Chapter 4. Cover Type Management Recommendations

4.1 Introduction

The purpose of this chapter is to provide background information and management recommendations by cover type. These management recommendations provide direction to field staff for on-the-ground management activities for stands in the various cover types. Some information from the general direction statements (GDSs) and strategies is incorporated into this chapter, but field foresters should be familiar with the full contents of the GDSs and strategies found in Chapter 3. Background information and management recommendations provided by cover type include:

- Current Condition
- Future Direction
- Stand Management
- Cover Type Conversion Management (as applicable)
- Stand Selection Criteria
- Stand Treatment Summary

These cover type management recommendations were developed by workgroups made up of DNR professionals from Forestry, Fish and Wildlife and Division of Ecological Resources. The intent was to gain a wide variety of disciples and input into drafting the cover type recommendations. These work groups drafted the cover type recommendations before adoption by the CP-PMOP planning team and incorporation into the CP-PMOP plan.

The following cover types are addressed with management recommendations:

- aspen/balm of Gilead
- birch
- ash / lowland hardwoods
- northern hardwoods
- oak
- white pine
- red pine
- jack pine
- black spruce lowland
- white spruce
- balsam fir
- tamarack
- white cedar
- stagnant spruce

For species of minor acreage, such as yellow birch and upland tamarack, within-stand composition strategies for cover types will be used to increase their presence.

Acreage figures in this chapter include state forestlands administered by the Division of Forestry, and Management Section of Wildlife. State lands in state parks, designated old-growth stands, and scientific and natural areas (SNA) are not included as managed acres in this plan.

In addition to the cover type management recommendations and background information that was used to develop direction on vegetation management for this plan, the following is a list of the more significant publications, guidelines, directives, and policies field foresters use as guides to manage state forest lands:

1. *Directions 2000, The Strategic Plan, September 2000*
2. Division of Forestry's *Forest Development Manual*
3. MFRCs *Voluntary Site-Level Guidelines including Biomass Harvesting guidelines for forestlands, brushlands and open lands* (DNR, December 2007
4. *North Central Landscape Plan, as amended January 2005*, Minnesota Forest Resources Council

5. *Preliminary Issues and Assessment*. Chippewa Plains / Pine Moraines and Outwash Plains, Minnesota DNR, August 2006
6. *Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province*. Minnesota DNR. 2003
7. *Forest Development Manual*. Minnesota DNR, 1994
8. *Voluntary Site-Level Forest Management Guidelines*. Minnesota Forest Resources Council. 1999
9. *Forestry-Wildlife Habitat Management Guidelines*. Minnesota DNR, 1985
10. Forestry - Wildlife Coordination Policy, *Interdisciplinary Forest Management Coordination Framework*, December 2007
11. *Cultural Resource Review Procedure*, Minnesota DNR;
12. *Old-Growth Forests Guideline Amendment #5*, Minnesota DNR, January 2002
13. OFMC Management Plans as prepared by forestry areas, various dates based on plan completion
14. Minnesota County Biological Surveys, Minnesota DNR, Division of Ecological Resources, various dates based on completion for each county
15. Natural *Heritage database, information, and survey,* various dates based on survey completion;
16. *Tomorrow's Habitat for the Wild and Rare: An Action Plan for Minnesota Wildlife, January 2006*
17. Manager's Handbooks for Cover types, North Central Forest Experiment Station, General Technical Reports, various dates for the individual publications for cover types common in the north central states
18. CP-PMOP *Stand Silvicultural Prescription Worksheet* (Appendix E)
19. *Forest Health Monitoring Program,* MN DNR
20. Wildlife management area management guidance documents as prepared by Minnesota DNR, Division of Fish and Wildlife
21. *Land Type Association Assessment and Analysis* documents, draft August 2007 (Appendix N)
22. *Biomass Harvesting Guidelines*, Minnesota DNR, November 2007
23. *Special Forest Products "Careful Harvest Fact Sheets," University of Minnesota Extension Service*
24. *Pesticide and Pest Control Operational Order #59*, Minnesota DNR, April 1989
25. *Visual Sensitivity Classifications* (inventories can be found at http://www.dnr.state.mn.us/forestry/visual_sensitivity/index.html)
26. *Visual Quality Best Management Practices for Forest Management in Minnesota" May 1994*
27. applicable local, state, federal, Indian band, private, and industrial vegetative
28. management policy, guidelines, and plans as these impact DNR forest management
29. *Environmental Indicators Initiative and Natural Resources Stewardship 2001*

Cover type determination is based on the stand composition at the time the stand was inventoried. The composition of a stand typically changes to some degree over time, sometimes resulting in a cover type change if the change is significant. Appendix B, *Tree Species in the CP-PMOP)* lists the tree species and cover types found in these subsections. Stand composition may range from a single species to several species. In general, a species or species group needs to comprise 40 percent of the stand composition to be called the cover type. For more details, see Appendix C, *Key for Main Cover type Determination*.

These cover type management recommendations are developed from background information concerning a wide range of existing forest conditions such as total acres, existing age classes, forest impacts, and issue identification, primarily as outlined in the Preliminary Issues and Assessment document. Using this background information, goals and strategies were developed and applied to the forest inventory to outline future forest vegetation management directions. These future directions are stated as desired future forest conditions (DFFCs).

These cover type management recommendations provide direction for the identified cover types in terms of conversions in-to and out-of other cover types; identification of NPCs and LTAs where conversions are most likely to succeed; stand management recommendations and identification of stand selection criteria from which the 10-Year Stand Exam Lists were developed. Although the plan includes a 10-Year Stand

Exam List, desired future forest conditions are expressed both as 10-year DFFCs and 50-year DFFCs, recognizing the long-term perspective of forest vegetation management.

The DFFCs provided guidance, as these cover type management recommendations were prepared. For example, for cover type conversions, several DFFCs recommend a decrease in the cover type acreage of specific cover types (e.g., aspen, birch, and balsam fir). These cover- type decreases will result in conversions through artificial (e.g., site preparation and planting) or natural conversion (e.g., natural succession) methods to other cover types (e.g., white pine, red pine, and white spruce). Stands may not be fully converted to the desired cover type for many years because of a gradual increase in the desired species over time. The composition of stands during conversion to cover types such as white pine or white spruce may also include significant portions of other species, such as aspen or birch. On some aspen, birch, and balsam fir stands where cover type conversion is desired, partial harvest, less intensive site preparation techniques, and/or successive prescribed fires may be appropriate for the conversion to long-lived conifers such as white pine, red pine, or white spruce.

DFFCs that influence cover type management recommendations for even-aged managed cover types include recommendations that balancing the distribution of the 10-year age classes is a long-term goal, which may take more than one rotation to achieve for most cover types.

Other clarifications of these cover type recommendations include that treatment acres determined in this plan comprise a stand-examination list that will be field-visited over the 10-year plan implementation period. Stands on the 10-year list will be field-visited based on the annual treatment acres recommended for each of the cover types. There may be a deviation from year to year, but the 10-year average should equal the annual treatment acres.

Several of these cover type management recommendations refer to a *Silviculture Prescription Worksheet* (Appendix E). This tool will be used by field foresters to assess management options for all stands that are identified for field visit. The *Stand Silvicultural Prescription Worksheet* is intended to provide guidance to appraisers when the field visit is made. As actual field decisions are made, all information assigned to a stand during the SFRMP planning process will be considered in determining stand-specific management objectives. This background information will be provided to appraisers after each Forestry Area Annual Stand Exam List is identified from the 10-year Stand Exam List as contained in this plan. Stands that are suitable for harvest will be appraised for a timber sale. For stands found not suitable for harvest, inventory data will be updated (i.e., alteration) and the appropriate prescription applied, such as manage for the understory, defer treatment, prescribe forest development activities (e.g., site preparation and tree planting), or alter (i.e., no treatment needed) to the current stand conditions or cover type.

4.2 Aspen/Balm of Gilead (A/BG)

4.2A Current Condition

1. Cover Type Characteristics: The aspen/balm of Gilead (A/BG) cover type includes quaking aspen, bigtooth aspen, and balm of Gilead. In 2007, the A/BG cover type comprised 42.6 percent (183,355 acres) of the state timberland (429,229 acres) managed in the CP-PMOP subsections. Of the total A/BG acres in the two subsections 63 percent (115,955 acres) occur in the PMOP and 37 percent (67,399 acres) are found in the CP subsection (See Table 4.2a). There are a total of 334 acres of the A/BG cover type reserved from harvest in these subsections.

Both aspen and balm of Gilead are combined into one cover type for the CP-PMOP Plan as the two cover types are commonly associated with each other and are managed using the same management prescriptions.

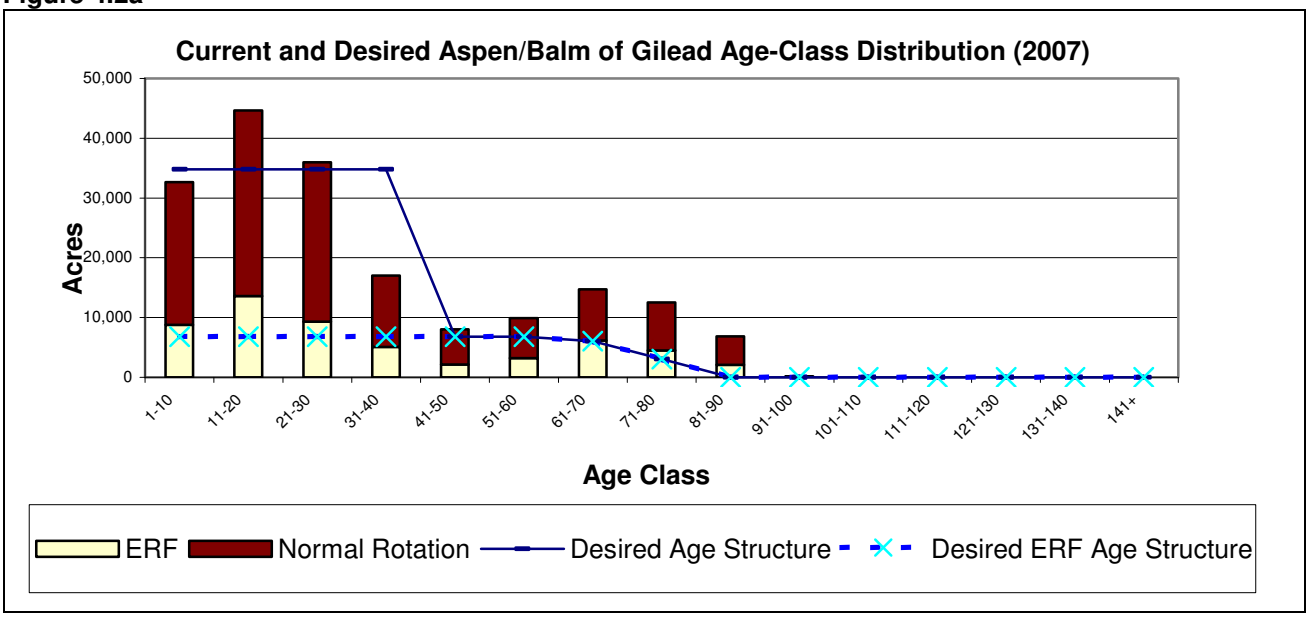
Table 4.2a Aspen/BG Cover Type Acres by Subsection

	CP	PMOP	Total
Aspen Acres	65,000	115,692	180,691
BG Acres	2,398	264	2,662
Total A/BG Acres	67,399	115,955	183,353
Percent	37	63	100

Aspen generally compete well on most sites within these two subsections, but quaking aspen is identified as not an excellent competitor in the following upland forest Native Plant Communities (NPCs): FDn12, FDc12, FDc23, FDs37, MHn47, MHc47, and MHs39. In early stages aspen is so prolific, it is typed as an aspen stand, however as the stand matures, other cover types, such as birch, come to dominate aspen stands, consequently changing the cover type classification.

2. Age-Class Distribution: The current A/BG age-class distribution does not reflect the balanced age-class structure desired for even-aged managed cover types. Figure 4.2a identifies the current and desired age-class distribution of the A/BG cover type.

Figure 4.2a



The normal rotation age for aspen is 45 years in the CP and 40 years in the PMOP. The normal rotation age for balm of Gilead is 40 years for both subsections. Considering the CP-PMOP combined, a total of 50,950 acres of A/BG (28%) are over their respective normal rotation ages (see Table 4.2b).

Table 4.2b Aspen/BG Cover Type Acres Over Normal Rotation Age by Subsection

Cover type	CP	PM	Total
Aspen	13,068 (45 years)	36,438 (40 years)	49,506
BG	1,198 (40 years)	246 (40 years)	1,444
Total Aspen/BG Acres	14,266	36,684	50,950 (28%)

The maximum rotation age for aspen is 80 years in the CP and 75 years in the PMOP. The maximum rotation age for balm of Gilead is 60 years in both subsections. Considering the CP-PMOP combined, a total of 15,193 acres of A/BG (8 percent) are over their respective maximum rotation ages (see Table 4.2c).

Table 4.2c Aspen/BG Cover Type Acres Over Maximum Rotation Age by Subsection

Cover Type	CP	PMOP	Total
Aspen	613 (80 years)	10,464 (75 years)	11,077
BG	4,003 (60 years)	113 (60 years)	4,116
Total Aspen/BG Acres	4,616	10,577	15,193 (8%)

3. Stand Composition: Mature aspen stands in the CP-PMOP subsections are typically comprised of a mixture of species, with aspen being 60 percent of the volume, followed by birch at 16 percent, balsam fir at 9 percent, and spruce species at about 6 percent. At times, the volume of these associated species may be quite high, nearly approaching the volume of aspen in the stand. It is not uncommon for the total volume of associated species to exceed that of the aspen.

4.2B Future Direction

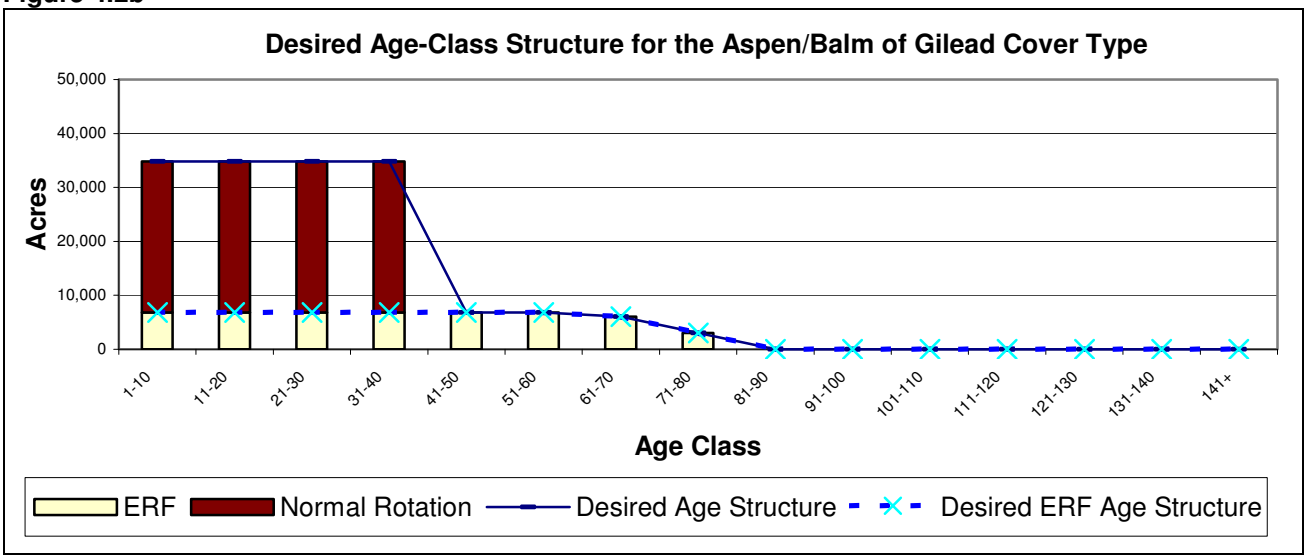
1. Cover Type Acres: Due to conversions to conifer cover types, the CP-PMOP plan recommends reducing the A/BG cover type by 2 percent (2,800 acres) during the next 10-year plan implementation period. These acres will be converted to white cedar (50 acres only within the CP Subsection), jack pine (1,500 acres), white spruce (700 acres), white pine (300 acres) and red pine (250 acres). The 50-year DFFC goal (which includes the first 10-year plan implementation period) is to convert 8 percent (14,369 acres) of the A/BG cover type to conifers. These A/BG acres will be converted to jack pine (5,169 acres); white spruce (1,700 acres); white pine (1,500 acres) and to red pine (2,000 acres in the CP with 4,000 acres to the PMOP) (See Table 4.2d). In terms of the dominant cover type in a particular stand it is difficult to predict how aspen stands will react with other cover types.

Table 4.2d Recommended A/BG Cover type Acres by Subsection by Selected Year

	2007	2017	2057
CP	67,166	66,600	NA
PMOP	115,579	113,345	NA
Total acres	182,745	179,945	168,376

2. Age-Class Distribution: A primary objective is to move the current age-class structure toward a more balanced condition. Figure 4.2a shows the current age-class distribution. Figure 4.2b shows the long-term desired age-class distribution or the desired future forest composition (DFFC) goal. Due to the current conditions, it will take more than 50 years to achieve this goal (see Figure 4.2d).

Figure 4.2b



The ERF goal for this cover type is to maintain 13.5 percent of the acres over normal rotation age (effective ERF), with a declining age-class distribution from normal rotation (45 years in CP and 40 years in PMOP) out to the maximum age (80 years in CP and 75 years in PMOP). Figure 4.2b illustrates the balanced age-class structure desired through the normal rotation age with a declining age-class structure following normal rotation age of 40 years.

3. Stand Composition: The desired future within-stand composition will range from pure aspen stands to a more diverse stand structure and/or mixed forest that includes long-lived conifers such as white pine, white spruce, red pine, and upland white cedar. Upland hardwoods such as birch, maple, and ash will be found in many stands. As part of the *Stand Silvicultural Prescription Worksheet,* field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plan Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

4. Patch Management: Patch management objectives are to maintain existing large patches consisting of aspen, and increase the size of patches where possible.

5. Limiting Factors: Increased prevalence of stem decay and butt rot are likely in trees wounded by falling trees, harvest activities, and storm damage. As aspen trees become older, the incidence and severity of white trunk rot increases. Aspen decline and decadence often occurs after forest tent caterpillar defoliation of over-mature stands. Hypoxylon cancers and Saperda stem borers cause tree mortality, especially in low-density stands and along stand edges. Aspen is also one of the preferred host species for gypsy moth.

4.2C Stand Management

1. Even-aged Management Direction: The A/BG cover type will be managed on an even-aged basis for pulpwood and bolts. The goal is to move toward a balanced age-class structure while maintaining or improving site productivity, forest wildlife habitat, and biodiversity.

2. Final Harvest: Aspen and balm of Gilead stands to be maintained in this cover type will be managed using clearcut or clearcut-with-reserves as the final harvest method. Natural stand boundaries or natural features such as topography or soil type should be used when possible to delineate timber sale boundaries. Harvest regulations and methods that favor maintaining or increasing within-stand diversity, with an emphasis on long-lived conifers, while retaining aspen or balm of Gilead as the main cover type are recommended. One strategy to accomplish this would be to reserve some existing individual trees or patches of long-lived conifer species from harvest. These reserve trees would maintain the within stand species diversity as well as add structural diversity for the newly regenerating stand. Reserve trees may also function as a seed source that could aid in increasing the abundance of these long-lived species in the new stand. Individual trees and patches of trees to be reserved should be healthy and able to last another rotation. Seed trees should be of good health and form.

A goal is to increase the average size of harvest areas. Selected larger blocks (100+ acres) should be harvested, where appropriate, using consolidated or natural stand boundaries. Small harvest blocks (less than 40 acres) will continue to be prescribed. Implementing a range of harvest block sizes will provide for a range of wildlife habitat needs.

3. Even-Aged Management Prescriptions: The following are the most common prescriptions that will be used on A/BG timber sales:

a. Clearcut-Sprouting
b. Clearcut with Reserves – Sprouting

Additional coding of objectives in the DNR's Forest Information System (FORIST) will be used to track accomplishments toward increasing within-stand diversity and mixed forest conditions.

4. Regeneration Methods after Final Harvest: Aspen and balm of Gilead stands regenerate naturally through root sprouting (suckering) and seeding. The recommended minimum stocking of aspen regeneration two years after harvest is 4000+ stems per acre scattered throughout the stand.[1]

Forest managers should consider the following strategies when the goal is to increase within-stand diversity or to create a more mixed hardwood-conifer composition in the future stand.

a. Direct seeding: This is most appropriate on sites where harvesting operations have scarified the soil creating a seedbed suitable for seed germination.
b. Planting: Planting long-lived conifers using small patches or variable density scattered plantings, with or without site preparation can be considered or implemented.

4.2D Cover Type Conversion Management

1. Conversion Goals: Over the next 10 years the DFFC is to convert 2 percent (2,800 acres) of the A/BG cover type to white cedar (50 acres in CP), jack pine (1,500 acres), white spruce (700 acres), white pine (300 acres) and red pine (250 acres). Over the next 50 years, it is recommended that approximately 14,369 acres of the A/BG cover type be converted to other cover types. Depending on site conditions, these stands will be converted to long-lived conifer species such as white pine, white spruce, red pine, or upland white cedar, as well as shorter-lived conifers such as jack pine. Some converted stands will be managed for a mixed conifer-hardwood composition. The decision of whether or not to convert a stand to another cover type will be determined when the stand is field-visited using the *Silviculture Prescription Worksheet* process. Conversion strategies include the following:

a. Conversion of aspen to the desired cover types will be accomplished using a range of management options, including: Allowing natural succession to occur on sites where the within-stand composition contains a high percentage of the desired species listed above, or there is adequate advanced regeneration of these species in the understory.
b. Using partial harvest in mixed stands to release existing understory conifers and to create mixed conifer-hardwood composition in the stand.

[1] *Manager's Handbook for Aspen in the North Central States*. Gen. Tech. Rep. NC-36. St. Paul, MN. USDA, Forest Service, North Central Forest Experiment Station.

c. Using post-harvest treatments such as herbicide application, mechanical site preparation, or prescribed burning; followed by hand planting or artificial seeding, to establish conifers on the site.
d. Underplanting long-lived conifers in thinned or existing stands where conditions are favorable for these seedlings to become established and grow.
e. Considering conversion to another species if more than 25 percent of the aspen stems in a stand contain hypoxylon canker (*DNR-Forest Development Manual*, page D-2.1).

As treatment and conversion is considered, field foresters should note that quaking aspen is not an excellent competitor in the following upland forest Native Plant Communities (NPCs): FDn12, FDc12, FDc23, FDs37, MHn47, MHc47, and MHs39.

4.2E Stand Selection Criteria

1. Normal Rotation Forest: Normal rotation ages of 45 and 40 will be used for calculating a regulated harvest level in the CP and PMOP respectively (see Table 4.2e).

Table 4.2e Aspen/Balm of Gilead Normal Rotation Ages and Maximum Ages

Subsection	Normal Rotation Age		Maximum Age	
	Aspen	Balm of Gilead	Aspen	balm of Gilead
CP	45	40	80	60
PMOP	40	40	75	60

The objective is to move the age classes toward a more balanced structure. The priority during the next 10 years will be to select the oldest and highest scoring stands for treatment. A *Stand Scoring System* was implemented which assigned scores to stands in the following priority: stands that were currently over maximum age; over maximum age within 10 years; currently beyond normal age; and, currently less than normal age. The *Stand Scoring System* considered both normal pool acres and ERF acres (see Appendix K).

2. Normal Rotation Harvest Treatment Level Calculations: The pool of stands considered for normal rotation (see glossary) harvest treatment in all stands:
a. not reserved from harvest (e.g. old growth, EILC);
b. not designated to be managed as extended rotation forest (ERF);
c. and near normal harvest rotation age.

Harvest treatment level is the sum of normal rotation acres to be harvested from each age class that will move the age class distribution towards a more balanced structure. Once a balanced age class distribution is achieved, stands can be scheduled for treatment upon reaching normal rotation age.

Adjustments to the normal harvest level were made to meet other goals such as balancing the age-class distribution and providing relatively stable harvest levels.

3. Extended Rotation Forest: Long-term DFFC goals are to retain 13.5 percent of the cover type acreage in Effective ERF and 30 percent in Prescribed ERF. This will provide a declining age-class structure out to the maximum harvest age as shown on Figure 4.2b.

The harvest level will be based on various harvest ages beyond the normal rotation ages, out to the maximum harvest ages as illustrated in Table 4.2e. The average rotation age for ERF stands, when the desired age-class distribution is reached, will be 73 years. The selection of older ERF stands for treatment will be emphasized to help move the population of ERF stands toward the desired declining age-class structure. Table 4.2f identifies the Prescribed ERF and Effective ERF total acres for the CP-PMOP subsections.

Table 4.2f A/BG ERF Acres (Plan Target Acres) and Maximum Age

Subsection	Prescribed ERF Acres	Effective ERF /DFFC Acres	Maximum Age			
			Aspen		BG	
			CP	PMOP	CP	PMOP
Total CP-PMOP	55,649	24,671	80	75	60	60

The previous Figure 4.2a showed the current age-class distribution of designated ERF and Figure 4.2b showed the desired declining age-class structure. Harvest of ERF stands during this 10-year period will be targeted at stands that are in the 61-100 year-old age classes. This will help maintain the desired 13.3 percent effective ERF into subsequent decades.

4. Extended Rotation Harvest Treatment (ERF) Level Calculations: The pool of stands considered for extended rotation harvest treatment is all stands:

a. not reserved from harvest (e.g. old growth, EILC);
b. designated to be managed as ERF;
c. and will be over normal harvest rotation age.

Extended rotation harvest treatment level is the sum of ERF acres to be harvested from each age class that will move the age-class distribution towards a more balanced structure, while attempting to retain the minimum level of effective ERF (see Glossary). A declining acreage of stands in each 10-year age class is desired between normal rotation age and maximum rotation age. Emphasis is on treating the oldest age classes first to minimize loss of fiber or tree mortality. Very few stands should be allowed to go untreated beyond the maximum rotation age (see Glossary).

4.2F Stand Treatment Summary

Table 4.2g shows the treatment acres, the recommended conversion acreage out of the A/BG cover type, old forest percent, effective ERF percent, and the average treatment ages for the next six decades. Based on the cover type management identified in this Plan, the average treatment age for aspen/balm cover type decreases during the plan implementation period with slight increases in later decades. There is considerable variation from decade to decade due to the current age-class distribution of the cover type. Old Forest Percent means acres that are over normal rotation age, except stands designated as Old Growth.

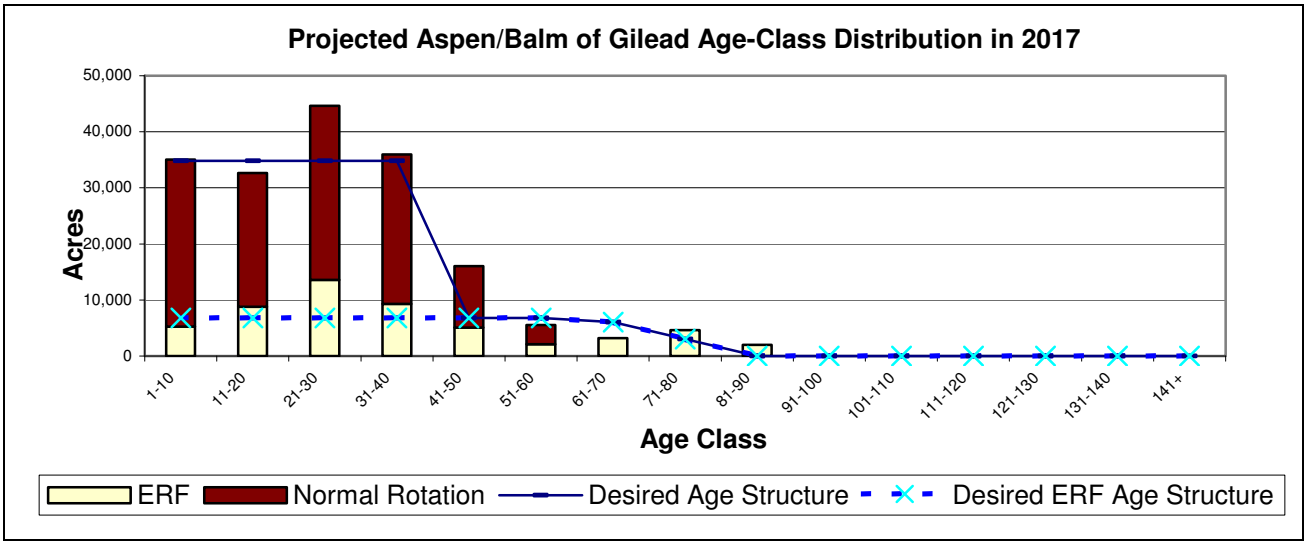
Table 4.2g Aspen/Balm of Gilead Treatment Summary by Decade for the CP-PMOP

Decades	Total Treatment	Conversion	Old Forest %	Effective ERF	Avg Treatment Age		Avg Age
					Normal	ERF	
1	37,864	2,800	27.8%	9.7%	71	81	31
2	37,844	2,631	15.8%	9.0%	46	68	27
3	39,339	4,198	14.9%	10.2%	43	62	26
4	35,707	3,900	18.0%	13.3%	43	66	26
5	33,491	840	17.3%	14.9%	42	73	27
6	29,587	0	18.4%	14.6%	43	78	28
Total	213,832	14,369					
DFFC	**34,802**[1]	**-14,364**[2]		**13.3%**	**41.9**[3]	**73.0**[3]	**25**[3]

[1] Total Treated Acres once a fully regulated forest is achieved.
[2] positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
[3] anticipated age once a fully regulated forest is achieved.

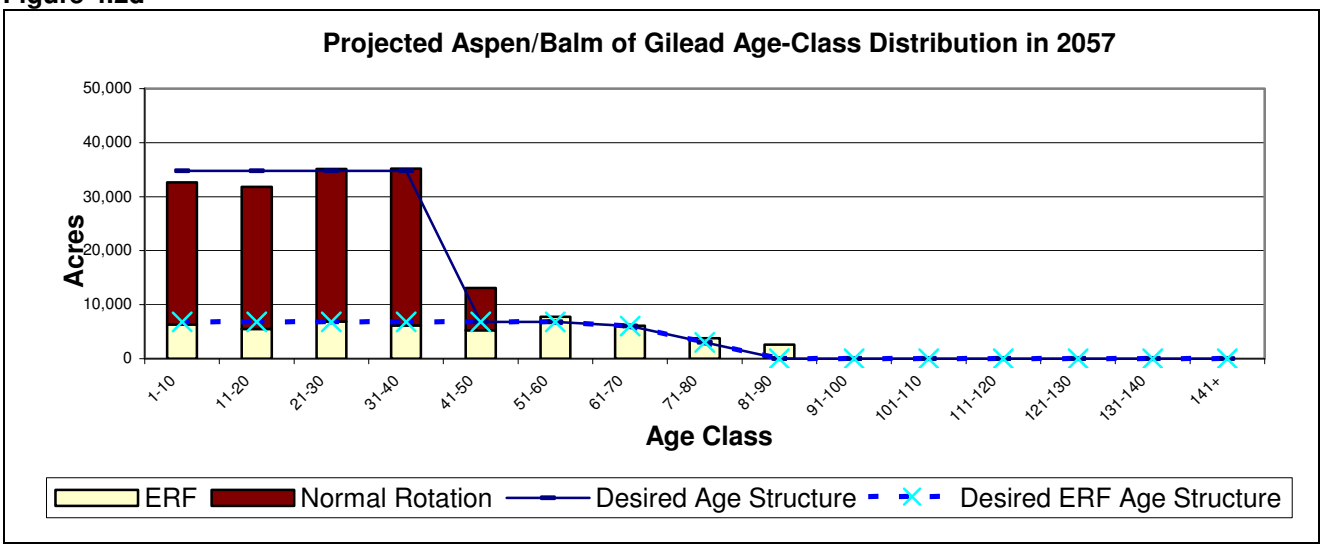
Based on modeling of the treatment levels by decade, Figure 4.2c shows the projected age-class distribution of the A/BG cover type in 2017, the end of the plan implementation period.

Figure 4.2c



Based on the modeling of the treatment levels by decade, Figure 4.2d shows the projected age-class distribution of the A/BG cover type in 2057.

Figure 4.2d



As each new 10-year plan is developed, the treatment levels by decade and modeling will be re-evaluated.

4.3 Paper Birch (Bi)

4.3A Current Condition

1. Cover type Characteristics: In 2007, the paper birch (Bi) cover type comprises 2.2 percent (9,946 acres) of the state timberlands (429,229 acres) under management in the CP-PMOP subsections. Approximately 41 percent (4,053 acres) of the birch cover type occurs within the CP and 59 percent (5,893 acres) occurs within the PMOP (see Table 4.3a). The birch cover type refers to stands of pure paper birch or mixed stands where paper birch is the species with the highest volume. Yellow birch may occur as individual trees on moist fertile sites but it is rare in these subsections. Because the birch cover type is quite often found mixed with young aspen/balm of Gilead, it can be expected that over time the acreage of the birch cover type will increase as it can dominate and overcome young aspen/balm stands. A total of 195 acres of the birch cover type has been reserved from harvest in these subsections.

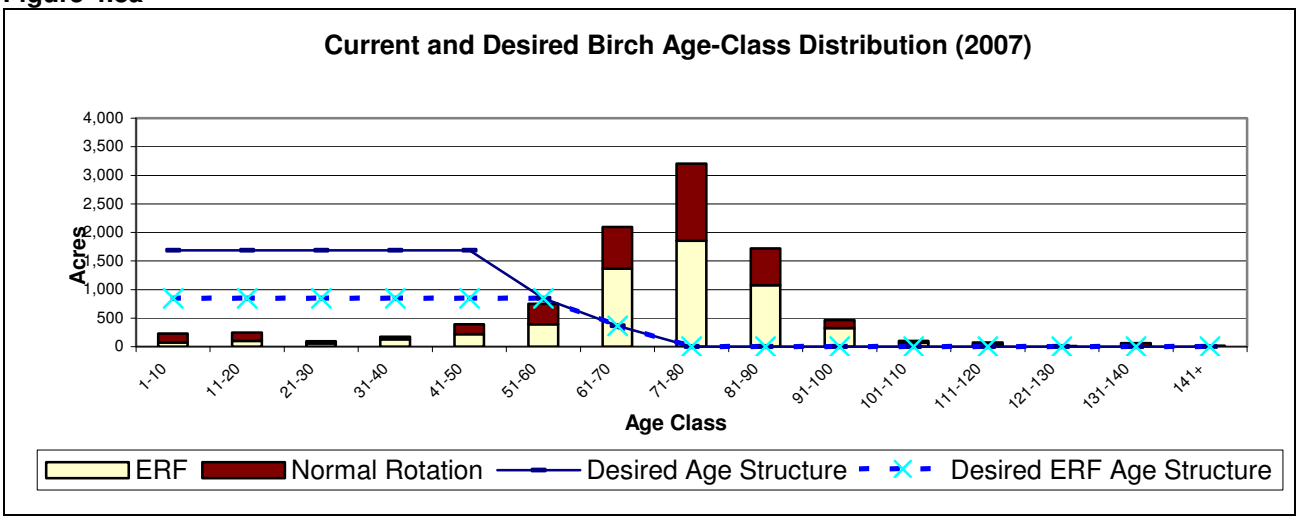
Table 4.3a Birch Cover Type Acres by Subsection

	CP	PMOP	Total
Acres	4,053	5,893	9,946
Percent	41	59	100

Paper birch is an excellent competitor in the following upland forest Native Plant Communities (NPCs): FDn33, FDn43, FDc25, FDc34, MHn35, MHn44, MHn46, MHc26, and MHc37.

2. Age-Class Distribution: The current birch age-class distribution is heavily weighted to age classes older than the maximum rotation age. It does not reflect the desired balanced age-class structure for even-aged managed cover types (see Figure 4.3a).

Figure 4.3a



Most of the birch cover type is located on mesic soils and originated after forest fires in the early 1900s, as can be seen by the acres of birch greater than 60 years old. Low acreage in the younger age classes is due to:

a. Natural conversion of birch stands to aspen following harvest.
b. Stand conversion from birch to plantations of other species, such as white spruce or pine.
c. High birch mortality that occurred in the late 1980's thru the mid-1990's resulted in conversion to other cover types. This mortality was caused by stresses to mature or over-mature stands from a combination of drought, attack by bronze birch borer, defoliation by forest tent caterpillar, and damage by birch leaf miner (often referred to as birch decline).

d. Historically, poor markets for birch have limited harvesting. Postponement of harvesting has resulted in many stands succeeding naturally to other cover types. (Note: Birch markets have improved in recent years so more young stands may become evident.)
e. Regeneration of stands has been inhibited because they are past their reproductive prime, resulting in lower seed production, poorer seed viability, and reduced sprouting vigor following harvest.
f. Herbivory near deer wintering areas.

In the two subsections, 71 percent (7,068 acres) of the birch cover type is over the recommended normal rotation age of 50 years. The goal is to maintain 12.5 percent of the timberland acres between the normal rotation age and the maximum rotation age. Currently, 32 percent (3,128 acres) is over the recommended maximum rotation age of 65 years for the CP and 60 years for the PMOP (see Table 4.3b).

Table 4.3b Birch Acres over Normal Rotation Age and Over Maximum Rotation Age

Cover Type	Over Normal Rotation Age (50)	Over Maximum Rotation Age (60 PMOP 65 CP)
Birch	71 percent 7,068 acres	32 percent 3,128 acres

4.3B Future Direction

1. Cover Type Acres: In the CP-PMOP subsections, the DFFC goal for the next 10-year period is to maintain the existing 9,946 acres of the birch cover type. The 50-year DFFC is to reduce the acreage in the birch cover type by 5 percent (500 acres) with conversion to conifer cover types. This change will take place as birch stands of site index less than 50 are examined for potential harvest. The primary conversion will be to red pine, mostly in the Pine Moraines Subsection (See Table 4.3c).

