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Minnesota's Forest Resources

Department of Natural Resources
Division of Forestry
December 2008

500 Lafayette Road
St. Paul, Minnesota 55155

Minnesota's Forest Resources

Revised 12/08

Preface

This report is compiled annually by the Minnesota DNR – Forestry Division Utilization & Marketing staff. Publication began in the mid 1980s by John Krantz, former Utilization & Marketing Program Coordinator. The report is intended to answer frequently asked questions about Minnesota's forest resources such as: current conditions and trends in forest resources, and forest resource industrial use. Foresters, other natural resource managers, planners, forest industry, and forest policy makers will find items of interest in these pages.

We thank those who cooperated in providing and updating information for this report. They include many of Minnesota's wood product companies, the Minnesota DNR Utilization & Marketing Program staff and the USDA Forest Service Forest Inventory and Analysis (FIA) unit. Without their cooperation and assistance this report would not be possible.

Highlights:

- Ainsworth's Grand Rapids Oriented Strand Board (OSB) mill has announced a permanent closure in September of 2008. The mill has not been in operation since September 2006. The Cook and Bemidji mills have been shutdown permanently as well, announced in early January 2009.Weyerhaeuser's Trust Joist mill in Deerwood has been in what has been termed an indefinite shutdown since September 2007. These and other slowdowns and curtailments continue to have a large impact on timber markets in Minnesota. Harvest levels of 2006 are down by over 500,000 cords from 2005 harvest levels. It is likely that a downward trend has continued through 2007 and 2008, resulting in opportunities and need for additional utilization and management of Minnesota's forest resources.
- Timber imports of pulpwood into the state as well exports out of the state saw declines in 2006, and it is likely that this continued into 2007 and 2008. The change has been due to several factors, most notably reduced demand from mill closures and slowdowns. It is likely that Minnesota is still a net importer of raw wood as of December 2008, but by a greatly reduced margin.
- Overall net growth for all species continued to outpace harvest levels. According to 2007 FIA figures, annual net growth of growing stock on timberland was approximately 5.8 million cords and net mortality of approximately 3.10 million cords. According to mill and fuelwood survey data, the volume of wood harvested & utilized by industry and fuelwood users was approximately 3.2 million cords.
- 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. An update pertaining to woody biomass use for energy and carbon credits are included in this report.

Contact Information

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Wood-Using Industry

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 Wood Industry At A Glance – 2008

Annual Economic Impact

- Value of Forest Products Manufacturing Shipments 2007: 6.02-7.2 Billion (estimated)**
- 4th Largest Manufacturing Industry in Minnesota Based on Employment (#1 Computer & Electronic Equipment, # 2 Fabricated Metal Products, #3 Food Manufacturing)*
- Generates 11% of dollars of all manufacturing shipments*
- Value-Added impact attributable to Minnesota timber = $41.60 per dollar of timber sold, and 4.3 billion dollars total that stays in Minnesota *

Employment

- 37,850 Employees (Primary Processing [including logging] = approximately 17,440; Secondary Manufacturing = approximately 20,410).** Indicators suggest a 9% decrease in 2008 employment.
- $1.6 Billion in wages paid** Indicators suggest an estimated 16% decrease in 2008.
- **Important Industries Include**: Pulp & paper, OSB, Cabinets and Cabinet Parts, Window & Door Components (MN # 2 in U.S.), Store Fixtures, Office & Residential Furniture, Pallets, Crating & Pallet Parts, Millwork, Wood Shavings (for poultry industry).
- **Non-Traditional Industries Dependent on Forestry**: Balsam Boughs for Wreath Industry (annual sales of $23 Million+), Wood "flour" energy for taconite industry, 6 co-generation facilities utilizing wood for energy production.

Industry

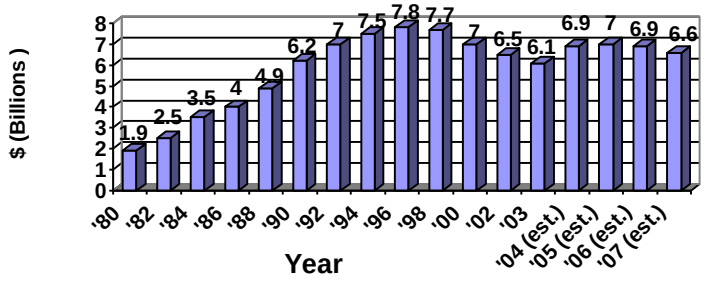
- *5 Pulp and Paper Mills*
- *3 Recycled Pulp & Paper*
- *3 Hardboard & Specialty*
- *2 Oriented Strand/Structural Board*
- *500+ Sawmills*
- *150 Associated Specialty Businesses*
- *Over 800 Secondary Manufacturers*

Annual Volume of Timber Harvested

- *Pulpwood = 2.44 Million (2006)*
- Sawlogs & Specialty = 272 Million Board Feet (2004). Included in this total are specialty items:
  - -Veneer = 8.0 Million Board Feet (domestic) = .9 Million Board Feet (exported)
  - -Chips = 8,000 Cords (fuel & mulch)
  - -Shavings = 11,000 Cords (animal bedding)
  - -Posts & Poles = 12,000 Cords
- *Fuelwood = 149,000 Cords live trees from timberland. (2002-03)*

*Minnesota Department of Employment & Economic Development analysis
**Minnesota Forest Industries estimates based on 2007 data

Value of Forest Products Manufactured in Minnesota



Minnesota Pulp and Paper – 2008

Firm	Wood Used	Product
UPM - Blandin Paper Mill Grand Rapids	Aspen, Balsam Fir and Spruce	Lightweight coated publication papers
Boise Cascade, 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
NewPage Duluth	Balsam Fir, Pine, Spruce	Uncoated, lightweight supercalendered magazine and publication papers
SAPPI North America Cloquet	Aspen, Balm, Maple, Basswood, Birch, Tamarack, Pine	Coated freesheet fine printing and publication paper, market pulp
Recycling Mills		
Rock-Tenn Company St. Paul	Recycled Paper & Corrugated	Cardboard and corrugated boxes
NewPage Recycled Fiber Mill Duluth	High Grade Office Paper & Computer Paper	Market pulp
Liberty Paper Company Becker	Recycled Paper & Corrugated	Cardboard and corrugated boxes

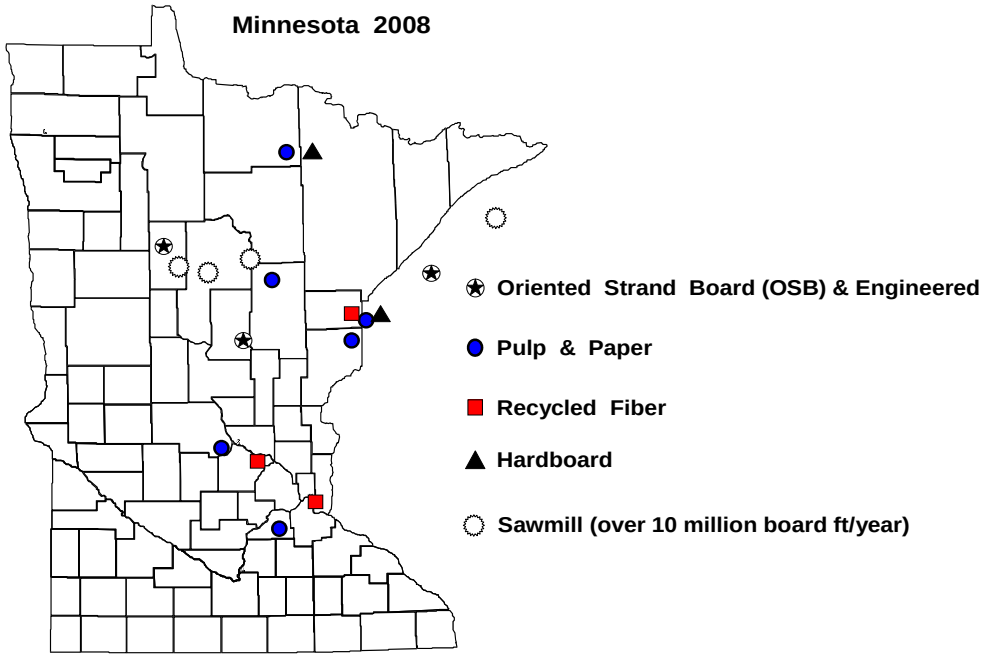
Minnesota Oriented Strand Board and Engineered Wood Products – 2008

Firm	Wood Used	Product
Ainsworth Engineered USA Grand Rapids	Aspen, Balm, Birch, Pine, Maple, Tamarack, Ash	OSB (Permanent shutdown since 8/08)
Louisiana-Pacific Two Harbors	Aspen, Balm, Birch	OSB – engineered siding panel
Northwood Panel board Bemidji	Aspen, Balm, Birch, Maple	OSB
Ainsworth Engineered USA Bemidji	Aspen, Balm, Birch, Pine, Maple, Tamarack, Ash	OSB (Permanent shutdown since 1/09)
Ainsworth Engineered USA Cook	Aspen, Balm, Birch, Pine, Maple, Tamarack, Ash	OSB (Permanent shutdown since 1/09)
Trus Joist - a Weyerhaeuser Business Deerwood	Aspen, Balm, Birch	Engineered lumber products (Indefinite shutdown since 9/07)

Minnesota Hardboard and Specialty – 2008

Firm	Wood Used	Product
Certainteed Corporation Shakopee	Aspen, Mixed Hardwoods & Recycled Paper	Roofing felt (Temporary shutdown since 9/07)
International Bildrite International Falls	Aspen, Balm & Recycled Paper	Sheathing
Georgia-Pacific Corporation, Superwood Division Duluth	Aspen, Pine, Mixed Hardwoods	Industrial hardboard

OSB & ENGINEERED, PULP & PAPER, HARDBOARD, RECYCLING MILLS and LARGE SAWMILLS



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 large sawmills in Minnesota. These mills utilize various species of wood material, with aspen pulpwood being by far the largest component.

Minnesota – New and Expanding Large Wood Industry

1975-2008	Product	Capital Investments ($Millions)
Potlatch (now SAPPI) - Expansion	Paper	$100
Potlatch (now Ainsworth Engineered USA) – Bemidji	OSB	40
Potlatch – (now Ainsworth Engineered USA) - Cook	OSB	40
Northwood Panelboard	OSB	45
Champion International (now International Paper)	Paper	250
Blandin (now Ainsworth Engineered USA)	OSB	50
Louisiana Pacific	OSB	30
Blandin (now UPM)	Paper	350
Potlatch (now SAPPI) – Modernization	Paper	100
LSPI (now Stora-Enso)	Paper	404
International Bildrite	Sheathing	12
Boise	Paper	990
MacMillian Bloedel (now Trus Joist - a Weyerhaeuser Business)	Laminated Strand Lumber	70
Potlatch – (now Ainsworth Engineered USA) Bemidji expansion	OSB	35
Potlatch	Lumber	22
Potlatch (now SAPPI)	Pulp Mill	525
Potlatch – (now Ainsworth Engineered USA) Cook expansion	OSB	60
Total		**$3.123 =$3,123 *Billion***

Source: MN DNR - Forestry

Wood Energy and Woody Biomass Utilization

Woody biomass includes entire living and dead trees and brush stems in a forest, and also residue material generated throughout various forest product processing steps.

Woody biomass is increasingly being used in expanding renewable energy producing facilities in the state. Wood energy is not new to Minnesota, especially in the wood manufacturing industry. However, rising fossil fuel prices, climate change concerns and other factors have resulted in wood energy markets expanding significantly over the past three years. The outlook is for continuing expansion.

The prospect of expanded woody biomass harvest and processing has many potential upsides, including reduced dependence on foreign energy sources, improved bottom lines for logging and processing operations, and increased opportunities for forestry and wildlife management.

However, as with almost any opportunity, there are potential pitfalls to be avoided. Some of these include: impacts to raw material supply for existing forest industry, nutrient depletion on sensitive sites, and negative habitat consequences. Every one of the potential downsides can be managed, but doing so will require thoughtful guidance as woody biomass markets expand.

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 is presently utilized for various products, mostly energy.
- "Secondary" Mill Residue from cabinet manufacturers, etc. Large majority is presently utilized.
- Dedicated energy crops. A very small resource in Minnesota at present.
- Land clearing projects. This contributes to the metro wood supply for a major energy facility.
- Brush from brushlands. A significant potential resource, but the economics of harvesting and transporting need to improve before widespread use.
- Precommercial thinning, Timber Stand Improvement (TSI), Fire Hazard Reduction Vegetation Management Projects. Potential resource from intensified forestry and wildlife management.
- Urban Forests. A resource from tree clearing and maintenance and storm cleanup in urban areas. Largely used in mulch markets in major metropolitan areas as wells as for energy in St. Paul.

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, some forms of wood manufacturing residue, and sometimes 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 in larger material.

Woody biomass is a good fit for a number of products and markets, however.

They include:

- Engineered Wood: The Georgia Pacific hardboard mill in Duluth and the International Bildrite insulite mill in International Falls are the two engineered wood product mills in Minnesota that take 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 due to most of the poultry and dairy industry being 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 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
BOISE	INT'L FALLS	MILL RESIDUE
VERSO PAPER	SARTELL	MILL RESIDUE
SAPPI	CLOQUET	MILL RESIDUE, LOGGING RESIDUE
MINNESOTA POWER	DULUTH	MILL RESIDUE, LOGGING RESIDUE
AINSWORTH	BEMIDJI	CURRENTLY CLOSED
ST. PAUL DISTRICT ENERGY	ST. PAUL	URBAN WOOOD RESIDUE
LAURENTIAN ENERGY AUTHORITY	HIBBING	LOGGING RESIDUE, MILL RESIDUE
LAURENTIAN ENERGY AUTHORITY	VIRGINIA	LOGGING RESIDUE, MILL RESIDUE
CENTRAL MN ETHANOL WOOD GASIFIER	LITTLE FALLS	MILL RESIDUE, LOGGING RESIDUE
CHIPPEWA VALLEY ETHANOL COMPANY	BENSON	MILL RESIDUE, LOGGING RESIDUE
FIBROMINN	BENSON	TURKEY MANURE, WOOD CHIPS
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 Harvest

Because there are important ecological and environmental reasons for leaving some residue on-site after timber harvest, the Minnesota Forest Resources Council and DNR have developed new site-level forest management guidelines for harvest of woody biomass, in order to provide forest managers with improved direction regarding the management and use of logging residues and brush. The Guidelines are available online at: http://www.frc.state.mn.us/FMgdline/BHGC.html

Forestry Opportunities

What are some forestry opportunities engendered by the developing woody biomass markets?

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 others.

Brush from Brushlands. There are excellent wildlife habitat benefits from brushland management.

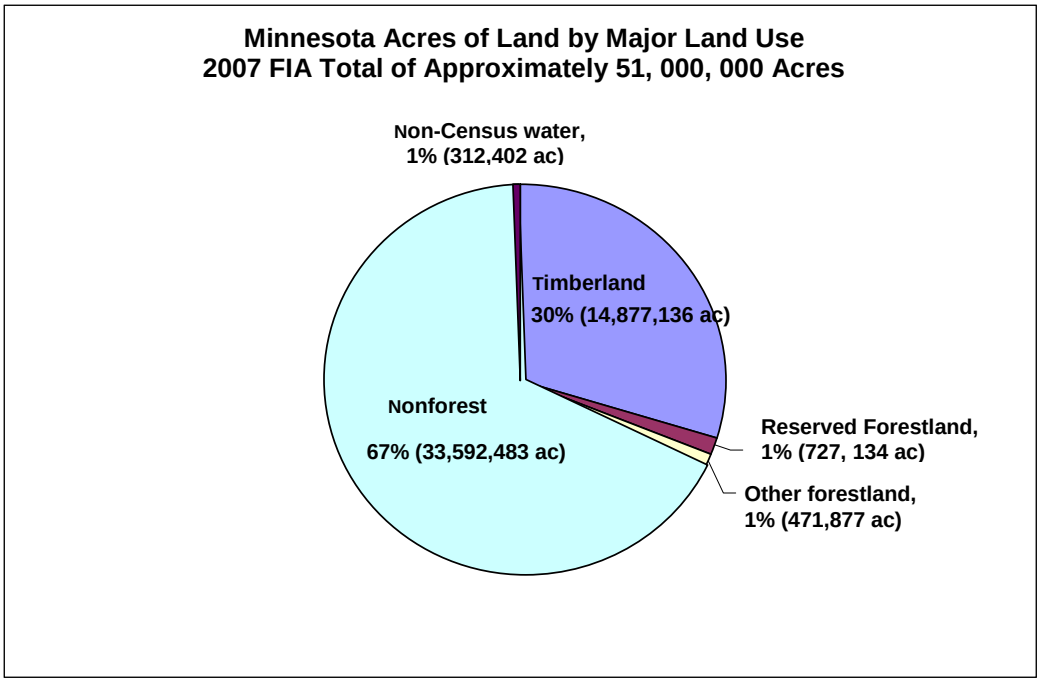
"Precommercial Thinning", Timber Stand Improvement (TSI) and Fire Hazard Reduction. A resource of currently unmerchantable woody material is produced during forest management activities such as very early thinnings and wildfire hazard reduction work. If the economics can be made to work and ecological concerns are addressed, the potential benefits of doing more of this work would be significant.

What is the Future for Woody Biomass?

- Policy trends leading towards reduced green house gas emissions and increased renewable energy development point towards significant expansion of woody biomass utilization over the next decade.
- Technologies to expand use of biomass for increased value added products like motor fuels and green chemistry are edging towards commercial deployment.
- There are forestry and wildlife management opportunities engendered by expanding biomass markets.
- Greater use of woody biomass is an emerging issue. It will take some time to sort out on both the natural resource management side, and also the market side. Natural resource management considerations, gathering and processing systems, and markets will evolve over time.

