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Minnesota's Forest Resources 2012

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St. Paul, Minnesota 55155

Resource Assessment
413 SE 13th Street
Grand Rapids, MN 55744

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

Minnesota's Forest Resources

Revised 06/13

Preface

This report is compiled annually by Minnesota DNR – Forestry Division, Resource Assessment and Utilization & Marketing Program staff. Publication began in the mid 1980s by John Krantz, former Utilization & Marketing Program Coordinator and has recently been overseen by Keith Jacobson. 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, people employed in 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 and Anna Dirkswager), and the USDA Forest Service Forest Inventory and Analysis (FIA) unit. Useful comments were received from Andrew Arends, Forest Operations and Management Section Manager, and Alan Ek, University of Minnesota. Without their cooperation and assistance this report would not be possible.

Resource and Industry Highlights:

- *Mill Changes:* Mill shutdowns, slowdowns and curtailments continue to have a large impact on timber markets in Minnesota. Harvest levels of 2010 are down by nearly 1 million cords compared to 2005 levels, resulting in opportunities (and need) for additional utilization and management of Minnesota's forest resources.
- Timber imports of pulpwood into the state increased while exports out of the state decreased in 2010. Imports are in contrast with the previous year while exports basically remained on the same trend as last year.
- Overall net growth for all species continued to outpace harvest levels. According to 2011 FIA figures, annual net growth of growing stock on timberland was approximately 5.2 million cords, with mortality of approximately 4.0 million cords. According to Draft 2010 mill and fuelwood survey data, the volume of wood harvested and utilized by industry and fuelwood users was approximately 2.81 million cords. Hence, there are significant volumes of wood above current harvest levels potentially available for additional harvest.
- Woody biomass use for energy markets and forest carbon credits are significant emerging issues that will have an impact on forest management in the future. Updates pertaining to woody biomass use for energy are included in this report.

Harvest levels: Total wood harvested and utilized from timberland by industry and fuelwood users in Minnesota was 2.81 million cords in 2010. ***Based on analysis of mill consumption (actual survey figures are not yet available), it appears that 2012 harvest levels are within the 2.6 to 2.9 million cord range. In 2013, harvest levels may dip to 2.5 million cords or below.***

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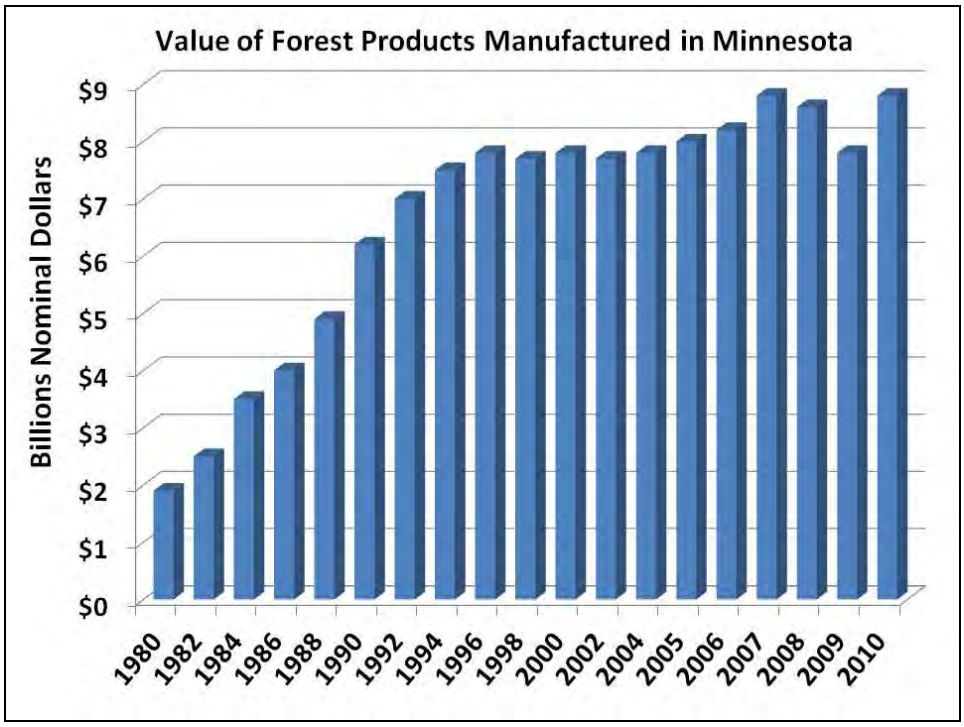
Wood-Using Industry Overview

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

- $15.8 billion total economic output effect with $8.8 billion value of shipments.
- $6.7 billion value added effect with $2.9 billion direct value added
- 5th largest manufacturing sector in Minnesota by employment (#1 food products, #2 computers & electronics, #3 fabricated metal products, and #4 machinery).
- 8.1 percent of all manufacturing shipments.
- 60,500 jobs total employment effect with 28,800 direct jobs.
- $3.2 billion payroll effect with $1.4 billion in direct payroll.
- $80 million stumpage revenue received by land owners.
- $24 value added by primary manufacturing per $1 stumpage value.
- $433 million total state and local tax receipts effect.



Important Industrial Sectors

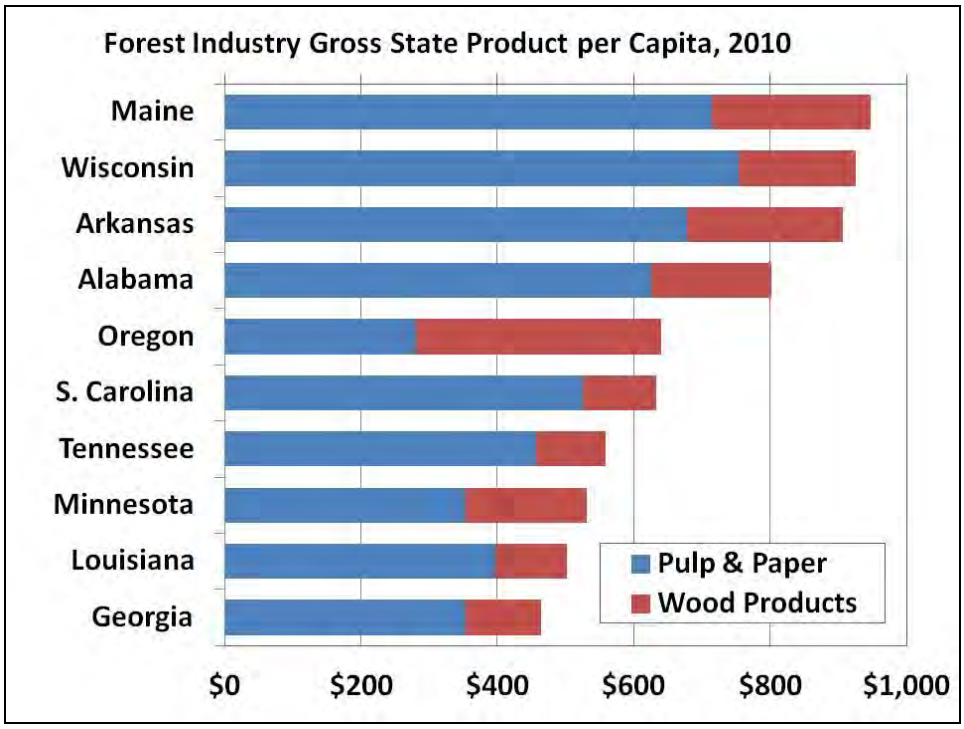
Pulp, paper, paperboard, converted paper products, window & door components (MN # 2 in U.S.), kitchen cabinets and cabinet parts, store fixtures, wood office & residential furniture, pallets & crating, millwork, wood shavings for poultry industry, and woody biomass energy (14 facilities with greater than 10,000 cords annual consumption).

Non-Traditional Industries Dependent on Minnesota's Forest Lands

Balsam boughs for wreath industry with annual sales exceeding $20 million, decorative spruce tops, birch bark, maple and birch syrup, and medicinal plants.

[1] CY 2010 data unless otherwise noted; compiled by Don Deckard, Ph.D., Forest Economist, Minnesota DNR.

Value Added (Gross State Product) per Capita
In 2010, Minnesota was ranked eighth nationally in forest products manufacturing with $531 value added (Gross State Product) per capita.



Manufacturing Facilities as of January 2013

- 4 pulp and paper Mills
- 3 recycled pulp & paper
- 2 oriented strand board (OSB and sheathing/siding)
- 1 specialty (insulation board)
- 500+ sawmills with 32 sawmills $\geq$ 1 million board feet annual consumption.
- 150 associated specialty businesses
- Over 800 secondary manufacturers

Volume of Timber Harvested
Annual harvest volume = 2.8 million cords including:

- Pulpwood = 2.03 million cords (2010)
- Sawlogs & specialty = 247 million board feet (2010) including the following specialty items:
  - Veneer (2007) = 4.5 million board feet domestic plus 0.6 million board feet exported
  - Shavings (2007) = 11,000 cords (animal bedding)
  - Posts & Poles (2007) = 8,000 cords
- Residential fuelwood = 196,000 cords live trees from timberland (2007-08)

Minnesota Pulp and Paper – 2012

Firm	Wood Used	Product
UPM - Blandin Paper Mill Grand Rapids	Aspen, Balsam Fir, Basswood, Spruce	Lightweight coated publication papers
Boise White Paper, LLC International Falls	Aspen, Balm, Pine, Spruce, Balsam Fir, Birch, Tamarack, Ash, Maple	Office papers, label and release papers, base sheets, business and specialty printing grades
Verso Paper Sartell	Aspen, Balsam Fir, Spruce	Coated and uncoated publication papers (Permanent shutdown 06/12)
NewPage Duluth	Balsam Fir, Spruce, small amount of Pine	Uncoated, lightweight supercalendered magazine and publication papers
SAPPI North America Cloquet	Ash, Aspen, Birch, Maple, Pine	Coated freesheet fine printing and publication paper, market pulp
	Ash, Aspen, Birch, Maple	Chemical cellulose (conversion expected May 2013 – afterwards 2/3 aspen and 1/3 maple)
Wausau Paper Brainerd	Market pulp	Tape backing
Recycling Mills		
Rock-Tenn Company St. Paul	Recycled paper and corrugated	Cardboard and corrugated boxes
NewPage 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 – 2012

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

Minnesota Hardboard and Specialty – 2012

Firm	Wood Used	Product
International Bildrite International Falls	Aspen, Balm and recycled paper	Sheathing
Georgia-Pacific Corporation, Superwood Division Duluth	Aspen, Pine, Mixed Hardwoods	Industrial hardboard (Permanent shutdown 08/12)

For additional information about sawmills, pulp and paper mills, Oriented Strand Board mills, veneer 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/index.html

Minnesota Large Sawmills – 2012

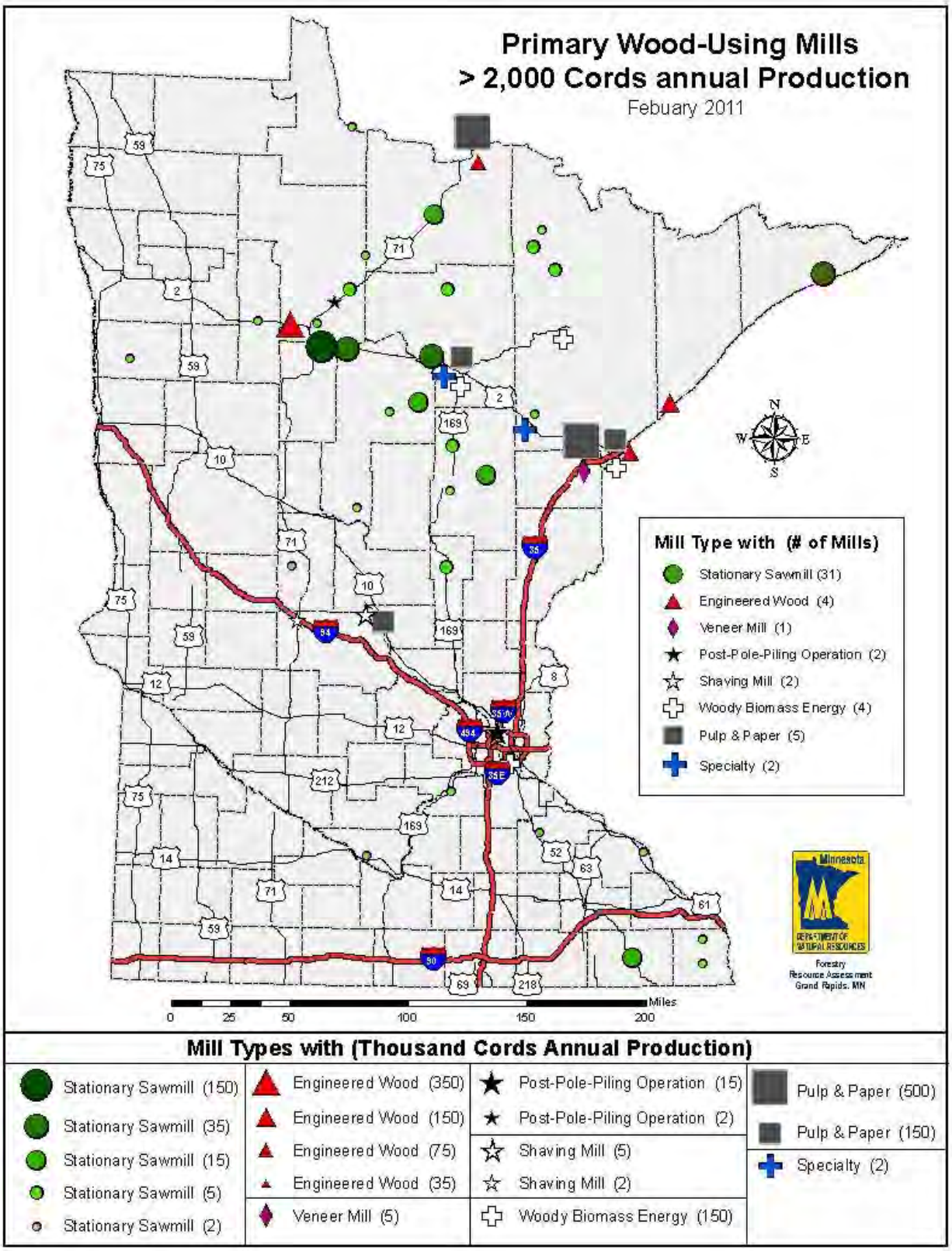
Mills Exceeding 3,000,000 Board Feet of Annual Production

Economic importance
The saw and specialty mill sector is very important to forestry because it creates market diversity. The approximately 494,900 cords used annually provides high-value markets for some species, sizes, and qualities of wood that do not have high demand or are not commonly used at pulpwood-using or energy mills. 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 helps them afford to engage in other management activities.

There are over 500 sawmills in Minnesota, but most are small, portable bandsaw mills that account for a tiny fraction of wood use. In contrast, 32 large sawmills in Minnesota utilize more than 1 million board feet annually. In fact, the top 10 mills by production volume account for over 65 percent of the total, with one large softwood mill accounting for about 40 percent of the total volume utilized by all specialty and sawmills.

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
Jarden Home Brands, Cloquet	Aspen, Paper Birch	Veneer
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
Woodline Sawmill Onamia	Black Ash, Aspen, Basswood, Paper Birch, Hard Maple, Soft Maple, Red Oak, Pine	Lumber, pallets/skids



Location of mills is an important factor in determining markets for wood. The map above shows the OSB, pulp & paper, recycled fiber, hardboard, sheathing and larger sawmills in Minnesota. These mills utilize various species of wood material, with aspen pulpwood being by far the largest component.

Wood Energy and Woody Biomass Utilization

As fossil fuel-based energy prices continue to rise and recognition of the impacts associated with carbon dioxide emissions increase, the use of renewable energy resources, such as woody biomass, continues to increase.

Woody biomass includes, but is not limited to: logging residue (non-merchantable tops and limbs left over from a commercial timber harvest along with non-merchantable small-diameter trees and stems, dead standing trees, and down logs), primary and secondary mill residue, dedicated energy crops, urban forest clearing material, land clearing material and brushland material. Within the last couple of years, woody biomass utilization has also included whole-tree chips due to a decrease in available logging residue resulting from decreased levels of commercial timber harvest.

Woody biomass continues to be used as a source of renewable energy for both industrial and non-industrial applications in Minnesota. As propane prices continue to increase, demand for woody biomass for thermal applications also increases; especially for commercial and residential facilities not connected to a natural gas line. In the forest products industry, using woody biomass for combined heat and power or for thermal applications is a practice that has placed a demand on biomass for over thirty years. Despite record low natural gas prices, concerns associated with climate change, rising fossil fuel prices and energy security point to an expanded use of woody biomass in years to come.

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 and wildlife management, and additional value-added product lines for the forest products industry. In fact, increased utilization of wood for bioenergy can be a tool for offsetting forest and wildlife management costs.

However, as with almost any opportunity, there are potential pitfalls to be avoided. Some of these include: impacts to raw material supply for the existing forest products industry, nutrient depletion on sensitive sites, and potential negative habitat consequences. Mitigating for potential negative effects associated with biomass harvesting must be done in order to allow woody biomass markets to expand in a sustainable and environmentally healthy manner. Several environmental safeguards to this extent exist and are effectively used in MN. These safeguards include: the Biomass Harvesting Guidelines (which Minnesota was the first state in the nation to develop in 2007), third-party certification and Minnesota Logger Education Program's Master Logger Program.

Sources of Woody Biomass
Some sources of woody biomass include:

- Logging residue. Tops and limbs leftover from commercial timber harvest operations.
- "Primary" mill residue from sawmills, etc. Almost all residue is utilized for various products; most commonly burned to produce energy.
- "Secondary" mill residue from cabinet manufacturers, etc. The majority of the residue is utilized.
- Dedicated energy crops. A very small resource in Minnesota at present.
- Land clearing projects. This contributes to the metropolitan wood supply for a major energy facility.
- Brush from brushlands. A significant potential resource, but the economics of harvesting and procurement technology need to improve before widespread use.
- Precommercial thinning, Timber Stand Improvement (TSI), fire hazard reduction, and vegetation management projects. A potential fiber source from intensified forestry and wildlife management.
- Urban forests. A fiber source from tree clearing and maintenance and storm cleanup in urban areas. Largely used in mulch markets in major metropolitan areas as well as for energy in St. Paul.

- Roundwood. Given mill shutdowns and curtailments, a meaningful amount of woody biomass in the form of roundwood has been used over the past few years.

Markets for Woody Biomass
Woody biomass markets normally use portions of the forest resource without traditional forest product markets such as tops and limbs, small diameter timber, poorly formed trees, under-utilized species, disease or insect infested trees, some forms of wood manufacturing residue, and potentially brush. Two main factors keep small-diameter timber, tops and limbs and brush from being used 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 high cost of processing smaller-diameter material. Processing efficiency is greater when using larger material.

Woody biomass is a good fit for a number of 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: Markets are limited in rural Minnesota, but are significant near metropolitan areas.
- Animal bedding: Animal bedding markets are limited in some of the highly forested regions of Minnesota because most of the poultry and dairy industry is located in the central and southern portions of the state.
- Energy: Energy is by far the largest market for woody biomass in Minnesota. The table below contains a list of some of the larger (greater than 100,000 oven dry tons annually) woody-biomass energy facilities in the state.

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
Laurentian Energy Authority	Hibbing/Virginia	Logging residue, mill residue, roundwood
FibroMinn	Benson	Turkey manure, logging residue, roundwood
Minntac Taconite Kiln	Mountain Iron	Mill residue

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

Guidelines for Woody Biomass Harvesting
Because there are important ecological and environmental reasons for leaving some residue on-site after a timber harvest, the Minnesota Forest Resources Council and the DNR developed site-level forest management guidelines for harvesting woody biomass. The guidelines are available online at: http://www.frc.state.mn.us/initiatives_sitelevel_management.html

Forestry Opportunities
Several opportunities exist to use woody biomass in a manner consistent with achieving sound natural resource management goals. Resource managers can use biomass harvesting as a tool to achieve desired conservation goals through the following practices:

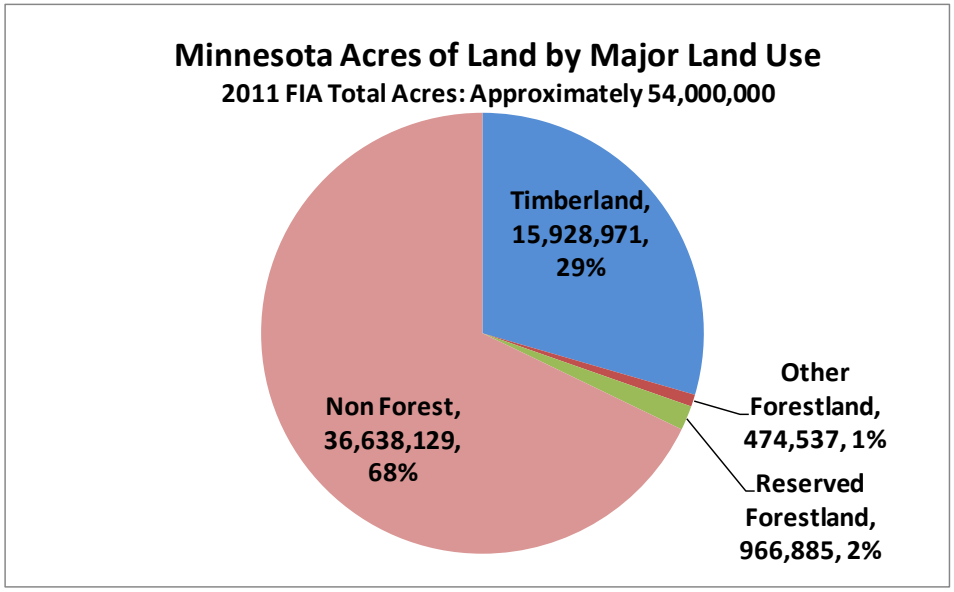
- Harvesting logging residue. In addition to local economic benefits, use of this material can, on some sites, improve ease and success of regeneration and reduce fuel loading and fire danger.
- Forest health management and invasive species control. Opportunities may include bark beetle control in small diameter pine thinnings, spruce sanitation harvests to control dwarf mistletoe, and removal of trees infested with Emerald Ash Borer (EAB).
- Harvesting brush from brushlands. There are potential wildlife habitat benefits from brushland management.
- "Precommercial thinning", Timber Stand Improvement (TSI) and fire hazard reduction. A source of currently non-economically recoverable woody material is produced during forest management activities such as very early thinnings and wildfire hazard reduction work. If the economics become profitable and ecological concerns are addressed, the potential benefits of doing more of this work could be significant.

