Softwood Sawtimber Supply Analysis

Minnesota Department of Natural Resources
Forestry Division
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Contacts

The report contains a significant volume of information that can be useful to informing discussion and decisions affecting softwood resource management. However, as with any analysis, time, staff and financial resource limits, and space limits for the report itself may leave the reader wanting more information in places. In those instances, readers may request more information from the following sources:

- General questions: Keith Jacobson, keith.jacobson@state.mn.us
- Forest economics: Don Deckard, donald.deckard@state.mn.us
- Thinning practices: Rick Klevorn, rick.klevorn@state.mn.us
- Forest management planning: Jon Nelson; jon.nelson@state.mn.us
- Timber sales statistics: Gaylord Paulson; gaylord.paulson@state.mn.us
- Forest biometrics and harvest modeling: Curtis VanderSchaaf; curtis.vanderschaaf@state.mn.us

Executive Summary

Background

The supply of softwood bolts and sawlog-sized materials for several of the state's large sawmills was severely restricted over the past two winters. This was primarily due to the combined effects of recessionary low lumber prices and an overall decline in statewide all-ownership harvest levels. The result was critically low mill inventories of sawbolt and sawlog-sized materials. DNR cannot resolve a softwood sawtimber material shortage on its own, but as one of the major forest land managers in the state and a leader in setting a strong management example for other ownerships, DNR can take action to help address the issue.

Alternatives and opportunities in this report were presented for use by decision-makers to consider for future action. None of the alternatives or opportunities should be viewed as a recommendation by the task group. Some alternatives would require further investigation, and in the case of DNR lands interdisciplinary discussions, prior to any action being taken (e.g. rotation age changes).

Key Findings

Major trends in softwood sawtimber supplies:

- Red pine acreage available for thinning is rising. Acreage of red pine reaching age and size classes amenable to thinning will be increasing for the next 20 years at least as large age class acreages transition to minimum merchantability standards.
- Jack pine volumes available for harvest are falling. Harvest has necessarily been accelerated for years due to an age class imbalance and budworm impacts. Therefore acres available for harvest are going down significantly due to fewer acres now being at harvest age. Volumes will need to be made up from red pine management.

Rather than potentially available net growth, market factors appear to be creating the major challenges in getting enough wood to Minnesota's softwood sawmills at a competitive price. Factors include:

- Greatly reduced overall private lands harvest levels since 2006. One of the major reasons the reduction has been proportionally greater on private lands than public is that private lands harvest is more sensitive to reduced timber prices.
- Volumes of softwood sawbolts going to other markets, especially pulpwood. It should be noted that competitive pressures and production costs limit softwood sawmill's ability to raise prices for stumpage and therefore encourage additional sorting.

While there are opportunities with other softwood species, the greatest opportunity to increase softwood sawtimber harvest volume is with red pine.

- The ownerships with the greatest opportunities to increase red pine sawtimber harvest volumes, by far, are private and federal which comprise 44% and 27% of the state's red pine timberland acreage respectively as compared to the DNR's 16%.

An important item for consideration will be identification of creative ways DNR and others may be able to facilitate additional management and timber supplies on other ownerships, even with the reality of less DNR staff in the future.

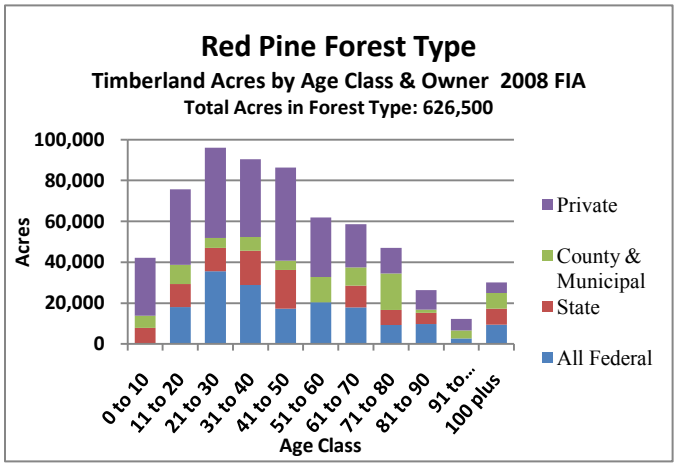
- Support of private forestry assistance will be <u>critical</u>. In addition to continued private landowner forestry technical assistance, private lands opportunities to consider may include:
    - Engagement and assistance from a variety of partners, including University of Minnesota Extension, private consulting foresters, landowner associations and others.
    - Assistance with implementing more thinning demonstration sites and field days.
    - Preparation of additional informational news articles and public media efforts
- Engagement with the National Forests will also be important - are there ways DNR and others can assist the National Forests with softwood management on these lands?

DNR has opportunities to consider for increasing available softwood sawtimber volumes on state lands.

- Decreasing red pine normal and maximum rotation ages, and the amount of older forest called for in some plans. Scale: 15,000 to 35,000 additional cords annually over the next decade.
- Additional red pine volumes during aspen forest type harvest. Scale: Perhaps 1 thousand additional cords annually.
- Change in thinning regimes. Scale: Probably few or no additional cords, but perhaps somewhat greater volumes of bolt material within the total. In other words, a greater proportion of total volume could come from larger trees in early thins. More information will be beneficial in fully assessing optimization of thinning regimes for a wide range of benefits.
- An additional opportunity for all softwoods, from all ownerships, is facilitation of improved sorting for sawbolts.

Red and Jack Pine Resource by Ownership

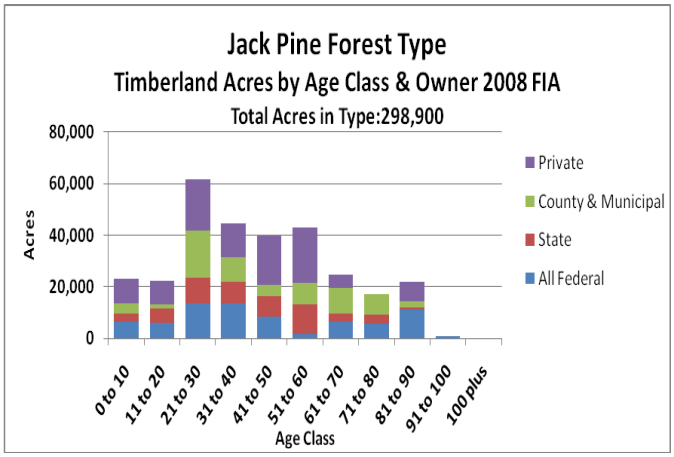
Red pine timberland total 626,500 acres in Minnesota. Private land owners control 276,000 acres or 44% of the red pine resource. The federal government controls 169,000 acres or 27%. The state of Minnesota administers 98,000 acres or 15.6% of the resource. Counties & municipalities administer 71,000 acres or 11.4%.



Red Pine Forest Type Acres of Timberland by Ownership				
Total Acres	All Federal	State	County & Municipal	Private
626,523	169,080	97,653	83,816	275,974
100%	27.0%	15.6%	13.4%	44.0%

Red Pine Net Annual Growth by Ownership (cords)				
Total Cords	All Federal	State	County & Municipal	Private
629,809	163,513	84,144	71,353	309,519
100%	25.96%	13.36%	11.38%	49.3%

Jack pine timberland total 299,000 acres in Minnesota. Private land owners control 105,000 acres or 35% of the jack pine resource. The federal government controls 74,000 acres or 25%. Counties & municipalities administer 66,000 acres or 22% of the resource. The state of Minnesota administers 54,000 acres or 18% of the resource.



Jack Pine Forest Type Acres of Timberland by Ownership				
Total Acres	All Federal	*State*	County & Municipal	Private
298,948	73,799	*53,926*	66,038	105,185
100%	24.7%	*18.0%*	22.1%	35.2%

Jack Pine Net Annual Growth by Ownership (cords)				
Total Cords	All Federal	State	County & Municipal	Private
107,402	56,806	*25,958*	12,286	11,389
100%	52.89%	*24.17%*	12.34%	10.60%

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1. Introduction

1.1 Background

A diverse and healthy industry is critical to supporting a healthy, diverse forest because forest management is enabled largely by markets and timber harvest. Minnesota's softwood sawmills are an important component of a diverse forest industry. Therefore it is in Minnesota DNR's interest to assess opportunities to improve forest health and productivity by improving industry health and employment and economic benefit. There are "win-win" opportunities for Minnesota's citizens, forest industry and DNR. Forest management prescriptions tailored for each site can result in improved timber growth and quality; and also achieve other long-term site objectives and goals. Timber markets are often the best tool for achieving these goals.

The supply of needed softwood bolts and sawlog-sized materials to several large mills has been restricted over the past two winters. This was primarily due to the effects of an overall decline in harvest levels on softwood supplies, especially in the aspen forest type, which contains significant softwood volumes. The result over the past two winters has been critically low inventories of bolt and sawlog-sized materials for a number of softwood-using sawmills.

The DNR cannot resolve a softwood sawtimber material shortage on its own, but as one of the major forest land managers in the state and a leader in setting a strong management example for other ownerships, DNR can take action to help address the issue.

1.2 Purpose

This analysis covers all ownerships in Minnesota, with an emphasis on DNR-administered lands. It is guided by two major goals and several underlying premises:

Goals:

1) Examine opportunities in pine, spruce and fir forest types across ownerships, to improve:
    a. Forest health and productivity
    b. Sustainable timber yields, and DNR revenue
    c. Forest industry health, economic and employment benefits
    d. Stand diversity
    e. Future management choices

2) Inform DNR decision-makers and key stakeholders on:
    a. Softwood resource condition, and DNR sustainable offer volumes under current management plans, policies and practices.
    b. Opportunities and alternatives that have potential for improving forest health and productivity; sustainable timber yields, forest industry health, and DNR revenues

The bottom line reason for the analysis was the need to move beyond crisis-driven management, in the critical endeavor of maintaining the ability to manage softwood resources through markets.

Underlying Premises:

- It is important to note that alternatives and opportunities are presented for use by decision makers. None of the alternatives or opportunities should be viewed as a recommendation by the task group.
- It is also noteworthy that some alternative will require further investigation, and in the case of DNR lands interdisciplinary discussions, prior to any action being taken. Especially for rotation age changes.
- Pine, spruce and fir forest types are managed as native plant communities with desired future conditions and are managed for multiple forest values.

1.3 Procedures

A task group of analysts within Division of Forestry was formed in August 2010. Members: Gaylord Paulson, Timber Sales Program Coordinator; Jon Nelson, Forest Planning & Policy Supervisor, Don Deckard, Forest Economist, Curtis Vanderschaaf, Forest Biometrician/Modeler, Rick Klevorn, Silviculture Program Coordinator, and Keith Jacobson, Forest Products Utilization Program Supervisor.

The task group spent over 400 hours of staff time reviewing existing softwood resource and management information and performing custom analyses as needed. Existing inventory data and research studies provided information on current softwood resource condition, and current softwood management practices such as thinning. Custom modeling analysis was used to assess economic impacts of differing rotation age and old forest policies for red pine.

Data and information sources included:
- USFS Forest Inventory & Analysis (FIA) forest resource information for all ownerships
- Cooperative Stand Assessment (CSA) forest resource information for DNR administered forestlands
- Several red pine growth and yield studies and manager's guides
- Minnesota DNR Sustainable Timber Yield Analysis, 2007.
- Minnesota DNR Subsection Forest Management Plans
- Minnesota DNR timber sales and silviculture program data

2. Red and Jack Pine, Spruce and Balsam Fir Information for All Ownerships

2.1 Resource Overview

Species use by softwood sawmills in Minnesota is essentially limited to red and jack pine, black and white spruce, and balsam fir. Resource size, quality, cost of production, and other market factors position jack and red pine as the species of greatest use by a wide margin. White and black spruce and balsam fir are also used, but in much lower volumes. White pine is used in very small volumes in non-structural market applications. Due to the present limited market demand, white pine was not included in this analysis.

The greatest acreages and volumes of pine are found on private and federal lands. The state of Minnesota owns about 16 % and 18% respectively, of the red pine and jack pine type acres and produces 14% and 24% respectively, of red and jack pine net growth volumes (Table 1).

Table 1. Red and jack pine forest type statistics by ownership.

Red Pine Forest Type Acres of Timberland by Ownership				
Total Acres	**Federal**	**State**	**County & Municipal**	**Private**
626,523	169,080	97,653	83,816	275,974
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100%	52.89%	24.17%	12.34%	10.60%

Source: 2008 USFS FIA Inventory Database.

While FIA net annual growth has limitations (partly due to the method used to calculate it), it can still be a useful indicator. Advantages as an indicator include its availability, and that it covers all ownerships. Other important resource condition indicators used in the report include forest type acreage and age class structure. The various indicators are most useful when considered together.

