4. Cover Type Management Recommendations

Section **Page**

4.1 Introduction

The purpose of this chapter is to provide data and management information by cover type. These management recommendations will also 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 staff should be familiar with the full contents of the GDSs and strategies found in Chapter 3. Information provided by cover type includes:

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

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 divisions of Forestry, Fish and Wildlife, and Trails and Waterways that are available for forest management activities. 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 recommendations and other information in this plan, following is a list of some other publications that field staff should refer to for managing state forestlands:

- *Voluntary Site-Level Forest Management Guidelines*. Minnesota Forest Resources Council. 1999.
- *Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province*. Minnesota DNR. 2003.
- *Preliminary Issues and Assessment*. North Shore Highlands, Toimi Uplands, and Laurentian Uplands SFRMP. Minnesota DNR. November 2002. For example, Chapter 6, Forest Insects and Disease.
- *Forest Development Manual*. Minnesota DNR. 1994.
- *Forestry-Wildlife Habitat Management Guidelines*. Minnesota DNR. 1985.
- 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.
- Field Visit Decision Tree (Appendix E).

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 North Shore Highlands, Toimi Uplands, and Laurentian Uplands[1] S*ubsections* list 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*.

A desired future forest composition (DFFC) goal is to decrease the cover type acreage of some 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 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.

For even-aged managed cover types, recommendations assume 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.

Treatment acres determined in this plan comprise a stand examination list or pool that will be field visited over the 10-year planning period. See GDS-9A for information on how treatment levels were determined. Stands on the 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. The *Field Visit Decision Tree* (Appendix E) will be used as a tool to assess management options for all stands that are identified for field visit. These stands include high-risk, low-volume (HRLV) stands, those identified through the stand selection process, and stands being considered for conversion. It is meant to provide guidance to appraisers when the field visit is made. In addition, management recommendations, preliminary objectives, or other issues that were assigned to a stand during the SFRMP planning process should be considered in the management of a stand. This information will be provided to appraisers after each annual harvest plan is assigned from the 10-year 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.

[1] The North Shore Highlands, Toimi Uplands, and Laurentian Uplands subsection names are abbreviated in this chapter as follows: individually as North Shore Highlands - NSH, Toimi Uplands - TU, and Laurentian Uplands – LU and as a group – NTL subsections.

4.2 Aspen/Balm of Gilead (A/BG)

4.2A Current Condition

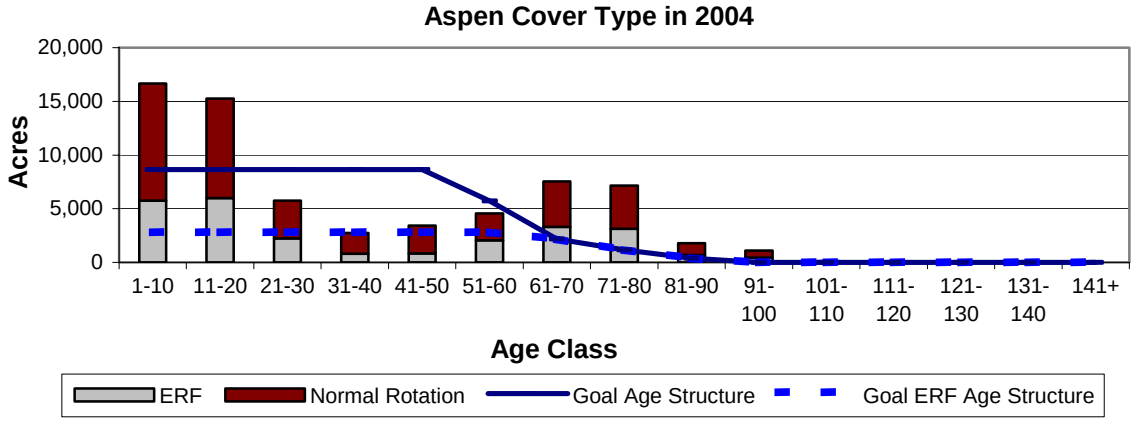
1. Cover Type Acres: In 2004, the aspen/balm of gilead (A/BG) cover type comprises 32 percent of state timberlands managed in the NTL subsections. The aspen and balm of gilead cover types are combined into one cover type group for the SFRMP plan because these two species are commonly associated with each other and are managed under the same management prescriptions.

Table 4.2a: Aspen/BG Cover Type Acres by Subsection

	NSH	LU	TU	Total
Aspen Acres	43,881	11,541	10,951	66,373
BG Acres	1,045	10	25	1,080
Total A/BG Acres	44,926	11,551	10,976	67,453
Percent	67%	17%	16%	

2. Age-Class Distribution: The current aspen/balm of gilead age-class distribution does not reflect the desired balanced age-class structure for even-aged managed cover types.

Figure 4.2a: Comparison of Current Aspen/Balm of Gilead Age-Class Distribution to the Desired Age-Class Structure



Note: The 1-10 age class is inflated because it includes 7,590 acres that are currently timber sale permits or are acres on the FY2004 annual harvest plan that haven't been harvested yet. This acreage will be treated within the next 1 – 5 years.

In the three subsections, 33 percent (22,481 acres) of the A/BG cover type is over the recommended normal rotation ages (varies with site index) of 50 and 55 years. The goal is to have 11 percent of the timberland acres between the normal rotation age and maximum rotation age.

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

	NSH	LU	TU	Total
Aspen Acres	14,600	3,511	3,589	21,700
BG Acres	781	0	0	781
Total A/BG Acres	15,381	3,511	3,589	22,481

Approximately 3.5 percent of the A/BG acres are currently over the recommended maximum rotation age of 85 years.

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

	NSH	LU	TU	Total
Aspen Acres	1,573	431	18	2,022
BG Acres	305	0	0	305
Total A/BG Acres	1,878	431	18	2,327

Twenty-six percent of the A/BG cover type over age 50 years meets the high-risk, low-volume *(*HRLV) criteria listed in the stand selection criteria section below.

3. Stand Composition: Table 4.2d shows the typical within-stand species composition of mature aspen stands (51-80 years old) in the three subsections. It is based on the aspen stand composition at the time that the forest inventory was completed. This shows that mature aspen stands in the NTL 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.

Table 4.2d: Species Composition of Mature Aspen Stands in the North Shore Subsections

Species	Percent of Stand Volume
Aspen	60.0
Birch	16.0
Balm of Gilead	1.6
Maple/Basswood/Oak	1.8
Ash	0.9
Deciduous Percent	**80.3**
Balsam Fir	9.0
White Spruce	3.1
Black Spruce	2.5
Cedar	0.9
White Pine	0.6
Jack Pine	0.5
Red Pine	0.2
Tamarack	0.1
Conifer Percent	**16.9**
Misc. Species Percent	**2.8**

(Misc. Species Percent includes multiple species volumes that were lumped together in the forest inventory because of minor volumes in the stand.)

4.2B Future Direction

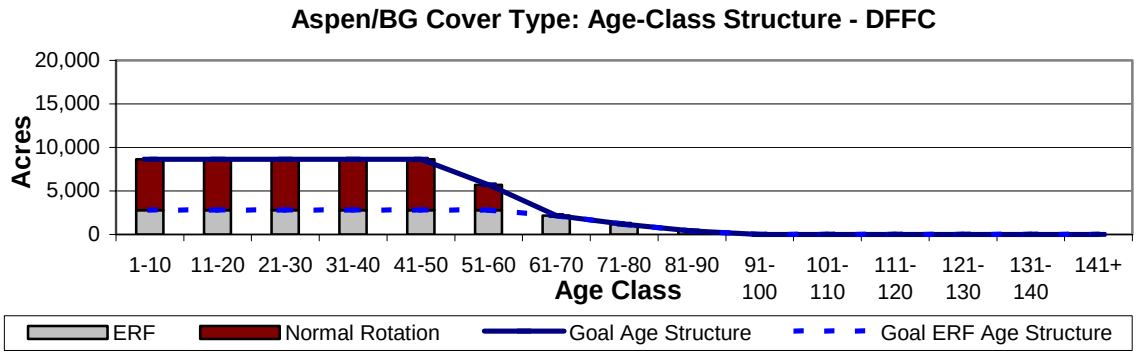
1. Cover Type Acres: The composition goal, over the next 60 years is to reduce the acreage in this cover type by an average of 22 percent (-14,821 acres) across the NTL subsections: -23 percent in the North Shore Highlands, -27 percent in the Toimi Uplands, and -13 percent in the Laurentian Uplands. In the next 10 years, the reduction will average 7 percent of the aspen acreage across the NTL subsections: 7, 9, and 4 percent per subsection respectively.

Table 4.2e: Recommended A/BG Cover Type Acres in the Subsections by Year

	2004	2014	2064
North Shore Highlands	44,975	41,608	34,606
Toimi Uplands	10,897	9,942	7,955
Laurentian Uplands	11,534	11,044	10,024
Total acres	**67,406**	**62,594**	**52,585**

2. Age-Class Distribution: Move the current age-class structure toward a more balanced age-class structure. 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 4.2c).

Figure 4.2b: Desired Age-Class Structure for the Aspen/Balm of Gilead Cover Type



The ERF goal for this cover type is to have 11 percent of the acres over normal rotation age (effective ERF) with a declining age-class distribution from normal rotation (50 – 55 years) out to the maximum age (85 years). Figure 4.2b illustrates this tapering off of the age-class distribution after age 50.

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, upland white cedar, and upland hardwoods such as birch, maple, and ash. (See GDS-1B and 3) A goal is to increase white pine, white spruce, red (Norway) pine, or upland white cedar (long-lived conifers) in some A/BG stands. Table 4.2d shows the typical composition of aspen stands now.

4. Patch Management: A/BG stands in designated large patches should be managed to maintain or increase the number of large patches of 250 acres or more. (See GDS-1C.)

4.2C Harvest Methods and Regeneration

1. Even-aged Management Direction: The A/BG cover type will be managed 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: A/BG stands to be maintained in the cover type will be managed using clearcut or clearcut with reserves as the final harvest method. Use natural stand boundaries or natural features such as topography or soil type to delineate timber sale boundaries. Use 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. One of the strategies to accomplish this would be to reserve from harvest most existing individuals or patches of long-lived conifer species. These reserve trees will 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.

A goal is to increase the average size of harvest areas. Harvest some larger blocks (100+ acres), where appropriate, using consolidated or natural stand boundaries. Small harvest blocks (less than 40 acres) will continue to be used. Using a range of harvest sizes will provide for various 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.[2] For some wildlife species, higher stem densities are desired. Usually, most clearcut stands regenerate at greater than 10,000 stems per acre. If stocking is below the desired level, consider conversion to another cover type or increase stocking by planting or seeding other species.

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 works best 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.

5. Intermediate Harvest Methods: Thinning captures timber volume that would be lost through natural mortality. It can increase tree quality and tree diameter at final harvest resulting in sawlog or veneer sized trees. Aspen stands respond to thinning on the more productive sites. Site index and stand age are criteria used to select sites. (See thinning criteria listed in the stand selection criteria section below.) The following guidelines[3] will be used in thinning aspen stands:

a. Thinning should occur during leaf-off periods and damage to residuals, regeneration, and the understory should be minimized.

[2] *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.
[3] *Northeast Region Guidelines for Commercial Aspen Thinning.* 2001. Minnesota Department of Natural Resources. Grand Rapids, MN.

b. On soils prone to compaction, utilization of a slash mat should be promoted.
c. To further minimize equipment effects, the total area of the cut strips within the sale area is to be minimized. Strips are to be as narrow and far apart as possible yet still accommodate equipment access and reach.
d. Thinning treatments resulting in residual basal areas per acre of less than 50 square feet are to be agreed upon by Division of Wildlife and Forestry staff.
e. To promote within-stand diversity and attain landscape objectives, other tree species components should be maintained or enhanced as a result of all thinnings. This is to be accomplished by: 1) leaving snags if present; 2) leaving portions of some stands, or entire stands unthinned; and 3) leaving all conifer and other desired species where feasible. Extra care should be taken to retain any white pine, oak, or species at the edge of its range.
f. Thinning will not normally be considered in WMAs, deer yards, or areas being managed for ruffed grouse or woodcock. The exception would be if the thinning helps attain a specific intent of the management unit, such as converting the thinned stand(s) to long-lived conifer species, or will help meet a landscape objective.
g. The effects of aspen thinning on aspen associated wildlife species or aspen habitat are not fully understood. Therefore, it is recommended that some stands that meet the thinning criteria be left unthinned and others be only partially thinned to allow monitoring, comparison, and evaluation.

6. Thinning Prescriptions: The following are the most common prescriptions that will be used for thinning in aspen stands:

a. Strip thinning
b. Selective thinning

4.2D Cover Type Conversion Management

1. Conversion Goals: Over the next 60 years, it is recommended that 14,821 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 upland black spruce or jack pine. In addition, some stands may be converted to oak or northern hardwoods. Some converted stands will be managed for a mixed conifer-hardwood composition. The 10-year conversion goal is 4,813 acres. It is expected that a majority of the conversion will be accomplished through the conversion of A/BG stands that meet the HRLV criteria (See 4.2E Stand Selection Criteria). 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 Field Visit Decision Tree (Appendix E). Conversion of aspen to the desired cover types will be accomplished using a range of management options, including:

a. Allow 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. Use partial harvest in mixed stands to release existing understory conifers and to create mixed conifer-hardwood composition in the stand.

c. Use 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. Underplant long-lived conifers in thinned or existing stands where conditions are favorable for these seedlings to become established and grow.
e. Consider 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)

4.2E Stand Selection Criteria

1. Normal Rotation Forest: Two site index classes will be used, with two corresponding normal rotation ages.

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

Site Index	Acres	Normal Rotation Age	Maximum Age
≥65	17,132	50	85
<65	23,705	55	85
Total	40,837		

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 stands for treatment Not all stands above the normal harvest age will be treated because of the large acreage of stands over normal rotation age.

All stands that have been identified as HRLV will be site-visited during the next 10 years. These stands were removed from the pool of stands used to calculate the normal rotation harvest level.

Normal Rotation Harvest Level Calculations:
Normal Management Pool = (Total Non-ERF A/BG) - (Non-ERF HRLV)
Normal Harvest Level = (Normal Management Pool) Rotation age)
Normal Selection Pool = Normal Management Pool that is over 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. For a more detailed description of harvest level calculations, see GDS-9A.

2. Extended Rotation Forest: The long-term goals are to retain 11 percent of the cover type acreage over the normal rotation age and to provide a declining age-class structure out to the maximum harvest age. See Figure 4.2b.

The harvest level will be based on various harvest ages beyond the normal rotation age (65, 75, and 85 years) out to the maximum harvest age (85 years). The average rotation

age for ERF stands when the desired age-class distribution is reached will be 73 years old.
The selection of older ERF stands for treatment will be emphasized to help move the subset of ERF stands toward the desirable declining age-class structure.

All stands that are tagged as HRLV will be site-visited and evaluated for treatment during the next 10 years. These stands will be removed from the pool of stands used to calculate the ERF harvest level.

Extended Forest Rotation Harvest Level Calculations:
ERF Management Pool = (Total ERFA/BG) – (ERF HRLV)
The ERF harvest level is determined by the desired acres in the declining age-class structure. Moving toward the long-term goal of achieving and sustaining 11 percent effective ERF was also considered.

Table 4.2g: A/BG ERF Rotation Ages and Maximum Age

Site Index	Acres	ERF Rotation Ages	Maximum Age
All	25,343	65, 75, and 85	85

Figure 4.2a shows the current age-class distribution of designated ERF and Figure 4.2b shows the desired declining age-class structure. Harvest of ERF stands during this 10-year period will be targeted at stands that are in the 71-80 and 81-90 year old age classes. This will help maintain the desired 11 percent effective ERF into the next decade.
ERF Selection Pool = ERF Management Pool that is over normal rotation age. Treatment acres will be targeted by age class.

3. High-Risk, Low-Volume Stands (HRLV): All A/BG stands that meet high-risk, low-volume criteria will be field visited over the next 10 years. HRLV stands are defined by the following criteria:

a. All A/BG stands over 85 years old.
b. Stands over age 49 and with total stand volume less than 7.6 cords per acres.
c. Stands over age 49 with greater than 50 percent of trees of the main species affected by disease damage.

Table 4.2h: A/BG High-Risk, Low-Volume Acreage by Subsection

	North Shore Highlands	Toimi Uplands	Laurentian Uplands	Total
HRLV Acres	4,923	539	728	6,190

The Field Visit Decision Tree (Appendix E) will be used to determine what treatment to prescribe for the stands when they are field visited. If a HRLV stand that was designated as ERF is converted to another cover type, it will maintain its ERF designation in the new cover type.

4. Thinning

The criteria for selecting stands to be evaluated for thinning is aspen stands 28 to 36 years old with a site index of 70 or greater and a basal area of 100 or more. This pool of stands will be field visited to determine if they are suitable for thinning. For example, a stand would need 7 – 8 cords of thinnable volume to make it economically viable for a timber sale. Some other considerations are wildlife habitat, insect and disease issues, accessibility, and stand size (i.e., enough acreage to provide a marketable volume).

4.2F Stand Treatment Summary

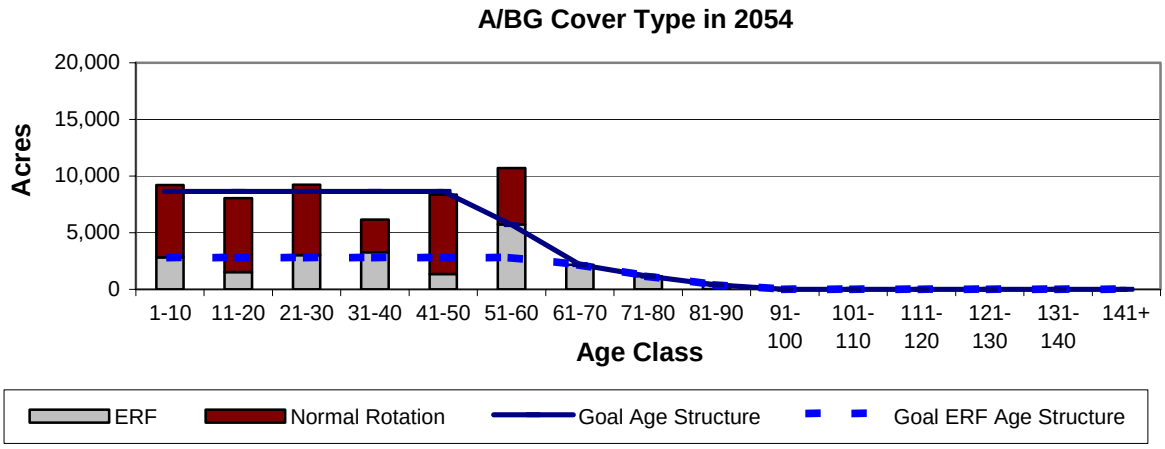
Table 4.2i shows the modeled treatment levels (acres), recommended conversion acreage out of the A/BG cover type, old forest percent, effective ERF percent, and the average treatment ages for the next six decades. There is considerable variation from decade to decade because of the current age-class distribution of the cover type. Treatment in Decade 1 includes HRLV acres.

Table 4.2i: Aspen/Balm of Gilead Treatment Summary by Decade

	Acres				Average Treatment Age	
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Effective ERF**	**Normal**	**ERF**
1	13,176	-4,813	31.7%	13.8%	76	83
2	6,158	0	18.9%	11.2%	73	86
3	9,287	-55	13.6%	7.2%	61	85
4	8,916	-870	7.3%	5.3%	51	59
5	14,211	-5,000	16.8%	11.4%	55	66
6	15,672	-4,083	20.4%	14.1%	56	66
DFFC	8,634	-14,840		10.9%	53	73

Based on the modeling of these treatment levels, by the end of the sixth decade, the cover type should be approaching the desired age-class distribution as shown in Figure 4.2c.

Figure 4.2c: Estimated A/BG Cover Type Age-Class Distribution in 2054



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

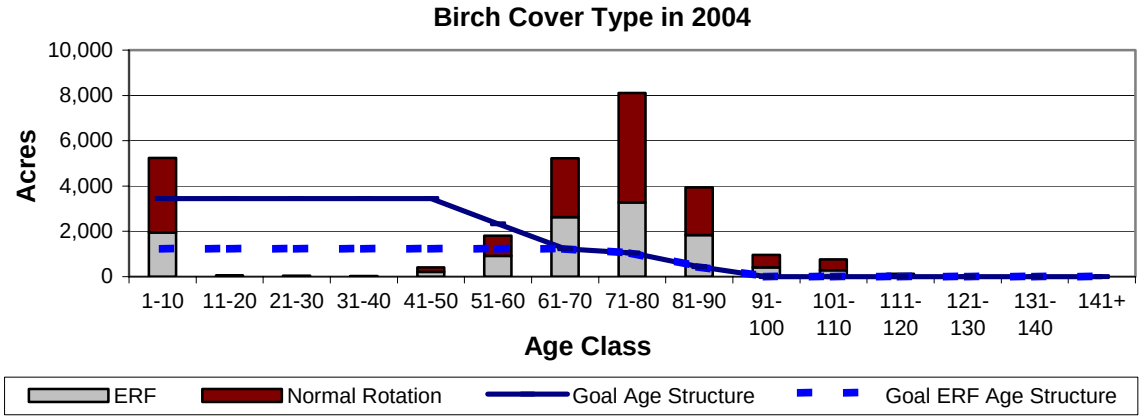
1. Cover Type Acres: In 2004, the paper birch (Bi) cover type comprises 14 percent (29,930 acres) of state timberlands managed in the NTL. The birch cover type most often refers to stands of paper birch (*Betula papyrifera*), but also includes stands of heartleaf birch (*Betula cordifolia*) and mixed stands of these species. (Heartleaf birch distribution in Minnesota: Cook, Lake, and northern St. Louis counties; has been found in the NSH and LU subsections and is possibly in the Toimi Uplands).

Table 4.3a: Birch Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	22,407	3,522	1,935	27,864
Percent	80%	13%	7%	

2. Age-Class Distribution: The current birch age-class distribution does not reflect the desired balanced age-class structure for even-aged managed cover types.

Figure 4.3a: Comparison of Current Birch Cover Type Age-Class Distribution to the Desired Age-Class Structure



Note: The 1-10 age class is inflated because it includes 5,193 acres that are currently timber sale permits or are acres on the FY2004 annual harvest plan that haven't been harvested or treated yet.

Much of the birch cover type originated after forest fires in the early 1900s as can be seen in 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 stands following harvest.
b. Stand conversion from birch to plantations of other species, such as white spruce or pines.
c. High birch mortality from the late-1980's thru the mid-1990's that resulted in conversion to other cover types. This was caused by stresses to mature or over-mature stands from a combination of drought, attack by bronze birch borer, and defoliation by forest tent caterpillar and birch leaf miner (often referred to as birch decline).
d. Poor markets for birch until recently, which resulted in more limited harvesting opportunities. This delay in harvesting resulted in many stands naturally succeeding to other cover types.
e. Inhibited regeneration of stands past their reproductive prime, due to lower seed production and viability, and reduced sprouting vigor following harvest.
f. Herbivory near deer wintering areas.

In the three subsections, 73 percent (20,276 acres) of the birch cover type is over the recommended normal rotation age of 55 years (stands with site index less than 60) or 65 years (stands with site index 60 or higher). The goal is to have 14 percent of the timberland acres between the normal rotation age and the maximum rotation age. Currently, 12 percent (3,449 acres) is over the recommended maximum rotation age of 85 years. A total of 24 percent (6,753 acres) of the birch cover type meets the high-risk, low-volume criteria.