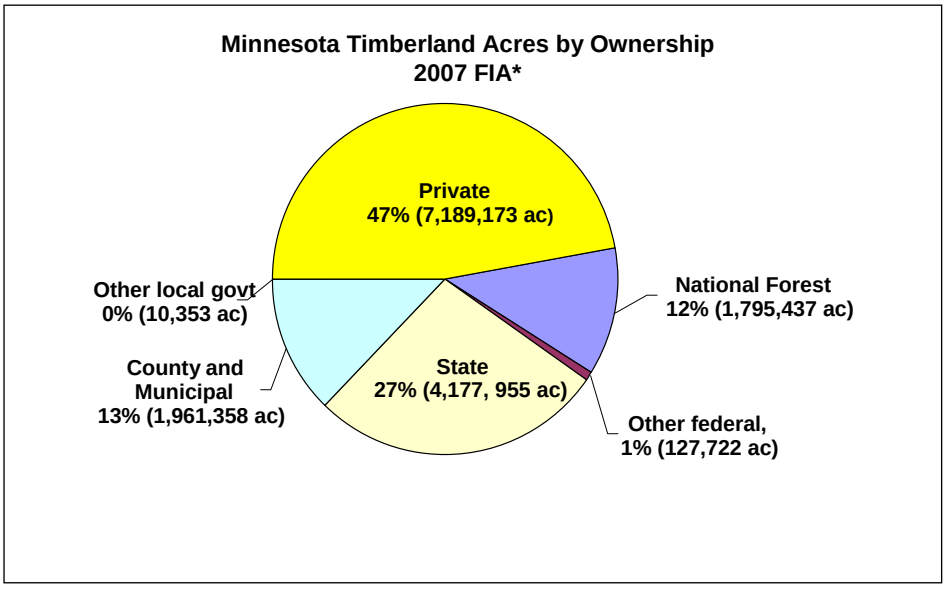
Forest Resources

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



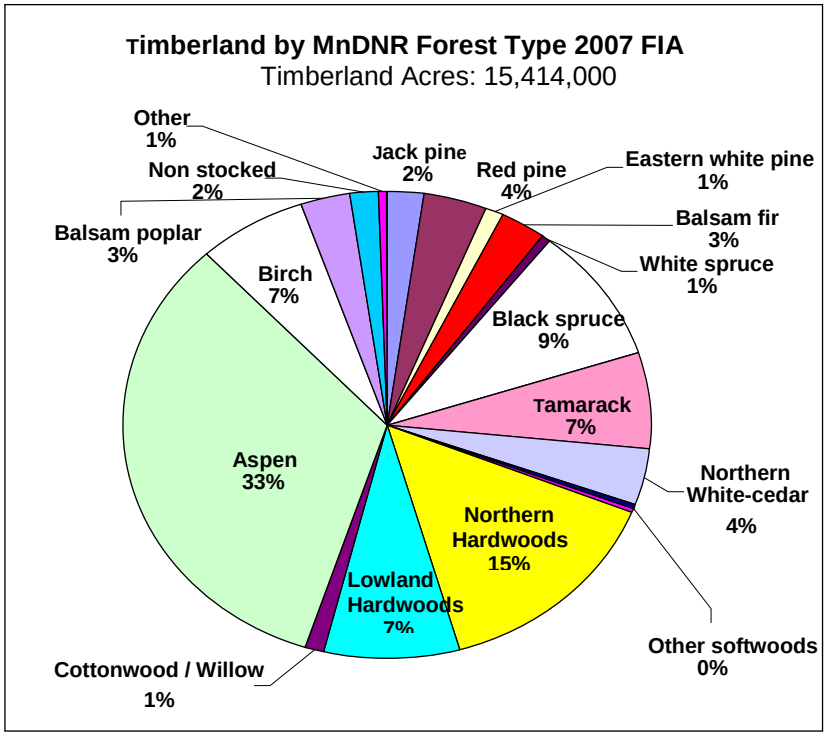
Source: 2007 FIA Database Provided by USFS Northern Research Station

Minnesota has approximately 15 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. Forest land reserved from harvest by policy or law includes designated wilderness areas like the Boundary Waters Canoe Area (BWCA), old growth reserves, and others.



Source: 2007 FIA Database Provided by USFS Northern Research Station

Ownership of timberland is an important factor in assessing many issues, including timber supply. **Readers should be aware that the FIA database ownership figures shown above appear to be in error and will be corrected in next year's report. Specifically, it is likely that approximately 460,000 acres will be corrected from "State" to "County" ownership.* ***Source:*** *Personal communication, FIA analyst Pat Miles*



Source: 2007 FIA Database Provided by USFS North Central Forest Experiment Station.

Cover 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 cover type in Minnesota.

Area of Timberland in Minnesota by DNR Forest Type – 2007

Forest Type	Acres
Jack Pine	316,138
Red Pine	585,024
White Pine	166,836
Balsam Fir	379,507
White Spruce	105,463
Black Spruce	1,377,013
White Cedar	569,851
Tamarack	979,980
Other Softwoods	8,277
Oak	820,967
Lowland Hardwoods	1,200,768
Northern Hardwoods	2,125,806
Aspen	4,86,3562
Birch	968,297
Balm of Gilead	437,683
Cottonwood/ Willow	145,405
Non-Stocked & Other	328,622
Total All Types	15,414,000*

Source: USDA Forest Service 2007 FIA Database
*Totals may not sum due to rounding.

Harvest Levels

Information on 2006 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 2006; Sawtimber 2004; Fuelwood 2002-03)

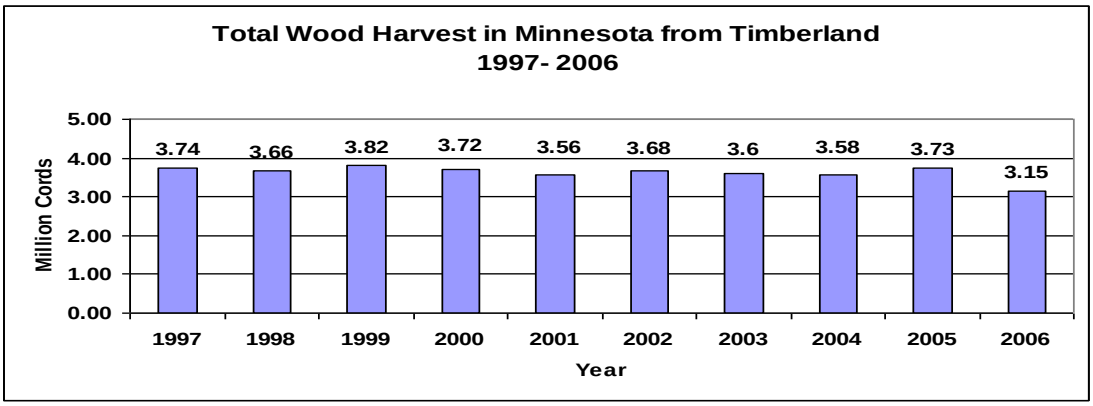
			Fuel		
Species	**Pulpwood**	**Sawlogs & Others**	**Residential***	**Commercial**	**Total**
Aspen and Balm	1,599.2	70.8	16.7	.7	1,687.4
Birch	161.3	27.1	41.0	6.3	235.7
Ash	15	8.3	15.1	.2	38.6
Oak	.2	73.3	45.1	1.0	119.6
Basswood	12.5	21.6	1.3	0	35.4
Maple	117.6	12.7	15.8	4.7	150.8
Cottonwood	0	11.6	0	0	11.6
Other Hardwood	0	13.8	8.1	0	21.9
Sub-Total Hardwood	1,905.8	239.2	143.1	12.9	2,301.0
Pine					
Red Pine	29.6	114.7	2.9	0	147.2
White Pine	1.3	7.6	1.4	0	10.3
Jack Pine	115.4	147.7	1.7	0	264.8
Spruce	194.7	18.4	0	0	213.1
Balsam	160.4	7.2	0	0	167.6
Tamarack	33.9	1.8	.7	0	36.4
Cedar	0	6.6	.4	0	7.0
Other Softwood	.8	1.1	0	0	1.9
Sub-Total Softwood	536.1	305.1	7.1	0	848.3
Total	2,441.9	544.3	150.2	12.9	3,149.3

Figures include cords of pulpwood exported to Wisconsin and Canada: Aspen: 23,913; Spruce: 31,939; Red Pine: 462; Balsam fir: 1,645; Tamarack: 2,085; Maple: 197. And cords of sawlogs exported to WI and Iowa of Oak: 13,881; Maple: 3,087.

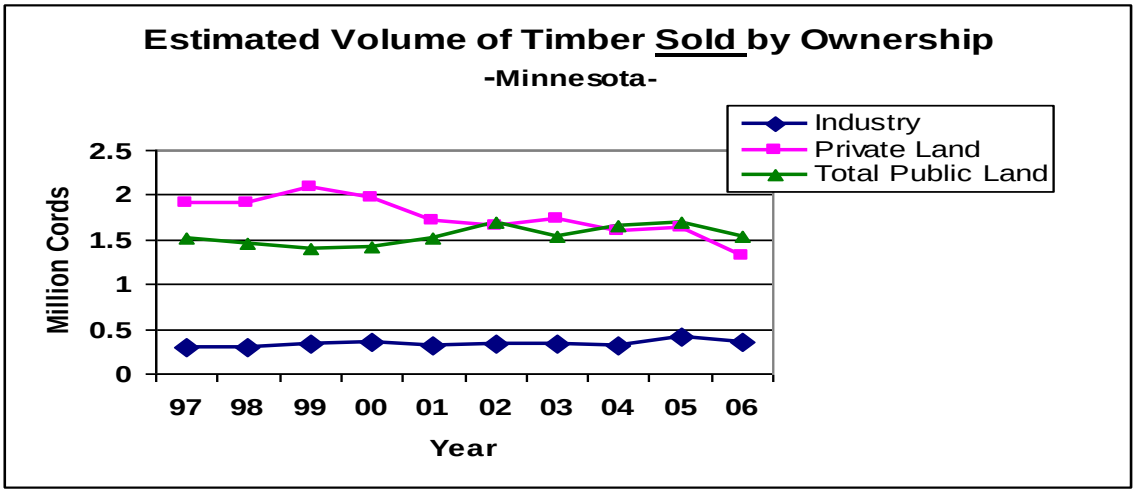
**Fuelwood removed from growing stock on timberland.*

Sources: USFS and DNR mill surveys & residential fuelwood survey.

***Note:** Actual survey figures will be available later, but based on analysis of mill closure impacts, it is likely that harvest levels have continued downward to an estimated level of approximately 2.8 to 3.0 million cords in 2008.*

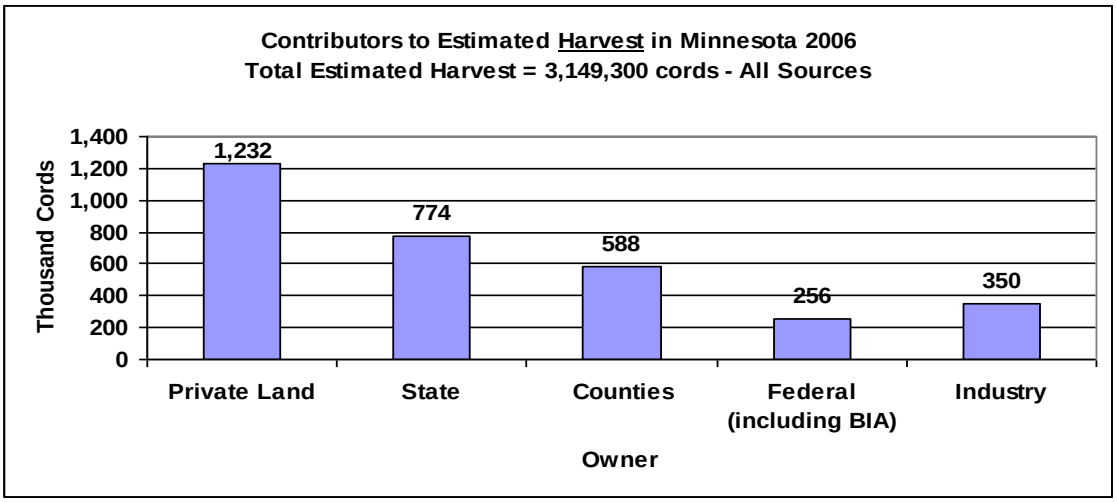


Sources: Pulpwood (USDA Forest Service, Northern Research Station), Sawtimber & Fuelwood (MN DNR surveys).



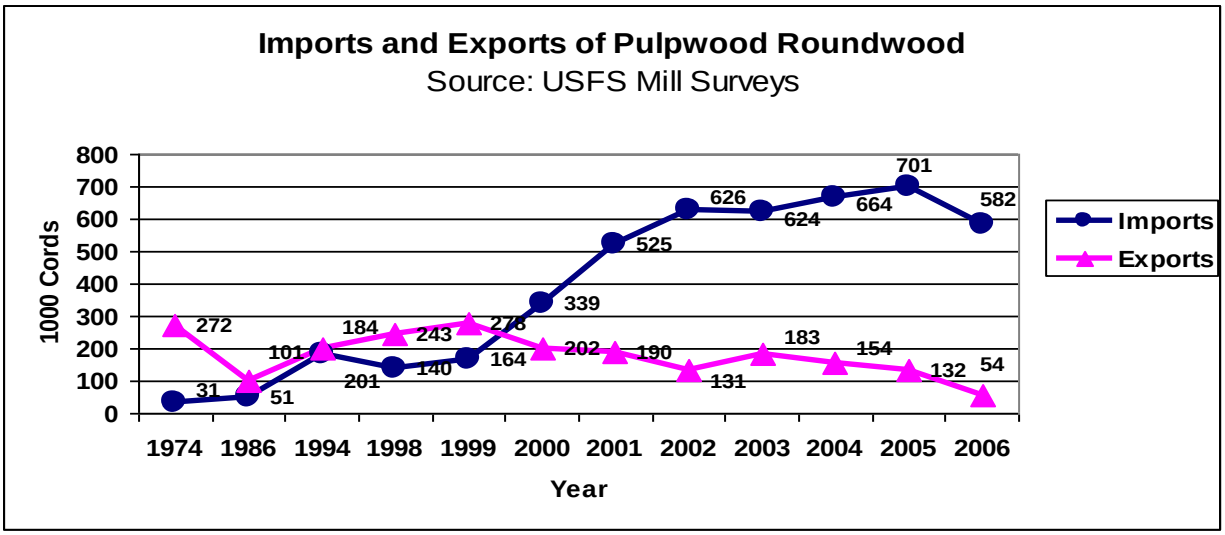
Source: Public Lands: Public Stumpage Price Review. Industry Lands: Minnesota Forest Industries survey of harvested volume. Private Lands = An estimate figured as follows: Total estimated harvest 2006, (Most recent figure available) minus 2006 Public Stumpage Price Review public volume sold or harvested, minus 2006 estimated industry volume harvested. Forest Capital Partners (formerly Boise) Timberlands continued in "Industry" totals.

It is worth noting that, harvest levels for 2006 are over 500,000 cords below 2005 harvest levels due to mill shutdowns and slowdowns. The decline in harvested volume is reflected in all ownerships but is more pronounced in private lands than public lands. This is due to several market factors, including private land supply being more sensitive to falling timber prices.



Source: State Lands: FY 2006 Harvest, DNR Timber Sales Annual Report. Federal: FY 2006 Harvest, Superior National Forest Timber Statistics, and Chippewa National Forest Timber Statistics; BIA: Public Stumpage Price Review 2006 harvest. County Lands: Public Stumpage Price Review timber sold or harvested 2006 used as an estimate for 2006 harvest. Industry Lands: Minnesota Forest Industries survey of 2006 harvested volume. Forest Capital Partners (formerly Boise) Timberlands included in Industry totals. Private Lands = An estimated figured as follows: Total estimated harvest 2006, minus state and national forest and BIA volume harvested, minus county volume harvested or sold (varies by county), minus estimated industry volume harvested.

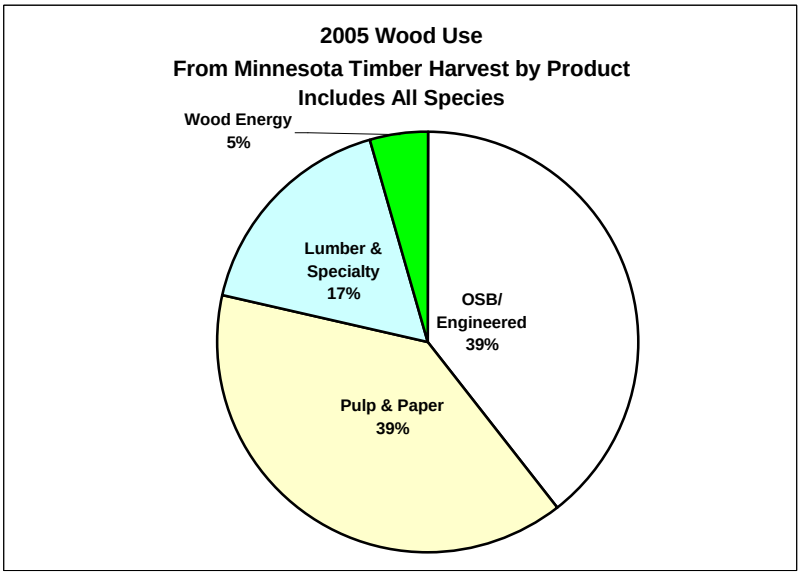
Ownership of lands has a large impact on policy regarding forest management and timber harvest.



Source: USFS Northern Research Station FIA Unit Survey of Industrial Wood Using Industry.

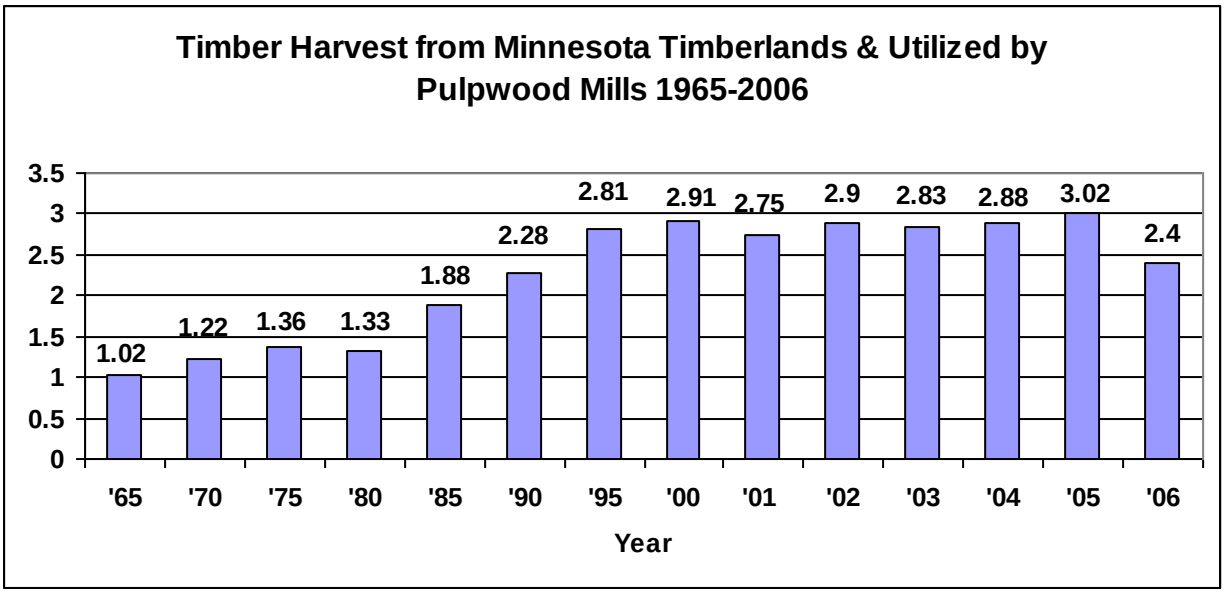
Minnesota became a large net importer of wood from 2000 through 2006, as mill demand and stumpage prices increased. Mills increasingly looked outside of Minnesota's borders in order to meet their raw material needs, especially for aspen and maple. Exports are mainly to Wisconsin mills. Imports are largely from Canada and Wisconsin, with a modest volume from Michigan and North Dakota.

It is worth noting that even though Minnesota remains a net importer of timber, imports have seen a sharp decline over the past several years. The change has been due to several factors, most notably reduced demand from mill closures and slowdowns.



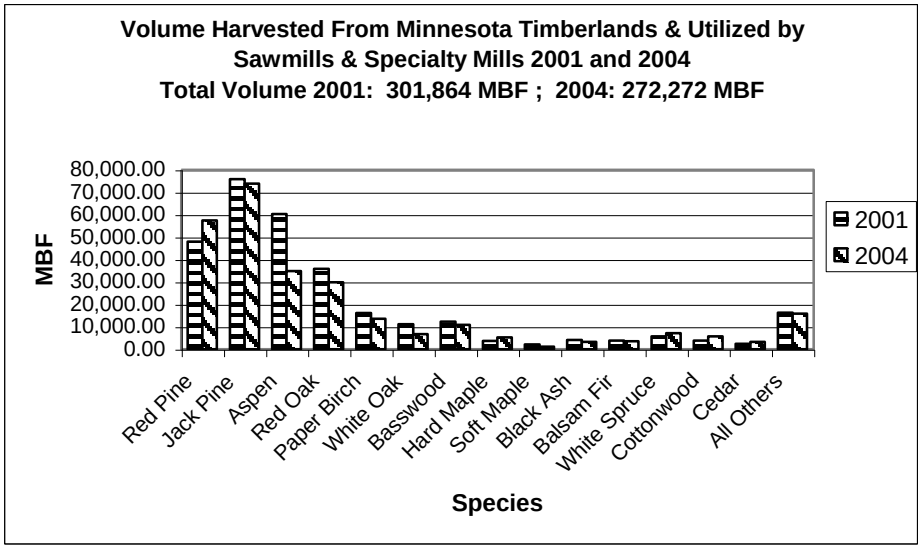
Source: Wood Use Data from Mill and Fuelwood Surveys conducted by USDA Forest Service, Northern Research Station & DNR. Specialty products include veneer, posts & poles, shavings & landscape chips

It is important to note that although the available figures do not yet reflect it, wood use in the OSB/Engineered wood sector has dropped significantly since 2005, due to mill shutdowns and slowdowns.