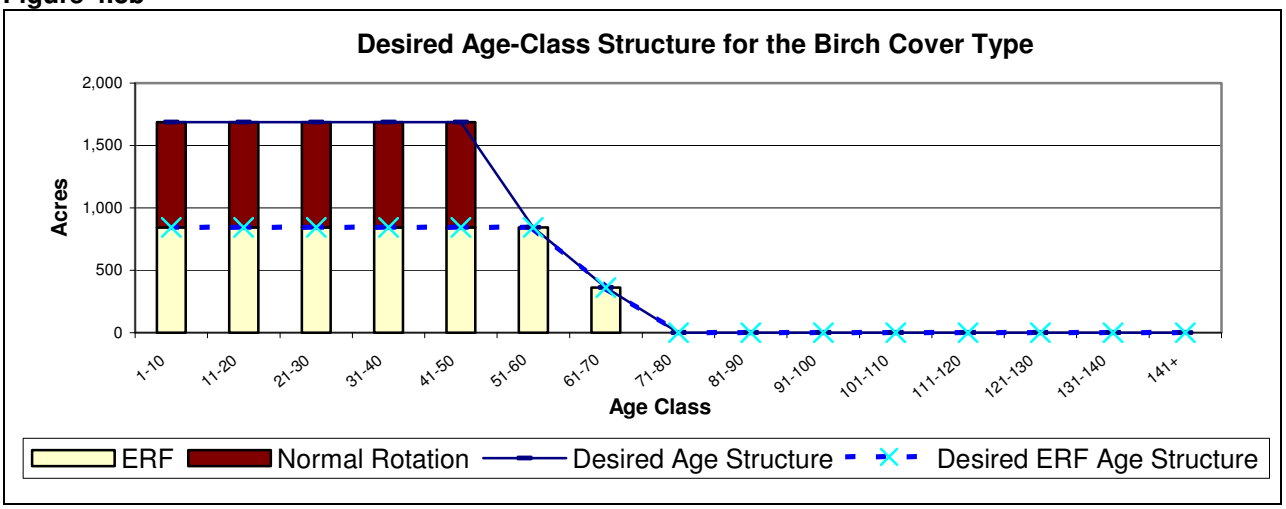
Table 4.3c Recommended Birch Cover Type Acres by Subsection and Selected Year

	2007	2017	2057
CP	4,053	4,053	NA
PMOP	5,893	5,893	NA
Total acres	**9,946**	**9,946**	**9,145**

2. Age-Class Distribution: A primary objective is to move the current age class structure toward a more balanced condition. Figure 4.3b shows the desired age-class structure. Due to the current imbalance, it will take more than 50 years to achieve this goal.

The ERF goal for the birch cover type is to maintain 12.5 percent of the acres over normal rotation age with a declining age-class distribution from normal rotation (50 years) to a maximum age of 65 years in CP and 60 years in PMOP. Figure 4.3b illustrates the desired gradual reduction in the size of age classes starting with the 51-60 age class.

Figure 4.3b



3. Stand Composition: The desired future within-stand composition will range from pure birch to a more diverse stand structure where birch is the majority species. Associated species will most often include aspen, red maple, balsam fir, and white spruce. As part of the *Stand Silvicultural Prescription Worksheet*, field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

4. Patch Management: Where possible, birch stands should be managed to maintain or increase the number of large patches (i.e. 250 acres or more).

5. Limiting Factors: Factors limiting birch management include: competition from other species (especially in over mature stands), browsing by deer and rabbits, insect damage from forest tent caterpillar and bronze birch borer, and drought impacts on poorer sites.

4.3C Stand Management

1. Even-aged Management Direction: Due to birch's shade intolerance, it is recommended to manage the cover type on an even-aged basis for pulpwood, bolts, and veneer products. The goal is to move toward a balanced age-class structure while maintaining or improving site productivity, forest wildlife habitat, and biodiversity.

2. Final Harvest: Birch stands will be managed using shelterwood, seed tree, clearcut, or clearcut with reserves as the final harvest method. Natural stand boundaries, or natural features such as topography or soil type, will be used to delineate timber sale boundaries.

3. Even-Aged Management Prescriptions: The following are the most common prescriptions that will be used on birch timber sale acres:

a. Shelterwood
b. Shelterwood with Reserves
c. Seed Tree
d. Seed Tree with Reserves
e. Clearcut - Sprouting
f. Clearcut with Reserves – Sprouting

4. Regeneration Methods after Final Harvest: Birch stands regenerate naturally through stump sprouting and seeding. Stump sprouting alone usually does not provide adequate stocking. A shelterwood or seed tree harvest method is preferred for regenerating a birch stand. A shelterwood provides the moderated environment preferred for the initial establishment of birch seedlings. Retention

of 20 to 40 percent crown cover is recommended for seed production and seedling development. Other recommendations include:

a. Scarification (e.g., summer harvest or disking) or prescribed fire to provide a mineral soil seedbed.
b. Site preparation, such as disking or anchor-chaining, to incorporate birch seed into the mineral soil. This is best done in late fall during seed fall, or within two years after a good seed crop.
c. Control competing vegetation on richer sites if aspen regeneration or shrubs are expected to overtop and suppress the birch seedlings.
d. The removal of shelterwood trees is an option after sufficient birch seedlings are established.

5. Intermediate Harvest Methods: Commercial thinning in merchantable birch stands is not recommended because it may result in unacceptable levels of damage to residual trees.

4.3D Cover Type Conversion Management

Conversion Goals: Over the 10-year period, the DFFC is to maintain the existing acreage of birch cover type. The DFFC over the next 50 years is to convert 5 percent (500 acres) of the cover type to red pine in the PM. It is expected that a majority of the conversion will be accomplished in birch stands with a site index below 50. Establishment of the desired cover type will be accomplished using post-harvest treatments such as mechanical site preparation, prescribed burning, and herbicide application, followed by hand planting of red pine seedlings.

4.3E Stand Selection Criteria

1. Normal Rotation Forest: The normal rotation age for birch in both subsections is 50 years. Maximum age is 65 years in the CP and 60 years in the PMOP (see Table 4.3d). The objective for the birch cover type is to move the age classes toward a more balanced structure. The priority during the next 10-years will be to select the oldest and highest scoring stands for treatment. Not all stands beyond the normal rotation age will be treated because of the large acreage of old stands.

Table 4.3d Birch Normal Rotation Ages and Maximum Age

Subsection	Normal Rotation Age	Max Rotation Age
CP	50	65
PMOP	50	60

2. Normal Rotation Harvest Treatment Level Calculations: The pool of stands considered for normal rotation (see Appendix V Glossary) harvest treatment in all stands:

a. not reserved from harvest (e.g. old growth, EILC);
b. not designated to be managed as extended rotation forest (ERF); and
c. and near normal harvest rotation age.

Harvest treatment level is the sum of normal rotation acres to be harvested from each age class that will move the age class distribution towards a more balanced structure. Once a balanced age class distribution is achieved stands can be scheduled for treatment upon reaching normal rotation age.

A *Stand Scoring System* was implemented which assigned scores to stands in the following priority: stands that were currently over maximum age; over maximum age within 10 years; currently beyond normal age; and, currently less than normal age. The *Stand Scoring System* considered both normal pool acres and ERF acres (see Appendix K).

3. Extended Rotation Forest: Long-term goals are to retain 12.5 percent of the cover type acreage as effective ERF and 56 percent as prescribed ERF to provide a declining age-class structure out to the maximum harvest age of 65 in the Chippewa Plains, and 60 in the Pine Moraines-Outwash Plains. (See Figure 4.3b.and Table 4.3e)

Adjustments to the normal rotation harvest level were made to meet other goals such as balancing the age-class distribution and providing relatively stable harvest levels.

Table 4.3e Birch ERF Acres (Plan Target Acres) and Maximum Age

	Prescribed ERF Acres	Effective ERF / DFFC Acres	Maximum Age
Total CP-PMOP	5,425	1,206	65 / 60

Selection of older ERF stands will be emphasized to help move the subset of ERF stands toward the desirable declining age-class structure.

4. Extended Rotation Harvest Treatment Level Calculations: The pool of stands considered for extended rotation harvest treatment in all stands:

a. not reserved from harvest (e.g. old growth, EILC);
b. designated to be managed as extended rotation forest (ERF); and
c. will be over normal harvest rotation age.

Extended rotation harvest treatment level is the sum of ERF acres to be harvested from each age class that will move the age class distribution towards a more balanced structure, while attempting to retain the minimum level of effective ERF (see Appendix V *Glossary*). A declining acreage of stands in each 10-year age class is desired between normal rotation age and maximum rotation age. Emphasis is on treating the oldest age classes first to minimize loss of fiber to tree mortality.

4.3F Stand Treatment Summary

Table 4.3e shows the total treatment acres, acres of recommended conversion out of the birch cover type, old forest percent, effective ERF percent, and the average treatment ages for the next six decades. Based on the cover type management identified in this Plan, the average treatment age for birch cover type decreases during the plan implementation period with a slight increase in the last decade. There will be considerable variation from decade to decade because of the current age-class distribution of the cover type. Old Forest Percent means acres that are over normal rotation age, except stands designated as Old Growth.

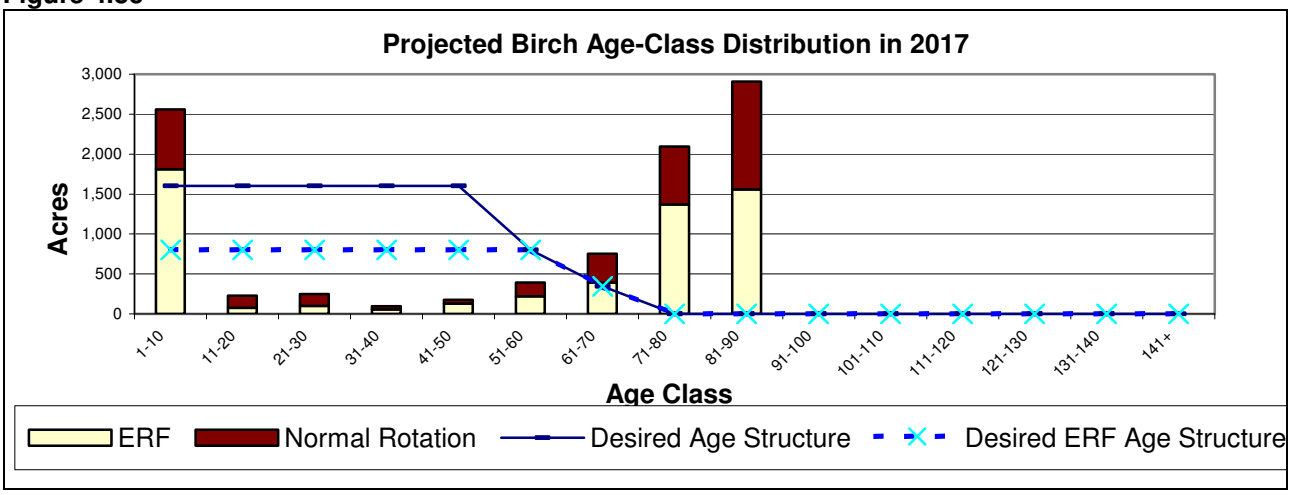
Table 4.3f Birch Treatment Summary by Decade for the CP-PMOP

Decades	Total Treatment	Conversion	Old Forest %	Effective ERF	Avg Treatment Age Normal	Avg Treatment Age ERF	Avg Age
1	2,558	0	88.0%	54.3%	94	92	69
2	2,850	500	65.0%	37.5%	90	90	54
3	1,782	0	38.8%	24.2%	90	91	38
4	1,295	0	19.9%	13.0%	87	95	30
5	1,366	0	8.2%	5.6%	48	55	27
6	1,370	0	5.6%	4.0%	47	53	29
Total	11,221	500					
DFFC	**1,600**[1]	**-500**[2]		**12.5%**	**50.0**[3]	**62.1**[3]	**29**[3]

[1] Total Treated Acres once a fully regulated forest is achieved.
[2] positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
[3] anticipated age once a fully regulated forest is achieved.

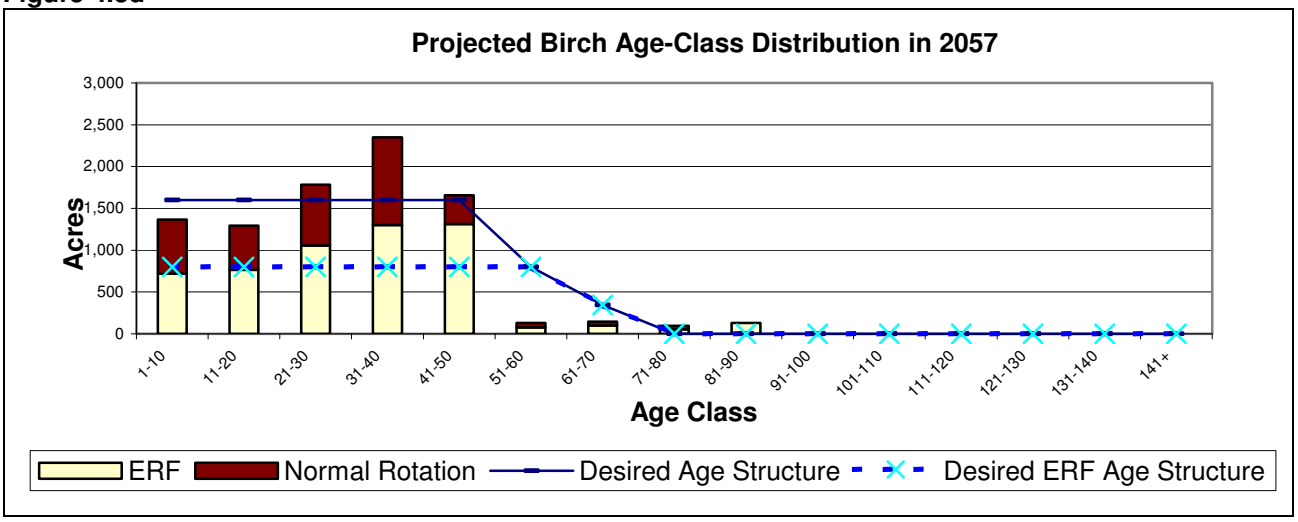
Figure 4.3c below illustrates the age-class structure of the birch cover type in 2017 at the end of the 10-year plan implementation period.

Figure 4.3c



Based on the modeling of the treatment levels by decade, Figure 4.3d shows the projected age-class distribution of the birch cover type in 2057.

Figure 4.3d



As each new 10-year plan is developed, the treatment levels by decade and modeling will be re-evaluated.

4.4 Ash/Lowland Hardwoods (Ash/LH)

4.4A Current Condition

1. Cover Type Characteristics: In 2007, the Ash and Lowland Hardwoods (Ash/LH) cover types comprise 3.9 percent (16,739 acres) of total state timberlands (429,229 acres) managed in the CP-PMOP. They are combined into one management category for CP-PMOP plan because they are commonly associated with each other and are managed under the same management prescriptions. There are a total of 672 acres of the ash and lowland hardwoods cover type reserved from harvest in these subsections.

Table 4.4a Ash/Lowland Hardwoods Cover Type Acres by Subsection

	CP	PMOP	Total
Ash	8,983	5,204	14,188
Ash Percent	63	37	100%
Lowland Hardwoods	1,778	890	2,668
LH Percent	67	33	100%
Ash/LH Total	10,761	6,094	16,856
Ash/LH Percent	64	36	100

Ash/Lowland Hardwoods is a broad cover type in that the lowland hardwood species can be found in a number of different Native Plant Communities (NPCs). The species that comprise the Ash/LH cover type are excellent competitors in the following NPCs: Black Ash-WFn55, WFn64; Green Ash-WFn55; Balsam Poplar-WFn55.

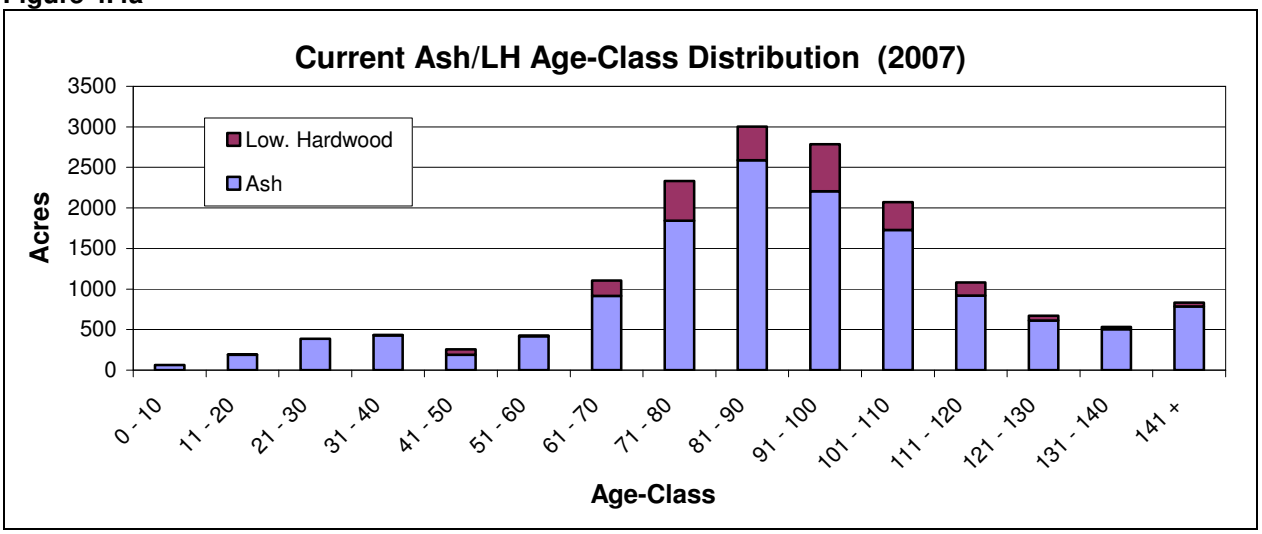
2. Age-Class Distribution: In both of the subsections, the current age-class distribution of these cover types reflects an aging forest with little acreage in the younger age-classes. Of the Ash/LH cover type, the ash component is summarized as 9 percent being under 50 years old, 23 percent between age 51 and 80 years, 36 percent between 81 and 100 years, and 32 percent is over 100 years old.

Summarizing the lowland hardwoods component of this cover type shows 2 percent is under 50 years old, 32 percent of the cover type is between age 51 and 80 years, 41 percent is between 81 and 100 years, and 25 percent is over 100 years in age.

3. Species Stand Composition: Ash/Lowland Hardwoods stands appear both as the dominant classification in FIM, and also as secondary tree species in other cover types.

4. Special Concerns: Although emerald ash borer (an exotic that kills ash trees) will eventually be found in Minnesota, it is unknown how quickly it will invade the state or where it will first be identified. Currently, there are no restrictions or limitations to managing ash stands in light of this threat, however, the DFFC for the ash / lowland hardwood cover type identifies a 4% acreage reduction over the 10-year period and an 11% reduction over the 50-year period..

Figure 4.4a



4.4B Future Direction

1. Cover type Acres: In the CP-PMOP Subsections, the 10-year DFFC is to convert this cover type by 4 percent or 600 acres (400 acres to tamarack and 200 acres to cedar cover types). The 50-year DFFC is to reduce the Ash/LH cover type by 11 percent or 1800 acres (1200 acres to tamarack and 600 acres to cedar). Because the Ash/LH cover type is quite often found mixed with young aspen/balm of Gilead, it can be expect that over time the acreage of the Ash/ LH cover type will increase, as it can dominate and overcome young aspen/balm stands.

2. Age-Class Distribution: The primary age-class distribution goal is to continue to move these cover types toward an uneven-aged structure in older age-classes.

3. Stand Composition: The stand composition goal is to maintain the species composition and structure that naturally occurs within these forest communities. Windthrow is a dominant natural disturbance in Ash/LH stands, resulting in large downed logs, hummocks, and hollows that promote tree seedling establishment and creates diverse sites for wet and mesic forest herbs. Recommendations for within-stand management are:

a. Maintain or restore associated tree species such yellow birch, white cedar, tamarack, silver maple, bur oak, box elder, elm, green ash, balm of Gilead, or basswood appropriate to the site.[1]
b. Retain the older forest characteristics within stands by retaining a component of large, old trees, coarse woody debris, and snags.
c. Retain large, old trees in the canopy for recruitment of future downed logs and the protection of hummock and hollow microtopography to promote seedling establishment.
d. Encourage multi-layered understory development.
e. Where practicing uneven-aged management, retain trees from all size-classes.

As part of the *Stand Silvicultural Prescription Worksheet*, field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

4. Patch Management: Patch management objectives are to retain the existing Ash/LH patches found within these subsections.

[1] Minn. DNR, 2003, *Field Guide to the Native Plant Communities of Minnesota: the Laurentian Mixed Forest Province.* Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. Minn. DNR. St. Paul, MN.

5. Limiting Factors: Although emerald ash borer, an exotic that kills ash trees, will eventually be found in Minnesota, we do not know when or where it will be first identified. Currently, there are some limitations, based on site index, to managing ash stands in light of this threat. To react to this threat:

a. Continue harvest activities in the higher site index (SI) black ash stands, and choose harvest methods that favor regeneration of species other than ash.
b. Avoid harvesting in low SI ash stands and be prepared to accept the loss of the sites due to high water tables if the ash die due to emerald ash borer infestation.

4.4C Stand Management

1. Management Direction: Ash and lowland hardwoods stands will be managed primarily as uneven-aged stands. However even-aged methods will be an option where a field visit determines it is the best method to regenerate the stand. During the field visit, staff will consider the hydrology, soils, existing stand composition, and riparian considerations of the stand in determining the stand treatment method. Stand density will be maintained at a level that promotes continued stand health and growth. Hydrologic alteration will be avoided. It is recommended that stands less than site index 45 not be managed through harvest but rather through the objective of maintaining wildlife habitat and water quality[2].

2. Even-Aged Management Direction: Manage some stands of Ash/LH on an even-aged basis, if warranted to regenerate the stands and improve site productivity and vigor while maintaining or improving wildlife habitat.

3. Even-Aged Management Prescriptions: The following are the most common prescriptions that will be used on Ash/LH timber sale acres where even-aged management is the objective:

a. Clearcut with Reserves - Sprouting
b. Clearcut with Reserves - Natural Seeding
c. Seed Tree with Reserves
d. Shelterwood
e. Shelterwood-with Reserves

4. Uneven-Aged Management Direction: Manage Ash/LH on an uneven-aged basis for pulpwood, bolts, sawtimber, and veneer products while maintaining or improving site productivity and wildlife habitat. Small group selection may be prescribed in even-aged stands to attain an uneven-aged condition. Selective harvest should retain trees from all size-classes, so that the residual basal area is approximately the same for trees under 10 inches as for those over 10 inches.

5. Uneven-Aged Management Prescriptions: The following are the most common prescriptions that will be used on Ash/LH timber sale acres where uneven-aged management is the objective:

a. Group Selection
b. Group Selection with Reserves
c. Single Tree Selection

6. Intermediate Harvest Methods: Some stands of Ash/LH may be thinned, or given an intermediate harvest prescription. Thinning will increase tree diameter and quality, resulting in more sawlog or veneer sized trees. Any harvest should reduce basal area to 75-90 square feet per acre in order to avoid adverse hydrological impacts and epicormic branching.

4.4D Cover type Conversion Management

Over the next 50 years, it is recommended that 1,800 acres of the Ash/LH type be converted to tamarack (1200 acres) or white cedar (600 acres). Conversion of Ash/LH to the desired cover types will be accomplished by conducting selective harvest in stands that already contain a tamarack component, a white cedar component, or have these species present as advanced regeneration. This will encourage tamarack or white cedar to become dominant in the stand.

[2] Erdman,G., et al., *Managing Black Ash in the Lake States*. Gen. Tech. Rep. NC-115. North Central Forest Experiment Station, 1987.

Conversion of Ash/LH to Tamarack should occur in WFn64, FPn72, FPn82, FPs63, and Apn81 NPC classes. Conversion to a stand dominated by white cedar will be accomplished in MHn46, WFn53, WFn55, and FPn63 NPC classes. The conifer component (white cedar and tamarack in these communities) generally increases in later growth stages.

4.4E Stand Selection Criteria

The Ash/ LH cover types will generally be managed on an uneven-aged basis. Stands to be managed as even-aged or thinned will be determined by the appraiser at the time of the field visit. The following criteria will be used for selecting stands to field visit and possible treatment during this 10-year plan:

a. Site index equals 45 or greater.
b. Basal area is greater than 100 square feet per acre.
c. Main species diameter is greater than 7 inches.
d. Basal area below 80 should not be examined/treated due to threat of conversion to lowland grass.

Forest inventory stand data was modeled forward to 2007 using the DNR's growth and yield models for determining which stands meet the stand selection criteria.

4.4F Stand Treatment Summary

Based on the above criteria, approximately 3,026 acres have been identified for possible treatment during this 10-year plan implementation period. Based on additional field evaluations (e.g., re-inventory) of Ash/LH stands during this plan implementation period, additional acres may be added for treatment if the stands meet the harvest criteria.

As each new 10-year plan is developed, the stand treatment level for the Ash/LH cover types will be determined.

4.5 Northern Hardwoods (NH)

4.5A Current Condition

1. Cover Type Characteristics: In 2007, the northern hardwoods cover type comprises 3.8 percent (16,142 acres) of state timberlands (429,229 acres) managed in the CP-PMOP. There are 1,583 acres of northern hardwoods reserved from harvest in these subsections. There is little variation in distribution of the cover type between the subsections: 45 percent of the northern hardwoods cover type is within the Chippewa Plains and 55 percent is in the Pine Moraines and Outwash Plains (see Table 4.5a).

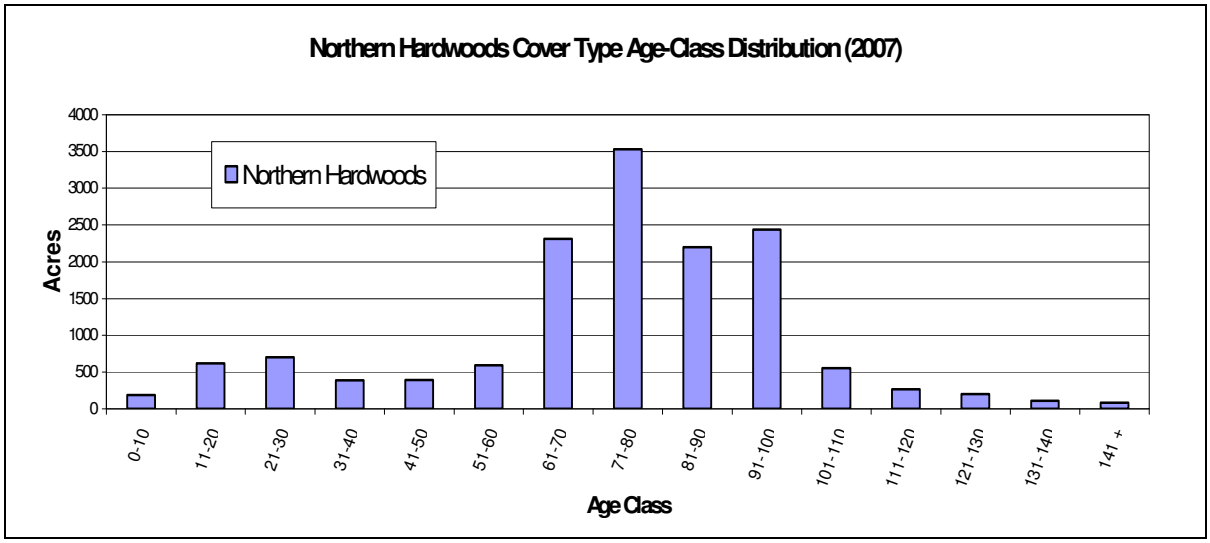
Table 4.5a Northern Hardwood Cover Type Acres by Subsection

	CP	PM	Total
Acres	7,260	8,882	16,142
Percent	45	55	100

Primary components of the NH cover type are sugar maple and basswood that are good competitors in most mesic Native Plant Communities (NPCs). These component species are listed as being not excellent competitors in the following NPC classes: Sugar maple is not an excellent competitor in the following upland forest communities: FDn12, FDn33, FDn43, FDc12, FDc23, FDc24, FDc25, FDc34, FDs37, and MHn44. Basswood is not an excellent competitor in the following upland forest communities: FDn12, FDn33, FDn43, FDc12, FDc23, FDc24, FDc25, FDc34, and FDs37. Ash / lowland hardwoods is a broad community that can be found in a number of NPCs.

2. Age-Class Distribution: The current age-class distribution shows an abundance of mature stands (61 - 100 years) while there is little acreage in the younger (<60 years) and older (>100 years) age-classes (see Figure 4.5a).

Figure 4.5a



3. Stand Composition: The northern hardwoods cover type is among the most diverse cover types in these two subsections with a distinct variation in tree species composition across the landscape. NH nearly always contains sugar maple mixed with basswood as the primary species. Found to varying degrees and in localized areas are a wide range of secondary species, including white pine, balsam fir, red oak, bur oak, ironwood, quaking aspen, bigtooth aspen, paper birch, red maple, white spruce, green ash, black ash, yellow birch, and white cedar. As part of the *Silvicultural Prescription Worksheet*, field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plan Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

Most stands are not regulated uneven-aged stands because they are lacking one or more size classes. A regulated uneven-aged stand has trees of many age or sizes that form a relatively homogeneous mixture. Periodically removing trees from all size-classes can achieve and maintain a specified diameter distribution. Regulated stands meet the desired stocking level for all size classes (see Table 4.5c and Figure 4.5b).

Almost all northern hardwood stands in these subsections are found on mesic soils, which are suitable for this cover type. But many of these stands are dominated by poor quality timber. Reasons for this include: stand history of fires, grazing, and past harvesting to remove higher quality trees; the key species of this cover type are living near the edge of their range; insect and disease attacks on trees of advancing age; frost cracks and canker damage; poor form; and gap size.

It is important to note that many species found in the northern hardwoods cover type are preferred host species for the gypsy moth and are likely to experience repeated prolonged defoliation and mortality. This may lead to changes in the composition of many northern hardwood stands.

4.5B Future Direction

Goals for the NH cover type are to improve the quality of the timber and ecological characteristics while enhancing or maintaining the aesthetic values.

1. Cover Type Acres: The 10-year DFFC is to reduce the northern hardwood cover type by 2 percent (250 acres), and by a total of 11 percent (1,750 acres) over the next 50 years. The decrease in northern hardwoods cover type will primarily come from re-inventory, particularly where over-mature hardwood types deteriorate, and conifer understory species such as white pine, white spruce or balsam fir become the dominant species. Other reductions in northern hardwood cover type acres may occur from natural succession or managed conversion to white pine, white spruce, red pine, or jack pine as indicated by soil conditions and native plant community indicators. Northern hardwoods can be a significant component of young aspen stands and under certain conditions can overcome young aspen and become the dominate cover type. Because of this, future inventories may show more NH on the landscape than presently shown.

2. Age-Class Structure: The cover type will be managed predominantly under uneven-aged management methods to move toward a regulated size-class structure within stands. No stands have been identified for even-aged management, but site visits may indicate that some stands may initially need to be managed through even-aged methods to move them toward desired uneven-age condition. Current age-class distribution shows significant acres of mature age-classes (see Table 4.5b). Regulated stands meet desired stocking level for all size classes (see Table 4.5c and Figure 4.5b).

3. Stand Composition: Within-stand composition goals will be to restore a more diverse stand structure and mix of species in most stands. It is desirable to increase the presence of birch, basswood, red oak, white pine, white cedar, aspen, and white spruce as components where NPC evaluations indicate. Artificial regeneration may be necessary where these species are no longer present, are not regenerating naturally, or there is a need to add species to the stand to meet various objectives. During selection or partial cuts, provide for at least six cavity trees, potential cavity trees or snags per acre as recommended in the MFRC *Voluntary Site-level Forest Management Guidelines*: Timber Harvest p.36 - and in TSI p. 7.

4. Patch Management: Patch management objectives are to maintain existing large patches consisting of primarily northern hardwoods and increase the size or number where possible. This includes maintaining any designated old growth stands.

5. Limiting Factors: Many species found in the northern hardwoods cover type, particularly oak, basswood, aspen and birch are preferred host species for the gypsy moth. In the next 20 years, these species are likely to experience repeated prolonged defoliation and increased mortality in stands that are stressed by drought, disturbance, or poor sites. This may lead to changes in the species composition of many northern hardwoods stands: a decrease of the preferred host species, with an associated increase in ash, maple, and conifer components.

4.5C Uneven-aged Stand Management

Note: A relatively small amount of harvest has occurred in recent years in the northern hardwoods cover type in these subsections. Therefore, additional forest management detail is provided below. Foresters are encouraged to study and use available stand management research data to formulate appropriate management strategies for northern hardwood stands.

1. Uneven-aged Management Direction

The first step in uneven-aged management decision-making is to evaluate the stand and determine if it is a regulated or unregulated stand. Regulated stands must meet the desired stocking level for all size classes (see Table 4.5c and Figure 4.5b).

Table 4.5b Current Condition Class of Northern Hardwoods in CP-PMOP Subsections

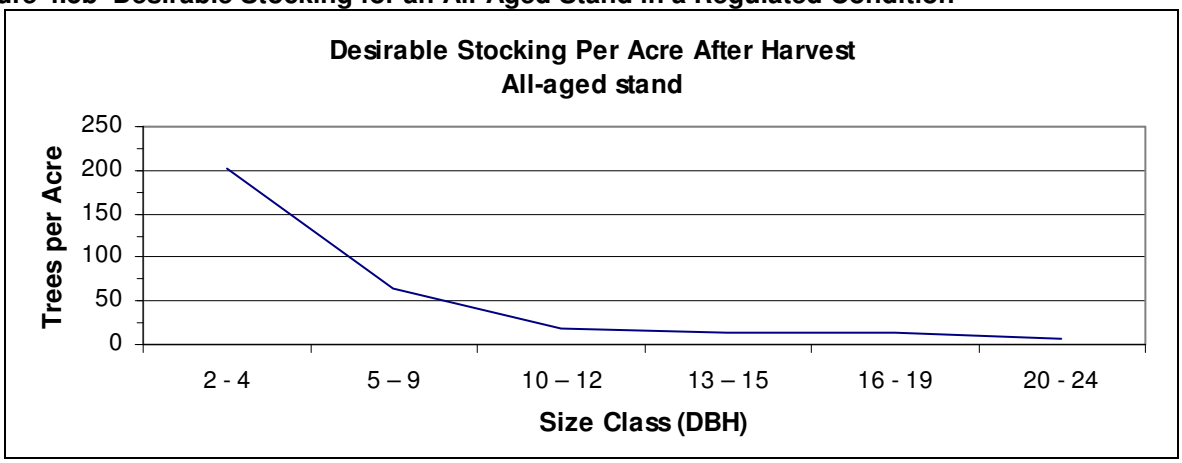
Current Condition Class of Northern Hardwoods in CP-PMOP		
Condition Class	**No. of Stands**	**Acres**
Nonstocked	4	36
Regenerating	48	745
Immature	536	10,763
Mature	203	4,012
High Risk	15	220

Table 4.5c Desirable Stocking Per Acre of Stems 2-inch DBH and Greater in a Regulated Stand for Good Continuous Growth of Northern Hardwoods Under Uneven-Aged (All-Aged) Management

Desirable Residuals after Harvest by Size Class			
Size Class	**DBH (inches)**	**No. of Trees**	**Basal Area (sq. ft.)**
Saplings	2-4”	200	20
Poles	5-9”	70	30
Small Sawlogs	10-12”	20	10
Medium Sawlogs	13-15’	15	15
Med-Large Sawlogs	16-19”	15	20
Large Sawlogs	20-24”	10	20
TOTAL		**330**	**115**

Adapted from Eyre, E.H. and W.M. Zillgitt. 1953. Partial cuttings in northern hardwoods of the Lake States. USDA Gen. Tech. Bull. 1076. 124 p.

Figure 4.5b Desirable Stocking for an All-Aged Stand in a Regulated Condition



1.1. Regulated Stands: Consider the following sequence when marking regulated stands for harvest:

a. Remove volume only from overstocked size classes.
b. Avoid harvest during and immediately following a drought or defoliation event. Selectively salvage oak, basswood, aspen, and birch mortality more than one year after a severe drought.
c. Remove high-risk and cull trees while retaining leave trees needed for plant and animal habitat, such as snags and recruitment of coarse woody debris. Retain a minimum of six cavity trees, potential cavity trees, and/or snags per acre.
d. Use three sawtimber size classes, 10-12", 13-15" and 16 - 24" for determining the basal areas to retain after harvest.
e. Remove crop trees that have reached the rotation size up to 24" DBH, depending on the species, while retaining two or more trees per acre beyond the rotation size DBH as leave trees (may include cull trees). Fell all stems in the gaps created by removing these mature trees. Gaps may be a range of sizes (depending on hardwood species) with the gap width limited to twice the height of the surrounding timber. Cuts in the pole-size class should be for improvement only, removing poorest quality trees.
f. Cut from the sapling size class only those saplings located within the canopy gaps.
g. Re-entry should be considered after 10-15 years when the stocking has increased to the point where another harvest is feasible.

1.2. Unregulated Stands: Typically, stands are overstocked in the smaller sawtimber size classes and lack adequate stocking in the sapling and large sawtimber size classes. Sawlog quality is generally poor. Within 3-4 cuts (30-50 years) these stands may become fully regulated with a marked improvement in log quality. Consider the following recommendations when moving an unregulated stand toward a regulated condition:

a. To increase the seedling and sapling size classes, apply the following gap management techniques:
    - Use individual tree and group selection to create gaps of various sizes ranging from 30 to 100-feet in diameter (depending on hardwood species) while retaining an average of 60 – 80 percent crown closure across the stand.
    - Fell or girdle culls and poor quality trees to create gaps. This provides space for the development of seedlings and saplings while retaining nurse logs and coarse woody debris.
    - For regenerating light seeded hardwoods, scarify, burn, or herbicide the gaps to prepare a seedbed and remove unwanted competition.
    - Remove all trees greater than one-inch diameter from the gaps.
b. To improve timber quality and desired stocking while retaining elements of structural diversity:
    - Leave additional high quality trees in the next smaller size class to allow them to grow into a deficient size class.
    - Remove poorer quality trees that compete with higher quality trees.
    - Remove trees infected with Nectria and Eutypella cankers.

- Retain leave trees needed for plant and animal habitat, such as snags and recruitment of coarse woody debris. Retain a minimum of six cavity trees, potential cavity trees, and/or snags per acre.
- Encourage drought-tolerant species on ridge-tops and southwest facing slopes.

After the initial entry, wait 10-20 years for the next entry. Subsequent entries may require repeated use of the above recommendations until the desired stocking level is reached for managing a regulated stand.

Depending on the hardwood species, 60 - 80 percent crown closure is recommended after selective harvest. Because basal area is not a good indicator of crown closure for different species with different crown shapes and sizes, stand densities to be left should be based on crown closure. For both regulated and unregulated stands, as a general guide, average stand basal area of trees greater than 5-inch DBH should be reduced to 60 – 80 square feet per acre. For stands with a larger average diameter of co-dominant trees, higher basal areas should be maintained.