It is important to note that while there are greater opportunities for sawbolts in the black spruce and balsam fir resources, they are limited by resource condition. Specifically, both species are dominated by small diameter material and susceptible to rot at advanced ages.

2.2 Market Demand

Total Minnesota all-ownership harvest for all products for red and jack pine, spruce and balsam fir averaged about 794,000 cords annually from 2003-2007 (Table 2).

Table 2. Minnesota all-ownership harvest of red and jack pine, spruce, and balsam fir
Annual average for the period 2003-2007

Market Sector	Cords
Utilized by Sawmills and Specialty Mills	279,400
Utilized by Pulp & Paper and Engineered Wood Product Mills	509,400
Utilized for Residential and Commercial Fulewood	4,700
Total Harvested and Utilized for Forest Products and Fuelwood	**794,000**

Source: DNR and U.S. Forest Service surveys.

2.3 Supply

Using FIA net growth as a measure, it appears that potentially available softwood sawbolt supplies appear to be sufficient to support a vibrant softwood sawmilling industry, with over 400,000 cords of sawlog and sawbolt material being grown annually across all ownerships. Net annual growth of jack and red pine, black and white spruce and balsam fir together on all ownerships is over 1.3 million cords. Using a conservative bolt and sawlog volume percentage for each species of 45% for red pine, 35% for jack pine, 10% for black spruce, 15 % for balsam fir and 30% for white spruce, results in an estimated net growth figure of over 420,000 cords of sawlog and sawbolt material grown annually.

Rather than potentially available supply, market factors appear to be creating the major challenges in getting enough wood to Minnesota's softwood sawmills at a competitive price. These challenges include:

1) Greatly reduced overall private lands harvest levels since 2006. One of the major reasons the reduction has been proportionally greater on private lands than public is that private lands harvest is more sensitive to reduced timber prices.

2) Volumes of softwood sawbolts going to other markets, especially pulpwood. It should be noted that competitive pressures and production costs limit softwood sawmill's ability to raise prices for stumpage and therefore encourage additional sorting.

There are several major trends in softwood supplies that should be noted:

1) Red pine acreage available for thinning is increasing. Acreage of red pine reaching merchantable age and size classes amenable to thinning will be increasing for the next 20 years at least as large acreages move into "thinnable" ages.

2) Jack pine volumes available for harvest are falling. Harvest has necessarily been accelerated for years due to an age class imbalance and budworm impacts. Therefore acres available for harvest are going down significantly due to fewer acres now being at harvest age. Volumes will need to be made up from red pine management.

2.4 Potential Opportunities to Increase Softwood Sawbolt Supplies on All Ownerships

It is important to note that the potential opportunities listed are not recommendations. It is also noteworthy that some will require further investigation prior to any action being taken.

All Species

1) Investments in forest management. It is possible to raise sustainable timber yields through investments in intensified forest management of all sorts. Included in the opportunities would be increasing softwood acreages. This is a desired future condition for DNR lands in most subsection plans.

2) Improved sorting. Some sawbolt material currently goes to other markets such as pulp and energy. While some of this material is a good fit for pulpwood markets and will continue to go there, it is possible to get additional sawbolt material to sawmills. The two methods with potential to increase the percentage of sawbolt material going to sawlog markets are to increase prices for stumpage and delivered sawbolts, and to improve forester, logger and landowner knowledge of markets.

Red Pine

1) Increased management efforts aimed at private lands. This will be critical. Most of the red pine resource is found on private and Federal lands. Strategies must be developed to increase thinning of red pine on private lands.

2) Increased red pine thinning on Federal lands. This may be a difficult opportunity to realize due to limited management intensity and a challenging budget environment, but Federal lands have significantly more red pine than state lands.

3) More intensive management of young stands may be another opportunity. More information is needed on growth and yield impacts of management on young red pine stands.

4) Management changes on DNR lands. There is potential in three areas: rotation age changes, red pine in other forest types, and changing thinning regimes.

3. Red and Jack Pine, Spruce and Balsam Fir Information for DNR Lands

3.1 Supply History

Annual pine volumes sold from DNR lands from 2001 to 2010 averaged about 94,000 cords. Pine volumes sold in FYs 08 through FY10 were higher than long-term averages for these species, largely because of forfeited permits being resold in FY08 and to softwood offer initiatives in FY09 and FY10 (Figure 1). As a result of the pine offer initiatives, pine harvest (scaled) volumes increased from 80,000 cords in FY09 to 110,000 cords in FY10.

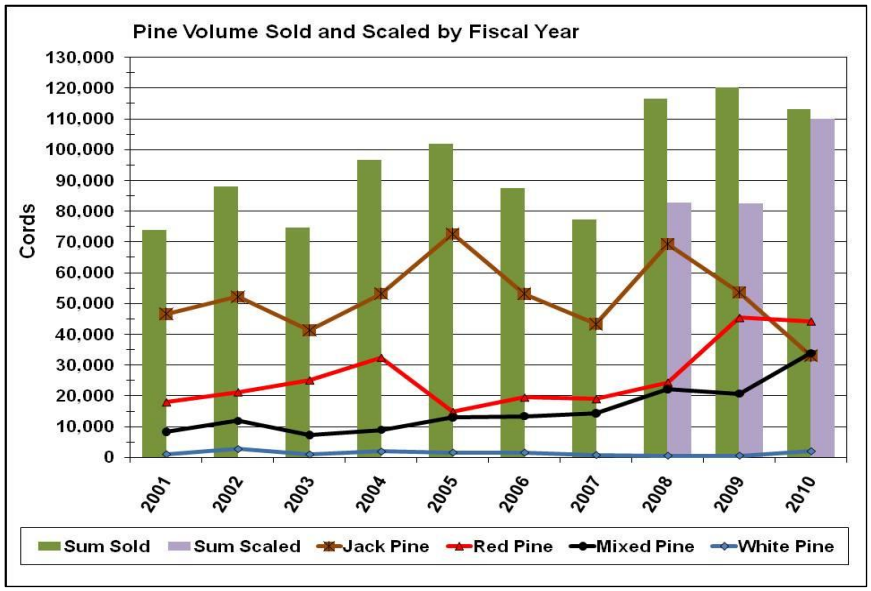


Figure 1. Pine volume sold and harvested by fiscal year.

Spruce volumes sold from DNR lands from 2008-2010 have averaged about 100,000 cords. Balsam fir volumes sold from DNR lands from 2008-2010 have averaged about 45,000 cords. While spruce and balsam fir harvest volumes are significant, almost the entire volume is used for paper manufacture with no more than 5 percent utilized by the state's softwood sawmills. Although mill demand figures have not yet been published for 2008 or 2009, industry sources have reported that between 20 to 25 percent of total softwood industry demand was obtained from DNR lands for these years.

3.2 Supply Outlook

Minnesota DNR relies on its internal forest inventory database to develop offer volume estimates. The method used for estimating timber offer volumes has undergone changes over the past several years. As a result, at present older subsection forest management plans used the old methods, with recent plans using the newer methods. For this analysis, volume offer estimates were developed using both methods in an attempt to validate the volume estimates and the harvest planning model inputs for developing alternative management scenarios. While the underlying volume estimation procedures were different, both methods produced similar results.

3.2.1 Sum of Existing Subsection Forest Management Plans Average Annual Volume Estimation Approach

Step 1: Identifying Average Annual Acres to be Field Examined

The DNR develops 10-year vegetation management plans for forest lands administered primarily by the Division of Forestry and Section of Wildlife (i.e., approximately 4.9 million acres statewide, roughly 2.8 million of which are considered commercial timber lands). The subsection level of the DNR's ecological classification system (ECS) defines the planning unit boundaries for these management plans. The two primary products of these DNR Subsection Forest Resource Management Plans (SFRMPs) are:

- Long-term (i.e., 10- and 50-year) strategic direction and desired future forest composition goals for DNR lands within a subsection; and

- Selection of specific locations (i.e., forest stands) that will be field examined over the 10-year planning period and potentially treated (e.g., harvested) to implement the identified strategic direction and goals.

The total acres (by forest type) selected for field examination and potential treatment in each ten-year plan are then divided by 10 to get an estimate of the average acres and associated timber volumes that potentially may be offered for sale in any given year. Summing the estimated annual acres from all completed SFRMPs provides the baseline information needed to develop volume estimates.

Step 2: Developing Volume Estimates from Average Annual Field Examination Acres
A series of adjustments were made to field examination acre figures to develop average annual estimates of timber sale offer volume from the acres.

- Volumes were estimated based on available forest inventory data obtained from the DNR Forest Inventory Module (FIM) and preliminary prescriptions assigned to stands selected for potential treatment during development of SFRMPs. Actual volumes offered and harvested will vary based on current site conditions and resulting decisions for appropriate treatments (e.g., not all stands on the list will result in a timber sale). Planned treatment levels (and associated volume estimates) are scheduled to be revised every 10 years for each SFRMP.
- Estimates in the table are only from SFRMPs that are being implemented at this time. Subsections included within these SFRMPs encompass about 98% of the total DNR-administered timberlands in the northern part of the state (i.e., excluding the Blufflands & Rochester Plateau subsections in SE Minnesota).
- Volumes estimates from the Aspen Parklands subsection were made assuming all cords harvested were from the Aspen cover type.[1]
- Volumes are for individual species across all cover types for species of interest in this analysis.
- Yields were initially predicted by cover type and then separated into individual species volumes based on statewide average species compositions by cover type. These statewide species compositions were obtained from the USDA Forest Service Forest Inventory and Analysis (FIA) database.
- Red pine figures include some volumes sold during pine initiatives of the past 2 years.
- All initial species volume offer estimates were increased by 5% to account for acres not included in existing SFRMPs.
- Initial red pine volumes were increased by 10% to adjust for revised yield tables.

Statewide estimates of annual volume offers from DNR managed lands for key species were compiled for the current 10-year planning period. The estimates are shown with a ±10% range to aid reader's understanding that the figures are estimates and therefore not exact, and also that there will be some annual variance. The red pine midpoint volume offer estimate was 36,900 cords and the midpoint jack pine estimate was 27,800 cords. The spruce midpoint volume estimate was 69,500 cords and the balsam fir midpoint estimate was 39,500 cords (Table 3).

[1] Source: Personal communication with Christopher Schwalm, Consulting DNR Forest Modeler.

Table 3. Annual offer volume estimates from individual SFRMP stand lists.

	Species Volumes (Cords) [a,b]				
Subsection	Red Pine	Jack Pine	Spruce	Balsam fir	Row Sum
Agassiz LL	4,000	8,800	19,800	7,800	40,400
Border Lakes	2,300	2,900	6,200	3,900	15,300
CPPMOP	10,700	6,700	7,200	5,900	30,500
MLU	1,800	2,600	3,500	4,200	12,100
North Shore	1,100	900	4,700	2,800	9,500
North 4	11,900	4,300	23,900	11,100	51,200
Aspen Parklands	300	300	900	1,900	3,400
Sub-total	32,100	26,500	66,200	37,600	162,400
Acre Adjustments	1,600	1,300	3,300	1,900	8,100
Thin Adjustments	3,200	---	---	---	3,200
Midpoint Estimate	**36,900**	**27,800**	**69,500**	**39,500**	**173,700**
Low Estimate (-10%)	33,200	25,000	62,500	35,600	156,300
High Estimate (+10%)	40,600	30,600	76,500	43,500	191,100

[a]Forest cover type volumes, except North 4, estimated using DNR SFRMP Guidebook IV methods.
[b]Species volumes estimated from type volumes using FIA 2005 statewide species compositions.

3.2.2 Base Harvest Planning Model Volume Estimation Approach[2]

The base model utilized statewide average values from existing management plans in combination with Forest Inventory Module (FIM) state land forest inventory data to approximate current DNR management. Volume estimates were model outputs obtained using Remsoft harvest planning software.[3] Current DNR red pine forest cover type management can be summarized as NRA (Normal Rotation Age) = 100 to 120 (statewide average = 110) and MRA (Maximum Rotation Age) = 160 to 240 (statewide average = 190) with the long-term goal of 5% to 48% EERF (Effective Extended Rotation Forest) by subsection (statewide average EERF=22%). Current practice is to leave at least 50% of the merchantable red pine volume while harvesting other forest cover types where red pine is a minor component.

Several adjustments were made to calibrate the model and to improve reflection of actual practice.

- Red pine species harvest volumes were reduced by 12% and 15% for FIM and FIA Inventory cover type acreage differences and an estimated 85% appraisal rate[4] respectively. Red pine clearcut volumes from cover types other than red pine were reduced by 60% to account for red pine reserve tree practices consistent with DNR management.
- Jack pine species harvest volumes were reduced by 15% to reflect the estimated 85% stand appraisal rate, and thinned volumes are only from red pine cover types.
- Spruce (both white and black) harvest volumes were reduced by 15% to reflect the estimated 85% stand appraisal rate, and clearcut volumes do not include northern white cedar cover type volumes of 3,100 cords. Thinned volumes are only from white spruce cover types.