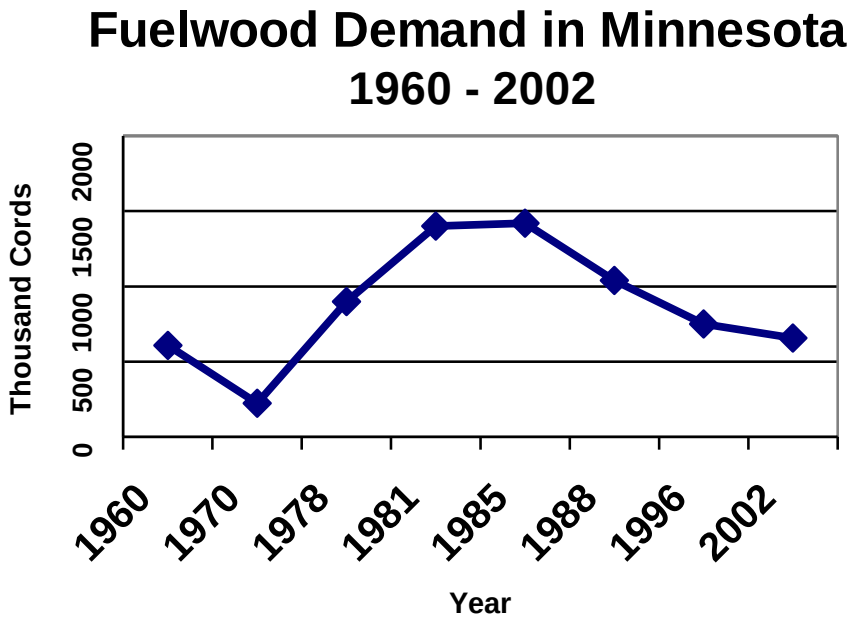
Source: USFS, North Central Forest Experiment Station Surveys

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



Source: MN DNR Sawmill 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 to 2004, a trend that has probably continued. 2007 sawmill production data will be available for next year's report.



Source: DNR Fuelwood Surveys

Fuelwood is a relatively small portion of total timber harvest.

It is important to note that only a portion of total fuelwood comes from live trees on timberland (about 150,000 cords in 2002). The remainder is from sawmill residue, urban tree waste, land and power line clearing.

Sustainable Harvest Information

Sustainable Harvest Levels

This section contains information on estimated sustainable harvest levels* for many of Minnesota's most significant tree species.

*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.

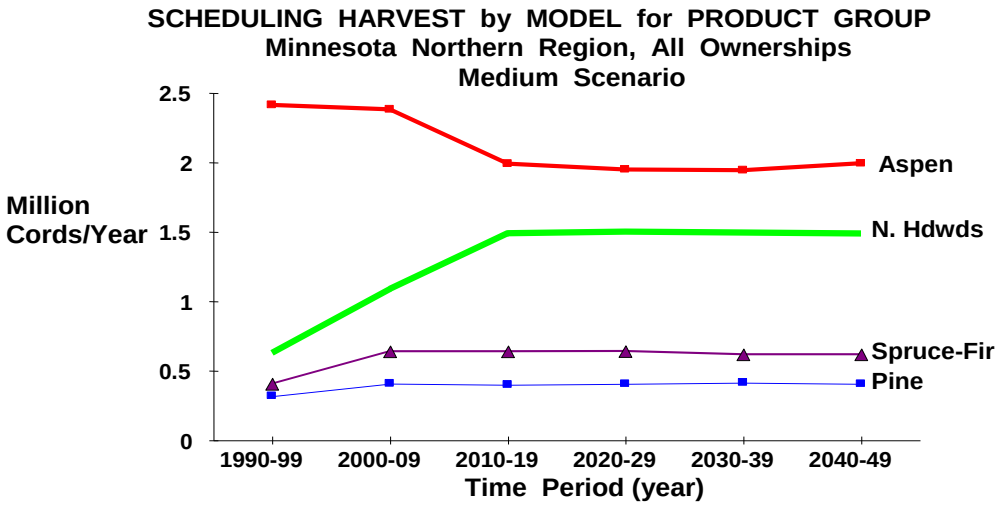
For the above reasons, it is important to view the levels as helpful benchmarks that are only one part of the picture in determining long-term sustainability of our forest resources. They should not be viewed as absolute targets.

DNR sustainable harvest estimates use the full, five-year panel of 2003 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-classes imbalances resulting from large acreages in older classes, current timber availability is likely to be *above* long-term sustainable estimates. This is due to a need to manage many old stands on timberlands before their health and available timber volume deteriorates. For cover types with young age-class imbalances such as red pine, current timber availability is likely to be *below* long-term sustainable estimates.

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.

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.)

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.

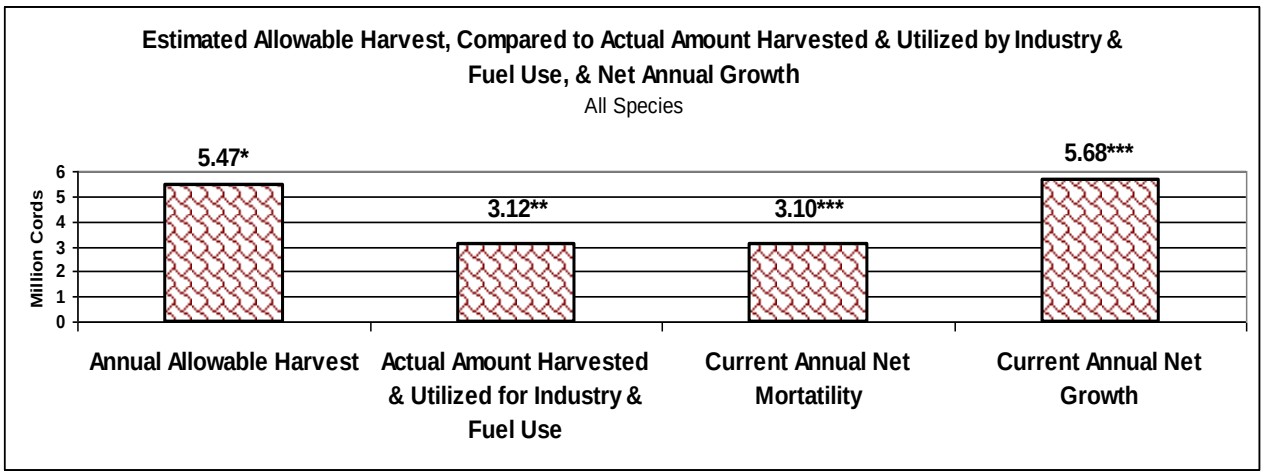
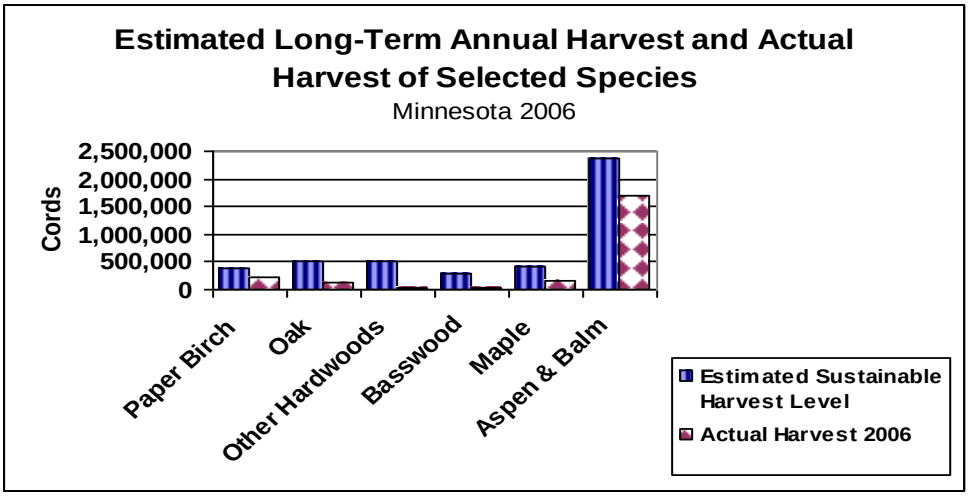
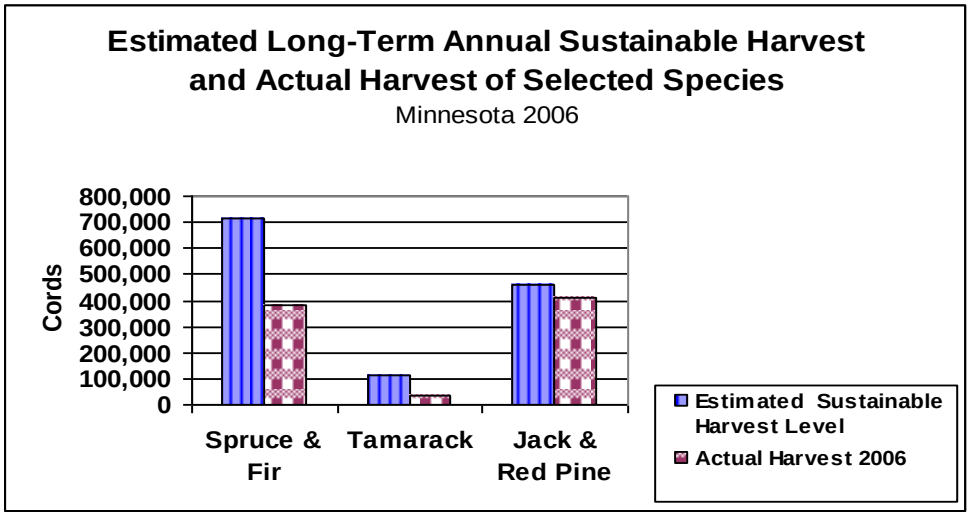


*Table 6.25, GEIS, High Long-Term Sustainable Level, Maintaining Forest Productivity Tech. Paper, Dec. '92.
** 2006 NFES Pulpwood Survey, 2004 DNR Sawmill Survey, 2002-03 Fuelwood Survey. For Harvest comparisons to Net Growth, it is necessary to add annual "growing stock" logging residue of approximately 275,000 cords to this figure.
***USFS FIA 2007 Database.

Note: While complete capture is not realistic, greater capture of a portion of annual mortality of approximately 3.1 million cords has the potential to substantially increase net growth and sustainable harvest levels.



Source: Harvest data for 2006 from NFES pulpwood survey & DNR 2004 sawmill & 2002 fuelwood survey.. Sustainable harvest data source as per the notes below.



Source: Harvest data for 2006 from NFES pulpwood survey & DNR 2004 sawmill & 2002 fuelwood survey. Sustainable harvest data source as per the notes below.

NOTES:

-Sustainable harvest levels for aspen and spruce-fir in the tables 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 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 harvest levels for birch, oak, basswood, maple and other hardwoods, tamarack and jack and red pine in the tables 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.

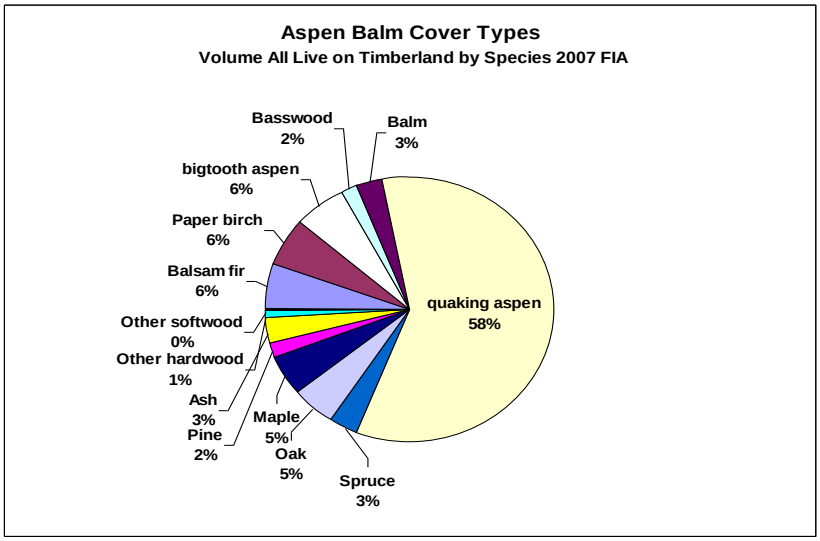
Wood Supply and Demand Information for Important Minnesota Cover Types and Species

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

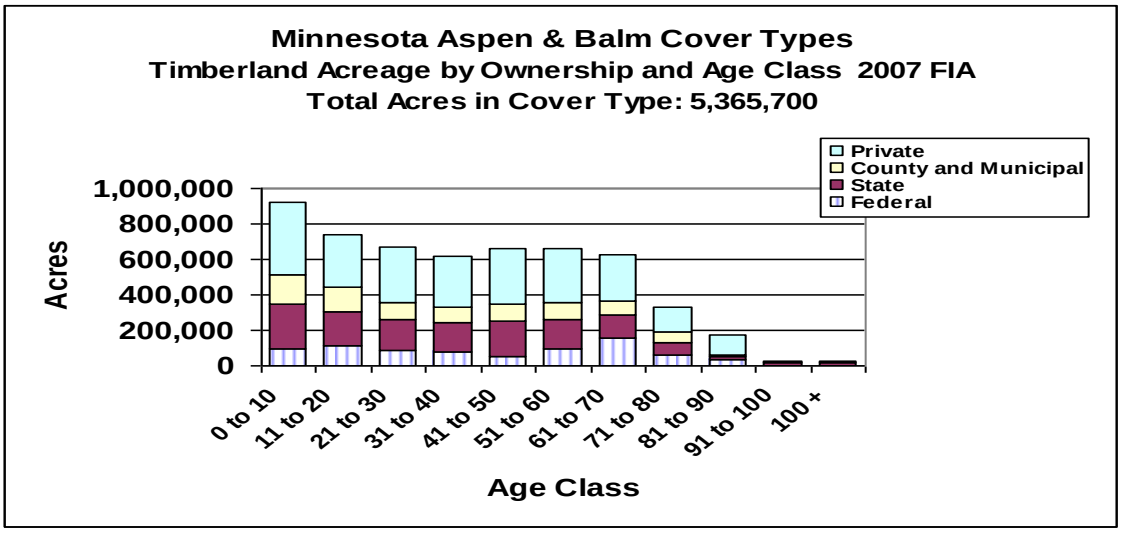
Minnesota's Aspen/Balm of Gilead Resource

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 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.

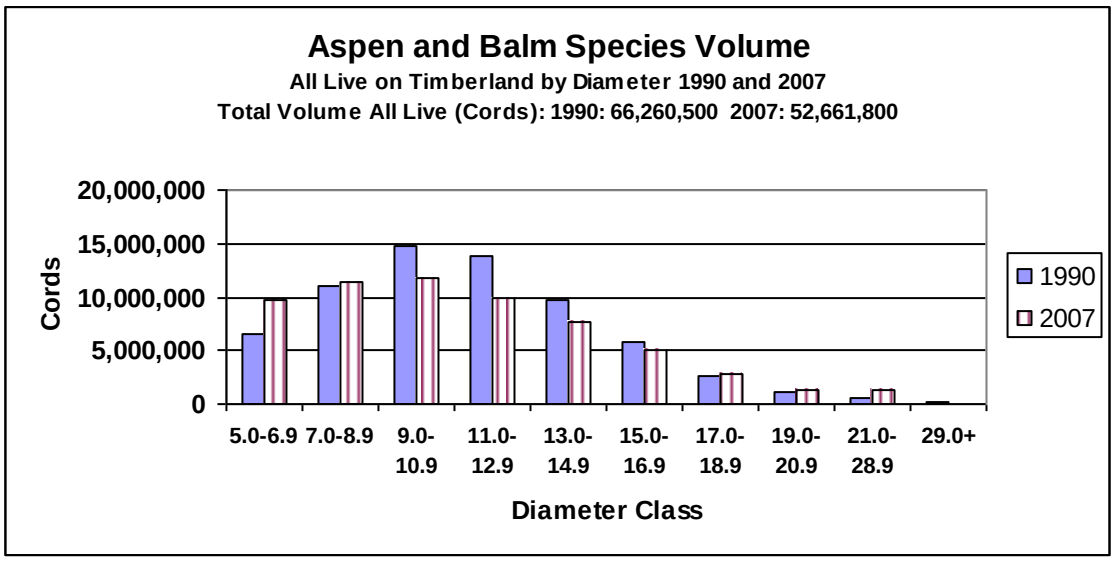


Source: 2007 FIA Database provided by USFS, Northern Research Station



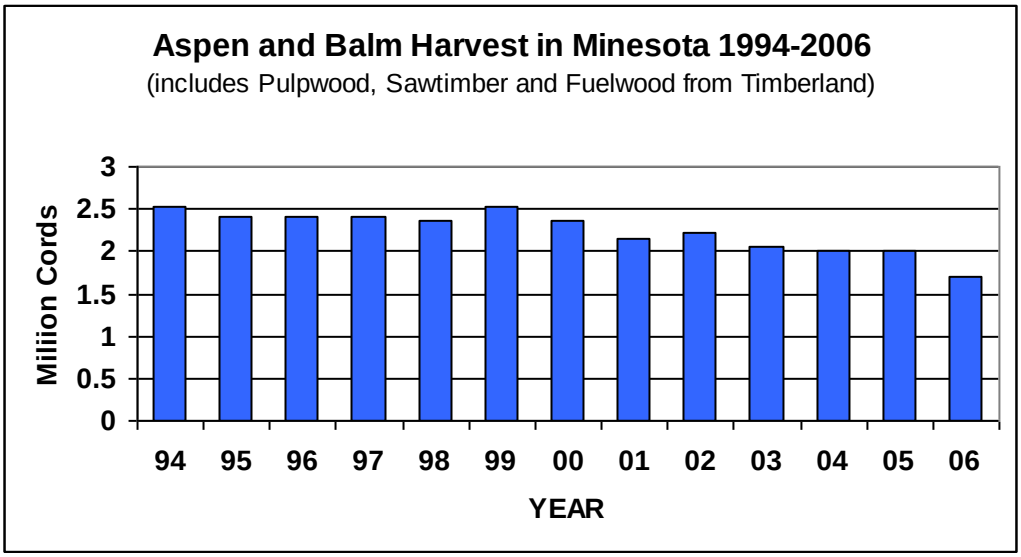
Source: 2007 FIA Database provided by USFS, Northern Research Station

The 2007 FIA inventory indicates a somewhat more even age-class distribution than the 1990 inventory. There is currently far more young aspen than existed 20 years ago, prior to the establishment of solid markets.



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.