2. Harvest Methods in Uneven-aged Managed Stands

2.1. Single Tree Selection: Single or individual tree selection will retain an unbroken and/or multistory canopy throughout the stand, providing aesthetic, wildlife, and ecological values. This technique favors shade tolerant species at the expense of moderately tolerant or intolerant species. If the objective is to increase intolerant species such as red oak or paper birch in the northern hardwood stand, use group selection to provide larger openings and more sunlight. Use harvest systems, methods, and sale regulations to protect advanced regeneration and maintain or improve the patterns, diversity, and composition of forest vegetation present before harvest.

Use the size-class distribution information in Table 4.5b as a guide for the desirable stocking in a stand when designing timber sales. See Page 24 of the *Manager's Handbook for Northern Hardwoods in the North Central States*[1] as a guide for selecting trees.

2.2 Group Selection: A second technique, group selection, should be used when attempting to maintain or encourage species that are intolerant or only moderately tolerant, where canopy gaps are acceptable, and for moving from an unregulated forest to a regulated forest. Group selection attempts to mimic natural disturbance patterns to meet species-specific regeneration requirements. Gaps are created naturally by ice or windstorm events, individual trees senescence, or during a large disturbance event where part of the stand is impacted.

Group selection should be used to encourage red oak, paper birch, yellow birch, white spruce, and white cedar. Landscape position (aspect), microclimate, and adjacency to seed source should be considered when cedar, birch, and white spruce are desired. Other methods that produce more shade should be used to increase white pine in northern hardwood stands, due to increased risk of white pine blister rust infection in small openings.

Group selection cuts should remove most or all timber in the gap, with the gap width limited to twice the height of the surrounding timber. Whenever possible, gaps should be oriented to take advantage of prevailing winds near the desired seed source trees. For heavier seed, such as oak, wind dispersal is not a concern.

Preserve legacy patches and inclusions in stands for seed sources and native plant diversity as well as to favor regeneration and seeding of native vegetation.

2.3. Uneven-aged Management Prescriptions: The following uneven-aged management harvest prescriptions will primarily be used:

a. Group Selection with Reserves
b. Single Tree Selection

[1] Tubbs, Carl H. 1977. *Manager's Handbook for Northern Hardwoods in the North Central States*. USDA Forest. Service General Technical Report NC-39, North Central Forest Experiment Station, St. Paul, MN.

4.5D Even-aged Stand Management

1. Even-aged Management Direction: Following a field visit, a very small portion of the northern hardwoods type may be harvested using even-aged methods, with long-term objectives of improving tree quality and eventually managing them as uneven-aged stands. Even-aged harvest methods may be needed because of undesirable conditions in some stands resulting from past management, or to move low quality even-aged hardwood stands toward an uneven-aged stand condition. A field visit to evaluate the site is required prior to deciding if a stand will be managed through even-aged methods.

Stands eligible for even-aged management option tend to be the poorest quality with the lowest site index (less than SI 45) and may be candidates for conversion to conifers or other drought-tolerant species, particularly on ridge-tops and southwest facing slopes. NPC indicators should be identified to determine if these stands are suitable for conifers. In the CP-PMOP subsections, eight northern hardwoods stands on 144 acres are found on very dry or moderately dry soils.

2. Shelterwood: Shelterwood systems are recommended because they have proven to be the most effective process for regenerating a wide variety of species. A two-aged shelterwood system is the most reliable method of regenerating an even-aged northern hardwood stand. This system works for both small seeded (birch) and large seeded species (sugar maple and red oak). The key is to establish adequate advanced (2-4 foot tall) reproduction prior to the removal of the overstory. Small seeded species will require scarification, herbicide application, and/or prescribed fire to prepare a seedbed.

To regenerate maples:

a. Cut from below down to 60 percent crown cover.
b. Logging in the winter is preferable to retain the leaf litter ground cover, which is more suitable for regenerating sugar maple over other northern hardwood species.
c. Do not scarify.
d. Remove overstory after regeneration is 2-4 feet tall (3-8 years).

To regenerate small seeded species in addition to maples:

a. Cut from below to 70-80 percent crown cover and remove trees infected with Nectria and Eutypella cankers.
b. Scarify, burn, or herbicide the site to prepare a seedbed and remove unwanted competition.
c. Remove overstory after regeneration is 2-4 feet tall (3-8 years).

3. Clearcut: Where the existing stand quality is very poor, and sugar and red maple dominate the stand, it may be desirable to use a clearcut technique. Advanced reproduction of preferred species is required prior to the final harvest. If advanced reproduction is absent, one or two thinnings should be done to encourage seedling establishment.

Consider the regeneration needs for the next stand when selecting the management prescription. Most northern hardwood species regenerate best in partial shade, but shade intolerant species require more sunlight. Species regenerating largely from stump sprouts may require thinning treatments in the future to reduce stems per clump.

4. Even-aged Prescriptions: The following even-aged management harvest prescriptions will primarily be used:

a. Clearcut with Reserves
    - Clearcut with Reserves – Sprouting
    - Shelterwood
    - Shelterwood with Reserves
    - Shelterwood with Reserves- Final Harvest

5. Intermediate Harvest Methods

a. Thinning in Even-Aged Pole-Sized Stands: Thinning in even-aged pole timber stands (5”-9” DBH) can be used to improve the quality of the timber, adjust the stands species composition, and capture volume that would otherwise be lost due to mortality. Following are recommendations:
    - Limit the harvest of trees 10 inches DBH or larger to retain these larger diameter trees in the stand for moving toward a regulated stand.

- Release crop trees (Class 1&2) down to 80 percent crown cover for trees greater than 5 inches diameter (DBH). A crop tree is one that is retained for future commercial harvest. Crop trees are desired species that have good form and quality, good crown vigor, a low risk to loss, are usually dominant or strong codominant trees, and have a good potential for producing high value sawlogs or veneer.
- Crown release, seven feet on at least three sides, on 60-75 crop trees per acre.
- Thin from below, removing primarily the culls, poorest formed, poorest quality, and suppressed trees, until the desired stocking level is reached.
- Leave an adjacent tree crown to correct for a fork.
- Avoid creating large canopy gaps (>15 feet).
- Delay next thinning until crown closure and lower branch mortality is achieved (15-20 years)
- Avoid harvest during and immediately following a drought or defoliation event. Selectively salvage oak, basswood, aspen, and birch mortality more than one year after a severe drought.

b. Thinning Prescription**:** Selective thinning is the most common prescription.

6. Regeneration Methods: When the stand is to be retained in the northern hardwoods cover type, harvest prescriptions are most often the regeneration methods. Consideration will be given to stand conversion for very poor quality stands or stands on offsite conditions (site index less than 45). Where conversion is the chosen option, see the desired cover type management recommendations for conversion methods. Conversion will favor white pine, white spruce, and red pine depending on soil conditions and native plant community indicators.

To artificially regenerate species that are present in low numbers or are no longer present, regeneration techniques including scarification, herbicide treatment, and/or fire is recommended, followed by direct seeding or planting. Species to consider are red oak, basswood, black and green ash, yellow birch, white spruce, and white cedar. White pine can be considered in shelterwood situations.

4.5E Stand Selection Criteria

The NH cover type will generally be managed on an uneven-aged basis. The few stands to be managed as even-aged or thinned will be determined by the appraiser at the time of the field visit. The following criteria will be used for selecting stands to field visit for possible treatment during this 10-year plan:

a. Basal area (BA) is greater than 100 square feet per acre, and
b. Main species diameter equals 5 – 9 inches will be assigned a thinning prescription, or
c. Main species diameter greater than 9 inches will be assigned a selective harvest prescription.

Two hundred fifty (250) acres will be targeted for conversion with 150 acres to white pine and 100 acres to white spruce.

Note: Site index was not used in the stand selection criteria because forest inventory (CSA) site indexes may not be accurate in NH stands. The use of site index is suspect because of the past history of some of these stands. Many stands were high-graded, removing the best quality trees and leaving poor trees behind, resulting in stands that may not accurately reflect site potential.

4.5F Stand Treatment Summary

It is recommended that 80 to 90 percent of stands be site visited every 10-years. Based on evaluations following site visits (e.g., re-inventory) on NH stands during this plan implementation period, additional acres may be added for treatment if the stands meet the harvest criteria.

As each new 10-year plan is developed, the stand treatment level for the NH cover type will be determined.

4.6 Oak (O)

4.6A Current Condition

1. Cover type Characteristics: In 2007, the oak cover type comprises 3.7 percent or 16,056 acres of the total state timberlands (429,229 acres) managed in the CP-PMOP subsections. There are 132 acres of the oak cover type reserved from harvest in these subsections. Historically the oak cover type has been relatively uncommon in both subsections, but particularly the Chippewa Plains. As shown on Table 4.6a, 94 percent of the oak cover type is found in the PMOP subsection, with 6 percent found in the CP. Across the CP-PMOP subsections, oak is more commonly found as a component of other cover types such as aspen, birch, and northern hardwoods. Oak is found as a component in 3,918 stands versus 810 stands where it is the defining cover type species. The oak cover type includes both northern red and bur oak.

Table 4.6a Oak Cover Type Acres by Subsection

	CP	PMOP	Total
Acres	964	15,092	16,056
Percent	6	94	100

Northern red oak is an excellent competitor in the following upland forest Native Plant Communities (NPCs): FDc34, FDs37, MHn35, MHc26, MHc36, MHc37, MHc47, and MHs39.

Bur oak is an excellent competitor in the following upland forest NPCs: FDc24, FDs37, MHn46, MHc26, MHc36, MHc37, and MHc47.

2. Age-Class Distribution: The current age-class distribution shows that the majority of the high site-index oak stands are greater than 50 years old (see Figure 4.6a). The current age-class distribution for low site-index oak stands shows the majority of stands are greater than 60 years old (see Figure 4.6b). The distribution currently found on both site index classes does not reflect the balanced age-class structure desired for the oak cover type.

Figure 4.6a

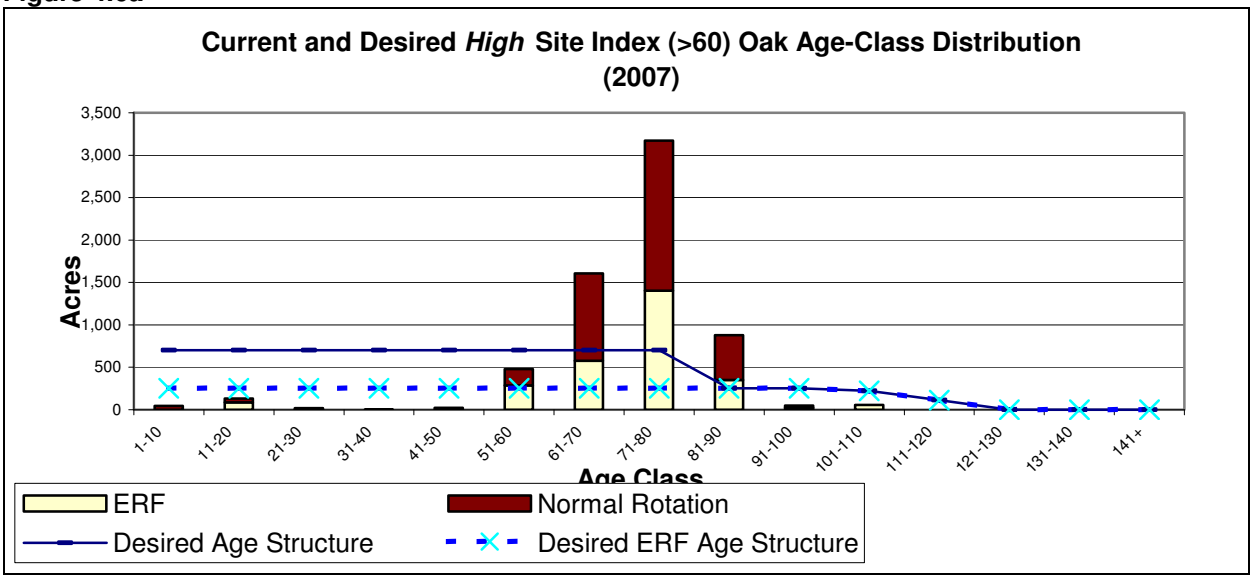
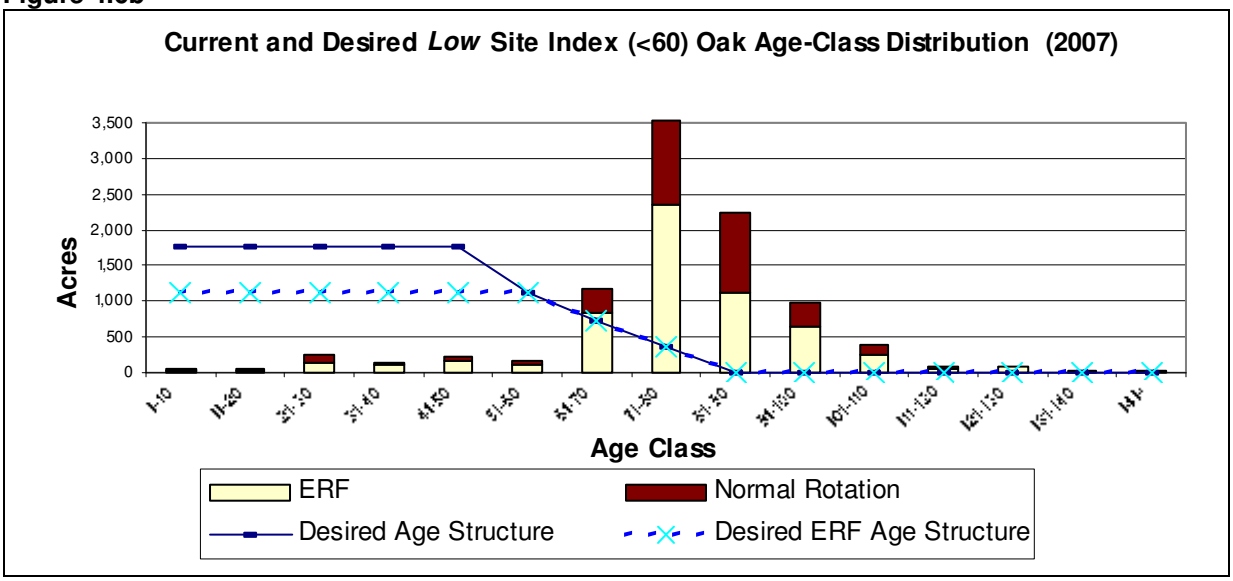


Figure 4.6b



4.6B Future Direction

1. Cover Type Acres: The 10-year DFFC is to convert 5 percent (750 acres) of the oak cover type in the PMOP to jack pine. The 50-year DFFC is to convert 11 percent (1,750 acres) of the oak cover type in the PMOP to jack pine. This conversion will generally occur in low site-index oak stands on drier sites, such as FDc24. Mesic oak communities such as FDc34, FDs37, MHn35, MHn46, MHc26, MHc36, MHc37, MHc47, and MHs39, will generally not be converted. An additional goal is to maintain or increase the oak component in other cover types where it occurs at present.

2. Age-Class Distribution: A goal is to move the oak age-classes toward a more balanced structure. Figures 4.6c and 4.6d show the desired age-class distribution of oak by site index. Due to the existing age-class imbalance, it will take more than 50 years to achieve the desired distribution for this cover type.

Figure 4.6c

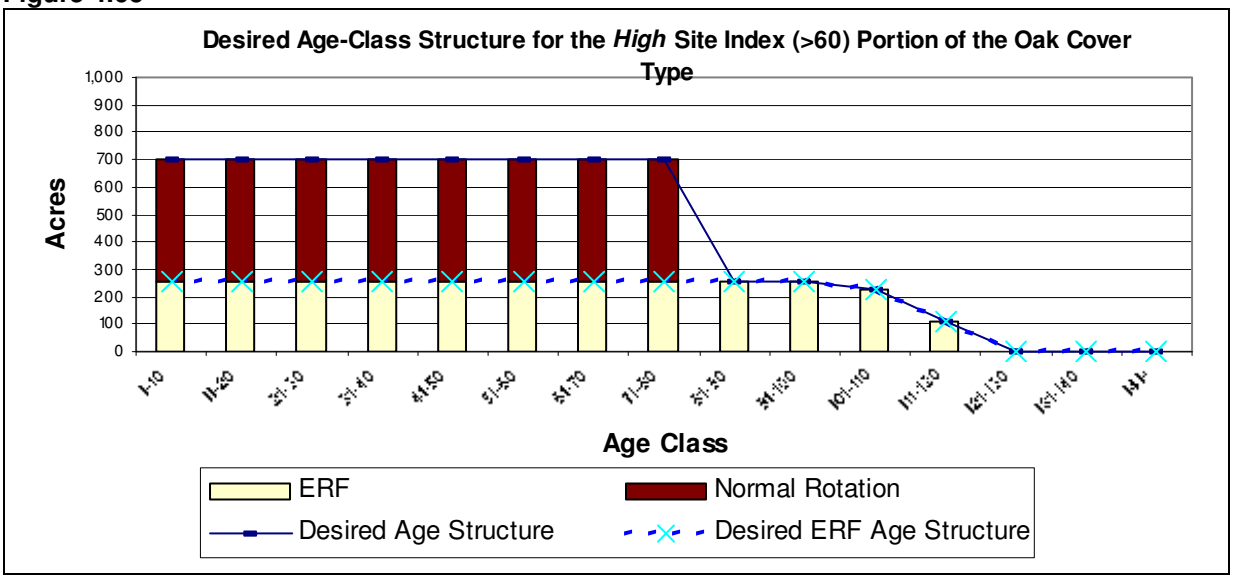
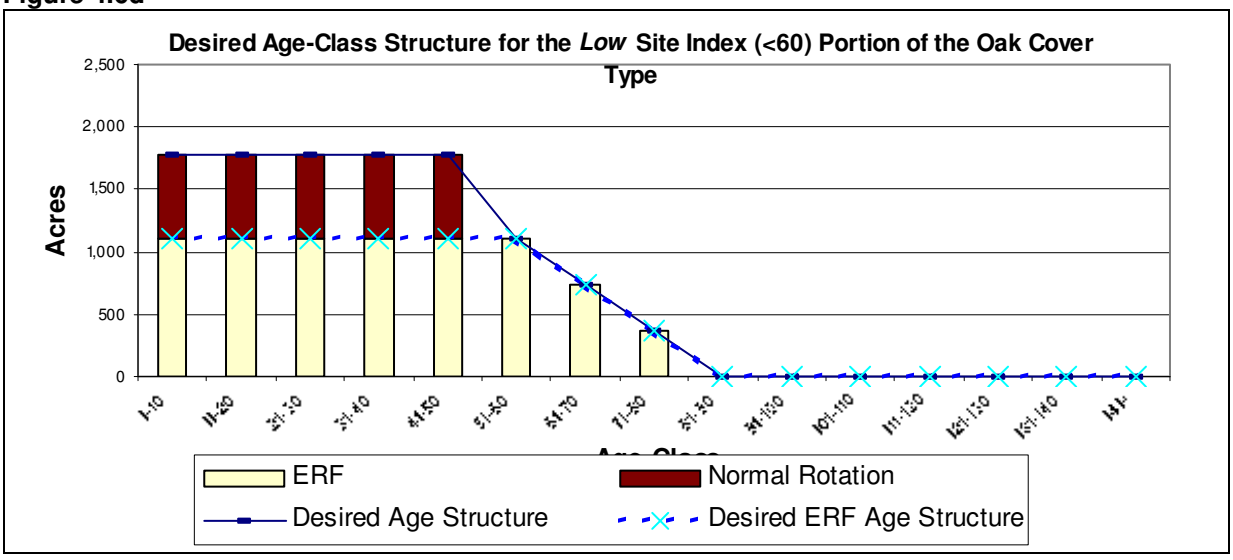


Figure 4.6d



The older oak age-classes will be managed with sufficient older stands deferred (ERF) to provide an adequate declining age-class distribution out to maximum age. The ERF goals for this cover type are to maintain 13 percent of the high site-index and 20 percent of the low site-index oak acres over the normal rotation age (i.e. as effective ERF) at any given time.

3. Stand Composition: The objective is to maintain the species composition and structure that naturally occurs within the oak forest communities. Recommendations for within-stand management include:

a. Maintain or restore associated tree species such paper birch, red maple, quaking aspen, big-toothed aspen, jack pine, red pine, sugar maple, basswood, black ash, green ash, white cedar, balsam poplar, ironwood, American elm, and white pine where appropriate to the site[1].
b. Retain the older forest characteristics within stands by retaining a component of large, old trees; coarse woody debris; and snags.
c. Retain large, old trees in the canopy for recruitment of future downed logs and cavity dens/nests.
d. Attempt to retain trees from all size-classes to retain mast production and availability to wildlife over time.
e. Increase mixed forest conditions in most stands. This will aid in reducing potential impacts of forest pests and diseases.
f. Maintain conifer component, where suitable to the site, according to NPCs.
g. Reserve legacy patches and inclusions within stands for seed sources and native plant diversity as well as to favor regeneration of native vegetation.

As part of the *Stand Silvicultural Prescription Worksheet*, field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

4. Patch Management Objectives: Patch management objectives are to retain the existing oak patches found within these subsections. Some oak stands will be managed together with adjacent hardwood stands to create larger, similarly aged hardwood patches.

5. Limiting Factors: Oak decline and mortality are caused by several factors, including drought stress and defoliation; it culminates in mortality caused by two-line chestnut borers (TLCB) and Armillaria root disease. Expect most losses on light soils, along ridge tops, and on steep slopes.

[1] Minn. DNR, 2003, *Field Guide to the Native Plant Communities of Minnesota: the Laurentian Mixed Forest Province.* Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. Minn. DNR. St. Paul, MN.

a. Avoid harvesting during, and immediately after a severe drought and/or defoliation by forest tent caterpillar.
b. Prepare oak stands for the future. Recognize competition from shade tolerant species. Anticipate oak wilt and gypsy moth defoliation in the next 20 years and subsequent TLCB attack. See *Gypsy Moth Tatum Guide* for management suggestions.

To minimize the potential impacts of these pests, it is important to maintain vigorous, structurally diverse forest stands, promote species diversity, avoid the transport of infected wood, and implement harvest strategies that minimize damage to reserve trees.

4.6C Stand Management

1. Even-aged Management Direction: Oak is shade intolerant and will be managed on an even-aged basis. Oaks are long-lived, with red and bur oak capable of exceeding 200 years of age.

2. Final Harvest: Oak stands will be managed using shelterwood, seed tree, clearcut, or clearcut with reserves as the final harvest method. Final harvest will be based on average tree diameter of the crop trees, depending on site index. The use of natural stand boundaries or natural features such as topography or soil type to delineate timber sale boundaries is recommended

3. Regeneration Methods: It is recommended to use harvest systems, methods and sale regulations that protect advanced regeneration and maintain or improve the patterns, diversity and composition of forest vegetation present prior to harvest. The preferred method of regenerating oak is to use the shelterwood system to establish advanced regeneration.

Some control of understory competition may be necessary after a shelterwood harvest or prior to planting. This will be particularly useful where advanced sugar or red maple reproduction is already established or where competition from sprouting aspen is anticipated. This can be accomplished using ground application of herbicide or by prescribed burning.

Advanced reproduction must be well distributed and well established (2-4 feet tall) to compete successfully with other woody vegetation in the new stand. Once advanced reproduction is adequate, the overstory should be removed. Legacy patches and inclusions will be preserved within stands for seed sources and native plant diversity as well as to favor regeneration and seeding of native vegetation.

Planted stands will be established and managed to more closely resemble naturally occurring stands by planting a variety of tree species and using a variety of variable density thinning techniques, with the objective of preserving existing natural vegetation and preserving advanced regeneration. In addition, protection of the seedlings from herbivory may be required.

4. Intermediate Harvest Methods: Where appropriate, thinning will be implemented according to standard stocking tables (See *Manager's Handbook for Oaks in the North Central States, Appendix IV*[2]) to increase the vigor of existing stands.

During the thinning process, crop tree selection criteria should include the following[3]:
a. Dominant/co-dominant trees with large crowns relative to DBH
b. No epicormic branches or dormant buds on the butt log
c. Trees should appear to have good life expectancy
d. Avoid selecting leaners, poor form trees as crop trees
e. Either stump sprouts or seedling origin stems are acceptable

Utilizing these criteria, it is possible to economically manage as few as five red oak pole or sawtimber crop trees (high value trees) per acre while maintaining wildlife habitat and biodiversity values from these trees and the others in the stand.

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[2] Sander, I.L. 1977. *Manager's Handbook for Oaks in the North Central States*. USDA Forest Service General Technical Report NC-37, North Central Forest Experiment Station, St. Paul, MN.
[3] Conference Proceedings, the Oak Resource in the Upper Midwest. 1991. Minn. Ext. Serv., U. of Minn.

5. **Intermediate Prescriptions:** The following are the most common prescriptions that will be applied:
    a. Shelterwood with Reserves-Interim Cut
    b. Selective thinning

4.6D Cover Type Conversion Management

1. Conversion Goals: The 10-year DFFC is to convert 5 percent (750 acres) of the oak cover type in the PMOP to jack pine. The 50-year DFFC is to convert 11 percent (1,750 acres) of the oak cover type in the PMOP to jack pine. This conversion will generally occur in low site-index oak stands on drier sites such as FDc24. Mesic oak communities, such as FDc34, FDs37, MHn35, MHn46, MHc26, MHc36, MHc37, MHc47, and MHs39, will generally not be converted.

4.6E Stand Selection Criteria

1. Normal Rotation Forest: To establish stand selection criteria, two site index groups have been identified (60+ and <60 SI), each with corresponding normal rotation and maximum ages and are identified on Table 4.6b. During this 10-year year plan implementation period, all merchantable oak stands will be field visited to determine current basal area and average diameter. This information will be used to determine if the stand is in need of thinning. Stands that are suitable for thinning will be marked and treated.

Table 4.6b Oak Normal Rotation Age and Maximum Age

Site Index	Normal Rotation Age	Maximum Age
60+	80	120
<60	50	80

The objective is to move the age-classes in each of the site index groups toward a more balanced structure. The priority during this 10-year management period is to select the oldest and highest scoring stands for treatment. A *Stand Scoring System* was implemented which assigned scores to stands in the following priority: stands that were currently over maximum age; over maximum age within 10 years; currently beyond normal age; and, currently less than normal age. The *Stand Scoring System* considered both normal pool acres and ERF acres (see Appendix K).

2. Normal Rotation Harvest Treatment Level Calculations: The pool of stands considered for normal rotation (see *Glossary*) harvest treatment is all stands
    a. not reserved from harvest (e.g. old growth, EILC);
    b. not designated to be managed as extended rotation forest (ERF); and
    c. near normal harvest rotation age.

Harvest treatment level is the sum of normal rotation acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure. Once a balanced age-class structure is achieved stands can be scheduled for treatment upon reaching normal rotation age.

Adjustments to the normal harvest level were made to meet other goals, such as balancing the age-class distribution and providing relatively stable harvest levels.

3. Extended Rotation Forest: Two site index classes (60+ and <60 SI) are recommended for oak management. The long-term DFFC goals are to retain 13 percent of the >60 site index oak and 20 percent of the <60 site index oak cover type acreage over the normal rotation age to provide a declining age-class structure out to the maximum harvest age. Varying harvest standards will be applied to age-classes beyond normal rotation age and out to the maximum age (see Table 4.6c).

Table 4.6c Oak ERF Acres (Plan Target Acres) and Maximum Age

Site Index	Prescribed ERF Acres	Effective ERF / DFFC Acres	Maximum Age
60+	2,854	839	120
<60	6,720	1,920	80
Total	**9,574**	**2,759**	

4. Extended Rotation Harvest Treatment Level Calculations: The pool of stands considered for extended rotation harvest treatment is all stands

a. not reserved from harvest (e.g. old growth, EILC);
b. designated to be managed as extended rotation forest (ERF); and
c. will be over normal harvest rotation age.

Extended rotation harvest treatment level is the sum of ERF acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure, while attempting to retain the minimum level of effective ERF. A declining acreage of stands in each 10-year age-class is desired between normal rotation age and maximum rotation age. Emphasis is on treating the oldest age-classes to minimize loss of fiber to tree mortality. Very few stands should be allowed to go untreated beyond the maximum rotation age (see glossary).

The selection of older aged stands will be emphasized to help move this subset of ERF stands toward a desirable declining age-class structure. The long-term goals are to retain at least 10 percent of the cover type acreage over the normal rotation age and to provide a declining age-class structure out to the maximum age.

4.6 F Stand Treatment Summary

Table 4.6d and Table 4.6e shows the treatment acres, conversion acres out of the cover type, old forest percent, effective ERF percent, and the average treatment ages for the next six decades by site index group. Based on the cover type management identified in this Plan, the average treatment age for both site index classes of oak cover type decreases during the plan implementation period. Old Forest Percent means acres that are over normal rotation age, except stands designated as Old Growth. There is variation from decade to decade, due to the current imbalance in the age-class distribution of the oak cover type.

Table 4.6d Oak (SI >=60) Treatment Summary by Decade

	Acres		Percent		Avg Treatment Age		Avg
Decade	Total Treatment	Conversion	Old Forest %	Effective ERF	Normal	ERF	Age
1	1,304	0	15.2%	6.6%	85	90	71
2	1,305	0	44.1%	26.1%	88	95	64
3	1,067	0	48.8%	27.2%	97	100	55
4	997	0	39.7%	27.0%	100	107	49
5	997	0	24.6%	19.2%	74	123	43
6	708	0	13.8%	13.8%	45	125	39
DFFC	**702**[1]	**0**[2]		**13.0%**	**80.0**[3]	**113.3**[3]	**47**[3]

[1] Total treated Acres once a fully regulated forest is achieved
[2] positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
[3] anticipated age once a fully regulated forest is achieved.

Table 4.6e Oak (SI <60) Treatment Summary by Decade

	Acres		Percent		Avg Treatment Age		Avg
Decade	Total Treatment	Conversion	Old Forest %	Effective ERF	Normal	ERF	Age
1	3,605	750	92.0%	57.8%	92	96	77
2	2,664	600	61.6%	44.6%	90	96	55
3	1,124	400	35.2%	29.3%	90	100	38
4	820	0	25.8%	22.2%	90	105	36
5	1,075	0	15.4%	12.7%	53	105	35
6	1,106	0	6.2%	4.9%	53	67	34
DFFC	**1,256**[1]	**-1,750**[2]		**20.0%**	**50.0**[3]	**70.0**[3]	**32**[3]

[1] Total treated Acres once a fully regulated forest is achieved
[2] positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
[3] anticipated age once a fully regulated forest is achieved.

Figures 4.6e and 4.6f shows the projected age-class distributions in 2017 for the two site index groups in the oak cover type.

Figure 4.6e

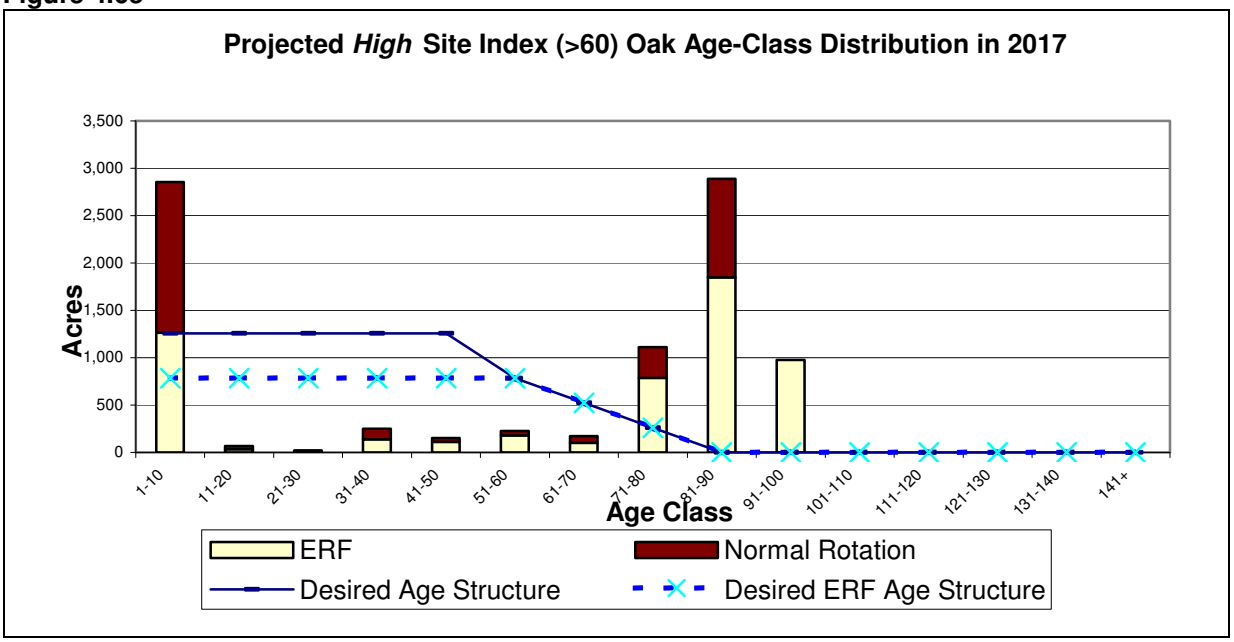
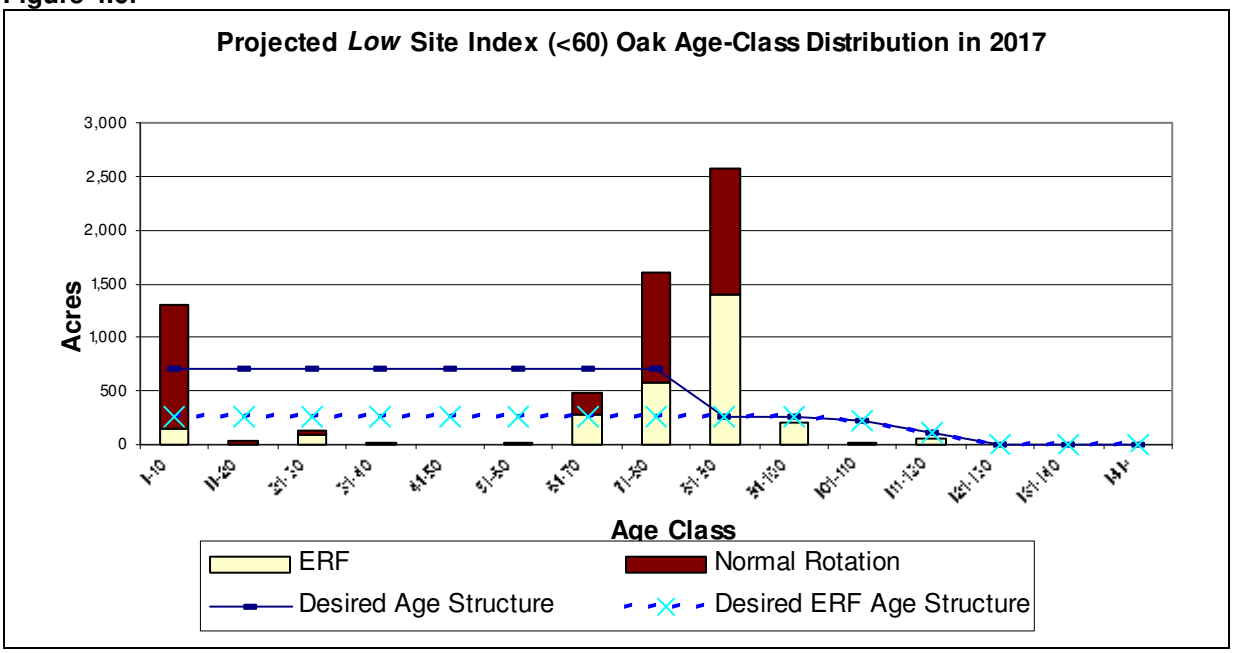


Figure 4.6f



Based on the treatment levels by decade, Figures 4.6g and 4.6h show the projected age-class distributions in 2057 for the two site index groups in the oak cover type.

Figure 4.6g

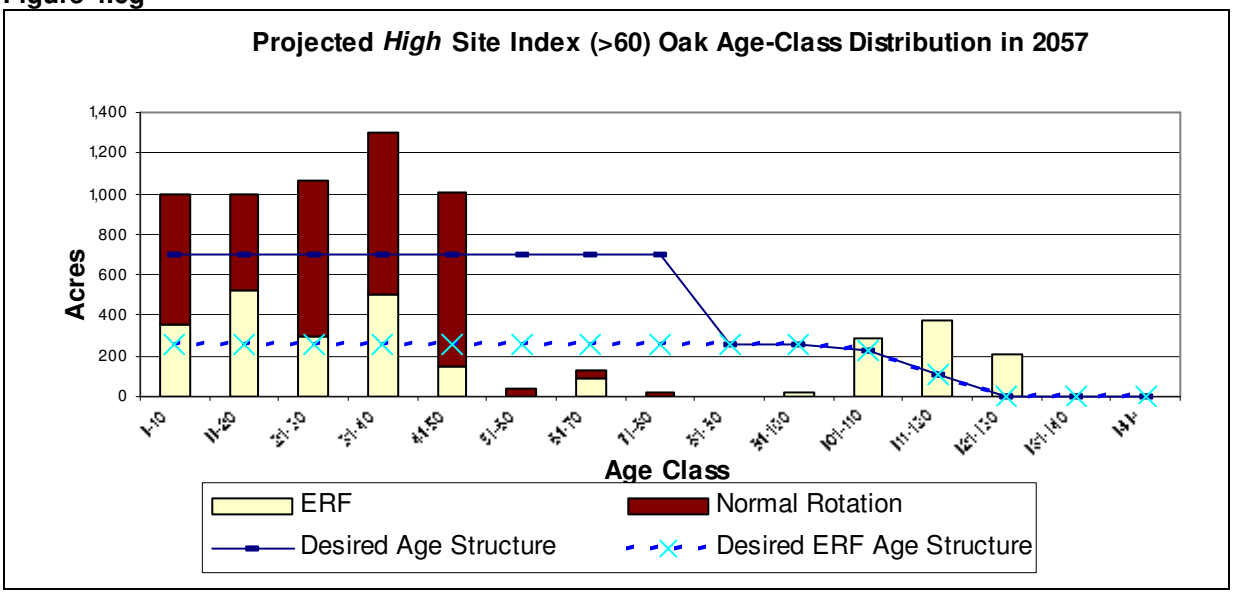
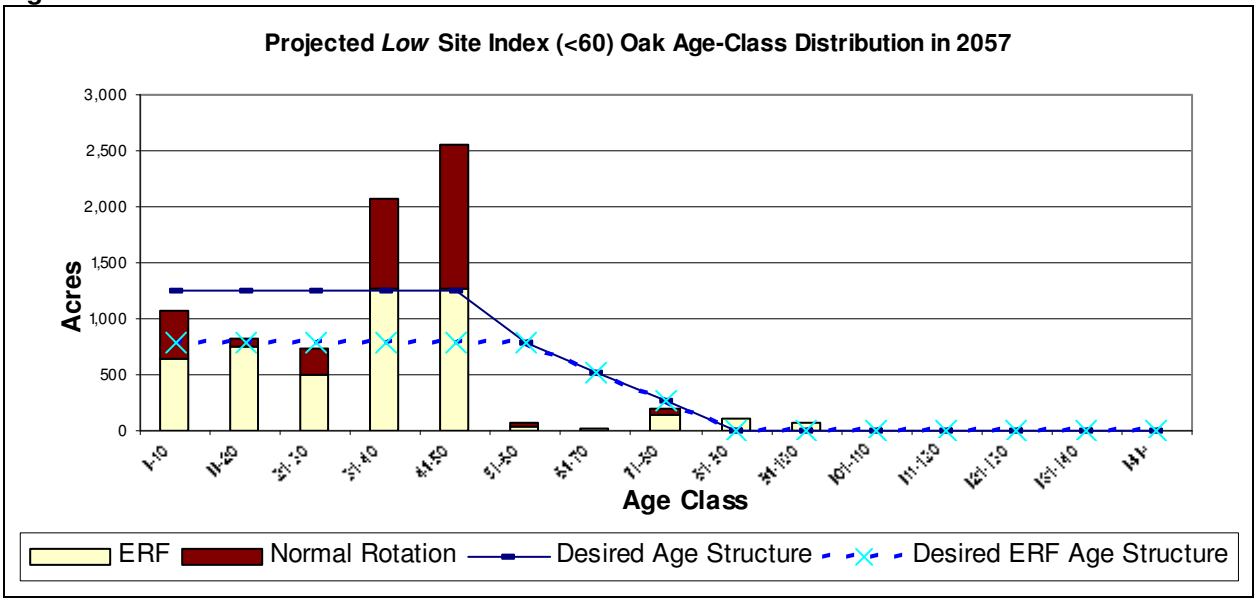


Figure 4.6h



As each new 10-year plan is developed, the treatment levels by decade and modeling will be re-evaluated.