[2] Model outputs for volumes by species and forest type, and age class distributions available from modeler Curtis VanderSchaaf upon request
[3] See appendix H for a description of Remsoft and forest modeling.
[4] Appraisal rate is the ratio of appraised acres to examined acres; not all exam stands result in a timber sale.

- Balsam fir harvest volumes were reduced by 15% to reflect the estimated 85% stand appraisal rate, and clearcut volumes did not include northern white cedar cover type volumes of 3,400 cords. Thinned volumes were only obtained from red and jack pine cover types.

The estimates are shown with a ±10% range to aid reader's understanding that the figures are estimates and therefore not exact, and also that there will be some annual variance. The red pine midpoint volume offer estimate was 37,400 cords and the midpoint jack pine estimate was 24,000 cords. The spruce midpoint volume estimate was 70,000 cords and the balsam fir midpoint estimate was 46,000 cords (Table 4).

Table 4. Base model statewide average annual offer volume estimates.[a]

Base Model Outputs	Species Volumes (Cords)				
Planning Period (Years)	Red Pine	Jack Pine	Spruce	Balsam fir	Row Sum
1-10 Midpoint Estimate	**37,400**	**24,000**	**70,000**	**46,000**	**177,400**
1-10 Low Estimate	33,700	21,600	63,000	41,400	159,700
1-10 High Estimate	41,100	26,400	77,000	50,600	195,100

[a]Species volume estimates from all forest cover types combined.
[b]Red pine midpoint includes 34,400 cords from the red pine forest type and 3,000 cords from other types.

3.3 Potential Volume Increases from Management Changes on DNR Lands

There are opportunities to increase volumes derived from sustained yield timber harvests by changing various aspects of forest management. It is important to note that each of these changes would have impacts to forest condition, as well as economic impacts. *Before deciding on any changes, it will be important to carefully consider the potential impacts to all values related to DNR's mission, including wildlife habitat and ecological diversity.*

Opportunities analyzed for timber yield and age class impacts included:

1) Changing age of final harvest and extended rotations and amount of old forest in the red pine forest type
2) Changing thinning regimes (period between thinning, basal area removed, size of trees removed, and timing of thinning)
3) Harvesting more red pine volume during management in the other forest types

Note: During the analysis, the team became aware of a need to assess opportunities to change thinning practices in the white spruce forest type, however time and staff resource constraints did not allow for a full assessment of spruce thinning for this report.

3.3.1 Opportunity #1: Rotation Age and Old Forest Acres[5] in the Red Pine Forest Type

The calibrated base model was deemed reliable enough to develop and run alternative management scenarios. A baseline and two change scenarios were modeled to assess the potential harvest volume and timber revenue impacts of decreasing rotation ages and modifying ERF particulars for red pine forest cover type using a 50-year planning horizon. The alternative management scenarios did not include potential changes in practices that currently leave at least 60% of red pine volume while clearcut harvesting other forest types. Volume currently harvested from other forest types was estimated to be about 3,000 cords per year.

The bottom line is that there would be significant potential volume and revenue gains from instituting either of the modeled changes to existing management direction, as well as significant changes to future age class structure.

[5] All modeled scenarios maintained greater than the minimum amount of old forest acreage established by DNR policy.

BASE MODEL – The base model was the same model used to generate the red pine offer volume estimate presented in section 3.2.2. Modeling results indicated under existing management, the red pine forest cover type can sustainably produce about 34,400 cords of red pine species volume annually in period one (years 1-10) with an annual stumpage value of about $1.2 million (Table 5). Of this amount, about 120 acres per year was projected to be regeneration harvest. Regeneration harvest acres were constrained by the current red-pine age-class distribution (i.e., limited number of acres beyond NRA), rotation ages established in SFRMP, and efforts to move towards the desired age-class distribution (including increasing the number of acres beyond NRA from the current 4% to the long-term goal of 22%). Red pine thinning volume potential was projected to increase to an average 51,100 cords per year in period two (years 11-20), an increase of 16,700 cords per year, as relatively large age classes start to reach minimum merchantability.

STATEWIDE STANDARDS SCENARIO – This scenario assumed implementation of a statewide standard of NRA=90, MRA=140, and 12% EERF (long-term goal) applied equally across all forest management planning units. In period 1 (years 1-10), an estimated 49,000 cords with a stumpage value of about $2.1 million could be produced annually under this scenario. The primary source of volume and revenue gain would come from increasing regeneration harvests to the 500-600 acre per year range.

ECONOMIC ROTATION SCENARIO – This scenario assumed implementation of a statewide standard economic rotation policy with NRA=60, MRA=90, and 12% EERF (long-term goal). In period one (years 1-10), an estimated 72,000 cords with a stumpage value of about $3.5 million could be produced annually under this scenario. The primary source of volume and revenue gain would come from increasing regeneration harvests to about 1,300 acres per year in period one then, increasing to the 1,500 -2,000 acre per year range in the long-term.

Table 5. Red pine forest type sustainable yield and revenue scenarios (cords).

Period	**(BS) BASE 110/190/22**			**(SW) STATEWIDE 90/140/12**			**(ER) ECON ROT 60/90/12**		
(Years)	Regen	Thin	**Total**	Regen	Thin	**Total**	Regen	Thin	**Total**
1-10	6826	27609	**34435**	21462	27609	**49071**	44457	27609	**72066**
Avg $	$409,530	$828,270	**$1,237,800**	$1,287,720	$828,270	**$2,115,990**	$2,667,420	$828,270	**$3,495,690**
11-20	6826	44311	51137	21462	44311	65773	44457	38763	83220
21-30	6497	50005	56502	21462	50005	71467	43873	35442	79315
31-40	6497	57232	63729	20367	57597	77964	42267	33690	75957
41-50	6497	54312	60809	20367	59276	79643	42267	42377	84644
Avg Vol	6579	51465	**58044**	20915	52797	**73712**	43216	37568	**80784**
Avg $	$394,748	$1,543,950	**$1,938,698**	$1,254,870	$1,583,918	**$2,838,788**	$2,592,960	$1,127,029	**$3,719,989**

Table Notes

Red pine volume estimates from the red pine forest cover type only.

All volume estimates reduced by 12% for acres variance and 15% for appraisal rate.

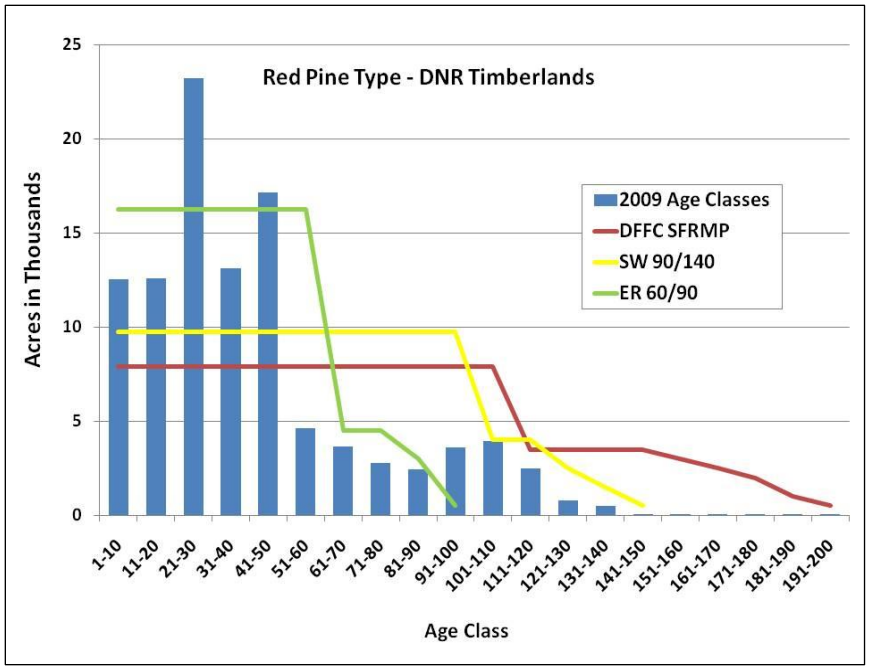
All period one thinning volumes were reduced by 40,000 cords or 4,000 cords per year to account for impacts of 2009 and 2010 pine initiatives.

Stumpage values equal $60 per cord for regeneration harvest volume and $30 per cord thinning volume.

Potential Changes in Red Pine Age Class Distribution

For the red pine cover type, the stated SFRMP desired future forest condition (DFFC) is to maintain a minimum 110,000 acres in the red pine cover type with about 8,000 acres in each evenly distributed 10-year age class through NRA=110, and carry a total of 24,000 EERF acres between age classes 120 and 190 (Figure 2). The STATEWIDE STANDARDS scenario would maintain about 10,800 acres in each evenly distributed 10-year age class through NRA=90 plus about 13,000 EERF acres in the 100 to 140 age classes. The ECONOMIC ROTATION scenario would maintain about 16,200 acres in each 10-year age class through NRA=60 plus 13,000 EERF acres in the 70-90 age class.

With ±5% even flow regeneration harvest volume constraints applicable in all scenarios, an allowance was included for carrying about 500 EERF acres for one period past MRA. It is important to note that age class acres and sustainable timber yield volumes could be increased across all management scenarios by increasing the total red pine cover type acreage.



Designated old growth acreage is an important part of DNR's older forest suite. Currently, about 5,000 acres of red pine forest type are designated as old growth and future old growth. These acres are not considered to be "timberlands" available for harvest, and were therefore not included in the analysis.

3.3.2 Opportunity # 2: Changing Thinning Regimes in the Red Pine Type [6]

DNR uses widely accepted silvicultural practices in its approach to red pine thinning. Red pine stands are thinned on DNR lands to achieve a number of goals, including optimal stand growth and yield, revenue production, and diversification of stand structure. Generally, the criteria used to determine a stand's inclusion on the list of stands to be examined for harvest is age. Stands over the age of 25 normally appear on the 10-year exam list with the understanding that stands will reach the minimum merchantable size class starting around age 25 depending on site quality.

Parameters for thinning vary by site conditions and goals. General practice is to thin stands when their thinned volume will allow an economically viable sale. This varies by site, but normally requires a minimum of 7 to 8 cords per acre, with stand basal area per acre greater than 120 square feet. Stands are normally thinned to a post-treatment target of 90 square feet of basal area. Thinning usually occurs on about a 10-year interval. On some sites a total of up to six thinnings may be implemented over an even-aged rotation. For the most part, if a red pine stand is between the ages of 25 to 80 years old and capable of producing an economically viable operation, it will be thinned.

Both a literature review[7] and growth & yield modeling[8] were used to assess the potential impacts of thinning regime changes to tree growth and yield, and timber volumes. The team gained valuable insights. However, it is important to note that while the data examined was extensive, time and staff resource limitations did not allow an exhaustive effort. Reviewers have indicated that additional data for both managed stands and very young stands (under age 30), may be needed to fully assess the impacts of changes to thinning intervals, reserve basal areas, and treatments to stands below the age of 30.

Key Thinning Regime Analysis Findings and Conclusions

[6] Thinning regime as used here means the parameters used to guide red pine thinning operations, especially for reserve basal area, size of trees to be thinned and reserved, and period of time between thinning operations.
[7] VanderSchaaf, Curtis. 2010. Summary document available from the author upon request.
[8] VanderSchaaf, Curtis and Don Deckard. 2010. Summary document available from the authors upon request.

1) It is critically important to regularly thin red pine to maintain stand stocking levels within the optimal range of growth and yield. Thinning can also help achieve other stand goals such as diversifying stand structure.

2) Data examined by the team indicated that there is only very modest-additional total volume or total stand growth over rotation to be gained from altering thinning regimes, as compared to common DNR practices for thinning interval and reserve basal area. Indeed, data indicated that at extremes for the variables of thinning interval and basal area, total stand growth over a rotation will be reduced.

Regarding thinning intervals, from an operational viewpoint it appears that 10-year thinning intervals are probably optimal for some 80% of DNR managed red pine forest cover type acres. An opportunity exists to utilize less than 10-year thinning intervals for the very high site index acres, about 7.4% of red pine type acres. Approximately 9.4% of the red pine type acres fall in the low-average category where a 15-year thinning interval may be appropriate. Additional considerations for thinning intervals include economic cost (staff time, logging cost/unit of wood removed), and site impacts. These are generally greater with more frequent entry intervals.

3) Two stand parameters that can unquestionably be altered through changes to thinning regimes are the size (diameter) and number of trees. Therefore it may be possible to produce a greater proportion of bolt-sized material over a stand's rotation, especially earlier in the rotation. In general, the same total stand growth achieved under current regimes could potentially be achieved by having lower basal area reserve levels, producing fewer, larger diameter trees. This opportunity would require further assessment of optimal thinning regimes.