4.3B Future Direction

1. Cover Type Acres: The composition goal, over the next 60 years is to reduce the acreage in the birch cover type by an average of 21 percent (5,854 acres) across the NTL subsections: -18 percent (4,125 acres) in the North Shore Highlands, -46 percent (875 acres) in the Toimi Uplands, and -24 percent (854 acres) in the Laurentian Uplands. In the next 10 years, the reduction will average 12 percent (3,467 acres) across the NTL subsections: 11, 27, and 14 percent per subsection respectively.

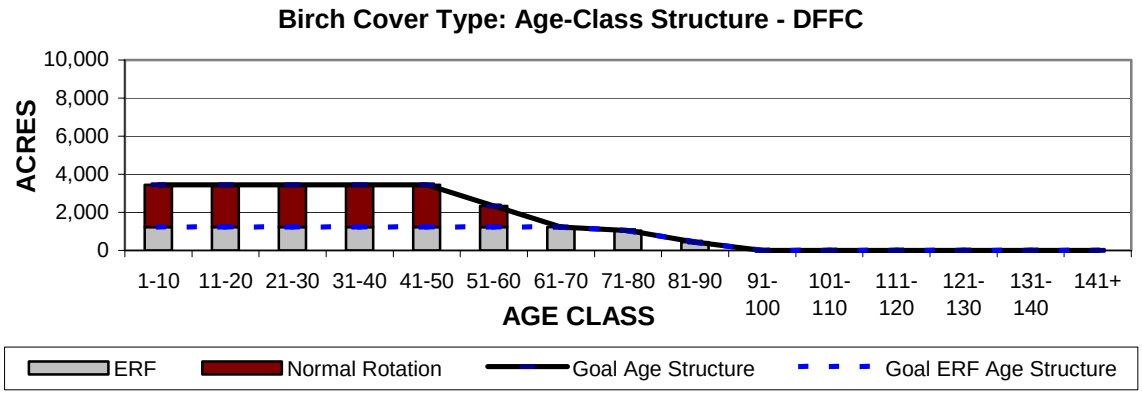
Table 4.3b: Recommended Birch Cover Type Acres by Subsection and Year

	2004	**2014**	**2064**
North Shore Highlands	22,509	20,066	18,384
Toimi Uplands	1,923	1,405	1,048
Laurentian Uplands	3,529	3,203	2,675
Total acres	**27,961**	**24,674**	**22,107**

2. Age-Class Distribution: Move the current age-class structure toward a more balanced age-class structure. Figure 4.3b shows the desired age-class structure. Due to the current conditions, it will take more than 50 years to achieve this goal.

The ERF goal for this cover type is to have 14 percent of the acres over normal rotation age (effective ERF) with a declining age-class distribution from normal rotation (55 or 65 years depending on site index) out to the maximum age (85 years). Figure 4.3b illustrates the desired tapering off of the age-class distribution starting with the 51-60 year age class.

Figure 4.3b: Desired Age-Class Structure for the Birch Cover Type



3. Stand Composition: The desired future within-stand composition will range from pure birch stands to a more diverse stand structure and/or mixed forest that maintains or increases long-lived conifers such as white pine, white spruce, red pine, upland white cedar, and upland hardwoods such as maple, oak, and ash. (See GDS-1B and 3.)
Birch stands that contain heartleaf birch should be managed to retain heartleaf birch, upland cedar, and other species associated with the site. These stands should be managed

for within stand diversity and/or mixed forest, with an emphasis on the composition of the native plant community associated with the site.

4. Patch Management: Birch stands in the designated large patch areas should be managed to maintain or increase the number of large patches of 250 acres or more. (See GDS-1C.)

4.3C Harvest Methods and Regeneration

1. Even-aged Management Direction: Manage the birch 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 Method: Birch stands to be maintained in the birch cover type will be managed using clearcut, clearcut with reserves, shelterwood, or seed tree as the final harvest method. Use natural stand boundaries or natural features such as topography or soil type to delineate timber sale boundaries.

Use harvest regulations and methods that favor maintaining or increasing within-stand diversity with an emphasis on long-lived conifers, while retaining birch as the main cover type. One of the strategies to accomplish this would be to reserve from harvest most existing individuals or patches of long-lived conifer species. These reserve trees will maintain the within stand species diversity as well as add structural diversity for the newly regenerating stand. The 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.
A goal is to increase the average size of harvest areas. Harvest some larger blocks (100+ acres), where appropriate, using consolidated or natural stand boundaries. Small harvest blocks (less than 40 acres) will continue to be used. A range of harvest sizes will provide for wildlife habitat needs.

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

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

4. Regeneration Methods after Final Harvest: Birch stands regenerate naturally through stump sprouting and seeding. Stump sprouting alone usually does not provide adequate stocking. Shelterwood or seed tree are the preferred harvest methods for

regenerating a birch stand[4]. A shelterwood provides a moderated environment that is 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 are as follows:

a. Scarification (e.g., summer harvest or disking) or prescribed fire may be necessary to provide a mineral soil seedbed.
b. Site preparation, such as disking or anchor-chaining, is recommended to incorporate birch seed into the mineral soil. This is best done in late fall during seed fall, or within 2 years after a good seed crop.
c. Herbicide application to control competing vegetation may be necessary on richer sites if aspen regeneration or shrubs are expected to overtop and suppress the birch seedlings.
d. Shelterwood trees may be removed after enough birch seedlings become established.

If birch stocking is below the desired level, consider conversion (natural or artificial) to another cover type or increase stocking by planting or seeding other species.

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 works best on sites where harvesting operations have scarified the soil creating a seedbed suitable for seed germination.
b. Planting long-lived conifers or hardwoods using small patches or variable density scattered plantings with or without site preparation.
c. Retain seed trees and/or advanced regeneration of desired tree species.

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

1. Conversion Goals: Over the next 60 years, 21 percent (5,854 acres) of birch will be converted to other cover types. The 10-year conversion goal is 12 percent (3,467 acres) of the birch cover type acres. Depending on site conditions, birch stands will be converted (naturally or artificially) to long-lived conifer species such as white pine, white spruce, red pine, and upland white cedar, as well as shorter-lived conifers such as upland black spruce or jack pine. Some stands may be converted to oak or northern hardwoods. Some converted stands will be managed for a mixed conifer-hardwood composition. It is expected that a majority of conversion will be accomplished through the conversion of birch stands that meet the HRLV criteria (See 4.3E Stand Selection Criteria). Conversion

[4] Perala, D. and Alm, A. *Regenerating Paper Birch in the Lake States with the Shelterwood Method*. Northern Journal of Applied Forestry, December 1989.

to the desired cover types will be accomplished using a range of management options, including:

a. Allow 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. In birch stands dominated by heartleaf birch, or where it exists as a lesser component, efforts should be made to retain this species in the stand during conversion. Avoid conversion of fully stocked stands of heartleaf birch.
c. Underplant long-lived conifers or hardwoods in existing stands where conditions are favorable for these seedlings to become established and grow.
d. Use post-harvest treatments, such as mechanical site preparation, prescribed burning, or herbicide application, followed by hand planting or artificial seeding, to establish conifers or desirable hardwoods on the site.

4.3E Stand Selection Criteria

1. Normal Rotation Forest: Two site index classes will be used with two corresponding normal rotation ages.

Table 4.3c: Birch Normal Rotation Ages and Maximum Age

Site Index	Acres	Normal Rotation Age	Maximum Age*
≥60	2,442	65	85
<60	12,653	55	85
Total	15,095		

*The maximum rotation age for the birch cover type is being evaluated during this 10-year planning period.

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 stands for treatment Not all stands above the normal harvest age will be treated because of the large acreage of stands over normal rotation age.

All stands that are tagged as HRLV (see criteria below) will be site visited during the next 10 years. These stands will be removed from the pool of stands used to calculate the normal rotation harvest level.

Normal Rotation Harvest Level Calculations:
Normal Management Pool = (Total Non-ERF Birch) - (Non-ERF HRLV Birch)
Normal Rotation Harvest Level = (Normal Management Pool / Rotation age)
Normal Selection Pool = Normal Management Pool that is over normal rotation age.

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. For a more detailed description of harvest level calculations, see GDS-9A.

2. Extended Rotation Forest: Long-term goals are to retain 14 percent of the cover type acreage over the normal rotation age and to provide a declining age-class structure out to the maximum harvest age of 85. (See Figure 4.3b.)

The harvest level will be based on the ERF acres in each of the two site index classes with ERF harvest ages of 75 and 85.

Table 4.3d: Birch ERF Rotation Ages and Maximum Age

Site Index	Acres	ERF Rotation Age	Maximum Age*
All	11,610	75 and 85	85

*The maximum rotation age for the birch cover type is being evaluated during this 10-year planning period.

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

All stands that are tagged as HRLV (see criteria below) will be site visited and evaluated for treatment during the next 10 years. These stands will be removed from the pool of stands used to calculate the ERF harvest level.

Extended Forest Rotation Harvest Level Calculations:
ERF Management Pool = (Total ERF Birch) – (ERF HRLV Birch)

ERF harvest level is determined by the desired acres in the declining age-class structure and achieving and sustaining a 14 percent effective ERF.

ERF Selection Pool = ERF Management Pool that is over normal rotation age. Acres will be targeted by age class.

3. High-Risk, Low-Volume Stands: All birch stands that meet high-risk, low-volume criteria will be field visited over the next 10 years. HRLV stands are defined by the following criteria:

a. All birch stands over age 85 years old.
b. Stands over age 49 and with total stand volume less than 7.6 cords per acres.
c. Stands over age 49 with greater than 50 percent of trees of the main species affected by disease damage.

The Field Visit Decision Tree (Appendix E) will be used to determine what treatment to prescribe for the stands when they are field visited. If a HRLV stand that was prescribed as ERF is converted to another cover type it maintains its ERF designation. These stands could be part of both the Normal Rotation or Extended Rotation Forests listed above.

Table 4.3e: Birch High-Risk, Low-Volume Acreage by Subsection

	North Shore Highlands	Toimi Uplands	Laurentian Uplands	Total
HRLV Acres	5,672	167	1,024	6,683

4.3F Stand Treatment Summary

Table 4.3f shows the treatment level (acres), recommended conversion acreage out of the birch cover type, old forest percent, effective ERF percent, and the average treatment ages for the first decade. It also shows the long-term DFFCs. There will be considerable variation from decade to decade because of the current age-class distribution of the cover type. Treatment in Decade 1 includes HRLV acres.

Table 4.3f: Birch Treatment Summary by Decade

	Acres				Average Treatment Age	
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Effective ERF**	**Normal**	**ERF**
1	8,543	-3,467	74%	33%	85	90
DFFC	3,452	-5,573		14%	57	82

Treatment levels for the birch cover type were developed for only the first decade. During this decade, additional field data will be collected on birch stands past maximum rotation age of 85 years. This information will be evaluated to aid in determining whether or not birch stands on some sites or locations in the subsections can be held beyond the current established maximum rotation age of 85 years without jeopardizing the ability of a stand to naturally regenerate back a birch cover type or lose significant timber volumes. The results will be used to determine if adjustments can be made to the maximum rotation age for paper birch. If birch stands can be retained beyond age 85, this would affect the harvest levels in future decades. 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 Acres: In 2004, the Ash/Lowland Hardwoods cover types comprise 3.5 percent of state timberlands managed in the NTL. The ash and lowland hardwoods cover types are combined into one management category for this SFRMP plan because these two cover types are commonly associated with each other and are managed under the same management prescriptions.

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

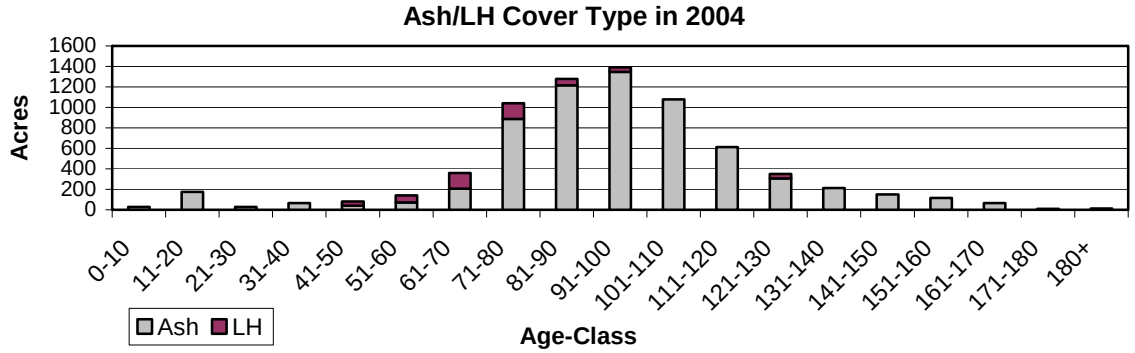
	NSH	LU	TU	Total
Ash	5,997	195	438	6,630
Ash Percent	90%	3%	7%	
Lowland Hardwoods	526	0	34	560
LH Percent	94%	0%	6%	
Ash/LH Total	6,523	195	472	7,190
Ash/LH Percent	91%	3%	6%	

2. Age-Class Distribution: In each of the subsections, the current age-class distribution of these cover types reflects an aging forest with little acreage in the younger age classes.

Ash summary: 5 percent of this cover type is under 50 years old; 19 percent of the cover type acres are between age 51 and 80 years; 38 percent are between 81 and 100 years; and 38 percent are over 100 years.

Lowland hardwoods summary: 6 percent of this cover type is under 50 years old; 56 percent of the cover type acres are between age 51 and 80 years; 19 percent are between 81 and 100 years; and 19 percent are over 100 years.

Figure 4.4a: Ash/LH Cover Type Age-Class Distribution



4.4B Future Direction

1. Cover Type Acres: No acreage change is proposed for these cover types during the next 10 years or over the next 50 years.

2. Age-Class Distribution: Continue to move these cover types toward an uneven-aged structure in older age classes.

3. Stand Composition: Maintain the species composition and structure that naturally occurs within these forest communities. Windthrow is a dominant natural disturbance in ash and LH stands, resulting in large downed logs, hummocks, and hollows that promote tree seedling establishment and create 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[5].
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.

4. Patch Management: Retain the existing ash/lowland hardwood patches found within these subsections.

4.4C Harvest Methods and Regeneration

1. Management Direction: Ash and LH stands will be managed as both even- and uneven-aged stands. Uneven-aged management will be the primary method, 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. Hydrologic alteration in these stands will be avoided. It is recommended that stands less than site index 45 not be managed through harvest with the objective of maintain wildlife habitat and water quality[6].

2. Even-Aged Management: Manage some stands of ash/LH on an even-aged basis 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:

a. Clearcut with Reserves - Sprouting
b. Clearcut with Reserves - Natural Seeding

[5] 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.
[6] Erdman,G., et al., *Managing Black Ash in the Lake States*. Gen. Tech. Rep. NC-115. North Central Forest Experiment Station, 1987.

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

6. Intermediate Harvest Methods: Some stands of ash/LH may be thinned. Thinning will increase tree diameter and quality resulting in more sawlog or veneer sized trees. Thinning should reduce basal area (BA) to 75-90 square feet per acre, or removal of one third or the BA, whichever leaves the most BA.

7. Intermediate Harvest Prescriptions: Selective thinning will be the most common thinning prescription.

4.4D Stand Selection Criteria

The ash and 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 (BA) is greater than 120 square feet per acre.
c. Main species diameter is greater than 7 inches.

Forest inventory stand data was modeled forward to 2003 using the DNR's growth and yield models (*Chen*) for determining which stands meet the stand selection criteria.

4.4E Stand Treatment Summary

Based on the above criteria, 221 acres have been identified for possible treatment during this 10-year planning period. Based on additional field evaluations (e.g., re-inventory) of ash/LH stands during this planning 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

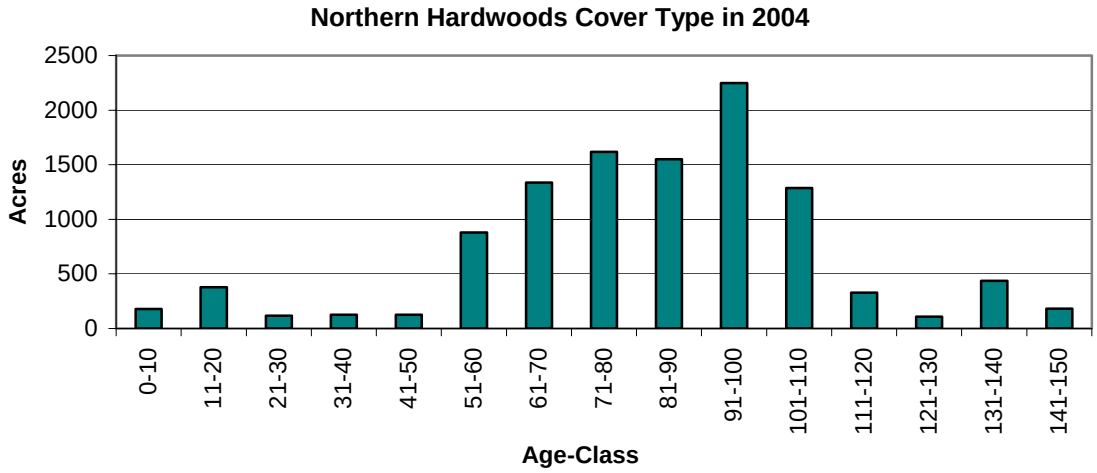
1. Cover Type Acres: In 2004, the northern hardwoods cover type comprises 5 percent (10,783 acres) of state timberlands managed in the NTL. Within the subsections, there is a distinct variation in distribution of the cover type. The majority of the cover type is within the NSH, where over 95 percent of the cover type is located. There is approximately 3 percent in the LU, and 2 percent in the TU.

Table 4.5a: Northern Hardwood Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	10,244	290	249	10,783
Percent	95%	3%	2%	

2. Age-Class Distribution: The current age-class distribution shows an abundance of middle-aged and mature stands (51 - 110 years) while there is little acreage in the younger (<50 years) age classes.

Figure 4.5a: Northern Hardwoods Cover Type Age-Class Distribution



3. Stand Composition: The northern hardwoods cover type is among the most diverse cover types in the subsection with a distinct variation in tree species composition from north to south. It nearly always contains sugar maple (Acer saccharum) usually mixed with red maple (Acer rubrum), and either basswood (Tilia americana), and/or yellow birch (Betula alleghaniensis) as the primary species. Found to varying degrees and in

localized areas are secondary species, including red oak (Quercus rubra), green ash (Fraxinus pennsylvanica), black ash (Fraxinus nigra), ironwood (Ostrya virginiana), quaking aspen (Populus tremuloides), bigtooth aspen (Populus grandidentata), paper birch (Betula papyrifera), heartleaf birch (Betula cordifolia), white spruce (Picea glauca), white cedar (Thuja occidentalis), white pine (Pinus strobes), and balsam fir (Abies balsamea).

Some second growth stands lack the tree species diversity that is typical of northern hardwood stands, and may be dominated by sugar and/or red maple, with smaller quantities of intolerant aspen and birch. Overall, there is less species (plant and animal) and structural diversity in northern hardwood communities than would occur under a natural disturbance regime.

Currently, 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. Cutting is regulated by periodically removing trees from all size-classes to achieve and maintain a specified diameter distribution. Regulated stands meet the desired stocking level for all size classes (See Table 4.5b and Figure 4.5b).

Many of the northern hardwood stands are dominated by poor quality timber. Reasons for this include: frost cracks and canker damage; insect and disease attacks on trees of advancing age; poor form; past harvesting to remove quality hardwoods; gap size; grazing; and the fact that the key species of this cover type are living near the edge of their range.

4.5B Future Direction

Cover type goals are to improve the timber quality and ecological characteristics of the northern hardwood cover type, while enhancing or maintaining the aesthetic values.

1. Cover Type Acres: The goal over the next 10 years is to increase the northern hardwood cover type by 3 percent (364 acres) and over the next 60 years by 7 percent (741 acres). Most of the increase will come from the partial harvesting of aspen and paper birch stands with a significant northern hardwood component, or from natural succession of these cover types.

2. Age-Class Structure: The cover type will be managed predominantly under uneven-aged management methods and move toward a regulated size-class structure within stands. Some stands will need to be managed through even-aged methods initially to move them toward the desired uneven-aged condition.

3. Stand Composition: The desired within-stand compositional goal will be to restore a more diverse stand structure and mix of species in most stands, while some stands will continue to be dominated by nearly pure stands of sugar or red maple. It is desirable to increase the presence of yellow birch, basswood, red oak, white pine, white cedar, and

white spruce. Artificial regeneration may be necessary where these species have been extirpated, are not regenerating naturally, or to add species to the stand (e.g., oak) to meet various objectives.

4. Patch Management: Maintain existing large patches consisting of primarily northern hardwoods and increase the size or number where possible.

4.5C Uneven-aged Stand Management Direction

Note: Additional detail is included regarding stand management for northern hardwoods because of the relatively small amount of harvest that has occurred in recent years in this cover type in these subsections.

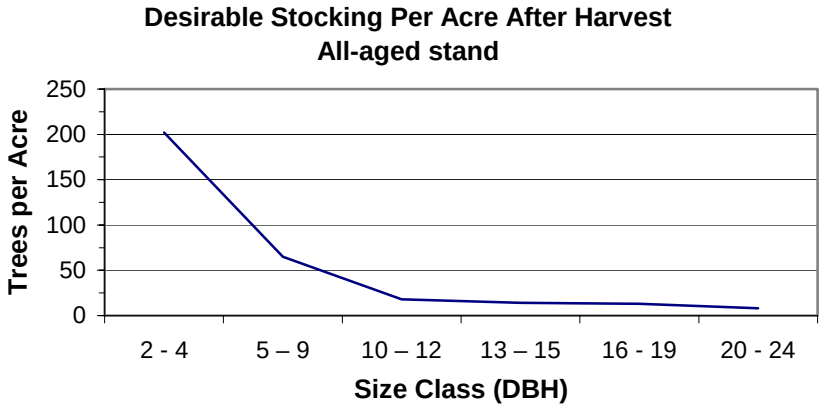
1. Uneven-aged Management Direction: The first step in uneven-aged management decision-making is to evaluate the stand and determine if it is a regulated or unregulated stand. Regulated stands must meet the desired stocking level for all size classes (See Table 4.5b and Figure 4.5b).

Table 4.5b: 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	
Size Class	**DBH (inches)**	**No. of Trees**	**Basal Area (sq. ft.)**
Saplings	2 - 4	202	8
Poles	5 – 9	65	16
Sawlogs			
Small	10 – 12	18	12
Medium	13 – 15	14	15
Large	16 - 19	13	21
	20 - 24	8	20
Subtotal		**53**	**68**
TOTAL		**320**	**92**

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



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

a. Remove volume only from overstocked size classes.
b. 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 6 cavity trees, potential cavity trees, and/or snags per acre.
c. Utilize three sawtimber size classes, 10-12", 13-15" and 16 - 24" for determining the basal areas to retain after harvest.
d. Remove crop trees that have reached the rotation size up to 24" DBH, depending on the species, while retaining 2 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.
e. Cuts in the pole size class should be for improvement only, removing the 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.