What is the Future for Woody Biomass?

- Potentially, future policy trends leading toward reduced green house gas emissions and increased renewable energy development point toward the expansion of woody biomass utilization over the next decade and beyond.
- Technologies to expand the use of biomass for increased value added products like motor fuels and green chemistry substitutes are edging toward commercial deployment.
- Using woody biomass more broadly is an emerging issue that requires time to sort out natural resource management issues and market development. The extent to which woody biomass is used as a renewable energy resource depends on a multitude of factors including, but not limited to: the price and availability of alternate energy sources, procurement and operation costs of biomass resources, and state and federal renewable policies.
- 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 for industrial process heat 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 and as an economic opportunity.

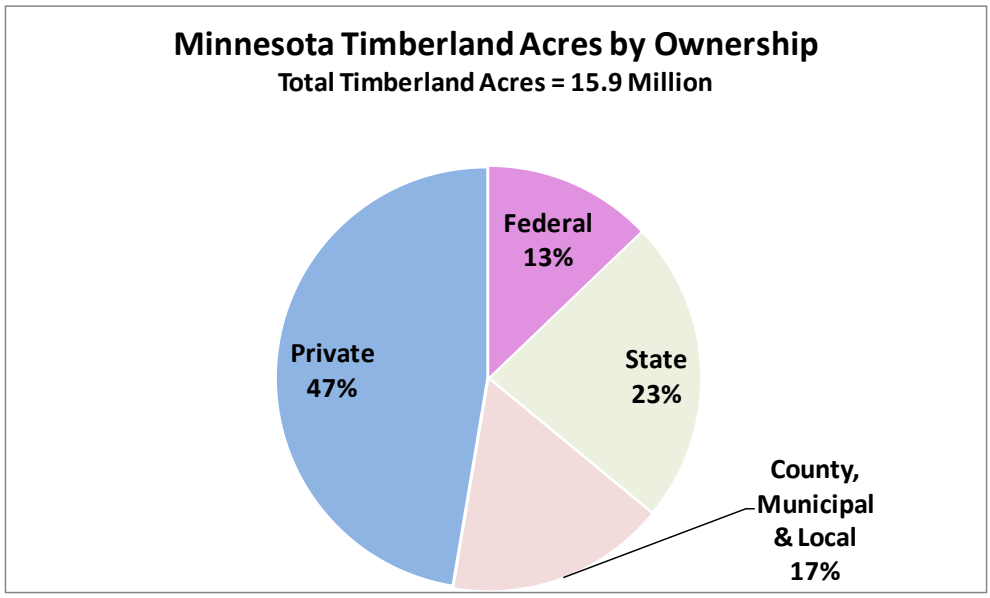
Forest Resources Overview

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



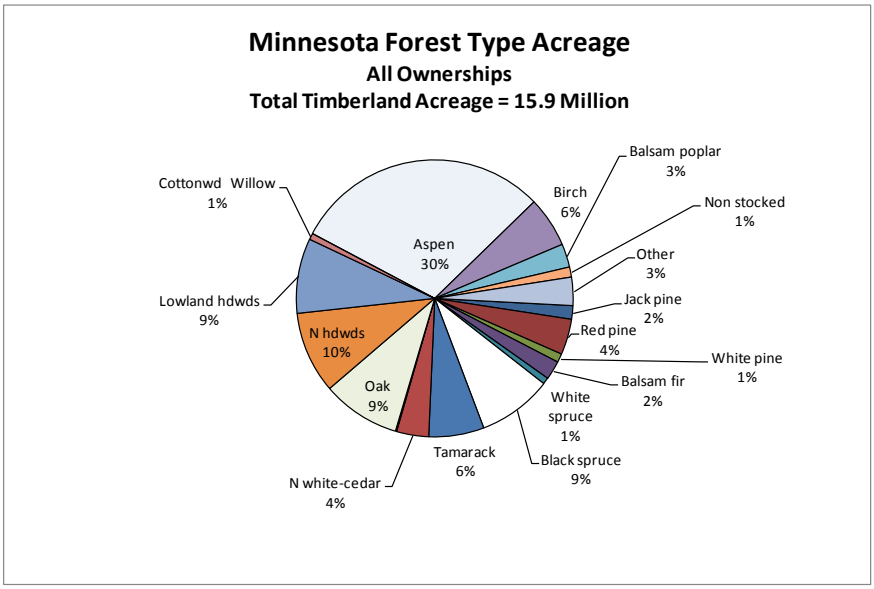
Source: USDA Forest Service 2011 FIA database

According to 2011 FIA data, Minnesota currently has about 15.9 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.



Source: USDA Forest Service 2011 FIA database

Ownership of timberland is an important factor in assessing many issues, including timber supply. Private 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, as well as family forest landowners (e.g. individuals, families, etc.), and other non-industrial landowners.



Source: USDA Forest Service 2011 FIA database

Forest Type: A classification of forest land based on the species forming a plurality of live tree stocking.

It is worth noting that aspen is by far the largest forest or "cover" type in Minnesota.

Area of Timberland in Minnesota by DNR Forest Type – 2011

Forest Type	Acres
Aspen	4,764,117
Northern Hardwoods	1,524,443
Oak	1,453,522
Lowland Hardwoods	1,400,262
Black Spruce	1,380,677
Tamarack	1,024,471
Birch	940,696
Red Pine	665,840
White Cedar	594,643
Balsam Poplar (Balm of Gilead)	436,792
Balsam Fir	350,763
Jack Pine	254,549
White Pine	161,830
White Spruce	121,691
Cottonwood/ Willow	116,985
Other Softwoods	22,487
Non-Stocked & Other	715,204
Total All Types	15,928,971*

Source: USDA Forest Service 2011 FIA Database
*Totals may not sum due to rounding.

Harvest Levels

Information on 2010 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)

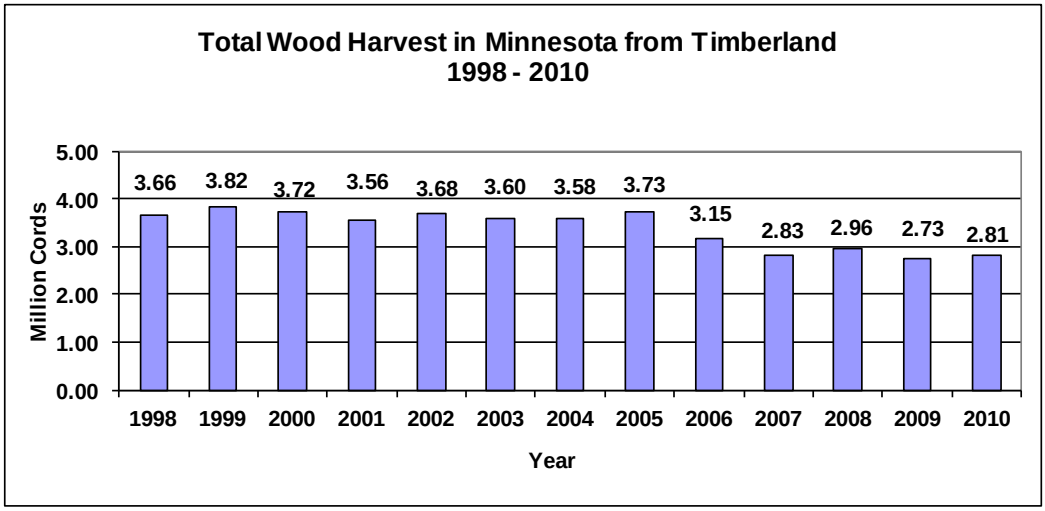
(Pulpwood 2010 (DRAFT); Sawtimber 2010 (DRAFT): Fuelwood 2007-08)

			Fuel		
Species	**Pulpwood***	**Sawlogs and Others***	**Residential****	**Commercial***	**Total**
Aspen and Balm	1278.5	64.6	31.9	17.8	1392.8
Paper Birch	105.1	23.9	31.0	11.1	171.0
Ash	19.0	5.4	27.1	14.8	66.3
Oak	0.2	43.5	57.5	1.9	103.1
Basswood	10.5	12.5	6.3	0.0	29.3
Maple	112.0	5.3	31.2	2.4	150.9
Cottonwood	22.6	3.6	0.3	0.0	26.5
Other Hardwood	2.3	40.6	2.3	17.5	62.6
Sub-total hardwood	1550.2	199.4	187.6	65.4	2002.6
Pine					
Red Pine	33.9	185.8	2.9	4.1	226.7
White Pine	2.9	5.6	0.4	0.1	9.0
Jack Pine	25.6	77.1	1.8	1.9	106.3
Spruce	207.1	7.4	0.3	0.1	214.9
Balsam Fir	144.9	7.2	0.2	0.1	152.5
Tamarack	51.5	7.1	2.0	16.1	76.7
White Cedar	1.0	2.9	0.8	0.0	4.6
Other Softwood	9.9	2.5	0.1	6.3	18.8
Sub-total softwood	476.7	295.5	8.5	28.7	809.4
Total	2026.9	494.9	196.1	94.1	2812.0

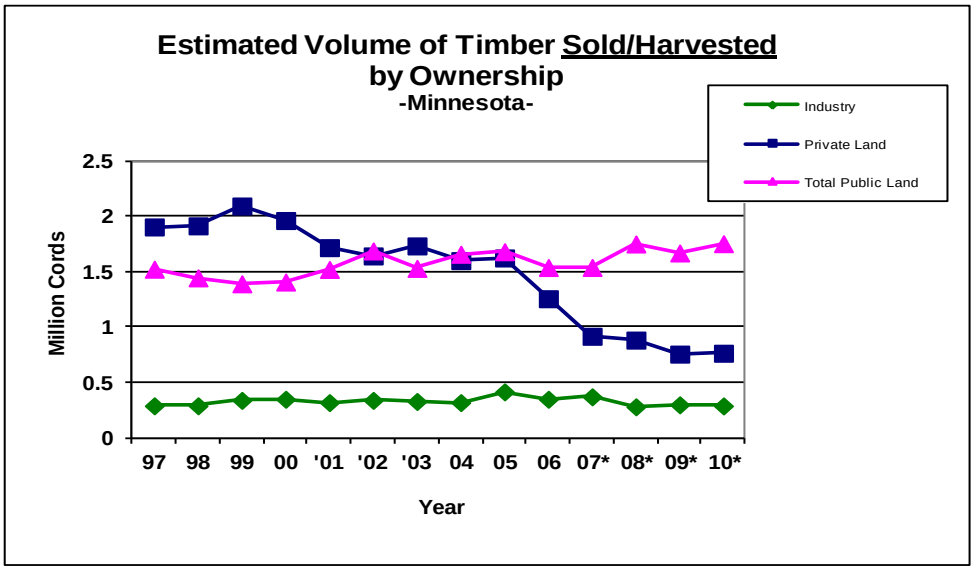
Source: USFS and MN DNR mill surveys & residential fuelwood survey.
-*Figures in chart may not total exactly due to rounding*
*Draft **Fuelwood removed from live trees on timberland.

-Figures include cords of pulpwood exported to Wisconsin and Canada: Aspen: 45,891; Spruce: 3,200; Birch: 13,981; Maple: 16,195; Red Pine: 10,905; Jack Pine:12,556; Tamarack: 8,317; White Pine: 1,572; Ash: 2,692; Balsam Fir: 4,004; Basswood: 1,891; Elm 937; Red and White Oak: 179; and total cords of sawlogs mainly exported to Wisconsin and Iowa of: 31,200, most of which is Oak and Maple.

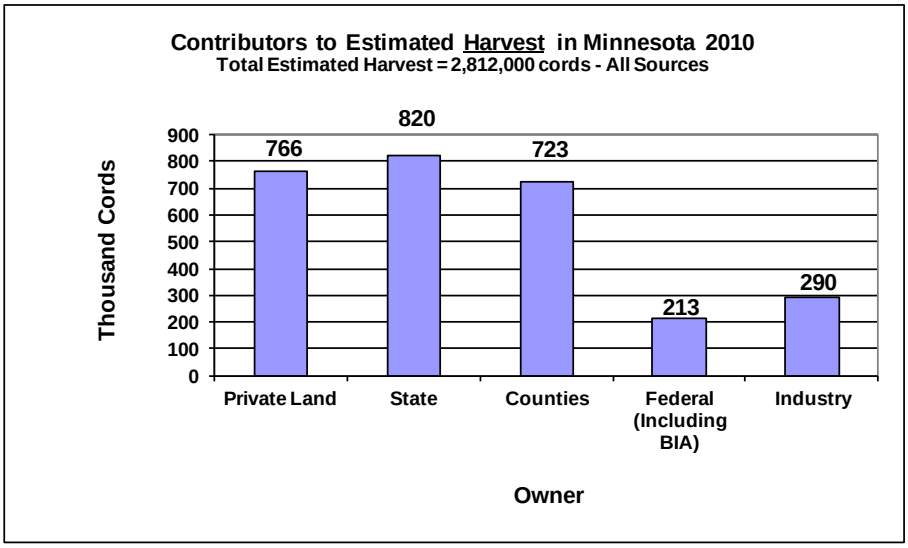
Based on analysis of mill consumption (actual survey figures are not yet available), it appears that 2012 harvest levels are within the 2.6 to 2.9 million cord range. In 2013, harvest levels may dip to 2.5 million cords or below.



Source: Pulpwood (USFS, Northern Research Station), sawtimber and fuelwood (MN DNR surveys).

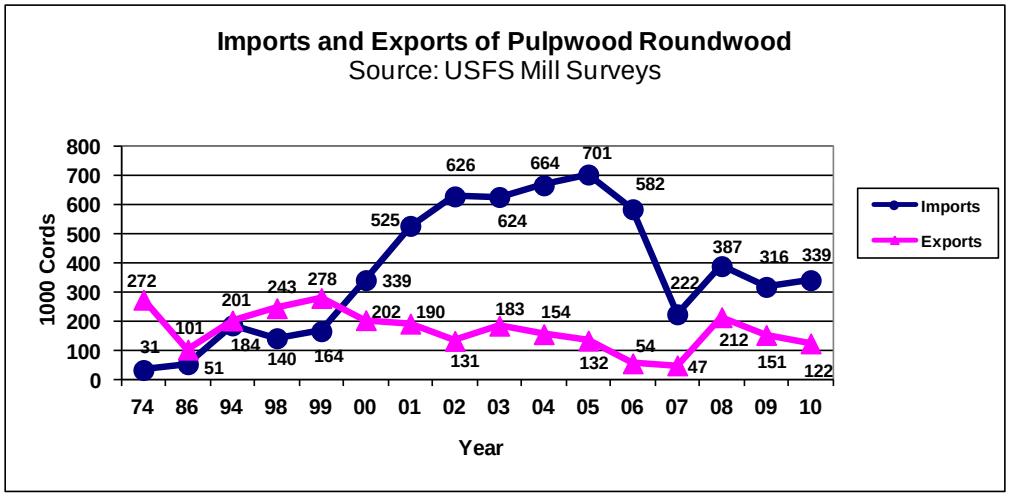


Source: Public Lands: Public Stumpage Price Review through 2006. ***Beginning with 2007, annual volume scale reports (harvested) are used for State and Federal lands rather than volumes sold. Change necessary due to large volumes of re-offered wood sold by public agencies in 2007.*** Industry Lands: Minnesota Forest Industries estimate of harvested volume from 2010. Private Lands = an estimate calculated as follows: Total estimated harvest 2010, minus 2010 public volume harvested (sold through 2006), minus 2010 estimated industry volume harvested. Forest Capital Partners (formerly Boise) Timberlands contained in "Industry" totals.



Source: State Lands: FY 2010 Harvest, DNR Timber Sales Annual Report. Federal: FY 2010 Harvest, Superior National Forest Timber Statistics, and Chippewa National Forest Timber Statistics; BIA: Public Stumpage Price Review 2010 sold. County Lands: Minnesota Forest Industries survey of 2010 harvested volume. Industry Lands: Minnesota Forest Industries survey of 2010 harvested volume. Forest Capital Partners (formerly Boise) Timberlands included in Industry totals. Private Lands = an estimated figure as follows: Total estimated harvest 2010, minus state, county, national forest and BIA volume harvested, minus estimated industry volume harvested.

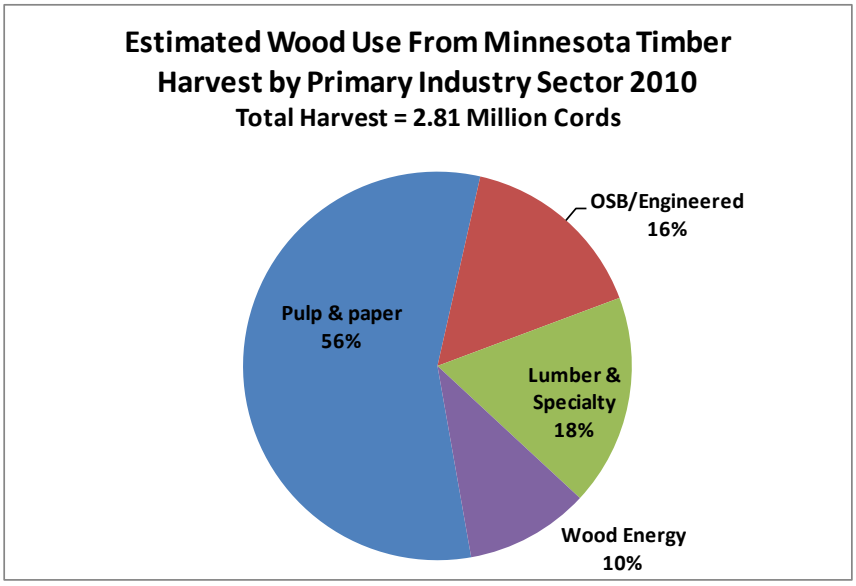
Ownership of lands has a large impact on policy regarding forest management and timber harvest.



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

Minnesota became a large net importer of wood from 2000 through 2006, as mill demand and stumpage prices increased. In 2010, mills still looked outside of Minnesota's borders in order to meet their raw material needs, especially for aspen (83,230 cords), balsam fir (25,691 cords), and maple (212,740 cords). Imports in 2010 were largely from Wisconsin (258,321 cords), with fair amounts from Michigan and Canada. Exports in 2010 were mainly to Canada and Wisconsin mills.

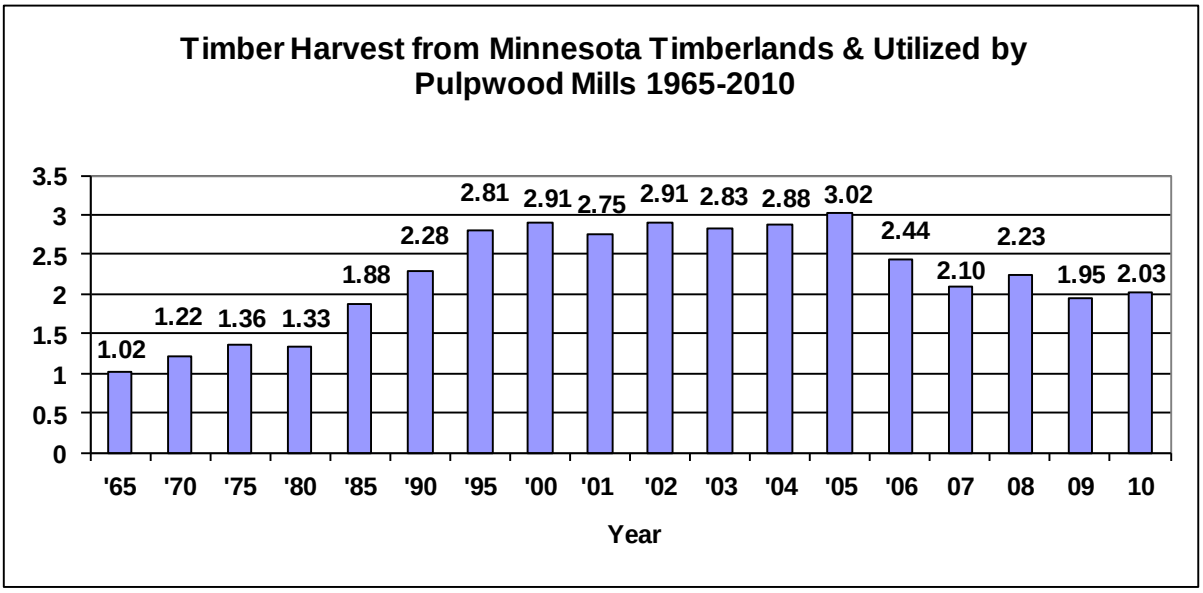
While Minnesota presently remains a net importer of timber, imports remain substantially less than 2005 levels. The change has been due to several factors, most notably reduced demand due to mill closures and slowdowns.



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.