4) Another opportunity that shows promise for increasing revenue without a negative impact on growth and productivity would be removing larger trees in early thinnings, resulting in additional bolt-size material during these thinnings. Research by Buckman, et. al.[9] and Berguson[10] suggested thinning larger than average diameter trees (more bolt-size material) during these early thins does not negatively impact total stand growth, as long as reserved trees have adequate crown ratios. In other words, the reserved smaller trees will "catch up" in growth if they have healthy crowns.

Any wildlife habitat and ecological impacts would need to be carefully assessed prior to wholesale adoption of this type of thinning. It is also likely that some operational trials would need to be established as a first step, since some implications of this approach on a wide variety of stands and conditions are unknown.

[9] Buckman, Robert E., et.al. 2006. Growth and Yield of Red Pine in the Lake States. GTR-NC-271. St. Paul, MN: USDA Forest Service, North Central Research Station. 114 pages. http://www.ncrs.fs.fed.us/pubs/viewpub.asp?key=9031

[10] Berguson, Bill. Univ. of Minn. Duluth, Natural Resources Research Institute. Unpublished data and presentations addressing red pine silviculture and management.

3.3.3 Opportunity # 3: Harvesting More Red Pine Volume During Management in Other Forest Types

Strategic analysis on DNR lands indicated there were approximately 6,200 cords of red pine volume in other forest types on annual stand exam lists. In practice, it is estimated that over 60% of this volume is reserved for various wildlife habitat, ecological diversity, aesthetic, and stand conversion goals.

Since these trees are generally reserved for specific purposes, it is likely that any additional harvest of these red pine would need to be filled with other species achieving the purpose(s) of the reserve trees. It is unknown how much of this might be desirable from a management standpoint, or might be operationally feasible. An interdisciplinary task group could be formed to further assess the opportunity, however. Depending on what the task group learns, there could be perhaps a thousand cords of additional timber volume available from this source.

Appendices

Appendix A - Softwood Supply History from DNR Lands

Total Pine Sold (All Species and Units of Measure)								
FY	Mixed Pine	White Pine	Red Pine	Jack Pine	Scotch Pine	Total All Pine Species Sold as Cords	Red, White and Mixed Pine Sold as MBF (Converted to cords)	Total All Pine Species Sold By All Units of Measure (Shown In Cords)
1998	6875	751	15926	41006	7	64565	3578	**68143**
1999	9935	884	16502	47915	628	75864	2632	**78496**
2000	9991	1961	13802	45758	119	71631	3828	**75459**
2001	8356	1016	17915	46592	323	74202	3458	**77660**
2002	11940	2783	21219	52185	179	88306	3166	**91472**
2003	7267	950	25091	41283	216	74807	3514	**78321**
2004	8979	1927	32463	53180	94	96643	4568	**101211**
2005	13021	1594	14796	72615	764	102790	5382	**108172**
2006	13347	1580	19467	53172	25	87591	4096	**91687**
2007	14310	747	18963	43326	602	77948	3072	**81020**
2008	22243	530	24370	69322	284	116749	6904	**123653**
2009	20707	552	45443	53646	23	120371	4614	**124985**
2010	33855	2024	44293	33062	129	113363	9540	**122093**
Average	13,910	1,331	23,865	50,236	261	**89,603**	**4,489**	**94,092**

-Volume is reported in the unit of measurement the species was sold.

- Average species percentages for “Mixed Pine” are: Red Pine: 65%; Jack Pine: 31%; White Pine: 4%.

Appendix B – Comparative Statistics for SFRMPs and Rotation Age Scenarios, DNR Lands

Summary statistics for base model SFRMP and rotation age scenarios.

SFRMP Subsection/ Scenario	Red Pine Mgt Ac	Red Pine Mgt Ac%	Red Pine Mgt Vol%	NRA	Min Harvest Age ERF	MRA	EERF%	EERF Acres	10Yr Age Classes in ERF
Agassiz LL	11500	11.8%	9.8%	100	150	150	12%	1380	1.2
B Lakes	16000	16.4%	5.8%	120	150	240	5%	800	0.6
CP-PMOP	31200	31.9%	35.6%	100	150	170	25%	7800	1.4
MLU	6800	7.0%	3.6%	120	150	180	6%	408	0.7
N Shore	8500	8.7%	2.9%	120	150	240	10%	850	1.2
North 4	21000	21.5%	39.3%	100	150	200	48%	10080	1.8
Anoka e.	2250	2.3%	2.3%	100	150	190	12%	270	1.2
SE Minn e.	550	0.6%	0.6%	100	150	190	12%	66	1.2
BS Var/Var	**97800**	**100.0%**	**99.9%**	**110**	**151**	**190**	**22%**	**21654**	**2.4**
SW 90/140	**109500**	**112.0%**	**112.0%**	**90**	**101**	**140**	**12%**	**13140**	**1.1**
ER 60/90	**109500**	**112.0%**	**112.0%**	**60**	**71**	**90**	**12%**	**13140**	**0.7**

Table Notes

NRA = minimum normal rotation age.

Min Harvest Age ERF = minimum harvest age for extended rotation forest acres.

MRA = maximum rotation age for extended rotation forest acres.

EERF% = effective (total) extended rotation forest % = percentage of total managed type acres held over NRA.

EERF Acres = effective (total) managed type acres held over NRA.

10Yr Age Classes in ERF = the number of fully regulated 10-year NRA age classes required to equal EERF Acres.

Appendix C – DNR Management Direction for Softwood Forest Types for Subsection Plans

Rotation Ages, Prescribed ERF and Old Forest Goals from SFRMP

Forest Type	Avg. NRA	Avg. ERA	% PERF	Old Forest DFC
Aspen/BG	45	68	30%	11.8%
Birch	55	73	41%	11.0%
Jack Pine	51	66	33%	9.6%
BSL 23-29	120	158	48%	13.2%
BSL 30-39	100	128	48%	12.4%
BSL 40+	75	93	45%	11.2%
Tamarack <40	84	124	46%	14.3%
Tamarack 40+	72	92	52%	14.2%
Balsam Fir	49	61	31%	7.0%
Red Pine	112	175	52%	12.1%

Source: DNR SFRMP manual.
NRA = normal rotation age
ERA = extended rotation age
PERF = prescribed ERF (acres identified to be managed to an ERA)
DFFC = desired future condition
PERF is the "tool" used to make sure we achieve the old forest DFC. Alternatively, RemSoft could be set to maintain the old forest DFC.
Summary includes SFRMPs addressing 95% of DNR timberlands. It does not include Blufflands/Rochester Plateau; Aspen Parklands, Anoka Sand Plains or Hardwood Hills subsections.

Thinning Criteria for Softwood Forest Types on DNR Lands			
	Criteria		
Species	**Thinning Intervals**	**Thinning Age**	**Basal Area**
Red Pine	Approximately every 10 years (Border Lakes suggested every 7-10 years); longer interval in older stands (e.g., >100 years; average diameter >15")	$\geq$ 25 to 30 years old (varies by plan)	$\geq$ 120 ft^2; Thin to about 90 ft^2
White Spruce	Every 10-20 years (some said every 10 and some said 10-20); older stands = longer intervals.	First thin at 25-40 years (CP-PMOP said no later than 30 years for 1st thin)	First thin remove no less than 1/3 of existing BA; subsequent thin to 100 ft^2 or no less than 40% live crown ratio.
White Pine	Every 10-25 years	>30 years old	$\geq$ 120 ft^2; traditional thinning up to age 90, thin to 90 ft^2 (some suggested a four step shelterwood harvest in younger stands); age 90+, thin to diversity age-classes, using group selection on every third thin.
Jack Pine	Thinning generally not applied. If applied, only thin if Site Index > 60 then, Interval: Thin once	Age: 25-40 years old	Thin when $\geq$120 ft^2; thin to 80 ft^2 or no more than 1/3 of BA removed.
Balsam Fir	Thinning generally not applied or only a very small percentage, 5% noted in one plan. If applied: then only if Site Index > 50, and Interval = Thin once (ERF maybe twice)	Age: 25-40 years old	Thin when BA $\geq$ 120 ft^2 ; remove no more than 1/3 of existing BA.

Appendix D - Selected Softwood Harvest in Minnesota by Species and Product 2003-2007

Selected Softwood Harvest in Minnesota by Species and Product All Ownerships (In Thousand Cords – From Timberlands)						
Species/Product	**Year**					
	Average	**2003**	**2004**	**2005**	**2006**	**2007**
Red Pine Total	**156.3**	**134.4**	**164.0**	**159.7**	**147.2**	**176.0**
Pulpwood	36.9	35.6	46.4	42.1	29.6	30.7
Sawlogs	116.5	95.9	114.7	114.7	114.7	142.4
Commercial Fuelwood	0	0	0	0	0	0
Residential Fuelwood	2.9	2.9	2.9	2.9	2.9	2.9
Jack Pine Total	**252.5**	**244.5**	**305.3**	**303.9**	**264.8**	**143.8**
Pulpwood	114.1	91.0	155.9	154.5	115.4	53.6
Sawlogs	136.7	151.8	147.7	147.7	147.7	88.4
Commercial Fuelwood	0	0	0	0	0	0
Residential Fuelwood	1.7	1.7	1.7	1.7	1.7	1.8
Spruce Total	**209.1**	**231.0**	**182.9**	**202.7**	**213.1**	**215.6**
Pulpwood	190.5	218.2	164.5	184.3	194.7	190.8
Sawlogs	18.5	12.8	18.4	18.4	18.4	24.5
Commercial Fuelwood	0	0	0	0	0	0
Residential Fuelwood	.1	0	0	0	0	.3
Balsam Fir Total	**176.5**	**176.1**	**174.3**	**198.7**	**167.6**	**165.7**
Pulpwood	167.9	168.5	164.5	191.5	160.4	154.4
Sawlogs	8.1	7.6	7.2	7.2	7.2	11.1
Commercial Fuelwood	0	0	0	0	0	.2
Residential Fuelwood	0	0	0	0	0	0
Total Red & Jack Pine, Spruce and Fir	**794.3**	**786.0**	**826.5**	**865.0**	**792.7**	**701.1**
Sawlogs Only **Total Red & Jack Pine, Spruce and Fir**	**279.8**	**268.1**	**287.7**	**287.7**	**287.7**	**266.4**

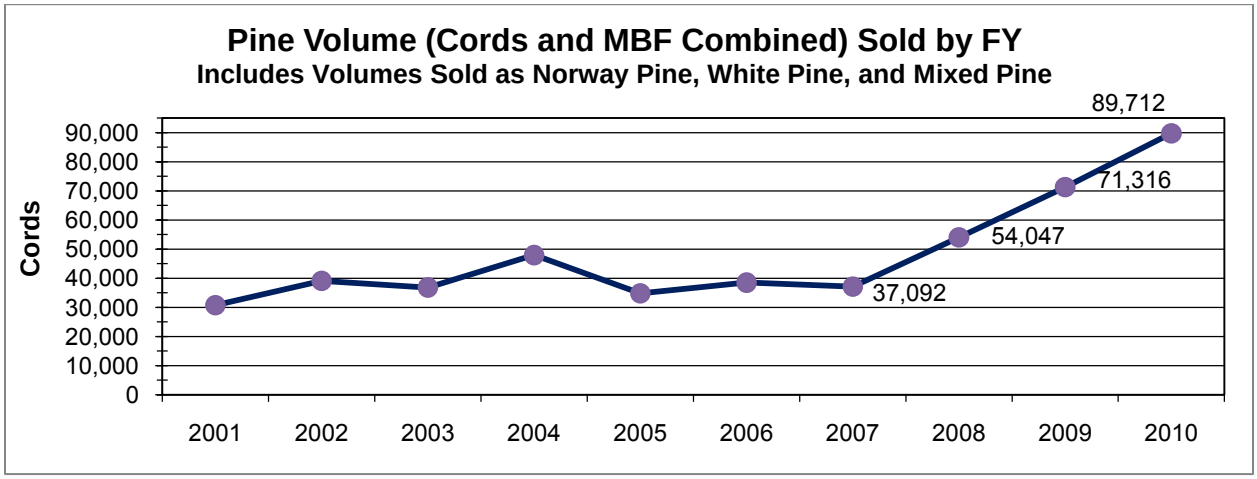
Appendix E - 2010 Pine-Spruce Initiative Summary, September 20, 2010

DNR FY2010 Pine-Spruce Initiative Objectives

- Improve habitat by increasing compositional and structural diversity in plantations.
- Provide additional softwood sawlog and bolt-sized material to help address the current shortage at softwood-using sawmills.
- Conduct an assessment of the DNR's pine and spruce plantations.
- Establish strategic thinning regimes tailored to each site.
- Improve timber growth and quality.
- Achieve long-term objectives through timely thinning.
- Increase the use of logger-select thinning on plantation thinning.