Source: Harvest data compiled by NFRS & 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 2007 USFS FIA database, estimated average net annual growth of aspen & balm growing stock: 1,887,568 cords, estimated average annual mortality of aspen & balm growing stock: 1,125,694 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
2006 Harvest	**1,686,100**
• Minnesota Pulpwood Industries	1,575,300
• Pulpwood Export	23,900
• Sawlogs & Other	69,600
• Fuelwood (from growing stock)	17,300

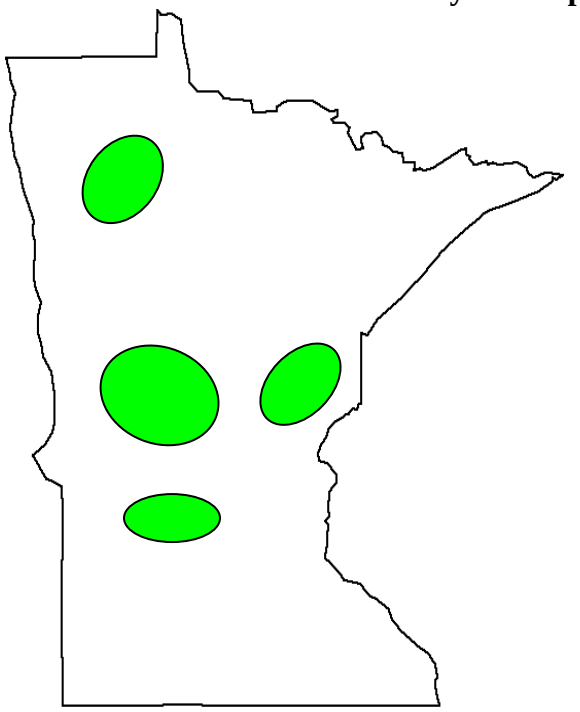
Resource Opportunities:

- 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:

- Much of the aspen resource is in private ownership, so managing it will require significant efforts in private landowner incentives and assistance.

Hybrid Poplar in Minnesota - 2007



Concentrated Plantation Areas

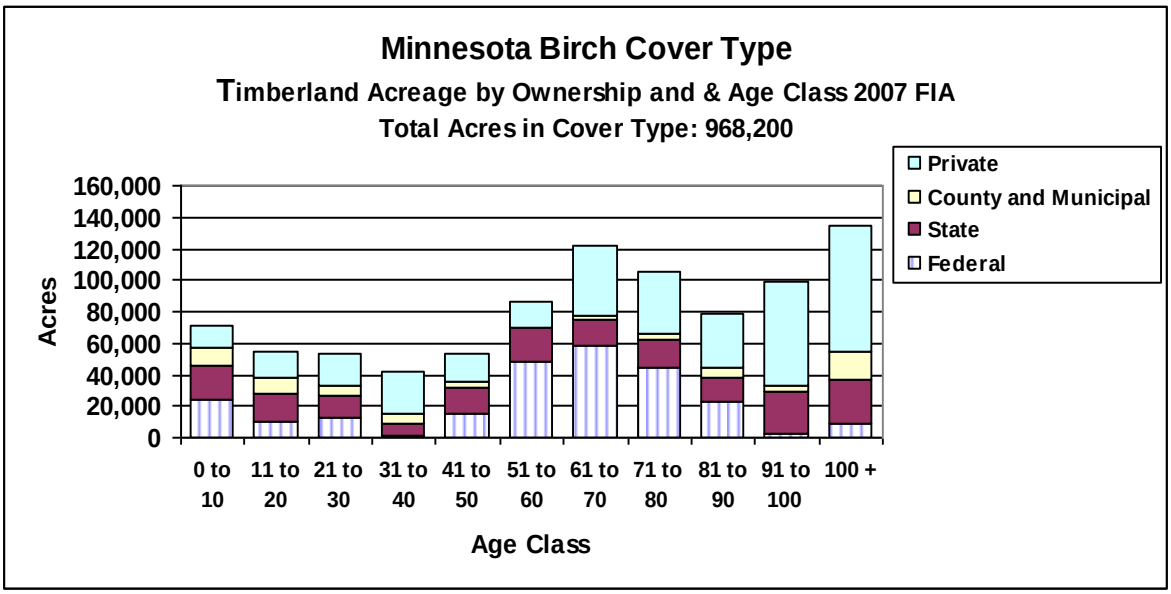
Private Landowners: Approximately 11,000 Acres

Industrial Landowners: Approximately 18,000 Acres

- Hybrid Poplar has been found to be an acceptable substitute for aspen fiber in papermaking and Oriented Strand Board (OSB) production.

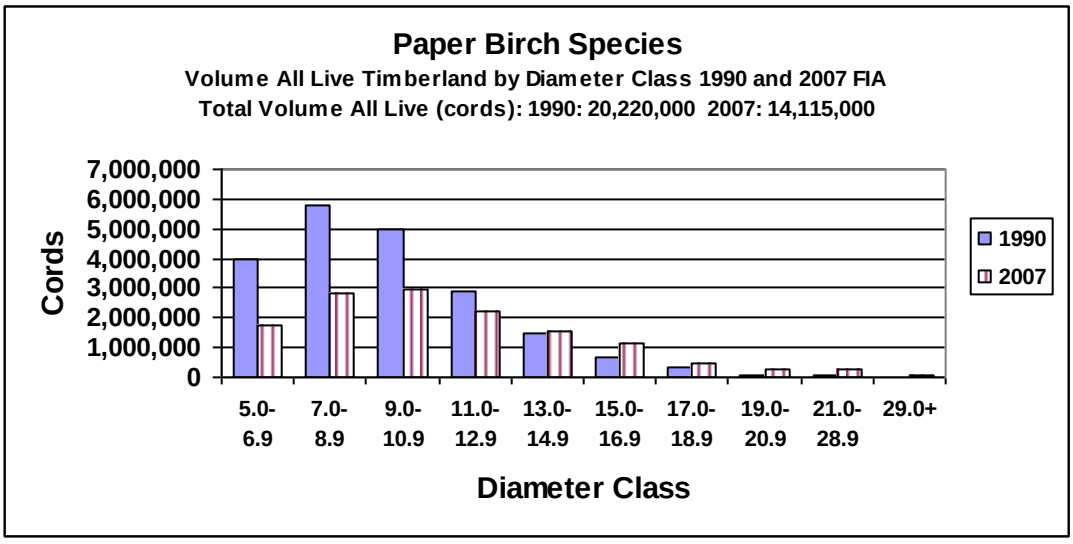
- Hybrid Poplar can reach merchantable size for traditional forest product markets in 10 to15 years. Poplar harvested for energy markets can be harvested on shorter rotations.
- Intensive culture is required for the first 3 years in order to grow hybrid poplar.
- It is commonly grown on marginal agricultural fields.

Minnesota's Birch Resource



Source: 2007 FIA Database provided by USFS, Northern Research Station.

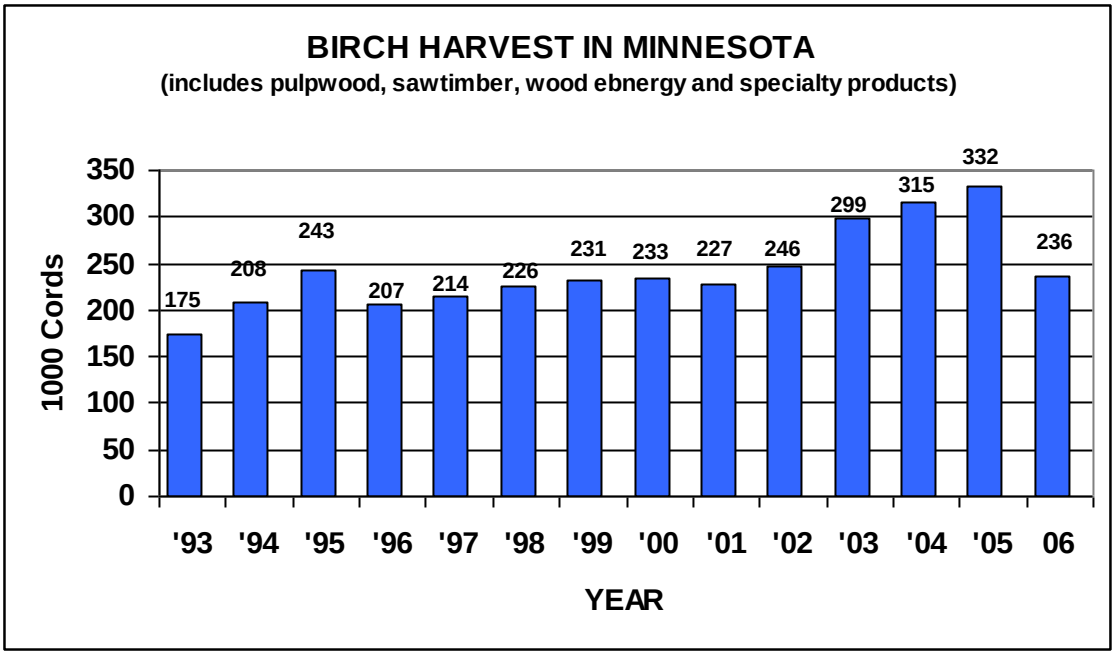
Paper birch is a relatively short-lived species that requires nearly full sunlight for regeneration. It can grow in nearly pure stands, or as a component in mixed stands. It comprises the large majority of the volume in the birch cover type, but it is also a significant component of several other upland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



Source: FIA Database provided by USFS, Northern Research Station

Paper birch resources have seen a significant rise in volume after a period of decline during the 1990s. Total volume decline in 1990 was due largely to serious mortality associated with an aging resource and stress caused by periodic drought.

BIRCH HARVEST IN MINNESOTA
(includes pulpwood, sawtimber, wood energy & specialty products)



Source: Harvest data compiled by NFRS & DNR

DNR estimated long-term annual sustainable harvest level: 371,500 cords/year. Estimated average net annual growth of paper birch growing stock: 169,062 cords, and estimated average annual mortality of birch growing stock: 292,079 cords, based on 2007 FIA data.

Current Demand for Birch from Minnesota Timberlands

	Cords
2006 Harvest	**235,700**
• Minnesota Pulpwood Industries	161,300
• Sawlogs & Other	27,100
• Fuelwood (from growing stock)	47,300

Source: NFRS & DNR Surveys

Resource Opportunities:

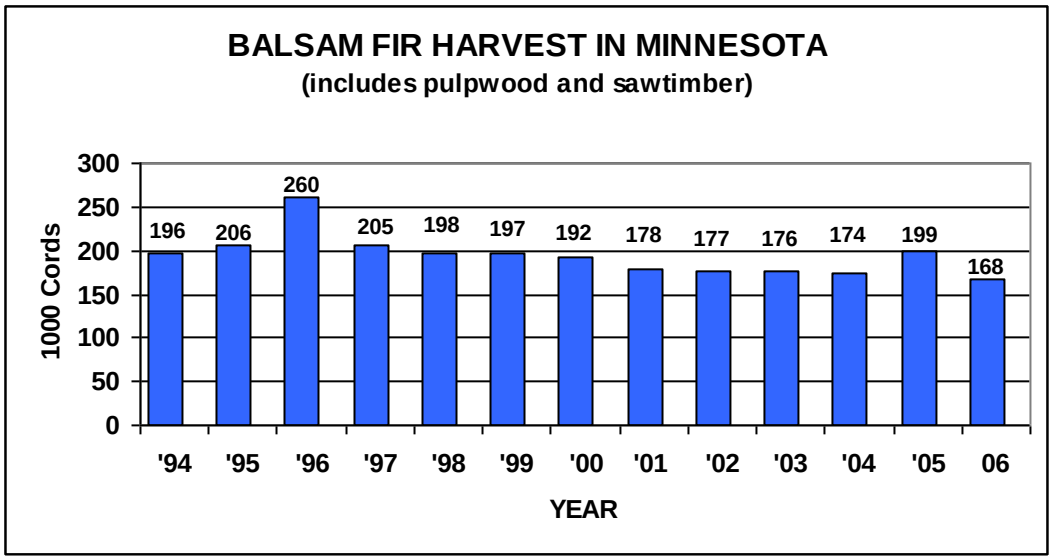
- Birch harvest is well below long-term sustainable levels.
- Birch in northeastern Minnesota is "fleck-free" (fleck is a common appearance defect in birch), so larger high-quality stems are a fit for veneer markets.

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.

Minnesota's Balsam Fir Resource

BALSAM FIR HARVEST IN MINNESOTA
(includes pulpwood and sawtimber)



Source: Harvest data compiled by NFRS & DNR.

Spruce-fir estimated annual sustainable harvest level 705,5000 cords/year based on Table C-20 UPM-Thunderhawk DEIS, average of high aspen A&B scenarios, 40 year planning horizon. Based on 2007 FIA data, estimated average net annual growth of balsam fir growing stock: 93,318 cords; estimated average annual mortality of balsam fir growing stock: 116,892 cords.

Balsam fir industrial use is similar to that of spruce. It is used largely for 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. Some fir is also used in making OSB.

Current Demand for Balsam Fir from Minnesota Timberlands

	Cords
2006 Harvest……	**167,600**
• Minnesota Pulpwood Industries & Export (Export 1500 cords)…..……..	160,400
• Sawlogs & Other……..	7,200

Source: NFES & DNR Surveys

Resource Opportunities

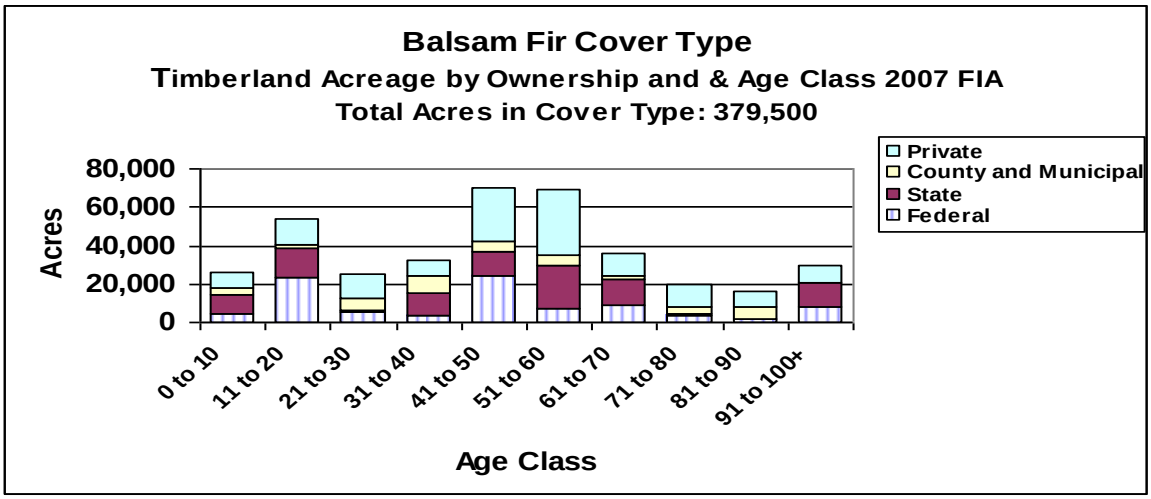
- High-quality balsam fir has excellent qualities for pulp & paper and stud manufacture.

Resource Issues:

- Balsam availability dependent on harvest of aspen (38% of balsam fir in aspen type).
- Older stands 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

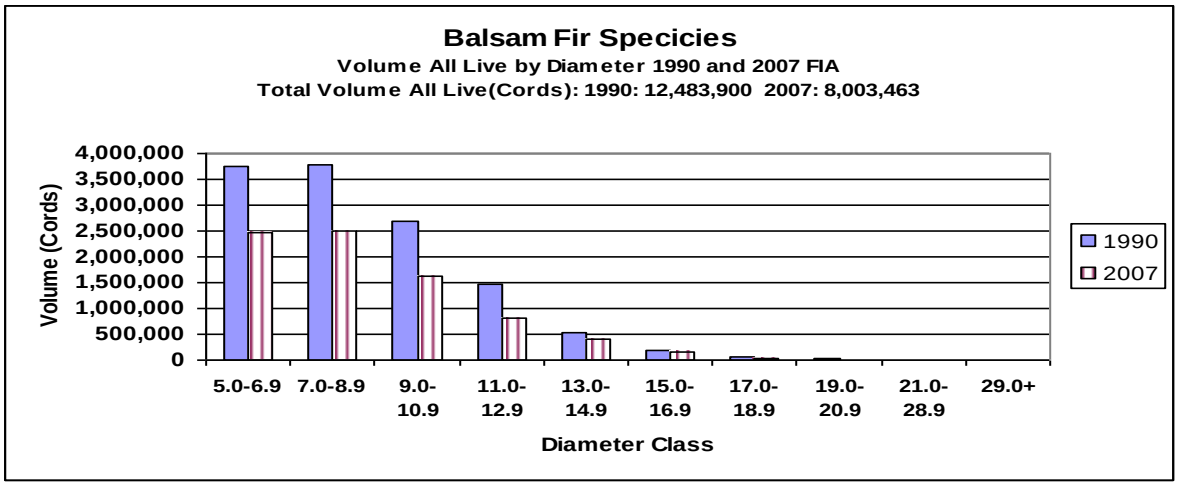
extended rotation ages, more reserve trees and more mixed stands result in more balsam fir of older ages, then budworm populations will periodically build up to outbreak levels.

- 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.



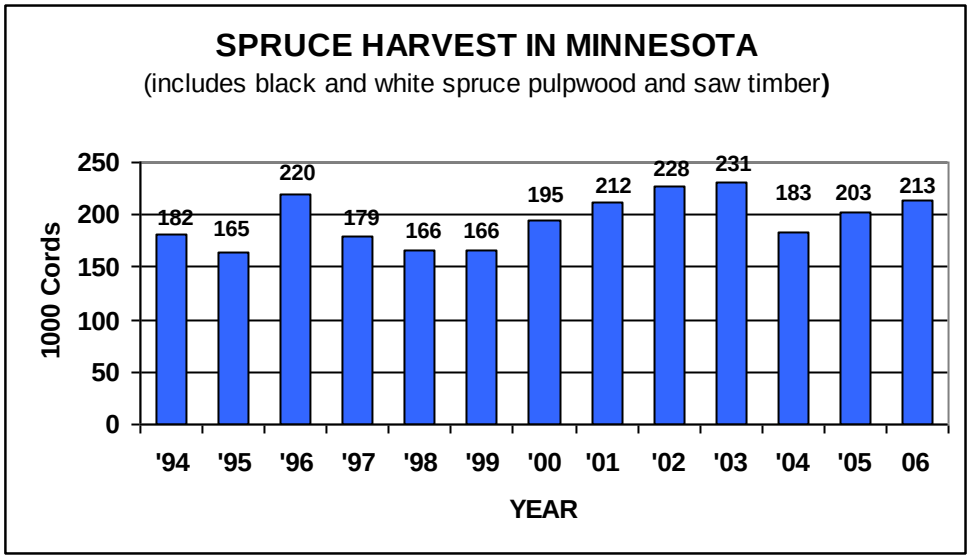
Source: 2007 FIA Database provided by USFS, Northern Research Station

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). Much of the balsam fir volume in Minnesota (53%) is found mixed in with the aspen and birch cover types, and is therefore tied to aspen and birch harvest. Total balsam volume has dropped significantly since 1990.



Source: FIA Database provided by USFS, Northern Research Station

Minnesota's Spruce Resource



Source: Harvest data compiled by NCFES & 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 2007 FIA database, estimated average net annual growth of spruce growing stock: 323,400 cords, estimated average annual mortality of spruce growing stock: 169,895 cords.