4.7 White Pine (WP)

4.7A Current Condition

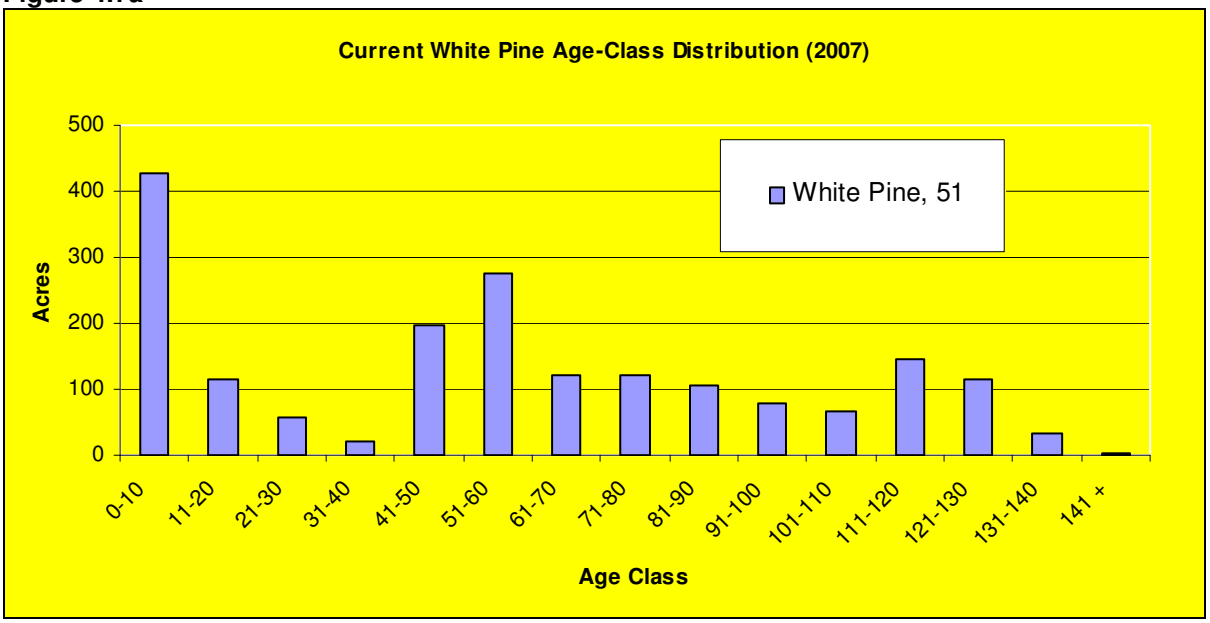
1. Cover Type Acres: In 2007, the white pine cover type comprised about 0.5 percent (2001 acres) of the state timberlands (429,229 acres). Seventy percent of this cover type is found within the PMOP. with 30 percent in the CP (see Table 4.7a). There are 116 acres of white pine reserved from harvest in these subsections. White pine can also be found as a component of most other cover types in these two subsections, typically on mesic sites. A stand will be considered a white pine stand for this plan if it contains ≥33 percent white pine by volume or basal area (see Appendix S, *Stands with a White Pine Component on the 10-Year Stand Exam List*).

Table 4.7a White Pine Cover Type Acres by Subsection

	CP	PM	Total
Acres	606	1,395	2,001
Percent	30	70	100

2. Age-Class Distribution: In each of the subsections, the current age-class distribution of the white pine cover type does not reflect the desired balanced age-class structure. This age-class imbalance is found across both subsections. There has been a dramatic increase in white pine acres in the 0 – 10 age-class (see Figure 4.7a). This is because of the increased emphasis and funding for regenerating white pine that started in 1998 with the DNR's white pine initiative. That initiative states that white pine will be managed under extended rotation forest guidelines to increase the acreage and distribution of older white pine stands and individual trees on the landscape.

Figure 4.7a



4.7B Future Direction

1. Cover Type Acres: The long-term goal is to double the white pine cover type acreage in LTAs containing state forestry or wildlife lands. The 50-year DFFC goal is to increase the white pine cover type by 112 percent (2,250 acres, 1,500 from aspen, and 750 from northern hardwoods). During the next 10 years, the DFFC goal is to increase the white pine acres by 23 percent (450 acres: 300 from aspen and 150 from northern hardwoods) (see Table 4.7b). A stand will be considered a white pine stand for this plan, if it contains ≥33% white pine by volume or basal area.

Table 4.7b Recommended White Pine Cover Type Acres in the Subsections by Year

	2007	2017	2057
CP	606	700	NA
PMOP	1,395	1,752	NA
Total acres	**2,001**	**2,452**	**4,252**

Approximately 79 percent of the acreage increase in the white pine cover type during the next 10 years is recommended to occur in the PMOP subsection.

Stands identified in the aspen and northern hardwood cover types will be site-visited during the next 10 years and assessed as to their native plant community (NPC) type and related capability for natural or artificial conversion to white pine as noted in the *Suitability of Tree Species by Native Plant Community* guide. This guide will also be used in other cover types to determine if a stand should be managed for, or converted to a white pine stand.

2. Age-Class Distribution: The long-term DFFC goal is to increase white pine on the landscape. Efforts will be made to protect advanced regeneration and maintain or improve diversity and composition of forest vegetation present in the stand prior to harvest.

3. Stand Composition: The 50-year DFFC is to increase the white pine cover type by an additional 2,250 acres with a 10-year DFFC of an additional 450 acres. White pine stands will range in species composition from nearly pure white pine stands to stands that are composed of mixed species (conifer-deciduous) with white pine being the predominant species. As *Stand Silvicultural Prescription Worksheets* are developed, field foresters will consider ECS information and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

4. Limiting Factors: Protective measures against insects, disease, and animal depredation need to be used for growing white pine in these subsections. The following summarizes limiting factors and selected management recommendations for white pine:

a. The presence of white pine blister rust (WPBR), an exotic disease, has altered the ability of white pines to grow and regenerate in northern Minnesota. Seedlings and saplings often die due to WPBR infections, especially if planted in open plantations. Establish white pines under an over-story to prevent dew formation on their needles and subsequent infection by WPBR. Once established, seedlings and saplings require tending: pathological pruning and deer browse protection. Pole-sized and mature trees can often live a long life and produce seed for many years, even though some branches have succumbed to WPBR. White pine weevil (WPW) repeatedly infests leaders when trees are young, causing stunting, cabbagy tree form, and forking of the stems. WPW attack can be prevented by planting/ regenerating seedlings under an overstory.

b. The CP subsection is in the Very High Hazard Zone for WPBR. Because this zone is characterized by abundant infections higher than nine feet, it is often difficult to grow disease-free pines. Strictly avoid open-field plantings of white pine. Instead, plant or regenerate white pine seedlings under a light overstory. Establishing solid blocks of white pine is not recommended, but rather scatter white pine seedlings among other species to become a component of the future stand. Be prepared to accept significant white pine losses.

c. The PMOP subsection is also in the High Hazard Zone for WPBR. As in the CP, avoid open-field plantings of white pine, plant or regenerate white pine seedlings under a light over-story.
d. In both subsections, protect natural and artificial regeneration from deer browse.

e. In both subsections, implement pathological pruning until there is nine feet of branch-free bole. See Silviculture Tip Sheet #10 for more information.

f. If natural regeneration is desired:
    - Mature white pines must be within 200 feet of each other to ensure pollination.
    - Scarification of the soil should be done just before seeds fall during a "good" seed year.

The establishment and follow-up management of new stands of white pine will be critical to the effectiveness of efforts to maintain and expand this cover type and to increase the white pine component in other cover types.

5. Patch Management Objectives: Patch management objectives are to retain the existing upland conifer patches found within these subsections and to manage upland conifers to create larger and older patches.

4.7C Stand Management

1. Management Direction: White pine stands will be managed primarily as uneven-aged stands with periodic intermediate thinnings, while maintaining or enhancing within-stand tree species diversity. Older white pine stands (90+ years) should be managed predominantly as multi-aged stands consisting of white pine and other species such as white spruce, balsam fir, red pine, birch, and aspen. In younger white pine stands (up to 90 years old), even-aged management treatments such as a 4-cut shelterwood treatment to establish long term goals of natural regeneration are recommended.

All white pine stands that are 15 years and older will be selected for a stand exam in the next 10 years.

2. Final Harvest Method: Due to the less-than-desired current acreage in older age-classes, no final harvest is planned in the white pine cover type during the next 10 years. Final harvest in the white pine cover type may occur in the future, but is recommended to occur only after a stand reaches 180 to 240 years old.

3. Intermediate Harvest Methods: Thinning will be used to capture mortality; reduce stand density to increase future tree growth, quality, and vigor; and to maintain or enhance species diversity.

Stands of merchantable size and basal area will be thinned at 10-25 year intervals, reducing the basal area usually to 90 square feet. In some stands, residual basal area may be modified to meet ERF or other objectives. Examples are: 1) thin to 60 BA versus 90 BA to encourage within-stand diversity and 2) maintain higher residual basal areas because of the larger diameter of older trees. Older stands may have longer intervals between thinnings to compensate for slower growth rates and to facilitate the growth of desirable understory species.

Thinning in stands will maintain or increase within-stand diversity, while retaining white pine as the main cover type. For example, the younger white pine stands may have a larger component of aspen and birch, while older stands (90+ years) may increase in white spruce and cedar with smaller amounts of aspen, birch, and balsam fir. Red pine may be present throughout the life of the stand. The following methods should be considered:

a. Consider creating or maintaining variable densities within stands when thinning ranging from unthinned areas to heavily thinned or group-selected areas within a stand.
b. Protect advanced regeneration of desirable understory species, where possible.
c. Higher stand densities (BA) are recommended along stand edges exposed to wind and along high visual quality corridors, such as major roads and lakes.

Shelterwood harvests may also be used as an intermediate harvest method to regenerate white pine in the understory. Some method of scarification may be needed to establish a suitable seedbed.

4. Intermediate Harvest Prescriptions: The most common prescriptions are:
a. Row Thinning (initial thinning only)
b. Strip Thinning (initial thinning only)
c. Selective Thinning
d. Shelterwood with Reserves-Intermediate harvest

5. Multi-Aged Stand Management: Older (90+ years) white pine stands will be managed primarily for a multi-aged stand structure using even-aged management techniques. The move toward a multi-aged structure will be accomplished through thinning and shelterwood harvests. A goal is to mimic light to high intensity surface fires and partial crown fires that historically occurred.

During thinning or shelterwood harvests, from 90 years old to final harvest, retain at least 25 percent of the largest white pine present, and manage out to the ERF age of 180 - 240 years. The goal is to retain a significant number of the largest cohorts out to the final harvest age, while creating or maintaining a multi-aged white pine stand.

Every third entry should be a group selection harvest, with goal of establishing a new age-class of white pine within the stand. The long-term goal is to create stands with layered age-classes (two or more). Timing of the first group selection harvest will depend on seed production and stand condition (age, density, and distribution of white pine).

6. Multi-aged harvest prescriptions: The most common prescriptions to use are:
a. Thinning
b. Shelterwood

4.7D Cover Type Conversion Management

Conversion of other forested cover types to a stand dominated by white pine will be accomplished primarily by converting aspen and northern hardwood stands. NPC classes where white pine competes well with all vascular plants and ranks excellent for suitability include: FDn33, FDc34 and FDn43. Most white pine stands will be in the latter growth stages of the Dry Pine, Dry-Mesic Pine/Oak, Dry-Mesic Pine, Mesic Northern Hardwoods, and Boreal Hardwood-Conifer Ecosystem Types that were delineated by Shadis (2000).

Priority LTAs for white pine cover type increase include: Rosey Lake Plain, Blackduck Moraine, Alida Till Plain, Becida Till Plain, Crow Wing Sand Plain, St. Croix Moraine, Spring Brook Till Plain, Itasca Moraine, Itasca Moraine Steep, Two Inlets Moraine, Bass Lake Moraine, and Naytahwaush Moraine. These LTAs currently contain 50+ acres of white pine cover type on state lands and have shown at least a significant decline (BT to FIA). The basic long-term goal is to double the white pine cover type acreage in LTAs with state forestry or wildlife land.

As stated, conversions of other cover types to white pine stands will be accomplished primarily by converting stands in the aspen and northern hardwoods cover types, and from other cover types that contain a major white pine component. A 10-year conversion pool of stands is identified in the aspen and northern hardwoods cover types that will be site-visited during the next 10 years and assessed for their potential for natural or artificial conversion to white pine.

The 10-year conversion pool criteria resulted in 2,075 total pool acres as identified below:

- Aspen: stands with white pine as a component (secondary species 2-10 with volume $\geq$ 1) and stand age $\geq$ 45 (1,545 acres); and,
- Northern hardwoods: stands with white pine as a component (secondary species 2-10) and stand age $\geq$ 50 (530 acres).

Where there is a significant component of white pine in other cover types, the *Stand Silvicultural Prescription Worksheet* and the NPC Field Guide will be used to determine if the stand should be managed toward developing into or converted to a white pine stand. The 10-year DFFC is to increase the white pine cover type by 23 percent (450 acres). The 50-year DFFC is to increase this cover type by 112 percent (2,250 acres).

4.7E Regeneration Methods

Following are recommendations to consider in regenerating white pine, both in stands that are white pine cover types now and stands of other cover types that will be converted to white pine.

1. Use a variety of site preparation techniques to provide the necessary ground scarification to prepare the seedbed or planting site.
    a. Site preparation techniques such as prescribed fire, anchor chains, broadcast skidding, disc-trenching, and/or herbicide will be favored over those that create more disturbance to the soil profile, such as deep rock raking.
    b. Decisions regarding whether or not site preparation is necessary, and the technique used, will be made following on-the-ground site evaluations.
2. Natural or artificial seeding, underplanting, and reserving advanced regeneration will be used to regenerate young white pine components in existing white pine stands.
    a. Varying proportions of aspen, birch, balsam fir, white spruce, white cedar, or red pine should co-exist as secondary stand components depending on site conditions and native plant community.
3. Reserving seed trees or clumps of mature or advanced regeneration of these secondary species will maintain their presence in the white pine cover type, especially in single species plantations.
4. Tending of white pine regeneration will be important to their survival. Site selection, bud capping, application of animal repellents, fencing, basal pruning, and release from competing vegetation are important for the long-term survival of young white pine.
    a. In some cases, areas of historically high incidence of white pine may be passed over for white pine regeneration efforts (e.g., near known deer yards), in favor of those sites where survival chances are more likely.

4.7F Stand Selection Criteria

1. Final Harvest: No final harvest is planned in this cover type during the next 10 years.

2. Thinning and Shelterwood Harvest: The following criteria will be used to establish a pool of stands to be field visited for evaluation for thinning or shelterwood harvest:

All white pine stands that are currently equal to or greater than 15 years old will be field visited to assess whether harvest is appropriate during this 10-year plan implementation period. The forest inventory will be updated, as needed, based on the field examinations. The field visit year will be scheduled based on the stand's current age or past thinning year. For example, 15-year-old stands should be scheduled for the last year of the plan, 16-year old for next to last, etc. This will capture those stands that grow into the recommended DBH and density for thinning during the plan implementation period. Stands that meet the criteria for thinning or shelterwood harvest will be treated through timber sales.

Stand treatment criteria includes:

a. Stands of merchantable size and volume.
b. Older (90+ years) white pine stands will be managed primarily for a multi-aged stand structure.

4.8 Red (Norway) Pine (NP)

4.8A Current Condition

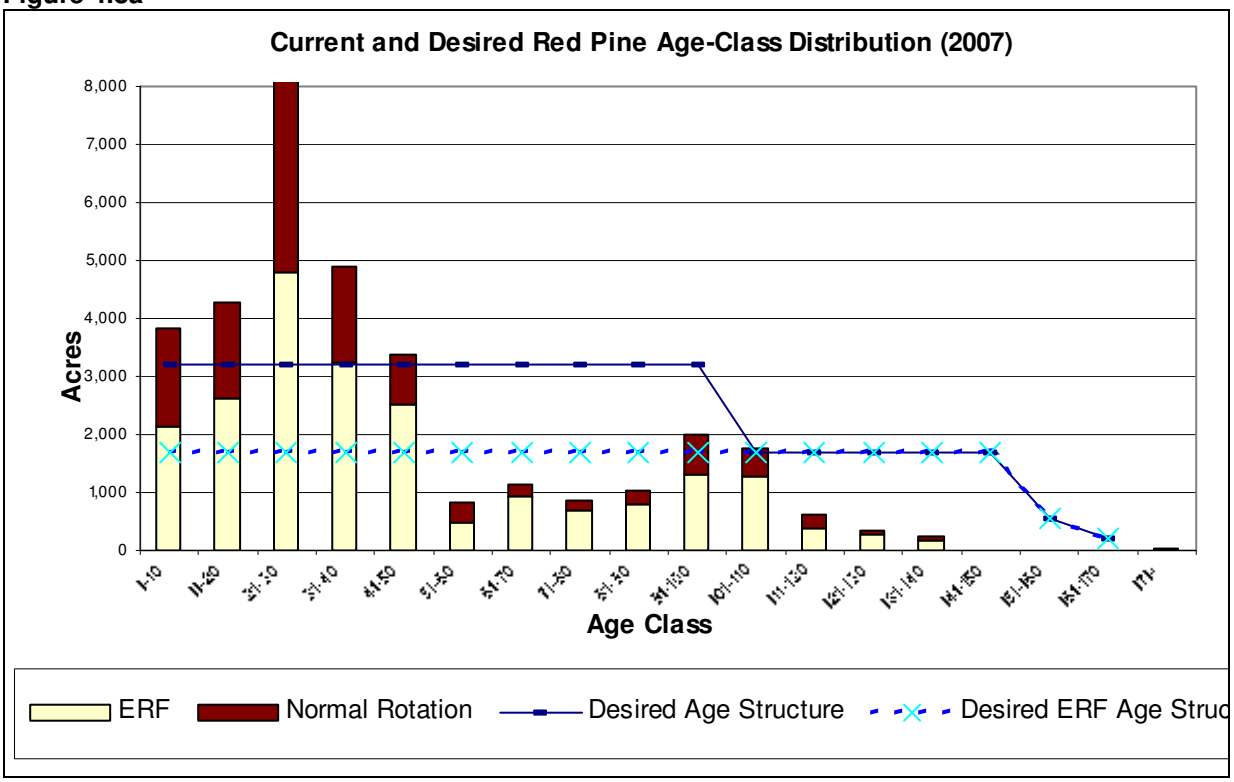
1. Cover Type Acres: In 2007, the red pine cover type comprised 8.2 percent (35,146 acres) of the state timberlands (429,229 acres) managed in the CP-PMOP subsections. Sixty-seven percent of the red pine cover type is found in the PMOP with 33 percent found in the CP. There are 946 acres of the red pine cover type reserved from harvest in these subsections.

Table 4.8a Red Pine Cover Type Acres by Subsection

	CP	PMOP	Total
Acres	11,637	23,507	35,144
Percent	33	67	100

2. Age-Class Distribution: In both subsections, the current age-class distribution of the red pine cover type does not reflect the desired balanced age-class structure for even-aged managed cover types. The current age-class distribution of the red pine cover type is skewed toward the younger age-classes. The primary reason for the large acreages found in the 0-40 age-classes is due to the planting of red pine on sites that were previously other cover types over the last 40 years. As a result, total acres predominate in the 0-40 year age-classes (see Figure 4.8a). This age-class imbalance is found across both subsections. Within the two subsections, less than 9 percent (2,985 acres) of the red pine cover type is currently over the recommended normal rotation age of 100 years.

Figure 4.8a



4.8B Future Direction

1. Cover type Acres: The DFFC goal over the next 50 years is a net increase of the red pine cover type by 17 percent (6000 acres). During the next 10 years, the DFFC goal is to maintain the current acreage due to the abundance of red pine stands in younger age-classes. However, it is recommended to convert 250 acres of red pine to jack pine during this initial 10-year plan implementation period. These are likely to be mature stands in the FDc23 native plant community. This conversion will be balanced by 250 acres converted from aspen to red pine, targeting the FDn33 and FDc34 communities (see Table 4.8b).

Table 4.8b Recommended Red Pine Cover type Acres in the Subsections by Year

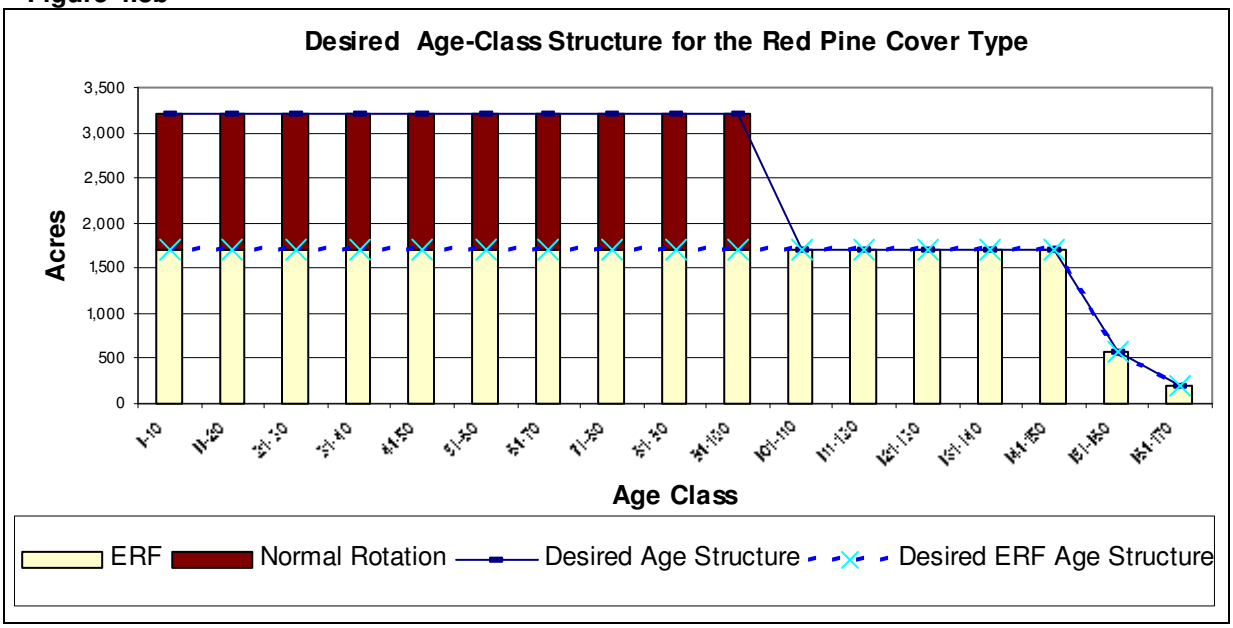
	2007	2017	2057
CP	11,637	11,572	NA
PMOP	23,507	23,587	NA
Total acres	**35,144**	**35,159**	**41,159**

Desired sites for conversion to the red pine cover type are sites that support a plant community where red pine is typically one of the dominant species. In these subsections, the plant communities that are likely to be associated with the red pine cover type are the FDn12, FDn33, FDn43, FDc12, FDc24, and FDc34.

2. Age-Class Distribution: A long-term DFFC goal is to move the age-class distribution in the red pine cover type toward a more balanced structure. Figure 4.8b shows the desired age-class distribution.

The ERF goal for this cover type is to maintain 25 percent of the acres over normal rotation age (effective ERF) with a declining age-class distribution from the normal rotation age (100 years) out to the maximum age (170 years). Figure 4.8b shows the desired age-class structure for normal rotation and ERF acres in the red pine cover type.

Figure 4.8b



3. Stand Composition: On drier sites, red pine forests range from nearly pure stands to mixtures of jack pine, eastern white pine, aspen, paper birch, and oaks. On wetter sites, red pine is found growing with eastern white pine, red maple, red oak, balsam fir, and white spruce. Red pine grows best on well-drained sandy to loamy sand soils, but is most common on sandy soils having site indices of 45 to 75 feet at 50 years of age.

The desired structure within the red pine cover type will range from predominantly single-canopied even-aged stands to multi-canopied, mixed-aged stands with red pine, other conifers, and deciduous species as co-dominants (as stands are thinned). See Appendix R (*Potential Pine Woodlands Areas*) for additional guidance.

In stands designated as ERF, an increase in compositional and structural complexity will be among the primary management objectives.

As *Stand Silvicultural Prescription Worksheets* are developed, field foresters will consider ECS information and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

4. Patch Management Objectives: Patch management objectives are to retain the existing upland conifer patches found within these subsections and to manage upland conifers to create larger and older patches.

4.8C Stand Management

1. Even-aged Management Direction: Red pine will be managed predominantly as an even-aged cover type for poles, high value sawtimber products, biological diversity, riparian buffers, recreation, aesthetics and wildlife habitat. As red pine stands age, manage to diversify within-stand species composition and increase within-stand structure to maintain or improve site productivity, wildlife habitat, and biodiversity.

2. Uneven-Aged Management: Isolated opportunities to manage red pine in uneven-aged stands include sites in the FDc12 NPC where feather moss provides an adequate seedbed. Removals of mature trees should not be so heavy as to allow the feather moss to dry out. Regeneration in uneven-aged red pine stands must be monitored for Diplodia and Sirococcus shoot blights.

3. Final Harvest Method: If the objective is to regenerate red pine, final harvest will occur using clearcut or clearcut with reserves. Shelterwood will be employed when converting to white pine. With either system, reserving biological legacies such as large, healthy, live trees, decadent trees, snags, and logs, and other coarse woody debris on the forest floor can carry some ecological complexity into the next rotation.[2]

4. Intermediate Harvest Methods: Thinning will be used to reduce stand density to increase future tree growth, quality, and vigor, and to obtain the desired composition of the stand. Recommendations are:

a. Normal rotation stand thinnings will occur in merchantable stands at approximately 10-year intervals, depending on site quality.
b. Older stands may have longer intervals between thinnings to compensate for slower growth rates and to facilitate the growth of desirable understory species.
c. Variable density thinning or other techniques will be incorporated to meet ERF or other objectives. Examples are: 1) thin 20 percent of the stand to 60 BA, 60 percent to 90 BA, and skip thinning in 20 percent to encourage within-stand diversity.
d. Large gaps (~3 ac) may be produced during early thinnings in mixed red pine/jack pine stands to encourage jack pine seeding, thereby ensuring that the species is not eliminated from the stand during later thinnings or due to early mortality.

Thinning in normal rotation and ERF stands will maintain (especially in natural origin stands) or increase within-stand diversity, while retaining red pine as the main cover type by the following methods:

a. Reserve from harvest individual trees or patches of other species appropriate to the site, where possible.
b. Consider creating or maintaining variable densities within stands when thinning.
c. Protect advanced regeneration of desirable understory species, where possible.
d. Higher stand densities (basal area) are recommended along stand edges exposed to wind and along high visual quality corridors, such as major roads and lakes.

e. Consider underplanting tolerant species, where seed sources or advance regeneration for these are lacking. For species suggestions, refer to the natural history section for the pertinent native plant community in the Field Guide to Native Plant Communities of Minnesota.
f. Provide for six cavity trees, potential cavity trees, or snags per acre as recommended in the MFRC *Voluntary Site-level Forest Management Guidelines*: Timber Harvest p.36 and TSI p. 7).

Potential impacts of bark beetles should be considered during intermediate harvest in the red pine cover type in these subsections. Bark beetle (*Ips pini)* feed and reproduce in the moist cambium of freshly cut, recently killed, or blown-down red pine, jack pine, and occasionally white pine. Bark beetles normally attack standing live trees in patches or pockets near the dead material in which they developed into adults. The DNR's bark beetle considerations should be followed when harvesting in pine stands.

5. Intermediate Harvest Prescriptions: The following are the most common management prescriptions that will be used for the red pine cover type:

a. Row Thinning
b. Strip Thinning
a. Selective Thinning
d. Variable Density Thinning

Where the goal is to artificially or naturally regenerate white pine in the understory of a red pine stand, the following prescriptions may be applied:

a. Shelterwood-Intermediate Cut
b. Shelterwood-With Reserves-Intermediate Cut

Intermediate thinning and even-aged management prescriptions should be modified to maintain or increase the proportion of other species in the canopy, understory, and ground cover.

6. Regeneration Methods: The following recommendations should be considered when regenerating red pine:

a. Plant using stock from local seed source.
b. Site preparation and herbicide use should consider maintaining within-stand diversity.
c. Scarify to encourage natural seeding of red pine and other species.
d. Scarify and artificially seed red pine and/or other species.
e. Prescribed surface fire in mature red pine stands can be an effective management tool for eliminating shrub competition, reducing thick duff layers, and preparing mineral seedbeds. Summer fires conducted over several growing seasons are most effective at controlling dense shrub competition and exposing mineral soil. This may be done before harvesting to prepare seedbeds, unless charred bark on harvested trees poses a problem. ("Red Pine Handbook").
f. Consider the risk of Diplodia tip blight and canker (*Sphaeropsis sapinea*) and shoot blight (*Sirococcus conigens*) infection on sites where taller infected red pine or jack pine are left on or next to sites being regenerated to red pine.
g. Provide for six cavity trees, potential cavity trees, or snags per acre as recommended in the MFRC *Voluntary Site-Level Forest Management Guidelines*.
h. Use natural regeneration in natural origin stands.

7. Limiting Factors: Pole-sized and mature stands can be attacked by bark beetles (*Ips* and *Dendroctonus* species) during (1) droughty weather, especially if basal area is high, (2) if bark beetles have built up in slash or cut products on the site or on an adjacent site, or (3) after a fire has scorched crowns and/or created or enlarged basal fire scars. Avoid creating pine slash, cut products, and wounding pines from March through August, especially when the weather is droughty.

Natural and artificial regeneration can succumb to infections caused by *Diplodia pinea*, an invasive pathogen. Fortunately, spores are spread in raindrops (and by cone insects), so this disease can be managed. Only seedlings growing directly beneath an infected overstory of red pines or growing within one chain of overstory trees are likely to be heavily infected and die when drought-stressed. The following are recommended:

a. Do not rely on the survival of understory red pine seedlings and saplings when they are growing under an overstory of red pine trees.
b. Planting red pine seedlings under red pine overstories should be discouraged.

c. Create a one-chain buffer between planted red pine seedlings and adjacent overstory red pines to minimize red pine losses. Do not plant jack pine in the buffer strip.
d. If red pine trees are retained as leave trees, choose locations where they are clumped together and are near the stand edges. This will minimize the area of disease impact.

4.8D Stand Selection Criteria

1. Normal Rotation Forest: The normal rotation age of 100 years will be used for calculating a regulated harvest level. Table 4.8c identifies normal and maximum rotation ages for red pine.

Table 4.8c Red Pine Normal Rotation Age and Maximum Age

Subsection	Acres	Normal Rotation Age	Maximum Age
CP	11,637	100	170
PMOP	23,507	100	170

The objective is to move the age-class toward a more balanced structure. The priority during this 10 year management period is to select the oldest and highest scoring stands for treatment. A *Stand Scoring System* was implemented which assigned scores to stands in the following priority: stands that were currently over maximum age; over maximum age within 10 years; currently beyond normal age; and, currently less than normal age. The *Stand Scoring System* considered both normal pool acres and ERF acres (see Appendix K).

2. Normal Rotation Harvest Treatment Level Calculations: The pool of stands considered for normal rotation (see glossary) harvest treatment is all stands:
a. not reserved from harvest (e.g. old growth, EILC);
b. not designated to be managed as extended rotation forest (ERF);
c. and near normal harvest rotation age.

Harvest treatment level is the sum of normal rotation acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure. Once a balanced age-class distribution is achieved, stands can be scheduled for treatment upon reaching normal rotation age.

3. Extended Rotation Forest: Long-term DFFC goals are to retain 25 percent of the cover type acreage in effective ERF. This will provide a declining age-class structure out to the maximum harvest age. Rotation ages for ERF stands begin at age 150 and continue until age 170. Table 4.8d identifies ERF acres and maximum age for the red pine cover type.

Table 4.8d Red Pine ERF Acres (Plan Target Acres) and Maximum Age

	Prescribed ERF Acres	Effective ERF / DFFC Acres	Maximum Age
CP-PMOP	22,228	8,786	170

4. Extended Rotation Harvest Treatment Level Calculations: The pool of stands considered for extended rotation harvest treatment is all stands
a. not reserved from harvest (e.g. old growth, EILC);
b. designated to be managed as extended rotation forest (ERF);
c. and will be over normal harvest rotation age.

Extended rotation harvest treatment level is the sum of ERF acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure, while attempting to retain the a minimum level of effective ERF. A declining acreage of stands in each 10 year age-class is desired between normal rotation age and maximum rotation age. Emphasis is on treating the oldest age-classes

to minimize loss of fiber to tree mortality. Very few stands should be allowed to go untreated beyond the maximum rotation age (see *Glossary*).

5. Thinning: The following criteria will be used to determine a pool of stands to be field visited for evaluation for thinning:

All red pine plantations that are currently equal to, or greater than 15 years old will be field visited to assess whether thinning is appropriate during this 10-year plan implementation period. The forest inventory will be updated, as needed, based on the field examinations. The field-visit year will be scheduled based on the stand's current age or past thinning year. For example, 15-year-old stands should be scheduled for the last year of the plan, 16-year-old for next-to-the-last, etc. This will capture those stands that grow into the recommended DBH and density for thinning during the plan implementation period. Stands that meet the criteria for thinning will be treated through timber sales. Normal rotations stands older than 80 years will generally not be considered for thinning (140 years for ERF stands). Stand treatment criteria include:

a. As a general guide, pole stands (5 to 9 inches average diameter) should be thinned when basal area reaches 140 sq ft or more per acre, leaving about 90-110 ft2 per acre[2].
b. A higher basal area will be maintained in stands where the average tree diameter is greater than 15 inches.

4.8E Stand Treatment Summary

Table 4.8e identifies the treatment acres, conversion acres out of the cover type, old forest percent, effective ERF percent, and the average treatment ages for the next six decades for the red pine cover type. Based on the cover type management identified in this Plan, the average treatment age for red pine cover type increases over time reflecting the goal of providing more older, longer lived conifers on the landscape. Old Forest Percent means acres that are over normal rotation age, except stands designated as Old Growth. There is variation from decade to decade due to the current imbalance in the age-class distribution for this cover type.

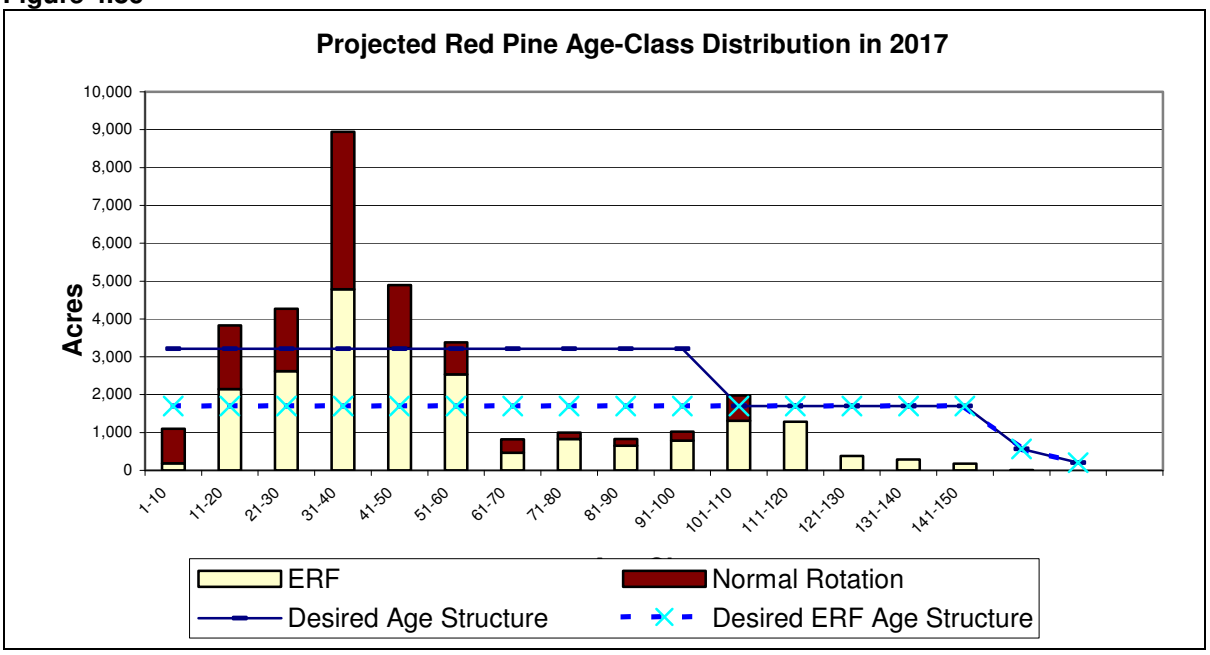
Table 4.8e Red Pine Treatment Summary by Decade

	Acres		Percent		Avg Treatment Age		Avg
Decades	**Total Treatment**	**Conversion**	**Old Forest %**	**Effective ERF**	**Normal**	**ERF**	**Age**
1	1,088	252	8.7%	6.3%	113	91	42
2	809	0	12.0%	10.1%	108	150	48
3	745	0	12.1%	11.3%	110	150	53
4	547	0	11.9%	11.9%	100	150	59
5	1,640	0	12.6%	12.6%	100	150	64
6	2,160	0	10.1%	10.0%	100	150	66
Total	6,989	252					
DFFC	**3,211**[1]	**6,017**[2]		**25%**	**100.0**[3]	**153.9**[3]	**64**[3]

[1] Total Treated Acres once a fully regulated forest is achieved.
[2] positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
[3] anticipated age once a fully regulated forest is achieved.