Accomplishments (MBF volumes converted to cords)

- Additional auctions were scheduled in May to quickly offer the pine-spruce.
    - Some included on the June auctions
- 27 percent increase in the amount of pine sold from FY2009 to FY2010
    - 71,000 cords to 90,000 cords
- Over the last 3-year period, pine volume sold has increase by nearly 250%.
    - 37,000 cords in FY2007 to 90,000 cords in FY2010



- In addition, 50,000 Cords of Jack Pine are sold each year (10-year average).
    - 33,000 cords were sold in FY2010
- White spruce volume remained relatively the same over the past 3 years at 12,000 cords sold per year.

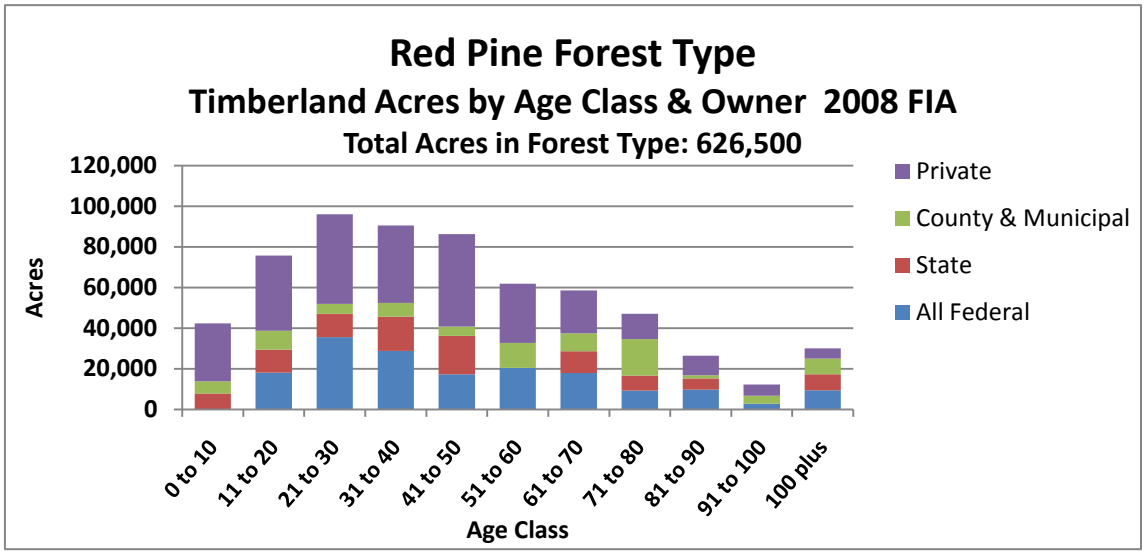
FY2010 Pine - Planned Acres, Sale Acres, and Harvest Method

	Norway Pine			White Pine			Jack Pine		
Harvest Method	**FY Plan Acres**	**Sale Acres**	**Method Sale %**	**FY Plan Acres**	**Sale Acres**	**Method Sale %**	**FY Plan Acres**	**Sale Acres**	**Method Sale %**
Clearcut with Reserves	86	538	8%	4	50	8%	1853	1709	74%
Seed Tree	3	77	1%	0	19	3%	0	199	9%
Shelterwood	15	84	1%	10	180	30%	0	9	0%
Thinning	2622	6168	90%	327	343	58%	392	399	17%
Totals	**2726**	**6867**	**100%**	**341**	**592**	**100%**	**2245**	**2316**	**100%**

Price of Pine Cordwood Increased

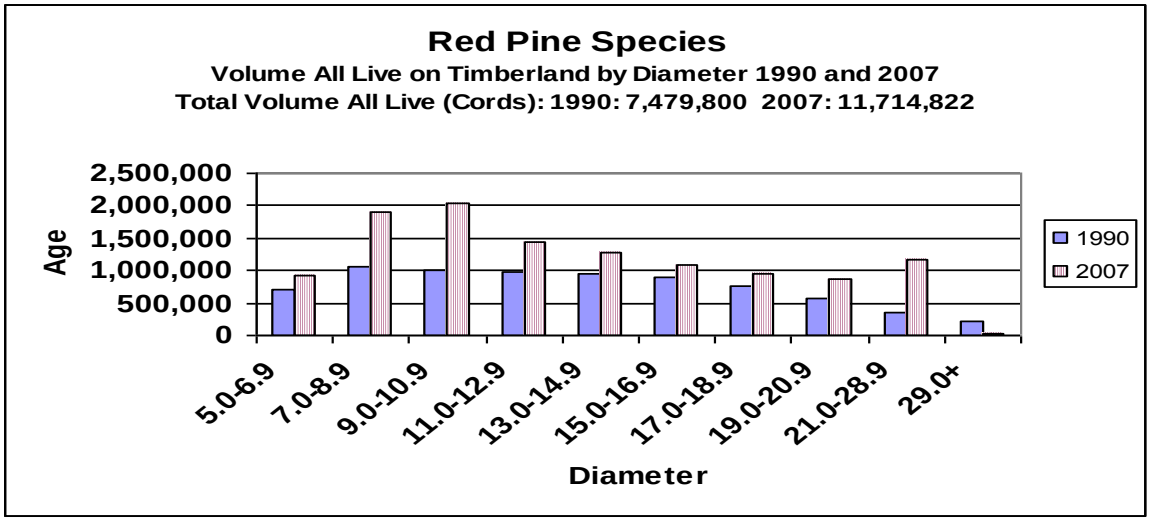
- FY2009 average price paid per cord was $26.30
- FY2010 average price paid per cord was $30.69

Minnesota's Red Pine Resource



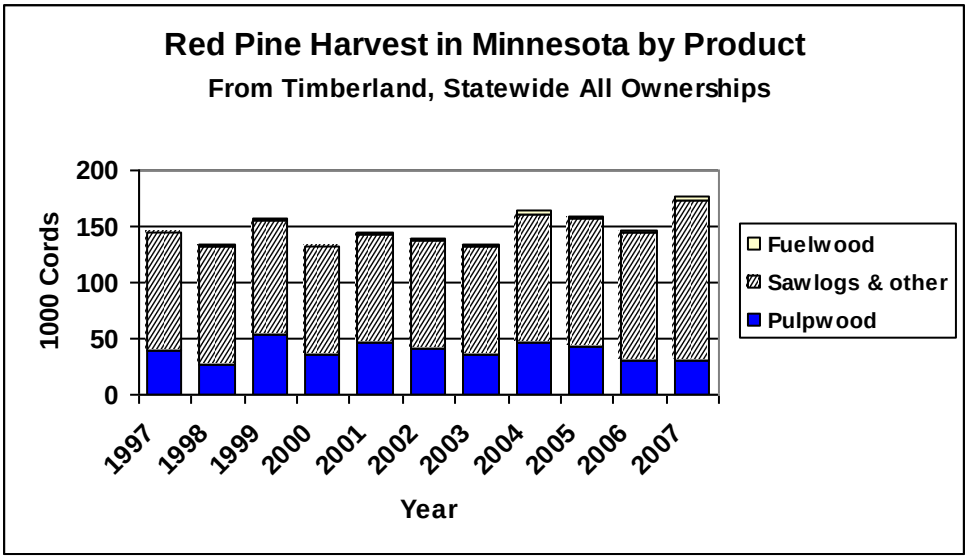
Source: 2008 FIA Database provided by USFS, Northern Research Station

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

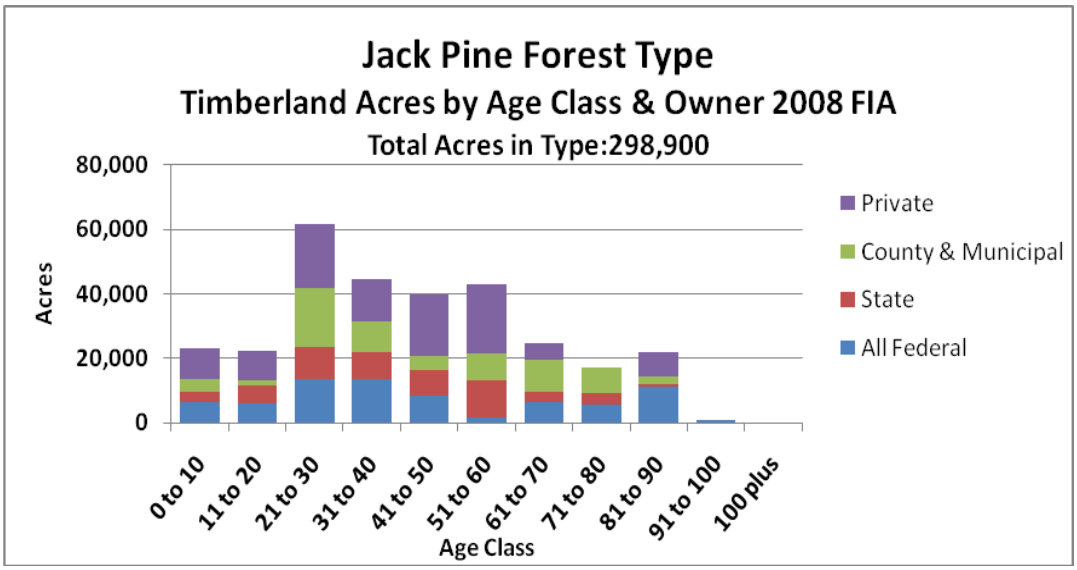
DNR estimated long-term annual all-ownership sustainable harvest level is approximately 345,000 cords*. Based on 2007 FIA data, average net annual growth of red pine growing stock: 638,800 cords; average annual mortality: 90,000 cords.

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

Resource Opportunities

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

Jack Pine

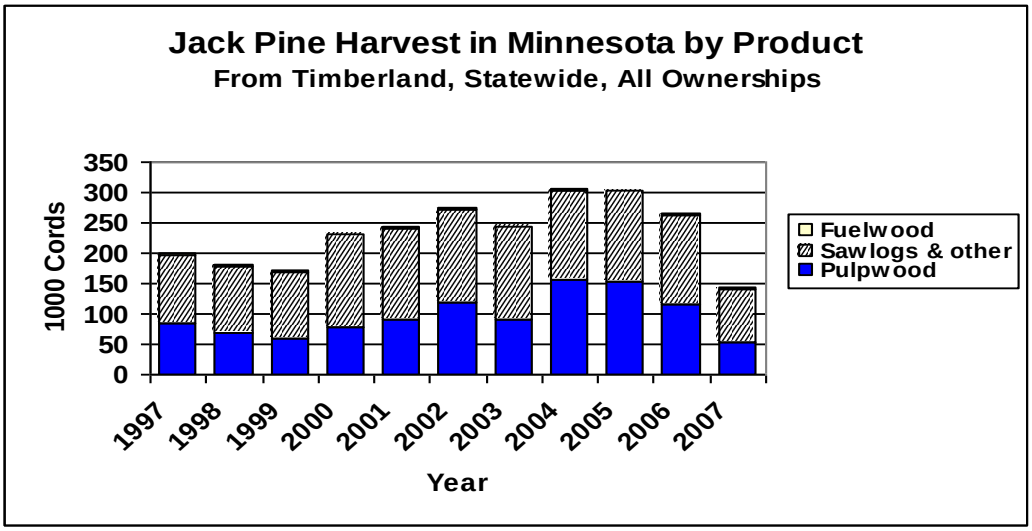


Source: 2008 FIA Database provided by USFS, Northern Research Station

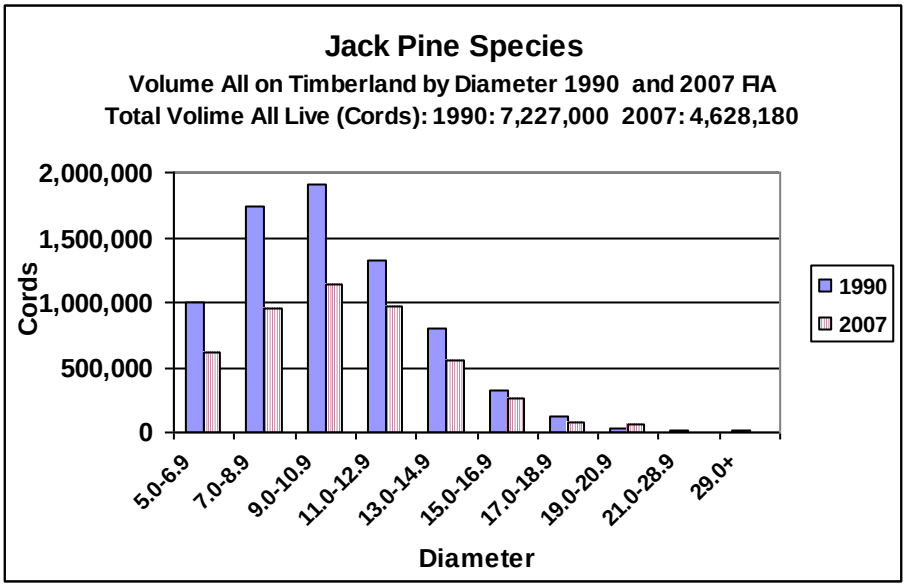
Ownership of the jack pine resource is well-distributed between the major ownership groups. Private landowners control the largest total acreage, but the federal government has by far the largest resource as a proportion of its total ownership. The jack pine cover type is heavily weighted to the 21 to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