3. Unregulated Stands: Typically, stands are overstocked in the pole or small sawtimber size class, and lack adequate stocking in the sapling and large sawtimber size classes. Within 3-4 cuts (30-50 years) these stands may become fully regulated. Consider the following recommendations when moving an unregulated stand toward a regulated condition:

a. To increase the seedling and sapling size classes, apply gap management techniques:
    i. 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.

ii. Fell 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.
iii. For regenerating light seeded hardwoods, scarify, burn, or herbicide the gaps to prepare a seedbed and remove unwanted competition.
iv. Remove all trees greater than one-inch diameter from the gaps.

b. To improve the timber quality and desired stocking while retaining elements of structural diversity:
   i. Leave additional high quality trees in the next smaller size class to allow them to grow into a deficient class.
   ii. Remove poorer quality trees that compete with higher quality trees.
   iii. Remove trees infected with Nectria and Eutypella cankers.
   iv. Retain leave trees needed for plant and animal habitat, such as snags and recruitment of coarse woody debris. Retain a minimum of 6 cavity trees, potential cavity trees, and/or snags per acre.

After the initial entry, wait 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, when marking trees, 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.

4.5D Harvest Methods in Uneven-aged Managed Stands

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 the shade tolerant species at the expense of moderately tolerant or intolerant species. If the objective is to increase yellow birch, red oak, heartleaf birch, or paper birch in the northern hardwood stand, group selection should be used.

Utilize 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*[7] for a guide for selecting trees.

[7] 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.

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 yellow birch, red oak, heartleaf birch, paper birch, white spruce, and white cedar. The landscape position (aspect), microclimate, and adjacency to seed source should be considered when cedar, heartleaf birch, and white spruce are desired. Other methods should be used for increasing white pine in northern hardwood stands because of the increased risk of white pine blister rust infection in small openings.

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, this is not a concern.

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

4.5E Even-aged Management Direction

Approximately 20 percent of the northern hardwoods type may be harvested using even-aged methods with the long-term objective of improving the quality and eventually managing them as uneven-aged stands. Even-aged harvest methods are needed because of undesirable stand conditions resulting from past management in some stands or to move low quality even-aged hardwood stands toward an uneven-aged stand condition. The stands under this management option will be those that are the poorest quality, and have the lowest site index (less than SI 45). A field visit to evaluate the site is recommended prior to deciding if a stand will be managed through even-aged methods.

1. Shelterwood: Because it has proven to be the most effective system in regenerating a wide variety of species, shelterwood systems are recommended. 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 (yellow birch) and large seeded species (sugar maple and red oak). The key to this system is to establish adequate advanced (2-4 foot tall) reproduction prior to the removal of the overstory. The light 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, light seeded species in addition to maples:
a. Cut from below to 70-80 percent crown cover, 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)

2. 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 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. Species regenerating largely from stump sprouts may require thinning treatments in the future.

3. Even-aged Prescriptions: The following even-aged management harvest prescriptions will primarily be used:
a. Clearcut with Reserves
b. Clearcut with Reserves – Sprouting
c. Shelterwood
d. Shelterwood with Reserves
e. Shelterwood with Reserves- Final Harvest

4.5F Intermediate Harvest

1. 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:
a. 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.
b. 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.
c. Crown release, seven feet on at least three sides, on 60-75 crop trees per acre.
d. Thin from below, removing primarily the culls, poorest formed, poorest quality, and suppressed trees, until the desired stocking level is reached.
e. Leave an adjacent tree crown to correct for a fork.

f. Avoid creating large canopy gaps (>15 feet).
g. Delay next thinning until crown closure and lower branch mortality is achieved (15-20 years).

2. Thinning Prescription: Selective thinning is the most common prescription.

4.5G Regeneration Methods

When the stand is to be retained in the NH cover type, the harvest prescriptions for the most part are the regeneration methods. Consideration will be give 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.

To artificially regenerate species that are present in low numbers, or those that are no longer present, regeneration techniques including scarification, herbicide treatment, and/ or fire, followed by direct seeding or planting is recommended. 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.

4.5H Stand Selection Criteria

The NH cover type 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. It is estimated that a maximum of 20 percent of the stands will be treated through even-aged harvest methods. 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.

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, and as a result, the present trees may not accurately reflect site potential.

Forest inventory stand data was modeled forward to 2003 using the DNR's growth and yield models (*Chen*) for determining which stands meet the stand selection criteria.

4.5I Stand Treatment Summary

Based on the above criteria, 4,837 acres have been identified as a pool of stands for possible treatment during this 10-year planning period. Based on additional field

evaluations (e.g., re-inventory) of NH stands during this planning 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

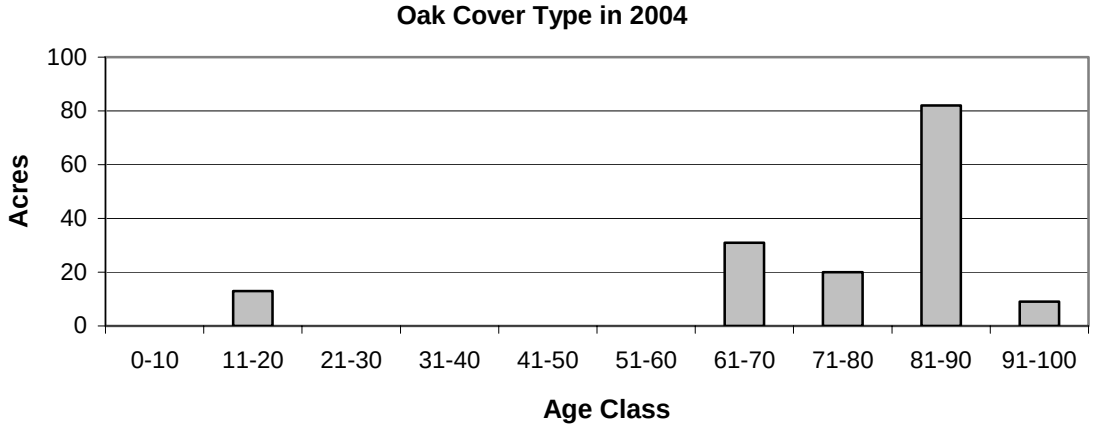
1. Cover Type Acres: In 2004, the oak cover type comprised less than 1 percent of state timberlands managed in the NTL subsections (All in the NSH subsection). Historically and currently, the oak cover type is rare in these subsections. It is more commonly found as a component of other cover types, such as aspen, birch, and northern hardwoods (106 stands as a component versus 8 stands as a cover type). The oak cover type includes northern red (*Quercus rubra – aka, Q. borealis Michx.*) and bur oak (*Quercus macrocarpa*).

Table 4.6a: Oak Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	155	0	0	155
Percent	100%			

2. Age-Class Distribution: The current age-class distribution shows that most of the oak stands are greater than 60 years old.

Figure 4.6a: Oak Cover Type Age-Class Distribution



4.6B Future Direction

1. Cover Type Acres: The 10-year goal is to increase the oak cover type in the North Shore Highlands by 84 percent (130 acres). The 60-year goal is to increase the oak cover type by 192 percent (297 acres). The increase will primarily come from the paper birch, aspen, and northern hardwoods cover types. The birch and aspen conversion will occur as these short-lived species are harvested and the longer lived oak are retained on the site. Also, a goal is to increase the oak component in other cover types where it is currently found through gap management.

4.6C Harvest Methods and Regeneration

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

2. Final Harvest: Final harvest will be based on average tree diameter of the crop trees. Final harvest will occur when trees reach a diameter of 18 to 24 inches diameter (DBH), depending on the site index. No final harvest is anticipated during the 10-year management period because of the current age and diameter of the oak in this cover type.

3. Intermediate Treatment: Thinning will produce best results if started before age 50. After that, the growth rate may not improve the merchantable products, but could still capture products from suppressed and intermediate trees. When thinning is begun, re-entry can be as often as every 10 years, but should be related to the stocking tables (See *Manager's Handbook for Oaks in the North Central States, Appendix IV*[8]).

During the thinning process, crop tree selection criteria should include the following[9]:

a. Dominant/codominant trees with large crowns relative to DBH

[8] 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.
[9] Conference Proceedings, the Oak Resource in the Upper Midwest. 1991. Minn. Ext. Serv., U. of Minn.

b. High quality trees with potential butt log grades of 1 or 2
c. No epicormic branches or dormant buds on the butt log
d. Trees should appear to have good life expectancy
e. Avoid selecting leaners, splitting forks, poor form trees, etc. as crop trees
f. 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. Quality crop trees vary with the site. A tree that would not qualify as a crop tree on a good site may be the best that is available as a crop tree on a poorer site. When picking crop trees, it is often a matter of picking the best available. Thinning should release the crop tree crown on at least three sides.

Standard stocking tables should be consulted when deciding if a stand should be thinned. The percent stocking is related to the basal area and average DBH.

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

5. Regeneration Methods: The preferred method of regenerating an oak stand is the shelterwood system to establish advanced regeneration. This system could be applied to oak stands or stands from other cover types that are being converted by planting to an oak cover type. Stands to be converted would be those most suitable for oak based on the *Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province* (NPC Field Guide).

Some control of understory competition may be necessary after the shelterwood harvest or prior to planting, particularly where sugar or red maple advanced reproduction is already established, or where there is competition from aspen sprouting. This can be done by ground spraying with an approved herbicide, or by prescribed burning.

Advanced reproduction must be well-distributed and relatively large (2-4 feet tall) in order to compete successfully with other woody vegetation in the new stand. When advanced reproduction is adequate, the overstory should be removed.
Protection of the seedlings from herbivory may be required. Various methods have been tried. Methods currently being used are placing self-adhesive drywall tape around the terminal bud or placing a small balloon over the terminal bud.

4.6D Stand Selection Criteria

During this 10-year year planning period, all merchantable-sized oak stands will be field visited to determine current basal area and average diameter. This information is needed

for using the stocking chart to determine if the stand is in need of thinning. Stands that are suitable for thinning will be marked and treated.

4.7 White Pine (WP)

4.7A Current Condition

1. Cover Type Acres: In 2004, the white pine cover type comprises about 1 percent (1,756 acres) of the state timberlands. White pine is also found as a component of most other cover types in these three subsections, typically on mesic sites.

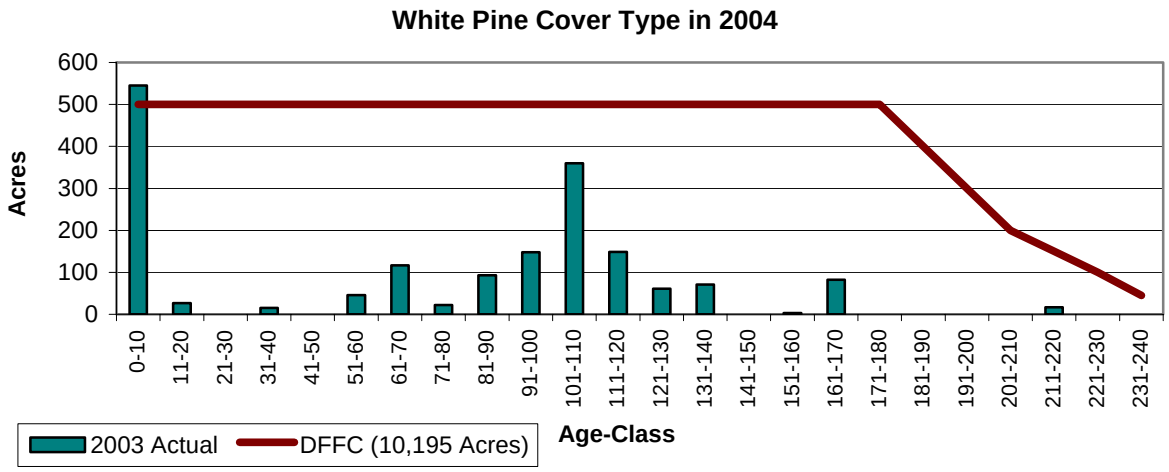
Table 4.7a: White Pine Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	990	388	378	1756
Percent	56%	22%	22%	

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 for even-aged managed cover types. This age-class imbalance is consistent across all three subsections. There has been a dramatic increase in the 0 – 10 age class. This is because of the increased emphasis and funding for regenerating white pine that started in 1998 with the white pine initiative.

Within these three subsections, only 17 acres (1 percent) of the white pine cover type is above the recommended extended rotation age of 180 years old. The DNR's white pine policy (1998) states that white pine will be managed under extended rotation forest guidelines to increase the acreage and distribution of older white pine stands and trees on the landscape.

Figure 4.7a: Current and Desired Age-Class Distribution of the White Pine Cover Type



The DFFC is the level when the desired future forest composition is reached after the white pine cover type acreage goal is achieved and a balanced age-class distribution is reached. Based on the current condition, it will take at least 170 years to reach this DFFC.

4.7B Future Direction

1. Cover Type Acres: The compositional goal, over the next 50 years, is to increase the white pine cover type by 480 percent (8,438 acres). During the next 10 years, the goal is to increase the acres by 213 percent (3736 acres).

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

	2004	**2014**	**2064**
North Shore Highlands	990	3,846	7,072
Toimi Uplands	378	821	1,778
Laurentian Uplands	388	825	1,345
Total acres	**1,756**	**5,492**	**10,195**

Approximately 75 percent of the acreage increase in the white pine cover type during the next 10 years should occur in the North Shore Highlands Subsection. White pine was historically more common in this subsection than the other two subsections.

2. Age-Class Distribution: Manage white pine stands to an extended rotation forest (ERF) age of 180 years before final harvest, according to DNR policy. The desired age-class distribution is to have approximately 500 acres in each age class out to 180 years old with declining acreage out to age 240 (See DFFC line in Figure 4.7a).

3. Stand Composition: White pine stands will range in species composition from nearly pure white pine stands to ones that are composed of mixed species (conifer-deciduous) with white pine being the predominant species.

4. Limiting Factors: Protective measures against insects, disease, and animal depredation need to be used for growing white pine in these subsections. They are a primary limitation in regenerating white pine. White pine blister rust, white pine weevil, and deer and snowshoe hare browsing pose challenges to regenerating this species. The subsections in this planning unit fall within the highest hazard zone for white pine blister rust. Silvicultural practices can minimize the damage to regenerating stands from blister rust and weevil. Bud capping, animal repellents, and fencing can be effective in reducing browsing damage.

Adequate funding to support the establishment and follow-up tending 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.

4.7C Stand Management

1. Management Direction: Younger white pine stands (up to 90 years old) will be managed primarily as even-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.

2. Final Harvest Method: Due to the 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 will occur in the future 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 greater then 110 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 Conversions to White Pine Stands

Conversions of other cover types to white pine stands will be accomplished primarily by converting stands in the aspen and birch cover types, and to a lesser degree from stands in the balsam fir cover type (*see Desired Cover Type Acreage Changes, Tables 3.1e – 3.1h*).
High-risk, low-volume (HRLV) stands identified in the aspen, birch, and balsam fir cover types will be site-visited during the next 10 years and assessed for their potential for natural or artificial conversion to white pine, or other long-lived conifers.

Where there is a significant component of white pine in non-HRLV stands of other cover types, guides such as the Field Visit Decision Tree and the NPC Field Guide should be used to determine if the stand should be managed toward developing into or converted to a white pine stand.

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.

a. Use a variety of site preparation techniques to provide the necessary ground scarification to prepare the seedbed or planting site.
    i. 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.
    ii. Decisions regarding whether or not site preparation is necessary, and the technique used, will be made following on-the-ground site evaluations.
b. Natural or artificial seeding, underplanting, and reserving advanced regeneration will be used to regenerate young white pine components in existing white pine stands.
    i. 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.
c. 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.
d. 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.
    i. 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 determine 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 planning 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 schedule 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 planning 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 that have a basal area of 110 square feet or greater.
b. Older (90+ years) white pine stands will be managed primarily for a multi-aged stand structure.

See Section 4.7C for more details on intermediate stand treatments.

4.8 Red (Norway) Pine (NP)

4.8A Current Condition

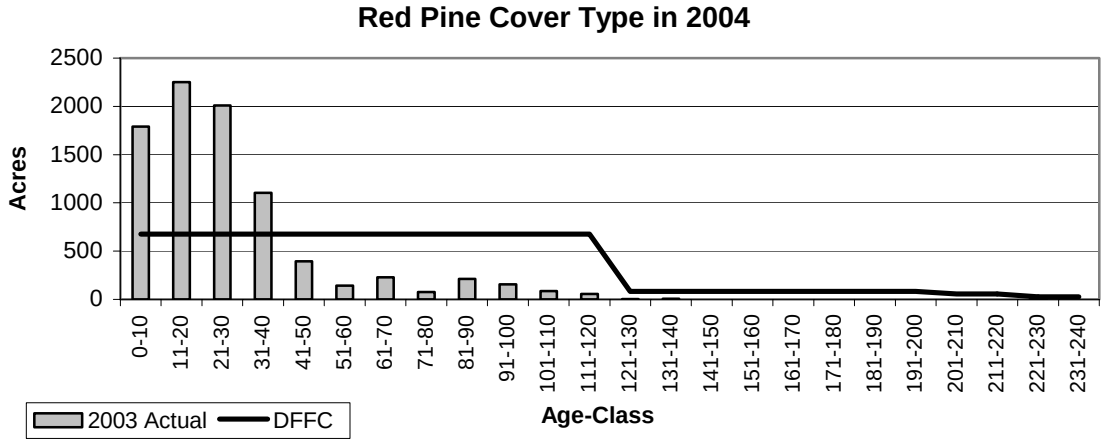
1. Cover Type Acres: In 2004, the red pine cover type comprised 4 percent (8,519 acres) of the state timberlands managed in the North Shore Highlands, Toimi Uplands, and Laurentian Uplands Subsections. There are 428 acres of old-growth red pine reserved from harvest in these subsections.

Table 4.8a: Red Pine Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	4,908	1,859	1,752	8,519
Percent	58%	22%	20%	

2. Age-Class Distribution: In each of the 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 acreage increase in the 0-40 age classes (North Shore Highlands) and 0-30 age classes (Laurentian Uplands and Toimi Uplands) is due to the planting of red pine on sites that were previously other cover types over the last 40 years. As a result, single cohort stands (i.e., of a similar age or a single disturbance) predominate in the 0-40 year age classes.

Figure 4.8a: Current and Desired Age-Class Distribution of the Red Pine Cover Type



This age-class imbalance is more or less consistent across all three subsections, although less markedly in the Toimi Uplands. Within the three subsections, less than 1 percent (12 acres) of the red pine cover type is currently over the recommended normal rotation age of 120 years.

4.8B Future Direction

1. Cover Type Acres: The compositional goal over the next 60 years is to increase the red pine cover type by 38 percent (3234 acres). During the next 10 years, the goal is to increase the acres by 18 percent (1500 acres).

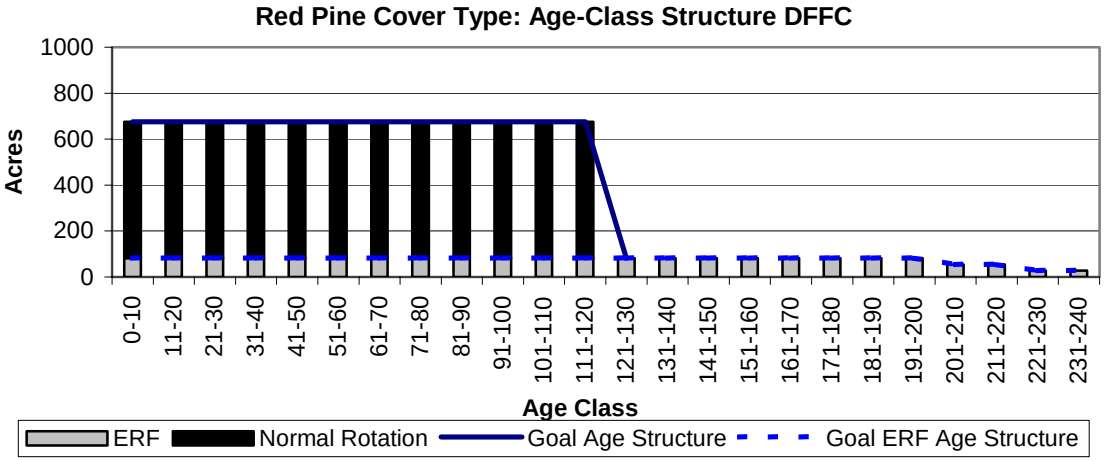
Desired sites for conversion to the red pine cover type are sites that support a plant community where red pine is typically one of the dominant species. In these subsections, the plant communities that are likely to be associated with the red pine cover type are the Northern Mesic Mixed Forest - White Pine-Red Pine Forest (FDn43a) or Northern Poor Dry-mesic Mixed Woodland (FDn32).[10]

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

The ERF goal for this cover type is to have 10 percent of the acres over normal rotation age (effective ERF) with a declining age-class distribution from the normal rotation age (120 years) out to the maximum age (240 years). Figure 4.8b shows the desired age-class structure for normal rotation and ERF acres in the cover type.

Figure 4.8b: Desired Age-Class Structure for the Red Pine Cover Type

[10] 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.



3. Stand Composition: The desired future within-stand composition in some of the red pine cover type will range from stands dominated by red pine to mixed red pine-white pine-jack pine or coniferous-deciduous stands, depending on the plant community appropriate to the site[8].

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).

4.8C Stand Management

1. Even-aged Management Direction: Red pine will be managed predominantly as an even-aged cover type for poles and high value sawtimber products. 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. Final Harvest Method: Due to the current age of stands and the age-class imbalance, there is no final harvest planned in the red pine cover type during the next 10 years. Final harvest in the red pine cover type will occur in the future using clearcut or clearcut with reserves.

3. 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. 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.

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.

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 guidelines should be followed when harvesting in pine stands.

4. 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
c. Selective 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.

5. 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 burning should be use for site preparation on some sites, or underburn on appropriate sites, to encourage natural regeneration of red pine (where disease is not a problem) and other species.

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.

4.8D Stand Selection Criteria

1. Normal Rotation Forest: The normal rotation age of 120 years will be used for calculating a regulated harvest level. Since no stands in the normal rotation pool of stands are greater than 120 years, no final regeneration harvest is planned during the next 10 years.

2. Extended Rotation Forest: No final regeneration harvest is planned during the next 10 years for ERF stands that are being managed under the extended rotation ages of 200, 220, and 240 years.

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

All red pine stands 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 planning 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 schedule 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 planning period. Stands that meet the criteria for thinning will be treated through timber sales.

Stand treatment criteria includes:

a. Stands of merchantable size and volume that have a basal area of 120 square feet or greater.
b. A higher basal area will be maintained in stands where the average tree diameter is greater than 15 inches.

See Section 4.8C for more details on intermediate stand treatments.

4.9 Jack Pine (JP)

4.9A Current Condition

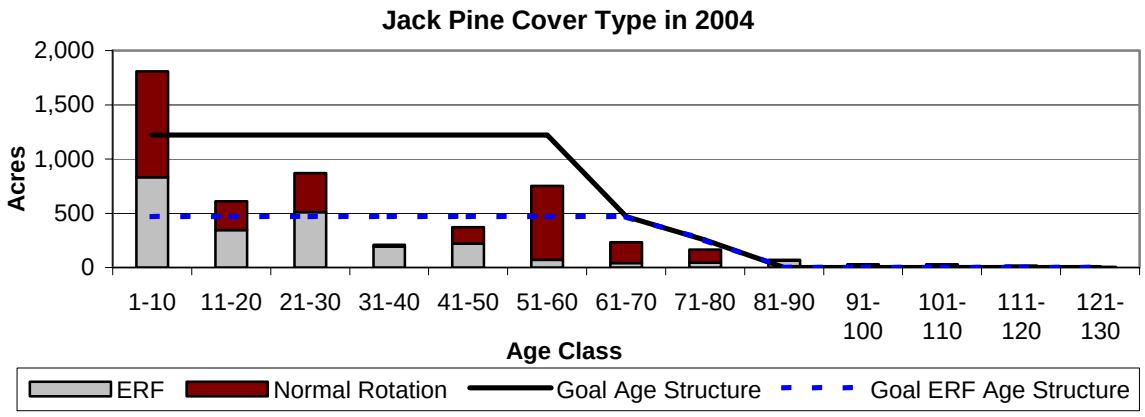
1. Cover Type Acres: In 2004, this jack pine cover type comprised 2.3 percent of state timberlands in the NTL subsections.