Current Demand for Spruce from Minnesota Timberlands

	Cords
2006 Harvest	**213,100**
• Minnesota Pulpwood Industries	169,900
• Pulpwood Export	24,800
• Sawlogs & Other	18,400

Source: NFRS & DNR Surveys

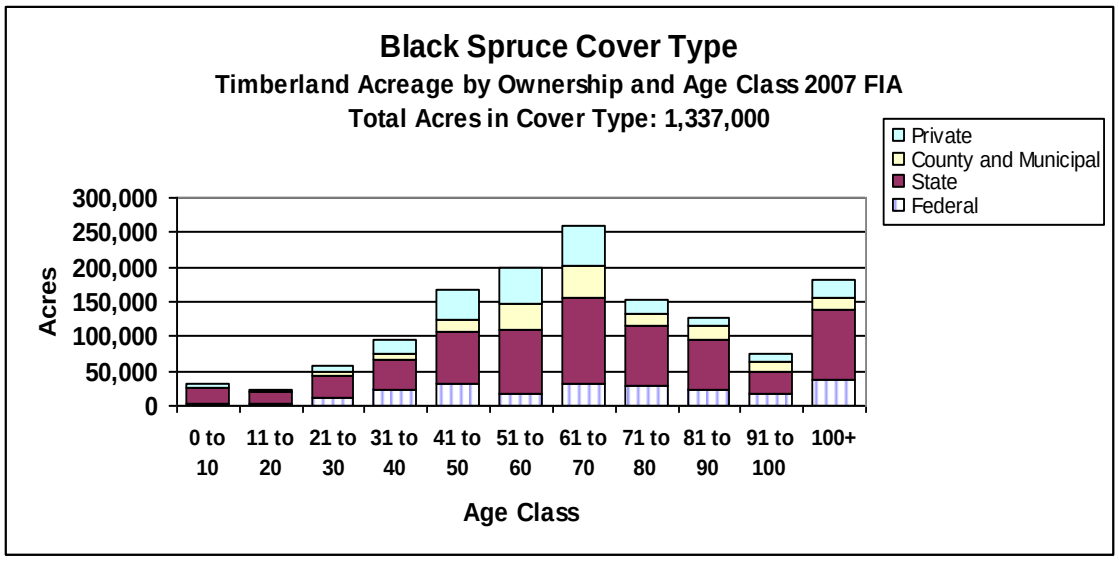
Resource Opportunities

- High-quality spruce has excellent qualities 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 ~~our~~ 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

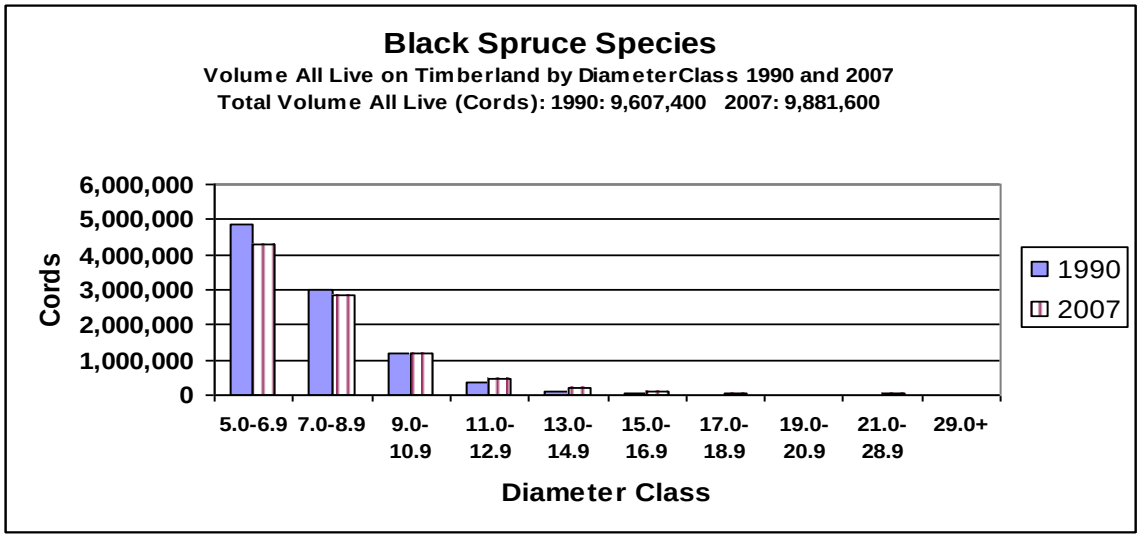


Source: 2007 FIA Database provided by USFS, Northern Research Station

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 75 to 120 years of age, with 100 years an average figure. 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.

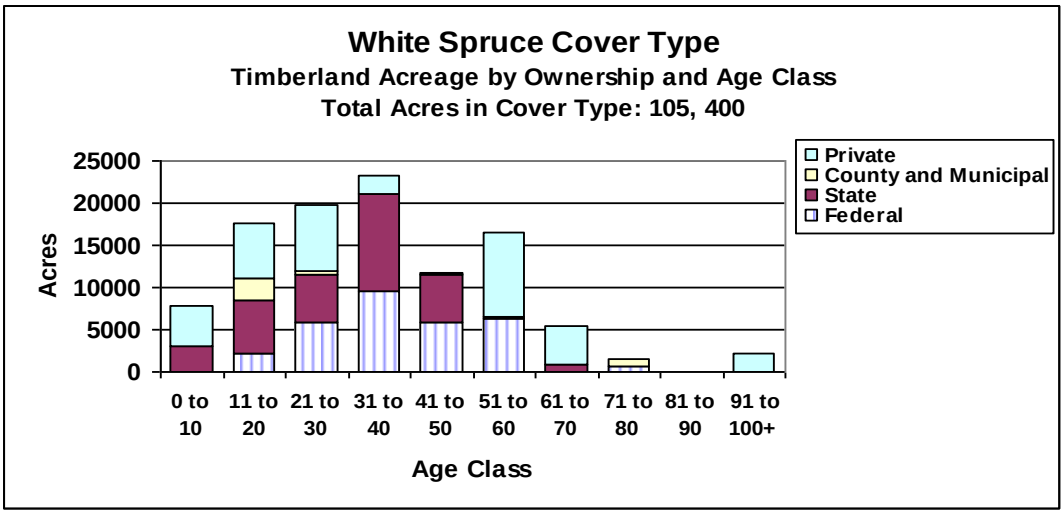
The State of Minnesota is by far the largest owner of black spruce cover type acres, but counties, private owners and our two national forests all have significant acreage.

The vast majority of black and white spruce in Minnesota (over 92%) 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 Oriented Strand Board (OSB).



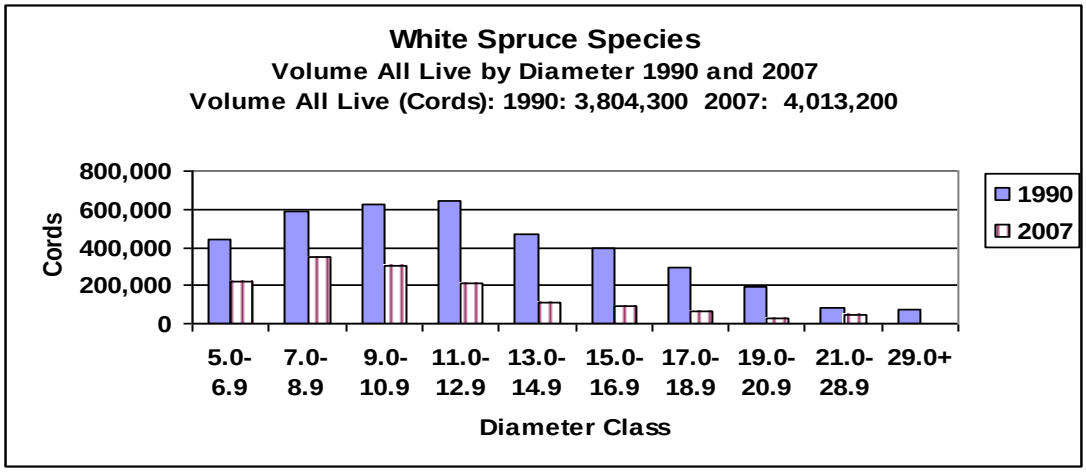
Source: FIA Database provided by USFS, Northern Research Station

White Spruce



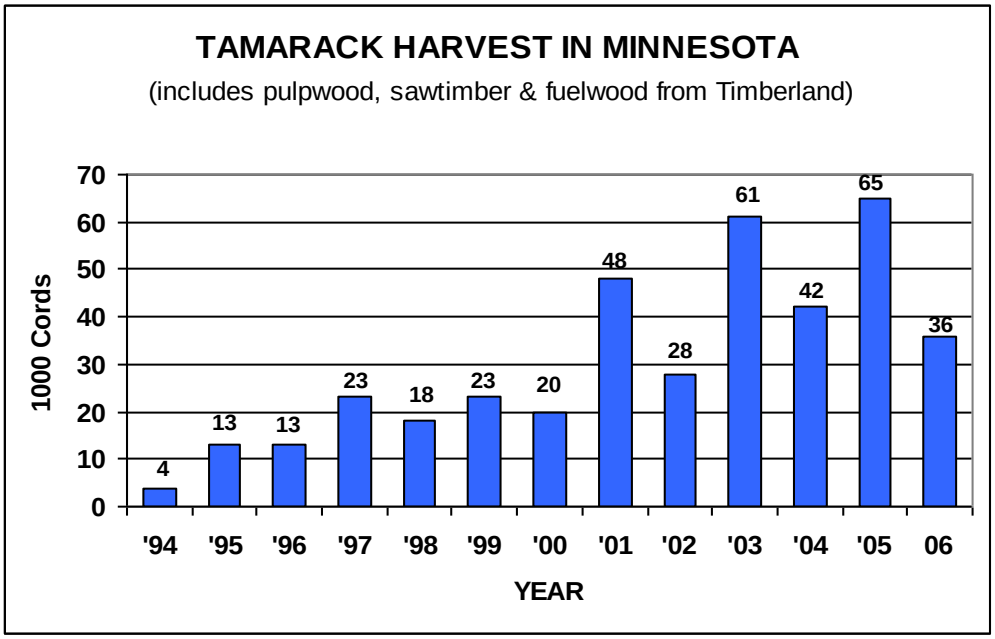
Source: 2007 FIA Database provided by USFS, Northern Research Station

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 60 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

Minnesota's Tamarack Resource



Source: Harvest data compiled by NFES & DNR

DNR estimated long-term annual sustainable harvest level = 114,800 cords/year. Based on the 2007 FIA database, estimated average net annual growth of tamarack growing stock: 119,300 cords, estimated average annual mortality of tamarack growing stock: 103,700 cords.

Current Demand for Tamarack from Minnesota Timberlands

	Cords
2006 Harvest	**37,100**
• Minnesota Pulpwood Industries	31,700
• Pulpwood Export (To Canada)	2,900
• Sawlogs & Other	1,800
• Fuelwood	700

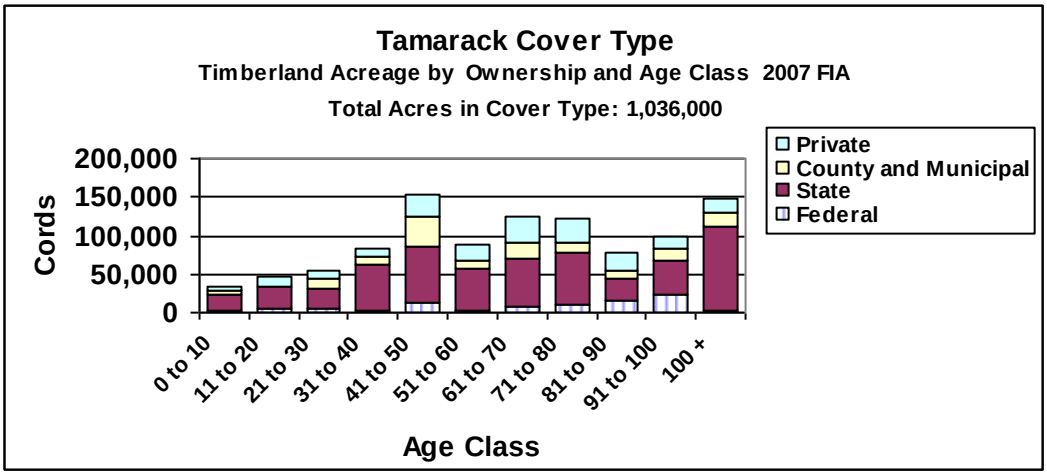
Source: NFRS & DNR Surveys.

Resource Opportunities:

- Harvest is well below long-term sustainable levels.
- Total tamarack volume has risen substantially since 1990.

Resource Issues:

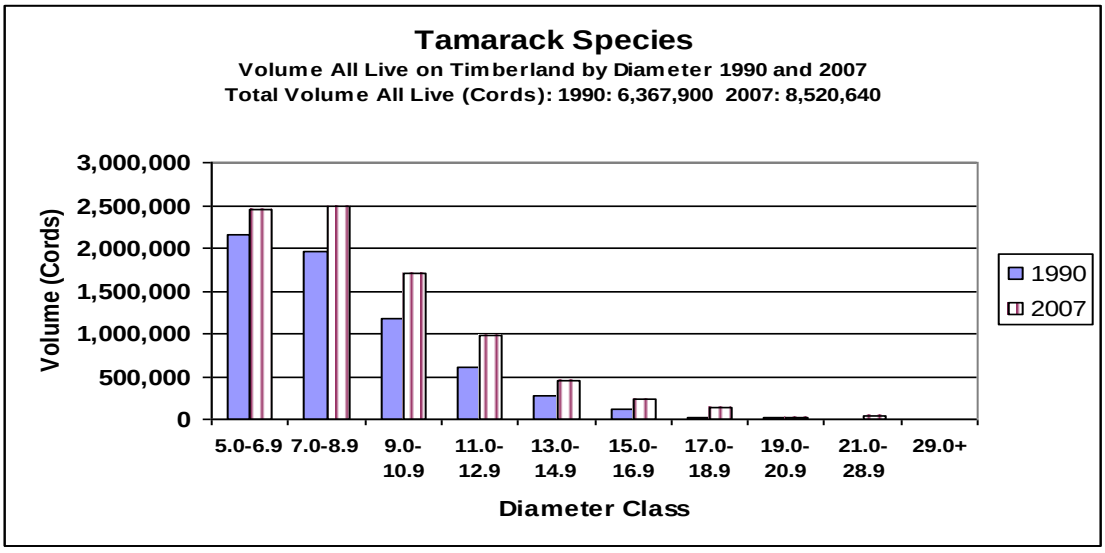
- Many stands have low volumes.
- Serious forest health and mortality issues, especially in older stands.
- Winter access only.
- Uncertain markets with closures of OSB mills that were a significant market.
- Additional market development needed.



Source: 2007 FIA Database provided by USFS, North Central 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 over 50% of the tamarack cover type.

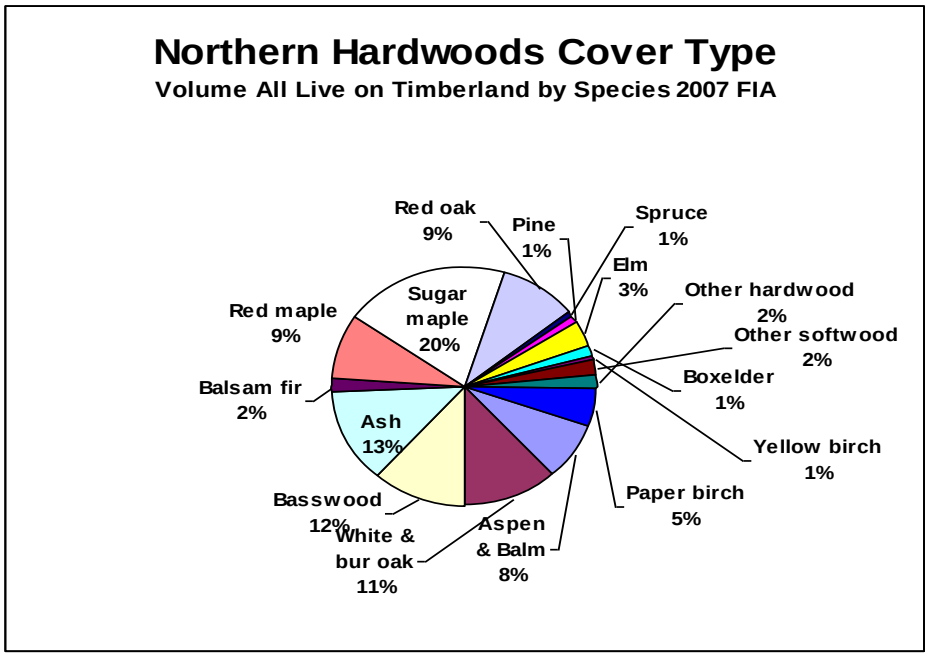
Tamarack is now used in the manufacture of OSB, and with Kraft pulp mills also using some markets for tamarack have improved somewhat over the past 6 years. Improved markets enhance the ability to manage this important resource.



Source: FIA Database provided by USFS, Northern Research Station

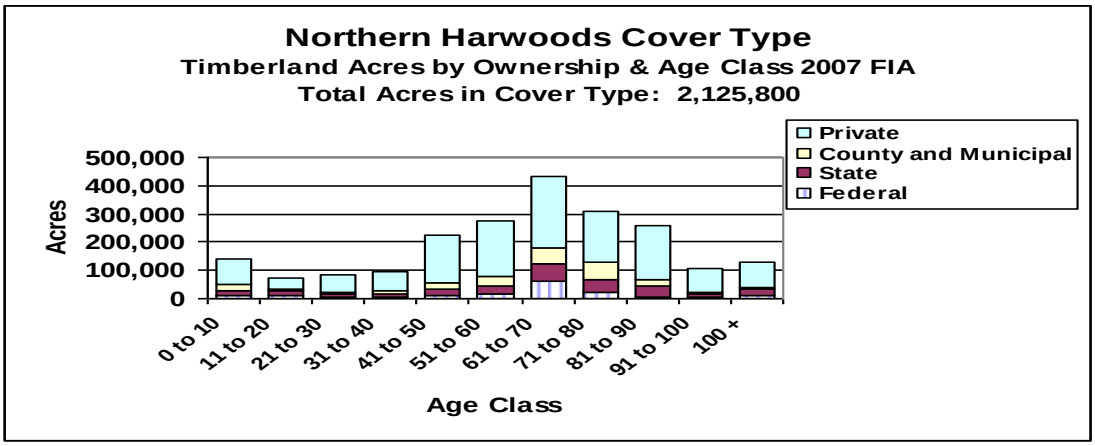
Total volume of tamarack has risen substantially since 1990.

Minnesota's Northern Hardwoods Resource



Source: 2007 FIA Database provided by USFS, Northern Research Station

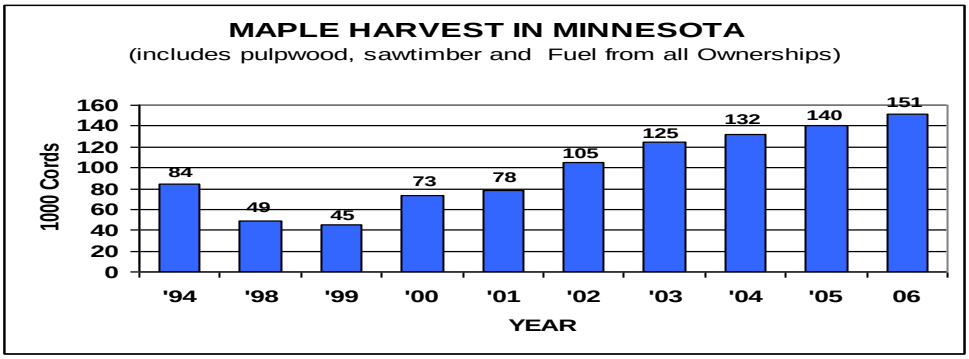
The northern hardwoods cover type is a conglomeration of a wide group of species. The dominant species are the shade tolerant sugar maple and basswood. There are also significant ash, oak, birch and aspen volumes.



Source: 2007 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, 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: NCRS Pulpwood Surveys, DNR Sawmill & Fuelwood Surveys.

DNR estimated long-term annual sustainable harvest level = 429,600 cords. Based on the 2007 FIA database, estimated average annual net growth for maple growing stock in Minnesota is 578,000 cords, estimated average annual mortality of maple growing stock is 102,100 cords.