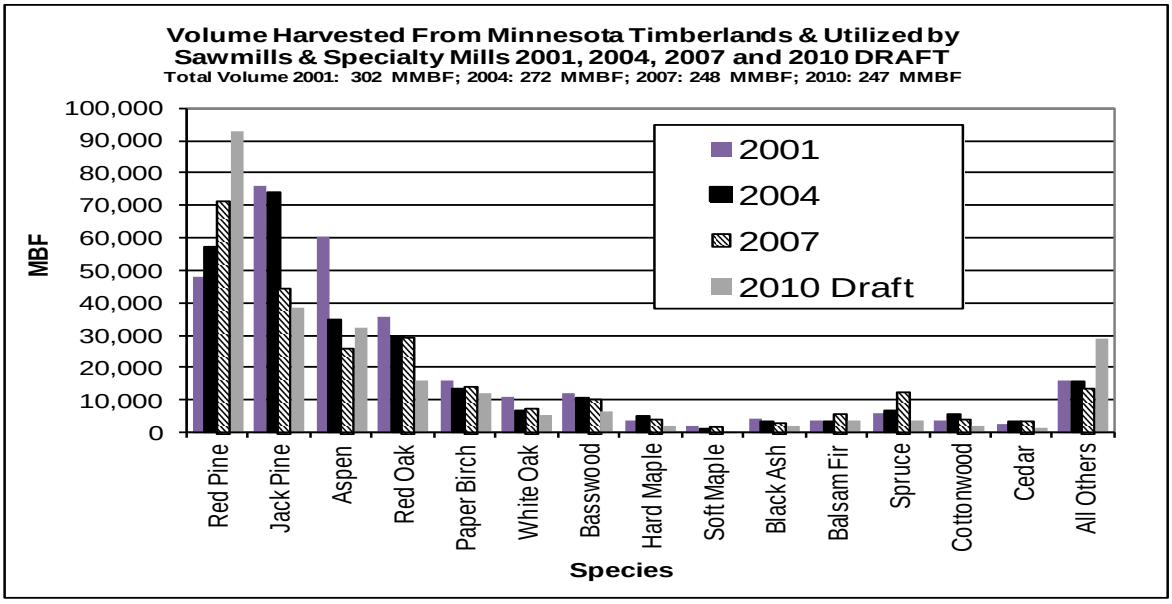
Wood use in the OSB/engineered wood sector has dropped significantly since 2005 due to mill shutdowns and slowdowns.

Wood use for energy has risen since 2005.



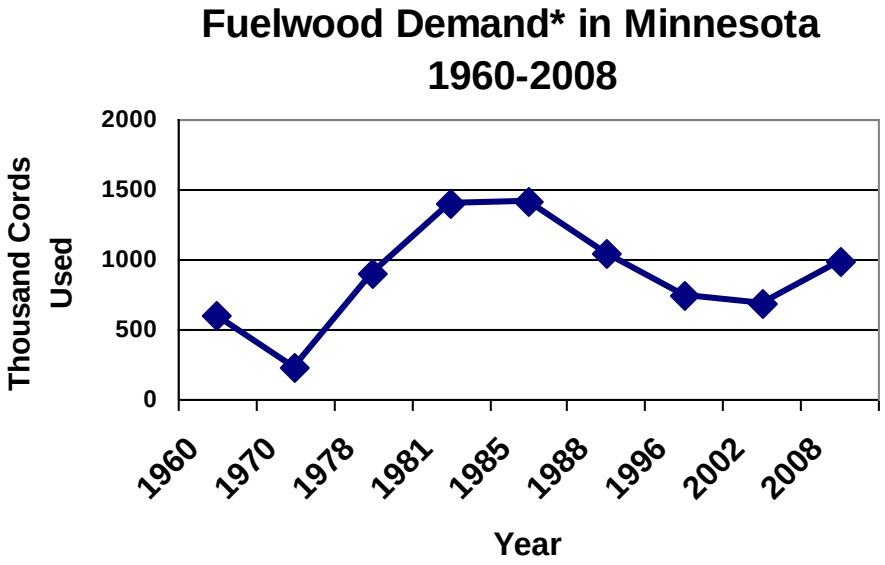
Source: USFS, Northern Research Station surveys

A major reason for harvest leveling off in the early to mid 2000s, during a period of increasing primary industry demand and use, was the increase in imports. Most of the imported pulpwood was aspen and maple from Wisconsin and Canada. Imports result in fewer logging, trucking and support jobs in Minnesota. **It is important to note that a significant reduction in timber utilized by pulpwood mills, including imports has occurred since 2005, due largely to mill closures and slowdowns.**



Source: MN DNR sawmill and specialty mill survey

Sawtimber is often the highest value product for wood that meets merchantability requirements. Generally speaking, a log needs to be at least 8 feet in length and 8 inches minimum diameter inside bark at the small end in order to be of merchantable sawlog size. However, there are an increasing number of sawmills that can utilize smaller diameter material profitably. Sawmill capacity dropped from 2001 through 2010, leveling off between 2007 and 2010. Jack pine, aspen and oak use dropped off most significantly in the sawmill sector; while red pine actually showed a significant increase in use by sawmills.



Source: MN DNR fuelwood surveys

Residential fuelwood is a relatively small portion of total timber harvest.

It is important to note that only a portion of the nearly million cords of total residential fuelwood demand comes from live trees on timberland. About 196,000 cords of residential fuelwood came from live trees on timberland in 2008. The remainder is from sawmill residue, 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.

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

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

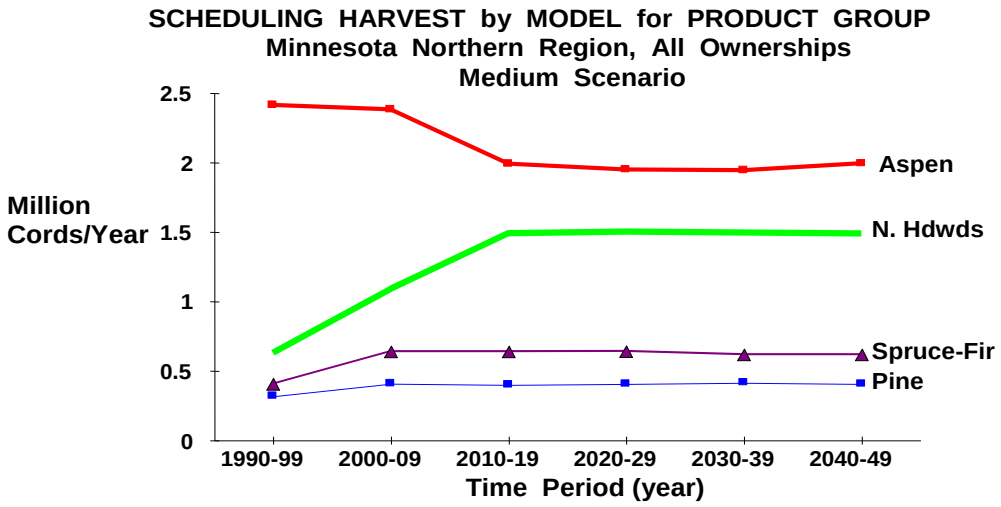
For the above reasons, it is important to view the levels as helpful benchmarks that are only one part of the picture in determining long-term sustainability of our forest resources. They should not be viewed as absolute targets.

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

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

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

For a document explaining the DNR procedure used to estimate sustainable harvest levels, contact Keith Jacobson at: keith.jacobson@dnr.state.mn.us.



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.

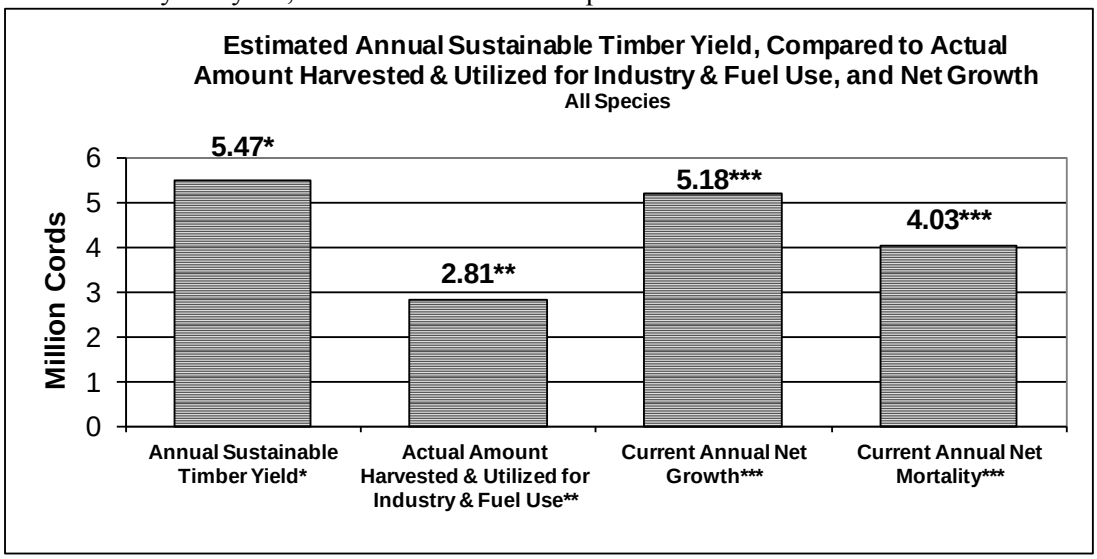
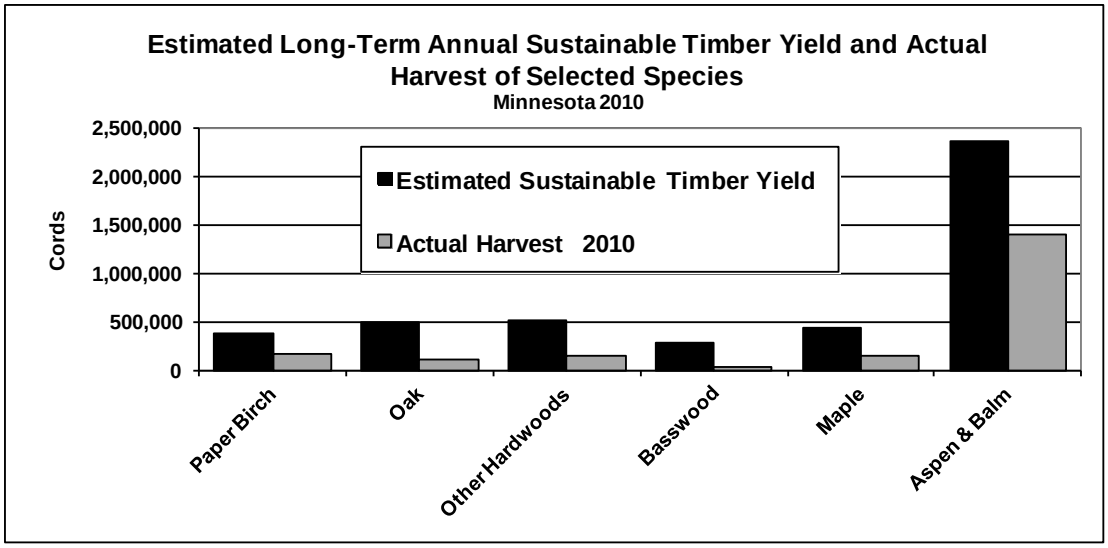
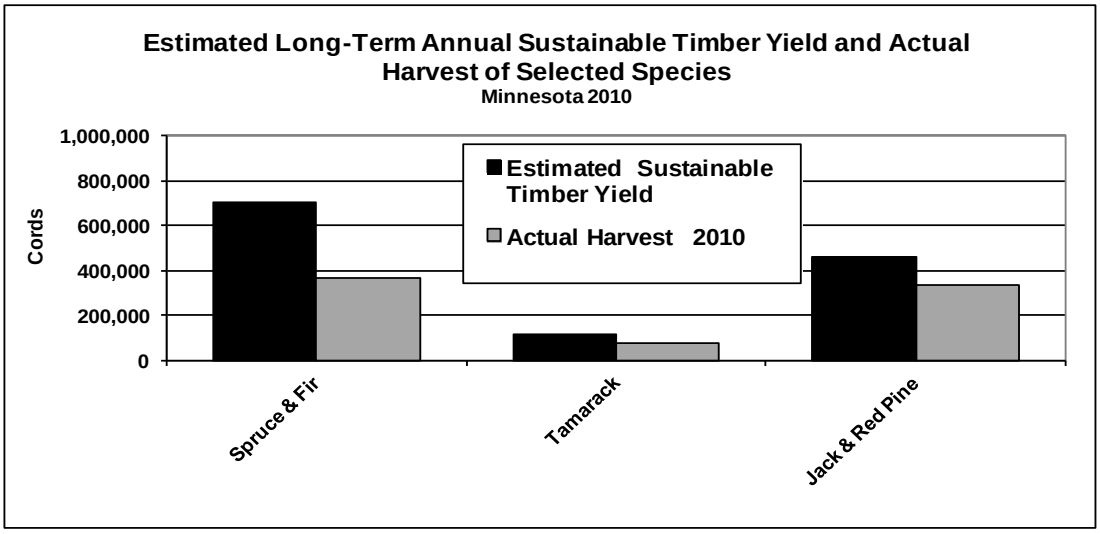


*Table 6.25, GEIS, High Long-Term Sustainable Level, Timber Productivity Tech. Paper, Dec. '92.
** 2010 NRS pulpwood survey, 2010 DNR sawmill survey, 2007-08 fuelwood survey. For Harvest comparisons to Net Growth, it is necessary to add annual "growing stock" logging residue of approximately 275,000 cords to this figure.
***USFS FIA 2011 database.

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



Source: Harvest data 2010 USFS pulpwood survey, DNR 2010 sawmill & 2007-08 fuelwood survey. Sustainable timber yield data source as per the notes below.



Source: Harvest data 2010 USFS pulpwood survey, DNR 2010 sawmill & 2007-08 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.

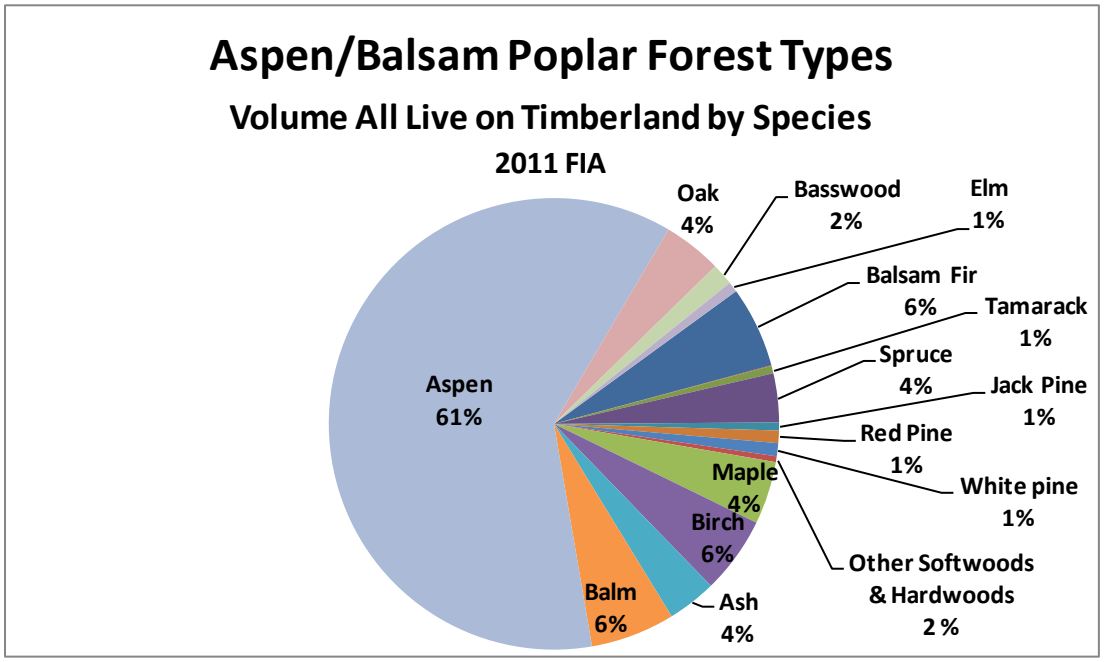
Wood Supply and Demand Information for Important Cover Types and Species

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

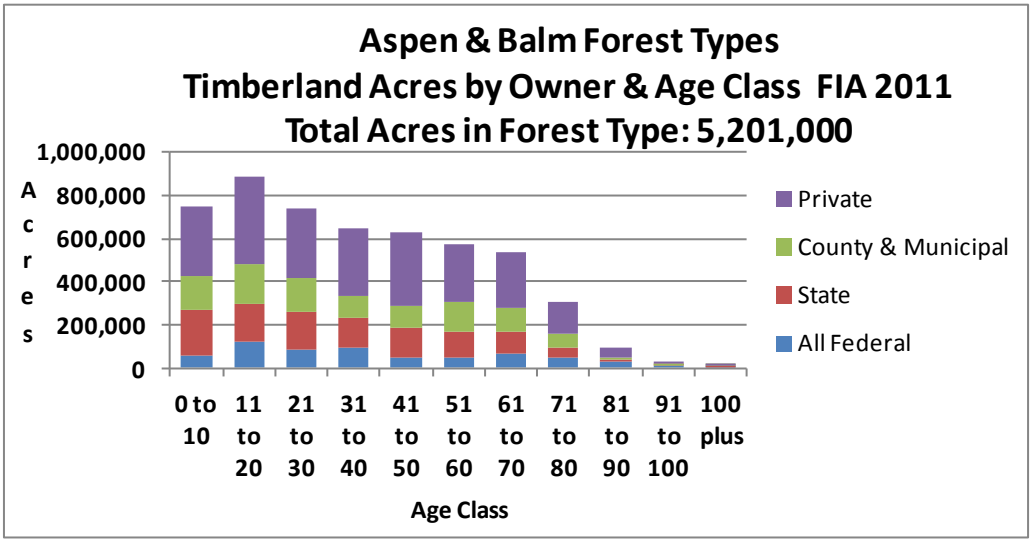
Minnesota's Aspen/Balm of Gilead Resource

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 every engineered wood mill in Minnesota is 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 were specifically designed 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.

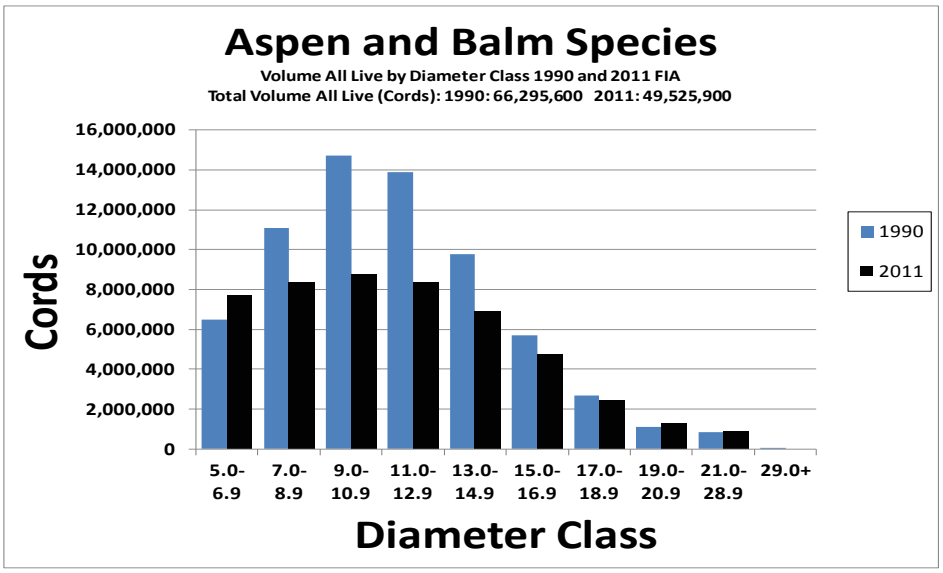


Source: 2011 FIA database provided by USFS, Northern Research Station



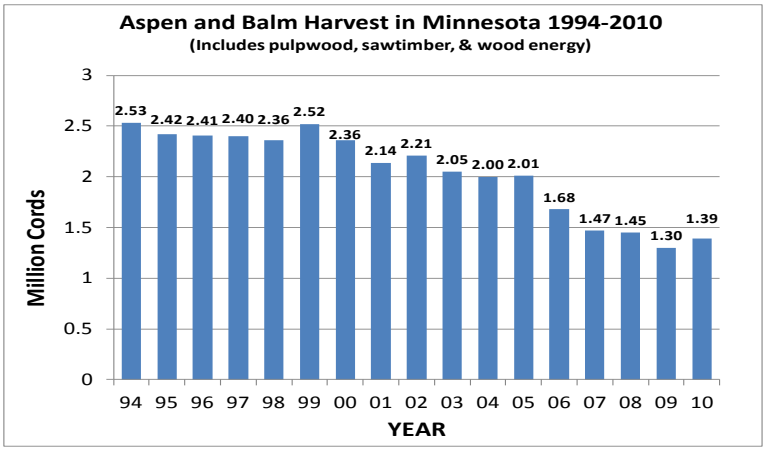
Source: 2011 FIA database provided by USFS, Northern Research Station

The 2011 FIA inventory indicates a much more even age-class distribution than the 1990 inventory.



Source: FIA 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

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 2011 USFS FIA database, estimated average net annual growth of aspen & balm growing stock: 1,045,900 cords, estimated average annual mortality of aspen & balm growing stock: 1,644,200 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.
- Closure of several large mills.

