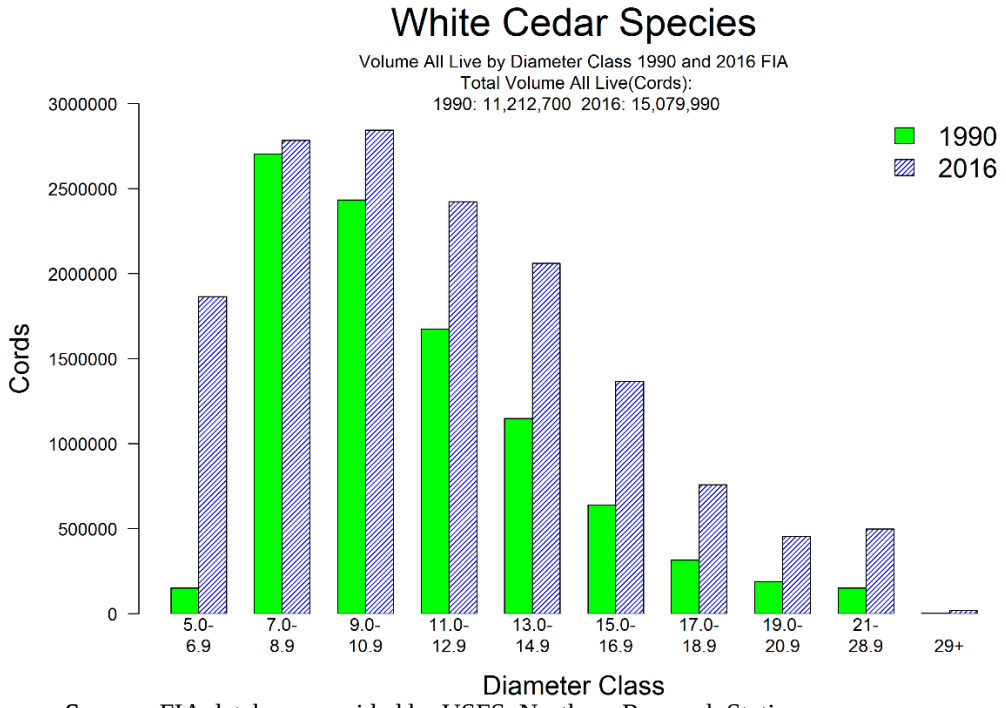
Source: 2016 FIA database provided by USFS, Northern Research Station

White cedar is generally an old resource, and it is getting older: around 327,000 cover type acres exist in stands over age 100, an increase from the 304,000 cover type acres over age 100 in 2014. Currently around 4,600 cover type acres are below age 30, it was 7,300 cover type acres below age 30 in 2014. Much of the white cedar resource exists on very wet sites, many of which have low productivity and slow growth, and are likely only accessible for harvest in the winter. 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: Harvest data compiled by USFS, Northern Research Station & DNR. Dashed line represents the trend.

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 177,694 cords, and average annual mortality is approximately 77,451 cords, according to the 2016 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: FIA database provided by USFS, Northern Research Station

Current Demand for White Cedar from Minnesota Timberlands

Cords

2014 Harvest……..... **3,395**

- Minnesota Pulpwood Industries…… 0
- Pulpwood Export (To Wisconsin)…...……...……..... 0
- Sawlogs & Other…….……..... 3,395

Source: NRS & DNR Surveys.

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.
- Lots of potential harvest acres available.
- There is tremendous resource potential as white cedar is utilized well below annual net growth.

Resource Issues

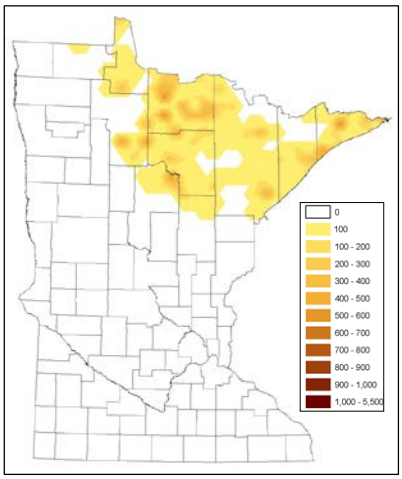
- White cedar has been somewhat of a "neglected" resource for many years. Probably the single biggest reason for this is an inability to consistently regenerate it on many sites. Cedar is in need of greater research efforts in regeneration techniques.
- Use of white cedar for industrial products is very 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.