Current Demand for Maple from Minnesota Timberlands

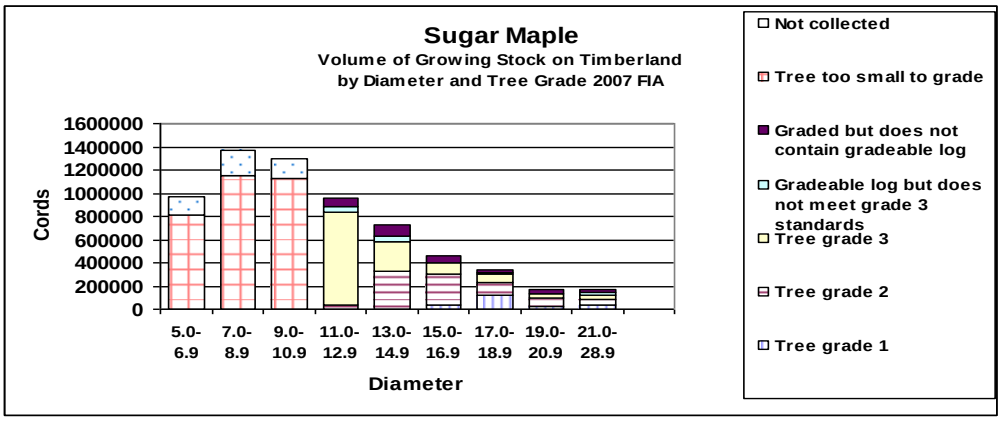
	Cords
2006 Harvest……..	**151,000**
• Minnesota Pulpwood Industries……..…..…...	117,600
• Pulpwood Export……..	200
• Sawlogs & Other……..	12,700
• Fuelwood……..	20,500

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.

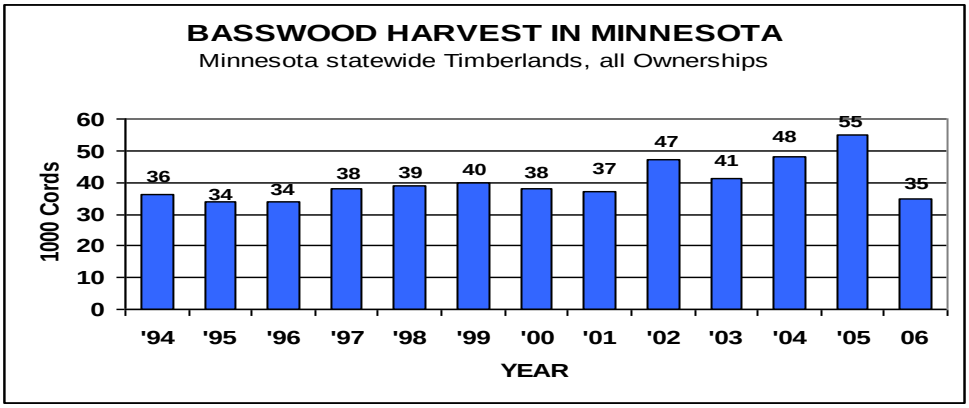


Source: 2007 FIA Database provided by USFS, North Central Research Station

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. Some higher quality sugar maple is grown in southeastern Minnesota, however.

Basswood



Source: NFRS Pulpwood Surveys, DNR Sawmill & Fuelwood Surveys.

DNR estimated long-term annual sustainable harvest level = 280,300 cords. Based on the 2005 FIA database, estimated net annual basswood growth: 280,300 cords, estimated annual mortality: 56,000 cords.

Current Demand for Basswood from Minnesota Timberlands

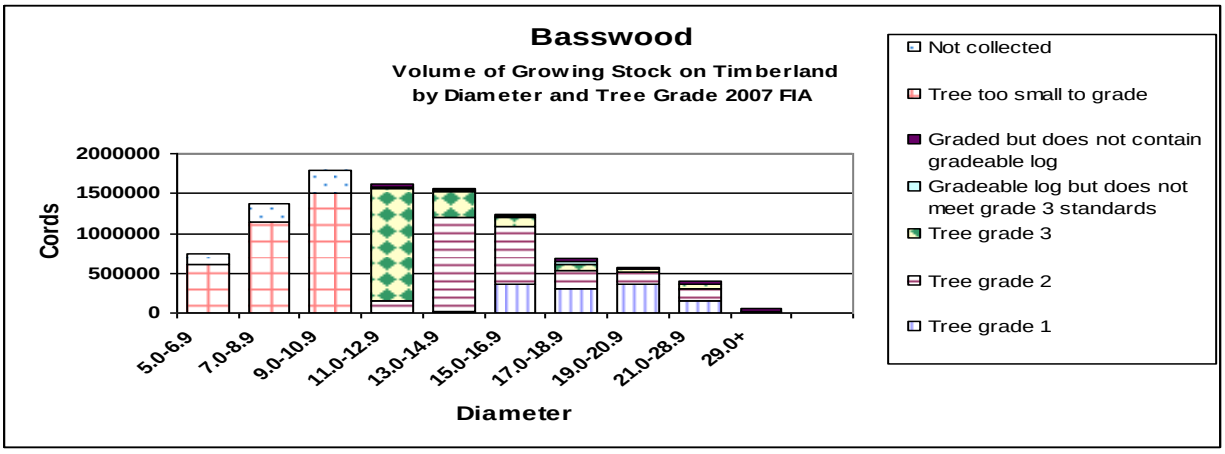
	Cords
2006 Harvest	**35,400**
• Minnesota Pulpwood Industries	12,000
• Pulpwood Export	500
• Sawlogs & Other	21,600
• Fuelwood	1,300

Resource Opportunities

- Harvest is well below long-term sustainable levels.
- There are opportunities to improve future oak 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

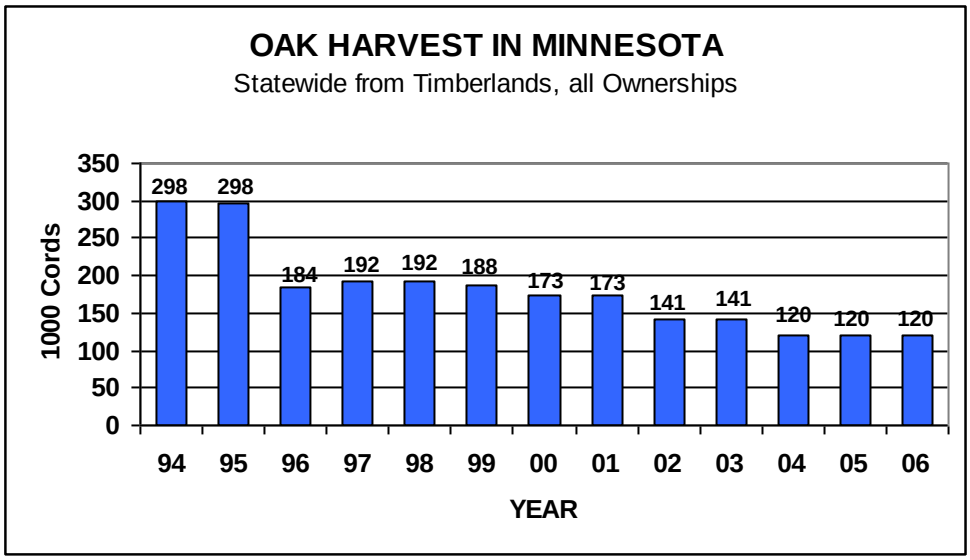
- Much of the basswood resource is in private ownership, so managing it will require significant efforts in private landowner incentives and assistance.
- Potential for harvest of high-quality stems as "pulpwood" on productive sites prior to their reaching sawlog size on private lands. Important to get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



Source: 2007 FIA Database provided by USFS, North Central Research Station.

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: NCRS Pulpwood Surveys, DNR Sawmill & Fuelwood Surveys.

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

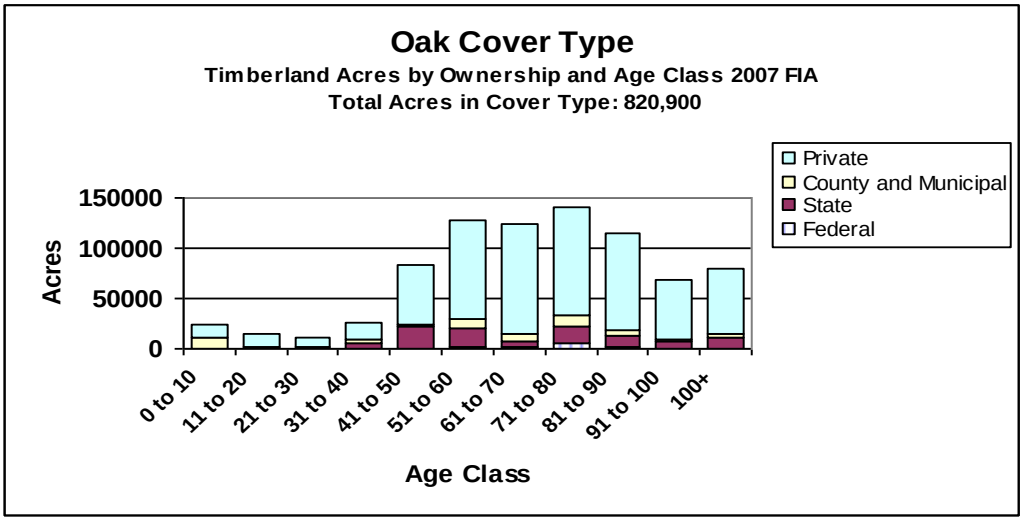
	Cords
2006 Harvest	**119,600**
• Minnesota Pulpwood Industries	187
• Pulpwood Export	12
• Sawlogs & Other	73,300
• Fuelwood	46,100

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:

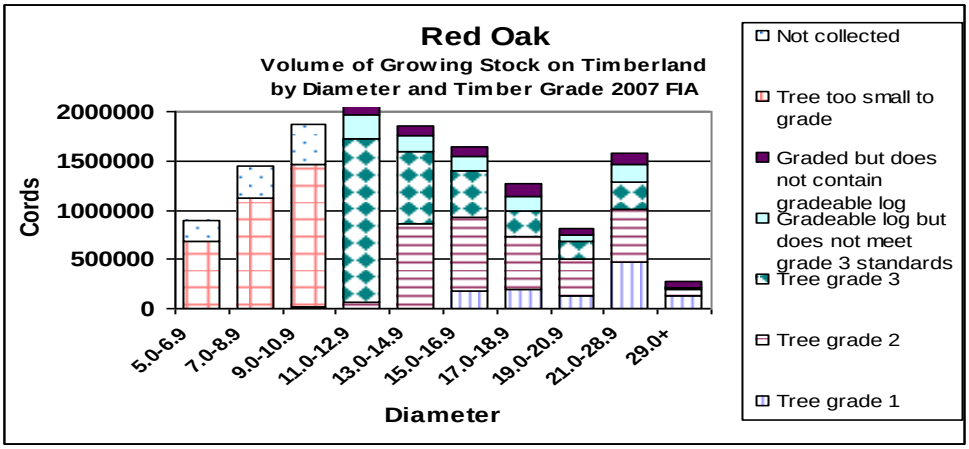
- High quality red oak sawlog resource continues to decline.
- Gypsy moth invasion making its way into MN will have a negative impact on oak resource.



Source: 2007 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.

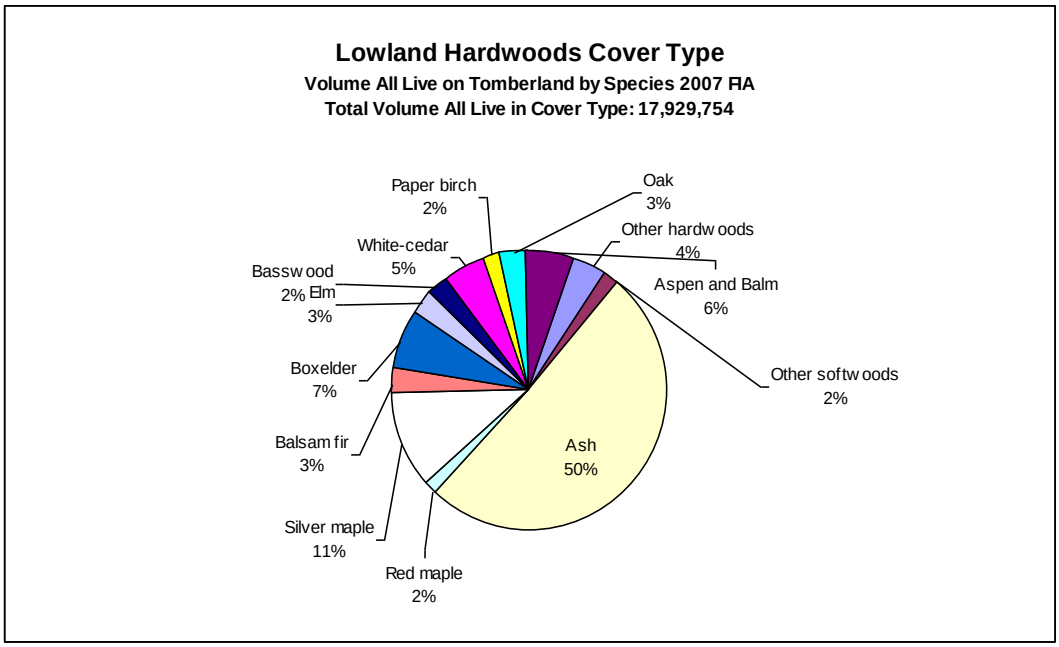
DNR estimated long-term annual sustainable harvest level for oak = 499,300 cords. Based on 2007 FIA data, estimated net annual oak growth: 500,667 cords; estimated annual oak mortality: 132,626 cords.



Source: 2007 FIA Database provided by USFS, North Central Research Station

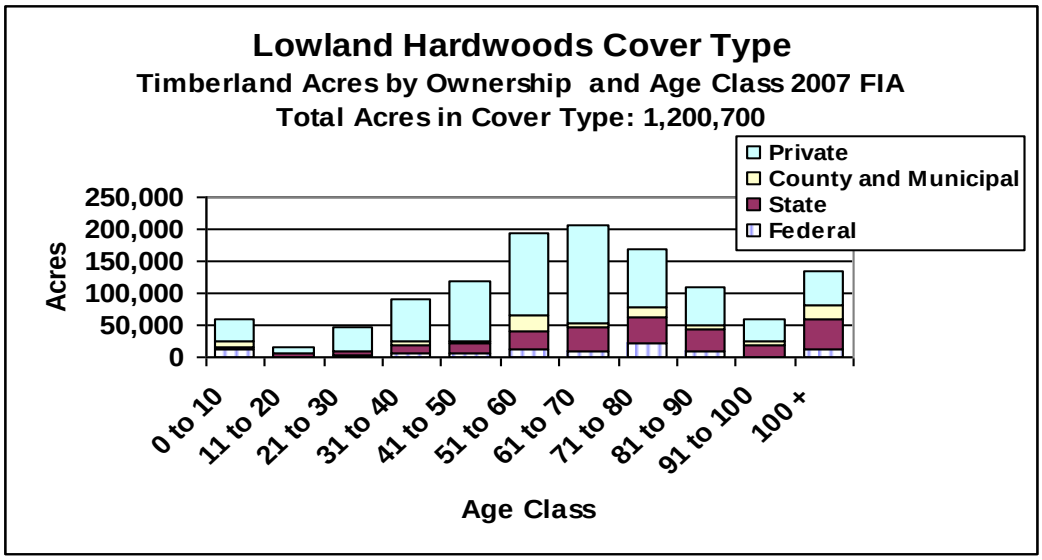
Some high quality sawlog and veneer red oak is grown on good sites in Minnesota.

Minnesota's Lowland Hardwoods Resource



Source: 2007 FIA Database provided by USFS, North Central Research Station

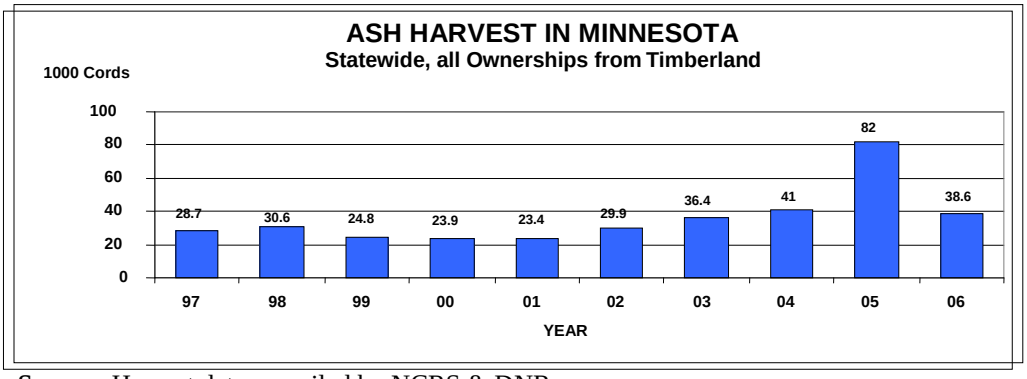
The lowland hardwoods cover type is made up of a variety of species. Most prevalent are black ash, silver maple, green ash and cottonwood.



Source: 2007 FIA Database provided by USFS, North Central Research Station

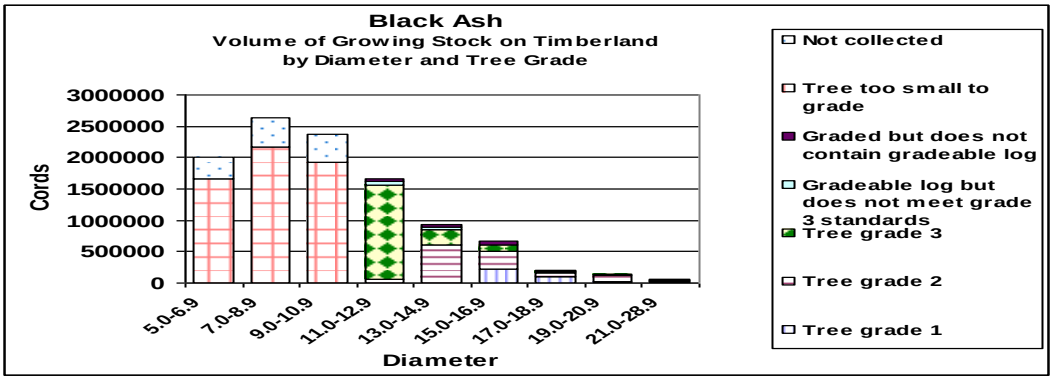
The lowland hardwood cover type is dominated by late "middle age" stands. A common rotation age for black ash is 90 years.

Ash



Source: Harvest data compiled by NCRS & 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 2007 FIA data, estimated net annual ash growth: 510,565 cords; estimated annual mortality: 83,628 cords.