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

Based on 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 NRS & DNR

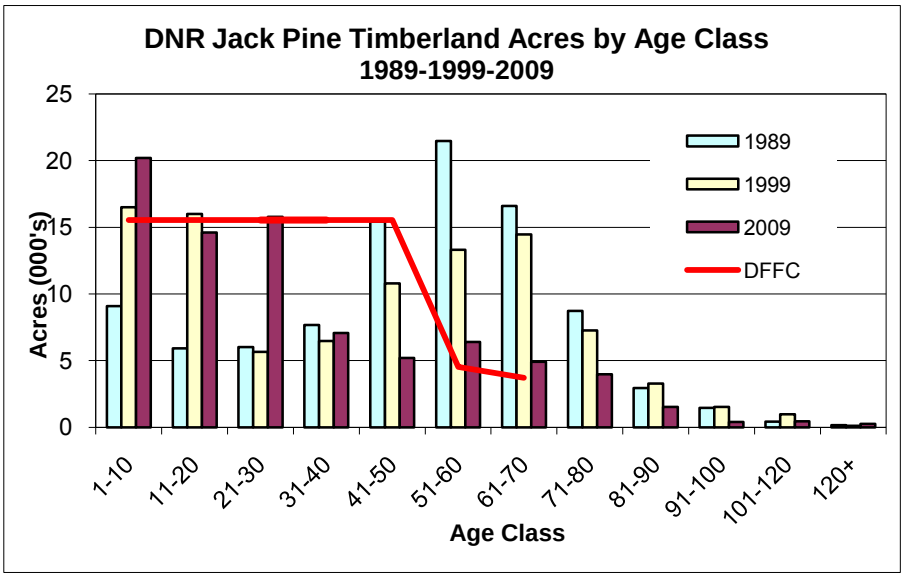


Source: FIA Database provided by USFS, Northern Research Station

Jack pine total volume of all live has declined from 7,016,000 cords in 1990 to 4,628,200 cords in 2007 – an over 35% decrease.

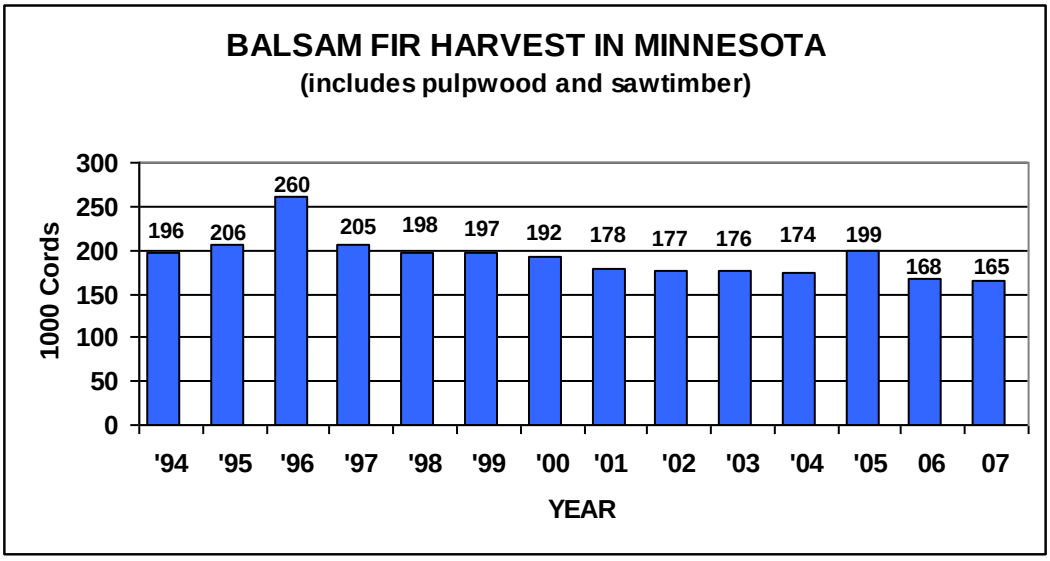
The vast majority of jack pine is under 15 inches in diameter.

Jack Pine on DNR Lands



Minnesota DNR has made a concerted effort to manage the jack pine resource over the past 20 years due to a previous age class imbalance, and forest health issues including budworm. One result is a much younger jack pine resource, with fewer acres at or beyond rotation age in upcoming years.

Minnesota's Balsam Fir Resource



Source: Harvest data compiled by NFRS & 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 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.

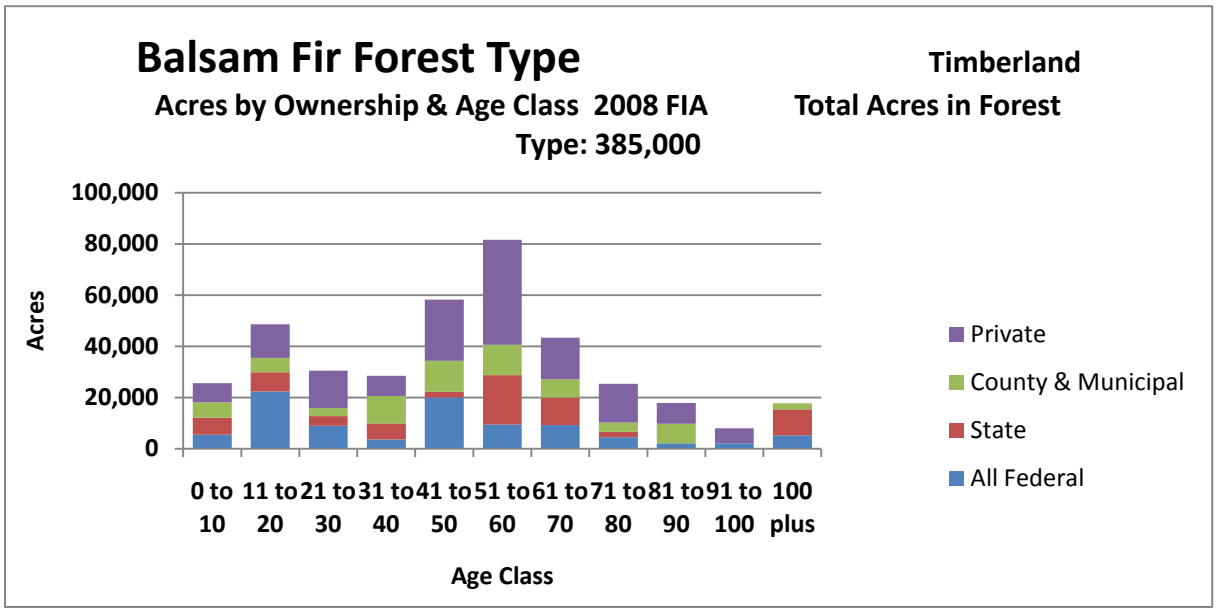
Current Demand for Balsam Fir from Minnesota Timberlands

	Cords
2007 Harvest…….	165,700
Minnesota Pulpwood Industries & Export (Export 30 cords)……...……..	154,400
Sawlogs & Other…….	11,300

Source: NFES & DNR Surveys

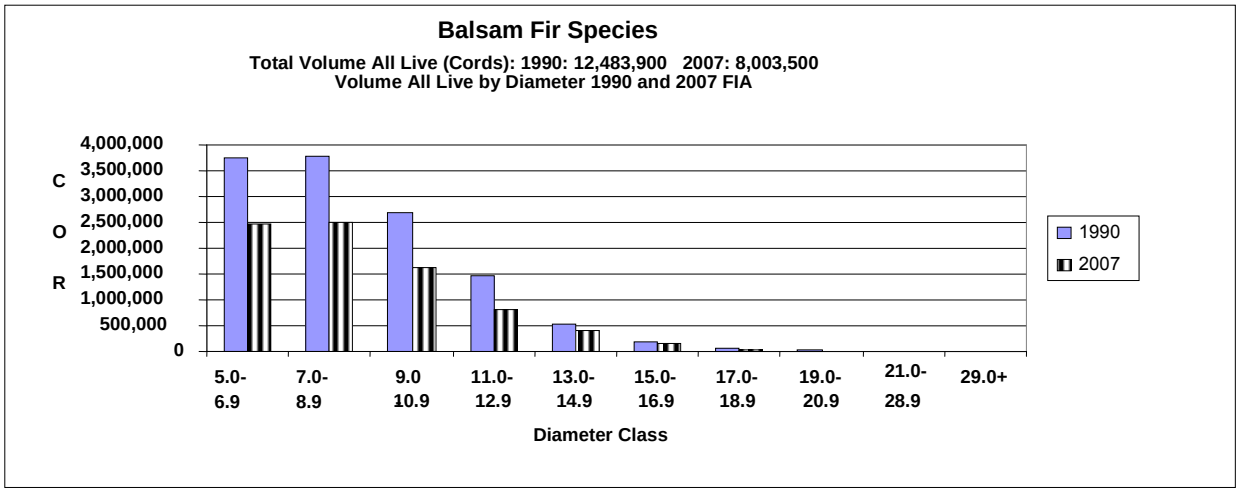
Resource Opportunities
High-quality balsam fir has excellent qualities for pulp & paper and stud manufacture.

Resource Issues:
-Balsam availability dependent on harvest of aspen (38% of balsam fir in aspen type).
-Older stands susceptible to spruce budworm impact. 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: 2008 FIA Database provided by USFS, Northern Research Station.

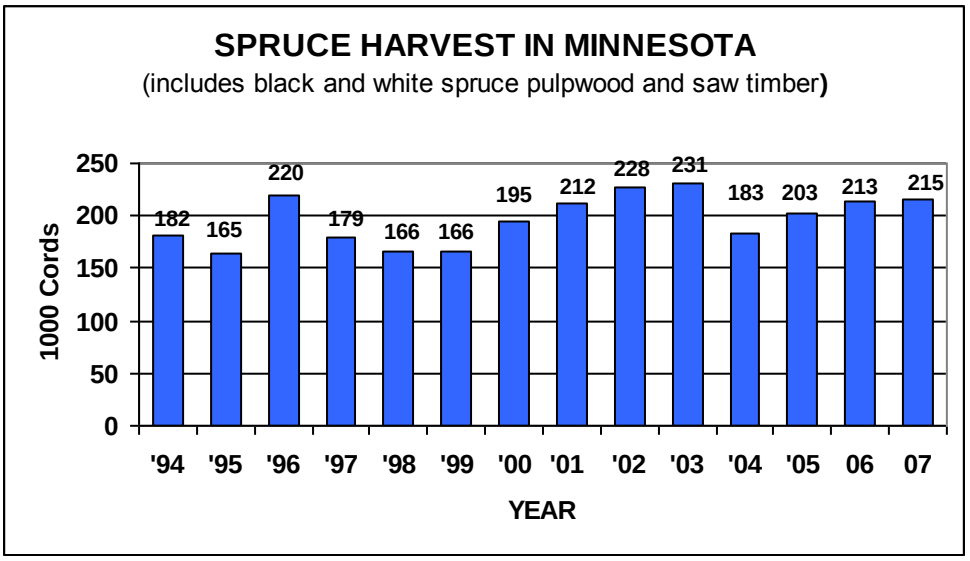
The cover type is dominated by stands at and above 40 years, making this a relatively old resource for such a short-lived species. Recommended rotation ages can vary with stand productivity and site condition, with 50 years a common average (stands managed as extended rotations are carried beyond this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



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

Much of the balsam fir volume in Minnesota (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.