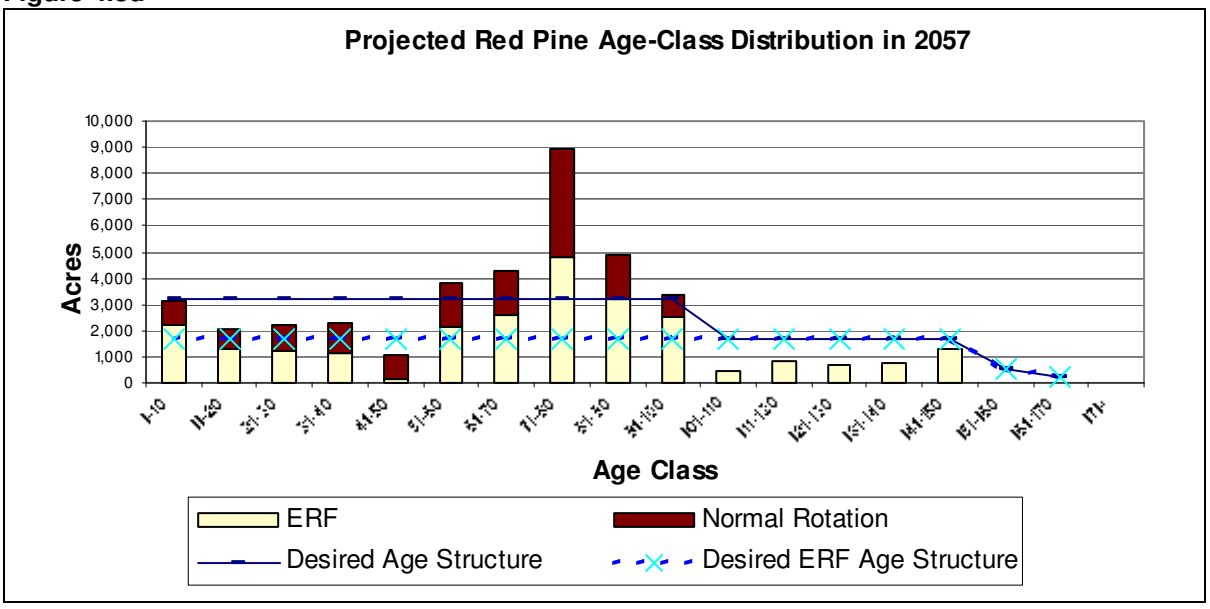
Based on the treatment levels by decade, Figure 4.8c identifies the projected age-class distribution in 2017 for the red pine cover type.

Figure 4.8c



Based on the treatment levels by decade, Figure 4.8d identifies the projected age-class distribution in 2057 for the red pine cover type.

Figure 4.8d



4.9 Jack Pine (JP)

4.9A Current Condition

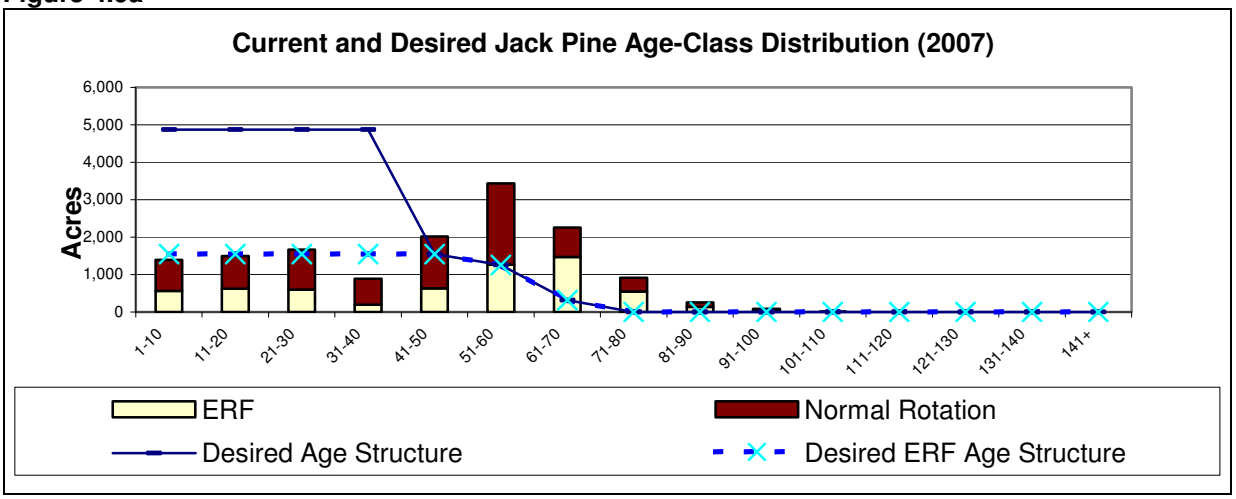
1. Cover Type Acres: In 2007, the jack pine cover type comprised 3.4 percent (14,419 acres) of state timberlands (429,229 acres) in the CP-PMOP subsections. Of the total jack pine cover type, approximately 68 percent (9,792 acres) is located in the PMOP, with 32 percent (4,627 acres) located in the CP (see Table 4.9a). A total of 80 acres of the jack pine cover type has been reserved from harvest in these two subsections. Due to several factors, including jack pine budworm and drought, the total acreage of the jack pine cover type has been declining in these two subsections.

Table 4.9a Jack Pine Cover Type Acres by Subsection

	CP	PMOP	Total
Acres	4,627	9,792	14,419
Percent	32	68	100

2. Age-Class Distribution: In these subsections, the current age-class distribution of the jack pine cover type does not reflect the balanced age-class structure desired for even-aged managed cover types. However, due to the occurrence of fire and disease outbreaks, historically jack pine may have never been a balanced age-class cover type. The current age-class distribution is skewed toward older age-classes (51+ years) with less acreage in the younger age-classes (see Figure 4.9a).

Figure 4.9a



3. Stand Composition: Natural origin stands comprise approximately 62 percent of the current jack pine cover type acreage. Associated species in jack pine stands may include red pine, aspen, bur oak, balsam fir, white spruce, paper birch, and/or white pine. Most CP-PMOP jack pine stands occur in Native Plant Community Classes that are woodlands (canopy cover ranging from 100 percent down to 25 percent). With recent fire suppression, many of these jack pine stands have developed more of a closed canopy condition.

Approximately 91 percent of the jack pine in the CP-PMOP forest inventory is currently within the central floristic region. The remainder of the CP-PMOP jack pine resource occurs in the northern floristic region. The following jack pine communities are identified as imperiled (very restricted range, very few populations, steep declines, or other factors) at the state (S2) and/or global (G2) level: FDc12a (S2), FDc23a (S2 and G2), FDc25a (S2), and FDn12a (S2) (Appendix J *Native Plant Communities*).

4.9B Future Direction

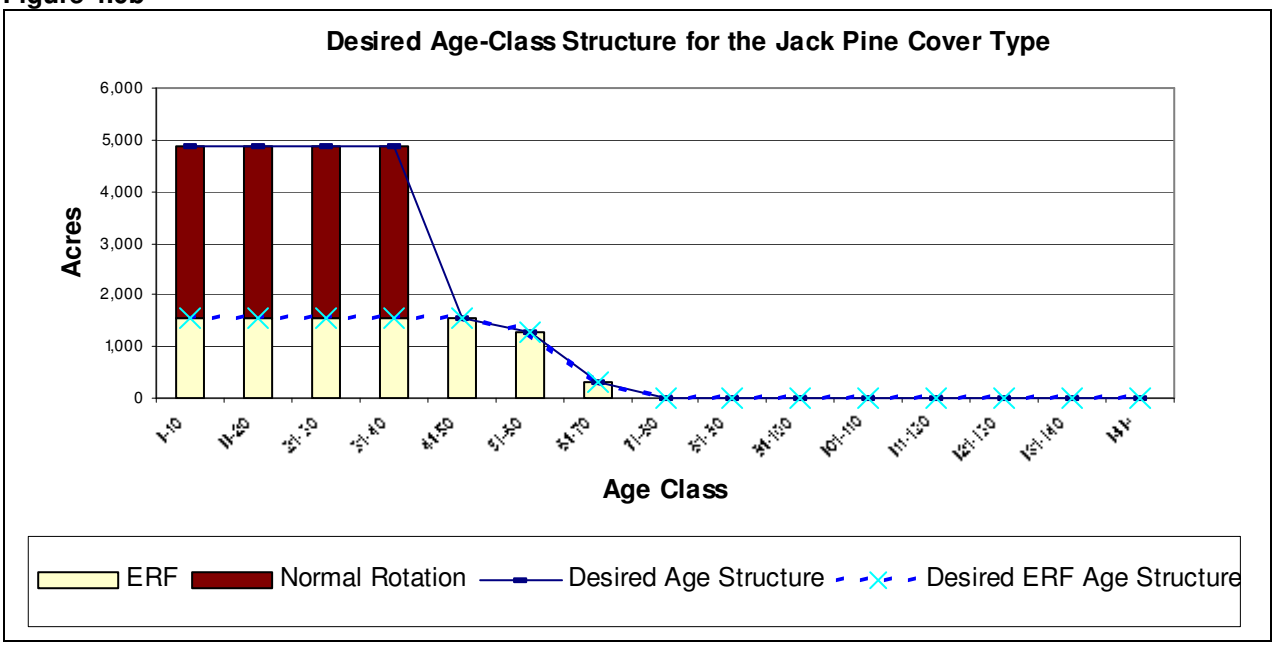
1. Cover Type Acres: Due to declines in the jack pine cover type in these subsections, the first priority is to maintain the existing acreage. The 10-year goal is to increase to 19,919 acres of jack pine cover type by 2017. The 50-year goal is to increase to 26,588 acres by 2057. Ideally, most of this cover type acreage will occur in Native Plant Communities (NPCs) where jack pine is an excellent competitor (see http://www.dnr.state.mn.us/forestry/ecs_silv/index.html). In the CP-PMOP subsections, these NPC classes include FDn12, FDc12, FDc23, FDc24, and FDc25. These communities are most likely to occur in higher scoring areas of the CP-PMOP *Potential Pine Woodland Areas* layer and thus would likely be the most appropriate areas for maintaining and increasing the jack pine cover type. See Section 4.9D for a description of this layer. Table 4.9b shows the desired changes by subsection.

Table 4.9b Recommended Jack Pine Cover Type Acres in the Subsections by Year

	2007	2017	2057
CP	4,627	6,239	NA
PMOP	9,792	13,680	NA
Total acres	**14,419**	**19,919**	**26,588**

2. Age-Class Distribution: The long-term goal is to move age-classes toward a more balanced structure. Accomplishing this goal will be delayed because jack pine stands selected for harvest in this plan implementation period exceeded targets designed to balance age-classes. Additional stands were selected because of the surplus of old jack pine cover type. Many stands across the subsections suffered severe mortality from recent jack pine budworm infestations. Young, healthy jack pine can withstand these infestations, but old weakened trees cannot. Without management, these old stands would likely not regenerate to jack pine. Jack pine stands that occur in FDc12 and FDn12 NPCs can generally be managed on a longer rotation. It is possible that balanced age-classes jack pine never occurred naturally in these subsections. Figure 4.9b shows the long-term desired age-class distribution for the jack pine cover type.

Figure 4.9b



The older age-classes will be managed so that enough older stands are deferred (ERF) beyond the normal rotation age to provide an adequate declining age-class distribution out to the maximum age of 65

years. The ERF goal for this cover type is to maintain 15 percent of the acres over the 40-year old normal rotation age (i.e., effective ERF) at any one time.

3. Stand Composition: The desired within-stand composition will be relatively pure jack pine in younger growth stages. Associated species may include red pine, aspen, bur oak, balsam fir, white spruce, paper birch, and/or white pine depending on the NPC. For detailed tree species composition descriptions, refer to the Vegetation Structure & Composition and the Natural History section for the pertinent NPC in the "*Field Guide to Native Plant Communities of Minnesota*." Most jack pine stands occur in NPC classes which are woodlands and should have canopy cover ranging from 100 percent down to 25 percent. Canopy cover generally increases as these stands age.

The jack pine dominated communities in the central floristic region evolved with frequent, mild surface fires in between catastrophic fires. Consequently, the jack pines in these subsections have adapted to this disturbance regime with a shorter life span and very few serotinous cones. These natural jack pine stands appear to have regenerated over a period of about 30 years with several age-classes of seedlings contributing to these classes. The remainder of the CP-PMOP jack pine resource occurs in the northern floristic region. In this floristic region, natural jack pine stands usually regenerate in a singe cohort after a catastrophic fire stimulates the serotinous cones to shed seed.

4. Patch Management: Catastrophic fires generally would have created larger patches, while mild surface fires would have created smaller patches. A number of large upland conifer patches identified for management in CP-PMOP subsections contain jack pine stands. In these managed patches, field foresters will consider incorporating patch, treatment, and conversion goals in management decisions. In other areas, they will practice whole stand management and try to group stands for harvest to maintain or enhance jack pine patch sizes.

5. Limiting Factors: Jack pine budworm is a perennial problem in these two subsections. Stands older than 50 years are at high risk for significant mortality due to budworm outbreaks. Outbreaks occur at 6-12 year intervals and usually last three to four years in any one location. Unlike other areas in the state, jack pine rotation age in these subsections is based on preventing adverse impact from jack pine budworm (rather than stem decay severity). The following are suggestions to address these limiting factors:

a. Maintain age-class diversity to minimize mortality losses.
b. Use a harvest age between 45 and 55 to manage jack pine stands.
c. Salvage budworm killed trees. Pre-salvage if intended products include dimensional lumber.
d. Minimize "edge" when designing timber sales as this also decreases the severity of budworm impact.
e. Regenerate jack pine from local seed sources to preserve the natural diversity of these drought-tolerant populations.
f. Recognize that natural regeneration on the central floristic sites can take many years to reach full stocking.

4.9C Stand Management

1. Even-aged Management Direction: The jack pine cover type will be managed primarily on an even-aged basis for pulpwood and bolts, and to support forest wildlife habitat and biodiversity. The goal is to move toward a balanced age-class structure while maintaining or improving site productivity and stand health.

2. Harvest Methods: The jack pine cover type will generally be treated through even-aged prescriptions using seed tree methods, clearcuts with reserves (e.g., jack pine, aspen, oak, red pine, white pine, white spruce, balsam fir, and/or birch), or clearcuts.

In the central floristic region, natural seeding may be accomplished by reserving ~30 sq. ft. of BA scattered seed trees, islands or clumps of mature seed trees, or advanced jack pine regeneration. Small gaps (~3 acre) could also be created in existing jack pine stands through a group selection harvest. These should be allowed to regenerate through natural seeding from remaining mature stands.

In the northern floristic region, natural seeding can be accomplished through summer harvest treatments and full tree skidding that distributes serotinous cones on mineral soil.

3. Harvest Prescriptions: The following are the most common prescriptions that will be used on jack pine timber sales:

a. Seed tree
b. Clearcut with reserves followed by natural seeding
c. Clearcut with reserves followed by artificial seeding or planting
d. Clearcut followed by natural seeding (from serotinous cones on exposed soil)
e. Clearcut followed by artificial seeding or planting
f. Group Selection

4. Intermediate Harvest Methods: Thinning is generally not recommended for CP-PMOP jack pine stands. Precommercial treatments may be considered to reduce extreme stand density or to manipulate stand composition to the desired species.

5. Intermediate Harvest Prescriptions: No thinning prescriptions are recommended for CP-PMOP jack pine stands.

6. Regeneration Methods: Natural seeding, artificial seeding, or planting will be used to regenerate jack pine. Consider that natural regeneration on the central floristic sites can take many years to reach full stocking. Regeneration recommendations are to:

a. Separate treatment/prescription types by northern and central floristic regions.
b. Promote natural regeneration through seed tree and small gap harvests in the central floristic region and use clearcuts with appropriate slash management in the northern floristic region.
c. Regenerate jack pine from local seed sources on these sites to preserve the natural diversity of these drought-tolerant populations.
d. Conduct brush and sod control when necessary, manage for prairie grasses and forbs (ground layer) in appropriate NPCs, use prescribed burning (understory and light slash burns) when possible, and discourage establishment of invasive or cool-season sod-forming grass species.
e. Consider mixing some other species that are appropriate to the site and NPC with jack pine when seeding or planting to regenerate some jack pine stands. Other species that may be included in smaller proportions are white pine and red pine.

4.9D Cover Type Conversion Management

Conversion Goals: The 10-year goal is to increase the jack pine cover type by 38 percent (5,500 acres). The 50-year goal is to increase the current acreage by 84 percent (12,169 acres). Table 4.9b shows the desired changes by subsection for year 2017 and for the subsections combined for 2057.

Conversion of other cover types to a stand dominated by jack pine will be accomplished by regenerating stands harvested in the FDn12, FDc12, FDc23, FDc24, and FDc25 NPC classes to jack pine. These stands will be primarily cutover areas, aspen, white spruce plantations on fire-dependant sites, dry oak sites in the PMOP, and red pine plantations. Priority LTAs for jack pine cover type increase include: Bemidji Sand Plain, Crow Wing Sand Plain, Park Rapids Sand Plain, Itasca Moraine Steep, and Two Inlets Moraine. Conversion to jack pine will likely be most successful in the higher scoring areas of the CP-PMOP *Potential Pine Woodland Areas* layer (see Appendix R). This layer was developed by overlaying woodland soil polygons with pre-settlement Jack Pine Barrens and Openings and GAP jack pine and red pine land cover data.

4.9E Stand Selection Criteria

1. Normal Rotation Forest: The normal rotation age of 40 will be used for calculating a regulated harvest level in the CP-PMOP. Historically an older rotation age was used (60 years) to manage jack pine. The rotation age used in this Plan (40 years) is lower than used in the past in an effort to capture volume before impacts from insect, disease and wind events.

Table 4.9c Jack Pine Normal Rotation Age and Maximum Age

Subsection	Normal Rotation Age	Maximum Age
CP	40	65
PMOP	40	65

The objective is to move the age-classes toward a more balanced structure. The priority during this 10-year management period is to select the oldest and highest scoring stands for treatment.

A *Stand Scoring System* was implemented which assigned scores to stands in the following priority: stands that were currently over maximum age; over maximum age within 10 years; currently beyond normal age; and, currently less than normal age. The *Stand Scoring System* considered both normal pool acres and ERF acres (see Appendix K).

2. Normal Rotation Harvest Treatment Level Calculations: The pool of stands considered for normal rotation (see glossary) harvest treatment is all stands:

a. not reserved from harvest (e.g. old growth, EILC);
b. not designated to be managed as extended rotation forest (ERF); and
c. near normal harvest rotation age.

Harvest treatment level is the sum of acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure. Once a balanced age-class structure is achieved stands can be scheduled for treatment upon reaching normal rotation age.

3. Extended Rotation Forest: The harvest level will be based on an ERF rotation age of 60 years. The long-term DFFC goals are to retain 15 percent of the cover type acreage over the normal rotation age to provide a declining age-class structure out to the maximum harvest age (see Figure 4.9b).

Table 4.9d Jack Pine ERF Acres (Plan Target Acres) and Maximum Age

Subsection	Prescribed ERF Acres	Effective ERF / DFFC Acres	Maximum Age
CP-PMOP	6056	2,163	65

4. Extended Rotation Harvest Treatment Level Calculations: The pool of stands considered for extended rotation harvest treatment is all stands

a. not reserved from harvest (e.g. old growth, EILC);
b. designated to be managed as extended rotation forest (ERF);
c. and will be over normal harvest rotation age.

Extended rotation harvest treatment level is the sum of ERF acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure, while attempting to retain the a minimum level of effective ERF. A declining acreage of stands in each 10-year age-class is desired between normal rotation age and maximum rotation age. Emphasis is on treating the oldest age-classes to minimize loss of fiber to tree mortality. Very few stands should be allowed to go untreated beyond the maximum rotation age (see Glossary).

4.9F Stand Treatment Summary

Table 4.9e shows the total treatment acres, recommended conversion acreage out of the jack pine cover type, old forest percent, effective ERF percent, and the average treatment ages for the next six decades. Based on the cover type management identified in this Plan, the average treatment age for jack pine cover type decreases during first two decades then increases reflecting the goal of maintaining more conifers on the landscape. Old Forest Percent means acres that are over normal rotation age, except

stands designated as Old Growth. There is variation from decade to decade because of the current age-class distribution of the cover type.

Table 4.9e Jack Pine Treatment Summary by Decade

Decades	Total Treatment	Conversion	Old Forest %	Effective ERF	Avg Treatment Age		Avg Age
					Normal	ERF	
1	3,076	0	62.1%	28.5%	68	79	43
2	4,528	0	33.8%	16.5%	64	78	29
3	2,460	0	17.9%	11.1%	52	77	22
4	2,361	0	12.4%	7.1%	51	69	23
5	3,206	0	11.7%	7.7%	45	59	26
6	5,643	0	27.5%	13.6%	49	54	28
Total	21,274	0					
DFFC	**5,318**[1]	**12,170**[2]		**13.8%**	**40.0**[3]	**60.2**[3]	**24**[3]

[1] Total Treated Acres once a fully regulated forest is achieved.
[2] positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
[3] anticipated age once a fully regulated forest is achieved.

Figure 4.9c identifies the age-class structure of the jack pine cover type in 2017 at the end of the 10-year plan implementation period.

Figure 4.9c

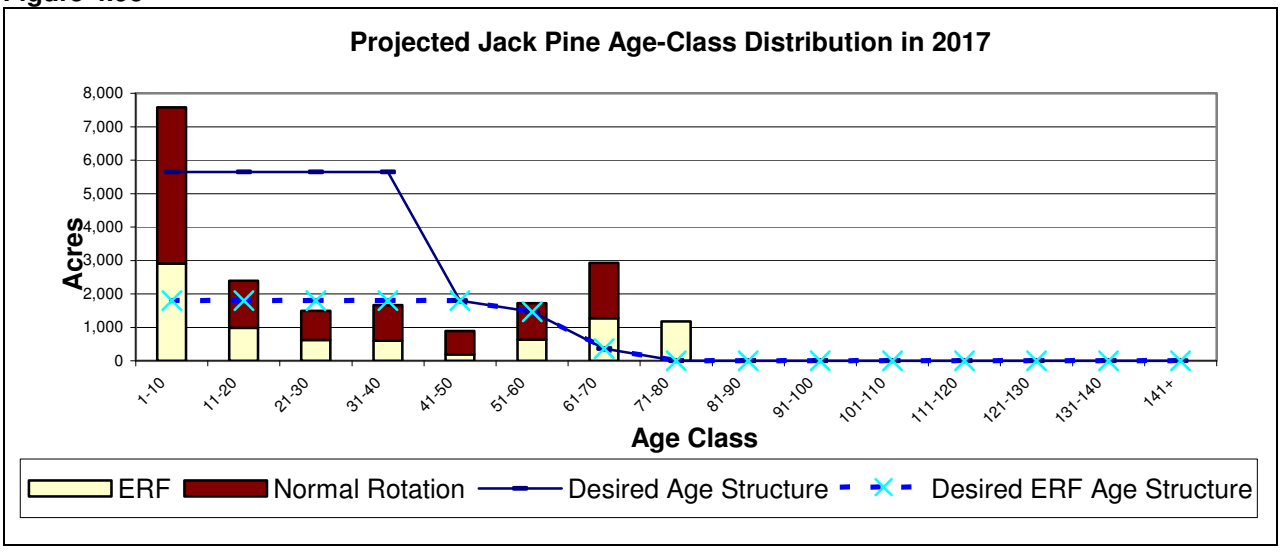
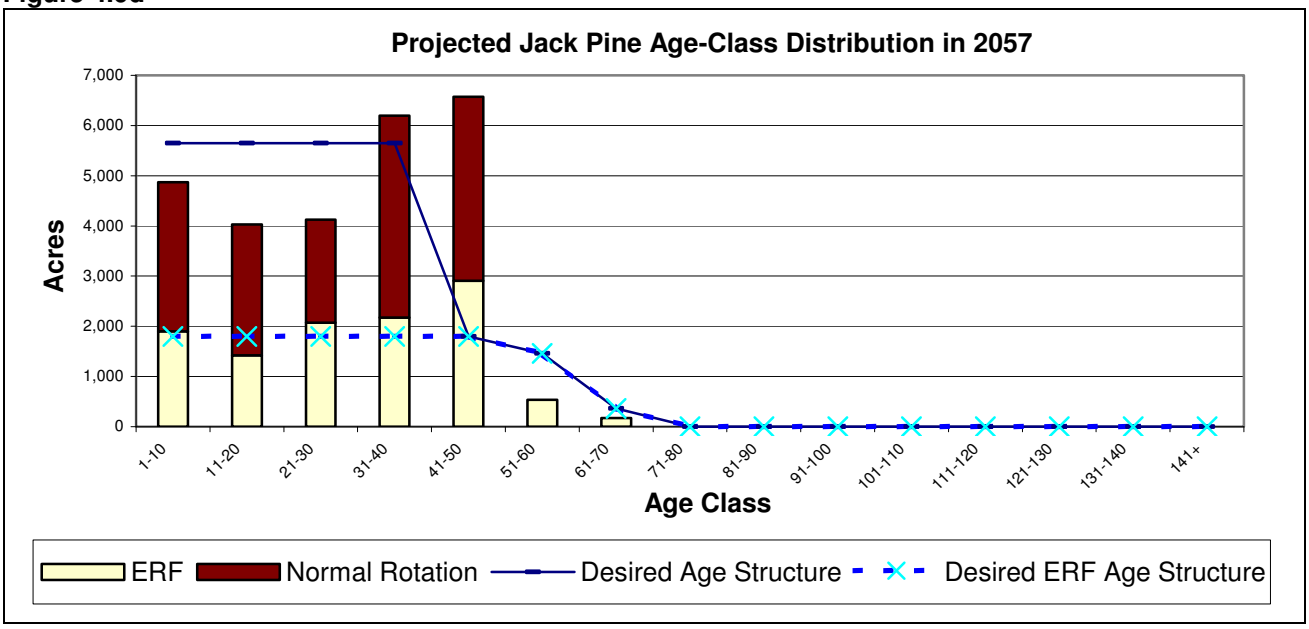


Figure 4.9d identifies the age-class structure of the jack pine cover type in 2057. Based on the modeling of these treatment levels, by the end of the fifth decade the cover type moves toward more consistency with the desired age-class distribution.

Figure 4.9d



As each new 10-year plan is developed, the treatment levels by decade and modeling will be re-evaluated.

4.10 Black Spruce Lowland (BSL)

4.10A Current Condition

1. Cover Type Characteristics: In 2007, the lowland black spruce cover type comprises 6.4 percent (27,677 acres) of the state timberlands (429,229 acres) managed in the CP-PMOP Subsections (see Table 4.10a). The black spruce cover type is mainly located in the Deer River and Blackduck Forestry Areas. Considering both site indexes for the CP and PMOP, approximately 2,657 acres have been designated as EILC and reserved from treatment for this plan implementation period.

Table 4.10a Lowland Black Spruce Cover Type Acres by Subsection

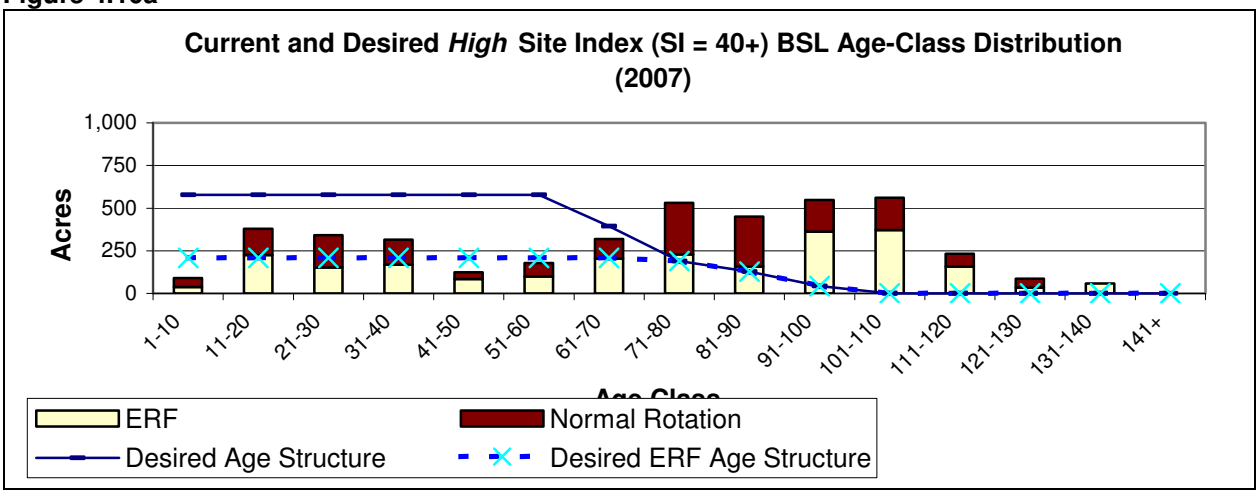
	CP	PMOP	Total
Acres	25,565	2,112	27,677
Percent	92	8	100

Black spruce is an excellent competitor in the FPn63, FPn82, FPs63, APn80, and APn81 wetland forest communities (i.e., NPCs).

2. Age-Class Distribution: The lowland black spruce cover type (BSL) has been divided into two site index groups (SI 40+, and SI 23-39) for determining harvest rotation ages and allowable treatment acres. Low site index BSL can be grown to a much longer rotation age than high site index. In both of the subsections, the current age-class distribution of the BSL cover type does not reflect the balanced age-class structure desired for even-aged managed cover types. The current age-class distribution is skewed toward older age-classes, with significant acreage being older than maximum rotation age.

Figure 4.10a shows the current and desired age-class distribution of BSL High Site Index for the combined two subsections.

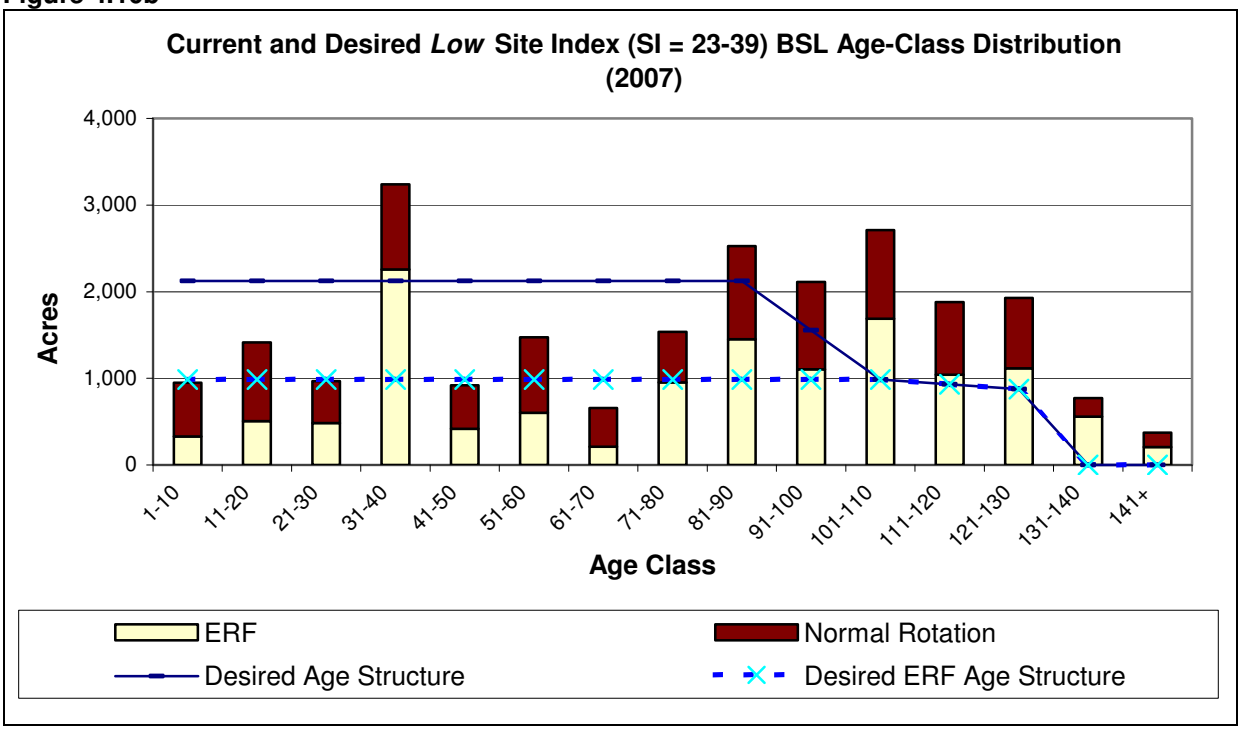
Figure 4.10a



3. Stand Composition: The BSL cover type is generally dominated by black spruce but there may be secondary species such as tamarack and white cedar present in stands.

Figure 4.10b shows the current and desired age-class distribution of BSL low site index for the combined two subsections.

Figure 4.10b



Within the two subsections, approximately 38 percent of non-ERF BSL acres are currently over the recommended normal rotation age.

4.10B Future Direction

1. Cover Type Acres: Both the 10-year DFFC and the 50-year DFFC for the BSL cover type acreage is to remain fairly consistent. No deliberate losses or gains are recommended, although minor changes may occur due to inventory updates.

2. Age-Class Distribution: A goal is to move the BSL age-classes toward a more balanced structure. Figures 4.10c and 4.10d show the desired age-class distribution of BSL by site index group.

Figure 4.10c

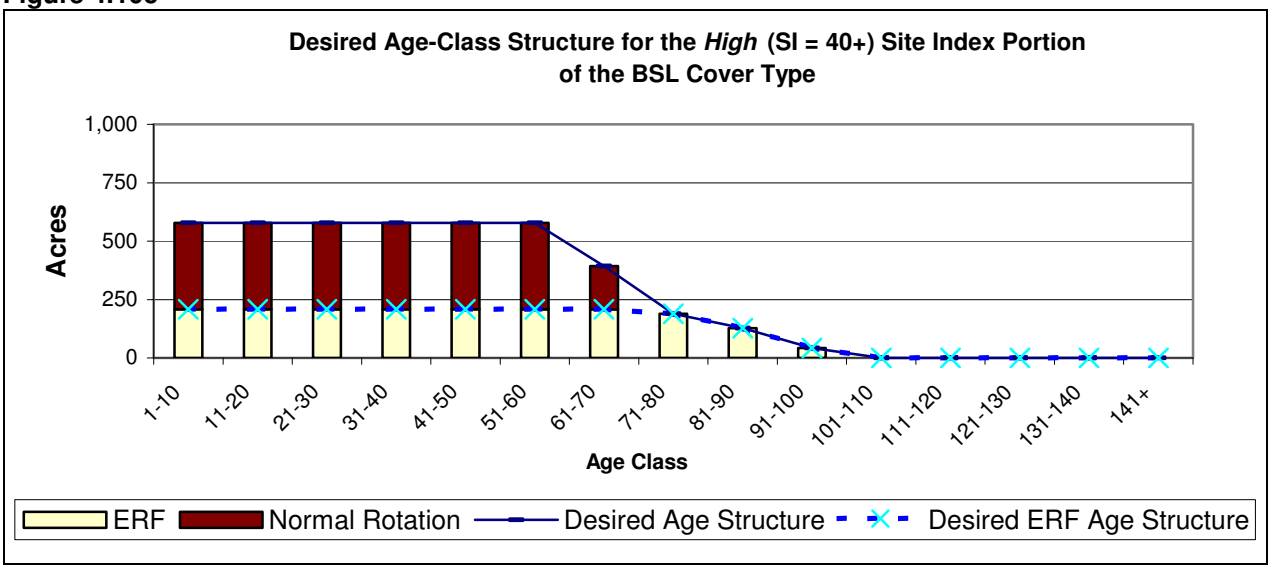
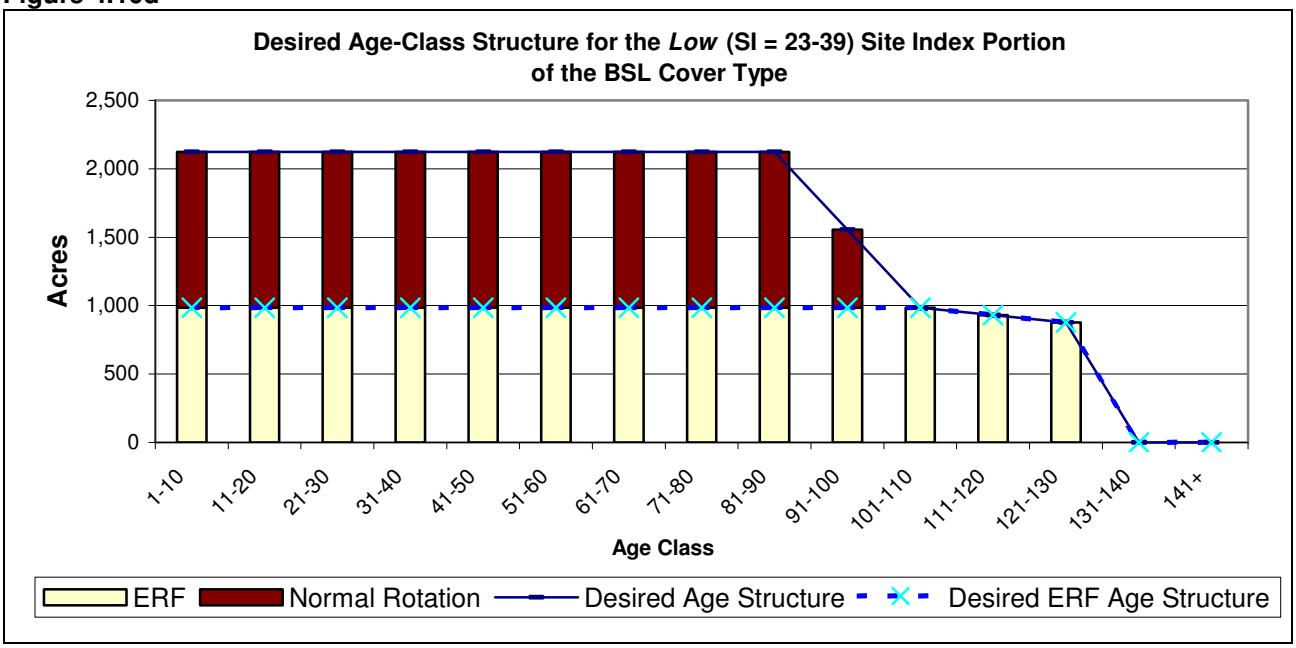


Figure 4.10d



The older age-classes will be managed with enough older stands deferred (i.e. ERF) to provide an adequate declining age-class distribution to the maximum age. The ERF goal for BSL Low Site Index is to maintain 14 percent of the acres over normal rotation age (i.e. effective ERF) at any one time. The ERF goal for BSL High Site Index is to maintain 11 percent of the acres over normal rotation age at any one time.