Source: 2007 FIA Database provided by USFS, North Central Research Station

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. We do grow a modest amount of high quality sawlog and veneer ash in Minnesota

Current Demand for Ash from Minnesota Timberlands

	Cords
2006 Harvest……	**38,600**
• Minnesota Pulpwood Industries……..…..	15,000
• Sawlogs & Other (including fuel)…….……..	23,600

Resource Opportunities

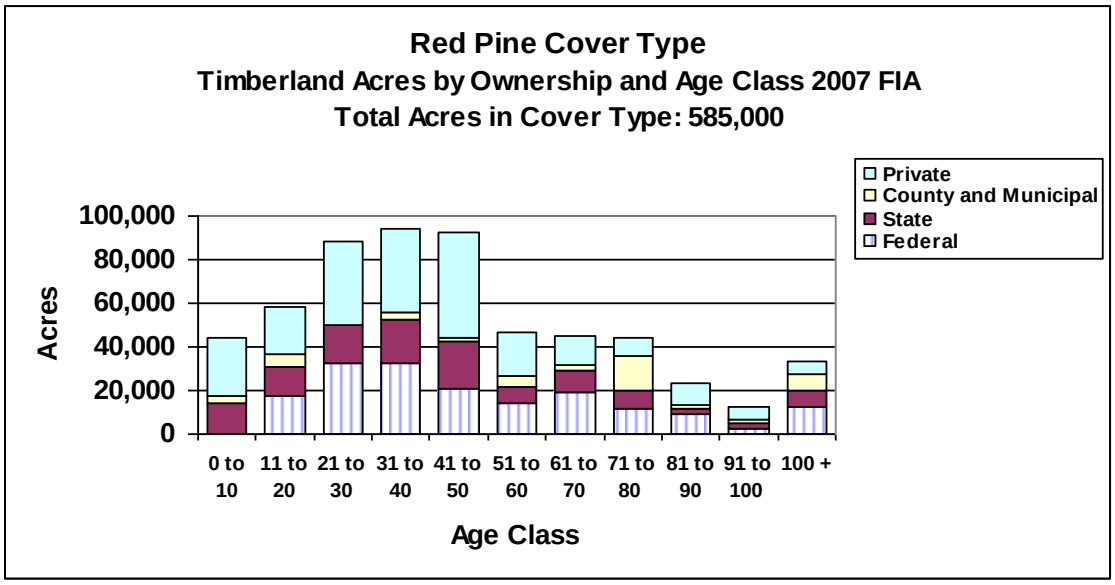
- Harvest is well below long-term sustainable levels.

Resource Issues

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

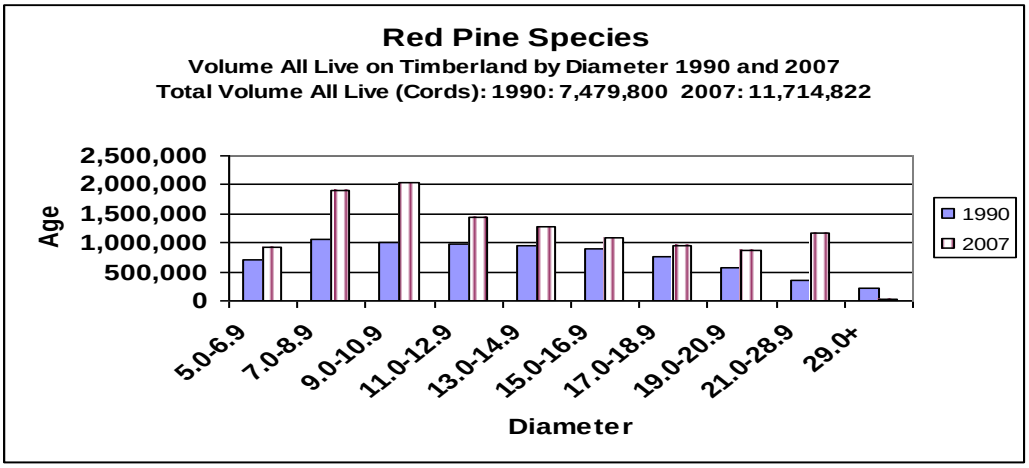
Minnesota's Pine Resource

Red Pine



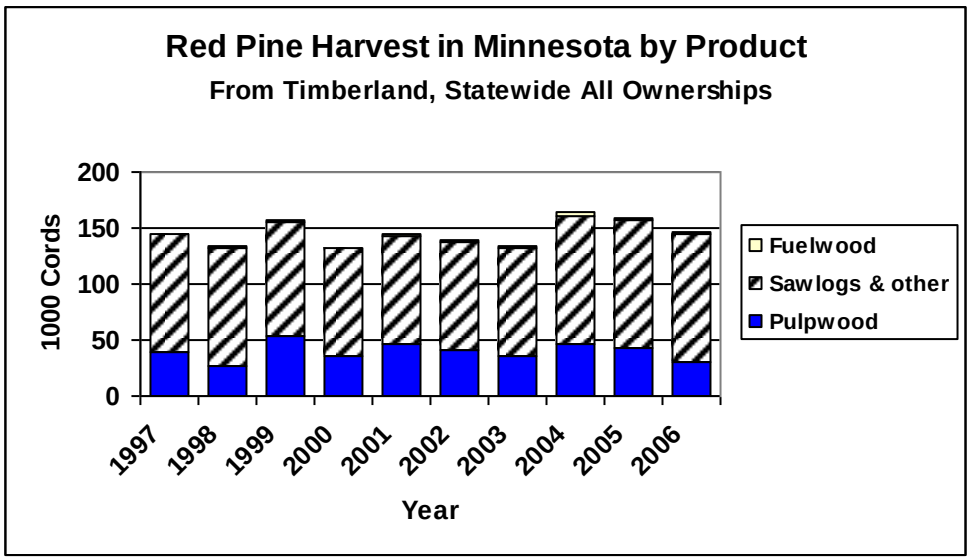
Source: 2007 FIA Database provided by USFS, Northern Research Station

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 NCRS & DNR

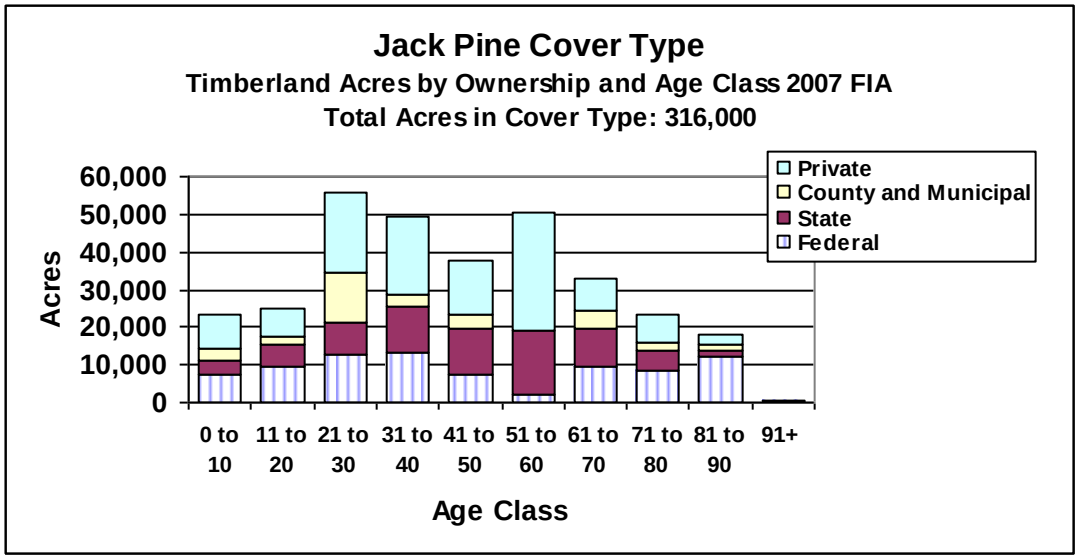
DNR estimated long-term annual sustainable harvest level = 340,000 cords*. Based on 2007 FIA data, average net annual growth of red pine growing stock: 638,837 cords; average annual mortality: 89,986 cords.

*It is important to note that due to the age-class structure of red pine (large acreages of young red pine) the short-term harvest level would be lower than the long-term sustainable figure. Short-term figure is approximately 300,000 cords, rising to 356,000 cords by 2012 and then continuing to rise for at least 50 years as the cover type ages and available volume for thinning increases.

Resource Opportunities

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

Jack Pine

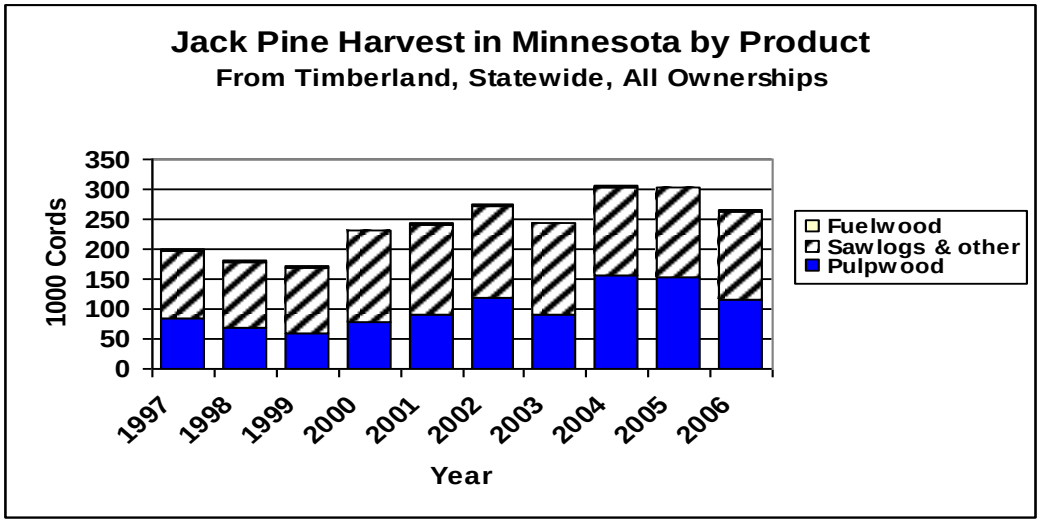


Source: 2007 FIA Database provided by USFS, Northern Research Station

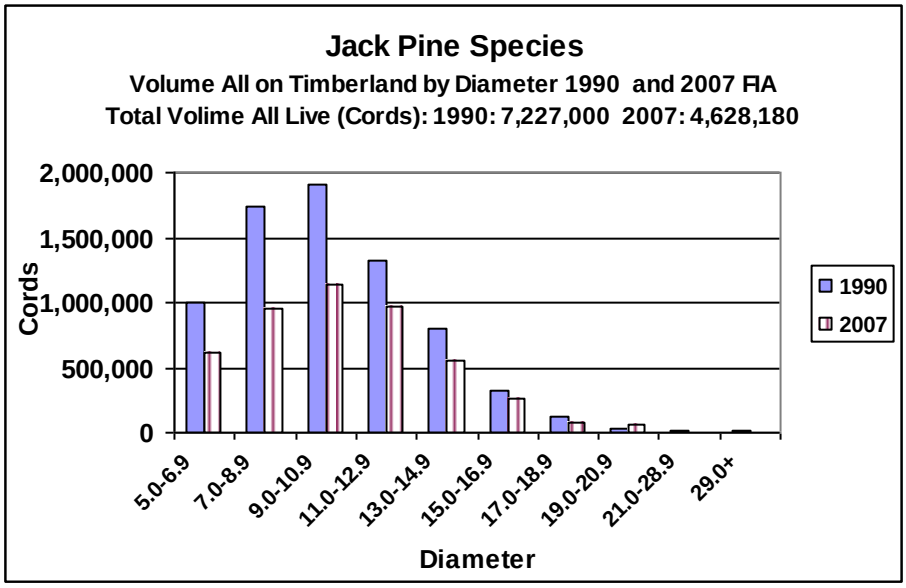
Much of the jack pine resource is owned by the state of Minnesota and by private landowners. The jack pine cover type is heavily weighted to the 21 to 60 year age classes. Many of these older stands are in need of management at the present time. Recent jack pine budworm outbreaks in older stands have resulted in heavy mortality in portions of northwest and east central Minnesota. The age-class imbalance, and the need to manage the related forest health issues and the mortality associated with them, has been key reasons for higher jack pine harvest rates of late.

While the accelerated harvest rates of the present have been necessary and prudent for management purposes, they are unlikely to be sustainable for the long term. Jack pine harvest levels are likely to remain near or above present levels for the next few years, and then will probably begin a downward trend within the next five to ten years. The volume "slack" caused by the coming reduction in available jack pine will need to be made up with increased thinning of the young red pine resource.

Based on 2007 USFS FIA data, average net annual growth of jack pine growing stock: 101,320 cords; average annual mortality of jack pine growing stock: 77,988 cords.



Source: Harvest data compiled by NCRS & DNR

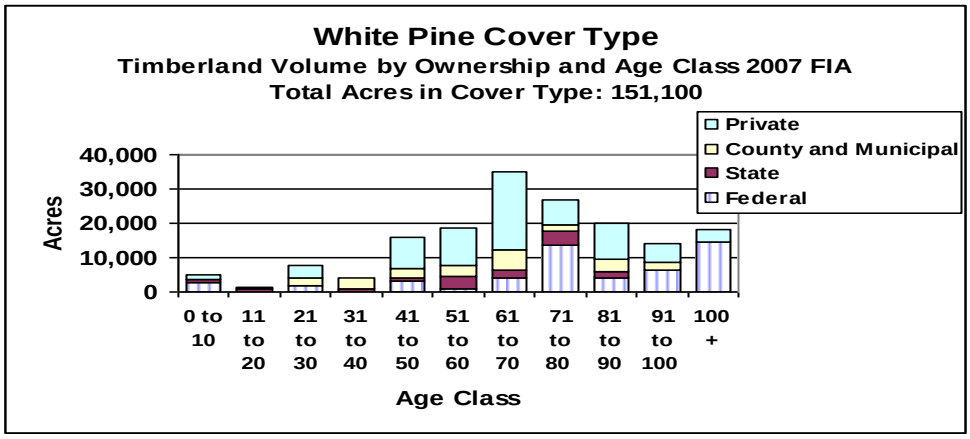


Source: FIA Database provided by USFS, Northern Research Station

Jack pine total volume has rapidly declined since 1990. Total volume of jack pine growing stock has gone from 7,016,000 cords in 1990 down to 4,,628,180 cords in 2007 – an over 35% decrease.

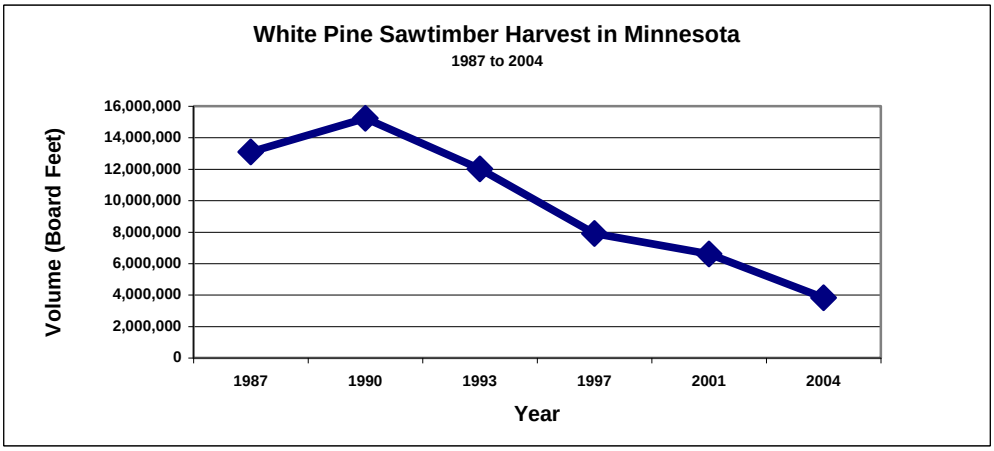
The vast majority of jack pine is under 15 inches in diameter.

White Pine

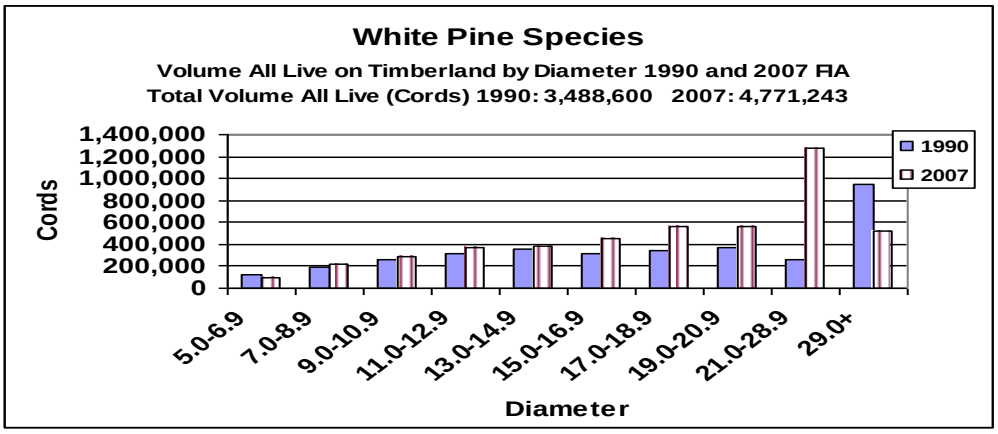


Source: 2007 FIA Database provided by USFS, North Central Research Station

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.



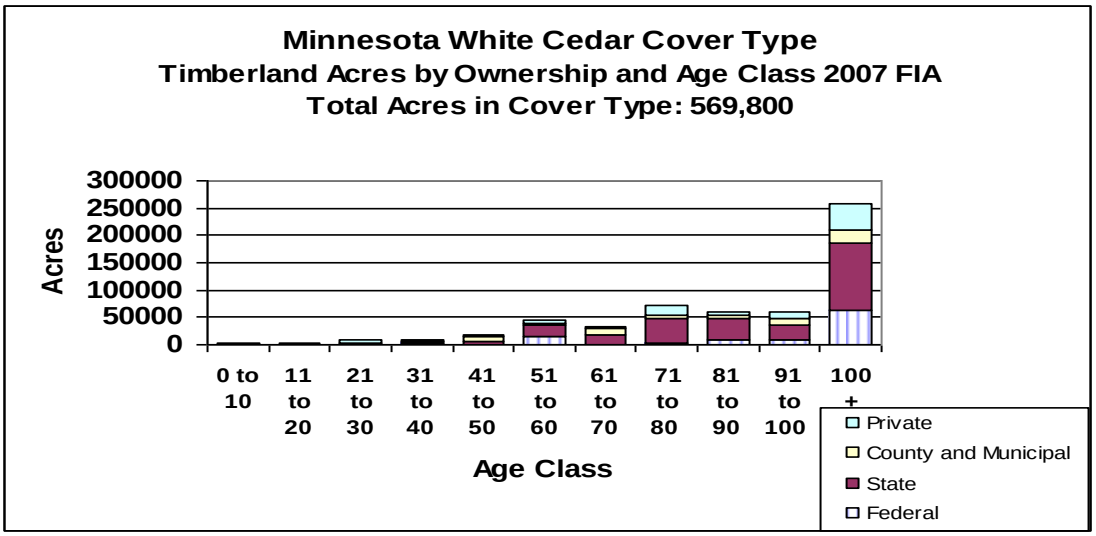
Source: DNR – Division of Forestry Sawmill Surveys



Source: FIA Database provided by USFS, Northern Research Station

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 2007 FIA data, average net annual growth of white pine growing stock: 195,799 cords; average annual mortality: 61,158 cords.