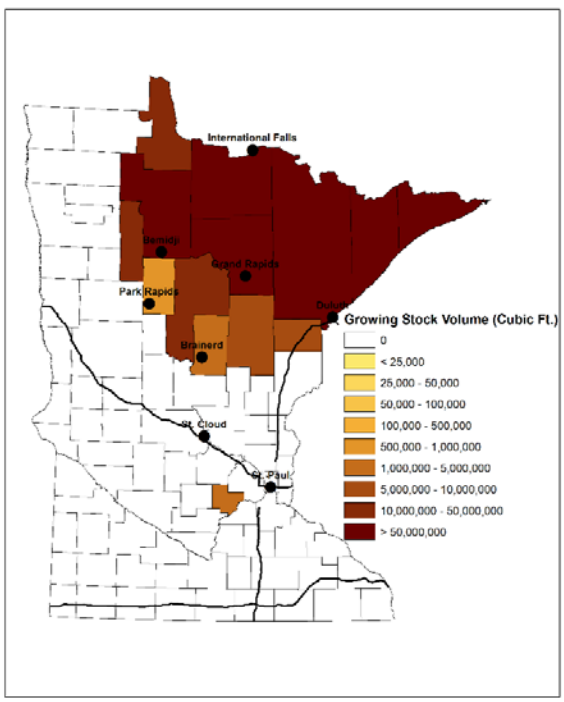
Percent of BAA	Acres	Balsam Fir	Tamarack	White Spruce	Black Spruce	Jack Pine	Red Pine	Eastern White Pine	White Cedar	Aspen	Paper Birch	Balm	Basswood	American Elm	Maple	Ash	Oak
< 25%	3,361	7	0	0	0	0	0	0	11.9	42.2	0	7.8	0	25.3	0	5.8	0
25-50%	82,759	6.6	10.3	1.9	11.2	0	0	1.9	46.2	4.6	10.1	1.7	0	0	1.2	2.7	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

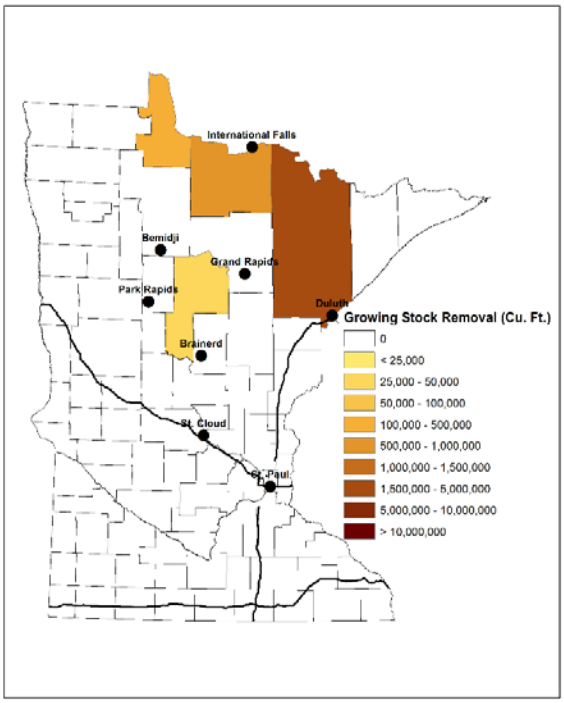
Predicted spatial distribution of northern white cedar CUBIC FOOT volume of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual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

Northern white cedar



Source: 2010 FIA database provided by USFS, Northern Research Station





Growing stock (left) and growing stock removal (right) volumes on timberland for Balsam Fir forest type by county.

Source: FIA database 2016

Timber Price Information

Average Prices Received by Product for Stumpage Sold by Public Land Agencies in Minnesota: 2006-2016

Average Prices Received for Stumpage Sold
by Public Land Agencies in Minnesota: 2006-2016

Notes:

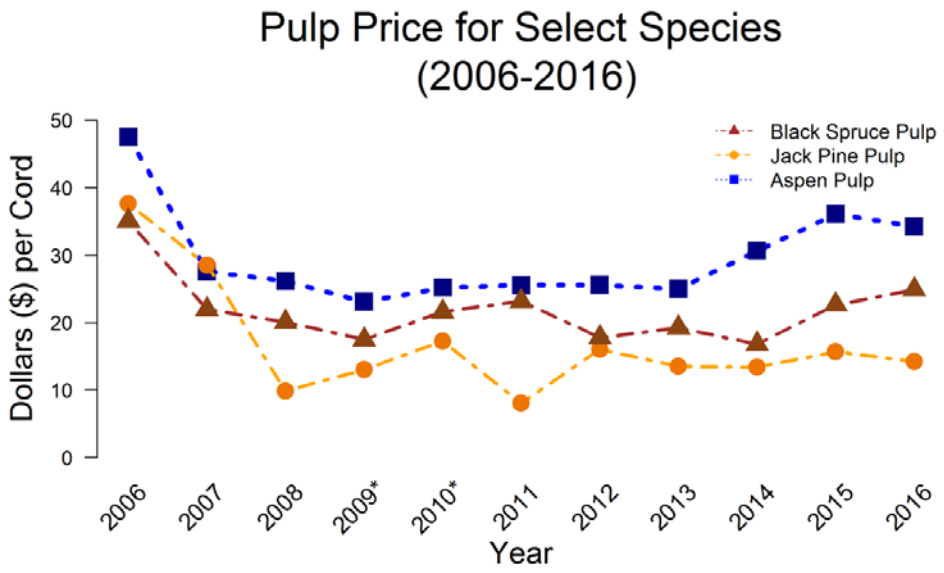
- Average prices based on those reported by Minnesota Counties (Aitkin, Becker, Beltrami, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Itasca, Koochiching, Lake, Pine, St. Louis, and Wadena), USDA Chippewa and Superior National Forests, USDI Bureau of Indian Affairs, and Minnesota DNR- Division of Forestry. Agency specific prices are available on the DNR website, in the annual "Minnesota Public Stumpage Price Review" at http://www.dnr.state.mn.us/forestry/timbersales/stumpage.html
- 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.
- The reported sales data includes numerous different products and units of measure. Conversion factors used: 500 BF/ Cd for hardwoods, 400 BF/ Cd for softwoods.
- Use caution when comparing prices shown in these tables with actual prices received or expected on any specific timber sale. For recent timber stumpage prices, readers can go to the DNR website and view recent auction results at http://www.dnr.state.mn.us/forestry/timbersales/index.html.

Table 1. Pulpwood ($ per cord)

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Aspen	47.52	27.52	26.14	23.07	25.16	25.55	25.58	24.99	30.62	36.08	34.26
Balm	38.85	23.70	21.18	20.83	21.22	20.01	22.77	20.56	24.8	27.68	24.29
Birch	14.76	9.68	9.06	9.17	8.48	9.41	9.31	8.44	9.89	12.02	13.77
Ash	8.22	7.65	6.86	8.73	6.97	7.41	6.26	6.62	6.82	6.00	8.07
Oak	18.27	16.23	8.39	15.32	13.41	11.29	11.69	15.44	13.10	14.63	17.00
Basswood	8.06	10.98	7.41	8.10	7.50	7.58	6.61	9.16	8.82	12.51	8.26
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
Balsam Fir	30.59	18.36	15.98	14.67	16.10	17.91	14.19	9.86	10.62	14.18	14.76
W. Spruce	35.06*	21.94	18.69*	17.44*	21.58*	17.91	15.12	17.57	16.55	19.09	17.25
B. Spruce	35.06*	21.94	20.05			23.14	17.77	19.22	16.80	22.63	24.87
Tamarack	5.96	5.40	4.61	5.01	5.03	5.51	6.20	5.05	5.40	7.81	6.26
W. Cedar	9.26	9.35	4.10	5.44	6.19	8.21	5.12	7.86	5.30	6.41	6.80
Jack Pine	37.62	28.5	9.87	13.02	17.21	8.06	16.03	13.50	13.41	15.66	14.20
Red Pine	35.59	27.15	11.99	16.22	9.08	19.25	10.27	15.50	12.44	18.59	11.84
White Pine	35.59	27.15	11.99	-	-	5.37	10.81	13.01	16.56	12.78	15.91
Maple	7.98	7.91	8.86	8.06	9.21	8.99	8.18	9.91	9.82	10.13	12.31

* Spruce Species

- Insufficient data



Source: DNR public price stumpage reports

In 2016, across all species and as reported on public lands, a total of 84,641.6 tons of biomass was sold for bioenergy consumption with an average price of $0.81 per ton.

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

Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Aspen	45.58	28.44	37.63	36.79	-	-	-	-	36.16	44.24	46.49
Balm	34.73	17.00	-	-	-	-	-	-	-	-	66.80
Birch	17.70	10.99	16.30	13.01	14.48	15.54	14.24	15.17	15.31	17.98	18.11
Ash	12.98	6.21	20.96	10.10	17.41	18.23	18.39	15.81	11.59	14.66	12.55
Oak	25.47	20.85	22.12	21.25	21.49	19.95	20.45	22.20	23.62	27.01	31.71
Basswood	18.21	10.35	16.87	11.62	13.15	10.70	11.58	13.78	12.03	14.52	16.62
Mixed/Other Hardwoods	12.15	11.85	17.98	-	-	18.75	17.30	14.32	16.02	15.67	17.15
Balsam Fir	30.57	21.47	22.77	21.91	23.44	20.39	20.78	16.65	17.93	23.97	24.73
W. Spruce	31.38**	30.29	26.82	23.37**	26.54**	24.99	24.00	25.48	29.57	25.73	27.63
B. Spruce	31.38**	30.29	-			-	26.91	24.65	27.90	30.48	41.36
Tamarack	9.31	3.18	16.50	-	-	-	16.57	12.75	15.54	13.87	-
W. Cedar	13.48	6.39	13.98	11.65	-	-	-	-	13.04	-	12.07
Jack Pine	49.49	32.07	30.28	25.41	28.34	28.03	29.84	27.31	32.06	30.88	34.03
Red Pine	45.98	33.52	27.51	29.32	31.04	36.29	32.01	40.48	43.09	43.78	37.71
White Pine	45.98	33.52	27.51	29.32	31.04	37.95	27.51	36.90	24.95	39.21	28.70
Maple	12.36	8.30	17.59	16.59	17.41	13.86	12.94	13.76	13.57	18.11	17.82