Current Demand for Aspen/Balm of Gilead from Minnesota Timberlands

	Cords
2010 Harvest…….. ……	**1,392,800**
• Minnesota Pulpwood Industries ……..……..…….	1,232,700
• Pulpwood Export (To Canada and Wisconsin)……..…….	45,900
• Sawlogs & Other……..…	64,600
• Fuelwood (from live trees on timberland)…..…….……	49,700

Source: NRS & DNR Surveys

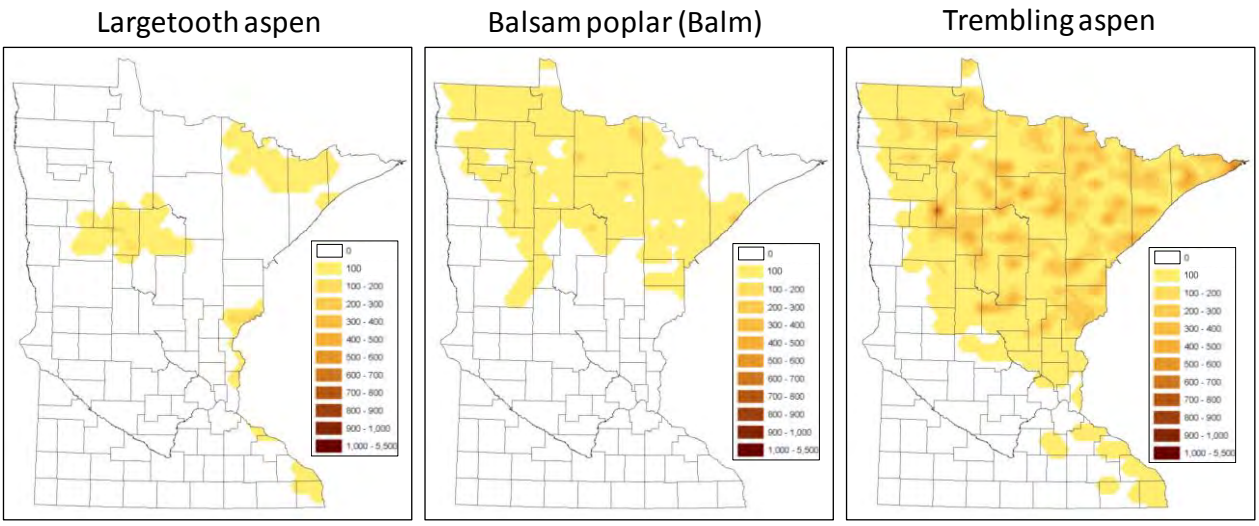
Resource Opportunities:

- The recent reduction in aspen harvest levels has resulted in a situation where current harvest levels are well below long-term sustainable levels.

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.

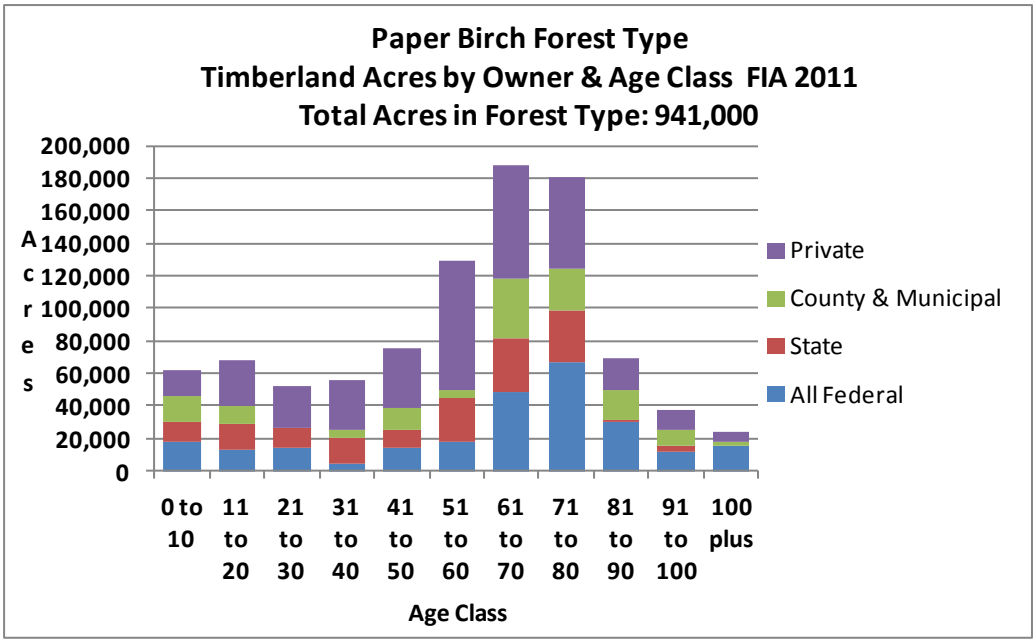
Predicted spatial distribution of aspen and balm CUBIC FOOT volume of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. These maps don't necessarily indicate where individual trees of a species are found, but rather where individual trees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



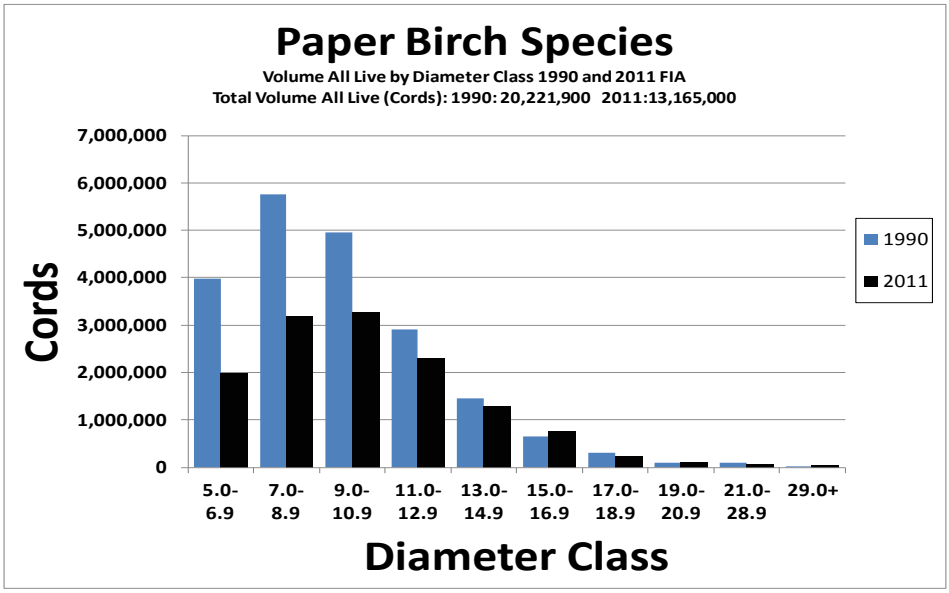
Source: 2010 FIA database provided by USFS, Northern Research Station

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.

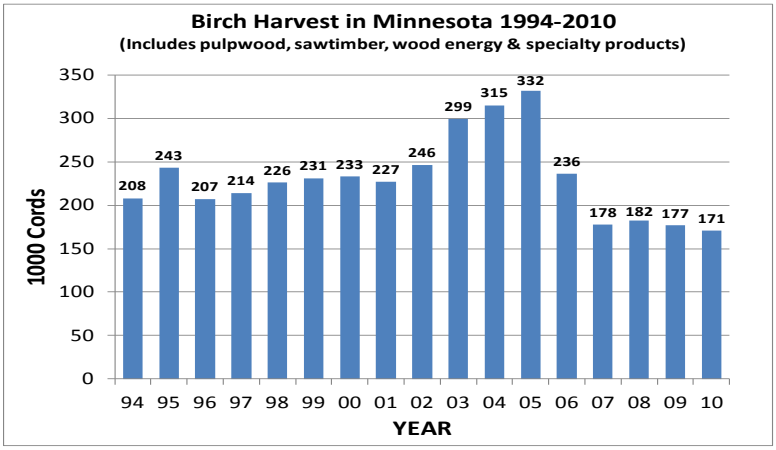


Source: 2011 FIA database provided by USFS, Northern Research Station



Source: FIA database provided by USFS, Northern Research Station

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



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

DNR estimated long-term annual sustainable harvest level: 371,500 cords/year. Estimated average net annual growth of paper birch growing stock: -44,100 cords, and estimated average annual mortality of birch growing stock: 417,100 cords, based on 2011 FIA data.

Current Demand for Birch from Minnesota Timberlands

	Cords
2010 Harvest	**171,000**
• Minnesota Pulpwood Industries	92,000
• Pulpwood Export (To Wisconsin)	13,100
• Sawlogs & Other	23,900
• Fuelwood (from growing stock)	42,100

Source: NRS & DNR Surveys

Resource Opportunities:

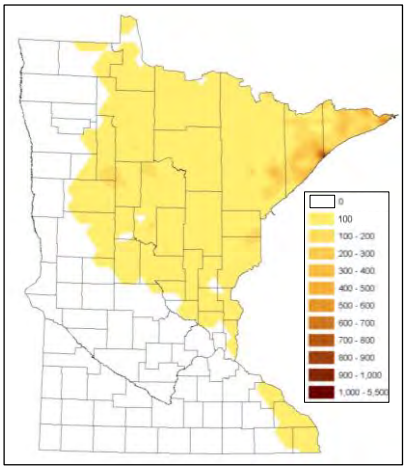
- Birch harvest is well below long-term sustainable levels.
- Birch in northeastern Minnesota is "fleck-free" (fleck is a common appearance defect in birch), so larger, high-quality stems are a fit for veneer markets.

Resource Issues:

- There is a need to improve ability to consistently regenerate birch stands.
- Wood quality. There is significant rot in older birch.
- A major age class imbalance, with significant volumes of older birch.
- Birch volume is declining. In part due to drought but also the birch bark borer and Armillaria root rot.

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

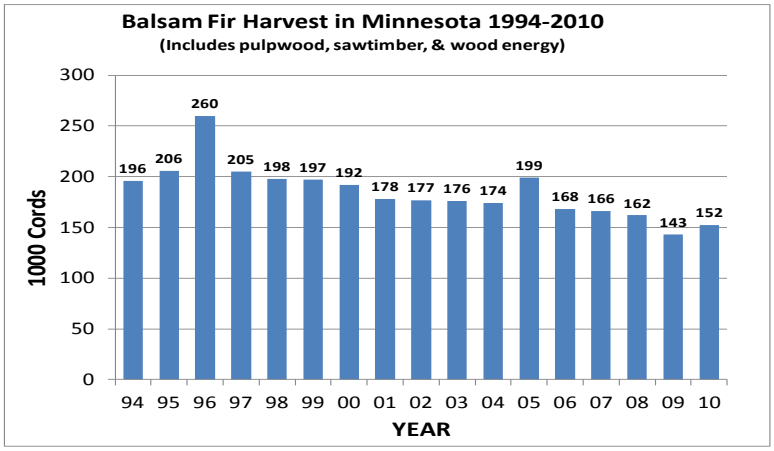


Source: 2010 FIA database provided by USFS, Northern Research Station

Minnesota's Balsam Fir Resource

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 2011 FIA data, estimated average net annual growth of balsam fir growing stock: 226,000 cords; estimated average annual mortality of balsam fir growing stock: 334,200 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.



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

Current Demand for Balsam Fir from Minnesota Timberlands

	Cords
2010 Harvest	**152,500**
• Minnesota Pulpwood Industries	140,900
• Pulpwood Export (To Canada and Wisconsin)	4,000
• Sawlogs & Other	7,500

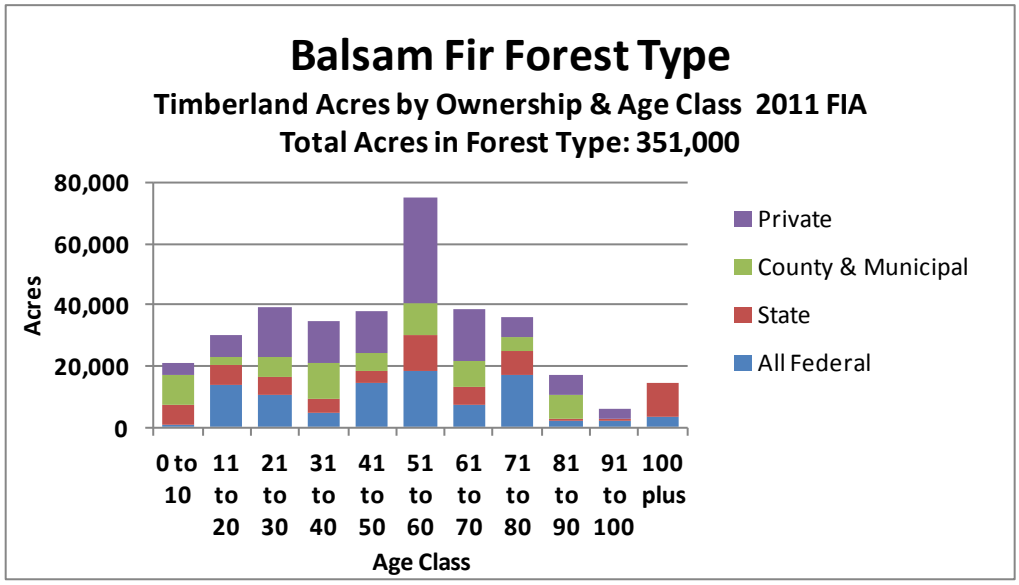
Source: NRS & DNR Surveys

Resource Opportunities

- High-quality balsam fir has excellent qualities for pulp & paper and stud manufacture.

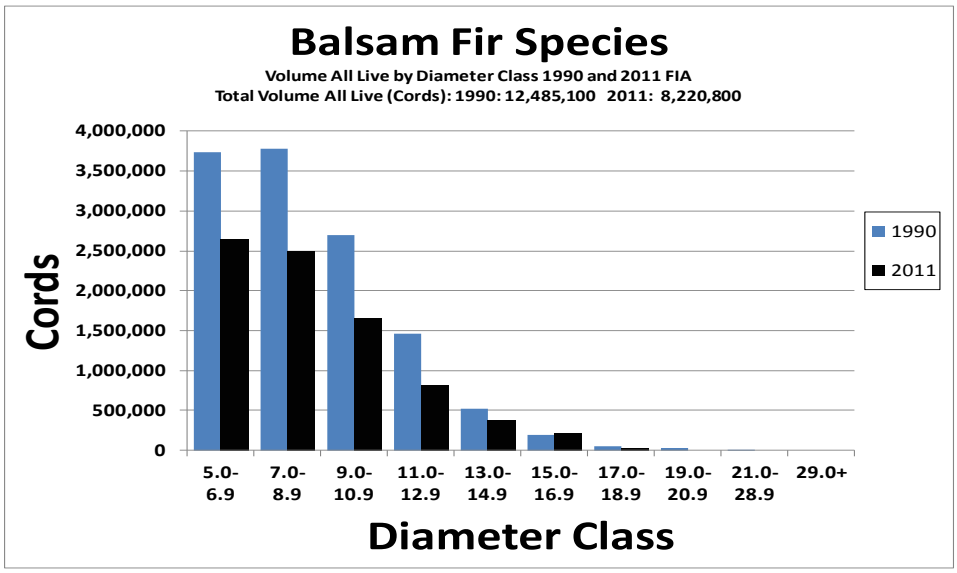
Resource Issues:

- Balsam availability dependent on harvest of aspen (37% of balsam fir in aspen type).
- Older stands are susceptible to spruce budworm impact. When there are concentrations of balsam fir over 45 to 50 years of age, spruce budworm will increase to take advantage of their preferred food source. If management favoring more conifers in stands, more extended rotation ages, more reserve trees and more mixed stands result in more balsam fir of older ages, then budworm populations will periodically build up to outbreak levels.
- Age class imbalance.
- Rot in older stands. High rot levels have a major impact on stand merchantability, and therefore ability to manage these stands. Rot is undesirable for higher-value wood products.



Source: 2011 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).

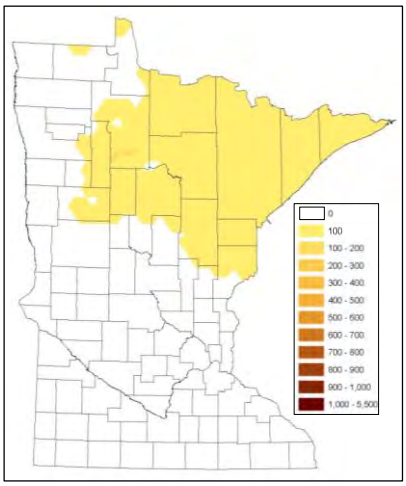


Source: FIA database provided by USFS, Northern Research Station

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

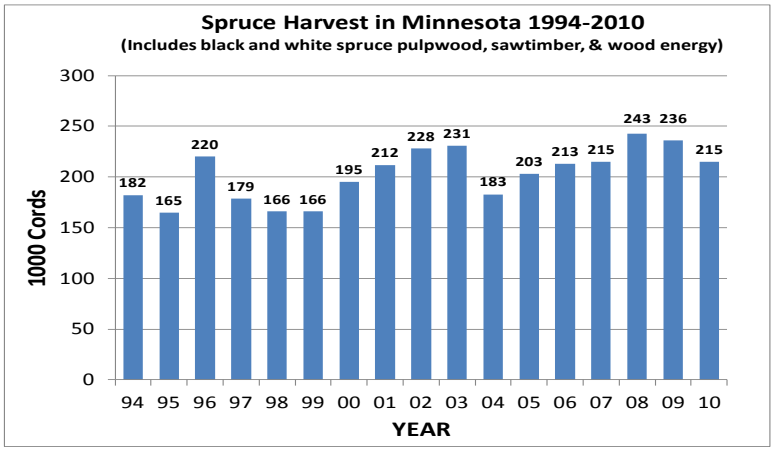
Predicted spatial distribution of balsam fir CUBIC FOOT volume of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees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

Minnesota's Spruce Resource



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

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 2011 FIA database, estimated average net annual growth of spruce growing stock: 416,300 cords, estimated average annual mortality of spruce growing stock: 186,300 cords.

Current Demand for Spruce from Minnesota Timberlands

	Cords
2010 Harvest	**214,900**
• Minnesota Pulpwood Industries	203,900
• Pulpwood Export (To Canada and Wisconsin)	3,200
• Sawlogs & Other	7,800

Source: NRS & DNR Surveys

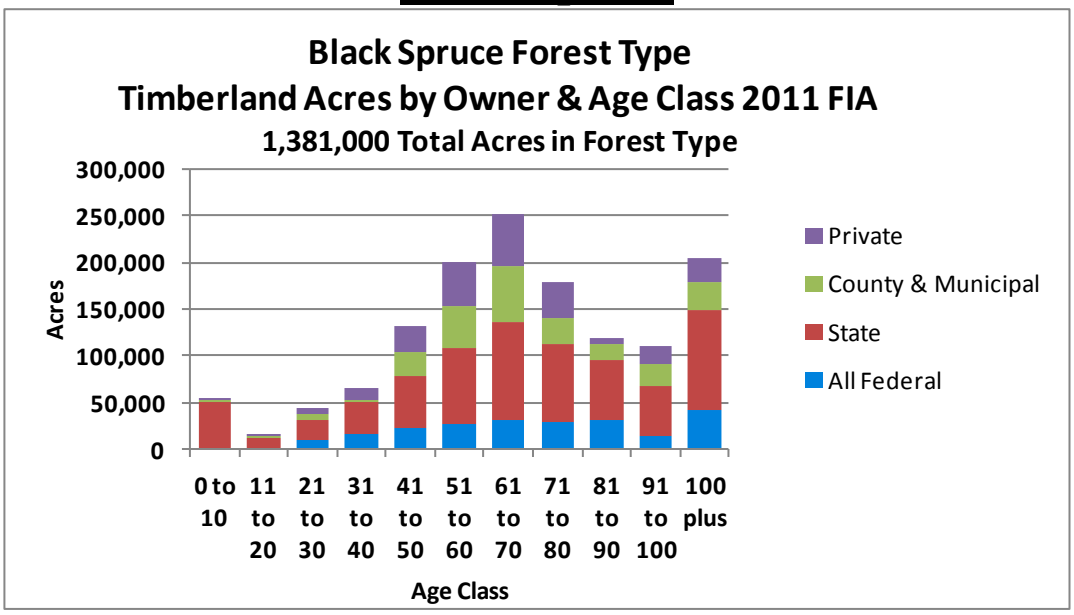
Resource Opportunities

- 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.
- 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. It can be lower volume productivity work for loggers, however.

Resource Issues:

- Many stands have very low volume/acre of spruce. This increases logging costs, which not only affects logger profitability, but can also impact production costs all the way to finished product. It can also impact the ability to manage some stands.
- Since black spruce is normally found on lowland sites only accessible during frozen conditions, accessibility of the resource is a major issue. Very little summer access.
- Spruce budworm has caused top kill and mortality on white spruce, including plantations. This impact can be lessened by management activities such as thinning to maintain stand vigor and by discriminating against balsam fir in some mixed stands.