3. Stand Composition: The desired composition will range from pure black spruce to mixed coniferous stands, depending on the plant community appropriate to the site. Appropriate NPCs for this cover type include Apn80, Apn81, FPn63, FPn82, and FPs63.

As part of the *Silvicultural Prescription Worksheet*, field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

4. Patch Management Objectives: Patch management objectives include: creating more large patches; identifying both younger and older forest patches; and, in particular, increasing the patch size and age-class distribution of all lowland conifers.

5. Limiting Factors: Many stands in the BSL cover type are infected with dwarf mistletoe, a slow spreading disease that deforms and ultimately kills individual trees. A primary goal is to use harvesting techniques to regenerate infected stands while minimizing volume and sustainability losses. To the extent possible, infected stands will be selected for field visit and potential treatment during the 10-year plan implementation period.

4.10C Stand Management

1. Even-Aged Management Direction: The BSL cover type will be managed on an even-aged basis for pulpwood, while providing forest wildlife habitat and maintaining biodiversity.

2. Final Harvest: BSL will be treated through even-aged management using clear-cuts or clear-cuts with reserves (of secondary species). Where possible, larger blocks (100+ acres), will be harvested using natural stand boundaries.

Secondary component species in BSL stands such as tamarack, white cedar, balsam fir, and paper birch will be maintained.

The spread of eastern dwarf mistletoe to regenerating stands of black spruce is a primary concern in the management of this cover type. All sales should specify that the 5-foot cutting rule be applied unless another management method is specifically described in the stand's harvest prescription.

The following recommendations for harvest and post sale treatment are recommended to further limit the spread of dwarf mistletoe:

a. During the stand selection process, infected stands will be selected for field visit and potential harvest during this plan implementation period.
b. Black spruce reserve trees are not recommended due to the possibility of spreading dwarf mistletoe to the regenerating stand.
c. All clearcuts should kill all live black spruce greater than 5 feet in height. If the 5-foot recommendation is not used, follow-up inspections and treatments of harvested sites are suggested two years after harvest.
d. If the site is to be prescribed burned, slash should be distributed evenly.
e. Timber sales boundaries should be designed to include mistletoe pockets, plus a two-chain (102 feet) buffer of non-infected black spruce.
f. Follow-up inspection and treatment of harvested sites two years after harvest are suggested, with the intent of killing all remaining black spruce that are 5 feet and taller on the site.

3. Harvest Prescriptions: Following are the most common prescriptions that will be used on black spruce timber sale acres:

a. Clear-cut followed by natural seeding.
b. Clear-cut with reserves followed by natural seeding.
c. Clear-cut followed by artificial seeding.
d. Clear-cut with reserves followed by artificial seeding.

4. Regeneration Methods: Natural seeding or artificial seeding will be used to regenerate black spruce stands after harvest.

To reduce dwarf mistletoe infection in newly regenerating stands:

a. Use prescribed fire or winter shearing to remove all residual infected trees if they are not removed during timber harvest.
b. Regenerate densely-stocked stands of black spruce because mistletoe spreads more slowly and causes less damage in dense stands than in open ones.

4.10D Stand Selection Criteria

1. Normal Rotation Forest: Two site index groups were used with two corresponding normal rotation ages as shown on Table 4.10b.

Table 4.10b: Lowland Black Spruce Normal Rotation Age and Maximum Age

Site Index	Acres	Normal Rotation Age	Maximum Age
23-39	23,460	95	100
40+	4,217	65	95

The objective is to move the age-classes in each site index group toward a more balanced structure. The priority during this 10-year management period is to select the oldest and highest scoring stands for treatment. A *Stand Scoring System* was implemented which assigned scores to stands in the following priority: stands that were currently over maximum age; over maximum age within 10 years; currently beyond normal age; and, currently less than normal age. The *Stand Scoring System* considered both normal pool acres and ERF acres (see Appendix K). Not all stands above the normal harvest age will be selected because of the large acreage of stands currently over normal rotation age.

2. Normal Rotation Harvest Treatment Level Calculations (calculated for each of the two site index groups): The pool of stands considered for normal rotation (see *Glossary*) harvest treatment is all stands:

a. not reserved from harvest (e.g. old growth, EILC);

b. not designated to be managed as extended rotation forest (ERF); and
c. near normal harvest rotation age.

Harvest treatment level is the sum of normal rotation acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure. Once a balanced age-class structure is achieved stands can be scheduled for treatment upon reaching normal rotation age.

Adjustments to the normal harvest level were made to meet other goals, such as balancing the age-class distribution and providing relatively stable harvest levels. Lowland conifer stands that have been designated as ecologically important lowland conifers (EILC) will be reserved from harvest during this 10-year plan, but have been included in harvest level calculations.

3. Extended Rotation Forest: Two site-index classes are used for planning. Varying amounts of harvest are applied to age-classes beyond normal rotation age and out to maximum age. Table 4.10c identifies the Prescribed ERF and Effective ERF acres for both site indexes of BSL.

Table 4.10c Lowland Black Spruce ERF Acres (Plan Target Acres) and Maximum Age

Site Index	Prescribed ERF Acres	Effective ERF / DFFC Acres	Maximum Age
23-39	12,645	3,285	130
40+	1,820	464	95
Total	14,465	3,749	N/A

The selection of older-aged stands will be emphasized to help move this subset of ERF stands toward a desirable declining age-class structure. The ERF goal for BSL High Site Index is to maintain 11 percent of the acres over normal rotation age (i.e. Effective ERF) at any one time. The ERF goal for BSL Low Site Index is to maintain 14 percent of the acres over normal rotation age at any one time, and to provide a declining age-class structure out to maximum age (see Figures 4.10e through 4.10i).

4. Extended Rotation Harvest Treatment Level Calculations: The pool of stands considered for extended rotation harvest treatment is all stands:
a. not reserved from harvest (e.g., old growth, EILC);
b. designated to be managed as ERF; and
c. will be over normal harvest rotation age.

Extended rotation harvest treatment level is the sum of acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure, while attempting to retain the a minimum level of effective ERF. A declining acreage of stands in each 10-year age-class is desired between normal rotation age and maximum rotation age. Emphasis is on treating the oldest age-classes to minimize loss of fiber to tree mortality. Very few stands should be allowed to go untreated beyond the maximum rotation age (see *Glossary*).

4.10E Stand Treatment Summary

Tables 4.10d and 4.10e show the total treatment acres, old forest percent, effective ERF percent, and the average treatment ages for the next six decades by site index group. Old Forest Percent means acres that are over normal rotation age, except stands designated as Old Growth. Based on the cover type management identified in this Plan, the average treatment age for black spruce lowland cover type decreases during the plan implementation period (both site index classes). There is variation from decade to decade because of the current age-class distribution of the cover type.

Table 4.10d BSL (SI = 40+) Treatment Summary by Decade

Decades	Total Treatment	Conversion	Old Forest %	Effective ERF	Avg Treatment Age Normal	Avg Treatment Age ERF	Avg Age
1	619	0	62.3%	34.9%	114	126	70
2	657	0	53.6%	32.6%	105	120	63
3	705	0	41.6%	26.0%	104	120	55
4	582	0	30.0%	20.4%	101	115	46
5	580	0	24.0%	17.4%	78	110	42
6	574	0	18.8%	14.7%	72	101	38
Total	3,717	0					
DFFC	**577**1	**0**2		**11.0%**	**65.0**3	**87.2**3	**38**3

1 Total Treated Acres once a fully regulated forest is achieved.
2 positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
3 anticipated age once a fully regulated forest is achieved.

Table 4.10e BSL (SI = 23-39) Treatment Summary by Decade

Decades	Total Treatment	Conversion	Old Forest %	Effective ERF	Avg Treatment Age Normal	Avg Treatment Age ERF	Avg Age
1	3,074	0	37.2%	22.0%	105	105	75
2	2,901	0	33.9%	19.4%	125	100	67
3	2,695	0	30.2%	20.1%	120	100	62
4	2,006	0	23.4%	15.4%	120	100	57
5	2,210	0	19.4%	12.4%	122	100	56
6	1,938	0	15.1%	8.4%	90	100	54
Total	14,824	0					
DFFC	**2,124**1	**0**2		**14.0%**	**95.0**3	**126.1**3	**57**3

1 Total Treated Acres once a fully regulated forest is achieved.
2 positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
3 anticipated age once a fully regulated forest is achieved.

Figures 4.10e and 4.10f below illustrate the age-class structure of the BSL cover type in 2017 at the end of the 10-year plan implementation period for the two site indexes.

Figure 4.10e

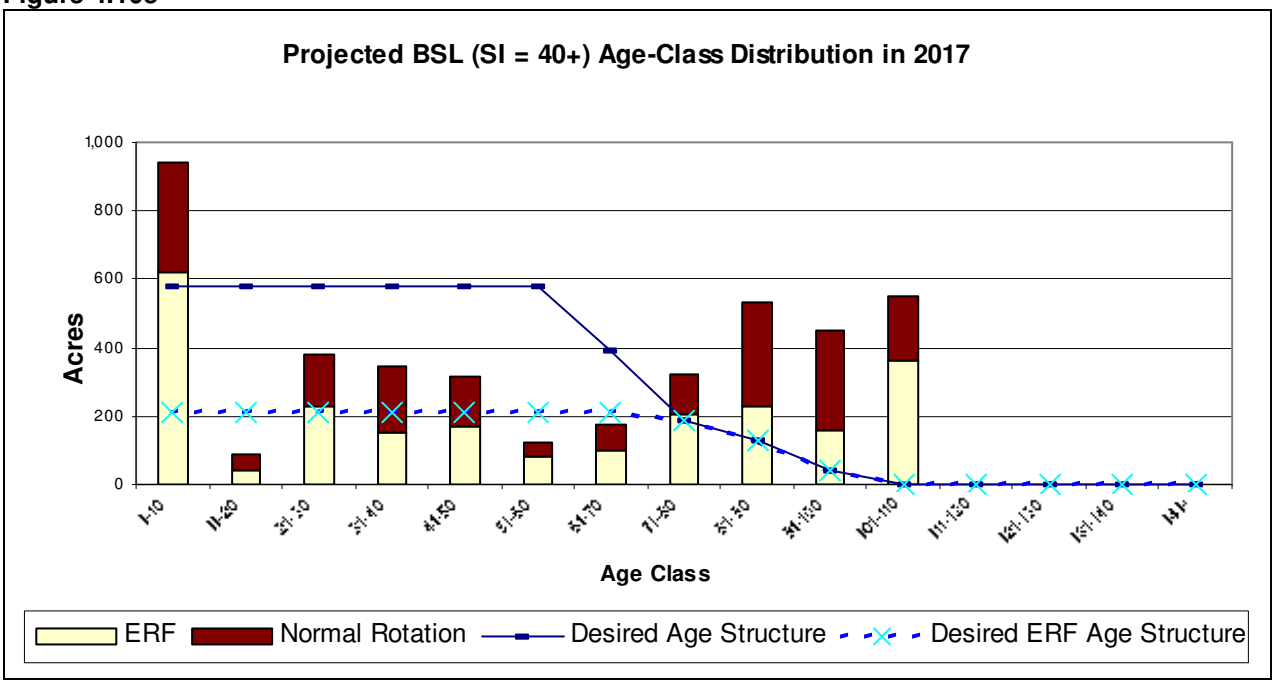
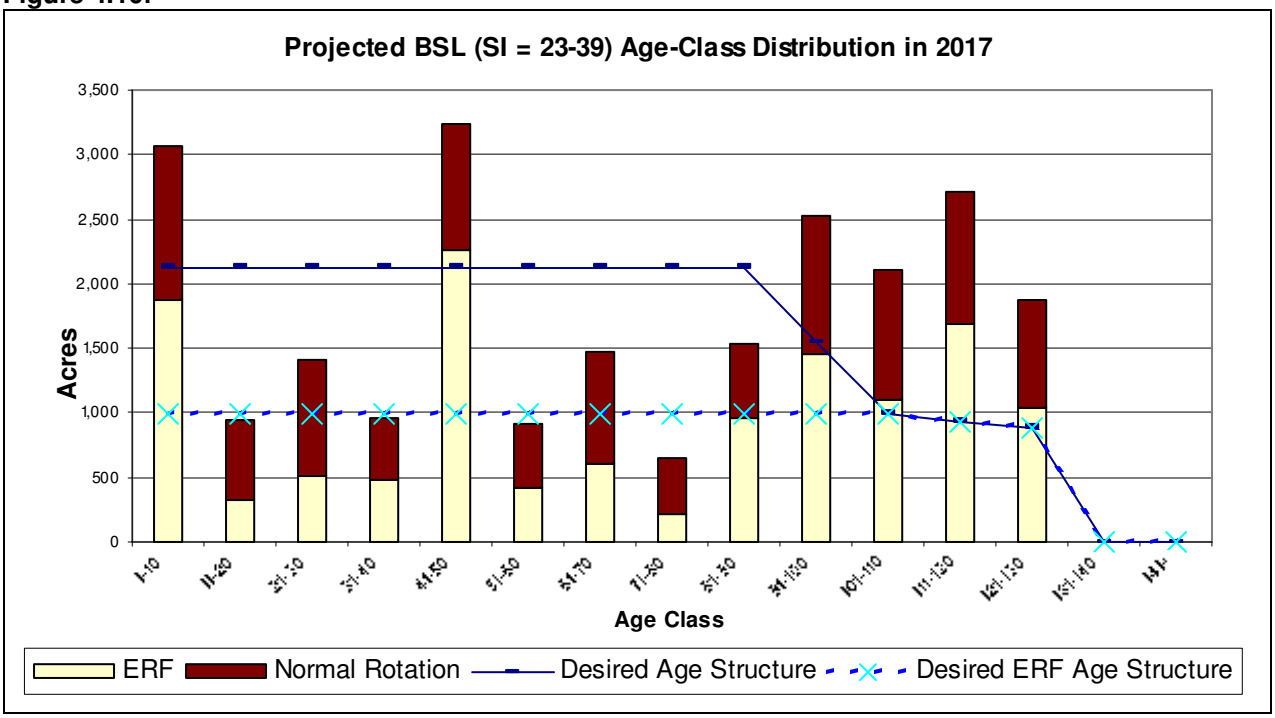


Figure 4.10f



Based on the modeling of the treatment levels by decade, Figures 4.10g and 4.10h show the projected age-class distributions in 2057 for the two site indexes in the BSL cover type.

Figure 4.10g

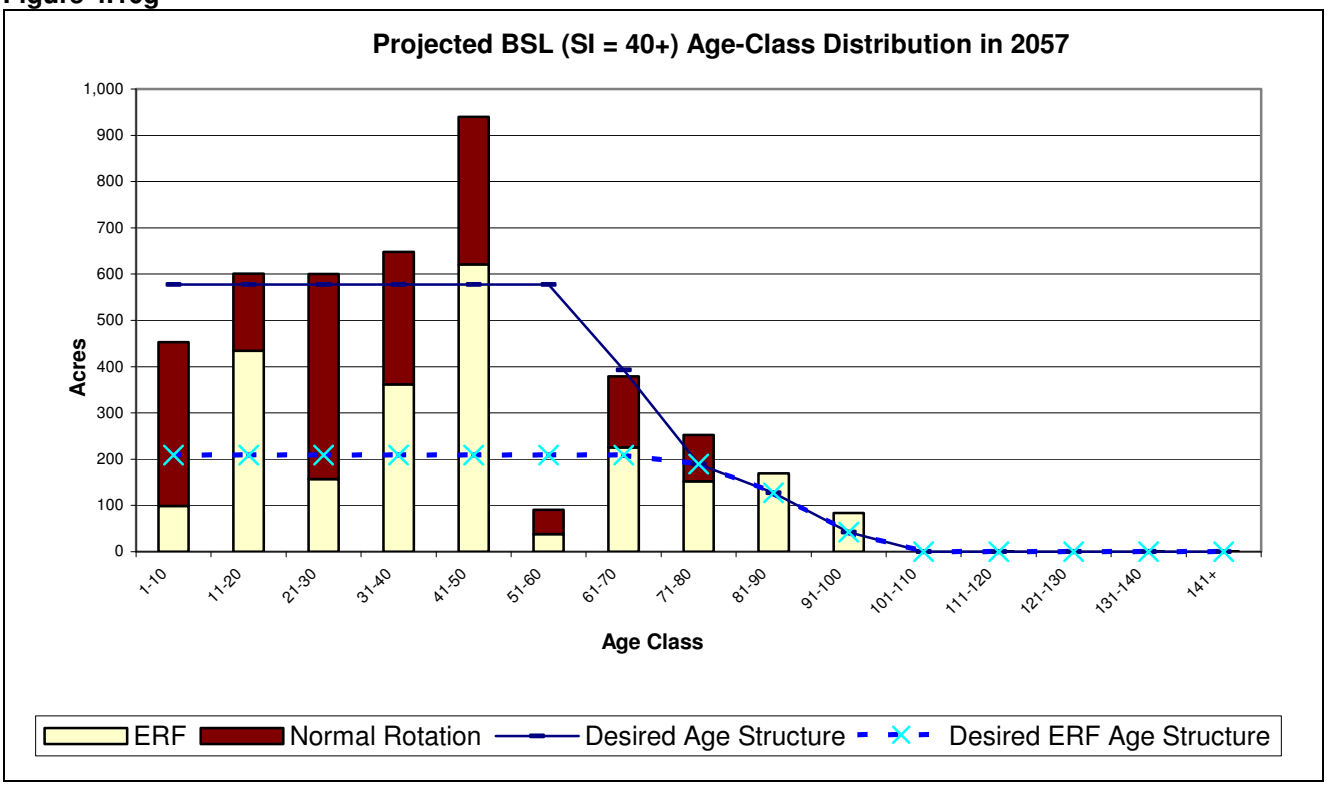
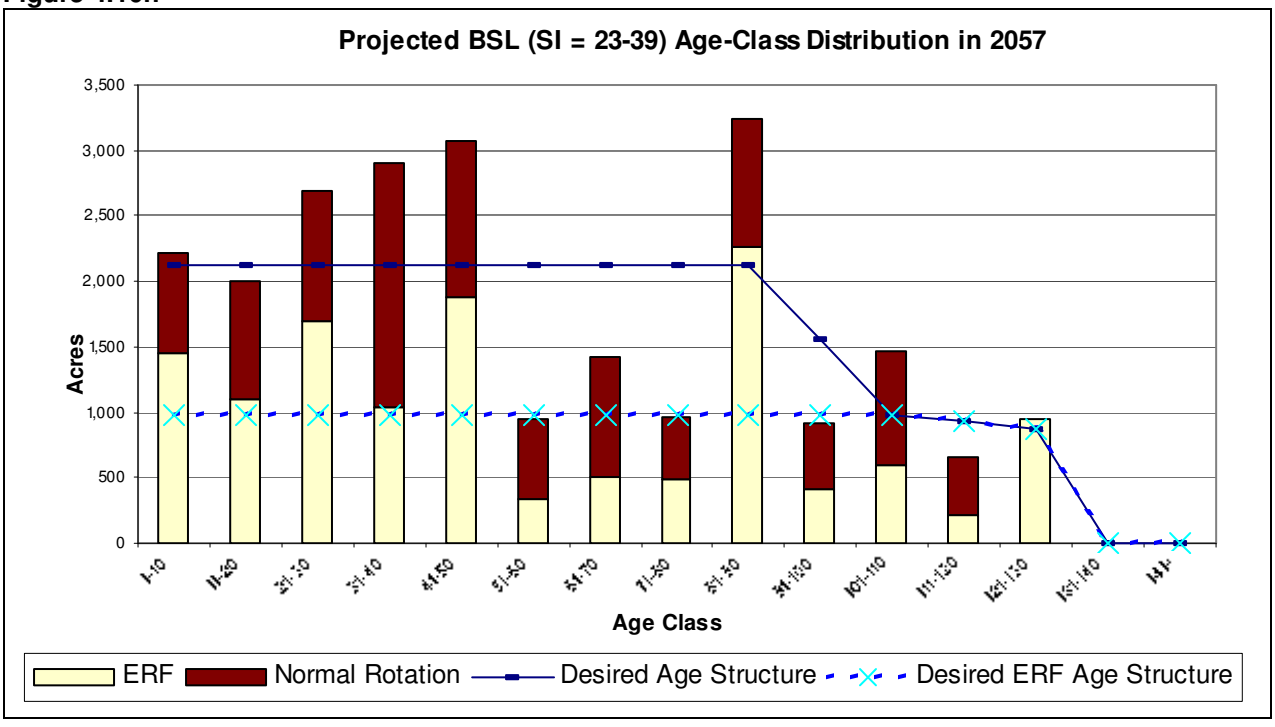


Figure 4.10h



As each new 10-year plan is developed, the treatment levels by decade and modeling will be re-evaluated.

4.11 White Spruce (WS)

4.11A Current Condition

1. Cover Type Characteristics: In 2007, the white spruce cover type comprises about 1.5 percent (7,089 acres) of state timberlands (429,229 acres) managed in the CP-PMOP subsections. Forty-three percent of this cover type is located in the CP subsection and 57 percent in the PMOP subsection (see Table 4.11a).

Table 4.11a White Spruce Cover Type Acres by Subsection

	CP	PMOP	Total
Acres	3,034	4,055	7,089
Percent	43	57	100%

The native plant communities (NPCs) identified where white spruce is an excellent competitor are FDn43 and MHn44.

2. Age-Class Distribution: The current age-class distribution of both natural and planted white spruce in the CP-PMOP subsections does not reflect the balanced age-class structure desired for even-aged managed cover types. In the two subsections combined, 91 percent of the white spruce cover type is under the recommended normal rotation age of 60 years for natural stands, and 50 years for planted. Figure 4.11a identifies the current age-class structure of natural white spruce and Figure 4.11b identifies the current age-class structure for planted white spruce.

Figure 4.11a

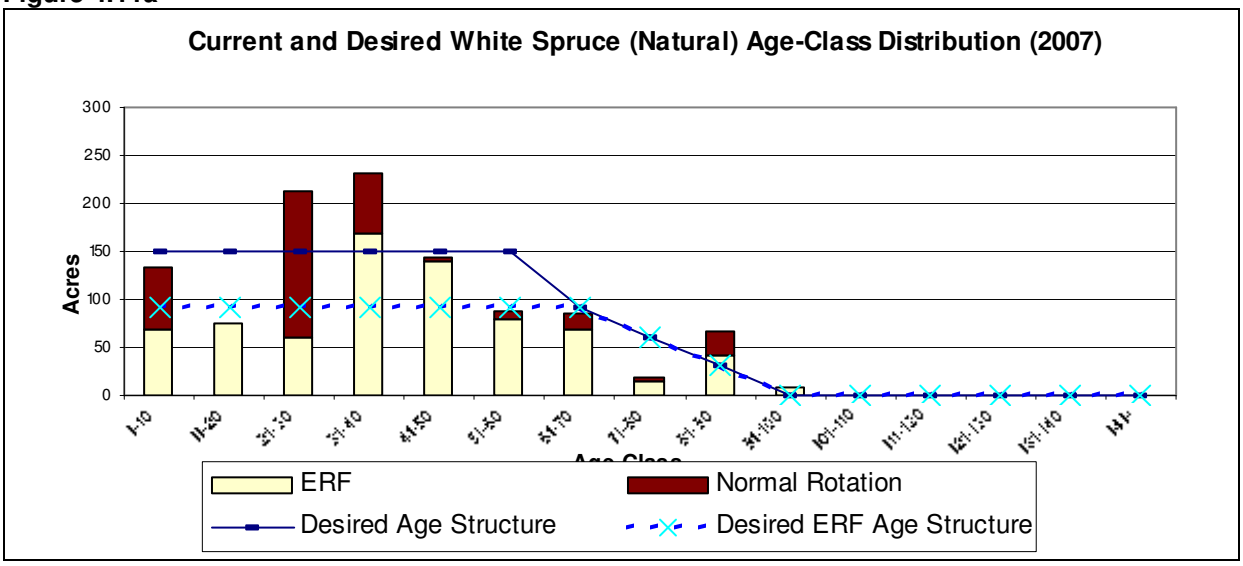
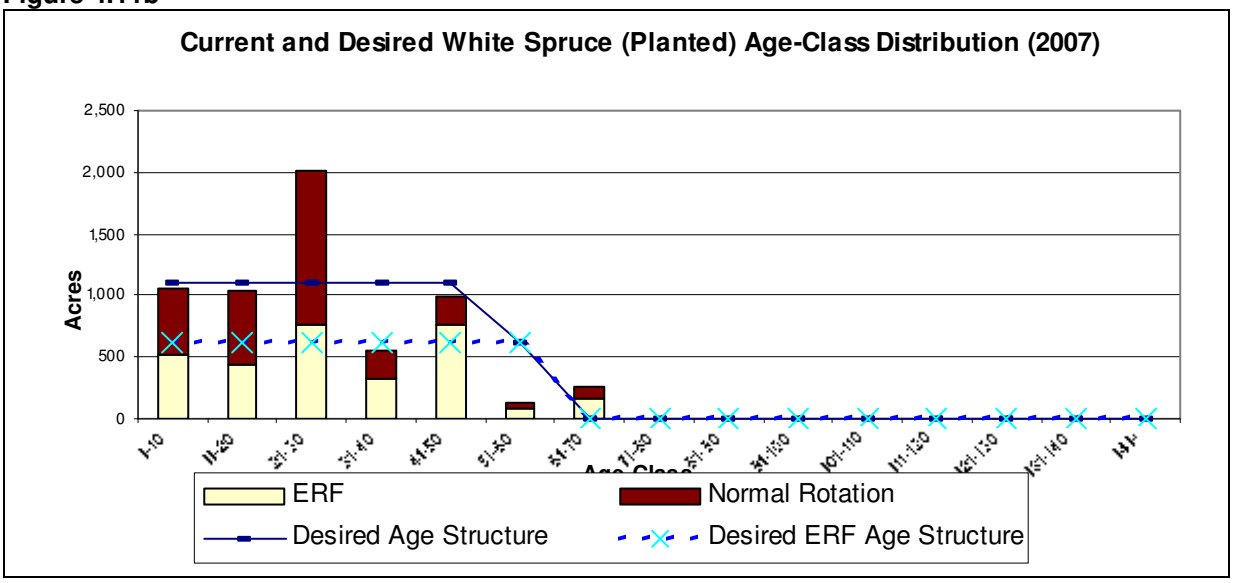


Figure 4.11b



3. Stand Composition: Most of the older, natural origin white spruce stands have a mixed coniferous-deciduous canopy with varying amounts of quaking aspen, paper birch and balsam fir. They also have smaller amounts of white pine, tamarack, or black spruce depending on landscape context, site conditions, and management history. Natural origin white spruce will be managed on a normal rotation age of 60 years. Approximately 85 percent of white spruce cover type less than 50 years old, originated as plantations and is being managed primarily as a single species on a normal rotation age of 50 years. As part of the *Stand Silvicultural Prescription Worksheet*, field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

4.11B Future Direction

1. Cover Type Acres: The 10-year DFFC is to decrease this cover type by 1 percent (net conversion of 50 acres). The 50-year DFFC is to increase the acreage in this cover type by two percent (net increase of 145 acres) across both subsections.

Table 4.11b Recommended White Spruce Cover Type Acres by Subsection by Year

Subsection	2007	2017	2057
CP	3,034	3,215	NA
PMOP	4,055	3,824	NA
Total acres	**7,089**	**7,039**	**7,233**

The 10-year net decrease will be accomplished by conversion of 1,000 acres to jack pine with an increase in white spruce acres from aspen (700 acres), balsam fir (150 acres) and northern hardwoods (100 acres).

The 50-year net increase will be accomplished through natural or artificial conversion by managing several cover types to result in a net increase of white spruce. This will be accomplished by conversion of 2,250 acres of white spruce plantation back to jack pine; 1,700 acres to aspen; 195 acres to balsam; and 500 acres to northern hardwoods.

It should be clarified that the white spruce cover type are net changes. The intent is to convert some white spruce stands to another cover type, while converting other cover types into white spruce stands.

2. Age-Class Distribution: The long-term goal is to move all white spruce cover types toward a more balanced age-class structure (See Figures 4.11c and 4.11d).

Figure 4.11c

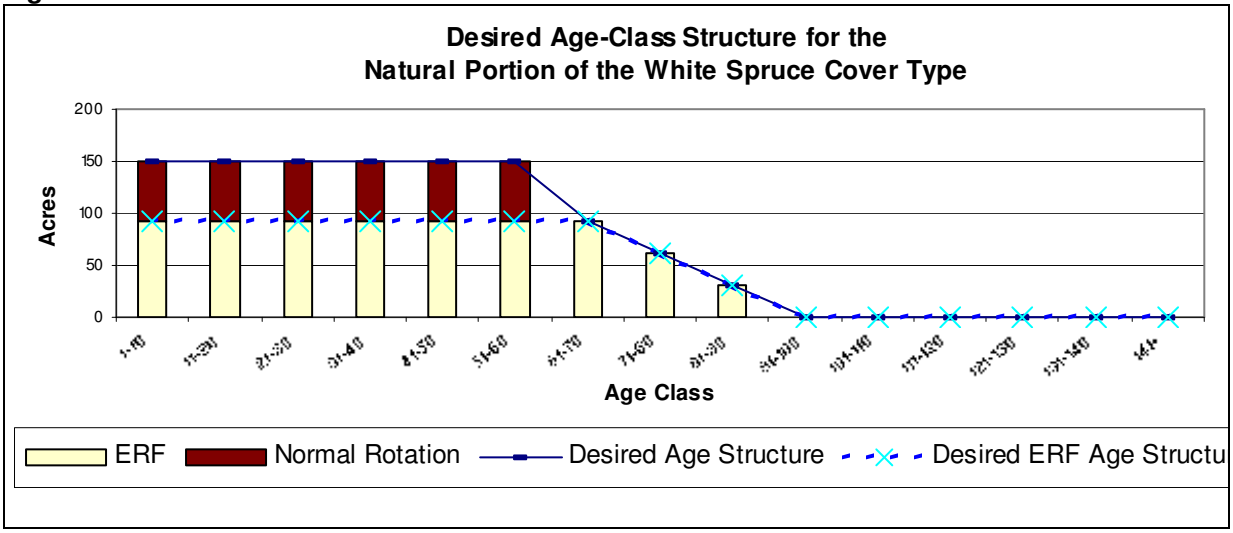
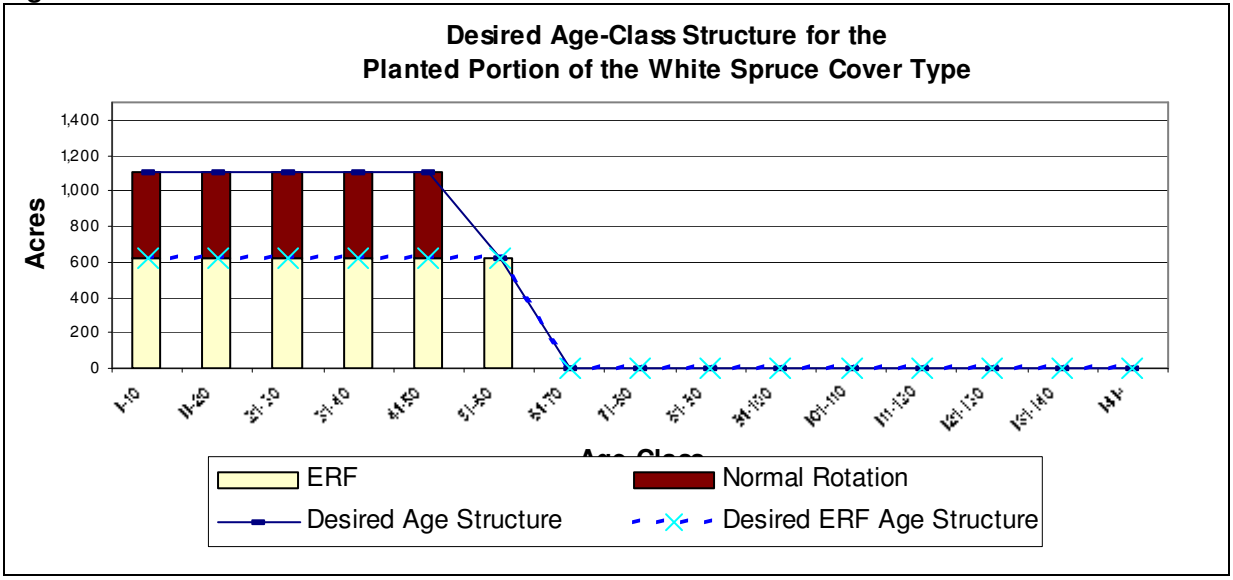


Figure 4.11d



Small portions of ERF and natural origin white spruce stands will be managed as multi-aged and mixed species stands. This type of management will be focused in specific areas such as riparian zones, and special management zones that are part of an Old Forest Management Complex.

3. Stand Composition: White spruce stands will vary from mostly pure white spruce to mixed species stands. A decreasing proportion of the white spruce plantations will be managed as single species, favoring a more diverse stand structure that includes varying amounts of conifers such as white pine, red pine, tamarack, black spruce, balsam fir, upland white cedar, and upland hardwoods such as aspen and birch depending on landscape context, site conditions, and management history. As part of the *Stand Silvicultural Prescription Worksheet*, field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition.

4. Patch Management Objectives: Patch management objectives include: creating more large patches; identifying both younger and older forest patches; and in particular, increasing the patch size and age-class distribution of all lowland conifers.

4.11C Stand Management

1. Even-Aged Management

1.1. Even-aged Management Direction: Planted white spruce will be managed as normal rotation stands on an even-aged basis for pulpwood, bolts, and sawtimber products while moving toward a balanced age-class structure and maintaining or improving site productivity and wildlife habitat.

1.2. Even-Aged Harvest Methods: Harvest methods for normal rotation white spruce stands will include clearcut, shelterwood, or seed tree prescriptions. The use of natural stand boundaries or natural features such as topography and soil type to delineate timber sale boundaries is recommended.

Harvest regulations and techniques should be applied that will favor maintaining or increasing within-stand diversity by reserving from harvest a portion of the hardwoods and other long-lived conifers, and protecting desirable advanced regeneration. These reserve trees will maintain the within-stand species diversity, add structural diversity for the newly regenerating stand, and may also function as a seed source that could aid in increasing the density of these species in the new stand.

The two most common defoliators of white spruce are spruce budworm and yellow-headed spruce sawfly. Reserve trees may mitigate impacts from the sawfly by providing partial overstory shade. When regenerating white spruce stands, efforts should be made to reduce the amount of balsam fir in the stand, since balsam fir is the preferred host for spruce budworm.

1.3 Intermediate Harvest Methods:

a. Thinning will be used to reduce stand density to increase future tree growth, quality, and vigor, and to reduce the risk of spruce budworm outbreaks and damage. Recommendations are:
    - Thinning in normal rotation stands will occur in merchantable stands at approximately 10-year intervals, depending on site quality.
    - Older stands of ERF may have longer intervals (15 – 20 years) between thinnings to compensate for slower growth rates and to facilitate the growth of desirable understory species.
    - In multi-aged stands, residual basal area may be modified to meet ERF and other objectives. Examples are: 1) to encourage within stand diversity and 2) maintain higher residual basal areas because of the larger diameter of older trees.

b. Thinning in normal rotation and ERF stands will maintain (especially in natural origin stands) or increase within-stand diversity, while retaining white spruce as the main cover type by the following methods:
    - Reserve from harvest, or regenerate individual trees or patches of other tree species appropriate to the site, where possible. Efforts should be made to reduce the amount of balsam fir in the stand, since balsam fir is the preferred host for spruce budworm.
    - Protect advanced regeneration of desirable understory species, where possible.
    - Consider creating or maintaining variable densities within stands when thinning.
    - Higher stand densities (BA) are recommended along stand edges exposed to wind, and along high visual quality corridors such as major roads and lakes.
    - Attempt to retain shrub and forb species diversity appropriate to the site during management activities. An example to achieve this is to locate thinning rows or landings to avoid disturbance of some patches of shrubs or forbs.

c. If the stand is used as a thermal cover area by deer, consider applying one of the following options:
    - Maintain a higher stand basal area (e.g., wider reserve strips with canopy closure).
    - Thin only a portion of the stand.
    - Don't thin.

1.4 Thinning Prescriptions: Prescriptions for thinning include:

a. Row thin.
b. Strip thin
c. Selective thin.

d. Thin only when the ground is frozen and snow is present.
e. Conduct the first thinning before the plantation is 30 years old.

1.5. Even-Aged Management Prescriptions: The following are the most common prescriptions that will be used on normal rotation, white spruce timber sale acres:

a. Clearcut with Reserves.
b. Clearcut followed by artificial regeneration (planting or seeding).
c. Clearcut with Reserves followed by artificial regeneration (planting or seeding).
d. Seed Tree.
e. Shelterwood.

Some research shows that light shade will aid survival and promote healthier and more vigorous growth.