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
2007 Harvest……	**215,500**
• Minnesota Pulpwood Industries……...	166,300
• Pulpwood Export……	24,400
• Sawlogs & Other…….	24,800

Source: NFRS & DNR Surveys

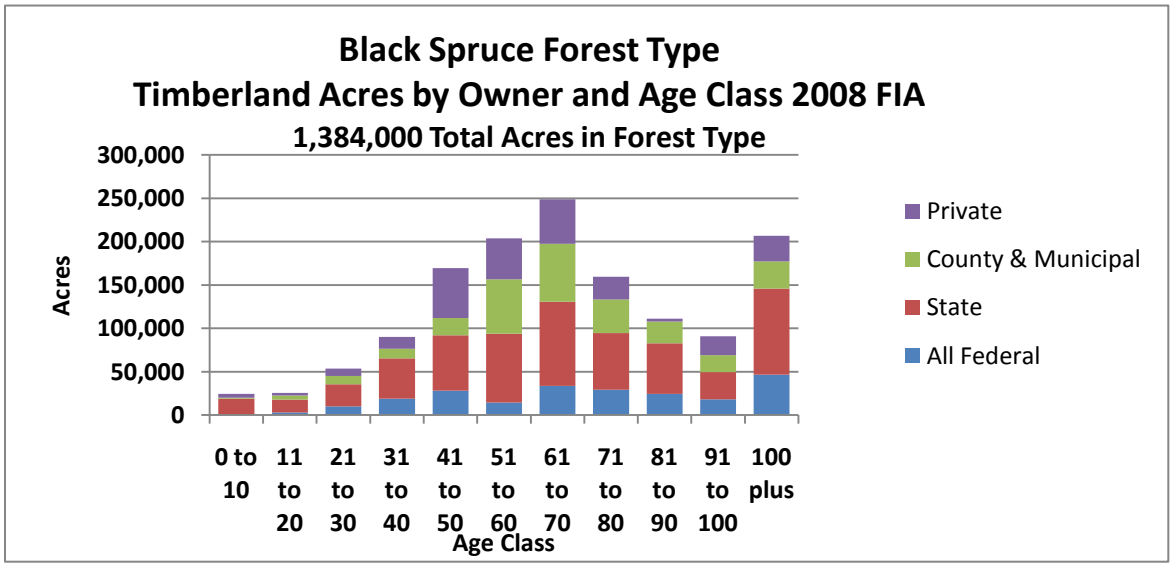
Resource Opportunities

- 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 the ability to manage some stands.
- Since black spruce is normally found on lowland sites only accessible during frozen conditions, accessibility of the resource is a major issue. Very little summer access.
- Spruce budworm has caused top kill and mortality on white spruce, (including plantations). This impact can be lessened by management activities such as thinning to maintain stand vigor and by discriminating against balsam fir in some mixed stands.

Black Spruce

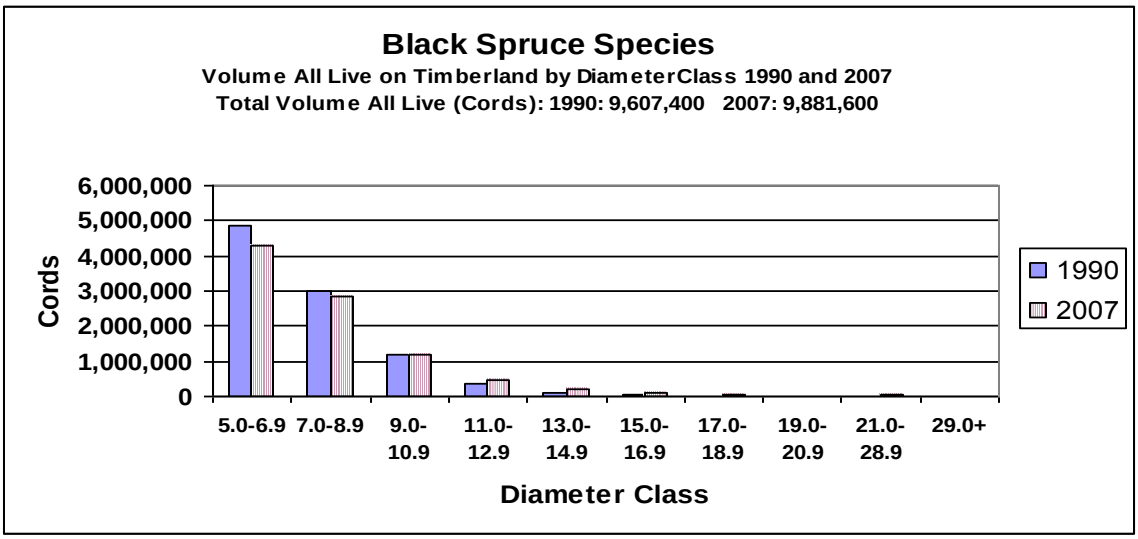


Source: 2008 FIA Database provided by USFS, Northern Research Station

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.

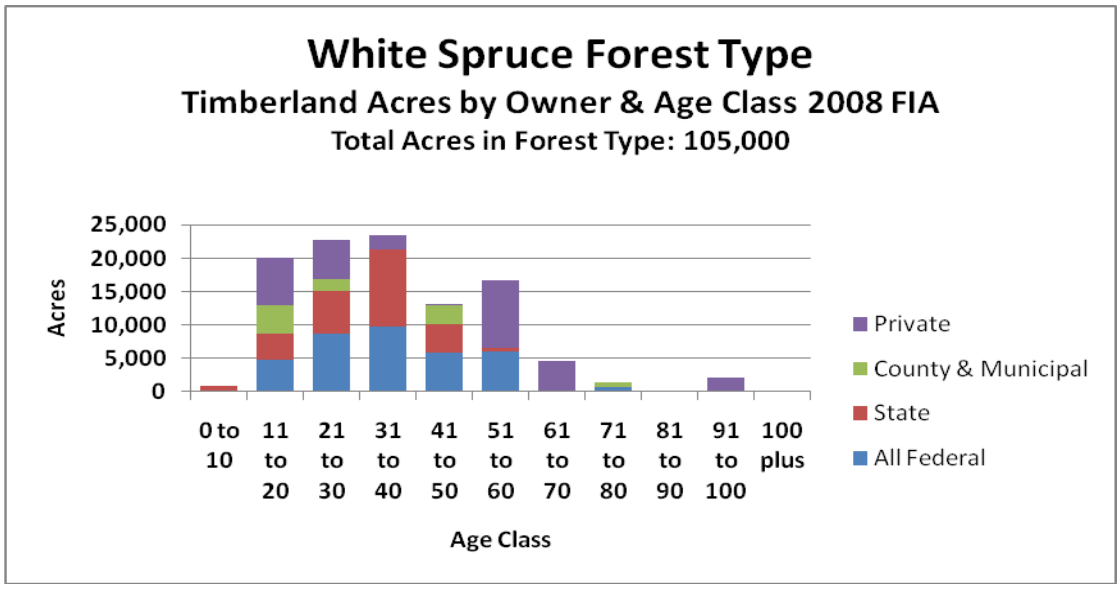
The State of Minnesota is by far the largest owner of black spruce cover type acres, but counties, private owners and our two national forests all have significant acreage.

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).



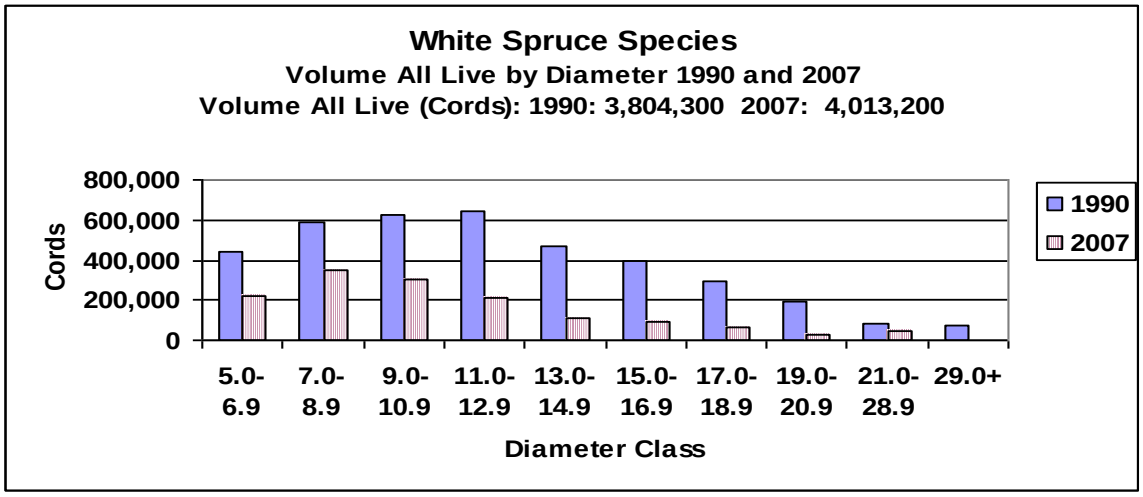
Source: FIA Database provided by USFS, Northern Research Station

White Spruce



Source: 2008 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.

Appendix G - DNR Sawmill Industry Crisis Response Memo

Natural Resources

Office Memorandum

February 16, 2010
Regional Managers – Forestry, Fish and Wildlife, Ecological Resources, Parks and Trails

Dave Epperly	Dave Schad	Steve Hirsch
Forestry Director	Fish & Wildlife Director	Eco Resources Director
651-259-5289	651-259-5180	651-259-5106
Courtland Nelson	Mike Carroll	Craig Engwall
Parks & Trails Director	NW Region Director	NE Region Director
651-259-5591	218-308-2629	218-999-7913

Responding to the Sawmill Industry Crisis

The economic recession of the past two years has taken its toll on wood using industries in Minnesota. The effects have been most pronounced in the Oriented Strand Board (OSB) industry in the state, which has suffered several mill closures and shut-downs. This has significantly reduced overall timber harvest levels in the state, especially in forest types predominantly used by OSB manufacturers (e.g., aspen, birch, balm of Gilead). However, some softwood timber markets have managed to regain some momentum. But while softwood timber markets have improved, the supply of needed softwood bolts and sawlog-sized materials continues to be severely restricted primarily due to the overall decline in harvest levels. For example, the harvest volume of softwoods that are secondary species within aspen stands has declined along with the volume of aspen harvested. In addition, loggers tend to limit harvesting in summer-accessible upland conifer stands when the ground is frozen, saving those stands for the summer months when access to harvest sites is generally much more limited. The result is critically low inventories of bolt and sawlog-sized materials for a number of softwood-using sawmills.

The DNR cannot resolve the current softwood sawtimber material shortage on its own. But as one of the major forest land managers in the state, we can take action to help address the immediate crisis. By working to increase the pool of available summer-accessible upland conifer stands, we can help provide loggers more opportunities to enter some existing upland conifer sales at this critical time.

While providing additional softwood bolts and sawlog material is an immediate driver of this initiative, it also provides a catalyst to begin implementing longer-term objectives related to plantation management: establishing strategic thinning regimes tailored to each site; improving timber growth and quality; and achieving long-term site objectives through timely thinning.

With this in mind, we are directing you to work with your staff to identify opportunities to expand short-term availability of softwood bolt and sawlog-sized material via the following tasks (in priority order):

- Identify additional red pine and spruce plantations (i.e., those not covered below) that may be suitable for thinning.

    - Consider plantations that have not received a first thinning, and those where it **has been more than five years** since their last thinning. Note that this approach is a change to our traditional scheduling of plantation thinning (i.e., entering/re-entering sooner).

- Move up the examination and sale dates of red pine and spruce stands already identified for potential thinning on multi-year Subsection Forest Resource Management Plan (SFRMP) stand lists.

- Move up the examination and sale date of any remaining red pine and upland spruce stands identified for potential thinning or regeneration harvest on the FY2010 and FY2011 annual stand examination lists (ASEL).

- Identify and assemble a list of these stands as soon as possible and submit it via the Annual Plan Addition (APA) process, including the associated two-week interdisciplinary review (see the Interdisciplinary Forest Management Coordination Framework, pp. 2-3). Note that stands from the FY2010 and FY2011 ASELs do not need to be submitted as an APA.

- Prepare timber to be offered for sale through this initiative in time for auctions in mid-May of 2010.

It is important to consider the following in identifying stands for treatment as described above:

- Give priority to stands that include bolt or sawlog-sized materials.
- Given the short time frames involved, it is critical to avoid stands where interdisciplinary consultation and agreement will take more time (e.g., sites with known locations of cultural values or rare species/communities, sites tagged for joint site visits, and some stands within Minnesota County Biological Survey Outstanding and High Biodiversity Sites). Refer to the most up-to-date Natural Heritage Information System.
- Review SFRMP goals and strategies related to plantation management (e.g., thinning of plantations to increase species and structural diversity via group selection or variable density thinning).
- Follow Site-Level Forest Management Guidelines for conifer retention on any regeneration harvest sites (i.e., from the FY2010 or FY2011 ASEL).
- Review stand specific information added during the SFRMP or annual stand exam process (e.g., review comment fields; check to see if the stand is within a special management area, such as a large patch or old forest management complex).
- Follow the DNR Invasive Species Operational Order and the associated Invasive Species Guidelines developed by each division. Multiple and more frequent entries increase the risk of introducing invasive species.

All divisions are also directed to identify projects within state parks or other DNR lands (i.e. forest lands not usually considered as available for harvest) where reduction of pine or spruce is a desired objective (e.g., converting a pine plantation to different land cover or forest type; opening up a pine or spruce plantation to achieve a structure more typical of natural origin stands) that can be

accelerated and accomplished under this objective. Regional Management Teams are expected to coordinate the identification and implementation of such projects.