Black Spruce

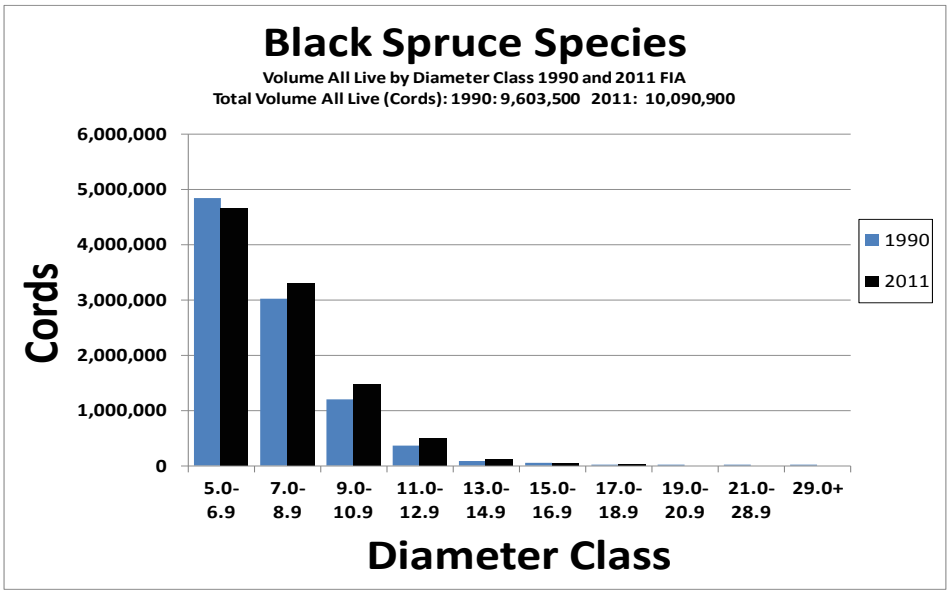


Source: 2011 FIA database provided by USFS, Northern Research Station

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

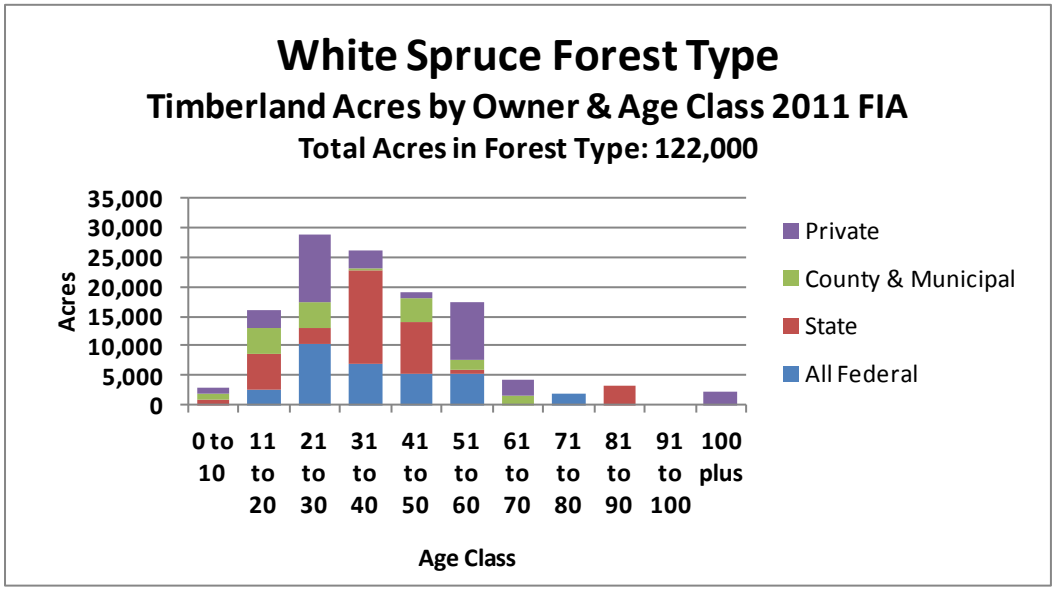
The State of Minnesota is by far the largest owner of black spruce cover type acres, but counties, private owners and our two national forests all have significant acreage.

The vast majority of black and white spruce in Minnesota (over 96%) 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.



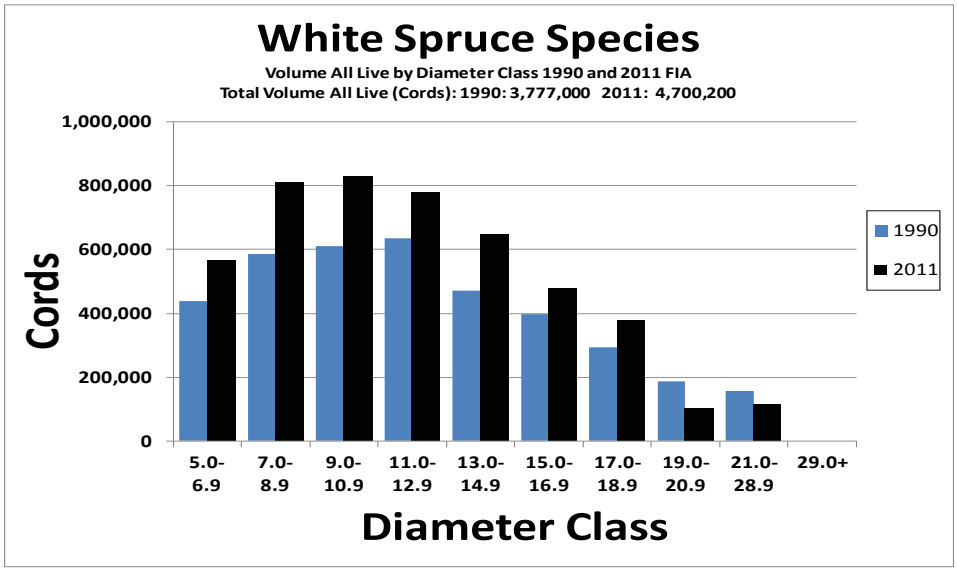
Source: FIA database provided by USFS, Northern Research Station

White Spruce



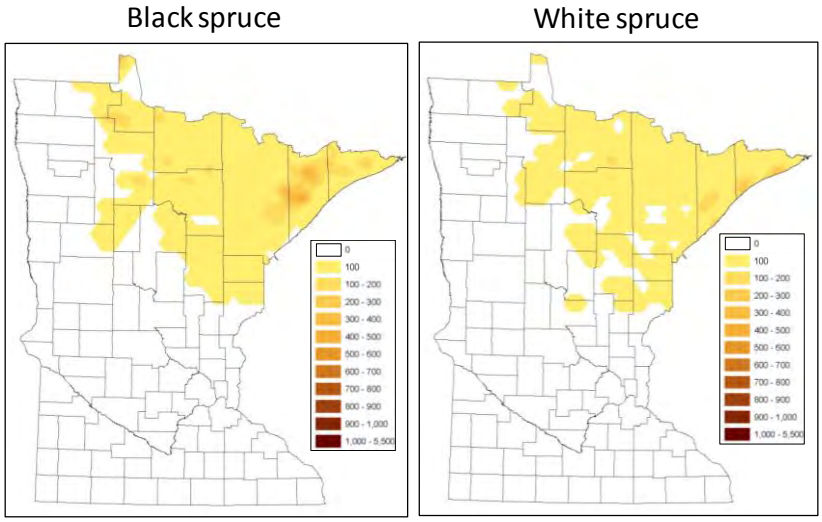
Source: 2011 FIA database provided by USFS, Northern Research Station

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. 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.



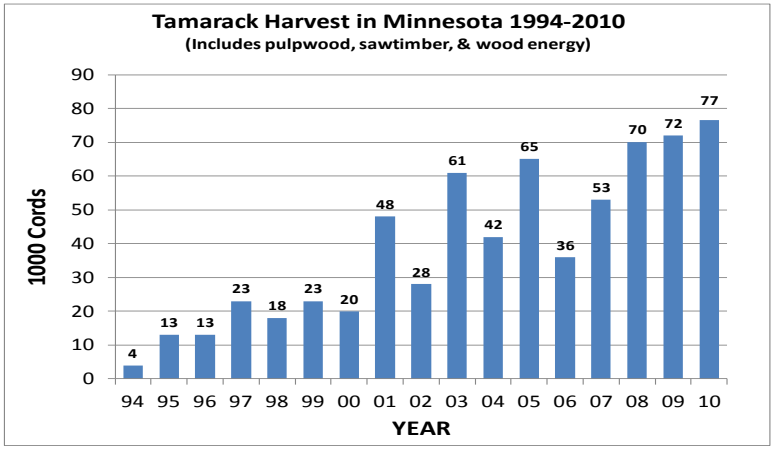
Source: FIA database provided by USFS, Northern Research Station

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.



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

Minnesota's Tamarack Resource



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

DNR estimated long-term annual sustainable harvest level = 114,800 cords/year. Based on the 2011 FIA database, estimated average net annual growth of tamarack growing stock: 62,300 cords, estimated average annual mortality of tamarack growing stock: 250,900 cords.

Current Demand for Tamarack from Minnesota Timberlands

	Cords
2010 Harvest	**76,700**
• Minnesota Pulpwood Industries	43,100
• Pulpwood Export (To Canada and Wisconsin)	8,300
• Sawlogs & Other	7,100
• Fuelwood	18,100

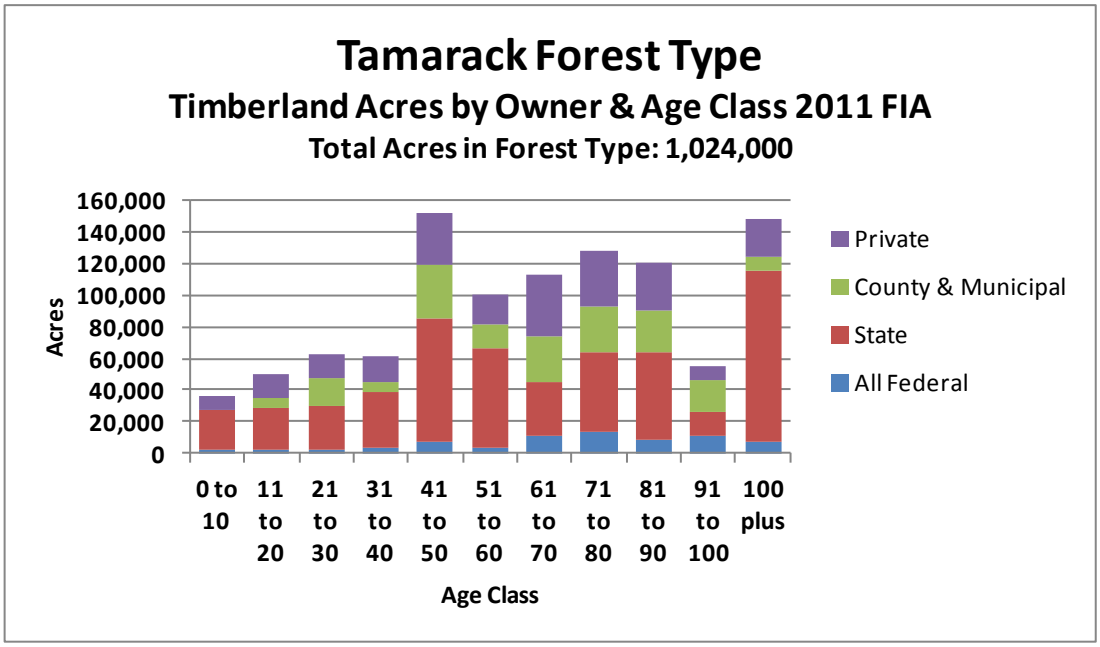
Source: NRS & DNR Surveys.

Resource Opportunities:

- Harvest is below long-term sustainable levels.

Resource Issues:

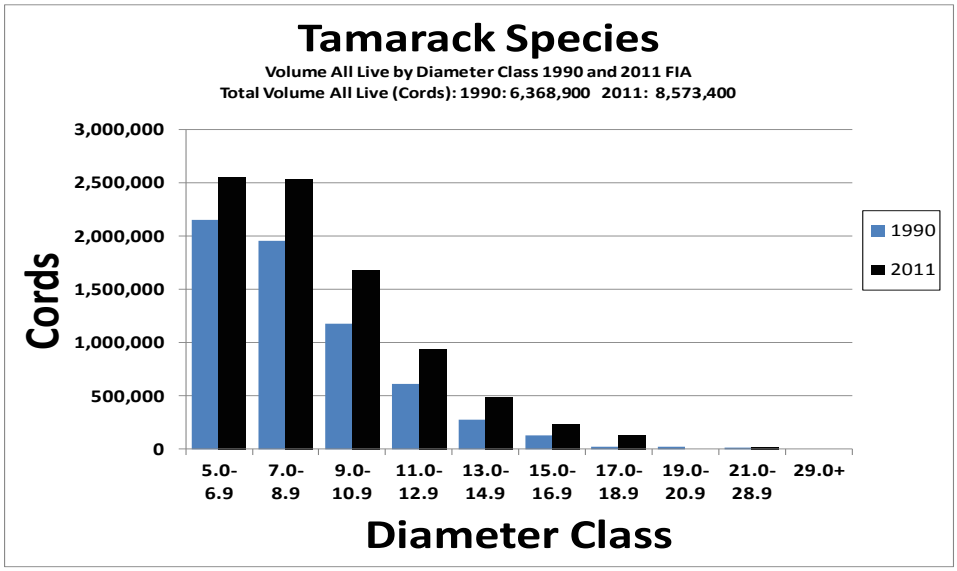
- Many stands have low volumes.
- Serious forest health and mortality issues, especially in older stands.
- Winter access only.
- Uncertain markets with closures of OSB mills that were significant consumers.
- Additional market development needed.
- Emerging markets include woody biomass energy and industrial lumber (pallets).



Source: 2011 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 50% of the tamarack cover type acreage.

Tamarack is used to a modest extent in the manufacture of OSB and Kraft pulp. Recently, biomass energy facilities have begun to use more tamarack. Markets for tamarack have therefore improved somewhat since the 1990s, although stumpage prices still remain quite low.

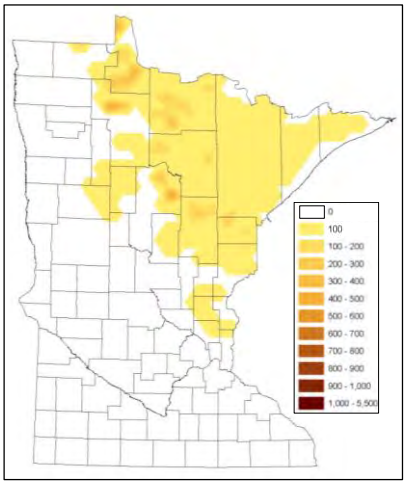


Source: FIA database provided by USFS, Northern Research Station

Total volume of tamarack has risen substantially since 1990.

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.

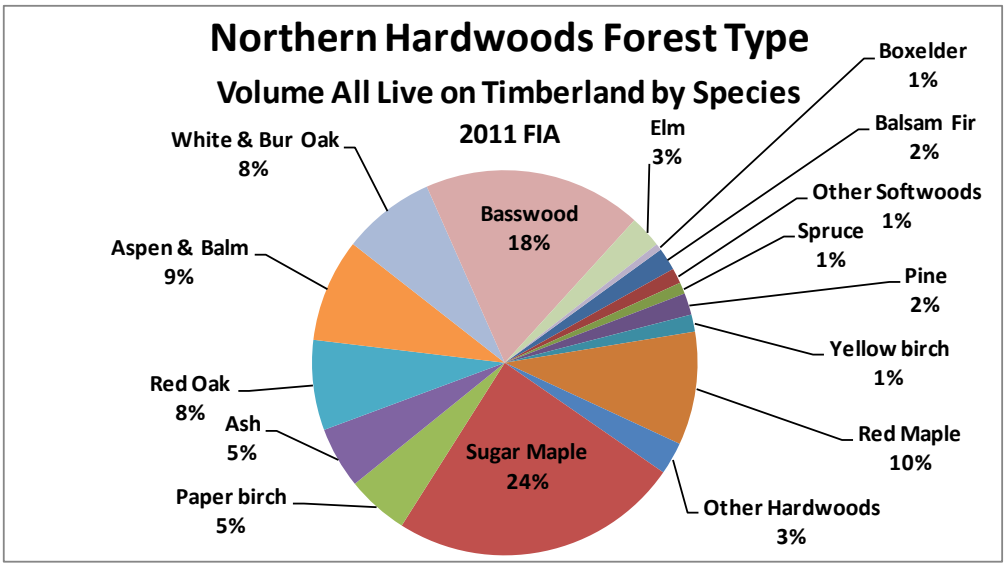
Tamarack



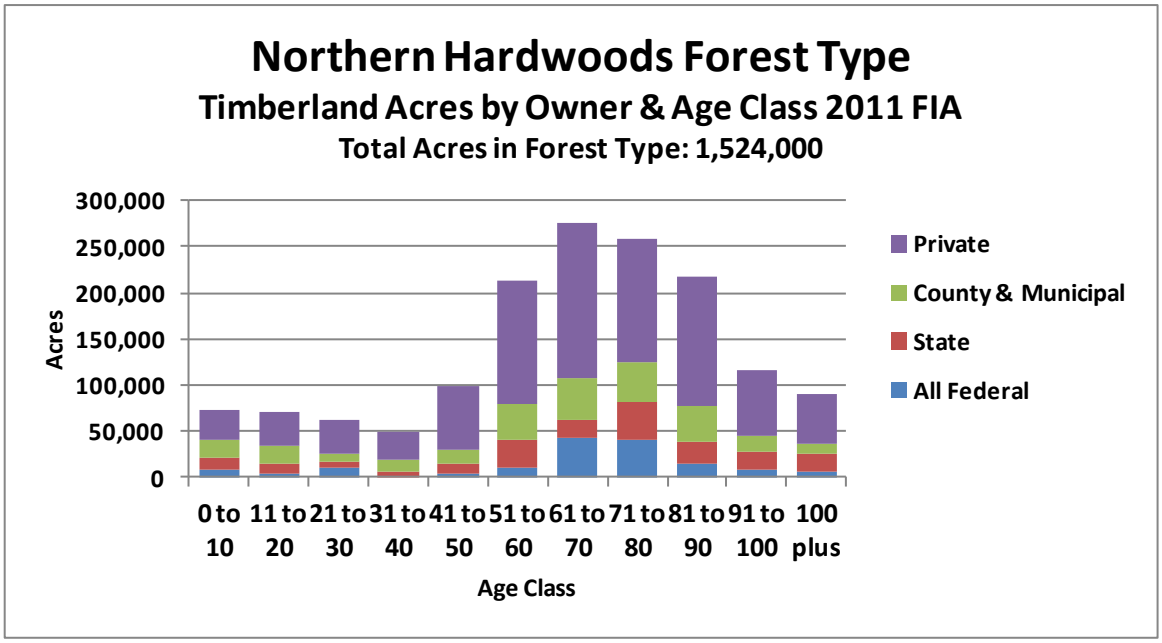
Source: 2010 FIA database provided by USFS, Northern Research Station

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.



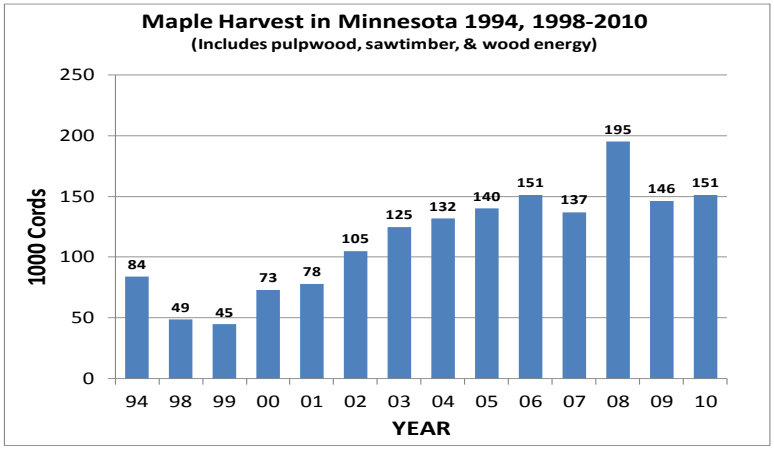
Source: 2011 FIA database provided by USFS, Northern Research Station



Source: 2011 FIA database provided by USFS, Northern Research Station

The northern hardwoods cover type is dominated by late "middle aged" stands (average rotation age = 80), many of which are in need of thinning in order to promote optimal growth and forest health. Northern hardwoods are often managed through periodic "thinning" harvests (or partial cuts), although clearcutting can be an appropriate tool in some situations. The northern hardwoods cover type is owned largely by private landowners. Continuing and improved availability and use of forest management technical assistance to private landowners is therefore a critical issue for this type. Our northern hardwoods cover type has been something of a "neglected" resource for many years. This has largely been due to a history of poor markets for many hardwood species and sizes in much of the state. The market situation for most hardwoods has changed drastically in recent years, however. Several Minnesota pulp and paper and OSB mills now use maple and other hardwoods.

Maple



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

DNR estimated long-term annual sustainable harvest level = 429,600 cords. Based on the 2011 FIA database, estimated average annual net growth for maple growing stock in Minnesota is 460,800 cords, estimated average annual mortality of maple growing stock is 163,900 cords.

Current Demand for Maple from Minnesota Timberlands

	Cords
2010 Harvest……..	**150,900**
• Minnesota Pulpwood Industries…….…….…...	95,800
• Pulpwood Export (To Wisconsin)..…….....	16,200
• Sawlogs & Other……..…..….	5,300
• Fuelwood……...……..	33,600

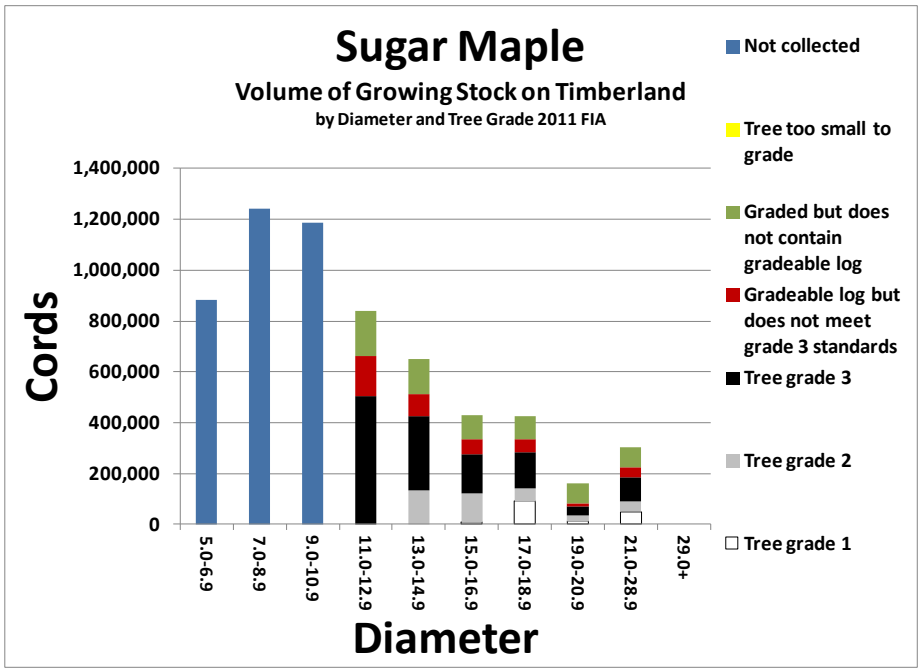
Source: NRS & DNR Surveys.