2. Uneven-Aged Management

2.1 Uneven-aged Management Direction: This is recommended specifically for riparian areas and other identified special management zones where even-aged management isn't appropriate. This management will only occur in natural white spruce cover types or ERF white spruce stands. Uneven-aged managed stands should result in multi-canopy, mixed species conditions that are desired on specific sites. Recommendations include:

a. Retain some supercanopy trees (e.g. white spruce, white pine, or other species) in patches or clumps at each treatment.
a. Encourage multi-layered understory development.
b. Emphasize regenerating white spruce in the understory.
c. Increase the amount of non-host tree species such as pines and hardwoods in the stand.

2.2 Uneven-Aged / Multi-Aged Management Prescriptions: Single-tree and group selection harvest methods should be used where multiple ages already exist in the stand. Where the stand is currently even-aged, shelterwood, seed tree with reserves, or group selection harvest methods may be needed to move the stand toward a multiple-aged stand. The following are the most common management prescriptions that will be used for white spruce ERF stands:

a. Group Selection
b. Single Tree Selection / Selective Tree Harvest
c. Seed Tree with Reserves
d. Shelterwood with Reserves

3. Limiting Factors

White spruce is usually a component of stands and is rarely found as a "pure" stand. Their root systems are shallow, so they are easily damaged during thinning. Declines observed in thinned white spruce plantations are likely due to thinning damage, attack by opportunistic insects (spruce weevil, spruce beetle, etc.), and to needlecast diseases. Spruce budworm is occasionally a defoliator in these subsections and can lead the white spruce stand into a decline.

a. Plant white spruce seedlings under a light overstory of aspen or aspen/birch as this discourages three insect pests that cause seedling mortality and impact height growth.
b. Thin only when the ground is frozen and snow is present.
c. Conduct the first thinning before the plantation is 30 years old.

Some observations indicate that white spruce stands may decline as a result of multiple stand entries to thin.

4. Regeneration

4.1 Regeneration Methods: After final or selective harvest, following are recommendations to consider when regenerating white spruce stands:

a. Use prescribed fire, mechanical scarification, or herbicides to site prep for natural or artificial seeding or planting.
b. During site preparation, discriminate against balsam fir and maintain non-host tree species such as pines and hardwoods in the stand to reduce the risk of spruce budworm infestation.

c. Consider within-stand diversity goals when determining the method, timing, and intensity of the site preparation or release so that species composition and structure within the stand is allowed to develop. For example, reduce the concentration of herbicide used or use a less intense method than rock raking.
d. Consider using techniques that make plantations look more like naturally regenerated stands.
    - Retain advanced regeneration of desired species from the previous stand.
    - Plant fewer trees per acre to allow other species to develop.
    - Plant trees at varied densities.
e. When regenerating spruce-fir stands, emphasis should be given to regenerating the white spruce and not the balsam fir, and also to increase the amount of non-host tree species such as pines and hardwoods in the stand.
f. After treatment of ERF stands, consider underplanting or artificial seeding of white spruce and other desired species to supplement natural seeding.

4.11 D Cover Type Conversion Management

1. Conversion Goals and Approach: The DFFC goal over the next 10-years is a net reduction of the white spruce cover type by 1 percent (50 acres). This net reduction will result from converting 1000 acres of the white spruce to jack pine on sites that were jack pine before being planted to white spruce. The 10-year DFFC goal also includes converting 950 acres to a white spruce cover type from 700 acres of aspen, 150 acres of balsam fir, and 100 acres of northern hardwoods. Locations for conversion of these cover types, to stands dominated by white spruce will be identified through conversion pool criteria queries and follow up site visits during the next 10-years. These sites will be assessed regarding their native plant community type and related capability for natural or artificial conversion.

Conversion of other forested cover types to a stand dominated by white spruce will be accomplished primarily by converting aspen, balsam fir, and northern hardwood stands. NPC classes where white spruce competes well with other vascular plants and ranks excellent for suitability include: FDn43 and MHn44. Most natural white spruce stands will be in the Mesic Northern Hardwoods and Boreal Hardwood-Conifer Ecosystem Types that were delineated by Shadis (2000). Many of the existing white spruce plantations on dry sites will be converted back to jack pine.

Priority LTAs for increasing the white spruce cover type include: Guthrie Till Plain, Bena Dunes and Peatlands, Rosey Lake Plain, Blackduck Till Plain, and Two Inlets Moraine. These LTAs currently contain 25-plus acres of white spruce cover type (natural stands) on state lands and have shown at least a two-fold decline (BT to FIA), or have shown a severe decline.

4.11E Stand Selection Criteria

1. Normal Rotation Forest: A rotation age of 50 years will be used for calculating a regulated harvest level for planted stands managed under normal rotation. A rotation age of 60 years will be used for calculating a regulated harvest level for natural stands under normal rotation. Table 4.11c identifies normal rotation and maximum rotation ages for planted and natural white spruce.

Table 4.11c White Spruce Normal Rotation Age and Maximum Age

Subsection	Site Index	Acres	Normal Rotation Age	Maximum Age
CP	Natural	461	60	90
CP	Planted	2573	50	60
PMOP	Natural	600	60	90
PMOP	Planted	3455	50	60

The objective is to move the age-classes toward a more balanced structure. The priority during the next 10-years will be to select the oldest and highest scoring stands for treatment. A *Stand Scoring System* was implemented which assigned scores to stands in the following priority: stands that were currently over maximum age; over maximum age within 10 years; currently beyond normal age; and, currently less than normal age. The *Stand Scoring System* considered both normal pool acres and ERF acres (see Appendix K).

2. Normal Rotation Harvest Treatment Level Calculations: The pool of stands considered for normal rotation (see glossary) harvest treatment is all stands:

a. not reserved from harvest (e.g. old growth, EILC);
b. not designated to be managed as extended rotation forest (ERF); and
c. and near normal harvest rotation age.

Harvest treatment level is the sum of normal rotation acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure. Once a balanced age-class structure is achieved stands can be scheduled for treatment upon reaching normal rotation age.

Applying the calculations, as stated above, results in a harvest level of 106 acres per year. Due to relatively small acreage in the older age-classes of normal rotation age stands, only 60 acres were selected for final harvest treatment during this 10-year plan.

3. Extended Rotation Forest: ERF stands (17 percent of the natural and 10 percent of planted white spruce cover type) will be managed as uneven-aged or multi-aged stands with a goal of increasing species and age-class diversity within the stand. Table 4.11d identifies ERF rotation and maximum age for the white spruce cover type. Seventeen percent of natural white spruce cover type was identified as extended-rotation forest in an effort to reflect the typical forest composition associated with OFMCs, special management zones and riparian areas.

4. Extended Rotation Harvest Treatment Level Calculations: The pool of stands considered for extended rotation harvest treatment is all stands:

a. not reserved from harvest (e.g. old growth, EILC);
b. designated to be managed as extended rotation forest (ERF); and,
c. will be over normal harvest rotation age.

Extended rotation harvest treatment level is the sum of ERF acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure, while attempting to retain the minimum level of effective ERF. A declining acreage of stands in each 10-year age-class is desired between normal rotation age and maximum rotation age. Emphasis is on treating the oldest age-classes to minimize loss of fiber to tree mortality. Very few stands should be allowed to go untreated beyond the maximum rotation age (see Appendix V *Glossary*).

Table 4.11d White Spruce ERF Acres (Plan Target Acres) and Maximum Age

Origin	Prescribed ERF Acres	Effective ERF / DFFC Acres	Maximum Age
Natural*	721	180	90
Planted	3616	603	60

* No ERF percentage was offered by the Statewide ERF Workgroup, reflects CP-PMOP Team-developed target

Due to the current age of ERF stands, no stands were selected for final harvest treatment during this 10-year plan implementation period. ERF stands were selected for treatment under the thinning criteria.

5. Thinning: Stands will be identified to be field visited and evaluated for thinning. Stands identified will be:

a. equal to or greater than 15 years old;
b. in a normal timber status; and,
c. of artificial (planted) origin.

The forest inventory will be updated, as needed, based on the field examinations. The field-visit year will be scheduled based on the stand's current age or past thinning year. For example, 15-year-old stands should be scheduled for the last year of the plan, 21-year-old for next to last, etc. This will capture those stands that grow into the recommended DBH and density for thinning during the plan implementation period. Stands that meet the criteria for thinning will be treated through timber sales.

6. Stand treatment criteria include:

a. Natural white spruce stands normal rotation age 30-60 years old.
b. Natural white spruce ERF stands 60-90 years old.
c. Plantation white spruce stands 30-50 years old.
d. Plantation white spruce ERF stands 50-60 years old.

See Sections 4.11B and C for more details on uneven-aged management and intermediate stand treatments.

4.11F Stand Treatment Summary

Tables 4.11e and 4.11f show the total treatment acres, recommended conversion acreage out of the white spruce cover type, and average treatment age over the next six decades for natural and planted white spruce cover types. Based on the cover type management identified in this Plan, the average treatment age for white spruce cover type generally increases over time reflecting the goal of providing more conifers on the landscape. Old Forest percent means acres that are over normal rotation age, except stands designated as Old Growth. There is variation from decade to decade because of the current age-class distribution.

Table 4.11e Treatment Summary by Decade for the Natural Portion of White Spruce

	Acres		Percent		Average Treatment Age		Average Age
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Avg**	**Normal**	**ERF**	
1	128	0	16.7%	12.6%	82	83	37
2	122	0	12.9%	12.2%	66	74	37
3	123	0	15.0%	15.0%	60	77	39
4	155	0	25.2%	25.2%	60	76	41
5	196	0	30.5%	21.5%	70	82	41
6	138	0	19.1%	19.1%	60	88	37
Total	862	0					
DFFC	**147**[1]	**0**[2]		**17.0%**	**60.0**[3]	**80.0**[3]	**37**[3]

[1] Total treated acres once a fully regulated forest is achieved.
[2] positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
[3] anticipated age once a fully regulated forest is achieved.

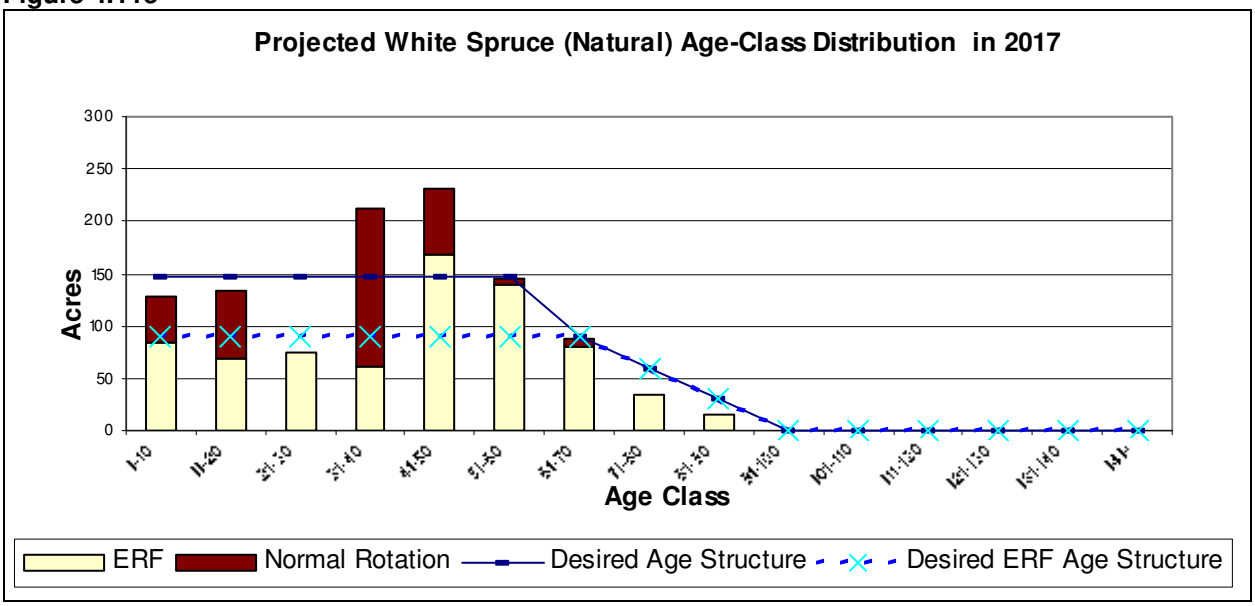
Table 4.11f Treatment Summary by Decade for the Planted Portion of White Spruce

	Acres		Percent		Average Treatment Age		Average Age
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Avg**	**Normal**	**ERF**	
1	1,000	1,000	6.3%	4.1%	55	57	26
2	842	313	6.7%	6.7%	44	60	28
3	1,050	312	5.5%	5.5%	50	53	30
4	1,132	313	17.3%	10.7%	57	63	31
5	1,150	312	15.5%	8.3%	57	61	30
6	1,254	0	17.9%	10.8%	57	60	29
Total	6,428	2,250					
DFFC	**1,111**[1]	**145**[2]		**10.0%**	**50.0**[3]	**60.0**[3]	**28**[3]

[1] Total treated acres once a fully regulated forest is achieved.
[2] positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
[3] anticipated age once a fully regulated forest is achieved

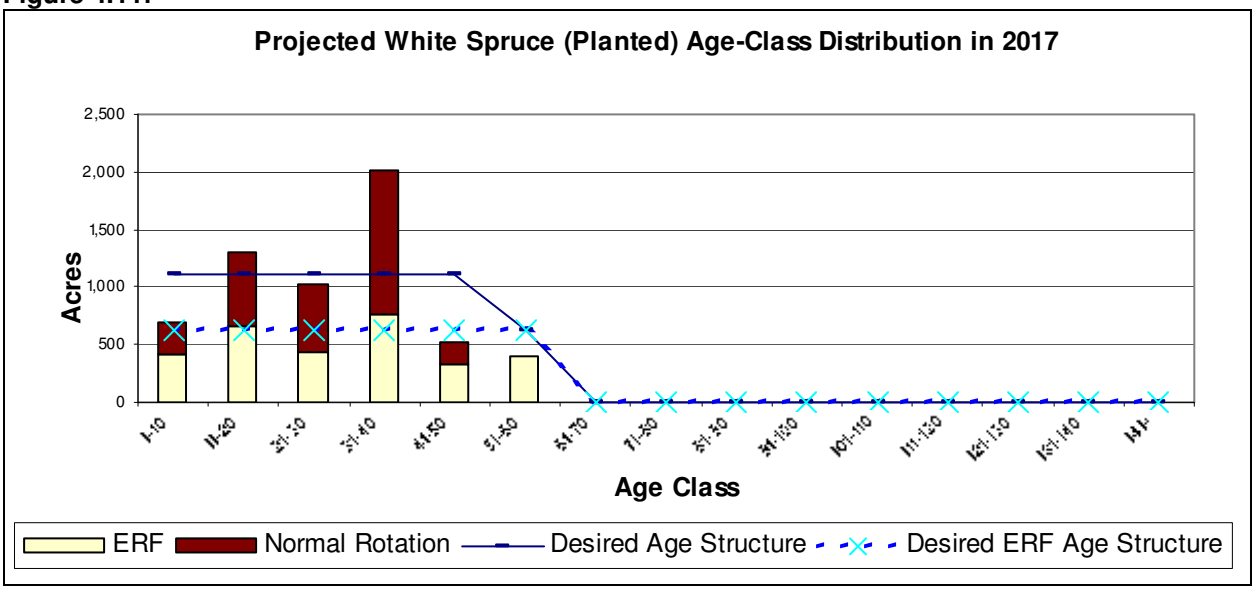
Based on the modeling of the treatment and conversion levels by decade, Figure 4.11e shows the projected age-class distribution in 2017 of the natural white spruce cover type.

Figure 4.11e



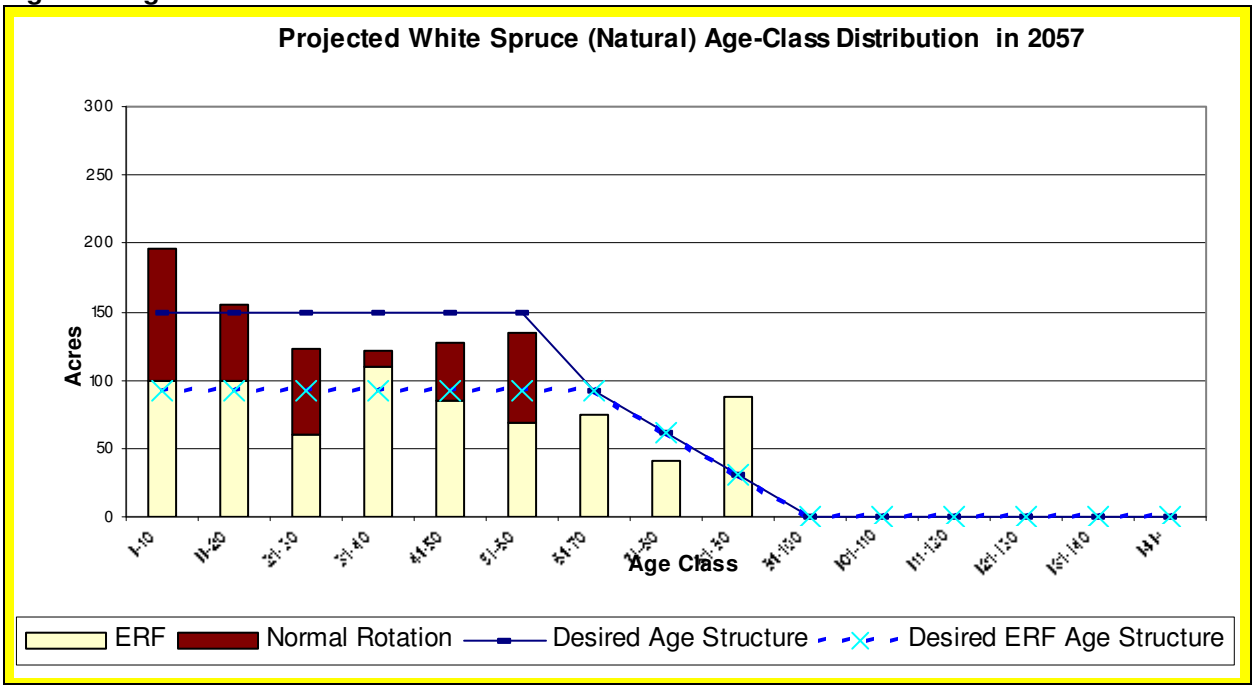
Based on the modeling of the treatment and conversion levels by decade, Figure 4.11f shows the projected age-class distribution in 2017 of the planted white spruce cover type.

Figure 4.11f



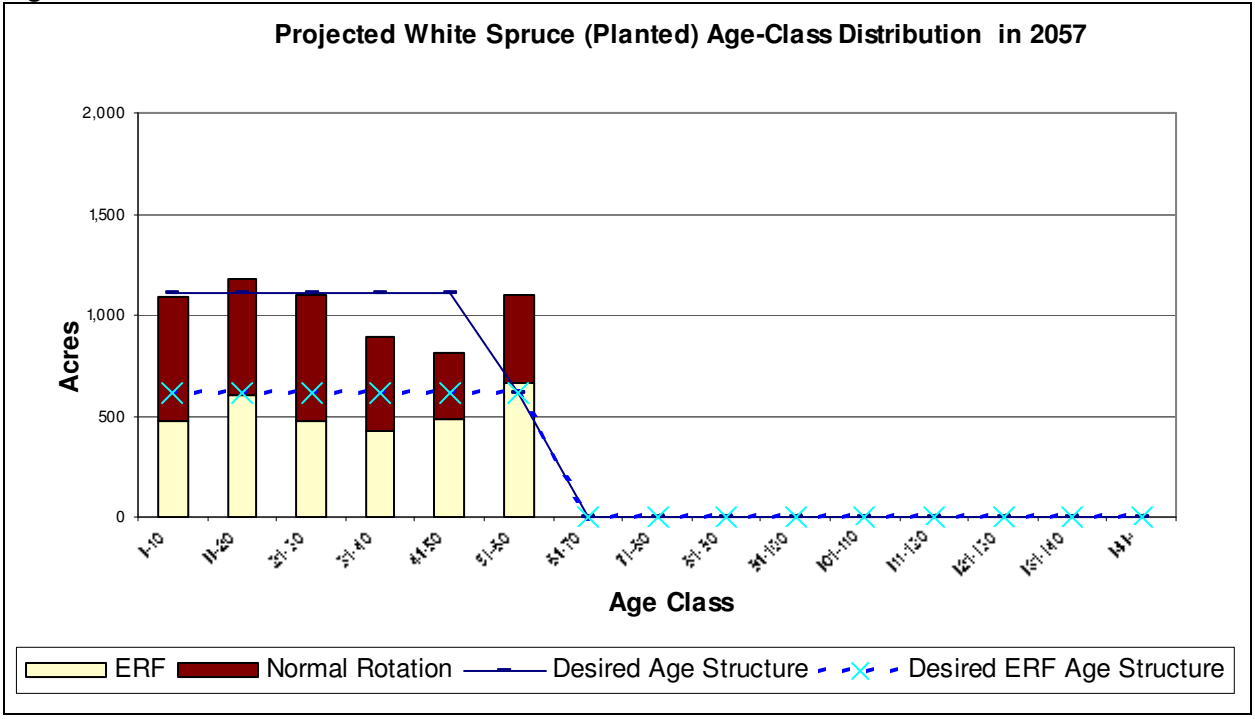
Based on the modeling of the treatment and conversion levels by decade, Figure 4.11g shows the projected age-class distribution in 2057 of the natural white spruce cover type.

Figure 4.11g



Based on the modeling of the treatment levels by decade, Figure 4.11h shows the projected age-class distribution in 2057 of the planted white spruce cover type.

Figure 4.11h



As each new 10-year plan is developed, the treatment levels by decade and modeling will be re-evaluated.

4.12 Balsam Fir (BF)

4.12A Current Condition

1. Cover Type Characteristics: In 2007, the balsam fir (BF) cover type comprised 1.8 percent (7,749 acres) of state timberlands (429,229 acres) managed in the CP-PMOP subsections. Of the total BF acres in the two subsections, 64 percent (4,971 acres) occurs in the CP and 36 percent (2,778 occurs in the PMOP (see Table 4.12a). A total of 60 acres of the balsam fir cover type has been reserved from harvest in these two subsections.

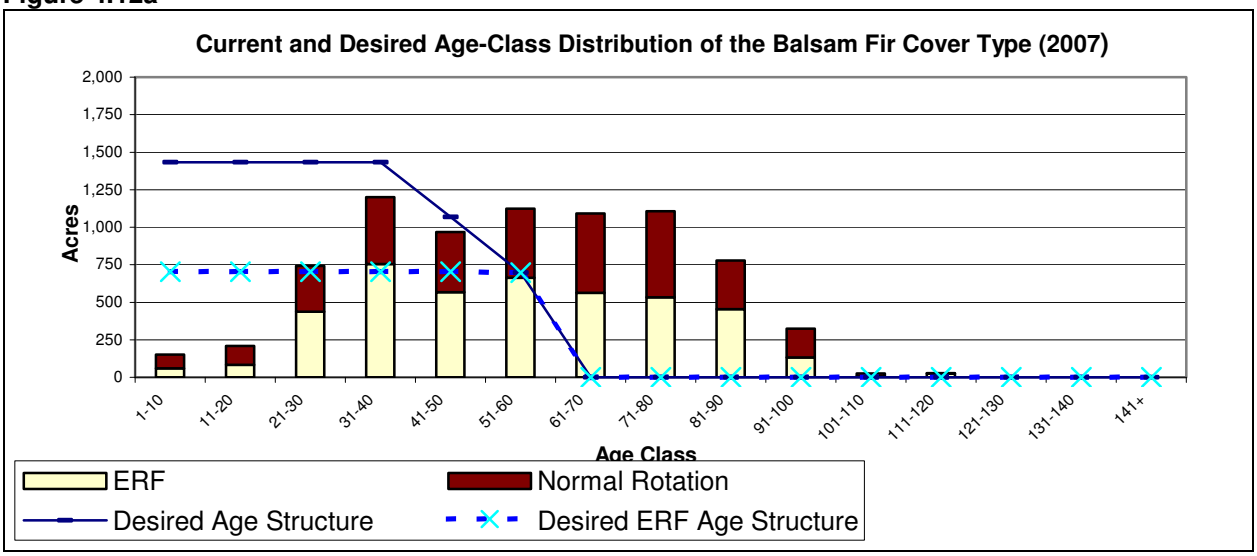
Table 4.12a Balsam Fir Cover Type Acres by Subsection

	CP	PMOP	Total
Acres	4,971	2,778	7,749
Percent	64	36	100

Balsam fir is an excellent competitor in Native Plant Communities (NPCs): FDn33, FDn43, MHn44, WFn53, and FPn63.

2. Age-Class Distribution: As shown on Figure 4.12a, the current balsam fir age-class distribution does not reflect the balanced age-class structure desired for even-age managed cover types.

Figure 4.12a



This figure shows that there are only 151 acres in the 1-10 age-class; that is less than in any other age-class. This is because balsam fir typically develops as a stand component following harvest of older balsam. Sometimes after 10-years, it often shows up in the inventory again as a balsam fir cover type.

Within the two subsections, approximately 64 percent of balsam fir acreage (4,965 acres plus 60 acres of old growth) is currently over the recommended normal rotation age of 45.

4.12B Future Direction

1. Cover type Acres: The DFFC over the next 50 years is to decrease the balsam fir cover type by 3 percent (256 acres), with balsam fir occurring primarily as the main component of mixed stands. These acres will be converted to white spruce (61 acres) and white cedar (195 acres) cover types.

Native plant communities favorable for balsam fir cover type maintenance are FDn33, FDn43, and MHn44. Balsam fir is best suited to wet-mesic sites where adequate soil moisture is available throughout

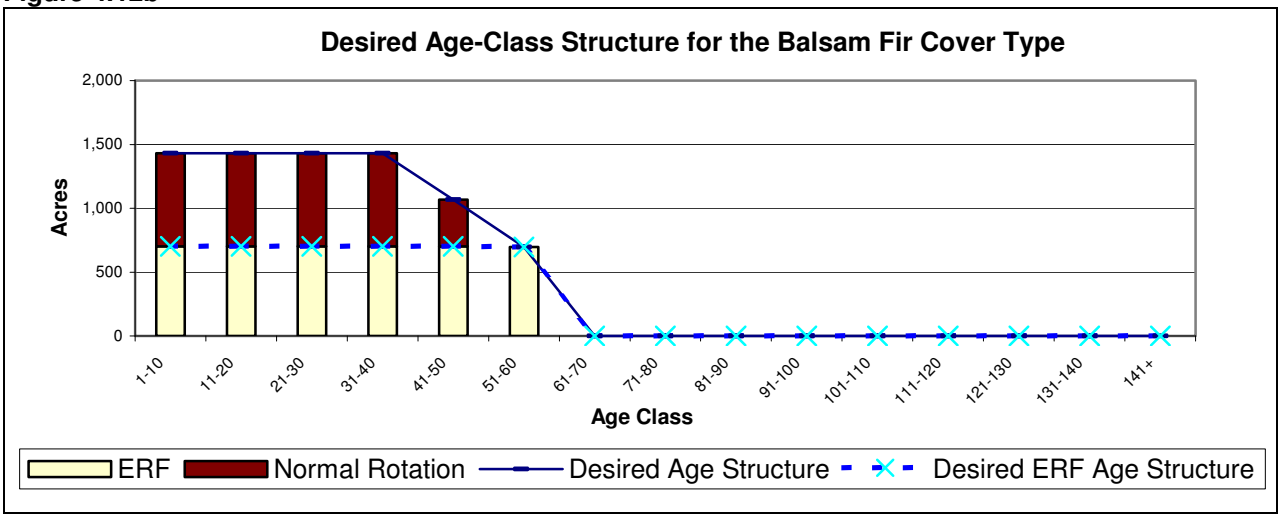
the growing season. After harvest, some balsam stands will naturally regenerate to aspen or birch cover types with balsam as a component.

Table 4.12b Recommended Balsam Fir Cover Type Acres in the Subsections by Year

	2007	2017	2057
CP	4,971	4,893	NA
PMOP	2,778	2,657	NA
Total acres	7,749	7,550	7,494

2. Age-Class Distribution: A goal is to move the current balsam age-class distribution toward a more balanced structure. Figure 4.12b shows the long-term desired age-class distribution for balsam fir. It is expected that the 0 – 10-year age-class will always be smaller than desired for a balanced structure because other pioneer species tend to dominate a balsam site after treatment. Gradually, however, the balsam component tends to increase in relative volume becoming the dominant species once again.

Figure 4.12b



The ERF goal for this cover type is to maintain 14 percent of the acres above normal rotation age at all times (i.e., effective ERF), with a declining age-class distribution from normal rotation (45 years) to maximum age (60 years).

3. Stand Composition: The desired future within stand composition for the balsam fir cover type has been identified as mixed forests that include upland hardwoods and long-lived conifers appropriate to the site. It will also be managed as a component of other mixed species cover types. As part of the *Stand Silvicultural Prescription Worksheet*, field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

4. Patch Management: Patch management objectives include: creating more large patches; identifying both younger and older forest patches; and, in particular, increasing the patch size and age-class distribution of lowland conifers.

5. Limiting Factors: Balsam fir trees and stands in these subsections are rarely defoliated and killed by spruce budworms. However, management strategies that increase the balsam fir component or its age will lead to more frequent incursions and mortality by spruce budworms. Recommendations to address these limiting factors include:

a. Keep the rotation age of balsam fir as low as possible as older trees are more vulnerable to spruce budworm-caused mortality.
b. When regenerating stands with spruce and fir in them, favor the spruce.

Occasionally, stands may be harvested below normal rotation age (45 years) if necessary to reduce rot, wind throw, and spruce budworm losses. (Note: To date, spruce budworm has not been a significant problem in these subsections, but it will be monitored and dealt with when detected.)

4.12C Stand Management

1. Even-aged Management Direction: The balsam fir cover type will be managed primarily on an even-aged basis for pulpwood and small saw logs. This will be accomplished while moving toward a balanced age-class structure and maintaining or improving forest wildlife habitat and biodiversity. Balsam is important for wildlife benefits, both as a cover type and as individual trees in other cover types.

Balsam fir is shade tolerant but grows best in about 50 percent or more full sunlight. Intermediate treatments offer an excellent opportunity to control species composition and speed up development of dense balsam fir stands. Mixed stands with 50-80 percent balsam fir component are likely the best candidates for enhancing wildlife habitat and esthetics. Balsam fir responds well to release. The best results occur when this is done while stands are young, vigorous and approximately 6-10 feet tall.

2. Uneven-aged Management Direction: Uneven-aged management may be appropriate where aesthetics is a priority. (See *Manager's Handbook for Balsam Fir in the North Central States*.)

3. Final Harvest: It is recommended that balsam fir final harvest be accomplished by overstory removal. Advanced balsam fir regeneration islands should be protected as a seed source where the goal is to maintain the stand as a balsam fir cover type, or to maintain balsam fir as a stand component.

4. Final Harvest Prescriptions: The following are the most common prescriptions that will be used on balsam fir timber sales:

a. Clearcut with reserves followed by natural seeding on exposed mineral soil.
b. Uneven-aged harvest with removal of older individuals creating space for new regeneration.
c. Artificial regeneration is not recommended.
d. Natural regeneration relying on advance regeneration and natural seeding.

5. Regeneration Methods after Final Harvest: Natural regeneration to mixed species stands is recommended. Natural regeneration of mixed stands relies on recent seed fall or advanced balsam fir reproduction present at the time of harvesting, seeding from surrounding stands, and sprouting or suckering of other tree species. Intermediate treatments may be used to increase balsam fir as a stand component.

6. Intermediate Harvest Methods: Thinning may be used to promote balsam as a stand component, or to increase future tree growth, quality, and vigor. Pre-commercial thinning may be used on some densely-stocked young stands. Thinning may be implemented on a small fraction of the cover type to enhance composition, but will not typically be applied for increasing volume production. (See *Manager's Handbook for Balsam Fir in the North Central States*.)

Following are recommendations for thinning balsam fir stands:

a. Pre-commercial thinning may be needed to alter species composition favoring balsam fir on desired sites. (See *Manager's Handbook for Balsam Fir in the North Central States*.)
b. Commercial thinning is acceptable in merchantable stands between 25 and 35 years old with a basal area greater than 120 square feet on the more productive sites (SI $\geq$ 50).
c. Do not remove more than one-third of the stand BA during a thinning. Protect advanced regeneration of desirable understory species.
d. Higher stand densities (BA) are recommended along stand edges exposed to wind and along high visual quality corridors, such as major roads and lakes.
e. If the stand is used as thermal cover by wildlife, consider applying one of the following options:
    - Maintain a higher stand basal area (e.g., wider reserve strips with canopy closure).
    - Thin only a portion of the stand.
    - Don't thin.

4.12D Cover type Conversion Management

1. Conversion Goals: Over the next 10-years, the DFFC is to convert 3 percent (200 acres) of the balsam fir cover type to white spruce (150 acres) and to white cedar (50 acres). The 50- year DFFC, which includes the 10-year DFFC, is to convert 256 acres to white spruce and white cedar. Balsam stands treated by timber harvest should result in a mixed conifer-hardwood composition. A management objective will be to maintain 98 percent of the balsam cover type with balsam fir as a significant component of the stand throughout the rotation.

Conversion of balsam fir to white spruce should occur in native plant community (NPC) FDn43 and MHn 44. Conversion of balsam fir to white cedar should occur on, MHn46, FPn63, FDn43 and WFn53, WFn55 sites.

Cover type conversions will be accomplished using a range of management options, including:

a. Allowing natural succession to occur on sites where the within-stand composition contains a high percentage of the desired species, or there is adequate advanced regeneration of these species in the understory.
b. Planting white spruce or white cedar on suitable sites.
c. Applying treatments such as mechanical site preparation, prescribed burning, or herbicide application followed by hand planting or artificial seeding, where required to establish the desired species.

4.12E Stand Selection Criteria

1. Normal Rotation Forest: A normal rotation age of 45 years old will be used for calculating a regulated harvest level (see Table 4.12.c).

Table 4.12c Balsam Fir Normal Rotation Age and Maximum Age

Subsection	Acres	Normal Rotation Age	Maximum Age
CP	4,971	45	60
PMOP	2,778	45	60

The objective is to move the age-classes toward a more balanced structure. The priority during the next 10-years is to select the oldest and highest scoring stands for treatment. A *Stand Scoring System* was implemented which assigned scores to stands in the following priority: stands that were currently over maximum age; over maximum age within 10 years; currently beyond normal age; and, currently less than normal age. The *Stand Scoring System* considered both normal pool acres and ERF acres (see Appendix K).

2. Normal Rotation Harvest Treatment Level Calculations: The pool of stands considered for normal rotation (see glossary) harvest treatment is all stands:

a. not reserved from harvest (e.g. old growth, EILC);
b. not designated to be managed as extended rotation forest (ERF); and
c. near normal harvest rotation age.

Harvest treatment level is the sum of normal rotation acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure. Once a balanced age-class structure is achieved stands can be scheduled for treatment upon reaching normal rotation age.

Adjustments to the normal harvest level may be made to meet other goals such as balancing the age-class distribution and providing relatively stable harvest levels.

3. Extended Rotation Forest: The harvest level will be based on an ERF rotation age of 60 years. Selection of older stands for examination will be emphasized to help move this subset of ERF stands toward the desirable declining age-class structure. The long-term goal is to retain 14 percent of the cover type as effective ERF to the maximum harvest age of 60. (see Table 4.12d.)

Table 4.12d Balsam Fir ERF Acres (Plan Target Acres) and Maximum Age

Subsection	Prescribed ERF Acres	Effective ERF /DFFC Acres	Maximum Age
CP-PMOP	4,356	1,085	60

4. Extended Rotation Harvest Treatment Level Calculations: The pool of stands considered for extended rotation harvest treatment is all stands:

a. not reserved from harvest (e.g. old growth, EILC);
b. designated to be managed as extended rotation forest (ERF); and
c. will be over normal harvest rotation age.

Extended rotation harvest treatment level is the sum of ERF acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure, while attempting to retain the a minimum level of effective ERF (see Appendix W *Glossary)*. A declining acreage of stands in each 10-year age-class is desired between normal rotation age and maximum rotation age. Emphasis is on treating the oldest age-classes first to minimize loss of fiber to tree mortality.

5. Thinned Stands: Normally, thinning will only be used to enhance composition goals as an occasional treatment, or with uneven-aged management.

4.12F Stand Treatment Summary

Table 4.12e shows the total treatment acres recommended conversion acreage out of the balsam fir cover type, effective ERF percent, and the average treatment ages for the next six decades. Based on the cover type management identified in this Plan, the average treatment age for balsam fir cover type decreases over time with a slight increase in the last decade. Old Forest Percent means acres that are over normal rotation age, except stands designated as Old Growth. There is variation from decade to decade due to the current age-class distribution for this cover type. This table does not include acreage treated through intermediate treatments or thinning.

Table 4.12e Balsam Fir Treatment Summary by Decade for the CP-PMOP

					Avg Treatment Age		Avg
Decades	**Total Treatment**	**Conversion**	**Old Forest %**	**Effective ERF**	**Normal**	**ERF**	**Age**
1	2,622	201	63.8%	34.6%	78	85	55
2	2,193	56	44.9%	27.8%	71	72	38
3	1,354	0	28.8%	21.3%	60	73	27
4	770	0	17.0%	14.7%	57	70	25
5	961	0	9.1%	7.4%	44	72	28
6	1,386	0	16.8%	11.4%	50	58	31
Total	9,286	257					
DFFC	**1,427**[1]	**-256**[2]		**14.0%**	**45.0**[3]	**57.5**[3]	**27**[3]

[1] Total treated acres once a fully regulated forest is achieved.
[2] positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
[3] anticipated age once a fully regulated forest is achieved.

Figure 4.12c below illustrates the age-class structure of the balsam fir cover type in 2017 at the end of the 10-year plan implementation period.