Table 4.9a: Jack Pine Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	1,333	3,485	442	5,260
Percent	25%	66%	9%	

2. Age-Class Distribution: In each of the subsections, the current age-class distribution of the jack pine cover type does not reflect the desired balanced age-class structure described for even-aged managed cover types. The current age-class distribution is skewed toward younger age classes. This age-class imbalance is consistent across all three subsections.

Figure 4.9a: Current and Desired Age-Class Distribution of the Jack Pine Cover Type



Note: The 1-10 age class is inflated because it includes 237 acres that are currently timber sale permits or are acres on the FY2004 annual harvest plan that haven't been harvested yet. This acreage will be treated within the next 1 – 5 years.

4.9B Future Direction

1. Cover Type Acres: The 10-year goal is an increase the jack pine cover type by 21 percent (1,115 acres). The 60-year goal is increase the acreage by 53 percent (2,808 acres). Table 4.9b shows the desired changes by subsection.

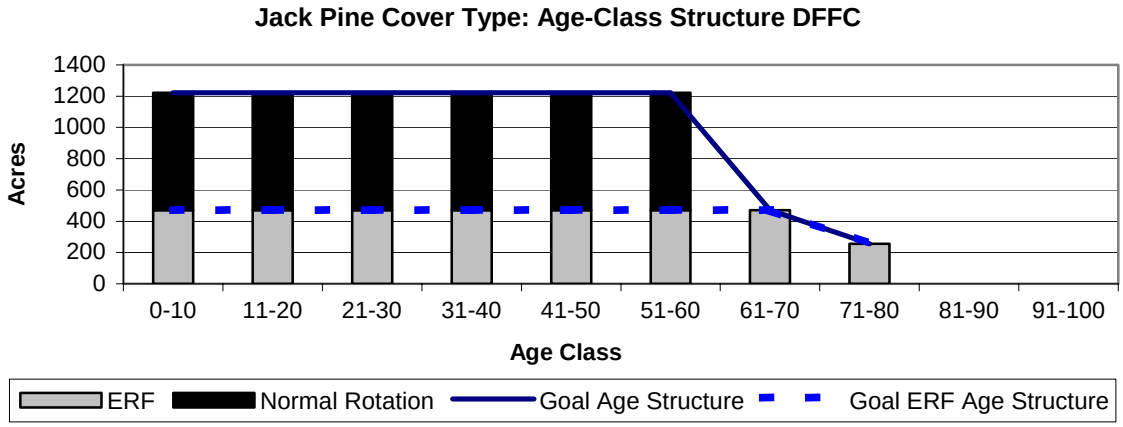
Table 4.9b: Recommended Jack Pine Cover Type Acres in the Subsections by Year

	2004	2014	2064
North Shore Highlands	1,333	1,992	2,990
Toimi Uplands	442	575	778
Laurentian Uplands	3,485	3,808	4,308
Total acres	**5,260**	**6,375**	**8,076**

The increase will be accomplished primarily by converting stands currently in the aspen, birch, and balsam fir cover types to the jack pine cover type. Drier and/or nutrient poor sites of any of these cover types will be more productive if converted to jack pine. An emphasis should be placed on converting stands to jack pine that are adjacent to existing jack pine stands in an effort to create larger stands.

2. Age-Class Distribution: The long-term goal is to move the age classes toward a more balanced structure. Figure 4.9b shows the desired age-class distribution.

Figure 4.9b: Desired Age-Class Structure for the Jack Pine Cover Type



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 80 years. The ERF goal for this cover type is to have 9 percent of the acres over the 60-year old normal rotation age (i.e., effective ERF) years at any one time.

3. Stand Composition: The desired stand composition will be relatively pure jack pine. Associated species may be red pine, white pine, black spruce, paper birch, and aspen. Upland black spruce often occurs as a codominant species in jack pine stands.

4.9C Stand Management

1. Even-aged Management Direction: The jack pine 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.

Manage the jack pine cover type to reduce the potential build-up of jack pine budworm and bark beetle populations. Poorly stocked stands, over-stocked stands, over-mature stands or stands with low-vigor trees are most susceptible to these insects. Maintain 70 - 100 square feet of basal area to minimize the number of wolf trees and suppressed trees.

2. Final Harvest Methods: The jack pine cover type will be treated through even-aged prescriptions using clearcuts, clearcuts with reserves (e.g., jack pine, red pine, white pine, white spruce, aspen, balsam fir, and birch), or seed tree methods. This can be accomplished by reserving seed trees, islands or clumps of mature trees, or advanced regeneration. In the Laurentian Uplands Subsection, harvest some larger blocks (100+ acres), where possible, using natural stand boundaries.

Bark beetle guidelines regarding timber harvest during summer months will be followed.

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

a. Clearcut followed by natural seeding
b. Clearcut with reserves followed by natural seeding
c. Clearcut followed by artificial seeding or planting
d. Clearcut with reserves followed by artificial seeding or planting
e. Seed tree

4. Intermediate Harvest Methods: Thinning is recommended on the more productive jack pine sites that meet the criteria for thinning. Thinning will capture volume that would be lost to mortality and will increase production of larger timber (saw bolts). Following are recommendations for thinning jack pine stands:

a. Stands should have 120 BA or greater to be thinned.
b. Thin down to a basal area no less than 80 square feet per acre.
c. Do not remove more than approximately one third of the basal area in the thinning.
d. If selective thinning between rows or strips, maintain 70-80 percent crown closure.
e. Maintain winter cover if the stand is in a deer wintering area.
    i. Maintain a higher stand basal area (wider reserve strips with canopy closure).
    ii. Thin only a portion of the stand.
    iii. Don't thin.
f. Retain tree, shrub, and forb species diversity.
    i. Maintain the mix of tree species naturally found in the stand.
        a) Species mix should exist in approximately the same proportion in the stand after a thinning.
    ii. Locate rows or strips to be thinned to reserve clumps of secondary tree species.

g. Follow bark beetle guidelines regarding timber harvest during summer months.

5. Intermediate Harvest Prescriptions: Following are the prescriptions:
a. Row Thinning
b. Strip Thinning
c. Selective Thinning

6. Regeneration Methods: Natural seeding, artificial seeding, or planting will be used to regenerate jack pine. Recommendations are:
a. Use seed or planting stock from the appropriate seed zone.
b. Manage slash to accomplish regeneration objectives.
    i. Use full-tree skidding prior to aerial seeding or hand planting.
    ii. Lop and scatter the slash for natural seeding.
    iii. Broadcast the slash if the site will be prescribed burned.
c. Consider mixing black spruce 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, red pine, and tamarack.

4.9D Stand Selection Criteria

1. Normal Rotation Forest: The normal rotation age of 60 will be used for calculating a regulated harvest level.

Table 4.9c: Jack Pine Normal Rotation Age and Maximum Age

Site Index	Acres	Normal Rotation Age	Maximum Age
All	2,801	60	80

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 stands for treatment. All stands that are tagged as HRLV (see criteria below) will be site visited during this 10-year planning period. These stands will be removed from the pool of stands used to calculate the normal rotation harvest level.

Harvest Level Calculations:
Normal Management Pool = (Total Non-ERF) - (Non-ERF HRLV)
Normal Harvest Level = (Normal Management Pool / Rotation age)
Selection Pool = Normal Management Pool that is over 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. For a more detailed description of harvest level calculations, see GDS-9A.
2. Extended Rotation Forest: The harvest level will be based on two ERF rotation ages (70 and 80 years).

Table 4.9d: Jack Pine ERF Rotation Ages and Maximum Age

Site Index	Acres	ERF Rotation Ages	Maximum Age
All	2,377	70 and 80	80

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. The long-term goals are to retain 9 percent of the cover type acreage over the normal rotation age and to provide a declining age-class structure out to the maximum harvest age. See Figure 4.9b.

All stands that are tagged as HRLV (see criteria below) will be site visited and evaluated for treatment during the next 10 years. These stands will be removed from the pool of stands used to calculate the ERF harvest level.

Harvest Level Calculations:
ERF Management Pool = (Total ERF) – (ERF HRLV)

The ERF harvest level is determined by the desired acres in the declining age-class structure and achieving and sustaining a 9 percent effective ERF.

ERF Selection Pool = Management Pool that is over normal rotation age. Acres will be targeted by age class.

Because of the current age-class distribution and the goal of retaining 9 percent effective ERF, no harvest of ERF designated stands (except the HRLV stands) are planned during the next 10 years.

3. High-Risk, Low-Volume: All stands over age 80 will be field visited over the next 10 years. The Field Visit Decision Tree (Appendix E) will be used to determine what treatment to prescribe for the stands when they are field evaluated. There are 154 jack pine acres that meet the HRLV criteria, 33 acres in the normal rotation management pool and 121 acres in the ERF management pool.

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

a. Stands between age 21 and 40 years old, and
b. 120 or more square feet of basal area
c. Site index is greater than 60.

Only two stands met the above criteria based on current forest inventory data. Additional stands may be evaluated for thinning based on field visits to stands. If they meet the above criteria they may be thinned.

4.9E Stand Treatment Summary

Table 4.9e shows the modeled treatment levels (acres), recommended conversion acreage into the jack pine cover type, old forest percent, effective ERF percent, and the average

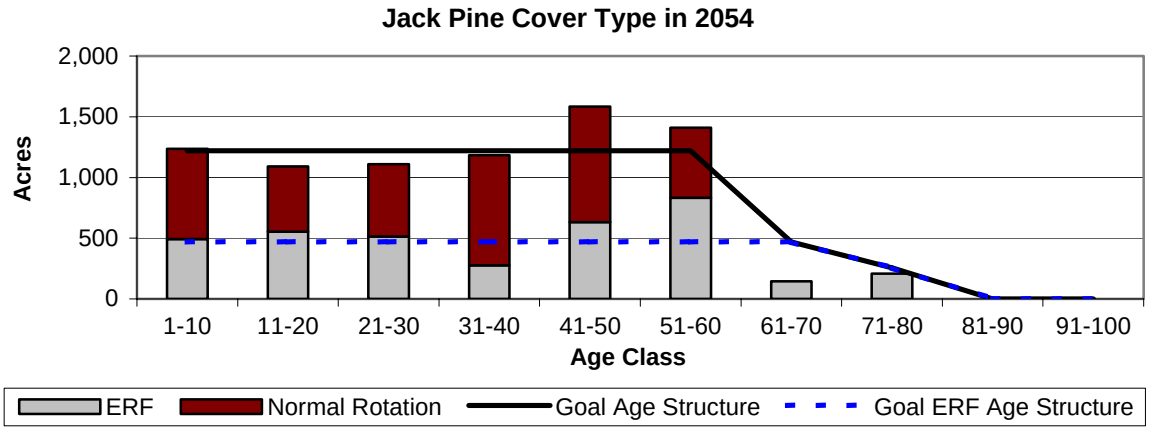
treatment ages for the next six decades. There is variation from decade to decade because of the current age-class distribution of the cover type. Treatment in Decade 1 includes HRLV acres.

Table 4.9e: Jack Pine Treatment Summary by Decade

	Acres				Average Treatment Age	
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Effective ERF**	**Normal**	**ERF**
1	468	+1115	10.7%	4.0%	74	NA
2	766	+418	13.3%	2.5%	70	85
3	691	+418	6.6%	4.4%	59	66
4	673	+418	3.7%	3.7%	55	69
5	818	+418	4.1%	4.1%	52	63
6	1,135	21	4.4%	4.4%	60	68
DFFC	**1,221**	**+2,808**		**9.0%**	**60**	**75**

Based on the modeling of these treatment levels, by the end of the fifth decade, the cover type should be approaching the desired age-class distribution.

Figure 4.9c: Estimated Jack Pine Cover Type Age-Class Distribution in 2054



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

4.10 Black Spruce Upland (BSU)

4.10a Current Condition

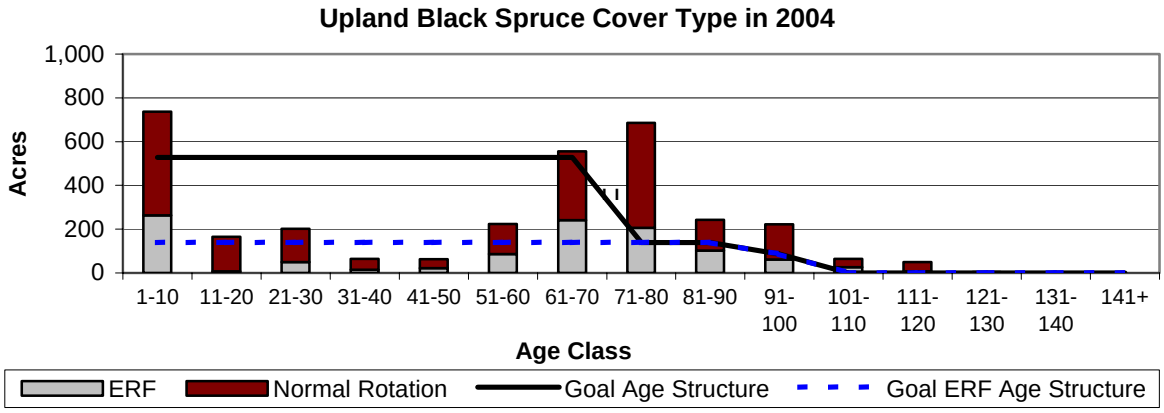
1. Cover Type Acres: In 2004, the upland black spruce cover type comprises 1.5 percent of state timberlands in the NTL subsections.

Table 4.10a: Upland Black Spruce Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	954	2,194	180	3,328
Percent	29%	66%	5%	

2. Age-Class Distribution: In each of the subsections, the current age-class distribution of the BSU cover type does not reflect the desired balanced age-class structure described for even-aged managed cover types. The current age-class distribution is skewed toward older age classes. This age-class imbalance is consistent across all three subsections.

Figure 4.10a: Current and Desired Age-Class Distribution of the Upland Black Spruce Cover Type



Note: The 1-10 age class is inflated because it includes 524 acres that are currently timber sale permits or are acres on the FY2004 annual harvest plan that haven't been harvested yet. This acreage will be treated within the next 1 – 5 years.

Within the three subsections, approximately 38 percent (1,275 acres) of the BSU acreage is currently over the recommended normal rotation age of 70.

4.10b Future Direction

1. Cover Type Acres: The 10-year goal is an increase of 9 percent (294 acres). The 50-year goal is that the cover type acreage will increase by 22 percent (734 acres). Table 4.10b shows the desired changes by subsection.

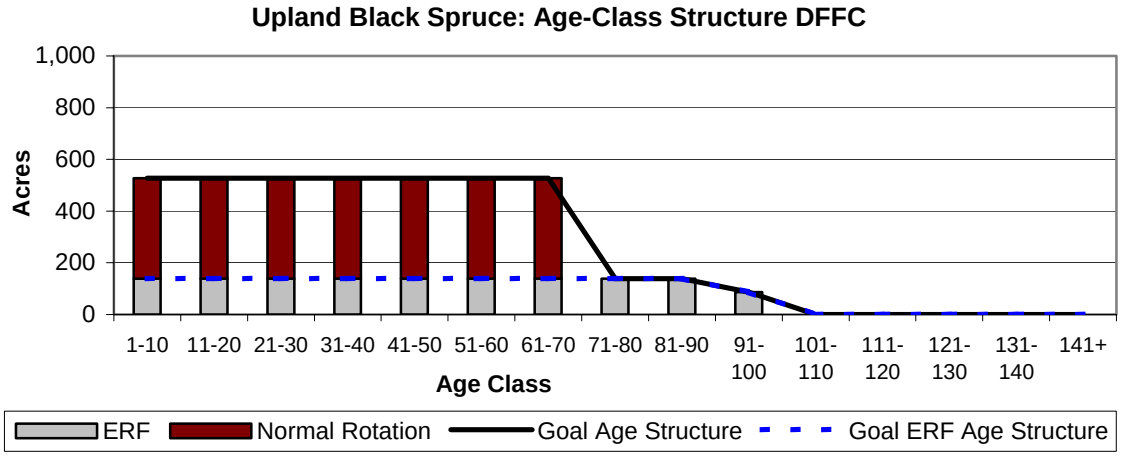
Table 4.10b: Recommended Upland Black Spruce Cover Type Acres in the Subsections by Year

	2004	**2014**	**2064**
North Shore Highlands	954	1,044	1,174
Toimi Uplands	180	180	180
Laurentian Uplands	2,194	2,398	2,704
Total acres	**3,328**	**3,622**	**4,061**

The increase will be accomplished primarily by converting stands currently in the aspen, birch, and balsam fir cover types by managing to increase the black spruce component.

2. Age-Class Distribution: A goal is to move the age classes toward a more balanced structure.

Figure 4.10b: Desired Age-Class Structure for the Upland Black Spruce Cover Type



The ERF goal for this cover type is to have 9 percent of the acres over the 70-year old normal rotation age (i.e., effective ERF) with a declining age-class distribution out to the maximum age of 100 years as shown in Figure 4.10b.

3. Stand Composition: The desired within stand composition will range from pure black spruce stands to a more diverse stand structure that might include upland species, such as jack pine, aspen, balsam fir, and birch, depending on the plant community appropriate to the site. Jack pine often occurs as a codominant species in upland black spruce types.

4.10C Stand Management

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

2. Harvest Methods: BSU stands will be treated through even-aged management using clearcut or clearcut with reserves prescriptions. Associated species in this plant community type that should be considered for reserve trees are jack pine, white pine, white spruce, aspen, balsam fir, or birch. This can be accomplished through reserving seed trees, islands or clumps of mature trees, or advanced regeneration. Where possible, harvest sites should use natural stand boundaries.

Stem decay can affect upland black spruce similar to jack pine. Stem decay can be more prevalent in upland black spruce than lowland black spruce and usually occurs at a younger age. Stands over age 70 are at higher risk for rot. Stem decay does not kill trees, but it does lead to more stem breakage from wind and can substantially reduce merchantable volume. Exposing the windward side of mature BSU stands should be avoided during harvest of adjacent stands.

The spread of eastern dwarf mistletoe to regenerating stands of black spruce is a concern in the management of this cover type. The following recommendations for harvest and post sale treatment are recommended *where dwarf mistletoe is present in a stand* to limit its spread:

a. Black spruce reserve trees are not recommended due to the possibility of spreading dwarf mistletoe infection to the regenerating stand.
b. All clearcuts should kill all live black spruce greater than 5 feet in height.
c. If the site is to be prescribed burned, slash should be distributed evenly across the site.
d. Design timber sales boundaries to include mistletoe pockets plus a two-chain (132 feet) buffer of non-infected black spruce.

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

a. Clearcut followed by natural seeding.
b. Clearcut with reserves followed by natural seeding.
c. Clearcut followed by artificial seeding or planting.
d. Clearcut with reserves followed by artificial seeding or planting.

4. Regeneration Methods: Regeneration of upland black spruce sites will be accomplished through natural seeding, artificial seeding, or planting. Recommendations are:

a. Plant or seed species appropriate to the site.
b. Manage slash to accomplish regeneration objectives. For example, use full-tree skidding prior to aerial seeding or hand planting, or broadcast the slash if the site will be prescribed burned.

4.10D Stand Selection Criteria

1. Normal Rotation Forest: A normal rotation age of 70 years will be used for calculating a regulated harvest level. The objective is to move the age classes toward a more balanced structure.

Table 4.10c: BSU Normal Rotation Age and Maximum Age

Site Index	Acres	Normal Rotation Age	Maximum Age
All	2,188	70	100

The priority during this 10-year management period is to select the oldest stands for treatment. Not all stands above the normal harvest age will be treated because of the current acreage of stands over normal rotation age.

All stands that are tagged as HRLV (see criteria below) will be site visited during this 10-year plan period. These stands will be removed from the pool of stands used to calculate the normal rotation harvest level.

Harvest Level Calculations:

Normal Management Pool = (Total Non-ERF BSU) - (Non-ERF HRLV)
Normal Harvest Level = (Normal Management Pool / Rotation age)
Selection Pool = Normal Management Pool that is over 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.

2. Extended Rotation Forest: The harvest level will be based on two ERF rotation ages (90 and 100 years).

Table 4.10d: BSU ERF Rotation Ages and Maximum Age

Site Index	Acres	ERF Rotation Ages	Maximum Age
All	1,091	90 and 100	100

The selection of older aged stands for treatment 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 9 percent of the cover type acreage over the normal rotation age and to provide a declining age-class structure out to the maximum harvest age. See Figure 4.10b.

All stands that are tagged as HRLV (see criteria below) will be site visited and evaluated for treatment during the next 10 years. These stands will be removed from the pool of stands used to calculate the ERF harvest level.

Harvest Level Calculations:
ERF Management Pool = (Total ERF BSU) – (ERF HRLV)
ERF harvest level was determined by the desired acres in the declining age-class structure and achieving and sustaining a 9 percent effective ERF
ERF Selection Pool = ERF Management Pool that is over normal rotation age.
Acres will be targeted by age class.

3. High-Risk, Low-Volume Stands: All HRLV stands will be site visited during the 10-year plan period. These stands may receive harvest, development, or inventory alteration treatments depending on the site conditions. See Field Visit Decision Tree, Appendix E. These stands could be part of either the normal rotation and extended rotation forest. HRLV stands were selected based on the following criteria:

a. All BSU stands over age 100 years.
b. Stands over age 70 and total stand volume less than 7.6 cords per acre.

There are 220 BSU acres that meet the HRLV criteria, 156 acres in the normal rotation management pool and 64 acres in the ERF management pool.

4.10E Stand Treatment Summary

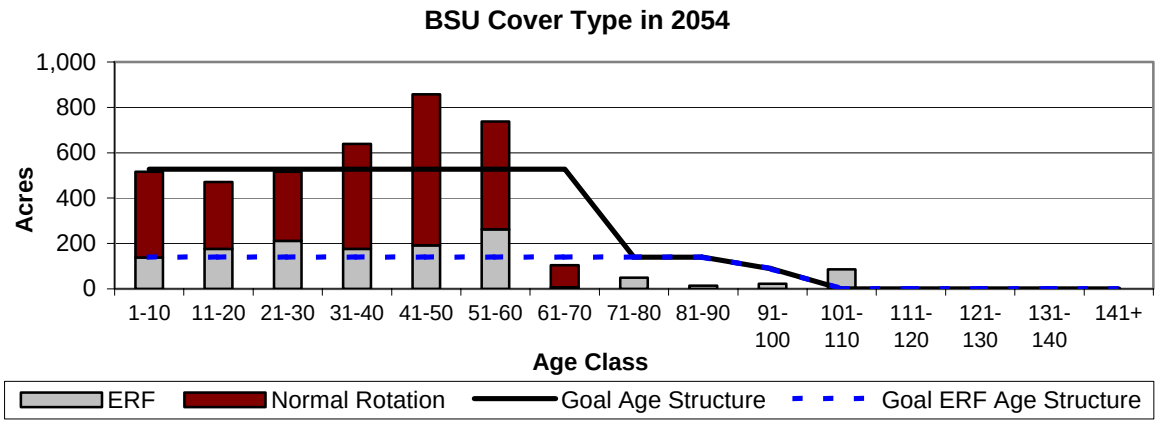
Table 4.10e shows the modeled treatment levels (acres), recommended conversion acreage into the BSU cover type, old forest percent, effective ERF percent, and the average treatment ages for the next six decades. There is some variation from decade to decade because of the current age-class distribution of the cover type. Treatment in Decade 1 includes HRLV acres.