Resource Opportunities:

- Harvest is well below long-term sustainable levels.
- Investments in appropriate harvesting equipment can improve ability to manage this resource.

Resource Issues:

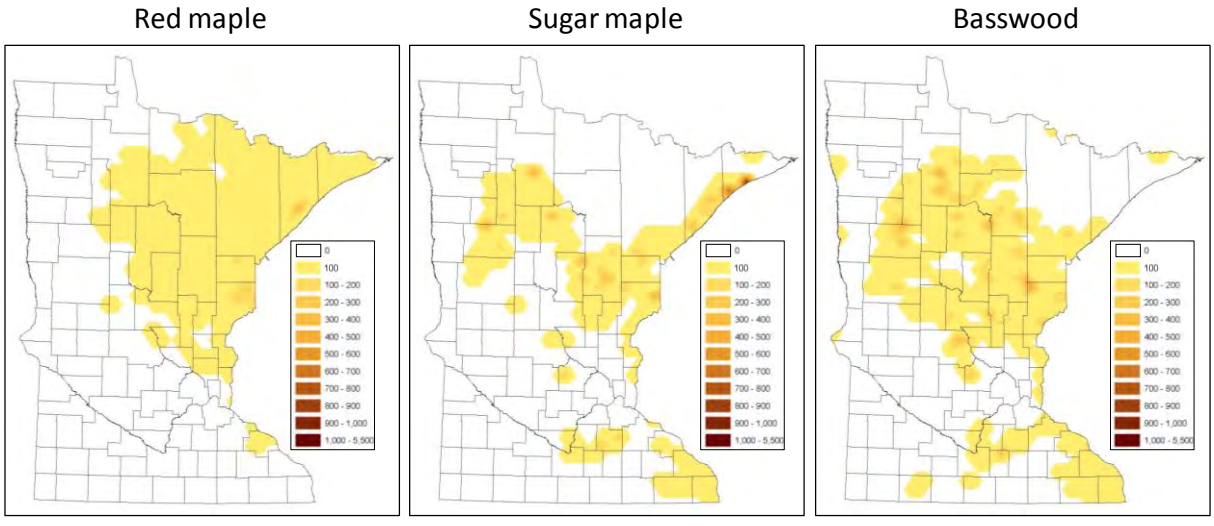
- Much of the maple resource is in private ownership, so managing it will require significant efforts in private landowner incentives and assistance.
- Different logging equipment and intensity of management required in multiple-entry management.



Source: 2011 FIA database provided by USFS, Northern Research Station
Note: Tree grade 1 = highest quality in the USFS tree grading system

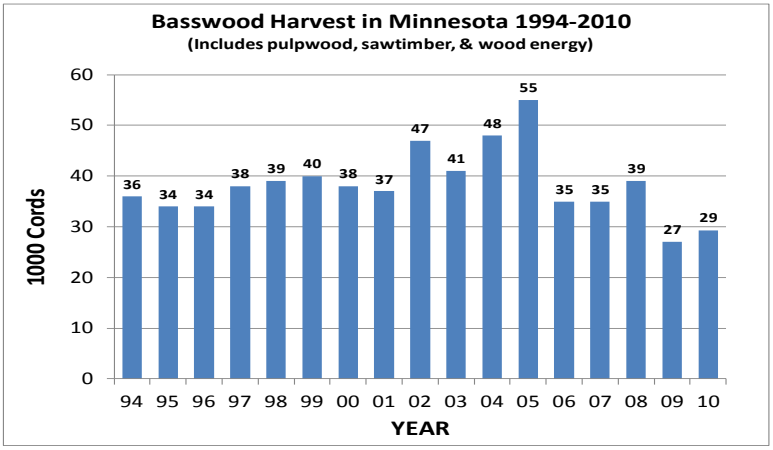
Minnesota's maple resource is made up of 4 species: sugar maple, red maple, silver maple and black maple. Sugar maple in much of Minnesota tends to be of fairly low sawlog quality, due to relatively small size and poor form. We are on the western edge of its natural growing range. However, some higher 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

Basswood



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

DNR estimated long-term annual sustainable harvest level = 280,300 cords. Based on the 2011 FIA database, estimated net annual basswood growth: 224,700 cords, estimated annual mortality: 112,900 cords.

Current Demand for Basswood from Minnesota Timberlands

	Cords
2010 Harvest	**29,300**
• Minnesota Pulpwood Industries	8,600
• Pulpwood Export (To Wisconsin)	1,900
• Sawlogs & Other	12,500
• Fuelwood	6,300

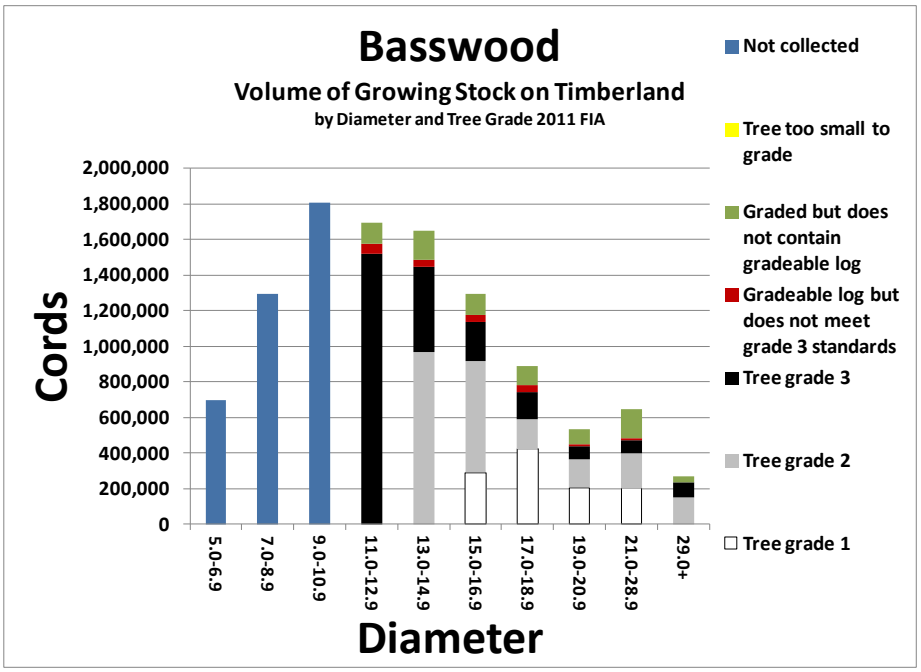
Source: NRS & DNR Surveys.

Resource Opportunities

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

Resource Issues

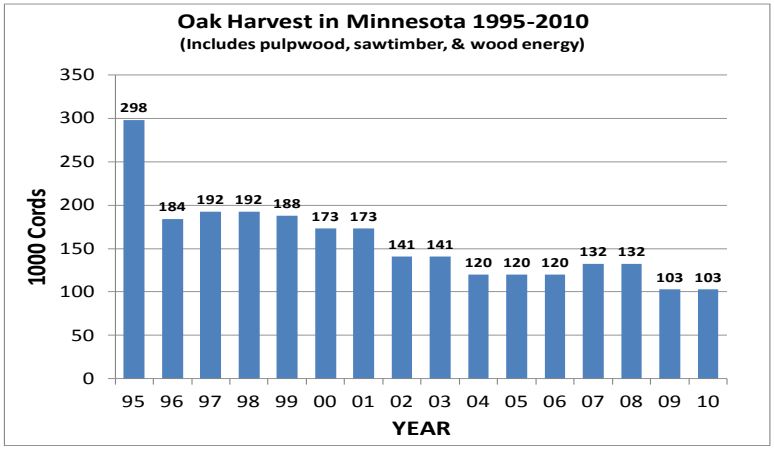
- Much of the basswood resource is in private ownership, so managing it will require significant efforts in private landowner incentives and assistance.
- Potential for harvest of high-quality stems as "pulpwood" on productive sites prior to their reaching sawlog size on private lands. Important to get quality material to higher-value markets.
- Different logging equipment and intensity of management required in multiple-entry management.



Source: 2011 FIA database provided by USFS, Northern Research Station.
Note: Tree grade 1 = highest quality in the USFS tree grading system

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

Minnesota's Oak Resource



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

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
2010 Harvest	**103,100**
• Minnesota Pulpwood Industries	0
• Pulpwood Export (To Wisconsin)	200
• Sawlogs & Other	43,500
• Fuelwood	59,400

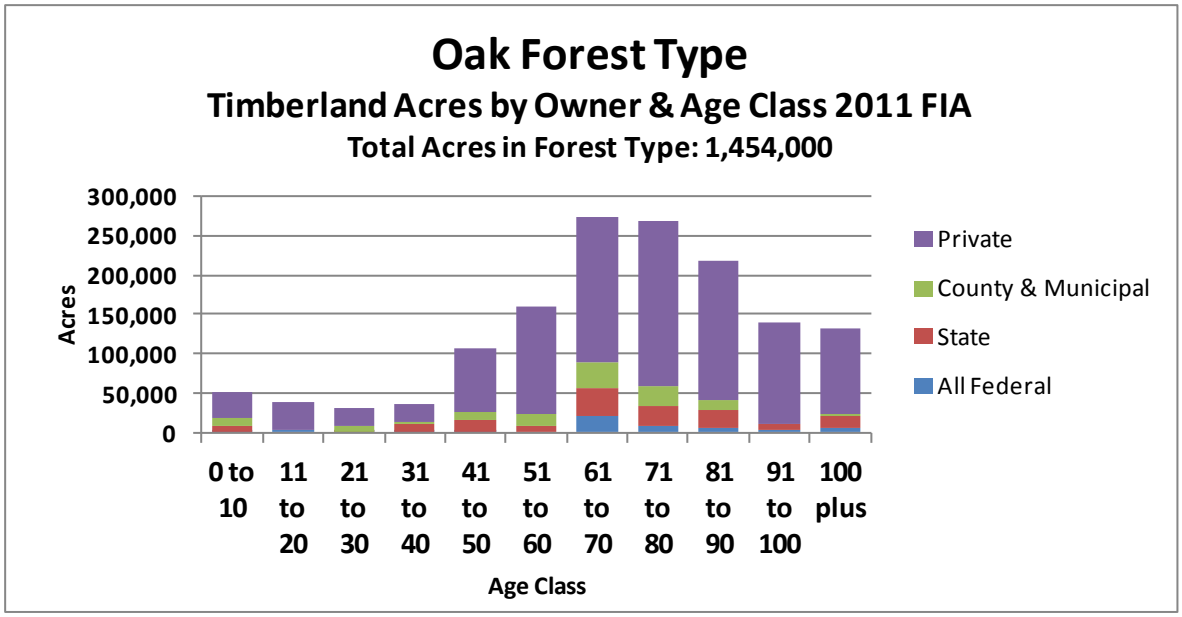
Source: NRS & DNR Surveys.

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.

Resource Issues:

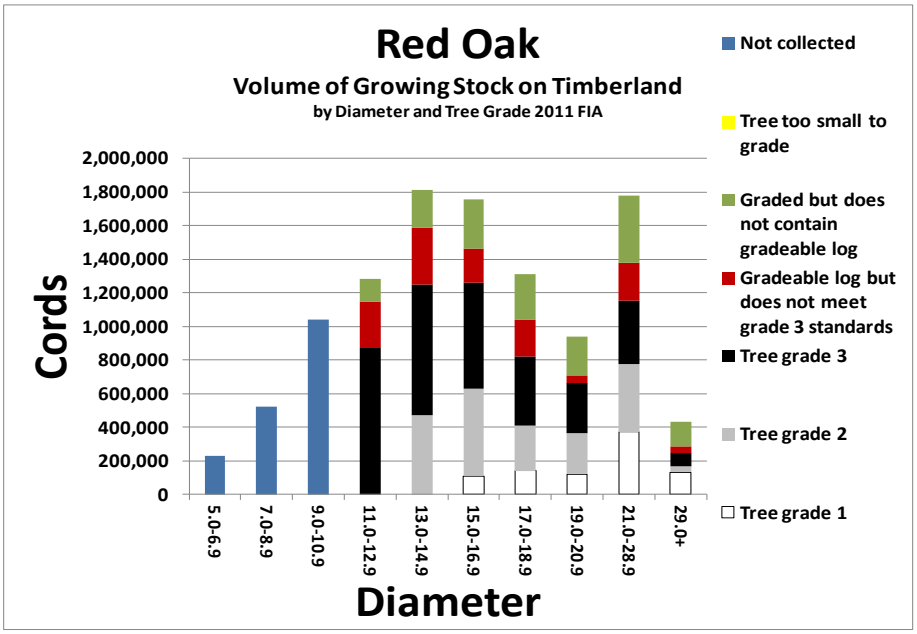
- High quality red oak sawlog resource continues to decline.
- Gypsy moth invasion making its way into Minnesota will have a negative impact on oak resource.



Source: 2011 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 2011 FIA data, estimated net annual oak growth: 591,700 cords; estimated annual oak mortality: 231,900 cords.

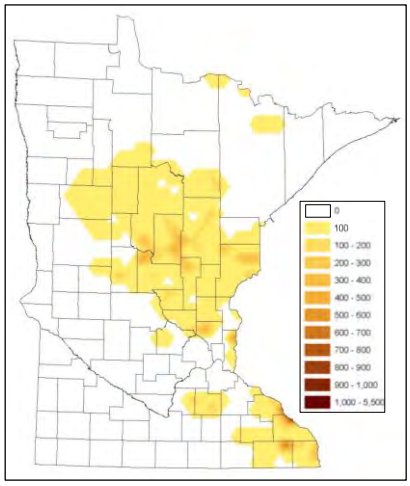


Source: 2011 FIA database provided by USFS, Northern Research Station (includes black oak, northern pin oak, and northern red oak).
Note: Tree grade 1 = highest quality in the USFS tree grading system

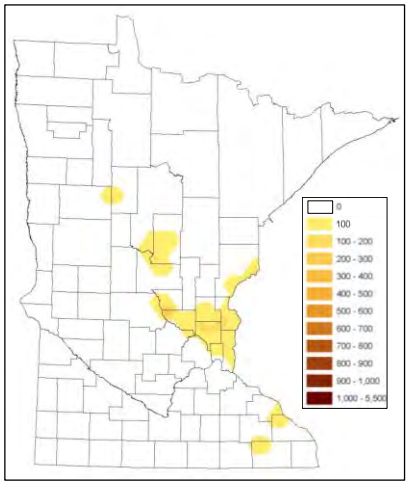
Some high quality sawlog and veneer red oak is grown on good sites in Minnesota.

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.

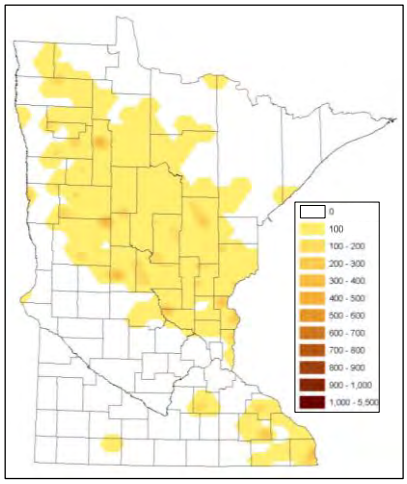
Northern red oak



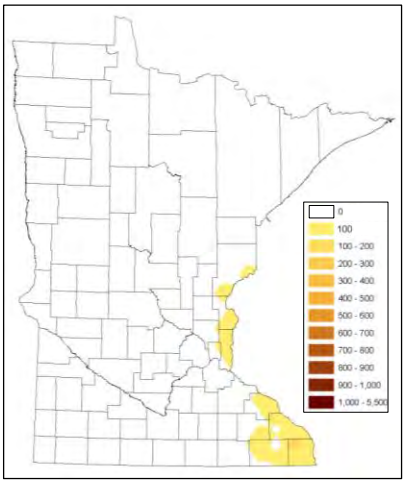
Northern pin oak



Bur oak

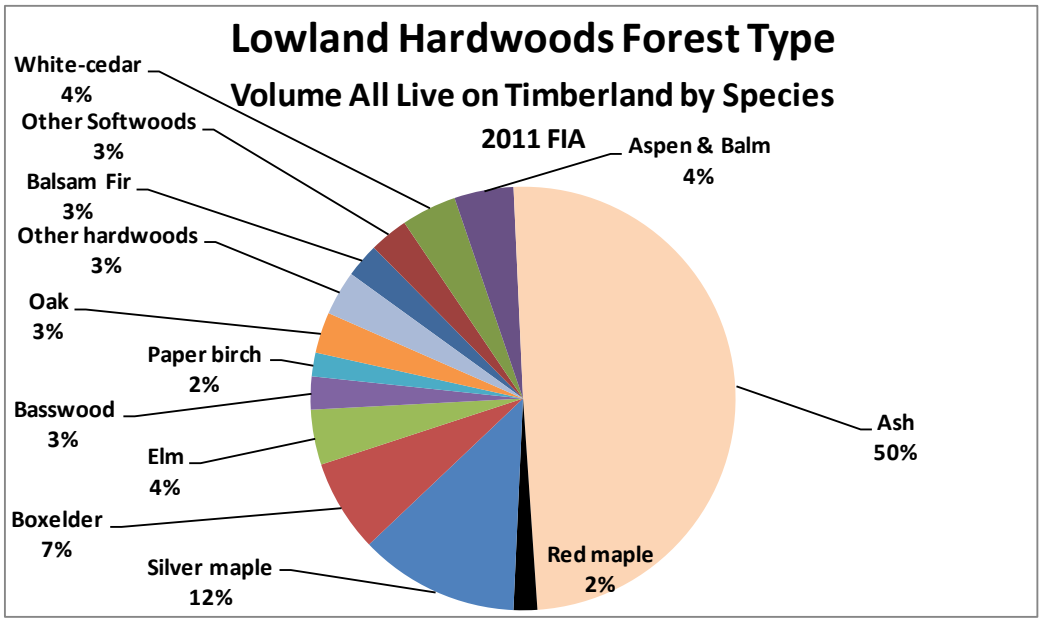


White oak



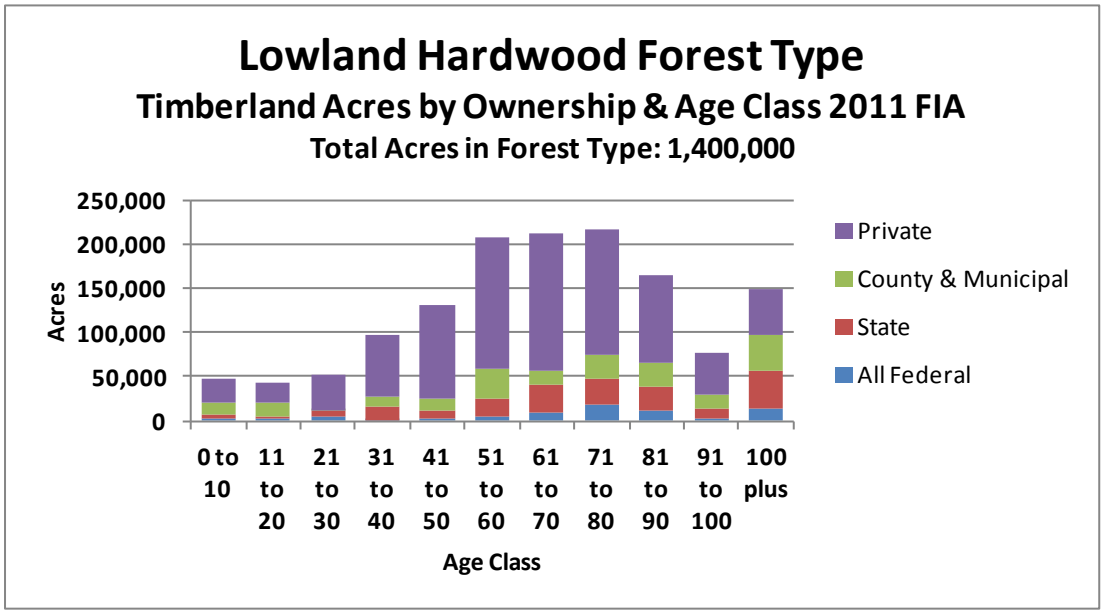
Source: 2010 FIA database provided by USFS, Northern Research Station

Minnesota's Lowland Hardwoods Resource



Source: 2011 FIA database provided by USFS, Northern Research Station

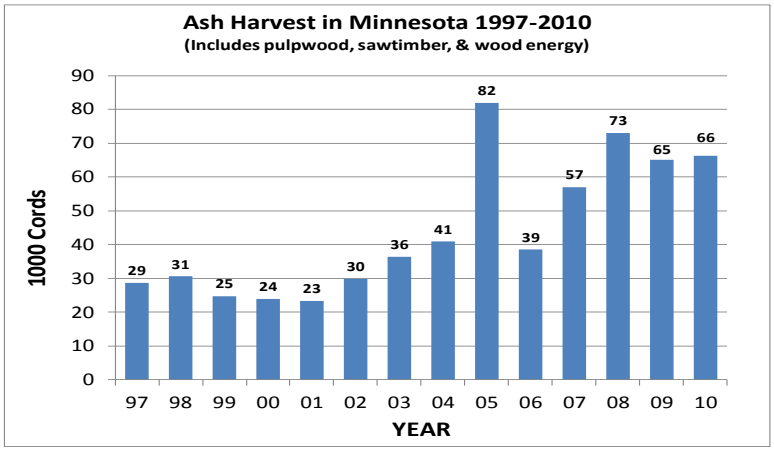
The lowland hardwoods cover type is made up of a variety of species. Most prevalent are black ash, green ash, silver maple, and boxelder.