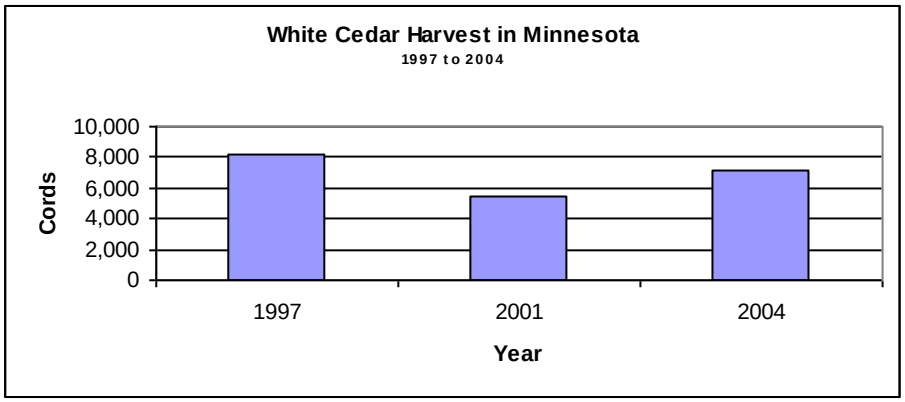
Minnesota's White Cedar Resource



Source: 2007 FIA Database provided by USFS, North Central Research Station

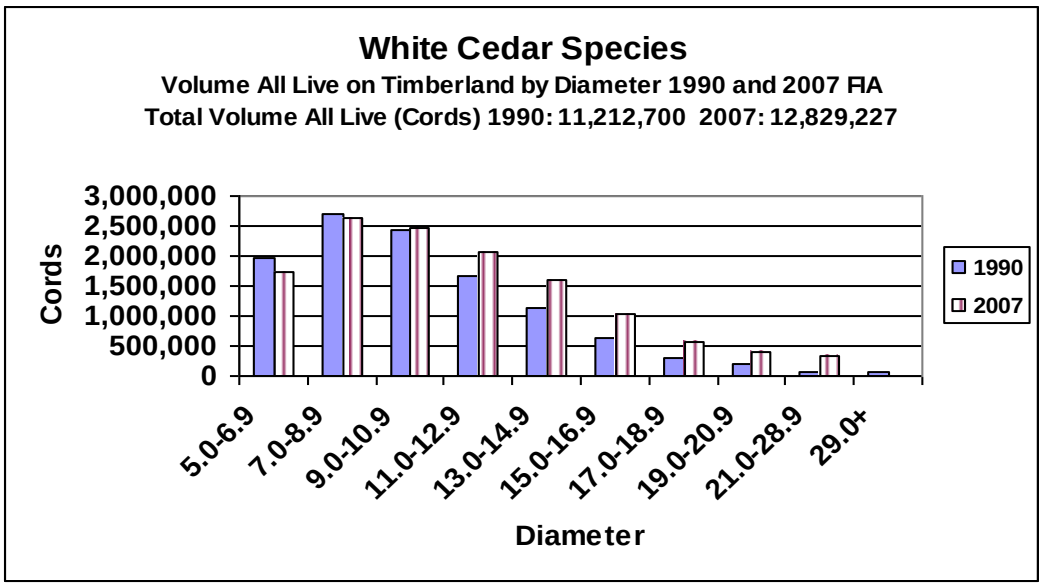
Northern white cedar is a slow-growing, long-lived conifer. The white cedar cover type in Minnesota is located largely in the northeastern 1/3 of the state and is made up of a variety of species. Cover type volume is dominated by white cedar, but includes spruce, tamarack, balsam fir, birch, ash and 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.

White cedar is generally an old resource, and it is getting older: over 258,000 cover type acres exist in stands over age 100, with less than 15,000 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: USFS Pulpwood Surveys, MN DNR Sawmill & Fuelwood Surveys.

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 193,678 cords, and average annual mortality is approximately 119,933 cords, according to the 2007 FIA inventory. Annual harvest is less than 8,000 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

Timber Price Information

$$$$

Average Prices Received by product for Stumpage Sold by Public Land Agencies in Minnesota: 1998-2007

Average Prices Received for Stumpage Sold by Public Land Agencies in Minnesota: 1999-2007

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, Utilization & Marketing Program page, in the annual "Minnesota Public Stumpage Price Review" at URL:http://www.dnr.state.mn.us/forestry/um/index.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 URL:http://www.dnr.state.mn.us/forestry/timbersales/index.html.

Pulpwood ($ per cord)									
Species	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Aspen	23.40	25.28	28.76	27.3	28.95	37.20	59.70	47.5	27.52
Balm	14.13	25.27	32.06	27.5	25.12	31.71	45.25	38.8	17.00
Birch	7.66	7.69	8.31	8.16	9.04	12.21	20.57	14.7	9.68
Ash	2.28	4.09	3.91	5.86	3.62	5.51	5.43	8.22	6.21
Oak	10.76	9.27	7.74	5.77	4.35	8.28	16.28	18.2	16.23
Basswood	5.67	5.68	5.48	6.51	6.05	6.58	10.64	8.06	10.35
Balsam Fir	12.09	14.84	14.61	13.9	13.46	21.12	33.54	30.5	18.36
W. Spruce	26.62	32.63	29.90	30.5	21.87	31.80	43.39	35.0	21.49
B. Spruce	20.61	22.23	29.17	27.0	31.96	31.50	43.39	35.0	21.49
Tamarack	5.79	5.67	6.40	4.11	4.56	6.42	9.84	5.96	3.18
W. Cedar	6.83	8.46	6.74	7.06	4.68	4.60	5.50	9.26	6.39
J. Pine	24.32	21.94	21.63	22.1	21.37	29.46	30.66	37.6	28.50
R&W Pine	17.02	18.61	20.79	20.9	19.55	19.18	29.06	36.5	27.15
Maple	---	---	---	---	---	---	13.30	7.98	7.91

---Insufficient data.

Pulp & Bolts in Combination* ($ per cord)									
Species	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Aspen	26.35	28.66	34.33	30.80	34.52	40.94	65.14	45.5	28.44
Balm	18.04	25.41	32.57	28.35	28.21	34.15	47.09	34.7	23.70
Birch	8.97	9.45	10.40	10.18	12.61	16.28	24.99	17.7	10.99
Ash	7.09	10.01	11.52	10.01	9.84	13.42	21.76	12.9	7.65
Oak	34.00	25.35	24.33	32.32	34.50	26.26	42.24	25.4	20.85
Basswood	17.65	17.00	18.87	16.94	18.34	19.46	23.89	18.2	10.98
Balsam Fir	15.60	19.87	24.01	20.53	23.04	26.76	41.38	30.5	21.47
W. Spruce	29.83	34.25	33.84	34.88	35.86	41.67	48.03	31.3	30.29
B. Spruce	21.28	23.04	30.01	27.65	31.96	32.88	48.03	31.3	30.29
Tamarack	6.97	6.60	7.37	4.55	5.21	6.96	10.07	9.31	5.40
W. Cedar	10.24	8.32	8.68	7.91	6.16	5.98	7.47	13.4	9.35
J. Pine	32.78	30.39	37.95	36.76	38.20	41.75	50.81	49.4	32.07
R&W Pine	57.93	53.35	43.89	40.01	39.13	39.76	55.17	45.9	33.52
Maple	---	---	---	---	---	---	16.30	12.3	8.30

*A bolt is defined as a short log, usually 100" length, with a specific minimum top diameter, generally sawn for lumber.

Sawtimber ($ per Thousand Board Feet)*									
Species	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Aspen	85.09	102.2	114.11	103.19	109.91	128.77	190.44	---	---
Birch	36.12	43.17	50.48	55.87	72.34	94.41	128.30	52.06	27.24
Ash	48.70	71.39	81.97	66.85	76.60	99.56	144.62	---	38.21
Elm	56.50	---	44.10	69.00	62.08	53.82	86.52	---	85.22
Oak**	146.00	109.5	118.72	151.77	150.04	145.57	185.90	378.03	182.8
Basswood	74.77	70.25	81.24	80.43	94.47	112.30	133.10	124.73	97.73
Balsam Fir	80.82	120.6	144.20	136.32	145.47	167.74	244.43	---	76.47
Spruce	81.91	90.00	91.27	94.95	101.81	131.34	204.73	113.02	96.41
W. Cedar	39.13	19.96	30.46	29.43	24.73	27.34	26.38	153.14	---
J. Pine	124.00	114.8	154.35	155.76	135.43	168.66	184.79	124.11	115.2
R&W Pine	198.99	176.0	170.13	153.78	153.10	139.41	181.21	143.45	114.0
Maple	---	---	---	---	---	---	131.53	206.45	137.1

*Includes veneer for certain hardwood species.
**Primarily from public lands in Southeastern Minnesota.
---Insufficient data.

Glossary and Conversion Factors

Glossary

BIA – Bureau of Indian Affairs

Cover Type - A classification of forest land 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. Things like 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 periodically. Field remeasurements were last completed in 1977 and 1990. A recent change is that after completion in 2004, the inventory will be updated continually, with approximately 20% of the plots revisited each year. Minnesota has recently completed year four of a five-year effort to update its FIA, which is a cooperative effort between the USDA Forest Service and Minnesota DNR. The inventory will be complete in late 2004.

FIA provides extremely important information on the condition of the forest resource. Things like 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.

NCRS – North Central 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 book would be available.

NIPF – Non-Industrial Private Forest Land. Forest land owned privately by people or groups not involved in forest industry.

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.

Rotation Age - Age at which a stand is generally considered mature and ready for harvest.

Sawtimber - Wood that is harvested and used by sawmills.

Glossary (continued)

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.

USDA – United States Department of Agriculture.

USFS – United States Forest Service.

Conversion Factors

Conversion factors used in the preparation of this report:

1 cord = 500 board feet
1 cord = 79 cubic feet

Appendix

Forest Management and Carbon Credits: An Update

People worldwide are dealing with global climate change, which has fluctuated throughout earth's history. In the past several years, the scientific community began to notice an acceleration of change, with what are thought to be probable human causes. Industrial processes, as well as conversion of forestlands and perennial grasslands for agriculture and urban development are the main factors responsible for the vast majority of carbon dioxide emissions, which is the primary greenhouse gas (GHG). GHGs are thought to be a significant factor in global climate change.

Climate change can result in severe fluctuations in temperature, precipitation, and natural disasters such as severe storms. Many scientists are increasingly considering reduction of net carbon dioxide emissions to the atmosphere as one way of addressing climate change.

Efforts by the international community to reduce and stabilize the accumulation of GHGs in the atmosphere resulted in the 1997 Kyoto Protocol Treaty, which involved the participation of over 150 countries including the United States. In the Kyoto protocol, developed countries such as the United States, Canada, and the United Kingdom agreed to reduce their GHGs emissions to levels comparable to the 1990s. The United States did not sign the treaty, but set a domestic goal of cutting emissions by 18 percent on a voluntary basis by the year 2010.

Carbon Credits in Forestry

It is worth noting that the impact of carbon markets on forest management is in its infancy. It is an emerging issue with many "moving parts" and unknowns that have potential to change rapidly, and at this point caution is advisable. The market will take time to mature. That being said, let's take a look at an overview of carbon credits and forestry.

Carbon credits represent a key component of national and international emissions reductions systems. These systems reduce greenhouse gas emissions on an industrial scale by capping total annual emissions. Industries can reduce their direct emissions or purchase credits for reduced or offset emissions from other parties. Credits can be exchanged between businesses or bought and sold in markets at the prevailing market price. Credits can be used to finance carbon reduction systems between trading partners around the world.

Forests and tree plantations are seen as part of the solution since they offer the highest per acre rate of carbon capture and storage. In addition, capturing stored carbon, called carbon sequestration, through tree cultivation can become a potential source of income for farmers and the forest landowners through the use of "carbon credits". Carbon credits are the credits an individual, landowner, or industry can receive for implementing a project such as tree planting, which results in demonstrable levels of carbon sequestration.

Carbon Credits Trading

In general, the worldwide carbon markets can be divided into two segments: the voluntary markets and the regulatory (compliance) markets. As the name implies, the voluntary carbon markets include all carbon offset trades that are not required by regulation. At the broadest level, the voluntary carbon markets themselves can be divided into two main segments: the voluntary, but legally binding, cap-and-trade system that is the Chicago Climate Exchange (CCX), and the broader, non-binding, over-the-counter (OTC) offset market.

The carbon credit market is now entirely voluntary in the United States, with buyers seeking credits to "offset" carbon dioxide. Legislation, backed by senators Lieberman and Warner, (the proposed Lieberman-

Warner Bill) is currently under consideration in Congress. It would establish mandatory industrial emission limits implemented through a "cap-and-trade" system of carbon credits. This system would offer greater participation and reasonable pricing for carbon credits. For example, assume an industry needs to reduce its emission 20,000 metric tons per year. Doing this could require new investments in equipment or alterations in operations levels. The industry emitter can weigh its options as to whether it would be cheaper to buy an offset credit from the carbon credit market or install new equipment to reduce emissions levels. In some cases it may be more economical to invest in new machinery but in others, it may be more profitable to buy offset credits from the market.

Current Status of Carbon Trade in USA

The ability of landowners, whether in tree farming, ranching, or perennial crop farming to enter the carbon credit trading depends on the availability of markets and on policies set forth by the government to reduce GHG emissions. The United States government allows voluntary reduction of GHGs. However, the voluntary nature of the GHGs emission program hasn't stimulated a widespread national market. Instead, there have recently been some state, regional, and private industry initiatives to reduce GHG emissions.

In November 2007, nine Midwestern states and the Premier of Manitoba, Canada signed the Midwestern Green House Gas Reduction Accord, an agreement to establish regional goals and initiatives to increase energy security, promote renewable energy, and reduce greenhouse gas emissions. Among the provisions in the new accord is the development of a regional multi-sector cap-and-trade system. A cap-and-trade mechanism sets limits on the total amount of GHGs that can be emitted by certain sources and permits those entities under the "cap" to trade pollution credits or "allowances" with each other.

Trading emissions in a well designed market system creates incentives for entities to arrive at a least-cost solution for reducing their emissions. The Regional Greenhouse Gas and the Western Climate initiatives also employ a cap-and-trade system. This system forms the cornerstone of several climate bills currently under consideration by Congress. It is notable to point out the consortium of Midwestern states that are fully participating in the multi-sector cap-and-trade component of the Accord-Illinois, Iowa, Kansas, Michigan, Minnesota, and Wisconsin, (Indiana, Ohio, and South Dakota are observers) because the total GHG emissions of this group is the largest of the three regional cap-and-trade initiatives, accounting for 14 percent GHG emissions nationwide. California is in the process of setting up a similar market. The Northeastern market aims to reduce emissions from power plants by 10 percent in 10 years.

By March 2008, thirty-nine US states, the District of Columbia, three Native American tribal nations, six Mexican states, and six Canadian provinces signed onto The Climate Registry. Like the California Climate Action Registry, this multi-state-and-tribe registry was created to facilitate regulatory or voluntary reporting and to "provide an accurate, complete, consistent, transparent and verified set of greenhouse gas emissions data from reporting entities, supported by a robust accounting and verification infrastructure. While the Registry is not currently being utilized by a cap-and-trade system, it could very well influence any future federal initiative.

Voluntary Carbon Markets

- *Chicago Climate Exchange (CCX)*

A voluntary market is already in place. The Chicago Climate Exchange (CCX) enables firms to buy and sell carbon credits. It is a publicly traded business that provides a market-based mechanism for reducing greenhouse gas emissions. The CCX is North America's only active, voluntary, and legally binding carbon trading system. Trading operations began in 2003. The CCX trade carbon credits in large quantities when major greenhouse gas producers voluntarily participate as carbon credit buyers to offset their emissions. The CCX then connects these emitters with carbon-storing or sequestering projects as carbon credit sellers through aggregators. Currently the price of carbon credit in this country is about $2 to $4 per metric ton of

carbon dioxide, while in Europe it has traded between $30 and $45 per ton due to stricter emission regulations (although the price has currently dropped well below this level). It is envisaged that in the future, if tighter control measures are implemented in the United States, the price for offset may be increased making it more lucrative for landowners to enroll into the carbon trade business.

Large forest landowners can be members and small forest landowners can participate in providing offsets through an aggregator, which is a CCX-registered entity that pools smaller projects to make them marketable on the exchange. Forestry is one of several types of CCX offset project. At present, the there are three qualifying forestry protocols: i) Afforestation, ii) Sustainably Managed and iii) Long Lived Wood Products Protocol. If qualified under any of these protocols, the amount of the payment would be dependent on the species and age of the forest stands and or trees and the price of carbon credits at the time of enrollment.

Landowners will receive annual payments on the value of the project, but the price will fluctuate depending on the price of carbon. A percentage of the project value will be paid to the broker, who organizes and presents the contract to CCX. Another 20 percent of the project credits will be set aside in a reserve pool to offset the risk of a natural calamity, such as wildfire. This reserve value belongs to the landowner. If the contract is fulfilled in 2010 with no acreage losses, the full value of the annual 20 percent reserve will be paid to the contract holder.

- *Over- the-Counter Market (OTC).*

Outside of the CCX, one finds the wide range of voluntary transactions that make up a voluntary market not driven by any sort of emissions cap. Because this market is not part of a cap-and-trade system, where emission allowances can be traded, almost all carbon offsets purchased in this voluntary market originate from project-based transactions. Because it does not operate via a formal exchange, the Ecosystems market Place has labeled it as the voluntary Over-the-Counter (OTC) market. This OTC market is also often referred to as the voluntary offsets market. However, it is important to note that offset credits also exist on the CCX.

Credits sourced specifically for the OTC market are often generically referred to as Verified (or Voluntary, depending on the source) Emission Reductions (VERs), or simply as carbon offsets. However, voluntary buyers may also purchase credits from the compliance markets or the CCX.

Buyer motivations include wanting to manage their climate change impacts, an interest in innovative philanthropy, public relations, the need to prepare for (or deter) upcoming regulation, and/ or plans to resell credits at a profit.

Suppliers in the offset market include retailers selling offsets online, conservation organizations hoping to harness the power of carbon finance, project developers interested in generating VERs, and aggregators of credits. Depending on their position in the supply chain, sellers can be categorized into four major types: 1) **Project developers -** Develop GHG emissions reduction projects and may sell carbon to aggregators, retailers, or final customers; 2) **Aggregators/Wholesalers-** Only sell offsets in bulk and often have ownership of a portfolio of credits; 3) **Retailers-** Sell small amounts of credits to individuals or organizations, usually online, and have ownership of a portfolio of credits; 4) **Brokers-** In some cases VERs also pass through brokers, who do not own credits but facilitate transactions between sellers and buyers.

The DNR's cooperative forest management program is examining methods to facilitate forest landowner participation in carbon markets. It is anticipated that management assistance may be available in due course. Not withstanding it is worth noting there are still some risks associated with the forestry offsets program especially in the event of disease outbreak or even fire when one is enrolled into the program as a landowner. For instance, if credits are sold by landowner before carbons are produced (ex-ante) and there is a fire outbreak leading to loss of some acreage of trees, the landowner may be held liable for the loss of anticipated carbon to be produced. However this can be mitigated by way of purchasing additional insurance other than the 20% reserve pool set aside during the contract. On the other hand, if a landowner only receives payments

for carbon produced (ex-post) and there is loss of some acreage of trees, the landowner does not get credit since no carbon is produced. However, in each of these two scenarios, the landowner can sell his trees after the contact expiration or re-enroll for a new contract.

In summary, it is worth noting again that the impact of carbon markets on forest management is an emerging issue that has potential to change rapidly, and could begin to have a significant impact in the future. Stay tuned.

For more information on forestry carbon offset programs, visit web sites listed below.

- Chicago Climate Exchange (CCX): http://www.chicagoclimateexchange.com
- *Ecosystem Market Place: http://www.ecosystemmarketplace.com*
  Information on ecosystem markets, including carbon markets
- CINRAM: http://www.cinram.umn.edu/publications/landowners_guide1.5-1.pdf
  University of Minnesota Center for Integrated Resources and Agricultural Management publication:
  "A Landowner's Guide to Carbon Sequestration Credits"
- Dovetail Partners Inc: http://www.dovetailinc.org/reportView.php?action=displayReport&reportID=92
  Dovetail Partners report: "Wood Products and Carbon Protocols: Carbon Storage and Low Energy Intensity Should be Considered"
- Minnesota Farmers Union:www.mfu.org
  Information about National Farmers Union national carbon credit program
- National Farmers Union: www.nfu.org; or
  Information about National Farmers Union national carbon credit program
- University of Minnesota College of Food, Agricultural and Natural Resources Sciences: http://www.cfans.umn.edu
- United Nations Convention on Climate Change: http://cdm.unfccc.int/index.html
- Voluntary Carbon Standards: http://www.v-c-s.org
- Western Climate Initiative: http://www.westernclimateinitiative.org
- Midwestern Greenhouse Gas Reduction Accord: http://www.midwesternaccord.org/