* 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)))*

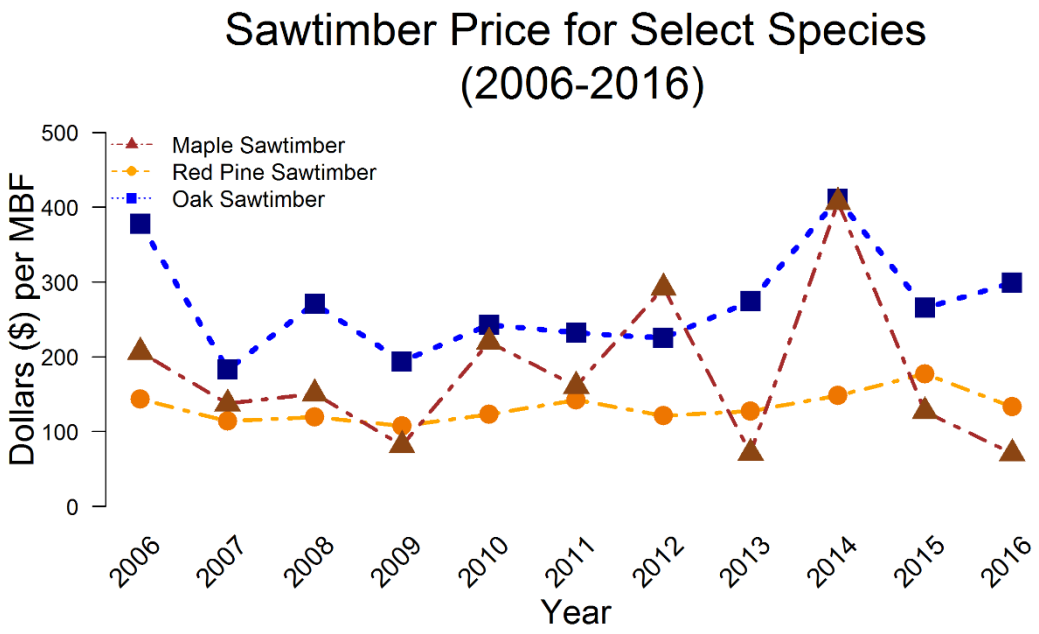
Species	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Aspen	43.96	41.33	43.64	51.11	33.67	52.11	53.48	53.12	-	-	-
Balm	-	-	-	-	-	-	-	-	-	-	-
Birch	52.06	27.24	32.04	19.82	38.92	42.15	35.70	36.97	47.04	42.84	45.24
Ash	61.41	38.21	42.41	51.89	56.27	58.09	36.12	34.06	73.41	54.17	97.67
Elm	--	85.22	60.08	53.99	45.08	60.43	42.45	41.41	42.19	42.5	42.54
Oak**	378.03	182.83	271.04	193.61	243.09	232.20	225.36	274.54	411.34	265.54	299.03
Basswood	124.73	97.73	97.33	66.24	63.47	66.11	55.87	54.44	68.87	59.24	80.40
Mixed/Other Hardwoods	209.61	52.91	52.86	37.72	29.80	48.31	36.88	28.56	65.40	47.87	47.04
Balsam Fir	-	76.47	72.75	58.34	-	-	-	66.51	-	-	-
W. Spruce	113.02	96.41	81.57	87.05†	102.15†	64.23	83.12	87.57	61.12	74.68	73.59
B. Spruce	113.02	-	-			-	-	-	-	-	-
Tamarack	-	-	-	-	-	-	-	-	-	-	-
W. Cedar	153.14	-	-	-	-	-	-	-	-	-	-
Jack Pine	124.11	115.21	109.95	106.19	-	145.76	138.95	112.00	89.56	-	118.77
Red Pine	143.45	114.04	119.51	107.40	123.36	142.33	121.15	127.10	148.33	177.18	133.22
White Pine	143.45	114.04	119.51	107.40	123.36	82.55	106.66	112.79	121.29	88.92	116.50
Maple	206.45	137.17	150.62	81.48	219.83	160.78	292.13	70.92	406.70	126.7	168.50

* Includes Veneer for certain hardwood species

** Primarily from public Lands in Southeastern Minnesota

† Spruce species

- Insufficient data



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