Figure 4.12c

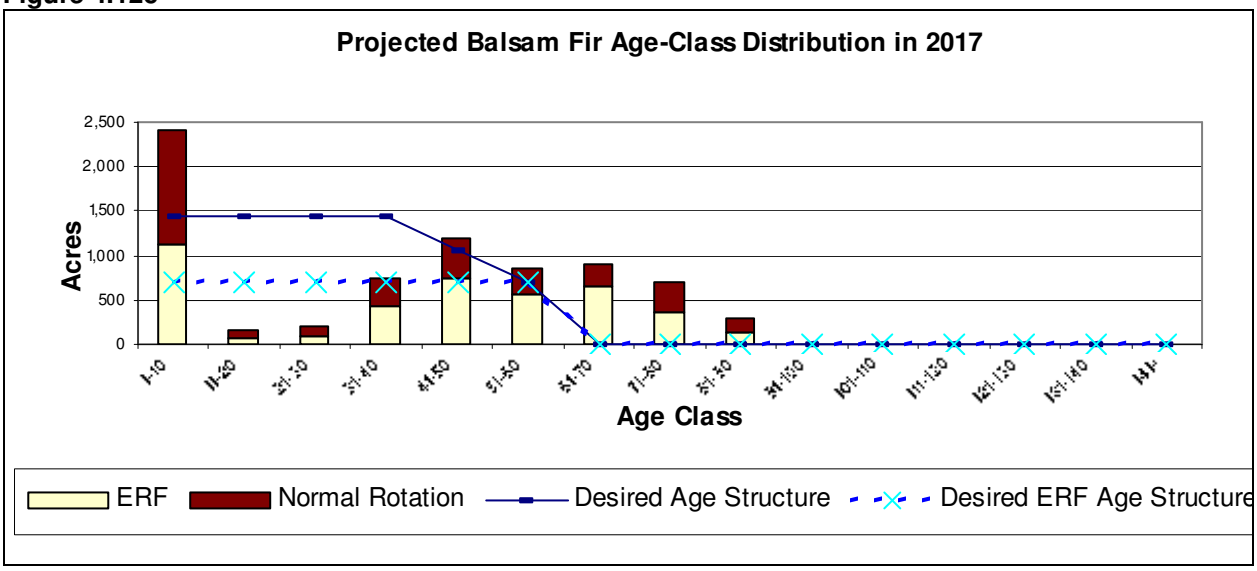
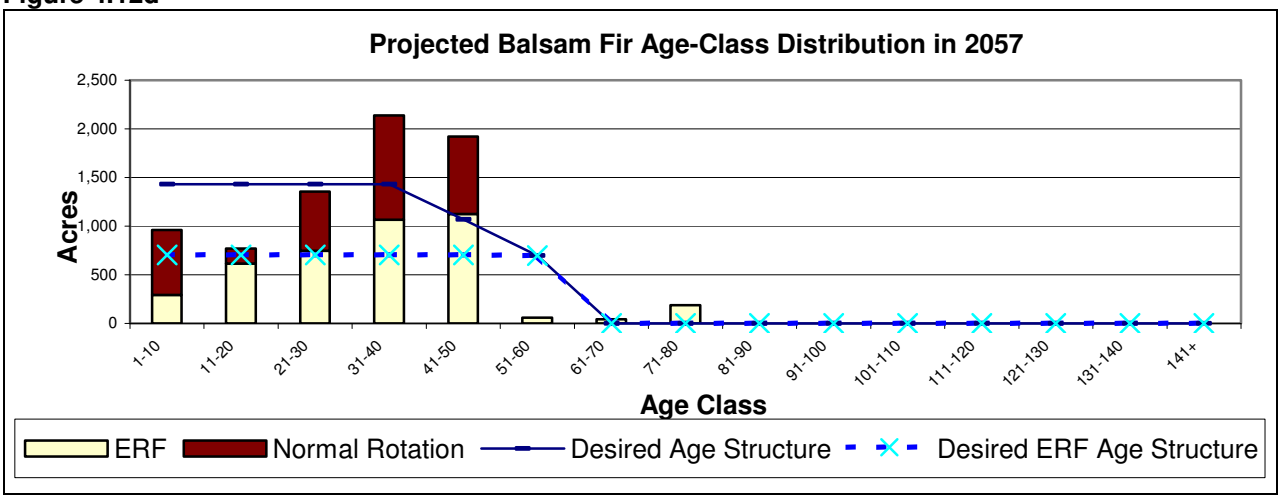


Figure 4.12d shows the projected age-class distribution of the even-aged portion of the balsam fir cover type in 2057 based on modeling of the treatment and conversion levels by decade.

Figure 4.12d



As each new 10-year plan is developed, the treatment levels by decade and modeling will be re-evaluated.

4.13 Tamarack (T) – on lowland sites

4.13A Current Condition

1. Cover Type Acres: In 2007, the tamarack cover type comprises 10.3 percent (44,269 acres) of the state timberlands (429,229 acres) managed in the CP-PMOP subsections. Approximately 88 percent (38,764 acres) of the tamarack cover type occurs in the CP and 12 percent (5,506 acres) occurs within the PMOP (see Table 4.13a). A total of 2,760 acres of the stagnant tamarack cover type has been designated EILC and reserved from treatment for this plan implementation period.

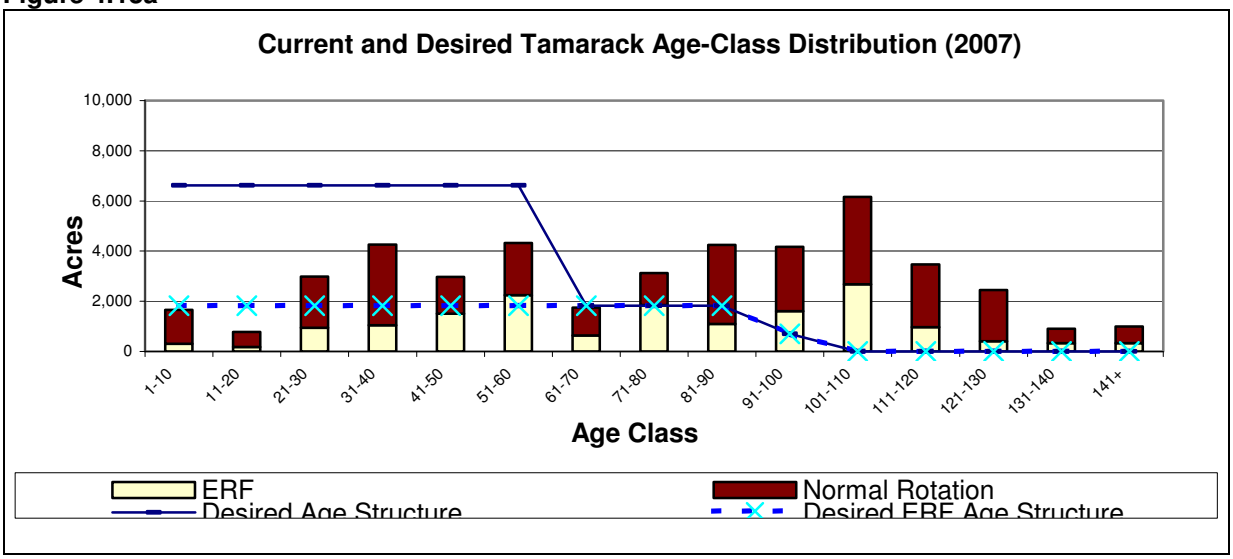
Table 4.13a Tamarack Cover Type Acres by Subsection

	CP	PMOP	Total
Acres	38,764	5,506	44,269
Percent	88	12	100%

Tamarack is often dominant in the following native plant community (NPC) types: WFn64 (N. Very Wet Ash Swamp), FPn82 (N. Rich Tamarack Swamp), and APn81 (N. Poor Conifer Swamp), FPn72 and FPs 63 NPC classes.

2. Age-Class Distribution: The current age-class distribution of the tamarack cover type does not reflect the desired balanced age-class structure for even-aged managed cover types. This age-class imbalance is consistent across both subsections (see Figure 4.13a).

Figure 4.13a



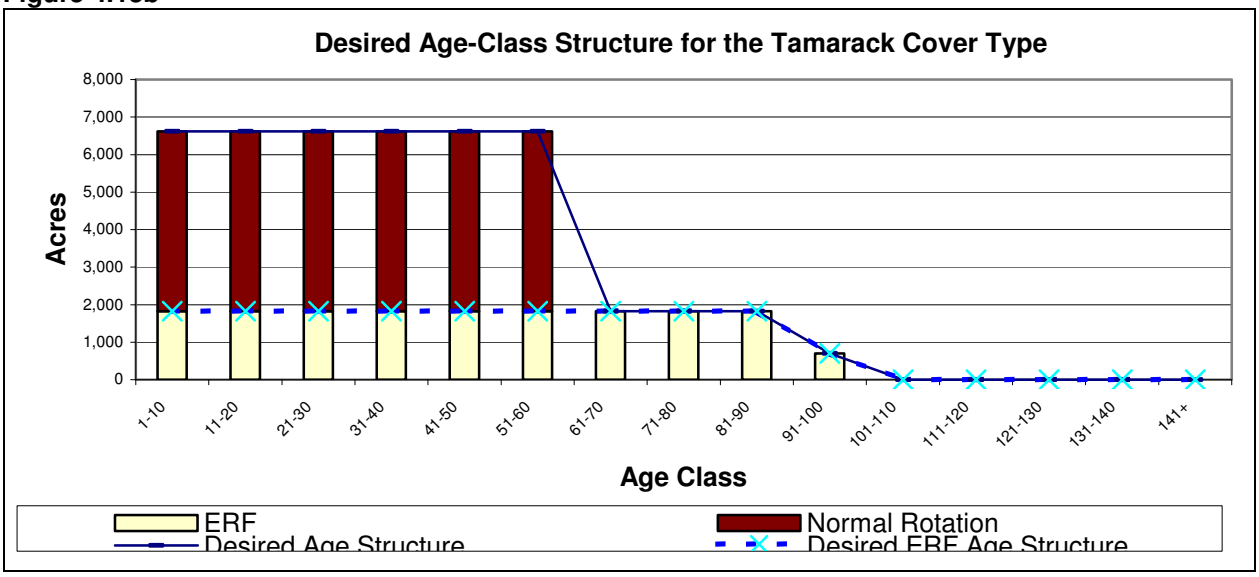
3. Species composition of mature stands: Mature stands of tamarack are often dominated by the single species, but there may be inclusions of other types such as balsam fir, black spruce, cedar or lowland hardwood.

4.13B Future Direction

1. Cover Type Acres: For the CP-PMOP subsections the 10-year DFFC is to increase this cover type approximately 2 percent or 800 acres. The 50-year goal is that the tamarack cover type acreage will increase about 5 percent or 2,400 acres. A goal is to increase tamarack within other cover types (e.g., aspen and birch) on upland sites.

2. Age-Class Distribution: A goal is to move the tamarack cover type age-classes toward a more balanced structure out to normal rotation age (60 years in the CP and 70 years in the PMOP) with a declining age-class distribution out to the maximum rotation age (105 years for both subsections). The older age-classes will be managed with enough older stands (ERF) deferred from treatment to provide an adequate declining age-class distribution out to the maximum age. The ERF goal for this cover type is to have 14 percent of the acres over normal rotation age (effective ERF) at any one time. Figure 4.13b shows the desired age-class structure for the tamarack cover type.

Figure 4.13b



3. Stand Composition: The desired composition of the tamarack cover type will range from pure tamarack to mixed stands, depending on the plant community appropriate to the site. As part of the *Stand Silvicultural Prescription Worksheet*, field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of Minnesota: Laurentian Mixed Forest Province,* to determine most appropriate species composition as stand management decisions are made.

4. Patch Management Objectives: Patch management objectives are to maintain existing large patches and increase the size of patches where possible as identified in the CP-PMOP subsection plan.

5. Limiting Factors: Since 2000, a statewide insect outbreak of eastern larch beetle has caused widespread mortality, ranging from 10-90 percent in individual stands. Consider pre-salvage or salvage harvest when stands are currently infested or are dying due to the infestation. Consider retaining a minimum of 5 to10 live tamarack per acre to serve as seed trees.

4.13C Stand Management

1. Even-Aged Management Direction: The tamarack cover type will be managed primarily by even-aged management methods for pulpwood, while providing forest wildlife habitat and maintaining biodiversity.

2. Harvest Method: Even-aged management using seed tree with reserves is the preferred method of harvest treatment for tamarack stands. Leaving about 10 tamarack per acre is recommended for successful seeding.

Where possible, maintain secondary component species of tamarack stands such as white cedar, paper birch, black spruce, and balsam fir. This can be accomplished by reserving seed trees, reserve islands, or clumps of mature trees or advanced regeneration.

Where possible, large treatment sites (100+ acres) are recommended using natural stand boundaries.

3. Harvest Prescriptions: Seed tree with reserves is the most common prescription that will be used on tamarack timber sales.

4. Regeneration Methods: Natural seeding from seed trees or artificial seeding are the methods used to regenerate tamarack stands. Where within-stand diversity is desired, artificial seeding may be an option for maintaining secondary species such as black spruce and cedar.

4.13D Cover Type Conversion Management

1. Conversion Goals: Over the next 10-years, the DFFC is to increase by 2 percent (800 acres) the tamarack cover type. The 50-year DFFC is to increase by 5 percent (2,400 acres) this cover type. These additional cover type acres will mostly be the result of reinventory, with older trees regenerating to becoming more dominant in what had previously been classed as lowland brush, or as ash/lowland hardwoods. To document these changes, a pro-active effort will be made to examine non-timber sites that may have tamarack regenerating on them.

Conversion of other cover types to a stand dominated by tamarack will be accomplished in WFn64, FPn72, FPn82, FPs63, and APn81 NPC classes. Priority LTAs for tamarack cover type increases include: Bemidji Sand Plain, Rosey Lake Plain, Blackduck Till Plain, and Blackduck Moraine. These LTAs currently contain 500+ acres of tamarack cover type on state lands and have shown a severe decline since the original land survey.

4.13E Stand Selection Criteria

1. Normal Rotation Forest: The normal rotation age recommended in the CP is 60 years, and 70 years in the PMOP (see Table 4.13b). The objective is to move the age-classes toward a more balanced age-class structure. The priority during this 10-year plan implementation period is to select the oldest and highest scoring stands for treatment. A *Stand Scoring System* was implemented which assigned scores to stands in the following priority: stands that were currently over maximum age; over maximum age within 10 years; currently beyond normal age; and, currently less than normal age. The *Stand Scoring System* considered both normal pool acres and ERF acres (see Appendix K). Not all stands above the normal harvest age will be treated because of the significant acreage of stands over normal rotation age.

Table 4.13b Tamarack Normal Rotation Age and Maximum Age

Subsection	Normal Rotation Age	Maximum Age
CP	60	105
PMOP	70	105

2. Normal Rotation Harvest Treatment Level Calculations: The pool of stands considered for normal rotation (see Glossary) harvest treatment is all stands:

a. not reserved from harvest (e.g. old growth, EILC);
b. not designated to be managed as extended rotation forest (ERF); and
c. near normal harvest rotation age.

Harvest treatment level is the sum of normal rotation acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure. Once a balanced age-class structure is achieved stands can be scheduled for treatment upon reaching normal rotation age.

Adjustments to the normal harvest level were made to meet other goals, such as balancing the age-class distribution and providing relatively stable harvest levels.

3. Extended Rotation Forest: The long-term DFFC goal is to retain 13 percent of the tamarack cover type over normal rotation age (60 years CP and 70 years in the PMOP) as effective ERF and provide a declining age-class structure out to maximum harvest age of 105 years in both subsections. The selection of older-aged stands for treatment will be emphasized to help move this subset of ERF stands toward the desirable declining age-class structure (see Table 4.13c).

Table 4.13c Tamarack ERF Acres (Plan Target Acres) and Maximum Age

Subsection	Prescribed ERF Acres	Effective ERF /DFFC Acres	Maximum Age
CP-PMOP	16,487	6,198	105

4. Extended Rotation Harvest Treatment Level Calculations: The pool of stands considered for extended rotation harvest treatment is all stands:

a. not reserved from harvest (e.g. old growth, EILC);
b. designated to be managed as extended rotation forest (ERF); and
c. will be over normal harvest rotation age.

Extended rotation harvest treatment level is the sum of ERF acres to be harvested from each age-class that will move the age-class distribution towards a more balanced structure, while attempting to retain the a minimum level of effective ERF (see *Glossary)*. A declining acreage of stands in each 10-year age-class is desired between normal rotation age and maximum rotation age. Emphasis is on treating the oldest age-classes first to minimize loss of fiber to tree mortality.

4.13F Stand Treatment Summary

Table 4.13d shows the total treatment acres, conversion acres out of the cover type, old forest percent, effective ERF percent, and the average treatment ages for the next six decades by site index group. Based on the cover type management identified in this Plan, the average treatment age for tamarack cover type decreases over time with a slight increase in the last decade. Old Forest Percent means acres that are over normal rotation age, except stands designated as Old Growth. There is variation from decade to decade because of the current age-class distribution of the cover type and how these age-classes are utilized over the 50-year period.

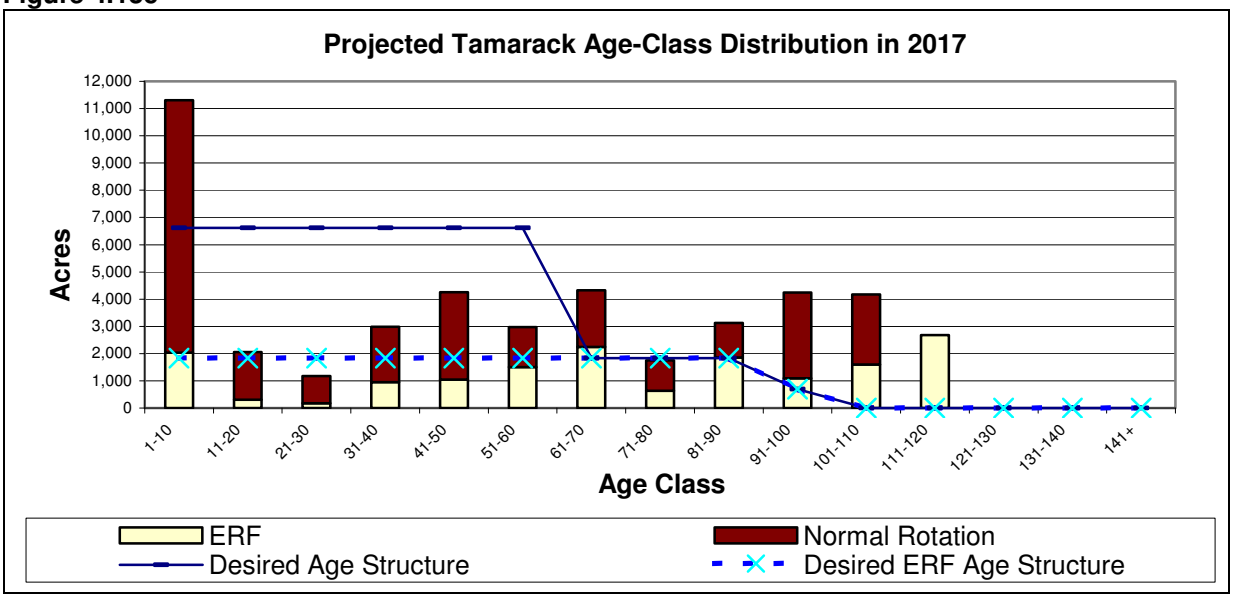
Table 4.13d Tamarack Treatment Summary by Decade

					Avg Treatment Age		Avg
Decades	**Total Treatment**	**Conversion**	**Old Forest %**	**Effective ERF**	**Normal**	**ERF**	**Age**
1	11,312	0	61.2%	22.2%	122	130	75
2	8,856	0	43.9%	21.8%	106	115	53
3	4,348	0	30.9%	13.6%	106	104	41
4	4,861	0	30.1%	13.8%	93	106	41
5	3,715	0	26.2%	12.2%	90	100	41
6	6,001	0	20.9%	7.8%	63	100	43
Total	39,093	0					
DFFC	**6,615**[1]	**2,399**[2]		**13.0%**	**61.2**[3]	**95.0**[3]	**36**[3]

[1] Total Treated Acres once a fully regulated forest is achieved.
[2] positive numbers are net acres into the cover type; negative numbers are net acres out of the cover type.
[3] anticipated age once a fully regulated forest is achieved.

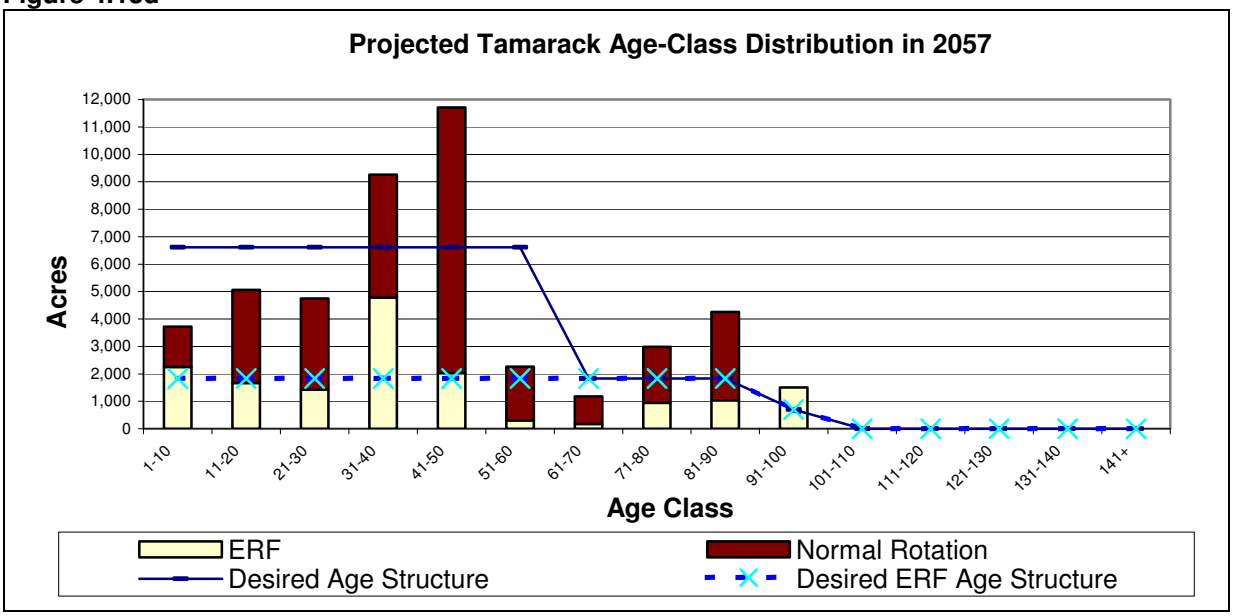
Based on the modeling of the treatment levels by decade, Figure 4.13c shows the age-class structure of the tamarack cover type in 2017, the end of this plan implementation period.

Figure 4.13c



Based on the modeling of the treatment levels by decade, Figure 4.13d shows the projected age-class distribution of the tamarack cover type in 2057.

Figure 4.13d



4.14 White Cedar (C)

4.14A Current Condition

1. Cover Type Characteristics: In 2007, the white cedar cover type comprises 2.9 percent (12,579 acres) of the state timberland acres (429,229 acres) found in the two subsections. White cedar totals 10,894 acres in the Chippewa Plains, and 1,685 acres of cedar in the Pine Moraine-Outwash Plains (see Table 4.14a). A total of 327 acres of the white cedar cover type and seven acres of stagnant cedar are reserved from harvest in these two subsections. In addition, a total of 2,023 acres of the white cedar and 1,397 acres of the stagnant cedar cover type has been designated as EILC and reserved from harvest during this plan implementation period.

Table 4.14a Cedar Cover Type Acres by Subsection

	CP	PMOP	Total
Acres	10,894	1,685	12,579
Percent	87	13	100

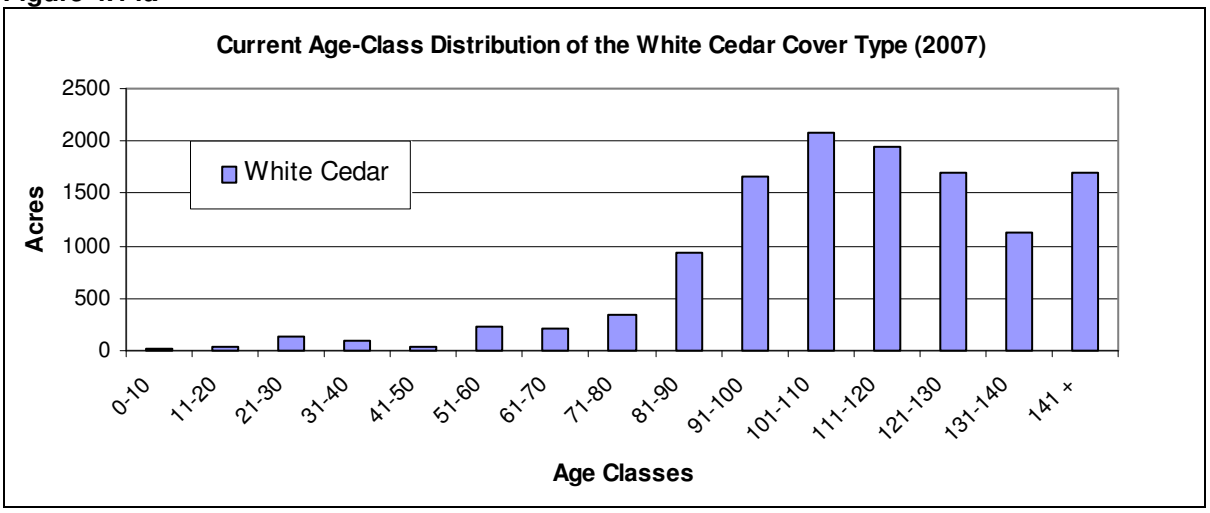
White cedar is an excellent competitor on lowland Native Plant Communities (NPCs) including: FPn63; FPn82; WFn53 and WFn55.

The DNR's forest inventory system does not separate cedar into upland and lowland cedar cover types. In the two sub-sections, 93 percent of cedar occurs on wet sites with a physiographic class of four or five.

2. Age-class Distribution: In both of the subsections, the current age-class distribution of the white cedar cover type, on both lowland and upland sites, does not reflect the desired balanced age-class structure. Cedar stands aged 100 years or older comprise 71 percent (8,972 acres) of the total cedar cover type acres. Only 4 percent (553 acres) of this cover type are less than 60 years old. This is a result of the very limited harvest that has occurred in this cover type over the past 30 years.

Figure 4.14a shows the current age-class distribution of white cedar cover type of the combined subsections for 2007.

Figure 4.14a



3. Stand Composition: On MHn46 sites, white cedar will be found with quaking aspen, black ash, and basswood. On lowland sites, white cedar occurs with black ash, balsam fir, or black spruce. White cedar grows on clay loams on upland sites and a variety of peat soils and mucks on lowland sites.
As part of the *Stand Silvicultural Prescription Worksheet*, field foresters will consider ECS and consult the appropriate Native Plant Community Fact Sheets in the *Field Guide to the Native Plant Communities of*

Minnesota: Laurentian Mixed Forest Province, to determine most appropriate species composition as stand management decisions are made.

4.14B Future Direction

1. **Cover Type Acres:** In the CP-PMOP subsections, the 10-year DFFC for white cedar cover type is to increase this cover type by 2 percent or 300 acres primarily from ash /lowland hardwoods, balsam fir, and aspen (from CP only). The 50-year DFFC is to increase the cedar cover type by 5 percent or 661 acres primarily from ash/lowland hardwoods and balsam fir (see Table 4.14b).

Typical cover type management strategies for white cedar include:

a. Maintain or increase the acreage of cedar stands that are traditionally used as thermal cover areas by deer.
b. Maintain or increase cedar as a component of other forest cover types.

Table 4.14b Recommended White Cedar Cover Type Acres in the Subsections by Year

	2007	2017	2057
CP	10,894	11,112	11,439
PMOP	1,685	1,179	1,769
Total acres	**12,579**	**12,291**	**13,208**

Additional cover type acres may result from reinventory of sites where developing regeneration has become more dominant on what had previously been classed as lowland brush (LB) or as black spruce lowland (BSL). To document these natural changes, a proactive effort will be made to examine nontimber sites that may have white cedar regeneration on them.

2. Age-Class Distribution: It is recommended that the age-class imbalance of the white cedar cover type be addressed by increasing the number of acres in the 0-50 year age-classes (even-aged), and increasing young cedar as a component within cedar stands (uneven-aged). Addressing this age-class imbalance must consider how to regenerate white cedar reliably in the presence of a high deer population. Achieving the desired even-age-class distribution may not be possible based on the limited harvest and difficulty in regenerating cedar.

3. Patch Management: Patch management objectives include: creating more large patches; identifying both younger and older forest patches; and in particular, increasing the patch size and age-class distribution of lowland conifers.

4.14C Stand Management

1. Management Direction: The white cedar cover type in the CP-PMOP subsections will be allowed to succeed naturally. No planned harvests are recommended in the subsections during this 10-year plan implementation period, with the exception of research plots where cedar regeneration is being targeted. All white cedar stands are designated ERF by department policy. White cedar provides significant value as wintering cover for deer, however regeneration is challenged due to browsing

Further, desired sites for conversion to the white cedar cover type are upland sites that support a plant community where aspen or balm-of-Gilead predominates with slight amounts of basswood and black ash. Otherwise, in these subsections the lowland plant communities that are likely to be associated with the white cedar cover type are the WFn53, WFn55, and FPn63.

2. Intermediate Harvest Methods: Some harvest of associated secondary species in cedar stands may be attempted in an effort to encourage natural regeneration of white cedar following a disturbance.

3. Final Harvest Methods: Final harvest in the white cedar is not planned until knowledge regarding its successful regeneration can be obtained.

4. Even-Aged Management Prescriptions: No even-aged management prescriptions for this cover type are recommended.

5. Regeneration Methods: The following recommendations should be considered when regenerating white cedar:

a. Plant using stock from local seed source.
b. Site preparation and herbicide use should consider maintaining within-stand diversity.
c. Protection from browsing is critical to a successful project.
d. Provide for six cavity trees, potential cavity trees, or snags per acre.[4]

4.14 D. Cover Type Conversion Management

Conversion of other cover types to a stand dominated by white cedar will be accomplished in MHn46 (primarily along the southern edge of the Agassiz basin, where white cedar may reach 90 feet in height and 30 inches in diameter,[1, 2)] WFn53, WFn55, FDn43 and FPn63 NPC classes. Priority LTAs for white cedar cover type increase include: Guthrie Till Plain, Rosey Lake Plain, Blackduck Till Plain, and Itasca Moraine. These LTAs currently contain 250+ acres of northern white cedar cover type on state lands and have shown some decline (BT to FIA). White cedar may be established after an initial shelterwood harvest of aspen and/or balm-of-Gilead.

4.14E Stand Selection Criteria

1. Stand Selection Criteria Pool: There is no pool for this cover type**.** The white cedar cover type in the CP-PMOP subsections will be allowed to succeed naturally. No planned harvests are recommended in the subsections during this 10-year plan implementation period. Other cover types will be selected for conversion to white cedar including aspen, ash/lowland hardwoods, and balsam fir. See these other cover type recommendations for stand selection criteria for conversion to white cedar.

2. Stand Treatment Criteria: There are no specific stand treatment strategies identified.

3. Extended Rotation Forest: All white cedar stands are designated ERF by department policy.

4. Harvest Calculation: No planned harvest is recommended during this plan implementation period.

[1]J.C. Ryan. 2006. *Minnesota Cedar.* Timber Bulletin. Sept/Oct 2006.
[2]John Almendinger. 2006 personal correspondence. Nov. 8, 2006.

[3] Minn. DNR. 2003. *Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province*. Ecological Land Classification Program, Minnesota County Biological Survey, Natural Heritage and Nongame Research Program. Minnesota Department of Natural Resources St. Paul, MN.
[4] Minnesota Forest Resources Council. 2005. *Sustaining Minnesota Forest Resources: Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers, and Resource Managers.* www.frc.state.mn.us. Minnesota Forest Resources Council, 2003 Upper Buford Circle, St. Paul, MN 55108-6146.

4.15 Stagnant Spruce (Sx)

4.15A Current Condition

1. Cover Type Characteristics: In 2007, the stagnant spruce cover type comprises 4.0 percent (15,675 acres) of the state-administered timberlands (429,229 acres) managed in these two subsections. There are 9,551 acres of the stagnant spruce cover type identified as EILC and reserved from harvest during this plan implementation period. The stagnant spruce (Sx) cover type is lowland black spruce with a site index of less than 23. This means that trees on these sites are likely to be 22 feet or less in height, when trees are 50 years old. Because of their small size, black spruce, in the Sx cover type, are not typically harvested for traditional timber products.

Table 4.15a Stagnant Spruce Cover Type Acres by Subsection

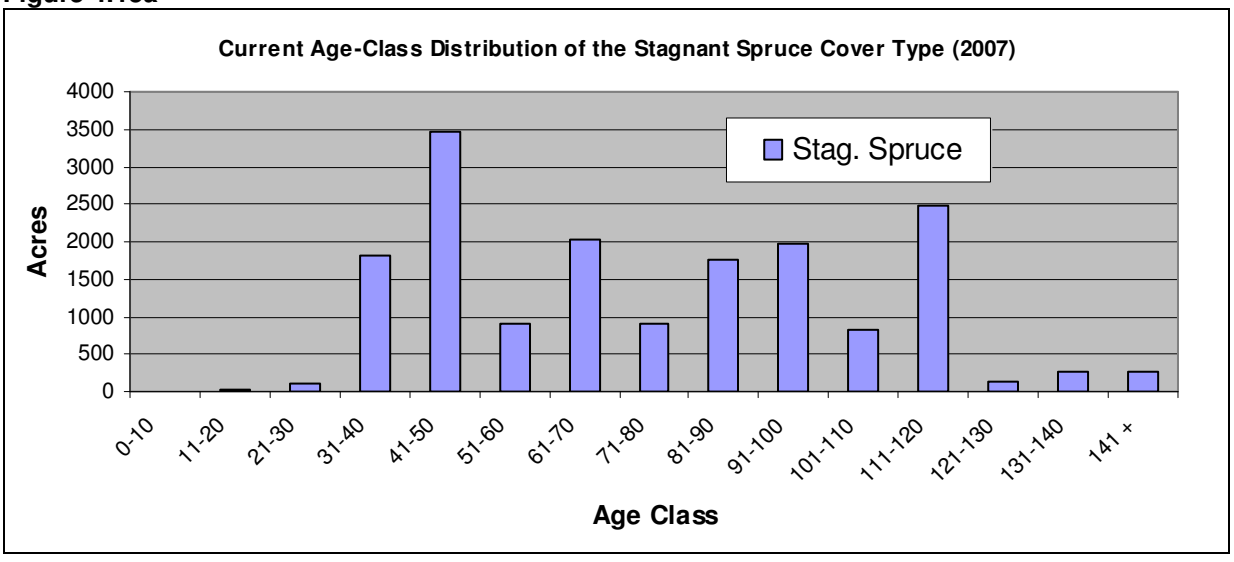
	CP	PMOP	Total
Acres	15,675	305	15,980
Percent	98	2	100

This cover type is composed of predominantly lowland black spruce, or a mix of black spruce and other lowland conifers (e.g., tamarack or white cedar), growing on very poor sites. These sites are composed of organic soils that are saturated year-round and have low nutrient levels. Plants that are commonly associated with Sx are Labrador tea, leather-leaf, alder, and bog birch with either sphagnum or feather mosses as a ground cover.

Sx is the predominant cover type where decorative spruce tops are harvested. Tree tops that are cut range from l½ feet to 6 feet in length. They are cut from selected trees and, over time, lateral branches grow a new top. The level of harvest within the stand varies with the quality of the trees, the size of the trees present, and the product specification used by the industry. For most stands, the selective harvest ranges from 5 -10 percent to as high as 20 percent of the trees. Harvesting in some higher quality stands has occurred periodically on a 10-15 year cycle.

2. Age-Class Distribution: Figure 4.15a shows the current age-class distribution of the stagnant spruce cover type.

Figure 4.15a



4.15B Future Direction

1. Cover type Acres and Age-Class Distribution: The Sx cover type acres should remain relatively constant. Since no, or very little clearcut harvest will occur in this cover type, the average age should increase over time.

4.15C Stand Management

1. Management Direction: The primary goal is to protect the hydrological and ecological integrity of Sx sites.

2. Management Prescriptions: The primary management prescription for this cover type is *decorative tree harvest* where tree tops are harvested for Christmas trees or winter greenery. Harvest operations will be directed to sites with a stocking of at least 1250 stems/acre and adequate numbers of trees from 3 to 20 feet tall. Trees over 20 feet are generally too tall for harvesting decorative tops.

Stagnant spruce stands found to be of merchantable size for pulpwood may be harvested using clear-cut methods. Occasionally, stagnant spruce stands that are infected with dwarf mistletoe disease and located adjacent to more productive black spruce are clear-cut harvested or sheared off and/or prescribed burned for disease control.

3. Harvesting Guidelines: The following recommendations will be used to guide decorative tree harvesting in this cover type:

a. Identify stands that are suitable for potential harvest of decorative tops.
b. Establish a sustainable harvest level (acres) for decorative tops.
c. Determine the percentage of stems that may be harvested.
d. Determine a re-entry period for repeat harvest.
e. Follow statewide guidelines and regulations for decorative tree site selection, harvest, operations, and sale supervision.
f. Promote alternative methods for transporting tops from the site, that reduce or eliminate impacts (e.g., helicopter slings).
g. Harvest on frozen ground whenever possible.
h. Leave at least 50 percent of the foliage on the tree. This will allow the tree to survive, continue to grow, and produce new top(s) from lateral branches.

Ideally, all harvest in stagnant spruce sites should be done in frozen conditions. Caution must be used to prevent site damage, however, since most harvest operations take place during the fall prior to freeze-up. Producers need to be limited to the use of small tracked vehicles or machines with high flotation tires to move the cut products to the landing area or pick-up location.

4. Regeneration Methods: Regeneration will occur through lateral branch growth after tops are harvested or through natural seeding from mature trees.

4.15D Stand Selection Criteria

1. Stand Selection Pool: The following criteria should be observed when selecting a pool of stands for possible tree top harvest:

a. Stands should have at least a density of 1250 trees per acre and a diameter less than 5 inches (DBH).
b. Include only stands that have not been harvested for 15 years.
c. Do not select stands that have been designated as ecologically important lowland conifers (EILC) stands.
d. Do not select stands in watershed protection areas of peatland SNAs.
e. Avoid stands with rare features or significant cultural resources.

The pool of stands created using the above criteria will be examined by photo interpretation or site visit. The pool will be further reduced by the following criteria:

a. Avoid stands where the only access route is across lags, and flowage areas that can't be crossed easily. These areas are excessively wet and often lack adequate root structure to support motorized traffic.
b. Avoid stands with poor access during the late fall period when decorative tree harvest typically occurs.

Allowable harvest levels will be developed annually based on DNR evaluations of local market demands.

The CP-PMOP SFRMP, maps, and Appendices can be viewed online at:
http://www.dnr.state.mn.us/forestry/subsection/cp_pmop/plan.html