Table 4.10e: Upland Black Spruce Treatment Summary by Decade

	Acres				Average Treatment Age	
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Effective ERF**	**Normal**	**ERF**
1	564	+293	39%	13%	91	100
2	529	+110	35%	16%	90	101
3	406	+110	26%	14%	90	100
4	361	+110	16%	9%	94	100
5	406	+110	8%	6%	72	110
6	506	0	4%	4%	62	108
DFFC	**528**	**732**		**9%**	**70**	**96**

Based on the modeling of these treatment levels, by the end of the fifth decade, the cover type should be approaching the desired age-class distribution.

Figure 4.10c: Estimated BSU Cover Type Age-Class Distribution in 2054



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

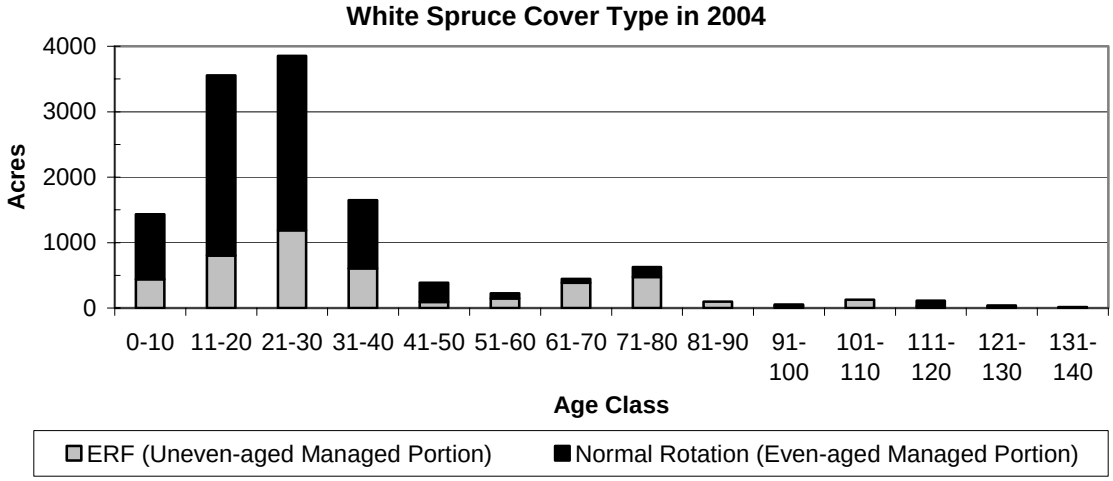
1. Cover Type Acres: In 2004, the white spruce cover type comprises about 6 percent of state timberlands managed in the NTL subsections.

Table 4.11a: White Spruce Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	8,467	2,602	1,545	12,614
Percent	67%	21%	12%	

2. Age-Class Distribution: The current white spruce age-class distribution for the portion of the cover type that will be managed as even-aged stands does not reflect the desired balanced age-class structure for even-aged managed cover types. In the three subsections, 93 percent of the white spruce cover type is under the recommended normal rotation age of 75 years.

Figure 4.11a: Current Age-Class Distribution of the White Spruce Cover Type



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, with smaller amounts of white pine, tamarack or black spruce depending on landscape context, site conditions, and management history. Approximately 70 percent of white spruce cover type less than 50 years old originated as plantations and is being managed primarily as a single species.

4. Recent Concern: Spruce beetle is a native bark beetle in Minnesota, but until recently was seldom found. It is currently causing a considerable amount of mortality in about the eastern half of NSH within five to six miles of Lake Superior. Older trees (greater than 10-inch DBH) are the most likely to be attacked and killed. The future impact and trend of the spruce beetle is not known, but the outbreak appears to be increasing.

4.11B Future Direction

1. Cover Type Acres: The composition goal, over the next 60 years is to increase the acreage in this cover type by an average of 28 percent (3,586 acres) across the NTL subsections. In the next 10 years, the increase will average 11 percent (1,435 acres) across the NTL subsections.

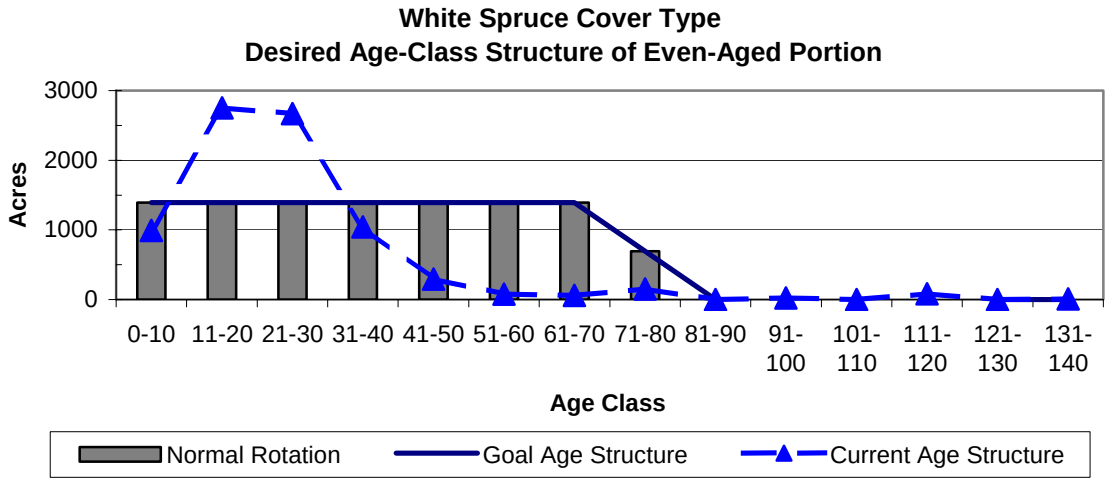
Table 4.11b: Recommended White Spruce Cover Type Acres in the Subsections by Year

	2004	**2014**	**2064**
North Shore Highlands	8,467	9,584	11,262
Toimi Uplands	1,545	1,745	2,035
Laurentian Uplands	2,602	2,720	2,892
Total acres	**12,614**	**14,049**	**16,189**

The increase will be accomplished through natural or artificial conversion of stands currently in aspen, birch, and balsam fir cover types by managing to increase the white spruce component.

2. Age-Class Distribution: A long-term goal is to move the portion of the cover type managed as even-aged stands toward a more balanced age-class structure. See Figure 4.11b.

Figure 4.11b: Desired Age-Class Structure for the Even-Aged Managed Portion of the White Spruce Cover Type



ERF and natural origin white spruce stands will be managed as multi-aged and mixed species stands. The ERF goal for this cover type is to have 12 percent of the white spruce acres over the 75-year old normal rotation age out to the maximum age (120 years). ERF will be provided in this uneven-aged (multi-aged) managed portion of the cover type.

3. Stand Composition: White spruce stands will vary from mostly pure stands of 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. (See GDS-1B and 3.)

4.11C Stand Management

A. Even-Aged Management

1. Even-aged Management Direction: Manage white spruce 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.

2. Even-Aged Harvest Methods: Manage normal rotation white spruce stands using clearcut, shelterwood, or seed tree prescriptions. Use natural stand boundaries or natural features such as topography and soil type to delineate timber sale boundaries.

Establish harvest regulations and apply harvesting techniques that will favor maintaining or increasing within-stand diversity by reserving from harvest a portion of the hardwoods and other long-lived conifers and protect 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.

3. 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.

B. Uneven-Aged Management

1. Uneven-aged Management Direction: ERF white spruce stands will be managed as uneven-aged stands with a goal of increasing species and age-class diversity within the stand. Uneven-aged managed stands should result in multi-canopy, mixed species conditions that are desired on some sites. Some recommendations are:

a. Due to spruce budworm considerations, balsam fir will be discriminated against in harvest prescriptions.
b. Retain some supercanopy white spruce, or other species such as white pine, to retain a portion of the largest cohorts in the overstory in patches or clumps, where possible, at each treatment.
c. Encourage multi-layered understory development.
d. When regenerating trees in the understory, 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.

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
c. Seed Tree with Reserves
d. Shelterwood with Reserves

C. Intermediate Harvest

1. Intermediate Harvest Methods: Thinning will be used to reduce stand density to increase future tree growth, quality, vigor, and to reduce the risk of spruce budworm outbreaks and damage. Recommendations are:

a. Thinning in normal rotation stands will occur in merchantable stands at approximately 10-year intervals, depending on site quality.
b. Thin down to a basal area no less than one-third of the current stand BA on the initial thinning. Subsequent thinnings should retain a minimum of 100 BA or 40 percent live-crown ratio.
c. 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.
d. In multi-aged stands, residual basal area may be modified to meet ERF and other objectives. Examples are: 1) thin to 60 BA vs. 100 BA to encourage within stand diversity and 2) maintain higher residual basal areas because of the larger diameter of older trees.

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:

a. 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.
b. Protect advanced regeneration of desirable understory species, where possible.
c. Consider creating or maintaining variable densities within stands when thinning.
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. 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.

If the stand is utilized as a thermal cover area by deer or moose, consider applying one of the following options:

a. Maintain a higher stand basal area (e.g., wider reserve strips with canopy closure).
b. Thin only a portion of the stand.
c. Don’t thin.

2. Thinning Prescriptions: Prescriptions for thinning include:

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

D. Regeneration

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.
    i. Retain advanced regeneration of desired species from the previous stand.
    ii. Plant fewer trees per acre to allow other species to develop.
    iii. 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 white spruce and other desired species to supplement natural seeding.

4.11D Stand Selection Criteria

1. Normal Rotation Forest: A rotation age of 75 years will be used for calculating a regulated harvest level for stands managed under normal rotation.

Table 4.11c: White Spruce Normal Rotation Age and Maximum Age

Site Index	Acres	Normal Rotation Age	Maximum Age
All	8,152	75	120

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 stands for treatment.

The HRLV stands were removed from the pool of stands used to calculate the normal rotation harvest level. All stands that are tagged as HRLV (see criteria below) will be site visited during the next 10 years.

Normal Rotation Harvest Level Calculations:
Normal Management Pool = (Total Non-ERF WS) - (Non-ERF HRLV)
Normal Harvest Level = (Normal Management Pool / Rotation age)
Selection Pool = Normal Management Pool that is over normal rotation age.

Adjustments to the normal harvest level for the next 10 years were needed to meet other goals such as balancing the age-class distribution and providing relatively stable harvest levels. For a more detailed description of harvest level calculations, see GDS-9A.

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

2. Extended Rotation Forest: ERF stands (35 percent of the 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: White Spruce ERF Rotation Age and Maximum Age

Site Index	Acres	ERF Rotation Ages	Maximum Age
All	1,091	100 and 120	120

Due to the current age of ERF stands, no stands were selected for treatment during this 10-year planning period. Some ERF designated stands were selected for treatment under the thinning criteria.

3. High-Risk, Low-Volume Stands: Stands that meet high-risk, low-volume criteria will be field visited over the next 10 years for possible treatment. HRLV stands were defined by the following criteria:

a. All white spruce stands over age 120 years.
b. Stands over age 75 with volume less than 7.6 cords per acre.

These stands could be part of either the Normal Rotation or Extended Rotation Forest.

Table 4.11e: White Spruce High-Risk, Low-Volume Acreage by Subsection

HRLV	North Shore Highlands	Toimi Uplands	Laurentian Uplands	Total
Normal	8	0	135	143
ERF	96	25	29	150

The Field Visit Decision Tree (Appendix E) will be used to determine the appropriate stand treatment for HRLV stands.

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

All white spruce stands that are currently equal to or greater than 20 years old will be field visited to assess whether harvest is appropriate during this 10-year planning 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, 20-year old stands should be schedule 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 planning period. Stands that meet the criteria for thinning will be treated through timber sales.

Stand treatment criteria includes:

a. Normal rotation white spruce stands 25 – 60 years old having a basal area of 140 square feet or greater.
b. ERF white spruce stands 25 – 105 years old having a basal area of 140 square feet or greater.

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

4.11E Stand Treatment Summary

Table 4.11f shows the modeled treatment levels (acres), recommended conversion acreage into the white spruce cover type, and the average treatment age over the next six decades for the even-aged portion (normal rotation age stands) of the cover type. There is variation from decade to decade because of the current age-class distribution of the cover type. Treatment in Decade 1 includes mostly HRLV acres. The table does not include acreage treated through uneven-aged management and intermediate treatments such as thinning. Conversion acres include both even-aged and uneven-aged portions of the cover type.

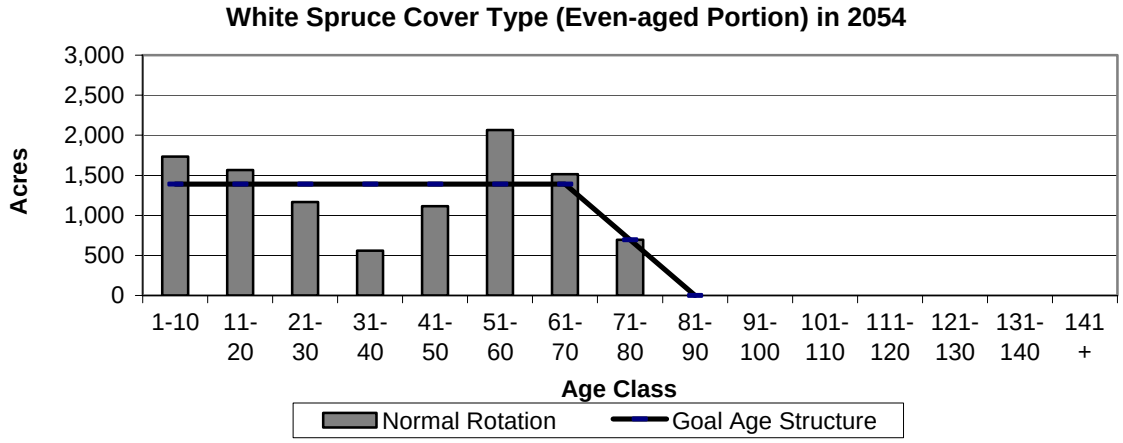
Table 4.11f: White Spruce Treatment Summary by Decade

	Acres		Average Treatment Age
Decade	**Total Treatment**	**Conversion**	**Normal**
1	203	+1413	83

2	215	530	62
3	824	530	54
4	1,223	530	60
5	1,391	530	61
6	1,515	0	75
DFFC	**1,391**	**+3,552**	**75**

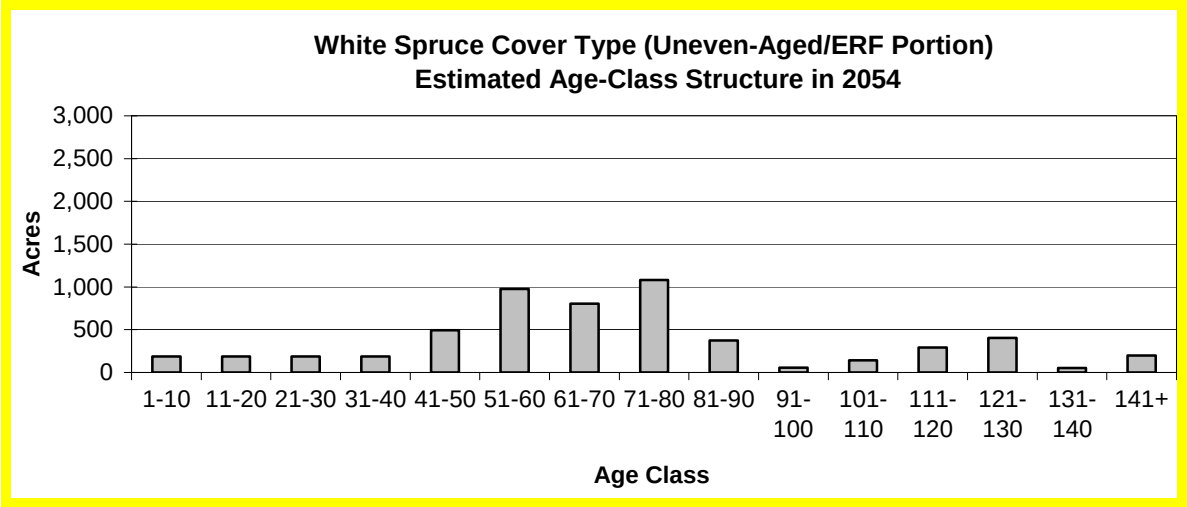
Based on the modeling of the treatment and conversion levels by decade, Figure 4.11c shows the projected age-class distribution in 2054 of the even-aged managed portion of the white spruce cover type.

Figure 4.11c: Estimated White Spruce Cover Type (*Even-aged* Managed Portion) Age-Class Distribution in 2054



Based on the modeling of the treatment and conversion levels by decade, Figure 4.11d shows the projected age-class distribution in 2054 of the uneven-aged managed portion of the white spruce cover type. The age-class structure illustrated in the chart for these uneven-aged managed stands is based on the oldest age class (i.e., oldest cohorts).

Figure 4.11d: Estimated White Spruce Cover Type (*Uneven-Aged* Managed Portion) Age-Class Distribution in 2054



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

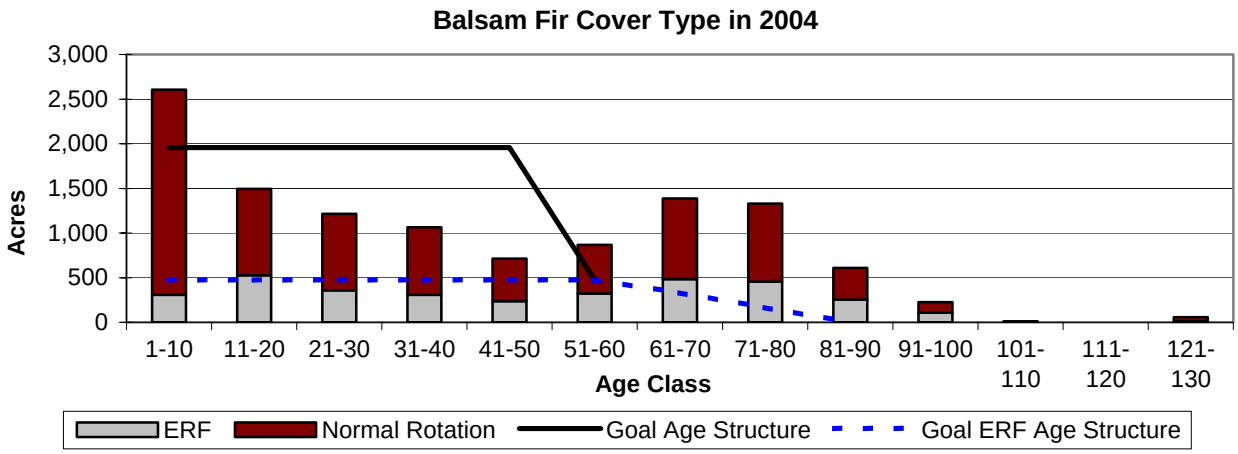
1. Cover Type Acres: In 2004, the balsam fir (BF) cover type comprises 6 percent (11,937 acres) of state timberlands managed in the NTL.

Table 4.12a: Balsam Fir Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	7,923	2,859	1,155	11,937
Percent	66%	24%	10%	

2. Age-Class Distribution: The current balsam fir age-class distribution does not reflect the desired balanced age-class structure described for even-aged managed cover types.

Figure 4.12a: Current and Desired Age-Class Distribution of the Balsam Fir Cover Type



Note: The 1-10 age class is inflated because it includes 2,356 acres that are currently timber sale permits or are acres on the FY2004 annual harvest plan that haven't been harvested yet. This acreage will be treated within the next 1 – 5 years.

There is a less acreage (only 267 acres recorded as 1-10 in the forest inventory) in the 1-10 age class in the forest inventory because: 1) Balsam fir typically shows up as a component in other cover types (e.g., aspen) after a balsam fir stand is harvested and becomes a balsam fir cover type again sometime after the 1 – 10 age class. 2) Some stands are converted to pine or white spruce after harvest.

Within the three subsections, approximately 47 percent of the normal rotation age balsam fir acres are currently over the recommended normal rotation age of 50.

4.12B Future Direction

1. Cover Type Acres: The composition goal, over the next 60 years is to reduce the acreage in the balsam fir cover type by an average of 10 percent (1,194 acres) across the NTL subsections. This reduction is planned to occur during the next decade.

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

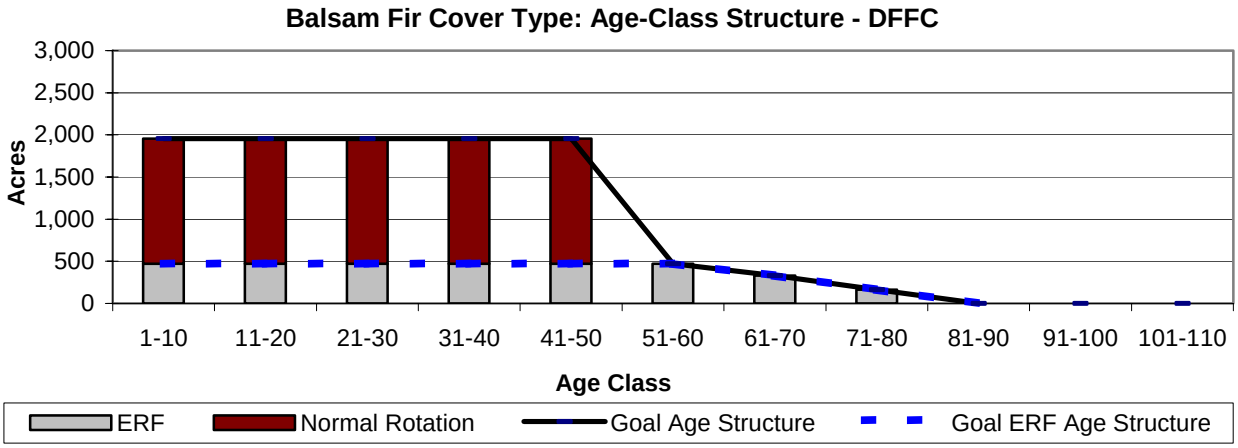
	2004	**2014**	**2064**
North Shore Highlands	7,923	7,126	7,126
Toimi Uplands	1,155	1,040	1,040
Laurentian Uplands	2,859	2,577	2,577
Total acres	**11,937**	**10,743**	**10,743**

Some balsam fir stands will be converted to white pine, white spruce, red pine, upland black spruce, and to a lesser degree, tamarack. After harvest, some stands will naturally regenerate to aspen or birch cover types.

2. Age-Class Distribution: A goal is to move the current age-class structure toward a more balanced age-class structure. (Note: The 0 – 10 age class is expected to be less than

the desired balanced structure because of the time it takes for a harvested stand to develop into a balsam fir cover type.)

Figure 4.12b: Desired Age-Class Structure for the Balsam Fir Cover Type



The ERF goal for this cover type is to have 9 percent of the acres over normal rotation age (effective ERF) with a declining age-class distribution from normal rotation (50 years) out to the maximum age (75 years).

3. Stand Composition: The desired future within stand composition will be mixed forests that include long-lived conifers appropriate to the site, such as white pine, white spruce, red pine, upland white cedar, and upland hardwoods such as aspen, maple, and ash (see GDS-1B and 3).