Source: 2011 FIA database provided by USFS, Northern Research Station

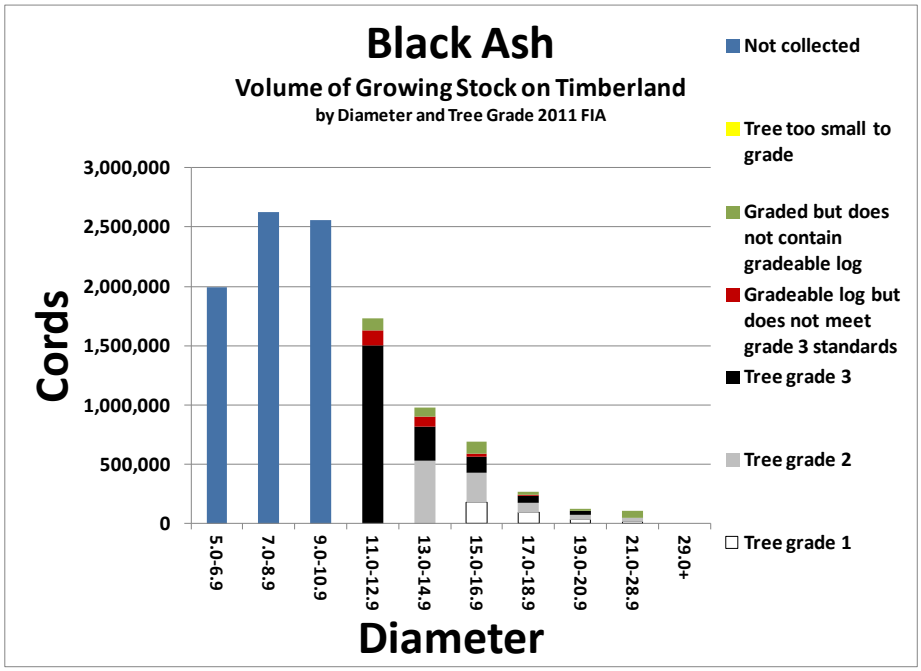
The lowland hardwood cover type is dominated by late "middle age" stands. A common rotation age for black ash is 90 years.

Minnesota's Ash Resource



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

Ash has not had a pulpwood market until recently, when several mills began using it. DNR estimated long-term annual sustainable harvest level for ash = 353,600 cords. Based on 2011 FIA data, estimated net annual ash growth: 487,900 cords; estimated annual mortality: 175,700 cords.



Source: 2011 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
2010 Harvest	**66,300**
• Minnesota Pulpwood Industries	16,300
• Pulpwood Export (To Wisconsin)	2,700
• Sawlogs & Other (including fuel)	47,300

Source: NRS & DNR Surveys.

Resource Opportunities

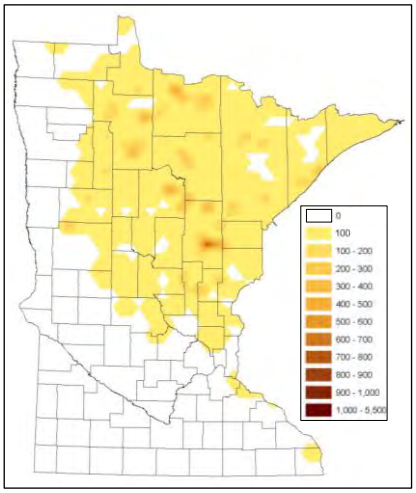
- Harvest is well below long-term sustainable levels.

Resource Issues

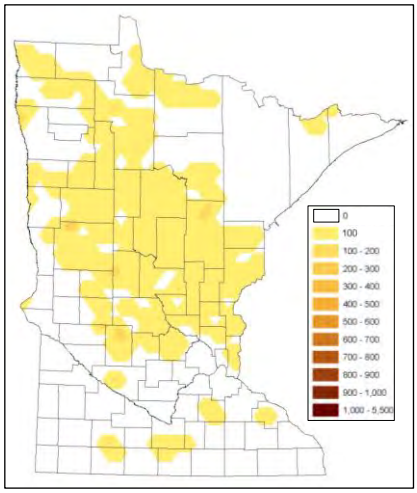
- Serious health concerns in black ash.
- Sorting high quality ash for highest value markets.
- Invasive Emerald Ash Borer found in Minnesota.

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.

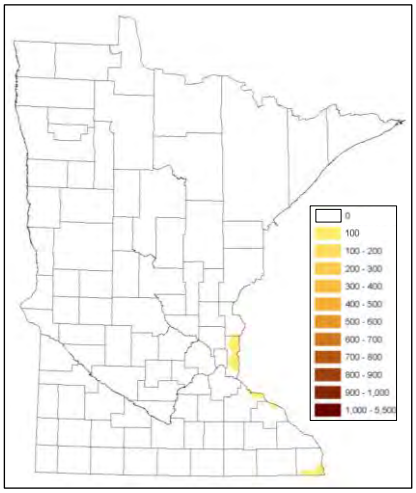
Black ash



Green ash



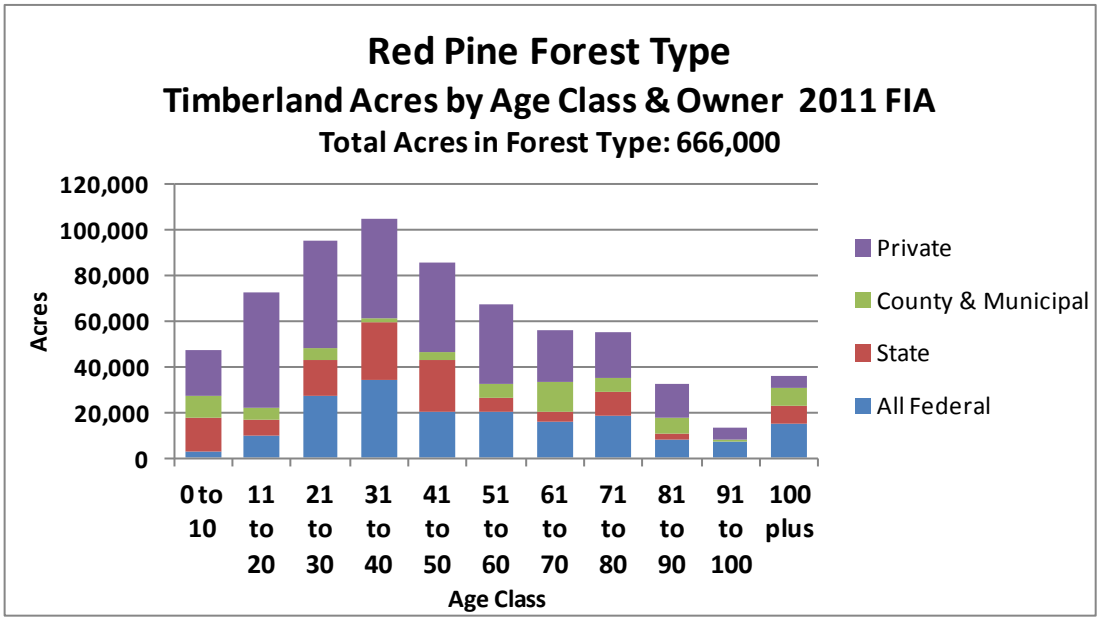
White ash



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

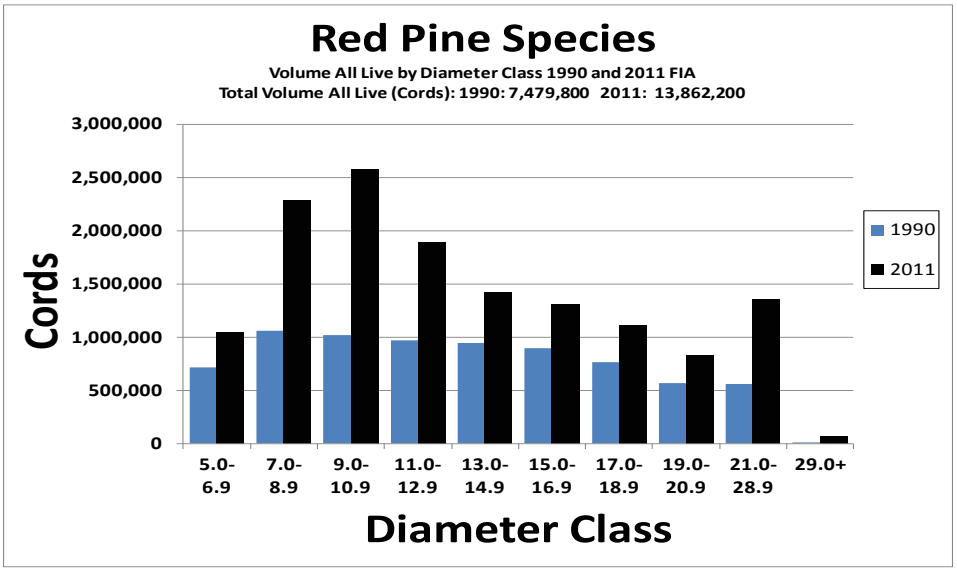
Minnesota's Pine Resource

Red Pine



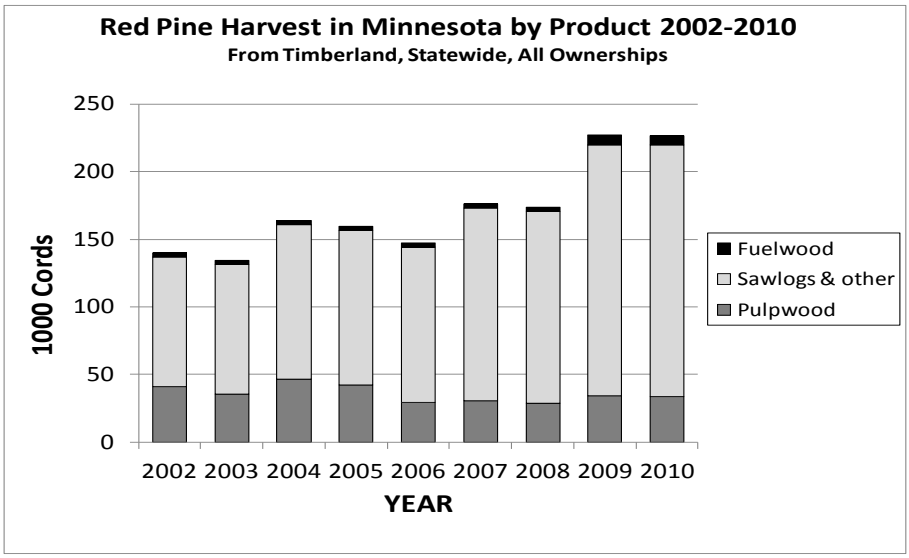
Source: 2011 FIA database provided by USFS, Northern Research Station

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.



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.



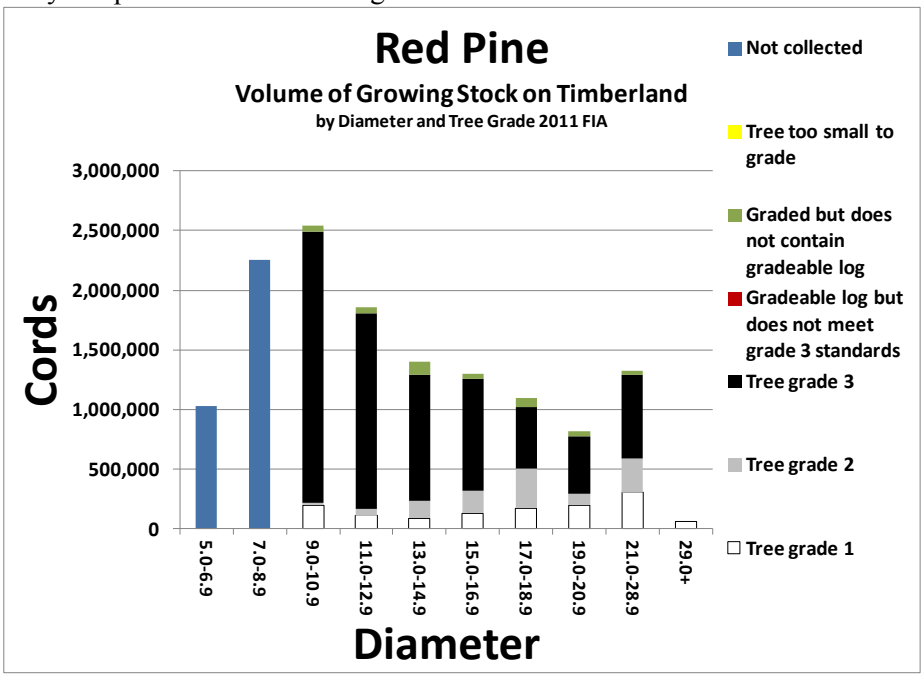
Source: Harvest data compiled by USFS, Northern Research Station & DNR

DNR estimated long-term annual all-ownership sustainable harvest level is approximately 345,000 cords*. Based on 2011 FIA data, average net annual growth of red pine growing stock: 640,900 cords; average annual mortality: 23,700 cords.

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

Resource Opportunities

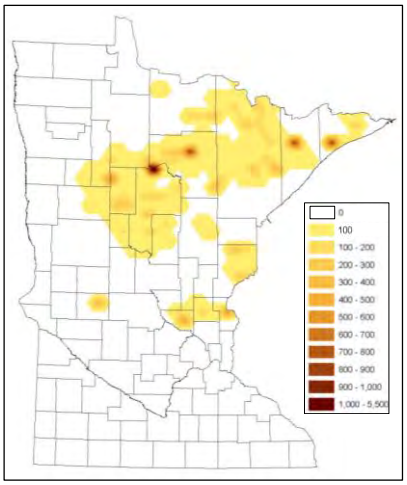
- Many red pine stands are moving into size classes that will benefit from additional thinning.



Source: 2011 FIA database provided by USFS, Northern Research Station
Note: Tree grade 1 = highest quality in the USFS tree grading system

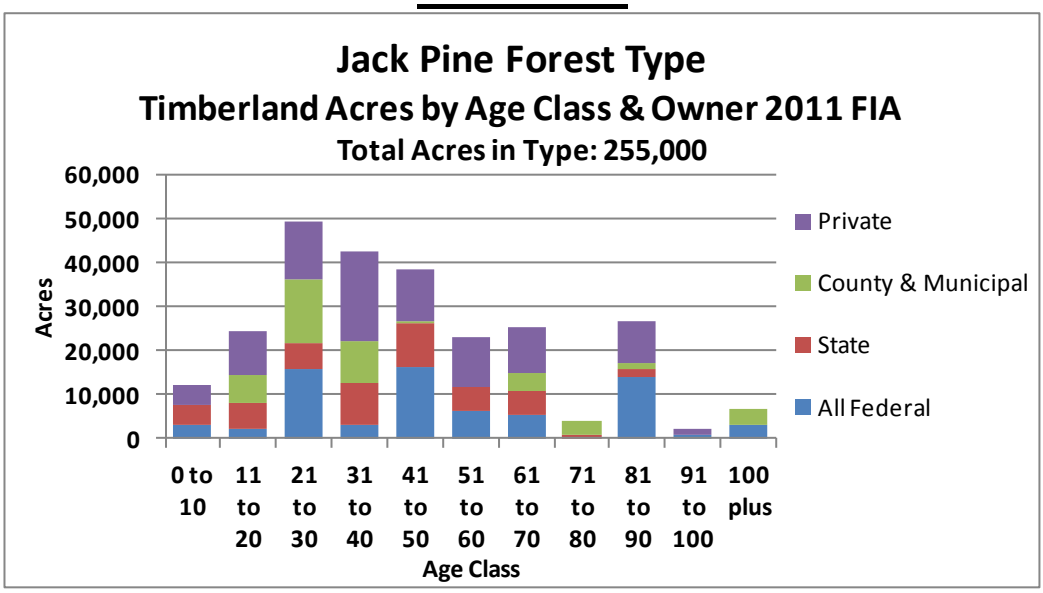
Predicted spatial distribution of red pine CUBIC FOOT volume of trees with a diameter of 5 inches and greater. Maps are constructed using interpolative procedures among FIA plots. This map doesn't necessarily indicate where individual trees of a species are found, but rather where individual trees of 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

Jack Pine

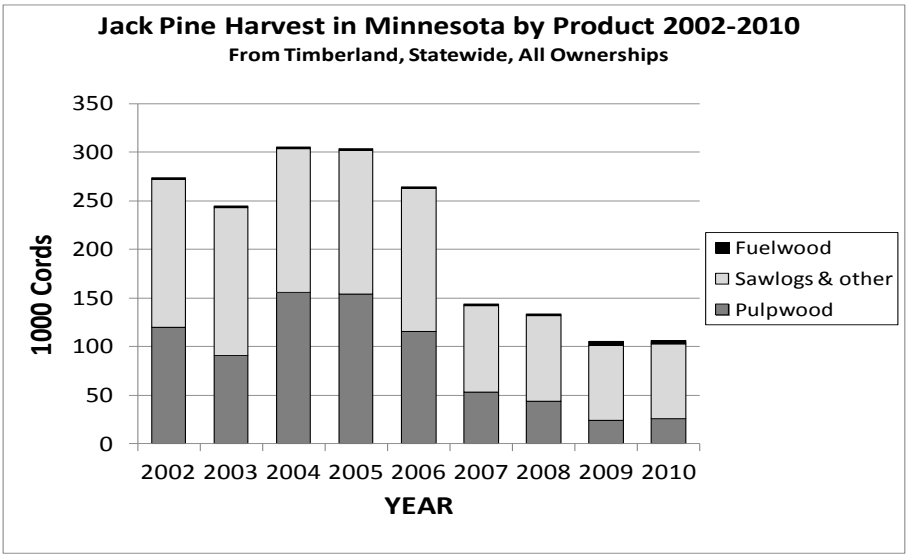


Source: 2011 FIA database provided by USFS, Northern Research Station

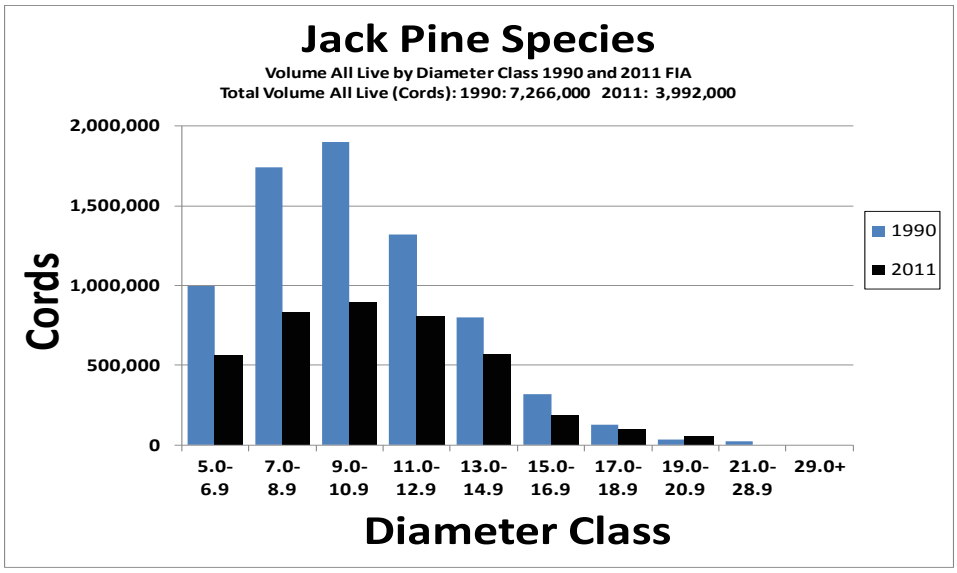
Ownership of the jack pine resource is well-distributed between the major ownership groups. Private landowners control the largest total acreage, but the federal government has by far the largest resource as a proportion of its total ownership. The jack pine cover type is heavily weighted to the 21 to 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.

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.

Based on 2011 USFS FIA data, average net annual growth of jack pine growing stock: 104,500 cords; average annual mortality of jack pine growing stock: 81,300 cords.



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

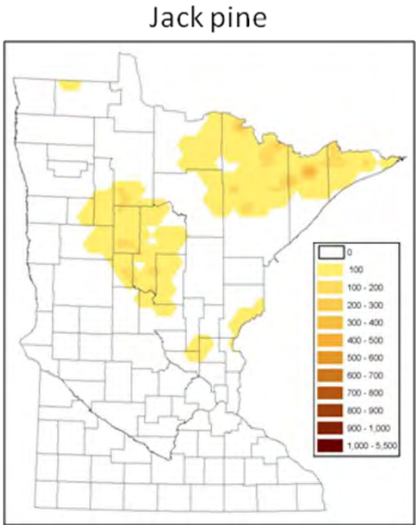


Source: FIA database provided by USFS, Northern Research Station

Jack pine total volume of all live has declined from 7,266,000 cords in 1990 to 3,992,000 cords in 2011 – a 45% decrease.