Forestry staff will be receiving project guidelines from central office staff regarding the following:

- Sale structure and packaging under this initiative.
- Implementing a diameter class appraisal methodology for thinning red pine and spruce plantations based on recent research studies.
- Limiting timber permit duration.
- Utilizing logger select thinning to reduce stand marking workloads.
- Tracking accomplishments under this initiative.

We understand that this initiative will require additional effort by all staff involved and expect that regional managers will work with their respective staff to adjust workload priorities as needed and appropriate. But the current extraordinary circumstances require an "out-of-the norm" response to do what we can to help a segment of forest industry survive the current economic crisis and retain our primary tool for managing forest conditions for the future (i.e., timber harvest). We also understand that this effort may have implications for future years (e.g., availability of pine and spruce thinning) that we will need to remain aware of and take steps to address as this emergency situation passes.

cc: Mark Holsten
Laurie Martinson
Joe Kurcinka
Mark Matuska
Wayne Brandt
Scott Dane
Greg Bernu (MACLC, Chair)

Appendix H - Growth and Yield Estimation Procedures

Timber supply analyses utilize information about existing forest conditions, projections of how the forest will grow in the future, and how management activities are expected to impact the existing forest and the future forest. Models are used to take data that depict key existing conditions of a forest (e.g. forest types, species compositions, site qualities, stand densities) and project it forward given various management activities and constraints. While any modeled system is an imperfect representation of reality with varying strengths and weaknesses, models often provide useful insights about key impacts and trade-offs from various management options.

In their efforts to develop modeled scenarios that were as realistic as possible given time and resource constraints, the team used the best available information. For this analysis, most predicted yields (merchantable gross volume and basal area) were obtained using models presented by Walters and Ek (1993)[1]. Data used in model fitting were obtained from the USDA Forest Service Forest Inventory and Analysis (FIA) database. FIA cover types were mapped to DNR Forest Inventory Module (FIM) cover types as described in Schwalm (2009)[2]. For the management activities conducted on most of the cover types modeled within the analysis, these models were applicable. However, models presented in Walters and Ek (1993) for red pine cover types were found to be insufficient because they failed to directly account for the impact of thinning on future yields, and because the species compositions of FIA red pine cover types were not entirely applicable to DNR red pine cover types. Hence, a growth and yield model named RP2005 and presented by Buckman et al. (2006)[3] was used. This model system better accounts for the impact of thinning on future yields and better represents the yields of DNR red pine cover types.

A variety of stand conditions were used in developing RP2005 (Buckman et al. 2006, pgs. 86-87). Plantations, as well as natural stands, a variety of thinning methods (including Pre-commercial, Row, Crown, Low/Below, etc.) were used, but one limitation is that most data measurements were made when the stands were relatively older. However, the dataset does contain some observations of younger ages. Based on management scenarios normally practiced on DNR lands, (e.g. thinning begins around age 30), RP2005 may not be entirely applicable for these younger ages. However, given the complexity of potential management scenarios, stand origins, site qualities, etc., and lack of available model alternatives, RP2005 was judged to result in the best available predictions for DNR red pine cover types. Yields obtained from RP2005 and used during the Remsoft analysis are presented in Table 1.

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[1]Walters, D.K., and A.R. Ek. 1993. Whole stand yield and density equations for fourteen forest types in Minnesota. Northern Journal of Applied Forestry 10: 75-85.
[2]Schwalm, C.R. 2009. Forest Harvest Levels in Minnesota. 48 pages.
http://files.dnr.state.mn.us/forestry/um/sustainedyieldreport.pdf
[3]Buckman, Robert E., et.al. 2006. Growth and Yield of Red Pine in the Lake States. GTR-NC-271. St. Paul, MN: USDA Forest Service, North Central Research Station. 114 pages.
http://www.ncrs.fs.fed.us/pubs/viewpub.asp?key=9031

Table 1. Red pine yields obtained from RP2005 and used in Remsoft software when conducting the timber supply analysis. All volumes are on a per acre basis. RP2005 inputs were customized to DNR practices. Stands were grouped by site index class (base age 50) and yields per acre were assigned based on this classification and age.

	Very Low (< 31 feet) [1]	Low (31-40 feet)[1]	Low Average (41-50 feet)		High Average (51-60 feet)		High (61-70 feet)		Very High (> 70 feet)	
Age	Clearcut Cords	Clearcut Cords	Thinned Cords	Clearcut Cords	Thinned Cords	Clearcut Cords	Thinned Cords	Clearcut Cords	Thinned Cords	Clearcut Cords
0	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-
30	3.4	5.3	-	-	-	-	8.1	23.2	12.6	30.1
40	4.9	7.7	7.6	21.3	14.0	30.7	10.9	30.7	13.3	36.1
50	6.4	9.9	8.2	25.5	11.0	32.1	13.9	38.8	16.7	45.4
60	7.8	12.1	7.9	28.2	10.5	35.0	13.2	44.0	15.8	49.0
70	9.2	14.1	7.5	30.0	10.0	38.0	12.5	45.6	15.0	53.1
80	10.4	16.0	7.2	32.2	9.5	40.2	11.8	48.1	14.1	55.9
90	11.5	17.8	7.0	33.7	9.0	41.8	11.2	50.0	13.3	58.1
100	12.6	19.4	-	34.8	-	43.2	-	51.5	-	59.8
110	13.6	20.9	-	42.4	-	53.2	-	63.8	-	74.3
120	14.5	22.2	-	49.6	-	62.6	-	75.5	-	88.0
130	15.3	23.5	-	56.2	-	71.3	-	86.2	-	100.7
140	16.1	24.7	-	62.1	-	79.1	-	96.0	-	112.3
150	16.9	25.8	-	67.4	-	86.2	-	104.8	-	122.9
160	17.5	26.9	-	71.8	-	92.2	-	112.6	-	132.3
170	18.2	27.9	-	75.5	-	97.3	-	119.2	-	140.6
180	18.8	28.8	-	78.2	-	101.3	-	124.7	-	147.7

[1] Thinning was not allowed in the Very Low and Low site qualities.

For softwood types managed by the DNR primarily via all-aged silivicultural systems (i.e., white pine and naturally regenerated white spruce) equations from Walters and Ek (1993) were applied for the initial thinning (assuming 33% of the volume was harvested) and thereafter it was assumed a regulated diameter distribution was obtained. Hence, volumes from the UPM-Thunderhawk Draft Environmental Impact Statement (MNDNR, 2007) and a 20-year reentry interval were used (Schwalm 2008)[4].

The picture above depicts several existing stands. An inventory of these stands will establish the cover types, site quality, age, etc. This inventory information can then be used as a baseline to predict how these stands will develop over time by using models. Harvest scheduling software is then used to determine optimal management scenarios based on the existing forest condition, potential management activities, economic and social constraints, and the use of models to predict responses to various management activities.

Harvest Scheduling

Forest resource management decisions take into account existing and desired conditions of forests and related resources. Inventories of forests provide baseline information for key parameters of existing resources, and models are used to project forest conditions forward in response to potential management actions. Harvest scheduling is the practice of determining the type and timing of management actions that result in best meeting management objectives.

The objective of this current analysis was to identify the timing and type of management actions given social and other existing constraints that would result in the greatest amount of softwood timber available for harvest over the next 50 years under several different scenarios with varying constraints. Actions included thinnings, clearcuts, and group harvests of both softwood and hardwood cover types. Constraints included rotation ages used by the DNR to obtain specific desired future forest conditions such as the acreage of Extended Rotation Forests (ERF) as well as even-flow constraints to limit extreme fluctuations in harvested volume over the next 50 years.

Analyses presented in this paper are based on those presented by Schwalm (2008)[4] but modified to more accurately reflect actual DNR management activities on softwood cover types. Due to the complexity of the analyses, software is needed to find the optimal harvest level given all the constraints. There are many suitable software packages but DNR utilizes the Remsoft Spatial Planning System software due largely to its wide acceptance and use by many other organizations.

[4] Schwalm, C.R. 2008. Technical Report – One Million Cord Analysis. 22 p.

This software is a forest estate and harvest schedule model based on linear programming (LP). LP is an optimization technique where an algorithm searches for the "best" solution – "best" being that solution that satisfies a mathematical objective. For this analysis a 50-year planning horizon, consisting of five, 10-year planning periods, was used throughout for each scenario.

Forest inventory data of the existing forest condition was obtained from the DNR Forest Inventory Module (FIM). Stands were classified as to 10-year age class, site productivity, and cover type. Stands sharing the same combination of the classification variables were grouped and then projected forward by using growth models (see the Growth and Yield Estimation Procedures section above) in relation to potential management actions. Remsoft was then used to determine the optimal treatments and timing of those treatments over the next 50 years to maximize harvested cords under several scenarios with varying social and even-flow constraints.

Appendix I - Glossary

Age of Merchantability – The age when most trees within stands normally become large enough (e.g., diameter, height) to be commercially marketable. This does not necessarily mean that stands will be "operable" from a logger's perspective.

Average Maximum Rotation Age – For DNR lands, the average maximum rotation age from all SFRMPs that have been developed to-date.

Average Normal Rotation Age – For DNR lands, the weighted average normal rotation age from all SFRMPs that have been developed to-date

Average Recommended Rotation Age – For DNR lands, a species-specific rotation age based on the popular literature (for DNR, the FS Manager's Handbooks), modified by Division of Forestry (Extended Rotation Forest Guideline, 1994).

CSA – Cooperative Stand Assessment. The inventory system used on DNR-administered forest land. Distinct 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. Information collected includes timber volumes, species mixes and insect and disease damage.

Cull – Portions of a tree that are unusable for industrial wood products because of rot, form, missing or dead material, or other defect.

Effective Extended Rotation Forest – For DNR lands, the portion of the prescribed ERF acreage that is actually over the normal rotation age for the cover type at any one time. (SFRMP Staff Guidebook IV, 2008). This is also referred to as stands that are considered to be "old forest."

Extended Rotation Forest – Areas or specific sites that have been assigned a management prescription to lengthen the time to the ultimate harvest of the tree(s) or stand; extended rotation forests insure that an adequate acreage of forests older than rotation age are maintained on a continuing basis (Extended Rotation Forest Guideline, 1994); forest stands for which the harvest age is extended beyond the normal or economic harvest age. ERF provides larger trees, old forest wildlife habitat, and other non-timber values. (SFRMP Staff Guidebook IV, 2008).

FIA – USDA Forest Service Forest Inventory and Analysis. Permanent plots across all forest ownerships are remeasured periodically. In Minnesota, the inventory is updated annually, with approximately 20% of the plots revisited each year. FIA provides information on condition of the forest resource. Timber volumes, species mixes, estimated growth 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 source of comprehensive data across all ownerships.

FIM – Forest Inventory Module. Another term for the inventory system used on DNR-administered forest land. See "CSA" definition above.

Forest Type (Same as "Cover Type") - A classification of forest land based on the species forming a plurality of live tree stocking.

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

Hardwoods - Deciduous tree species. In Minnesota, these include aspen, birch, ash, basswood, maples, oaks and others.

Maximum Rotation Age – For DNR lands, the maximum age at which a forest type will retain its biological ability to regenerate to the same forest type and remain commercially viable as a marketable timber sale.

Minimum Extended Rotation Age – For DNR lands, the minimum extended rotation ages identified in the DNR Extended Rotation Forest Guideline

NIPF – Non-Industrial Private Forest Land. Forest land owned privately by individuals or groups. Does not include private lands owned by forest industry.

Normal Rotation Age - For even-aged managed cover types on DNR lands, the rotation age set for non-ERF timberland acres. It is based on the culmination of mean annual increment (MAI), other available data related to forest productivity that also considers wood quality, and local knowledge.

Prescribed Extended Rotation Forest – For DNR lands, the cover type acreage designated for management as ERF. Stands designated as ERF will be held beyond the recommended normal rotation (harvest) age out to the established ERF rotation age(s). A stand of any age can be prescribed as ERF. (SFRMP Staff Guidebook IV, 2008).

Pulpwood – Wood 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. For DNR lands, the period of years required to establish and grow timber crops to a specified condition of maturity; this time period is an administrative decision based on economics, site condition, growth, or other factors (Extended Rotation Forest Guideline, 1994).

SFRMP – Subsection Forest Resource Management Plans. Vegetation management plans developed to guide forest management on DNR lands.

Sawbolt - A short log, usually 100" length, with a specific minimum top diameter (often 6" minimum inside bark, small end), generally sawn for lumber.

Sawtimber - Wood that is harvested and used by sawmills. Dimensions vary, but generally for hardwoods sawlogs have 10 inch minimum inside bark diameter, for softwoods an 8 inch inside bark small end minimum diameter is common.

Softwoods - Coniferous tree species. In Minnesota, these include balsam fir, black and white spruce, jack, white and red pine, tamarack, and white and red cedar.

Specialty Products – Includes product categories such as log homes, shavings mills and veneer mills.

Timberland – As defined by USFS FIA, 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.

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