The balsam fir cover type will be managed to reduce the intensity and extent of spruce budworm outbreaks. Management will be directed toward:

a. Increasing non-host species in balsam fir stands.
b. Smaller patch sizes where balsam fir is a significant component.
c. Even-aged balsam fir stands and against multi-aged balsam fir to reduce damage to young balsam fir in the stand.

4.12C Stand Management

1. Even-aged Management Direction: The balsam fir cover type will be managed on an even-aged basis for pulpwood and small saw logs. This will be done while moving toward a balanced age-class structure and maintaining or improving site productivity, forest wildlife habitat, and biodiversity.

2. Final Harvest Methods: Harvest stands by clearcutting. Protect advanced balsam fir regeneration along with non-host species where the goal is to maintain the stand as a balsam fir cover type. Leaving scattered mature balsam fir may attract spruce budworm to a stand resulting in an increased risk of damage to the younger regenerating balsam fir.

Plan the selection of cutting areas and design of timber sales to break up large areas of even-aged balsam fir.

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

a. Clearcut followed by natural seeding.
b. Clearcut with reserves followed by natural seeding

4. 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. Objectives in regenerating balsam fir stands are to increase long-lived conifers, increase long-lived hardwoods, or increase both long-lived conifers and hardwoods in the stands.

5. Intermediate Harvest Methods: Thinning will be used to reduce stand density to increase future tree growth, quality, and vigor. Thinning will increase production of small saw logs and reduce the risk of spruce budworm (SBW) outbreaks and damage by increasing non-host tree species in the stand. Pre-commercial thinning may be used on some densely stocked young stands. Following are recommendations for thinning balsam fir stands:

a. Thinnings are recommended 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).
b. Do not remove more than one-third of the stand BA during a thinning. (See stocking chart in Manager's Handbook for Balsam Fir in the North Central States.)
c. Normal rotation stands that meet the thinning criteria will be thinned once, while ERF rotation stands may receive multiple thinnings because of the longer rotation age. However, since no previous balsam fir thinnings have occurred, ERF stands currently over 35 years old may receive only one thinning.
d. Protect advanced regeneration of desirable understory species, where possible.
e. Higher stand densities (BA) are recommended along stand edges exposed to wind and along high visual quality corridors, such as major roads and lakes.
f. If the stand is utilized as a thermal cover area by deer or moose, consider applying one of the following options:
    i. Maintain a higher stand basal area (e.g., wider reserve strips with canopy closure)
    ii. Thin only a portion of the stand
    iii. Don't thin.

6. Thinning Prescriptions: The following harvest prescriptions will be used for thinning:

a. Strip Thinning
b. Selective Thinning

4.12D Conversion Management

1. Conversion Goals: Over the next 10 years, 10 percent (1,194 acres) of the balsam fir cover type will be converted to other cover types. Depending on site conditions, balsam fir stands identified for conversion will be converted (naturally or artificially) to long-lived conifer species such as white pine, white spruce, red pine, upland white cedar, as well as shorter-lived conifers such as upland black spruce or jack pine, or hardwoods such as aspen, birch, oak, ash, or northern hardwoods. Some converted stands will be managed for a mixed conifer-hardwood composition. It is expected that a majority of balsam fir conversion will be accomplished through the conversion of balsam fir stands that meet the HRLV criteria (See Stand Selection Criteria). Conversion of balsam fir to desired cover types will be accomplished using a range of management options, including:

a. Allow 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. Plant long-lived conifers or hardwoods on suitable sites. If planting white spruce, avoid retaining overstory balsam fir.
c. Treatments such as mechanical site preparation, prescribed burning, or herbicide application, followed by hand planting or artificial seeding, may be required to establish desired species on the site.

4.12E Stand Selection Criteria

1. Normal Rotation Forest: A normal rotation age of 50 years old will be used for calculating a regulated harvest level.

Table 4.12c: Balsam Fir Normal Rotation Age and Maximum Age

Site Index	Acres	Normal Rotation Age	Maximum Age
All	8,198	50	75

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 stands for treatment. All stands that are tagged as HRLV (see criteria below) will be site visited during this 10-year plan period. These stands will be removed from the pool of stands used to calculate the normal rotation harvest level.

Harvest Level Calculations:
Normal Management Pool = (Total Non-ERF) - (Non-ERF HRLV)
Normal Harvest Level = (Normal Management Pool / Rotation age)
Selection Pool = Normal Management Pool that is over 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.
2. Extended Rotation Forest: The harvest level will be based on an ERF rotation ages of 60, 70, and 75.

Table 4.12d: Balsam Fir ERF Rotation Age and Maximum Age

Site Index	Acres	ERF Rotation Ages	Maximum Age
All	3,384	60, 70, and 75	75

The selection of older aged stands will be emphasized to help move this subset of ERF stands toward the desirable declining age-class structure. The long-term goals are to retain 9 percent of the cover type acreage over the normal rotation age and to provide a declining age-class structure out to the maximum harvest age of 75. See Figure 4.12b.

All stands that are tagged as HRLV (see criteria below) will be site visited and evaluated for treatment during the next 10 years. These stands will be removed from the pool of stands used to calculate the ERF harvest level.

Harvest Level Calculations:
ERF Management Pool = (Total ERF) – (ERF HRLV)
ERF harvest level is determined by the desired acres in the declining age-class structure and achieving and sustaining a 9 percent effective ERF.
ERF Selection Pool = Management Pool that is over normal rotation age. Acres will be targeted by age class.

3. High-Risk, Low-Volume: All stands that meet high-risk, low-volume criteria will be field visited over the next 10 years to determine the appropriate treatment. The Field Visit Decision Tree (Appendix E) will be used in determining the stand treatment. The HRLV stands could be part of either the normal rotation or extended rotation forests listed above. HRLV stands are defined by the following criteria:

a. Stands over age 75.
b. Stands over age 50 and total stand volume less than 7.6 cords per acre.
c. Stands over age 50 with greater than 50 percent of trees of the main species affected by insect or disease damage.

Table 4.12e: Balsam Fir High-Risk, Low-Volume Acreage by Subsection

HRLV	North Shore Highlands	Toimi Uplands	Laurentian Uplands	Total
Normal	1,493	192	370	2,055
ERF	490	83	220	793

If a HRLV stand that is designated as ERF is converted to another cover type, it maintains its ERF designation.

4. Thinned Stands: Normal rotation stands that meet the thinning criteria will only be thinned once, while ERF rotation stands may be thinned a second time because of the

longer rotation age. The following criteria will be used to determine a pool of stands to be field visited for evaluation for thinning:

a. All stands between the ages of 25 and 35 years old with a site index greater than 49 and a BA greater than 120.
b. ERF stands between the ages of 35 and 45 years old with a site index greater than 49 and a BA greater than 120.

Based on field evaluations (e.g., re-inventory) of balsam fir stands during this planning period, a stand may be thinned if it meets the criteria. Not all stands that meet the criteria are expected to be treated due to merchantability or marketability because the harvestable volume is too low, stand size is too small, or access is poor.

4.12F Stand Treatment Summary

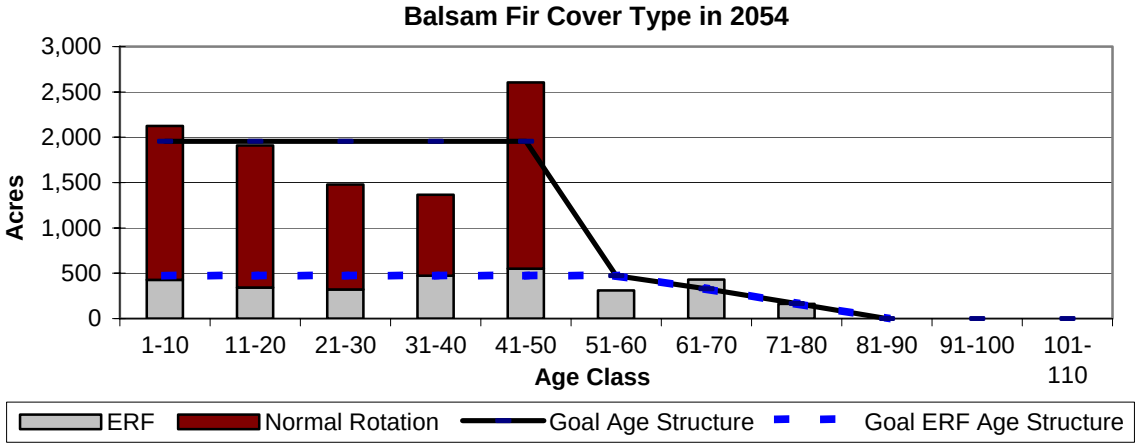
Table 4.12f shows the modeled treatment levels (acres), recommended conversion acreage out of the balsam fir cover type, old forest percent, effective ERF percent, and the average treatment ages for the next six decades. There is variation from decade to decade because of the current age-class distribution of the cover type. Treatment in Decade 1 includes mostly HRLV acres (2,848 acres). The table does not include acreage treated through intermediate treatments or thinning.

Table 4.12f: Balsam Fir Treatment Summary by Decade

	Acres				Average Treatment Age	
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Effective ERF**	**Normal**	**ERF**
1	3,800	-1,194	38.7%	14.2%	70	80
2	1,367	0	13.5%	9.2%	55	83
3	1,479	0	10.6%	7.7%	53	81
4	1,908	0	8.0%	8.0%	46	74
5	2,126	0	9.8%	9.8%	50	72
6	1,811	0	8.7%	8.7%	50	75
DFFC	**1,955**	**-1,194**		**9.0%**	**50**	**69**

Based on the modeling of the treatment and conversion levels by decade, Figure 4.12c shows the projected age-class distribution in 2054 of the even-aged portion of the balsam fir cover type.

Figure 4.12c: Estimated Balsam Fir Cover Type Age-Class Distribution in 2054



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

4.13 Black Spruce Lowland (BSL)

4.13A Current Condition

1. Cover Type Acres: In 2004, the lowland black spruce cover type comprises 14 percent of the state timberlands managed in the North Shore Highlands, Toimi Uplands, and Laurentian Uplands Subsections.

Table 4.13a: Lowland Black Spruce Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	10,860	15,679	2,451	28,990
Percent	37%	54%	9%	

2. Age-Class Distribution: The lowland black spruce has been divided into three site index groups (SI 40+, 29-39, and 23-28) for determining harvest rotation ages and allowable treatment acres. Low site index BSL can be grown to a much longer rotation age than the high site index portion. In each of the subsections, the current age-class distribution of the BSL cover type does not reflect the desired balanced age-class structure described for even-aged managed cover types. The current age-class distribution is skewed toward older age classes, especially in the high and medium site index groups. This age-class imbalance is consistent across all three subsections.

Figure 4.13a: Current and Desired Age-Class Distribution of the *High* Site Index Portion of the BSL Cover Type

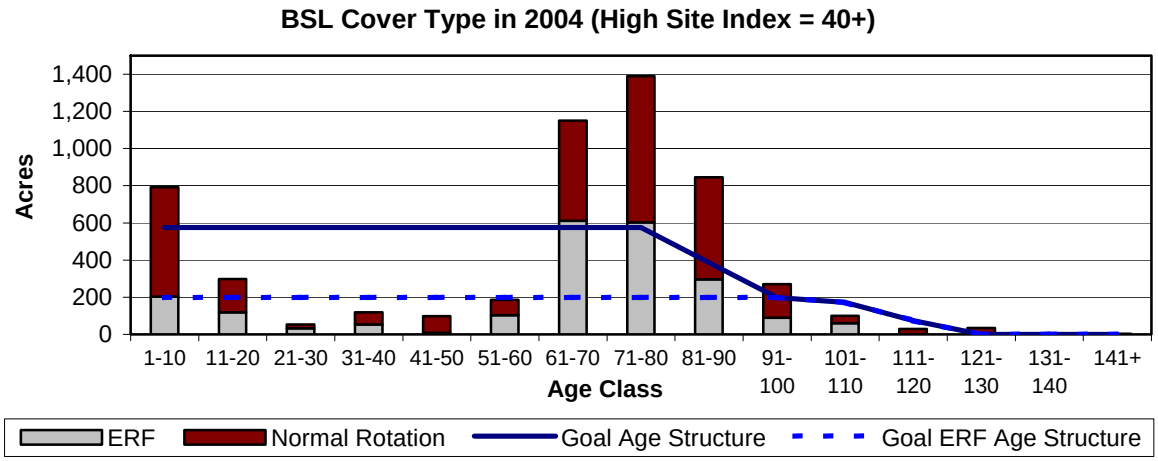


Figure 4.13b: Current and Desired Age-Class Distribution of the *Medium* Site Index Portion of the BSL Cover Type

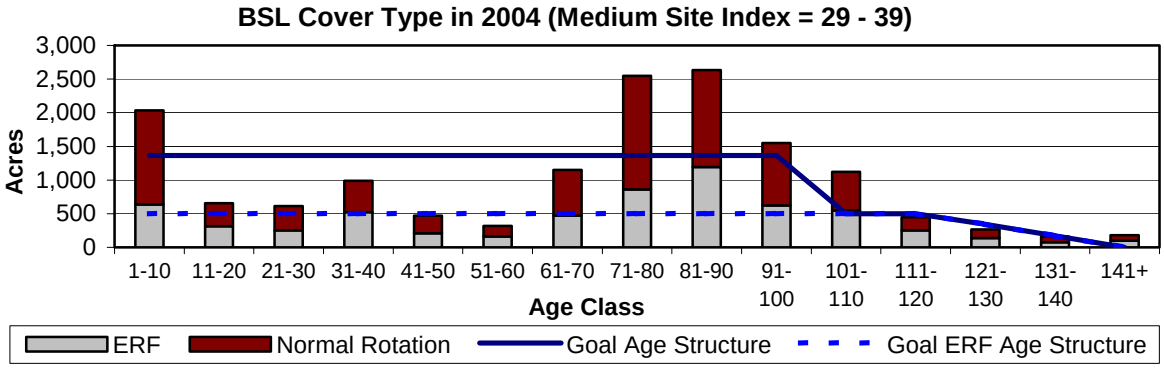
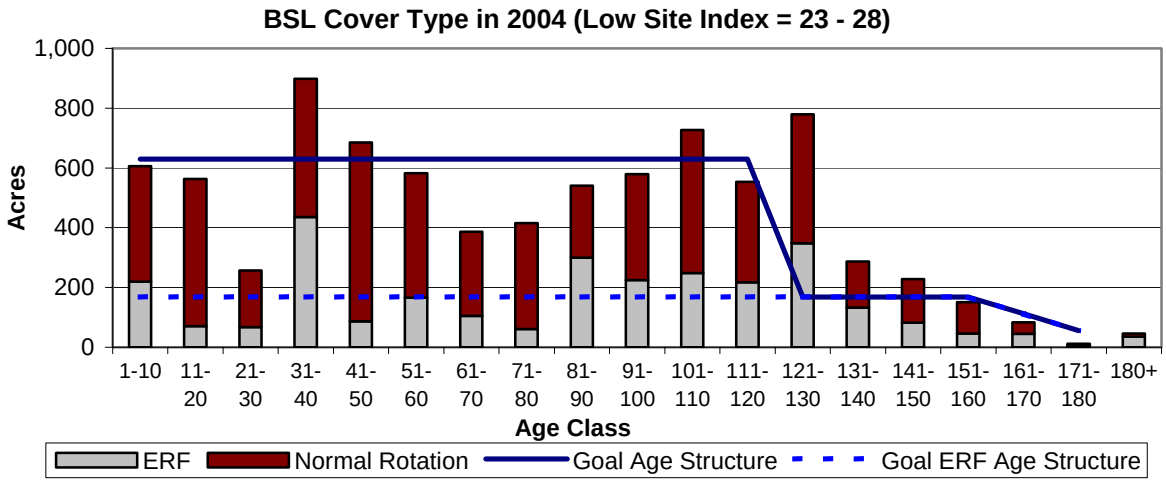


Figure 4.13c: Current and Desired Age-Class Distribution of the *Low* Site Index Portion of the BSL Cover Type



Within the three subsections, approximately 15 percent (2615 acres) of the normal rotation BSL acres are currently over the recommended normal rotation age.

4.13B Future Direction

1. Cover Type Acres: The 60-year goal is that the BSL cover type acreage will remain about same as it is now. No deliberate losses or gains of the BSL cover type are recommended, although minor changes may occur due to inventory updates.

2. Age-Class Distribution: A goal is to move the age classes toward a more balanced structure. Figures 4.13d – f show the desired age-class distribution by site index group.

Figure 4.13d: Desired Age-Class Structure for the *High* Site Index Portion of the BSL Cover Type

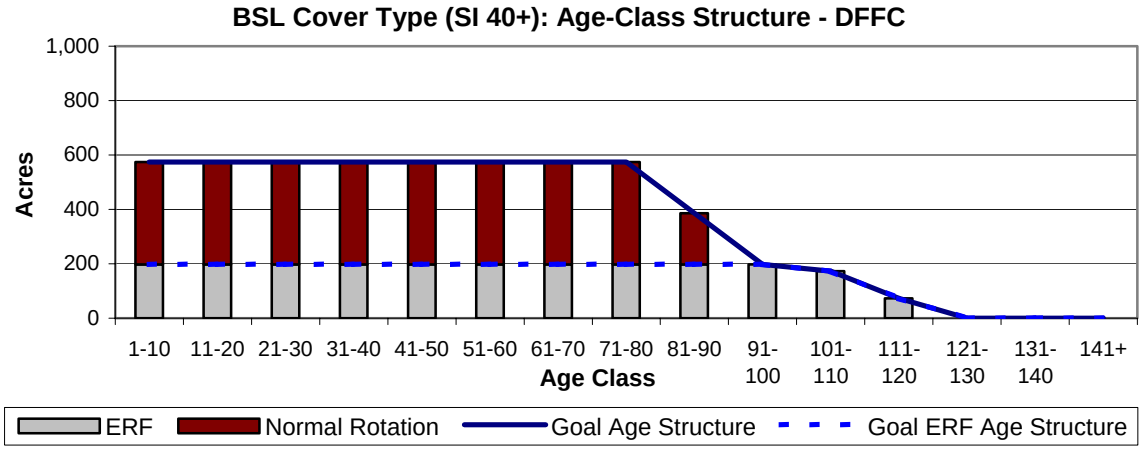


Figure 4.13e: Desired Age-Class Structure for the *Medium* Site Index Portion of the BSL Cover Type

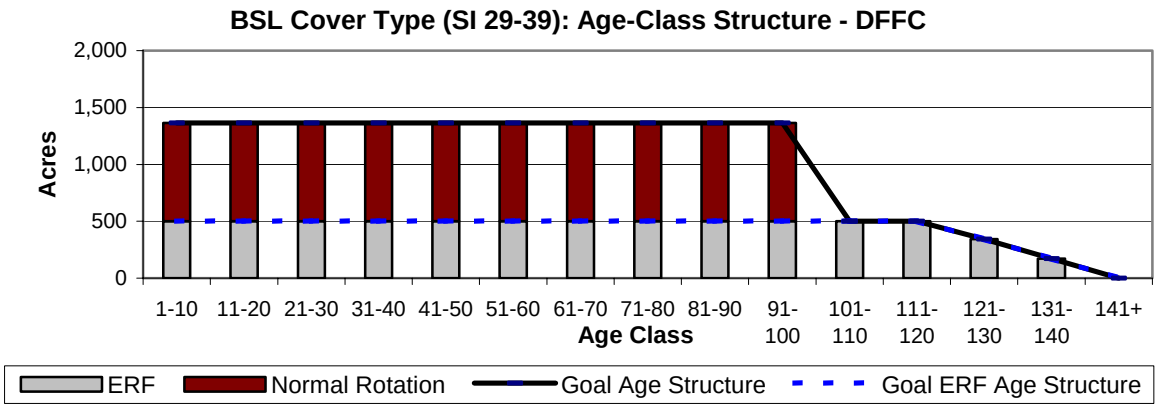
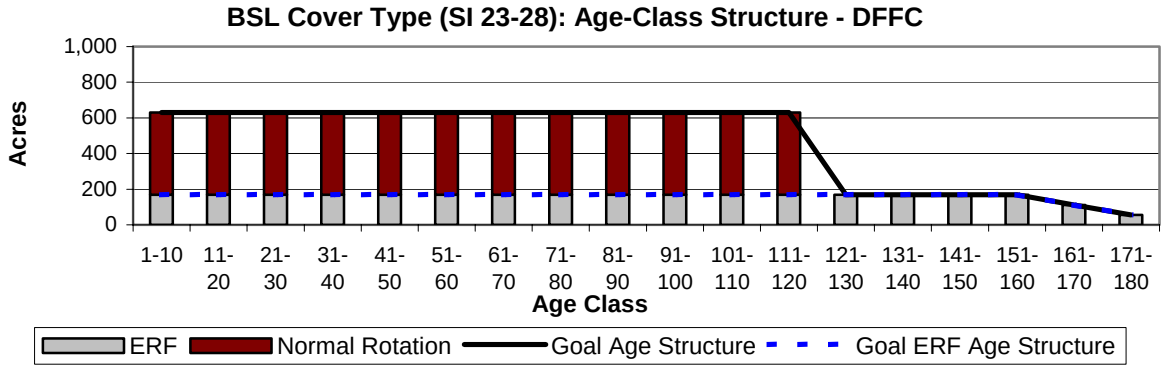


Figure 4.13f: Desired Age-Class Structure for the *Low* Site Index Portion of the BSL Cover Type



The older age classes will be managed with enough older stands deferred (ERF) to provide an adequate tapering age-class distribution out to the maximum age. The ERF goal for this cover type is to have 10 percent of the acres over normal rotation age (effective ERF) 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.

4.13C Stand Management

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

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

Maintain secondary component species in BSL stands such as tamarack, white cedar, balsam fir, and paper birch. This can be accomplished through reserving seed trees, islands or clumps of mature trees, or advanced regeneration, or harvesting to promote sprouting of deciduous species.

The spread of eastern dwarf mistletoe to regenerating stands of black spruce is a primary concern in the management of this cover type. The following recommendations for harvest and post sale treatment are recommended to limit its spread:[1]

a. Black spruce reserve trees are not recommended due to the possibility of spreading dwarf mistletoe infection to the regenerating stand.
b. All clearcuts should kill all live black spruce greater than 5' in height.
c. If the site is to be prescribed burned, slash should be distributed evenly across the site.
d. Design timber sales boundaries to include mistletoe pockets plus a two-chain (132 feet) buffer of non-infected black spruce.

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

a. Clearcut followed by natural seeding.
b. Clearcut with reserves followed by natural seeding.
c. Clearcut followed by artificial seeding.
d. Clearcut 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 them than open stands.

4.13D Stand Selection Criteria

Note: Lowland conifer stands that have been designated as ecologically important lowland conifers (EILC) will be reserved from harvest during this 10-year plan period, but they will be included in harvest level calculations.

1. Normal Rotation Forest: Three site index groups were used with three corresponding normal rotation ages.

Table 4.13b: Lowland Black Spruce Normal Rotation Age and Maximum Age

Site Index	Acres	Normal Rotation Age	Maximum Age
40+	3,226	85	115

29-39	8,794	100	135
23-28	5,494	120	180
Total	17,514		

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 stands for treatment. Not all stands above the normal harvest age will be treated because of the current acreage of stands over normal rotation age.

All stands that are tagged as HRLV (see criteria below) will be field visited during this 10-year plan period. These stands will be removed from the pool of stands used to calculate the normal rotation harvest level.

Harvest Level Calculations (calculated for each of the 3 site index groups)**:**

Normal Management Pool = (Total Non-ERF BSL) - (Non-ERF HRLV)
Normal Harvest Level = (Normal Management Pool / Rotation age)
Selection Pool = Normal Management Pool that is over normal rotation age – Ecologically Important Lowland Conifer (EILC) stands.