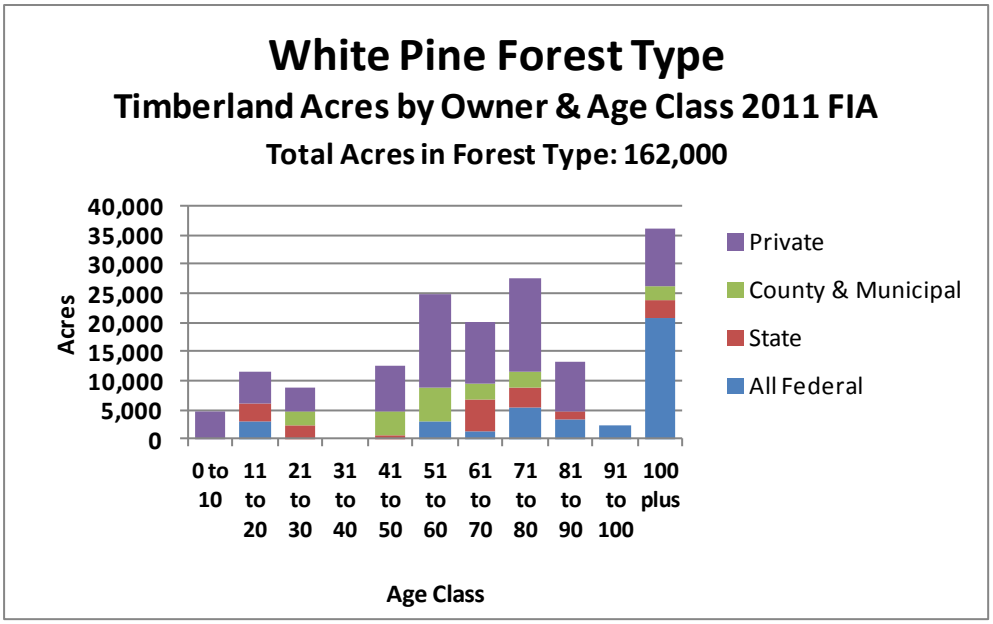
The vast majority of jack pine volume is found in trees with diameters smaller than 15 inches.

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.



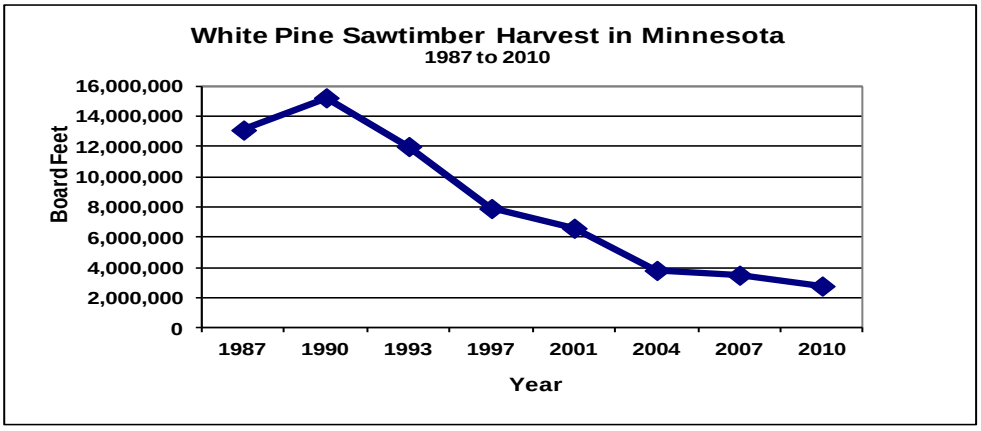
Source: 2010 FIA database provided by USFS, Northern Research Station

White Pine



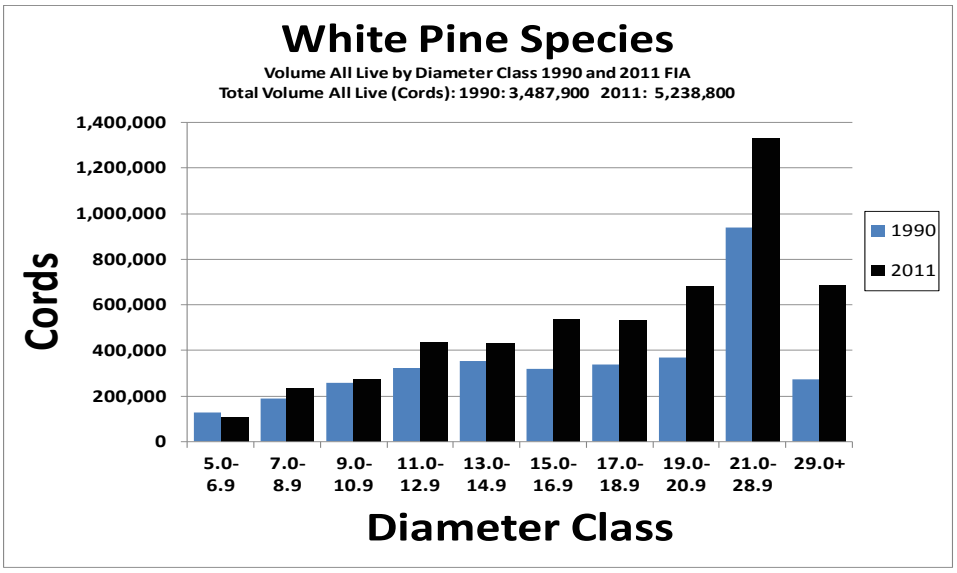
Source: 2011 FIA database provided by USFS, Northern Research Station

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.

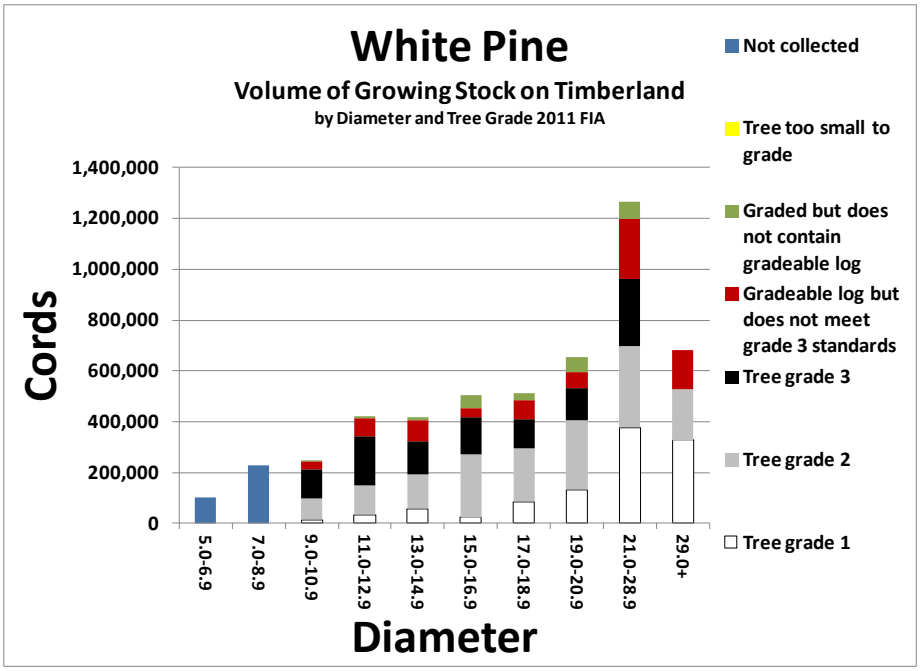


Source: MN DNR sawmill surveys

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 2011 FIA data, average net annual growth of white pine growing stock: 183,000 cords; average annual mortality: 36,300 cords.



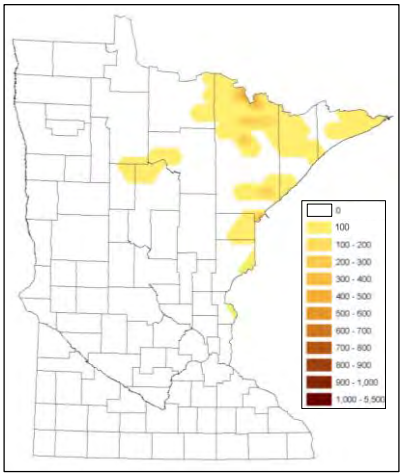
Source: FIA database provided by USFS, Northern Research Station



Source: 2011 FIA database provided by USFS, Northern Research Station
Note: Tree grade 1 = highest quality in the USFS tree grading system

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.

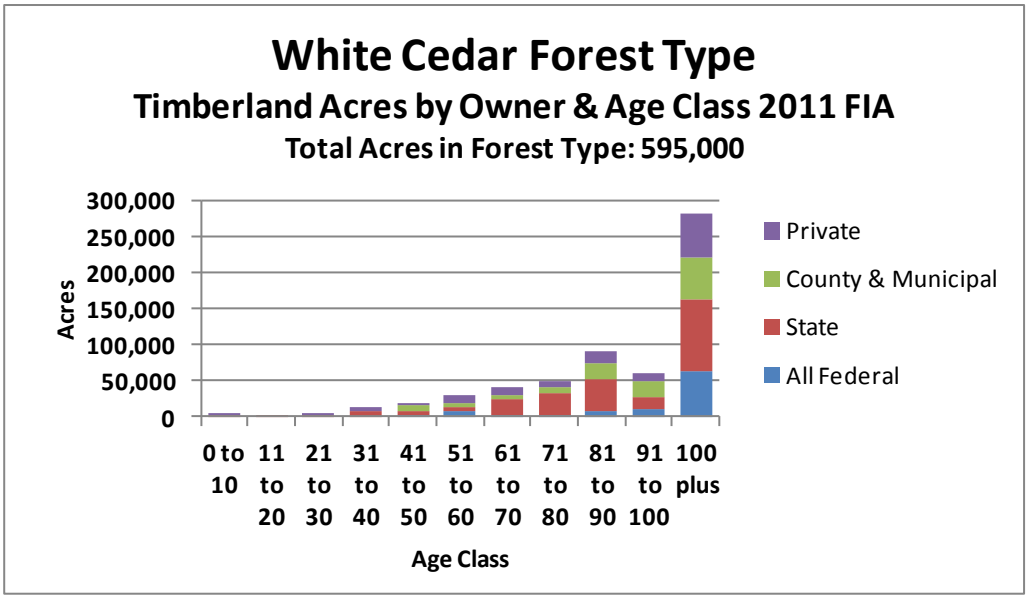
Eastern white pine



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

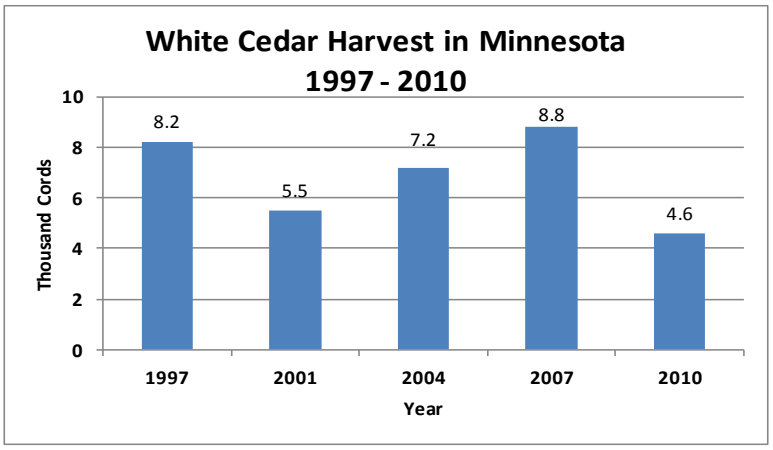
Minnesota's White Cedar Resource

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, balsam fir, birch, ash and several other minor species. Significant volumes of cedar can also be found mixed with other lowland cover types and it also exists as a minor component of some upland cover types. Cedar is significant because it provides critical habitat for white-tailed deer and for many rare plant species including the threatened ram's head orchid, and because it is a potentially valuable timber resource.



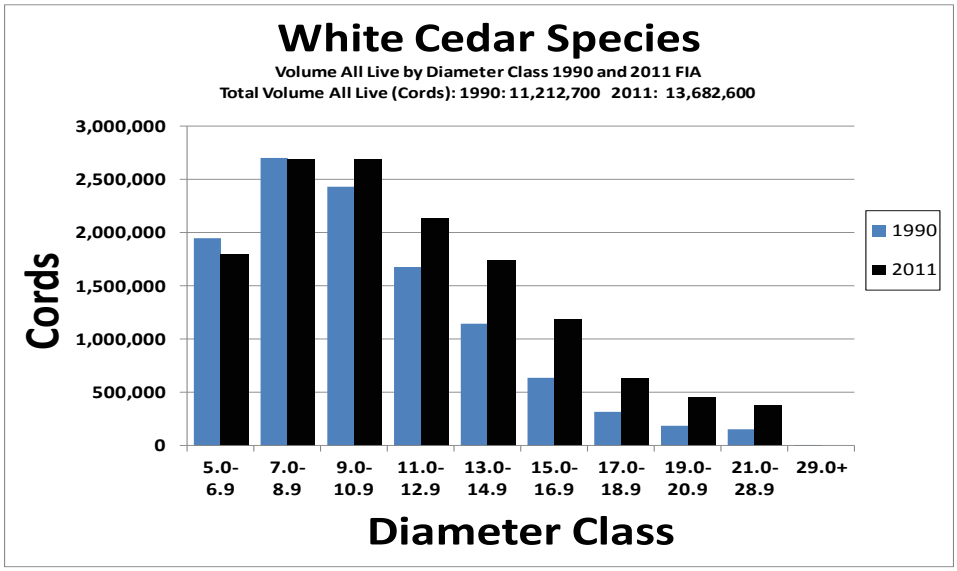
Source: 2011 FIA database provided by USFS, Northern Research Station

White cedar is generally an old resource, and it is getting older: around 282,000 cover type acres exist in stands over age 100, with less than 9,600 cover type acres below age 30. Much of the white cedar resource exists on very wet sites, many of which have low productivity and slow growth. High amounts of heart rot are common in older stands on wet sites. Much of the volume of white cedar is contained in material below 13 inches in diameter.



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

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 214,900 cords, and average annual mortality is approximately 43,400 cords, according to the 2011 FIA inventory. Annual harvest is less than 5,000 cords, so 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

Resource Opportunities:

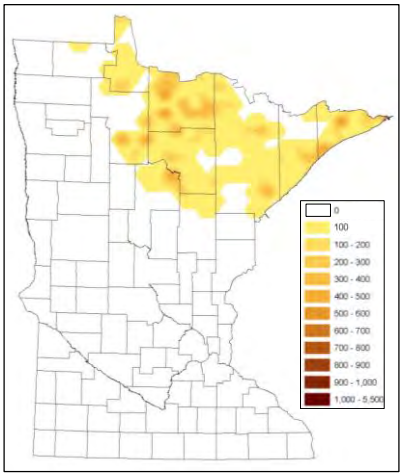
- Cedar can be a great fit for some high-value products due to its natural decay resistance.

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 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, but doesn't often regenerate naturally.

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

Timber Price Information

Average Prices Received by Product for Stumpage Sold by Public Land Agencies in Minnesota: 2000-2011

Average Prices Received for Stumpage Sold by Public Land Agencies in Minnesota: 2000-2011

Notes:

- Average prices based on those reported by Minnesota Counties (Aitkin, Becker, Beltrami, Carlton, Cass, Clearwater, Crow Wing, Hubbard, Itasca, Koochiching, Lake, Pine, and St. Louis), 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.

Pulpwood ($ per cord)												
Species	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Aspen	25.28	28.76	27.36	28.95	37.20	59.70	47.52	27.50	26.14	23.07	25.16	25.55
Balm	25.27	32.06	27.53	25.12	31.71	45.25	38.85	17.00	21.18	20.83	21.22	20.01
Birch	7.69	8.31	8.16	9.04	12.21	20.57	14.76	9.68	9.06	9.17	8.48	9.41
Ash	4.09	3.91	5.86	3.62	5.51	5.43	8.22	6.21	6.86	8.73	6.97	7.41
Oak	9.27	7.74	5.77	4.35	8.28	16.28	18.27	16.23	8.39	15.32	13.41	11.29
Basswood	5.68	5.48	6.51	6.05	6.58	10.64	8.06	10.35	7.41	8.10	7.50	7.58
Balsam Fir	14.84	14.61	13.99	13.46	21.12	33.54	30.56	18.36	15.98	14.67	16.10	17.91
W. Spruce	32.63	29.90	30.51	21.87	31.80	43.39	35.06*	21.49	18.69*	17.44*	21.58*	17.91
B. Spruce	22.23	29.17	27.05	31.96	31.50	43.39	35.06*	21.49	20.05			23.14
Tamarack	5.67	6.40	4.11	4.56	6.42	9.84	5.96	3.18	4.61	5.01	5.03	5.51
W. Cedar	8.46	6.74	7.06	4.68	4.60	5.50	9.26	6.39	4.10	5.44	6.19	8.21
J. Pine	21.94	21.63	22.18	21.37	29.46	30.66	37.62	28.50	9.87	13.02	17.21	8.06
R&W Pine	18.61	20.79	20.99	19.55	19.18	29.06	36.59	27.15	11.99	16.22	9.08	18.06
Maple	---	---	---	---	---	13.30	7.98	7.91	8.86	8.06	9.21	8.99
---Insufficient data.												
* Spruce Species												

In 2011, across all species and as reported on public lands, a total of 72,831 tons of biomass was sold for bioenergy consumption with an average price of $1.17 per ton.

Pulp & Bolts in Combination*												
($ per cord)												
Species	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Aspen	28.66	34.33	30.80	34.52	40.94	65.14	45.58	28.44	37.63	36.79	---	---
Balm	25.41	32.57	28.35	28.21	34.15	47.09	34.73	23.70	---	---	---	---
Birch	9.45	10.40	10.18	12.61	16.28	24.99	17.70	10.99	16.30	13.01	14.48	15.54
Ash	10.01	11.52	10.01	9.84	13.42	21.76	12.98	7.65	20.96	10.10	17.41	18.23
Oak	25.35	24.33	32.32	34.50	26.26	42.24	25.47	20.85	22.12	21.25	21.49	19.95
Basswood	17.00	18.87	16.94	18.34	19.46	23.89	18.21	10.98	16.87	11.62	13.15	10.70
Balsam Fir	19.87	24.01	20.53	23.04	26.76	41.38	30.57	21.47	22.77	21.91	23.44	20.39
W. Spruce	34.25	33.84	34.88	35.86	41.67	48.03	31.38	30.29	28.82	23.37**	26.54**	24.99
B. Spruce	23.04	30.01	27.65	31.96	32.88	48.03	31.38	30.29	---			---
Tamarack	6.60	7.37	4.55	5.21	6.96	10.07	9.31	5.40	---	---	---	---
W. Cedar	8.32	8.68	7.91	6.16	5.98	7.47	13.48	9.35	13.98	11.65	---	---
J. Pine	30.39	37.95	36.76	38.20	41.75	50.81	49.49	32.07	30.28	25.41	28.34	28.03
R&W Pine	53.35	43.89	40.01	39.13	39.76	55.17	45.98	33.52	27.51	29.32	31.04	36.36
Maple	---	---	---	---	---	16.30	12.36	8.30	17.59	16.59	17.41	13.86
*A bolt is defined as a short log, usually 100" length, with a specific minimum top diameter, generally sawn for lumber.												
** Spruce Species												
---Insufficient data.												

Sawtimber												
($ per Thousand Board Feet)*												
Species	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Aspen	102.28	114.11	103.19	109.91	128.77	190.44	---	---	43.64	51.11	33.67	52.11
Birch	43.17	50.48	55.87	72.34	94.41	128.30	52.06	27.24	32.04	19.82	38.92	42.15
Ash	71.39	81.97	66.85	76.60	99.56	144.62	---	38.21	42.41	51.89	56.27	58.09
Elm	---	44.10	69.00	62.08	53.82	86.52	---	85.22	60.08	53.99	45.08	60.43
Oak**	109.53	118.72	151.77	150.04	145.57	185.90	378.03	182.83	271.04	193.61	243.09	232.20
Basswood	70.25	81.24	80.43	94.47	112.30	133.10	124.73	97.73	97.33	66.24	63.47	66.11
Balsam Fir	120.65	144.20	136.32	145.47	167.74	244.43	---	76.47	72.75	58.34	---	---
Spruce	90.00	91.27	94.95	101.81	131.34	204.73	113.02	96.41	81.57	87.05	102.15	64.23
W. Cedar	19.96	30.46	29.43	24.73	27.34	26.38	153.14	---	---	---	---	---
J. Pine	114.86	154.35	155.76	135.43	168.66	184.79	124.11	115.21	109.95	106.19	---	145.76
R&W Pine	176.01	170.13	153.78	153.10	139.41	181.21	143.45	114.04	119.51	107.40	123.36	140.45
Maple	---	---	---	---	---	131.53	206.45	137.17	150.62	81.48	219.83	160.78
*Includes veneer for certain hardwood species.												
**Primarily from public lands in Southeastern Minnesota.												
---Insufficient data.												

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. Two complete cycles have been completed, Cycle 12 (panels of 1999, 2000, 2001, 2002, and 2003) and Cycle 13 (panels of 2004, 2005, 2006, 2007, and 2008). Minnesota has recently completed the first three panels (2009, 2010, and 2011) of the third five-year cycle in an effort to update its FIA, which 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.

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

MAI – Mean Annual Increment. The average annual increase 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.

Glossary (continued)

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.

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