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. For a more detailed description of harvest level calculations, see GDS-9A.

2. Extended Rotation Forest: Three site index classes were used with various harvest ages beyond the normal rotation age out to the maximum harvest age.

Table 4.13c: Lowland Black Spruce ERF Rotation Ages and Maximum Age

Site Index	Acres	ERF Rotation Ages	Maximum Age
40+	2,200	105 and 115	115
29-39	6,374	120 and 135	135
23-28	2,902	160, 170, and 180	180
Total	11,476		

The selection of older aged stands will be emphasize to help move this subset of ERF stands toward a desirable declining age-class structure. The long-term goals are to retain 10 percent of the cover type acreage over the normal rotation age and to provide a declining age-class structure out to the maximum harvest age. See Figures 4.13d - f.

All stands that are tagged as HRLV (see criteria below) will be field visited and evaluated for treatment during the next 10 years. These stands will be removed from the pool of stands used to calculate the ERF harvest level.

Harvest Level Calculations (calculated for each of the 3 site index classes):
ERF Management Pool = (Total ERF BSL) – (ERF HRLV)
ERF harvest level is determined by the desired acres in the declining age-class structure and achieving and sustaining a10 percent effective ERF. Acres will be targeted by age class.
ERF Selection Pool = Management Pool that is over normal rotation age – EILC stands.

3. High-Risk, Low-Volume Stands: All stands that meet the following HRLV criteria will be site visited during the 10-year plan period.

BSL High Site Index (40+):

a. Stands 115 years old or more.
b. Stands 85 years old or more with a volume less than 7.6 cords per acre.
c. Stands 85 years old or more with a damage affected code of greater than 50 percent.

Table 4.13d: BSL (SI = 40+) High-Risk, Low-Volume Acreage by Subsection

HRLV	North Shore Highlands	Toimi Uplands	Laurentian Uplands	Total
Normal	30	11	88	129
ERF	0	0	54	54

BSL Medium Site Index (29-39):

a. Stands 100 years old or more with a volume less than 7.6 cords per acre.
b. Stands 100 years old or more with a damage affected code of greater than 50 percent.

Table 4.13e: BSL (SI 29-39) High-Risk, Low-Volume Acreage by Subsection

HRLV	North Shore Highlands	Toimi Uplands	Laurentian Uplands	Total
Normal	101	13	77	191
ERF	60	3	26	89

BSL Low Site Index (23-28):

a. Stands 130 years old or more with a volume less than 7.6 cords per acre.
b. Stands 130 years old or more with a damage affected code of greater than 50 percent.

Table 4.13f: BSL (SI 23-28) High-Risk, Low-Volume Acreage by Subsection

HRLV	North Shore Highlands	Toimi Uplands	Laurentian Uplands	Total

Normal	2	18	244	264
ERF	0	30	36	66

These stands may receive harvest, development, or alteration treatments depending on the site conditions. See Field Visit Decision Tree (Appendix E). The stands could be part of either the normal rotation and extended rotation forest.

4.13E Stand Treatment Summary

Tables 4.13g - j show the modeled treatment levels (acres), old forest percent, effective ERF percent, and the average treatment ages for the next six decades by site index group. There is variation from decade to decade because of the current age-class distribution of the cover type.

Table 4.13g: BSL (SI = 40+) Treatment Summary by Decade

	Acres				Average Treatment Age	
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Effective ERF**	**Normal**	**ERF**
1	799	0	16.0%	5.5%	95	85
2	691	0	22.9%	9.8%	97	97
3	702	0	32.7%	15.9%	100	105
4	658	0	32.1%	17.5%	107	108
5	528	0	22.5%	12.0%	110	113
6	537	0	14.7%	7.4%	116	120
DFFC	**575**	**0**		**10.0%**	**85**	**112**

Table 4.13h: BSL (SI = 29-39) Treatment Summary by Decade

	Acres				Average Treatment Age	
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Effective ERF**	**Normal**	**ERF**
1	1,720	0	14.4%	7.3%	114	121
2	1,752	0	13.9%	7.8%	107	109
3	1,536	0	20.4%	11.8%	111	126
4	1,486	0	25.8%	13.0%	116	128
5	1,480	0	23.5%	11.9%	120	129
6	1,294	0	15.9%	9.0%	123	133
DFFC	**1,365**	**0**		**10.0%**	**100**	**129**

Table 4.13i: BSL (SI = 23-28) Treatment Summary by Decade

	Acres				Average Treatment Age	
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Effective ERF**	**Normal**	**ERF**
1	1,130	0	18.9%	8.3%	134	190
2	589	0	12.1%	8.7%	124	181
3	671	0	14.4%	11.1%	126	155
4	523	0	12.6%	11.5%	126	162
5	507	0	12.8%	12.8%	120	169
6	529	0	11.7%	11.7%	120	167
DFFC	**630**	**0**		**10.0%**	**120**	**170**

Table 4.13j: BSL (All SI Combined) Treatment Summary by Decade

Decade	Total Treatment Acres
1	3,649
2	3,032
3	2,909
4	2,667
5	2,515
6	2,360
DFFC	**2,570**

Based on the modeling of the treatment levels by decade, Figures 4.13g - j show the projected age-class distributions in 2054 for the various site index groupings in the BSL cover type.

Figure 4.13g: Estimated BSL (SI = 40+) Cover Type Age-Class Distribution in 2054

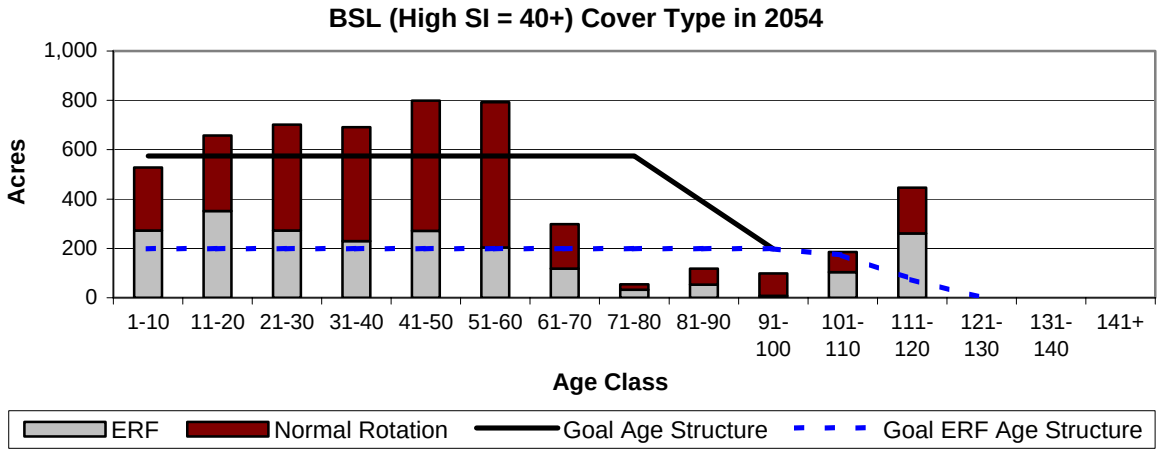


Figure 4.13h: Estimated BSL (SI = 29-39) Cover Type Age-Class Distribution in 2054

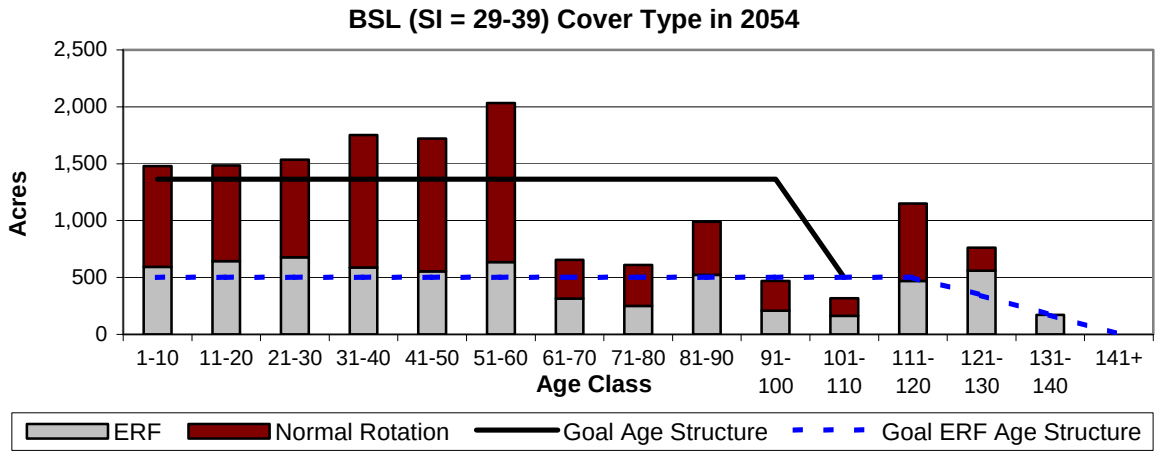


Figure 4.13i: Estimated BSL (SI = 23-28) Cover Type Age-Class Distribution in 2054

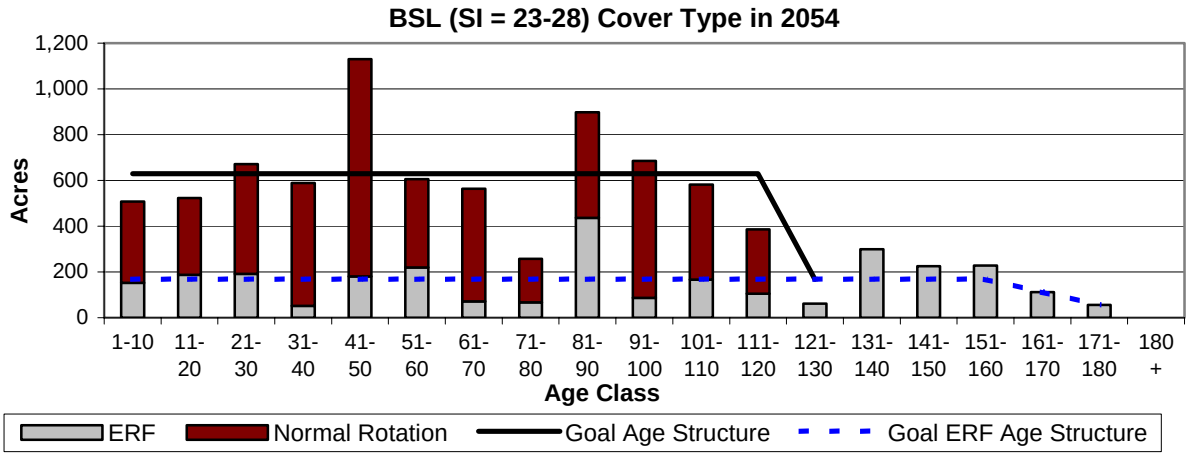
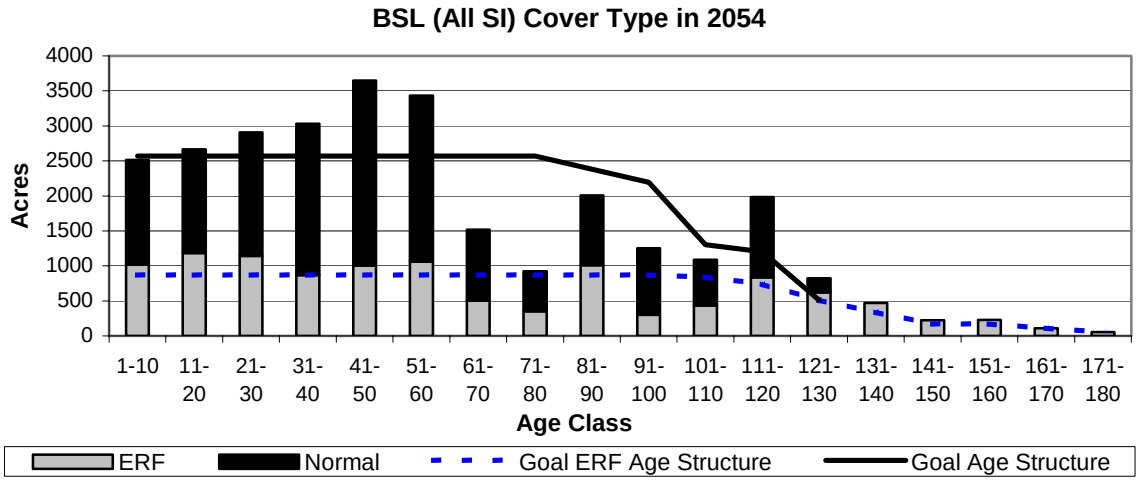


Figure 4.13j: Estimated BSL (All SI Combined) Cover Type Age-Class Distribution in 2054



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

4.14 Tamarack (T) – on lowland sites

4.14A Current Condition

1. Cover Type Acres: In 2004, this cover type comprises 2.5 percent (5,486 acres) of the state timberlands managed in the North Shore Highlands, Toimi Uplands, and Laurentian Uplands subsections.

Table 4.14a: Tamarack Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	3,257	1,695	534	5,486
Percent	59%	31%	10%	

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 all three subsections.

Figure 4.14a: Current and Desired Age-Class Distribution of the *High* Site Index Portion of the Tamarack Cover Type

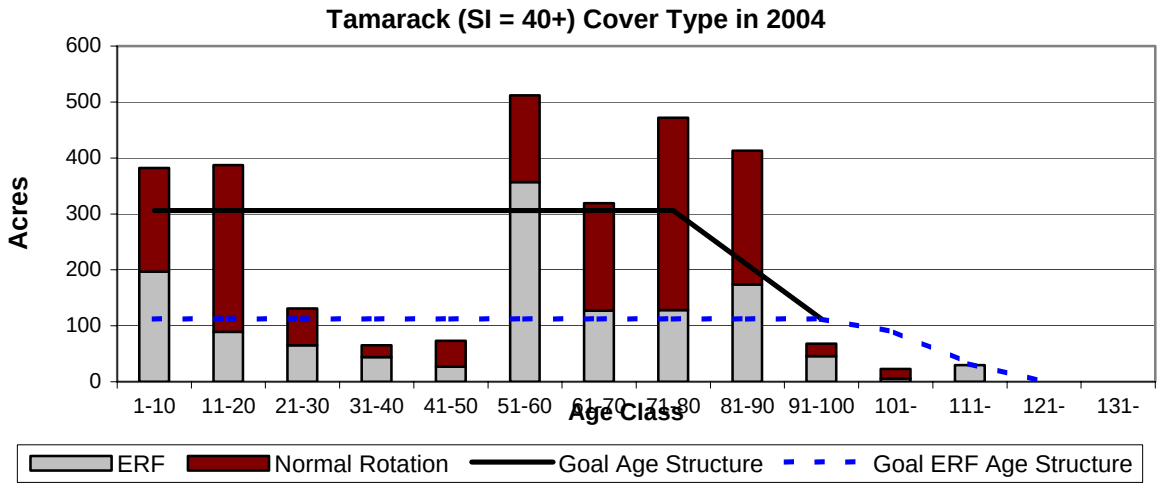
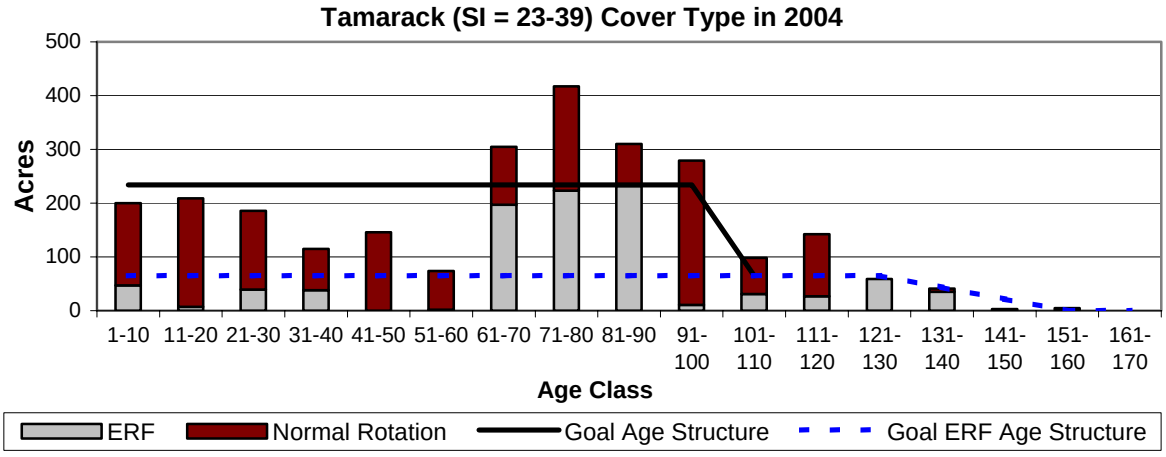


Figure 4.14b: Current and Desired Age-Class Distribution of the *Low* Site Index Portion of the Tamarack Cover Type



4.14B Future Direction

1. Cover Type Acres: The 60-year goal is that the tamarack cover type acreage will remain about the same as it is now. No deliberate losses or gains of the cover type are recommended, although minor changes will occur due to inventory updates. 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 age classes toward a balanced structure out to normal rotation age with a tapering age-class distribution out to the maximum rotation age. The older age classes will be managed with enough older stands (ERF) deferred from treatment to provide an adequate tapering age-class distribution out to the maximum age. The ERF goal for this cover type is to have 10 percent of the acres over normal rotation age (effective ERF) at any one time.

Figure 4.14c: Desired Age-Class Structure for the *High* Site Index Portion of the Tamarack Cover Type

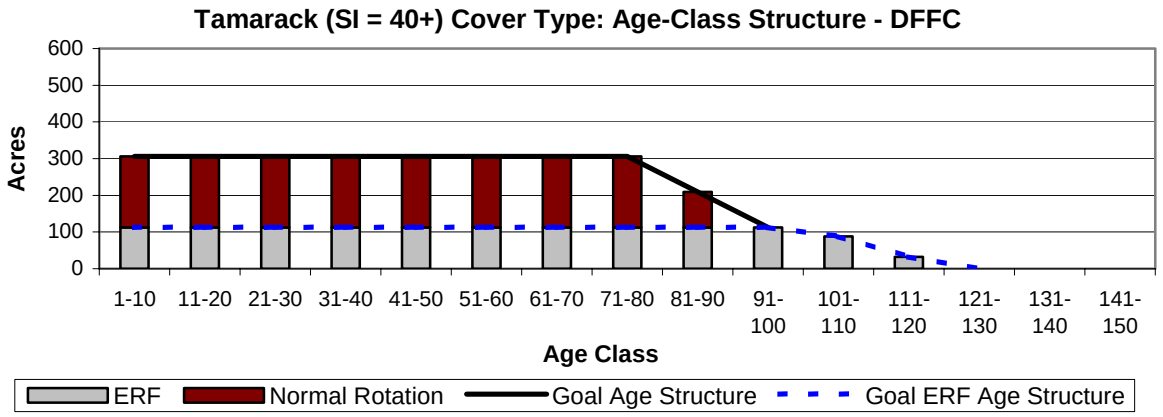
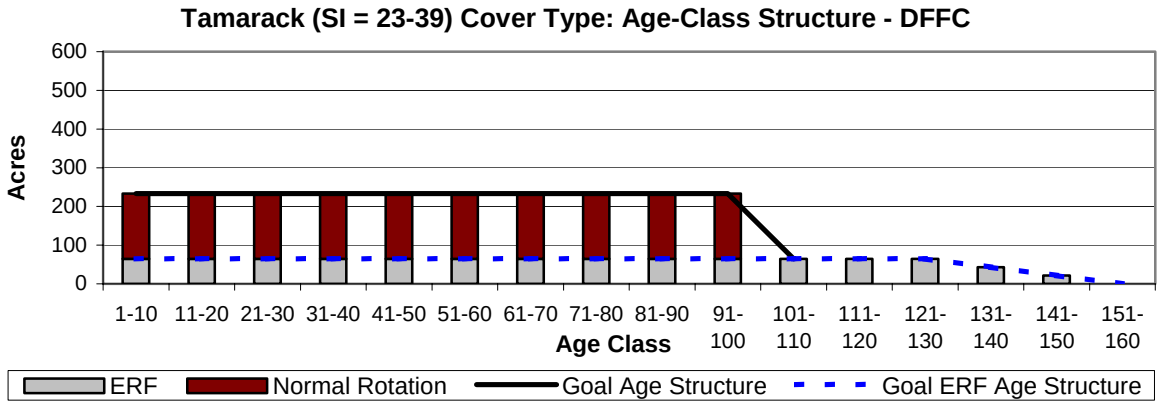


Figure 4.14d: Desired Age-Class Structure for the *Low* Site Index Portion of the Tamarack Cover Type



3. Stand Composition: The desired composition will range from pure tamarack to mixed stands depending on the plant community appropriate to the site.

4.14C 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 that are wind firm and vigorous with an open grown form (full crown) are recommended for successful seeding.

Where possible, maintain secondary component species of tamarack stands such as white cedar, paper birch, 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. Artificial seeding may be an option for maintaining secondary species, especially for black spruce, which is not recommended as a mature reserve tree due to the possibility of spreading dwarf mistletoe to black spruce regeneration.

4.14D Stand Selection Criteria

1. Normal Rotation Forest: Two site index classes are being used with two corresponding normal rotation ages.

Table 4.14b: Tamarack Normal Rotation Age and Maximum Age

Site Index	Acres	Normal Rotation Age	Maximum Age
40+	1,585	85	115
23-39	1,636	100	150
Total	3,221		

The objective is to move the age classes toward a more balanced structure. The priority during this 10-year planning period is to select the oldest stands for treatment. Not all stands above the normal harvest age will be treated because of the current acreage of stands over normal rotation age.

All stands that are tagged as HRLV (see criteria below) will be site-visited during this 10-year plan period. These stands will be removed from the pool of stands used to calculate the normal rotation harvest level.

Harvest Level Calculations (calculated for each of the two site index classes):
Normal Management Pool = (Total Non-ERF Tamarack) - (Non-ERF HRLV)
Normal Harvest Level = (Normal Management Pool / Rotation age)
Selection Pool = Normal Management Pool that is over normal rotation age – EILC stands.
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.

2. Extended Rotation Forest: Two site index classes are being used with various harvest ages beyond the normal rotation age out to the maximum harvest age.

Table 4.14c: Tamarack ERF Rotation Ages and Maximum Age

Site Index	Acres	ERF Rotation Ages	Maximum Age
40+	1,290	105 and 115	115
23-39	953	130 and 140	150
Total	2,243		

The selection of older aged stands for treatment will be emphasizes to help move this subset of ERF stands toward the desirable declining age-class structure. Long-term goals are to retain 10 percent of the cover type acreage over the normal rotation age and to provide an adequate "tail" out to the maximum harvest age. See Figures 4.14c and d. All stands that are tagged as HRLV (see criteria below) will be site-visited and evaluated for treatment during the next 10 years. These stands will be removed from the pool of stands used to calculate the ERF harvest level.

Harvest Level Calculations (calculated for each of the two site index classes):
ERF Management Pool = (Total ERF Tamarack) – (ERF HRLV)
ERF harvest level is determined by the desired acres in the declining age-class structure and achieving and sustaining a10 percent effective ERF. Treatment acres will be targeted by age class.
ERF Selection Pool = Management Pool that is over normal rotation age – EILC stands.

3. High-Risk, Low-Volume Stands: All stands that meet the following HRLV criteria will be site visited during the next 10 years.

Tamarack High Site Index (40+):

a. Stands 115 years old or more.
b. Stands 85 years old or more with a volume less than 7.6 cords per acre.

Table 4.14d: Tamarack (SI = 40+) High-Risk, Low-Volume Acreage by Subsection

HRLV	North Shore Highlands	Toimi Uplands	Laurentian Uplands	Total
Normal	6	5	44	55
ERF	0	0	0	0

Tamarack Site Index (23-39):

a. Stands 150 years old or more.
b. Stands 100 years old or more with a volume less than 7.6 cords per acre.

Table 4.14e: Tamarack (SI 23-39) High-Risk, Low-Volume Acreage by Subsection

HRLV	North Shore Highlands	Toimi Uplands	Laurentian Uplands	Total
Normal	27	8	0	35
ERF	0	43	0	43

The HRLV stands may receive harvest, forest development, or alteration treatments depending on the site conditions. See Field Visit Decision Tree (Appendix E). These stands could be part of both the normal rotation and extended rotation forest.

4.14E Stand Treatment Summary

Tables 4.14f - h show the modeled treatment levels (acres), old forest percent, effective ERF percent, and the average treatment ages for the next six decades by site index group. There is variation from decade to decade because of the current age-class distribution of the cover type and the treatment of the HRLV acres during the first decade.

Table 4.14f: Tamarack (SI = 40+) Treatment Summary by Decade

	Acres				Average Treatment Age	
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Effective ERF**	**Normal**	**ERF**
1	447	0	11.4%	5.9%	86	100
2	310	0	8.2%	5.0%	95	81
3	311	0	16.7%	10.2%	95	111
4	346	0	19.0%	13.1%	95	105
5	246	0	16.0%	13.4%	93	109
6	278	0	10.2%	10.2%	74	113
DFFC	**306**	**0**		**10.0%**	**85**	**111**

Table 4.14g: Tamarack (SI = 23-39) Treatment Summary by Decade

	Acres				Average Treatment Age	
Decade	**Total Treatment**	**Conversion**	**Old Forest**	**Effective ERF**	**Normal**	**ERF**
1	330	0	13.4%	6.1%	114	-
2	260	0	11.5%	2.7%	110	104
3	259	0	14.0%	9.1%	110	113
4	259	0	19.5%	13.7%	110	121
5	259	0	21.3%	17.8%	105	130
6	234	0	14.4%	14.4%	100	134
DFFC	**234**	**0**		**10.0%**	**100**	**140**

Table 4.14h: Tamarack (All SI Combined) Treatment Summary by Decade

Decade	Total Treatment Acres
1	777
2	570
3	570
4	605
5	505
6	512
DFFC	**540**

Based on the modeling of the treatment levels by decade, Figures 4.14e - g show the projected age-class distribution in 2054 of the various site index groupings of the tamarack cover type.

Figure 4.14e: Estimated Tamarack (SI = 40+) Cover Type Age-Class Distribution in 2054

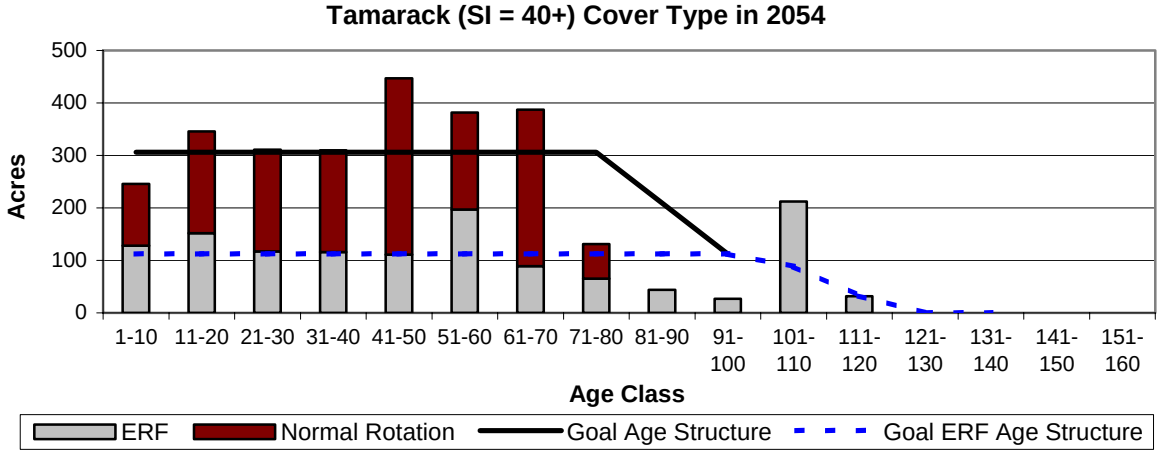


Figure 4.14f: Estimated Tamarack (SI = 23-39) Cover Type Age-Class Distribution in 2054

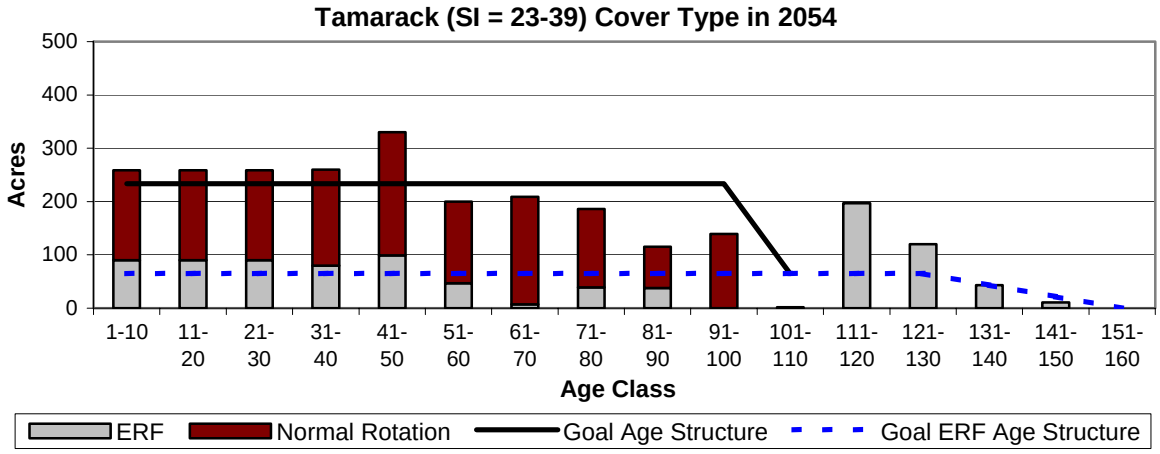
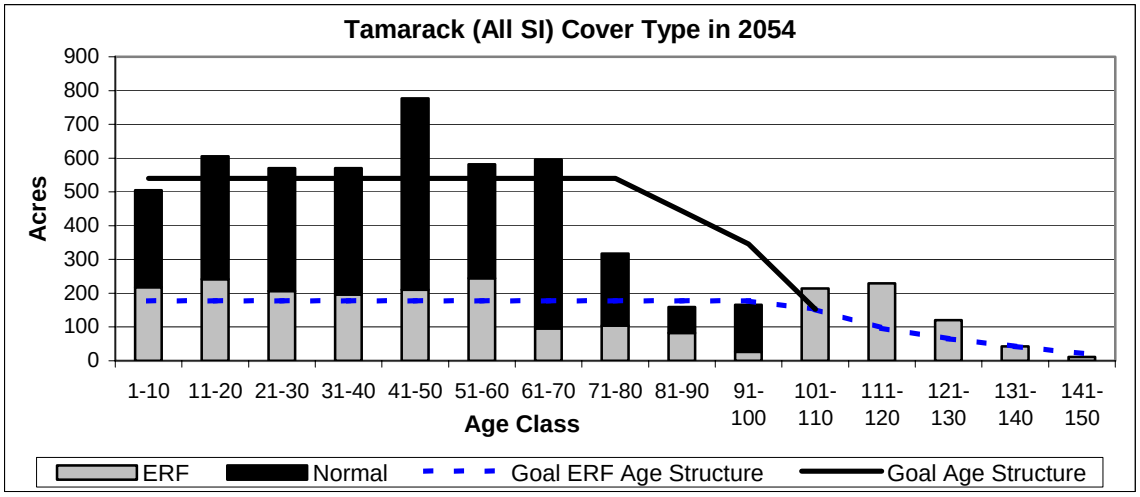


Figure 4.14g: Estimated Tamarack (All SI Combined) Cover Type Age-Class Distribution in 2054



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

4.15 White Cedar (C)

4.15A Current Condition

1. Cover Type Acres: In 2004, the white cedar cover type comprises 7 percent (15,101 acres) of the state timberland acres found in the three subsections.

Table 4.15a: Cedar Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	12,577	1,896	628	15,101
Percent	83%	13%	4%	

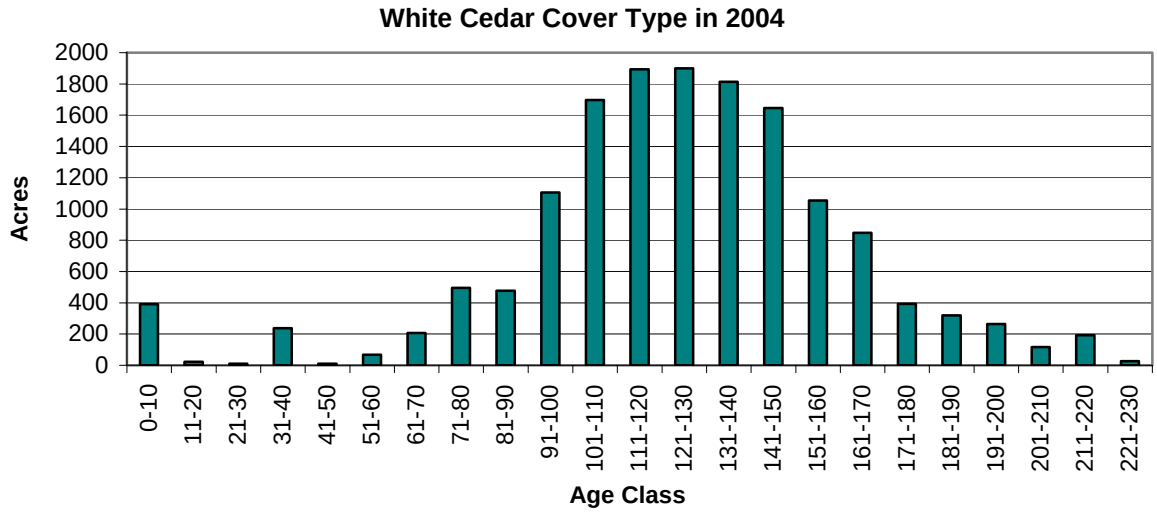
White cedar cover types are typically found on lowland sites, including wet cedar forest and cedar swamp native plant communities, and on upland sites in the mesic hardwood (cedar) forest and mesic mixed forest native plant community (NPC) classes. The DNR's forest inventory system does not separate cedar into upland and lowland cedar cover types. In all three subsections, cedar cover types are found primarily on the lowland sites, but cedar stands on upland sites are more common in the NSH.

Within the mesic hardwood (cedar) forest occurs a unique and uncommon native plant community known as white cedar-yellow birch type. This NPC type is considered an imperiled plant community based on state ranks for NPC types in Minnesota.[11] (Also, see *Voluntary Site-Level Forest Management Guidelines*, Rationale for Guidelines, Wildlife Habitat, pages 26-27.)

2. Age-Class Distribution: In each of the subsections, the current age-class distribution of the white cedar cover type, on both lowland and upland sites, does not reflect a balanced age-class structure. Cedar stands aged 100 years or older comprise 82 percent (12,440 acres) of the cover type acres and there are only 348 acres (2 percent) that are less than 60 years old.

[11] Minn. DNR, Division of Ecological Services, Natural Heritage and Nongame Research Program. State Ranks for Native Plant Communities in Minnesota.

Figure 4.15a: Current Age-Class Distribution of the White Cedar Cover Type



Note: The 1-10 age class consists of 390 acres that are timber sale permits that haven't been harvested or acres on the FY2004 annual harvest plan that haven't been appraised or sold.

4.15B Future Direction

1. Cover Type Acres: In the Toimi and Laurentian Uplands Subsections, the 10-year and 60-year goals for the white cedar cover type will be to maintain the current acreage. In the North Shore Highlands, the cover type will be increased by 900 acres (7 percent) in the next 10 years, and 2031 acres (16 percent) in 60 years.

In addition, cover type goals include:

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

Table 4.15b: Recommended White Cedar Cover Type Acres in the Subsections by Year

	2004	**2014**	**2064**
North Shore Highlands	12,577	13,477	14,608
Toimi Uplands	628	628	628
Laurentian Uplands	1,896	1,896	1,896
Total acres	**15,101**	**16,001**	**17,132**

2. Age-Class Distribution: In all three subsections, improve the current age-class imbalance by increasing the number of acres in the 0-50 year age classes (even-aged) and increase young cedar as a component within cedar stands (uneven-aged). Achieving an even-aged class distribution may not be possible based on the limited harvest and difficulty in regenerating cedar.

4.15C Stand Management

1. Management Direction: The white cedar cover type will be managed for wildlife habitat value, biodiversity, and wood products. Very limited harvest is recommended at this time due to the difficulties in regenerating cedar. Area Forestry and Wildlife division's staff will work together to evaluate various sites and harvest methods for regenerating cedar. Even-aged management is recommended for most white cedar stands. Consider uneven-aged management, such as group selection, on some sites. Forest managers should incorporate new management recommendations and research as they are completed regarding white cedar. Following are recommendations when harvesting stands in the cedar cover type:

a. Pre-harvest assessment of stands selected for harvest and long-term monitoring after harvest is recommended.
    i. Pre-harvest assessment should include information on site characteristics such as ground water conditions (inundated, saturated, pools, or dry), nurse logs, moss type (sphagnum or feather), soils, native plant community type, shrub density, and advanced cedar regeneration (seedlings and layering). Information from existing inventories such as CSA forest inventory and Natural Heritage (e.g., relev9s and rare features data) databases should also be used.
    ii. Long-term monitoring of regeneration and recruitment is recommended after harvest because it may take 20 years or more for cedar regeneration to develop after harvest. Regeneration surveys may be needed at 5, 10, 15, and 20 years after harvest to assess cedar stocking, damage, and site conditions affecting recruitment.
b. Harvest in deer and moose thermal cover areas where regeneration of the cedar cover type is a habitat goal. Protective measures are essential, e.g., exclosures.
c. Harvest from a variety of stand ages to assess regeneration success from various aged stands.
d. Coordinate with other agencies and groups interested in the management of cedar in sharing information and possible funding for cedar management and research.

2. Final Harvest Methods: White cedar stands will be treated primarily through even-aged management using clearcut strips or small patches (width depending on tree height), shelterwood, or seed tree methods.

3. Even-Aged Management Prescriptions: Even-aged management prescriptions include:

a. Clearcut with Reserves - Natural Seeding
b. Clearcut - Artificial Regeneration
c. Clearcut with Reserves - Artificial Regeneration
d. Shelterwood
e. Shelterwood with Reserves
f. Shelterwood - Final Harvest
g. Shelterwood with Reserves - Final Harvest.
h. Seed Tree

4. Regeneration Methods after Final Harvest: White cedar is a difficult species to successfully regenerate after harvest. To determine the effectiveness of the various practices attempted, monitoring and information sharing will be important components of the following regeneration methods:

a. Natural seeding from adjoining stands, shelterwood trees, or seed trees.
b. Plant harvested sites with cedar.
c. Underplant on appropriate sites and conditions (e.g., 50 percent or less shade).
d. Natural or artificial seeding.
e. Site preparation may be needed to create favorable conditions for successful regeneration. Some methods are full-tree skidding, prescribed fire, rock-raking, or disc trenching, depending on site conditions.
    i. Retain natural seedbeds such as nurse logs, tip-ups, and micro-topography (pit and mound) on the site.
f. Protection of seedlings from herbivores may be required such as fencing, application of animal repellents, or other methods.
g. Protect advanced cedar regeneration during final or intermediate harvest.

5. Partial Harvest Methods: Uneven-aged management or intermediate treatments may be appropriate for some stands. Prescriptions include:

a. Group Selection
b. Single Tree Selection
c. Thinning

4.15D Stand Selection Criteria

1. Stand Selection Criteria Pool:
Age range: 60 – 160 years.
Volume per acre = greater than 12.5 cords per acre.
Stands with advanced cedar regeneration present are preferred: Small seedlings (less than 1 inch diameter) greater than 250 stems per acre or regeneration of saplings (1 to 4.9 inch diameter) present.

Cedar stands meeting the above criteria that will be excluded from the 10-year stand selection pool are:

a. Cedar stands that are designated as EILC.
b. Cedar stands in MCBS Sites of Outstanding and High statewide biodiversity significance in the NSH Subsection.

2. Stand Treatment Criteria: Consider the following in selecting stands to treat:

a. Select stands by site index based on the following percentages: Site index 35+ = 6 percent and less than site index 35 = 94 percent.
b. Do not treat stands that key out to the white cedar-yellow birch NPC type because of its rarity in the state.
c. Stands should reflect the range of physiographic classes roughly proportional to the percent in each class as follows: xeromesic (Physiographic Class 2) and mesic (3) sites = 20 percent and hydromesic (4) and hydric (5) sites = 80 percent.

d. Stands from across the range of ages (60 – 160 years) in the harvest pool should be treated.

3. Extended Rotation Forest: The cedar cover type will all be managed as ERF with a harvest age of 160 years used for calculating the stand treatment level.

4. High-Risk, Low-Volume Stands: There are no cedar stands designated as HRLV stands.

5. Harvest Calculation (under a regulated harvest scenario): 14,957 acres divided by 160 years = 93 acres.

Proposed Annual Treatment Level: 30 acres.
Approximately one-third of the calculated harvest level is recommended for treatment each year due to the regeneration concerns listed in the above management recommendations. This harvest level allows for some active management and monitoring of the cedar cover type under various harvest methods to regenerate cedar under a variety of site conditions. The total treatment through harvest that is proposed for the 10-year period is 300 acres.

The cedar cover type annual treatment level will be re-evaluated when the next 10-year plan is developed.

4.16 Stagnant Spruce (Sx)

4.16A Current Condition

1. Cover Type Acres: In 2004, the stagnant spruce cover type comprises 6 percent (16,250 acres) of state-administered forestlands managed in these three subsections.

Table 4.16a: Stagnant Spruce Cover Type Acres by Subsection

	NSH	LU	TU	Total
Acres	5,775	9,569	906	16,250
Percent	35%	59%	6%	

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

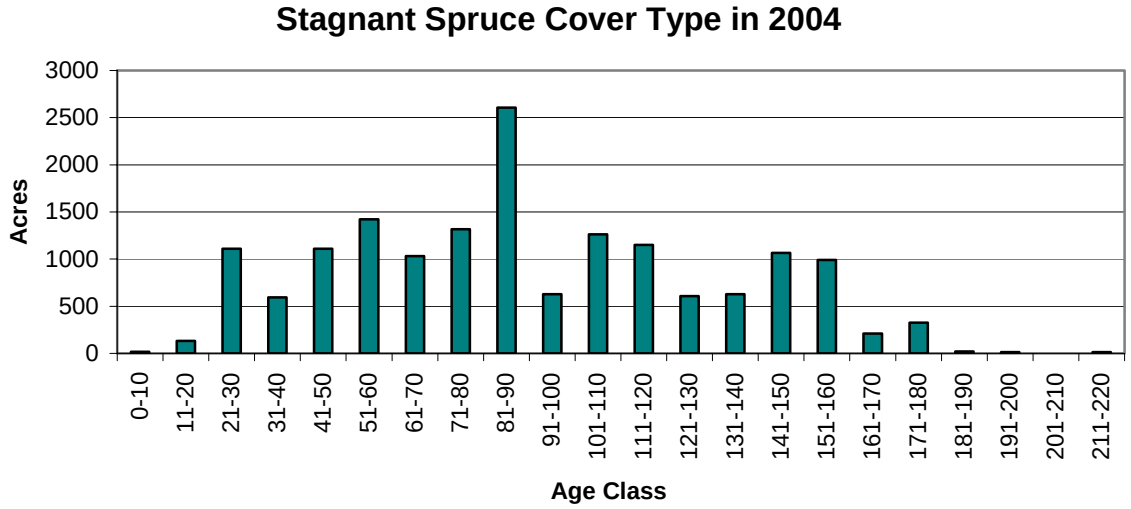
Stagnant spruce (Sx) is lowland black spruce that has a site index of less than 23. This means that when these trees are 50 years old, they are 22 feet or less in height. Because of their small size, the black spruce found in this cover type is not typically harvested for timber purposes. Harvesting in this cover type is primarily selective harvest of spruce tops for decorative purposes.

Currently, this is the predominant cover type where decorative spruce tops are harvested. The tree tops that are cut range from l½ feet to 6 feet in length. These products are harvested by cutting the tops from selected trees. Lateral branches grow a new top on the cut trees. The level of harvest within the stand varies with the quality of the trees in the stand, 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 within some stands has occurred periodically, usually on a 10-15 year cycle.

Since harvest operations take place during the fall prior to freeze-up of the site, caution must be used to prevent site damage. Most producers are using small tracked vehicles or high flotation tires to move the cut products to the landing area or pick-up location.

2. Age-Class Distribution: The following graph shows the current age-class distribution of the stagnant spruce cover type.

Figure 4.16a: Current Age-Class Distribution of the Stagnant Spruce Cover Type



4.16B Future Direction

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

4.16C Stand Management

1. Management Direction: The primary goal is to protect the hydrological and ecological integrity of the site. Following are recommendations that will be used to guide the 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 during within stand removals.
d. Determine re-entry period for repeat harvest in SX stands.
e. Follow statewide guidelines and regulations (currently being reviewed) for decorative tree site selection, harvest operations, and sale supervision.
f. Promote alternative methods of transporting tops off the site that reduces or eliminates impacts to the sites (e.g., helicopter slings).

Harvest operations will be directed to sites with the following features:

a. Stocking of at least 1250 stems/acre, and
b. adequate numbers of trees from 3 to 20 feet tall. Trees taller than 20 feet are generally too tall for harvesting decorative tops.

At least 50 percent of the foliage must be left on the tree. This will allow the tree to survive, and continue to grow and produce new top(s) from lateral branches.

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. Occasionally, stagnant spruce stands are found to be of merchantable size for pulpwood and they may be harvested through clearcut methods. Sometimes stagnant spruce stands that are infected with dwarf mistletoe disease and located adjacent to more productive black spruce are clearcut harvested or sheared off with a dozer and/or prescribed burned for dwarf mistletoe disease control.

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

4.16D Stand Selection Criteria

1. Stand Selection Pool: The following criteria will be used to select a pool of stands for possible tree top harvest:

a. Do not select Sx stands that have been designated as ecologically important lowland conifers (EILC) stands, stands that are in MCBS Sites of Outstanding and High biodiversity significance (NSH) or Sites with a high priority for survey (LU and TU), or in Watershed Protection Areas of Peatland SNAs.
b. Avoid stands with rare features or significant cultural resources.
c. Stands should have at least a density of 1250 trees per acre and a diameter less than 5 inches (DBH).
d. Do not include stands that have been harvested from in the past 15 years.

The above criteria creates a pool of stands which will be followed by photo interpretation or site visit. The pool will be further reduced by the following criteria:

a. Avoid stands where the only access routes are across laggs 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. Stands with poor access for the time of year (late fall) that decorative tree harvest typically occurs.

The DNR is currently evaluating local market demand for decorative trees. Harvest levels will be developed annually.